ICIAM 2019
VALENCIA

9th International Congress on Industrial and Applied Mathematics

July 15-19
Valencia · Spain

PROGRAM & ABSTRACTS BOOK

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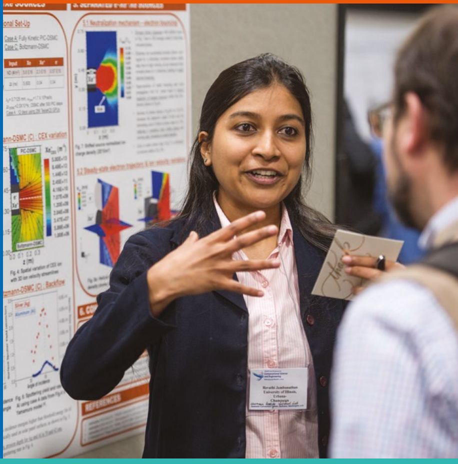

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6/19

9th International Congress on Industrial and Applied Mathematics
ICIAM 2019
VALENCIA

Table of Contents

1. Welcome from the ICIAM President

Welcome to the ICIAM 2019 congress!

The ICIAM congresses are the largest existing events for the international community of applied and industrial mathematicians, and it is a wonderful showcase for the very diverse span of activities of this very active community, and its interactions with the society.

These congresses take place every four years, in different countries, and now, after the two last ones having taken place in Vancouver (2011) and Beijing (2015), the congress arrives to Valencia (Spain).

The 2019 ICIAM prizes will be awarded during the opening ceremony. The winners will receive their certificates and prize awards followed by a brief introduction of their work. Later during the congress, the prize winners will present their own research.

In addition to the prize winners' talks, there will be 27 invited lectures, which have been selected by the Scientific Program Committee. This committee, chaired by professor Alfio Quarteroni, has worked hard to put together a wonderful array of applied mathematicians who work in different areas showcasing the diversity of the topics represented in the ICIAM community. Another great moment this week will be the Olga Taussky-Todd (OTT) lecture, given this year by professor Françoise Tisseur.

The public lecture will be given by professor Victor M. Pérez-García, a Spanish mathematician who works on the applications of mathematics to health, specifically to oncology seeking to find optimal treatments. In addition to these talks, there will be many interesting presentations in the mini-symposia and also in the embedded SEMA (Sociedad española de matemática aplicada) and SIAM congresses.

The congress organizers have worked very hard to assemble the program together, to make the congress facilities as welcoming and nice as possible, and to create very interesting social events in wonderful places, like the Palau de la Música (opening ceremony) or the Opera house (public lecture). It is remarkable that the organizing team includes mathematicians not only from Valencia, but from the whole of Spain. This congress is an effort by the whole community of Spanish applied mathematicians, coordinated by SEMA. ICIAM is indebted to the organizing team and to SEMA for their superb work.

In concluding, let us point out that an Industry Day is going to be part of the congress. Wednesday July 17th will be devoted to conferences and mini-symposia concerned with industrial applications and collaborations.

I am sure that this congress will be a great success and that all the participants will keep a wonderful memory of their stay in Valencia!

Maria J. Esteban
ICIAM President

2. Welcome from the ICIAM 2019 Organizers

Welcome to ICIAM2019-Valencia

On behalf of the Spanish Society for Applied Mathematics (SeMA) and the Organizing Committee of the congress, we are pleased to warmly welcome you to Valencia and ICIAM 2019 Congress. ICIAM Congresses are the main tool of ICIAM to achieve its core objective, namely to 'advance the applications of mathematics in all parts of the world'. We are extremely pleased to be able to contribute to this goal.

As many of you already know, ICIAM conferences are truly special events. At ICIAM 2019 Valencia you may choose among a total of 34 invited talks, including 27 invited speakers, 5 ICIAM prize winners' lectures, the Olga Taussky-Todd lecture, and the Public Lecture. There will also be nearly 300 thematic minisymposia, 25 industrial minisymposia, 800 contributed talks and 250 posters covering virtually all aspects of applications of mathematics to science, engineering and industry. As an additional effort to highlight the innovation potential of using advanced mathematical tools in the industrial sector, we have scheduled an Industry Day on Wednesday, 17th of July, including 14 talks by delegates of technology companies. The purpose is to promote the exchange of experiences and to open new channels of communication between researchers and potential users of high-level mathematical technology. There will be over 20 exhibitors: scientific publishers and high technology companies, that present their latest products, as well as research institutions that feature their achievements and present recruitment opportunities.

This is complemented by a satellite program split over the cities of Bilbao, A Coruña, Málaga, Santiago de Compostela, Sevilla and Zaragoza: each venue will host several satellite activities, which are part of a Satellite Meetings program that includes over 30 events.

The celebration of ICIAM 2019-Valencia has been made possible by the work of a large and enthusiastic team and the support of many organizations and sponsors. We express our sincere gratitude to the Advising Committee for guidance when preparing our candidacy back in 2013, and to Barbara Keyfitz and Maria Esteban for the continuous advice as ICIAM Presidents. Special thanks go to the Scientific Program Committee, chaired by Alfio Quarteroni, for selecting invited speakers, and to the members of the Thematic Committees, for their unabated attention to the many organizational details of such a complex event. The organizers of all ICIAM 2019 satellite and embedded activities also deserve a special mention, as well as the organizers of the many events where the promotional material of ICIAM 2019 was displayed. Last but not least, we would like to thank the enthusiastic crowd of young volunteers working at ICIAM 2019 Valencia. We are sure that this congress will have a decisive impact on their future careers.
Private and public sponsors of the event are gratefully acknowledged: Universitat de València, Gobierno de España, Generalitat Valenciana, Ajuntament de València, Diputació de València, Banco Santander and the many research centers, institutes and mathematics departments in the Spanish educational system who have contributed to support the Financial Aid Program of the congress. The latter was carefully designed to foster the participation of young researchers as well as mathematicians from developing countries.

We expect nearly 4000 participants from all over the world, an unprecedented number which clearly indicates that ICIAM congresses have become more and more attractive with each new edition. We are certainly indebted to the entire mathematical community in Spain, for their commitment toward the success of the congress. Most importantly, we are indebted to all ICIAM 2019 participants, for making this 9th edition of the ICIAM congress a truly exceptional event.

Mathematics is silently shaping the present technological world. It not only provides a deep insight in countless processes and systems, thereby advancing scientific knowledge. It also generates added value in virtually all economic sectors. You are at a perfect time and place to learn about and explore new mathematical tools, exchange ideas and move ahead in the thrilling challenge of shaping the world with mathematics.

Tomás Chacón

ICIAM 2019 Valencia
Congress Chairman

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Gene Golub g2s3 2020 SIAM Summer School

July 20-31, 2020
Cape Town, South Africa

Application Deadline
February 1, 2020

For more information on how to apply, on past summer schools, and on Professor Gene Golub, go to:
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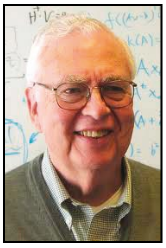
Theory and Practice of Deep Learning



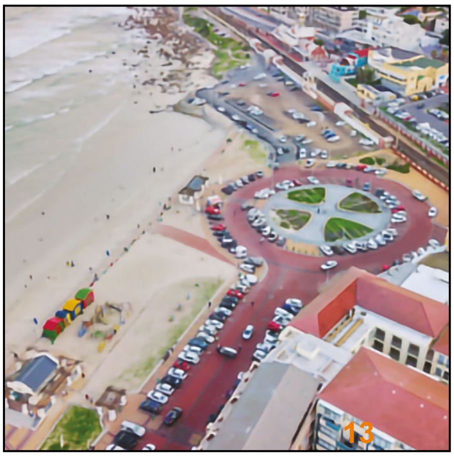
The eleventh Gene Golub SIAM Summer School will take place at the African Institute for Mathematical Sciences (AIMS) in Muizenberg, a small seaside suburb of Cape Town, South Africa.

The focus of the school will be the theory, implementation, and application of deep learning based on neural nets with many layers. Students will learn the mathematical underpinnings of deep learning using a combination of functional analysis and optimization theory. They will be introduced to applications that include computer vision, nonlinear programming, and forecasting, in addition to attending lectures by practitioners of deep learning in industry.

The summer school will include an important computing component, in which students will implement deep learning algorithms primarily using Python with TensorFlow and Keras. High performance computing resources will be provided by the AIMS South Africa supercomputing facility.

The summer school is being organized by Bubacarr Bah (AIMS South Africa and Stellenbosch University), Coralia Cartis (University of Oxford), and Kasso Okoudjou (University of Maryland, College Park).

The intended audience is graduate students, meaning anyone studying beyond a three- or four-year undergraduate degree. Applicants are expected to have done a significant amount of mathematics and some computing in their studies in order to have the required mathematical and computational background for the summer school. Ideal candidates will be working on a research project that requires the use of deep learning methods. Applicants selected to participate will pay no registration fee, will be provided local accommodations, and will have their meal expenses paid.



4. How to Use the Schedule Book

The information of each talk is encoded as a 9/10-character string, AB-CD-e-f-xx-y, meaning that the talk of TYPE "AB" will be given in BUILDING "CD", at FLOOR "e", at ROOM "f", on DATE & TIME "xx", and in the PRESENTATION ORDER "y".

The symbols are explained as follows:
Code: Type / Building / Floor / Room No. / Date & Time / Presentation order

TYPE:

- **SL** = Special Lectures
- **IL** = Invited Lectures
- **MS** = Minisymposia
- **IM** = Industrial Minisymposia
- **CP** = Contributed Papers
- **P** = Posters (**PA**: session on Monday-Tuesday; **PB** session on Wednesday; **PC** session on Thursday-Friday)

BUILDINGS:

- **A1** = Aulari I
- **A3** = Aulari III
- **A6** = Aulari VI
- **MA** = (air-conditioned) Marquee
- **ME** = Facultat de Medicina i Odontologia
- **PS** = Facultat de Psicologia
- **FT** = Facultat de Filologia, Traducció i Comunicació
- **FE**: = Facultat de Filosofia i Ciències de l'Educació
- **GH** = Facultat de Geografia i Història

FLOOR:

- **S** = Basement Level
- **0** = Ground Floor
- **1** = First Floor
- **2** = Second Floor
- **3** = Third Floor
- **4** = Fourth Floor

DATE & TIME:

- **1** = Monday 17:00h-19:00h
- **2** = Tuesday 11:00h-13:00h
- **3** = Tuesday 14:30h-16:30h
- **4** = Tuesday 17:00-19:00h
- **5** = Wednesday 11:00-13:00h
- **6** = Wednesday 14:30h-16:30h
- **7** = Wednesday 17:00h-19:00h
- **8** = Thursday 14:30h-16:30h
- **9** = Friday 11:00h-13:00h
- **10** = Friday 14:30h-16:30h

Examples:

MS-GH-1-1-2-3: Minisymposium, GH-Building, 1st floor, Room 1, Tuesday 11:00h-13:00h, Presentation order No. 3

CP-A3-S-C2-9-1: Contributed Paper, A3-Building, Basement, Room C2, Friday 11:00h-13:00h, Presentation order No. 1

5. ICIAM 2019 Classification Topics

01. Applied Mathematics for Industry and Engineering
02. Astronomy, Astrophysics and Geophysics
03. Biology, Medicine and other Natural Sciences
04. Chemistry, Chemical Engineering
05. Computational Geometry
06. Computer Science
07. Control and Systems Theory
08. Discrete Mathematics
09. Dynamical Systems and Nonlinear Analysis
10. Education
11. Finance and Management Science
12. Fluids Physics and Statistical Mechanics
13. Information, Communication, Signals
14. Linear Algebra and Geometry
15. Materials Science and Solid Mechanics
16. Mathematics and Computer Science
17. Numerical Analysis
18. Optimization and Operations Research
19. Ordinary Differential Equations
20. Partial Differential Equations
21. Probability and Statistics
22. Real and Complex Analysis
23. Simulation and Modelling
24. Social Science
25. Other Mathematical Topics and their applications
26. General

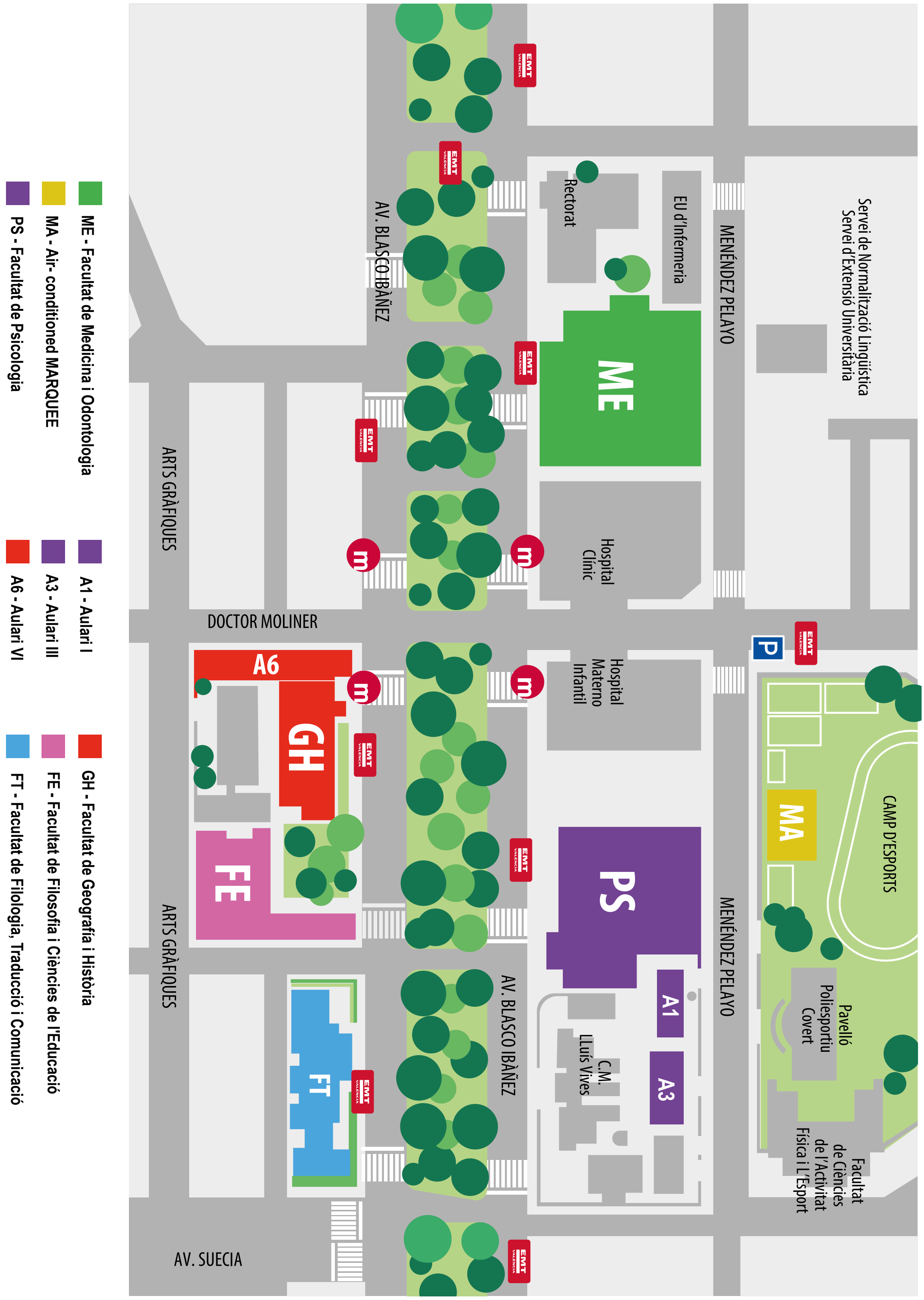
6. Program at a Glance

PROGRAM AT A GLANCE ICIAM 2019

TIME	SUNDAY JULY 14	MONDAY JULY 15	TUESDAY JULY 16	WEDNESDAY JULY 17 INDUSTRY DAY	THURSDAY JULY 18	FRIDAY JULY 19
8:00		Valencia Conference Centre REGISTRATION REGISTRATION OPENS	Universitat de València REGISTRATION REGISTRATION OPENS	Universitat de València REGISTRATION REGISTRATION OPENS	Universitat de València REGISTRATION REGISTRATION OPENS	Universitat de València REGISTRATION REGISTRATION OPENS
8:15						
8:30			INVITED LECTURES (3 in Parallel 08:30h - 09:15h)	INVITED LECTURES (3 in Parallel 08:30h - 09:15h)	INVITED LECTURES (3 in Parallel 08:30h - 09:15h)	INVITED LECTURES (3 in Parallel 08:30h - 09:15h)
8:45						
9:00						
9:15						
9:30			INVITED LECTURES (3 in Parallel 09:30h - 10:15h)	INVITED LECTURES (3 in Parallel 09:30h - 10:15h)	INVITED LECTURES (3 in Parallel 09:30h - 10:15h)	INVITED LECTURES (3 in Parallel 09:30h - 10:15h)
9:45						
10:00		Opening Ceremony & AWARDS (10:00h - 11:15h)				
10:15						
10:30			COFFEE BREAK & POSTER SESSION (10:30h . 11:00h)	COFFEE BREAK & POSTER SESSION (10:30h . 11:00h)	COFFEE BREAK & POSTER SESSION (10:30h . 11:00h)	COFFEE BREAK & POSTER SESSION (10:30h . 11:00h)
10:45						
11:00			Scientific Sessions (11:00h - 13:00h)	Scientific Sessions (11:00h - 13:00h)	INVITED LECTURES (3 in Parallel 11:00h - 11:45h)	Scientific Sessions (11:00h - 13:00h)
11:15		COFFEE BREAK				
11:30						
11:45						
12:00		Laudations for ICIAM prize winners (11:45h - 12:20h)			ICIAM LAGRANGE PRIZE LECTURE (12:00h - 12:45h)	
12:15						
12:30		Olga Taussky-Todd LECTURE (12:30h - 13:15h)				
12:45						
13:00			LUNCH BREAK (13:00-14:30)	LUNCH BREAK (13:00-14:30)	LUNCH BREAK (13:00-14:30)	LUNCH BREAK (13:00-14:30)
13:15		LUNCH BREAK (13:15h - 15:00h)				
13:30						
13:45						
14:00						
14:15						
14:30			Scientific Sessions (14:30h - 16:30h)	Scientific Sessions (14:30h - 16:30h)	Scientific Sessions (14:30h - 16:30h)	Scientific Sessions (14:30h - 16:30h)
14:45						
15:00		Universitat de València REGISTRATION ICIAM PIONEER PRIZE LECTURE (15:00h - 15:45h)				
15:15						
15:30						
15:45		ICIAM COLLATZ PRIZE LECTURE (15:45 h - 16:30h)				
16:00						
16:15						
16:30		COFFEE BREAK & POSTER SESSION (16:30h - 17:00h)	COFFEE BREAK & POSTER SESSION (16:30h - 17:00h)	COFFEE BREAK & POSTER SESSION (16:30h - 17:00h)	COFFEE BREAK & POSTER SESSION (16:30h - 17:00h)	
16:45						Closing Ceremony (16:45h - 17:15h)
17:00	Valencia Conference Centre REGISTRATION	Scientific Sessions (17:00h - 19:00h)	Scientific Sessions (17:00h - 19:00h)	Scientific Sessions (17:00h - 19:00h)	ICIAM SU BUCHIN PRIZE LECTURE (17:00h - 17:45h)	
17:15						
17:30						
17:45					ICIAM MAXWELL PRIZE LECTURE (17:45h - 18:30h)	
18:00						
18:15						
18:30	WELCOME RECEPTION (18:30 h- 20:30h)					
18:45						
19:00						
19:15		Peter Henrici LECTURE (19:15h - 20:00h)	John von Neumann LECTURE (19:15h - 20:00h)	Sonia Kovalevsky LECTURE (19:15-20:00h)		
19:30						
19:45					Palau de les Arts Public Lecture (19:45h - 20:45h)	
20:00						
20:15						
20:30						
20:45						
21:00						

Venue

Blasco Ibáñez Campus of the Universitat de València



🟩 ME - Facultat de Medicina i Odontologia
🟨 MA - Air- conditioned MARQUEE
🟪 PS - Facultat de Psicologia
🟪 A1 - Aulari I
🟪 A3 - Aulari III
🟥 A6 - Aulari VI
🟥 GH - Facultat de Geografia i Història
🟪 FE - Facultat de Filosofia i Ciències de l'Educació
🟦 FT - Facultat de Filologia, Traducció i Comunicació

MONDAY, JULY 15

09:00 - 10:15, OPENING CEREMONY, Valencia Conference Centre

10:15-11:30, LAUDATIONS FOR PRIZE WINNERS, Valencia Conference Centre

Chair person: Maria J. Esteban

- ICIAM Pioneer Prize: **YVON MADAY,** Sorbonne University, Paris, France
  Laudation: Alfio Quarteroni
- ICIAM Collatz Prize: **SIDDHARTHA MISHRA**, ETH Zürich, Switzerland
  Laudation: Zdenek Strakos
- ICIAM Lagrange Prize: **GEORGE PAPANICOLAOU,** Stanford University, EEUU
  Laudation: Margaret Wright
- ICIAM Su Buchin Prize: **GIULIA DI NUNNO**, University of Oslo, Norway
  Laudation: Ya-xiang Yuan
- ICIAM Maxwell Prize: **CLAUDE BARDOS**, Université Paris Denis Diderot, France
  Laudation: Alex Mielke

ICIAM Pioneer Prize: **YVON MADAY,** Sorbonne University, Paris, France

Monday, July 15, 15:00h - 15:45h, FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: Lisa Fauci

Title: Coupling of reduced mathematical models and data for assimilation and the development of digital twins

ICIAM Collatz Prize: **SIDDHARTHA MISHRA**, ETH Zürich, Switzerland

Monday, July 15, 15:45h - 16:30h, FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: Heike Fassbender

Title: On the convergence of numerical schemes for hyperbolic systems of conservation laws

ICIAM Lagrange Prize: **GEORGE PAPANICOLAOU**, Stanford University, EEUU

Thursday, July 18, 12:00h - 12:45h, FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: Luca Formaggia

Title: Data structures in imaging

ICIAM Su Buchin Prize: **GIULIA DI NUNNO**, University of Oslo, Norway

Thursday, July 18, 17:00h - 17:45h, FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: Pingwen Zhang

Title: Time change in modelling, stochastic calculus and control

ICIAM Maxwell Prize: **CLAUDE BARDOS**, Université Paris Denis Diderot, France

Thursday, July 18, 17:45h - 18:30h, FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: Edriss Titi

Title: From the d'Alembert paradox to the 1984 Kato criteria via the 1941 1/3 Kolmogorov law and the 1949 Onsager conjecture

INVITED LECTURES

Tuesday, July 16, Universitat de València, 08:30h - 09:15h

IL01: James Sethian, University of California, Berkeley, California, USA

MA - (air conditioned) Marquee

Chair Person: Maurizio Falcone

Title: Advances in Advancing Interfaces: The Mathematics of Manufacturing of Industrial Foams, Fluidic Devices, and Automobile Painting

IL02: Carlos Conca, Universidad de Chile, Santiago, Chile
ME - Aula Magna

Chair Person: Luis Vega

Title: Modeling Our Sense of Smell

IL03: Xiao-Ping Wang, Hong Kong University of Science and Technology, China
FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: Liliana Borcea

Title: An iterative thresholding method for topology optimization

Tuesday, July 16, Universitat de València, 9:30h – 10:15h

IL04: Donald Goldfarb, Columbia University, USA
MA - (air conditioned) Marquee

Chair Person: Qiang Du

Title: The Alternating Direction Method of Multipliers: Recent Advances and Applications

IL05: Ruo Li, Pekin University, China
ME - Aula Magna

Chair Person: Manuel J. Castro

Title: Globally hyperbolic regularization to Grad's moment system

IL06: Isabelle Gallagher, Univ. Paris Diderot (P7) and École Normale Supérieure de Paris, France
FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: Carlos Kenig

Title: From particle systems to the Boltzmann equation

Wednesday, July 17, Universitat de València, 8:30h – 9:15h

IL07: Alfredo Bermúdez de Castro, Univ. of Santiago de Compostela, Spain
MA - (air conditioned) Marquee

Chair Person: Wil Schilders

Title: Some case studies in environmental and industrial mathematics

IL08: Wolfgang Dahmen, University of South Carolina, USA
ME - Aula Magna

Chair Person: Gitta Kutyniok

Title: High-Dimensional Operator Equations - Error Control and Complexity

IL09: Hans de Sterck, University of Waterloo, Canada
FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: Mejdi Azaiez

Title: Scalable Solvers for Computational Science and Data Science: Multilevel, Nonlinearly Preconditioned, and Parallel-in-Time

Wednesday, July 17, Universitat de València, 9:30h – 10:15h

IL10: Peter Bühlmann, ETH Zurich, Switzerland
MA - (air conditioned) Marquee

Chair Person: Carlos Vázquez Cendón

Title: Statistical Robustness, Stability and Interpretability of Algorithms

IL11: Marsha J. Berger, Courant Institute, NYU, New York, USA
ME - Aula Magna

Chair Person: Leslie Greengard

Title: Progress in Modeling of Asteroid-Generated Tsunamis

IL12: Kazue Sako, Security Research Labs NEC, Japan
FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: Yasumasa Nishiura

Title: Cryptography and Digital Transformation

Thursday, July 18, Universitat de València, 8:30h – 9:15h

IL13: Eitan Tadmor, University of Maryland, College Park, USA
MA - (air conditioned) Marquee

Chair Person: Mari Paz Calvo

Title: Emergent behavior in collective dynamics

IL14: Omar Ghattas, Texas University, Austin, USA
ME - Aula Magna

Chair Person: Douglas Arnold

Title: Large-scale stochastic PDE-constrained optimization

IL15: Yunqing Huang, Xiangtan University, China
FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: Henar Herrero

Title: Recent advances in mathematical analysis and numerical simulation of invisibility cloaks with metamaterials

Thursday, July 18, Universitat de València, 9:30h – 10:15h

IL16: Thomas A. Grandine, The Boeing Company, USA
MA - (air conditioned) Marquee

Chair Person: Volker Mehrmann

Title: 21st Century Industrial Computing at Boeing

IL17: Claude Le Bris, École des Ponts & Chaussées and Inria, Paris, France
ME - Aula Magna

Chair Person: Juan Luis Vázquez

Title: Homogenization of materials with defects

IL18: Anna-Karin Tornberg, Kth Royal Institute of Technology, Stockholm, Sweden
FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: Ricardo Nochetto

Title: Close interactions of drops and particles in viscous flow

Thursday, July 18, Universitat de València, 11:00h – 11:45h

IL19: Kristin Lauter, Microsoft Research and University of Washington, USA
MA - (air conditioned) Marquee

Chair Person: Nick Trefethen

Title: Private AI

IL20: Hiroshi Suito, Tohoku University, Japan
ME - Aula Magna

Chair Person: Maurizio Falcone

Title: Geometrical characteristics of human anatomical structure in thoracic diseases

IL21: Panagiotis E. Souganidis, University of Chicago, USA
FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: José Antonio Carrillo De La Plata

Title: Nonlinear Stochastic Partial Differential Equations

Friday, July 19, Universitat de València, 8:30h – 9:15h

IL22: Karen Wilcox, University of Texas at Austin, USA
MA - (air conditioned) Marquee

Chair Person: Peregrina Quintela

Title: Predictive data science for physical systems: From model reduction to scientific machine learning

IL23: Sylvia Serfaty, Courant Institute, New York University, USA
ME - Aula Magna

Chair Person: M. Elena Vázquez Cendón

Title: Systems of points with Coulomb interactions

IL24: Marcelo Viana, IMPA, Rio De Janeiro, Brazil
FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: Jesús Sanz-Serna

Title: Lyapunov exponents, from the 1960s to the 2020s

Friday, July 19, Universitat de València, 9:30h – 10:15h

IL25: Nicholas J. Higham, University of Manchester, UK
MA - (air conditioned) Marquee

Chair Person: Cleve Moler

Title: Exploiting Low Precision Arithmetic in the Solution of Linear Systems

IL26: Leah Edelstein-Keshet, University of British Columbia, Vancouver, Canada
ME - Aula Magna

Chair Person: Ami Radunskaya

Title: Pattern formation inside living cells

IL27: J. A. C. Weideman, Stellenbosch University, South Africa
FT - Saló d'Actes *Manuel Sanchis Guarner*

Chair Person: Pablo Pedregal

Title: Dynamics of Complex Singularities of Nonlinear PDEs: Analysis and Computation

OLGA TAUSSKY-TODD LECTURE: **Françoise Marie Louise Tisseur**, School of Mathematics-University of Manchester, UK

Monday, July 15, Valencia Conference Centre, 12:00h – 12:45h

Chair Person: Barbara Keyfitz

Title: Challenges in the numerical solution of nonlinear eigenvalue problems

PETER HENRICI PRIZE LECTURE: **Weinan E**, Princeton University, USA

Monday, July 15, FT-Saló d'Actes *Manuel Sanchis Guarner,*19:15h - 20:00h

Chair Person: Lisa Fauci, SIAM President

Title: Machine Learning and Multi-scale Modeling

THE JOHN VON NEUMANN PRIZE LECTURE: **Margaret H. Wright**, Courant Institute of Mathematical Sciences, New York University, USA

Tuesday, July 16, FT-Saló d'Actes *Manuel Sanchis Guarner,* 19:15h - 20:00h

Chair Person: Lisa Fauci, SIAM President

Title: A Hungarian Feast of Applied Mathematics

AWM-SIAM SONIA KOVALEVSKY PRIZE LECTURE: **Catherine Sulem**, University of Toronto, Canada

Wednesday, July 17, FT-Saló d'Actes *Manuel Sanchis Guarner,* 19:15h - 20:00h

Co-Chairs: Ami Radunskaya, AWM President and Lisa Fauci, SIAM President

Title: The Dynamics of Ocean Waves

Tuesday, July 16, FE-Building, Aula Magna, First Floor, Room: FE-1-A

ICIAM - ERC

14:30 - 16:30

Organizer: María Teresa González

During the first part of this session, the President of the European Research Council Jean-Pierre Bourguignon, together with a scientific officer working in the agency, will give an overview of the funding opportunities offered by the ERC as well as some general information on funded projects and the application and evaluation process. This will be complemented by the testimonies of panel members and current ERC grantees.

Informative talk about the ERC, funding schemes and evaluations
Speakers:
Jean-Pierre Bourguignon (ERCEA President)
María Teresa González Cerverón (ERCEA Scientific Officer Mathematics Panel)

ERC grantees and panel members experience
Speakers:
Panel members: Maria J. Esteban and Jose Antonio Carrillo de la Plata
Consolidator grantee: Martin Burger
Advanced grantee: Peter Bühlmann

THE FUTURE OF MATHEMATICS IN THE AGE OF MACHINE LEARNING

17:00 - 19:00

Organizer: Gitta Kutyniok

During the last years, machine learning methods have entered various areas of industrial and applied mathematics, often outperforming classical approaches. At the same time, many of those methods such as deep learning still lack a profound theoretical understanding.

The goal of this looking forward panel is to discuss the potential, but also limitations of machine learning methods in various areas of industrial and applied mathematics as well as possible future directions and visions. The panelists are the chairs of SIAM Activity Groups of main areas in industrial and applied mathematics which are particularly amenable for machine learning methods.

Panelists:
Hans De Sterck (University of Waterloo, SIAM Activity Group on Computational Science and Engineering)
Eitan Tadmor (University of Maryland, SIAM Activity Group on Analysis of Partial Differential Equations)
Gitta Kutyniok (Technische Universität Berlin, SIAM Activity Group on Imaging Science)
James Nagy (Emory University, SIAM Activity Group on Linear Algebra)

Friday, July 19, FE-Building, Aula Magna, First Floor, Room: FE-1-A

CAREERS IN MATHEMATICAL SCIENCES TO ACADEMIA AND INDUSTRY

11:00-13:00

Organizer: Carlos Vázquez

Mathematical sciences are increasingly used in a wide range of application areas of research in industrial sectors. Also the training at all levels evolves accordingly, mainly at the higher levels of master and PhD. In this way, an increasing variety of career opportunities arises to people with high talent in mathematics and a suitable training. On one hand, academic careers are evolving and also producing new profiles strongly based on mathematical and computational skills, with additional deep knowledge on specific applications areas. On the other hand, mathematics is increasingly playing a major role in industrial organizations, thus demanding trained mathematicians with special skills in helping to solve real-world problems arising in industry and society.

In this panel, we aim to discuss about the current and future role to be played by mathematicians in academia and industry, as well as about the possible improvements to develop successful careers in academia and industry. Gender aspects will be also discussed. Panelists represent different mathematical societies, in which the topic of the panel has been largely followed and discussed.

Panelists:
Sven Leyffer (ICIAM)
Volker Mehrmann (European Mathematical Society)
Jill Pipher (American Mathematical Society)
Wil Schilders (European Consortium of Mathematics in Industry)
Ami E. Radunskaya (Association of Women in Mathematics)

The Industry Day is a mathematical technology transfer oriented activity that will take place during the Congress.

The goals are:

- To show to the industrial sector the high innovation potential of the mathematical tools of Statistics & Big Data and MSO (Modelling, Simulation and Optimization).
- To open new channels of communication between researchers and potential users of mathematical tools.

In this full day activity, speakers from industry with a broad representation of the different sectors will be selected. The target audience will be mainly the industrial attendees, but it will also be addressed to the academy and open to the society in general.

Companies with experience of collaboration with academy in these fields are invited to present the results of these collaborations and the benefits that are derived: better products, better services, optimization of processes and/or organization, growth of innovation, improvement of the results account, etc.

The attendance of academic participants is encouraged to exchange experiences and to open new channels of communication between researchers and potential users of mathematical tools. Specific actions of disclosure in companies will be carried out.

INDUSTRY DAY PROGRAM

Wednesday, July 17, 2019, FE-Building, Aula Magna (first floor) Room: FE-1-A

10:30-11:00 **Opening session and welcome**

11:00-13:00 **FIRST SESSION**

- *Mathematics a key enabler for Digital Twins.*

  Dirk Hartmann. Siemens, Corporate Technology (Germany).

  Chair Person: Wil Schilders, President of EU-MATHS-IN

- *The Ferrosolar project: industrial R&D&I for new applications of silicon.*

  Ramón Ordás Badía. Chief Executive Officer of Silicio Ferrosolar (Spain).

  Chair Person: Dolores Gómez Pedreira, Affiliated researcher of ITMATI and Universidade de Santiago de Compostela.

- *Methods and issues for the analysis of complex systems by numerical simulation at EDF.*

  Bertrand Iooss. Senior researcher in EDF R&D, Department PRISME (Performance, Industrial Risk, Monitoring for Maintenance and Operations), Chatou (France).

  Chair Person: Tomeu Coll, Vice President of math-in and Universitat de les Illes Balears.

- *To BEM, or not to BEM, that is the question.*

  Stefan Kurz. Vice President for Strategies and Technologies of Modeling and Simulation, Corporate Sector Research and Advance Engineering, Robert Bosch GmbH (Germany).

  Chair Person: Adérito Araujo, President of the European Consortium for Mathematics in Industry (ECMI).

13:00-14:30 **Lunch break**

14:30-16:30 **SECOND SESSION**

- *How to embed artificial intelligence in a Bank?*

  Julien Crowe. Leader, Artificial Intelligence. National Bank of Canada (Canada).

  Chair Person: Alejandro Adem, CEO and Scientific Director of Mitacs, Canada.

- *Big Data & Machine Learning Strategy in Banco Santander.*

  Álvaro Fernández Velando. Chief Risk Data Officer, Banco de Santander (Spain).

  Chair Person: José Miguel Lorente, Director of Institutions in Comunidad Valenciana and Murcia, Banco Santander, Spain.

- *Solving social and industrial issues via digital co-creation based on advanced mathematical technologies.*

  Hirokazu Anai. Artificial Intelligence Laboratory, FUJITSU LABORATORIES LTD (Japan).

  Chair Person: Osamu Saeki, Director of the Institute of Mathematics for Industry, Japan.

- *Towards Secure and Scalable Industrial Blockchains.*

  Ghassan Karame. NEC Laboratories Europe.

  Chair Person: Osamu Saeki, Director of the Institute of Mathematics for Industry, Japan.

16:30-17:00 **Coffee break**

17:00-19:00 **THIRD SESSION**

- *GANESO, a complete tool for gas networks.*

  Carlos Vales Fernández. Director of Hub Project, Reganosa (Spain).

  Chair Person: Alfredo Bermúdez de Castro, member of the Governing Council of ITMATI and Universidade de Santiago de Compostela.

- *Industrial mathematics in Nors Group: driving a new management approach.*

  Margarida Pina. Nors Group Business Development Director. NORS Automotive (Portugal).

  Chair Person: Manuel Cruz, President of PT-MATHS-IN.

- *Mathematics and Los Alamos National Laboratory: Advances and Collaboration.*

  Carrie A. Manore. Staff Scientist, Los Alamos National Laboratory (USA).

  Chair Person: Mª Luisa Rapún, member of the Board of Directors of math-in and Universidad Politécnica de Madrid

- *Algorithms for mass spectral library searching.*

  Arun S. Moorthy. Director's Postdoctoral Fellow and Mathematical Statistician, NIST (USA).

  Chair Person: Carlos Parés, Former Vice-President of math-in and Universidad de Málaga.

19:00-19:15 **Break**

19:15-20:15 **FOURTH SESSION**

- *Modeling of an in-situ technique for measuring surface impedance and reflection coefficient using Acoustic Particle Velocity.*

  Graciano Carrillo Pousa. Research & Development, Microflown Technologies (Netherlands).

  Chair Person: Andrés Prieto Aneiros, Afiliated researcher to ITMATI and Universidade da Coruña.

- *Some experiences from mathematical modeling studies with academic institutions.*

  Uwe Beuscher. PSD Modeling & Simulation Team. 7, W.L. Gore & Associates (USA).

  Chair Person: José Luis Ferrín, member of the Board of Directors of math-in and Universidade de Santiago de Compostela.

BEST INDUSTRY-RELATED POSTER AWARDS

ICIAM 2019 will grant two awards ($512 and $307 approx.) to the two best industry-related posters presented at the conference.

These awards, sponsored by *Mathematics* (ISSN 2227-7390), an MDPI Open Access Journal, are part of the Industry Day, a mathematical technology transfer-oriented activity that will take place on Wednesday July 17th, within ICIAM 2019. All posters with the PB- Poster Code are automatically eligible for the prizes.

An evaluation panel will choose the winners. The prizes will be announced and awarded to the authors at the closing session of the Industry Day on Wednesday July 17th, 2019 at the Aula Magna of the FE building.

ACADEMIC SPONSORS OF THE INDUSTRY DAY

European Consortium for Mathematics in Industry (ECMI), Europe.

European Service Network of Mathematics for Industry and Innovation (EU-MATHS-IN), Europe.

Institute of Mathematics for Industry, Japan.

MITACS, Canada.

Rede Portuguesa de Matemática para a Indústria e Inovação (PT-MATHS-IN), Portugal.

Sociedad Española de Matemática Aplicada (SEMA), Spain.

Spanish Network for Mathematics & Industry (math-in), Spain.

Technological Institute for Industrial Mathematics (ITMATI), Spain

CODE	SESSION
IM FT-4-2 1	Academia-industry case studies from MI-NET and ECMI
IM FT-2-3 10	Advances in computation and analysis of PDE's for multiphase system - Part 3
IM FT-2-3 8	Advances in computation and analysis of PDE's for multiphase system - Part 1
IM FT-2-3 9	Advances in computation and analysis of PDE's for multiphase system - Part 2
IM FT-2-2 8	BIGMATH: an ITN-EID project based on academic and industrial cooperation
IM FT-4-2 10	Case studies in industrial mathematics from MACSI
IM FT-4-4 4	ECMI SIG Mathematics for Big Data - Optimization and Statistics
IM FT-4-1 1	EU-MATHS-IN: Success Stories of Mathematics in Societal Challenges and Industry - Part 1
IM FT-4-1 2	EU-MATHS-IN: Success Stories of Mathematics in Societal Challenges and Industry - Part 2
IM FT-4-1 3	EU-MATHS-IN: Success Stories of Mathematics in Societal Challenges and Industry - Part 3
IM FT-4-1 4	EU-MATHS-IN: Success Stories of Mathematics in Societal Challenges and Industry - Part 4
IM FT-4-4 3	Geometrical inverse problems and Completion data
IM FT-4-3 8	Geophysical Applications - Part 1
IM FT-4-3 9	Geophysical Applications - Part 2
IM FT-4-3 10	Geophysical Applications - Part 3
IM FT-4-4 2	Industrial Math Problems Based on Big Data
IM FT-4-3 3	Mathematical and numerical tools for Tsunami Early Warning Systems

CODE	SESSION
IM FT-2-2 1	Mathematical modeling, simulations and theories related to biological phenomena - Part 1
IM FT-2-2 2	Mathematical modeling, simulations and theories related to biological phenomena - Part 2
IM FT-4-3 1	Mathematical Optimization and Gas Transport Networks: Industrial Collaborations - Part 1
IM FT-4-3 2	Mathematical Optimization and Gas Transport Networks: Industrial Collaborations - Part 2
IM FT-4-2 8	Mathematical Solutions of Industrial Applications
IM FT-4-2 2	Mathematics for Industry in the Asia Pacific Area - Part 1
IM FT-4-2 4	Mathematics for Industry in the Asia Pacific Area - Part 2
IM FT-2-3 2	Modeling, Simulation and Optimization in Electrical Engineering - Part 1
IM FT-2-3 3	Modeling, Simulation and Optimization in Electrical Engineering - Part 2
IM FT-2-3 4	Modeling, Simulation and Optimization in Electrical Engineering - Part 3
IM FT-2-2 3	Molecular and Mesoscopic Modelling in Chemical Engineering Data Science - Part 1
IM FT-2-2 4	Molecular and Mesoscopic Modelling in Chemical Engineering Data Science - Part 2
IM FT-4-4 1	New international perspectives in industrial applied mathematics
IM FT-4-2 9	Preparing Future Industrial Mathematicians Through Industry-Academic Partnerships
IM FT-4-1 10	Societal Impact of Industrial Mathematics and Supporting Infrastructures Worldwide - Part 3
IM FT-4-1 8	Societal Impact of Industrial Mathematics and Supporting Infrastructures Worldwide - Part 1
IM FT-4-1 9	Societal Impact of Industrial Mathematics and Supporting Infrastructures Worldwide - Part 2

We are pleased to announce the following events at ICIAM 2019:

PUBLIC LECTURE: **Víctor M. Pérez-García**, Mathematical Oncology Laboratory (MOLAB), University of Castilla-La Mancha, Spain

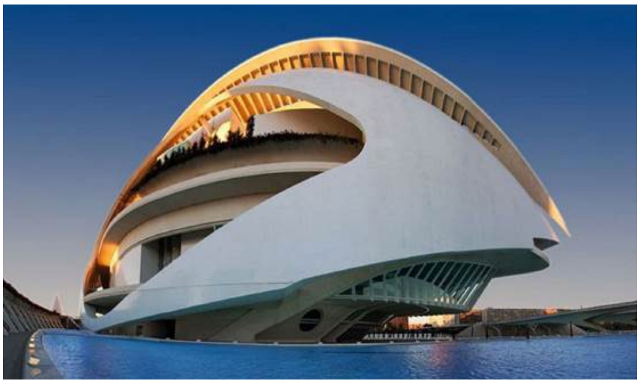
Thursday, July 18, Palau de les Arts (Ciutat de les Arts i les Ciències), 19:45h – 20:45h

Chair Person: José Antonio Carrillo de la Plata, Imperial College London, UK

Title: Can Mathematics help in the war against cancer?

The fight against disease is one of the greatest challenges in modern society. Mathematics has contributed substantially to the development of many disciplines, such as Physics and Engineering. Life Sciences, and specifically Medicine, are, however, perceived as 'different', because of the complexity of life itself.

In this talk I shall discuss how Mathematics may lead to important breakthroughs in the fight against disease, and what advances are to be expected in the coming decades. I will describe examples involving brain tumors where Applied Mathematics is being used to improve our knowledge and clinical practice well beyond the current standard.



ARCHIMEDES – A PLANETARIUM OPERA BY JAMES DASHOW

Thursday, July 18, 2019, Hemisfèric (Ciutat de les Arts i les Ciències), 22:00h

Tickets can be bought through the on-line registration form at the Special price for Attendees (cost 6€); **Limited places!**

Libretto by Cary Plotkin with Ted Weiss, based on the composer's idea.
Archimedes describes the life of the hellenistic polymath (physicist, mathematician and engineer) from his childhood until the end of his life, based on the Greek historian Plutarch's biography of the Roman general Marcellus.

The selected scenes combine electroacustic music and synchronized video images, vocal soloists and mimes showing physical and mathematical concepts that Archimedes developed and applied to mechanical and pneumatic machines. Dashow adds some artistic licenses towards the end: shortly before dying, Archimedes imagines present-day physics, mathematics and cosmology (Feynman diagrams, string theory, the Big Bang, the multiverse, etc.).

In collaboration with the Conservatorio Superior de Música de Valencia, Escuela Superior de Arte Dramático de Valencia and ISEACV.

The Planetarium Opera, will be celebrated at the Hemisfèric (how to get there). Hemisfèric, was the first element to be built at the Ciutat de les Arts i les Ciències. The Hemisfèric, opened on April 10th 1998, is a unique and spectacular building designed by Santiago Calatrava and represents a large human eye, surrounded by water to enhance its beauty. It houses the planetarium and the largest IMAX Dome cinema in Spain.

ICIAM 2019 Schedule

Monday sessions
July 15

SL01 **12:00-12:45**

Olga Taussky-Todd Lecture

Chair Person: Barbara Keyfitz — The Ohio State University

Challenges in the numerical solution of nonlinear eigenvalue problems

Françoise Marie Louise Tisseur — School Of Mathematics, University Of Manchester, UK

Abstract: Given a matrix-valued function F that depends nonlinearly on a single parameter z, the basic nonlinear eigenvalue problem consists of finding complex scalars z for which F(z) is singular. Such problems underpin many areas of computational science and engineering, including acoustics, control theory, fluid mechanics and structural engineering. They can be difficult to solve due to their nonlinear nature, the large problem size and poor conditioning. There have been numerous breakthroughs in the development of numerical methods in the past ten years for nonlinear eigenvalue problems. We discuss such advances, including - how to approximate F by a rational or polynomial matrix function, - how to linearize rational/polynomial eigenproblems, and in particular which linearizations we should choose, - the use of low precision arithmetic in the eigenvalue solver.

IPL01 **15:00-15:45**

ICIAM Pioneer Prize

Chair Person: Lisa Fauci — Tulane University

15:00-15:45

Coupling of reduced mathematical models and data for assimilation and the development of digital twins

Yvon Maday — Sorbonne University, Paris, France

Abstract: The digitisation in all its aspects and the dematerialisation of most acts have brought us into the worlds of digital technology, of simulation, of artificial intelligence and of massive data. The idea of retrieving, acquiring and using this data to make digital twins (of complex machines, but also why not of all or part of ourselves) is truly fascinating (but can of course frighten). The reality is nevertheless more complex because the data are often partial, even oriented, flawed and sometimes also costly. Mathematical modelling of the phenomena that govern these data often exists, based on physical laws and proven in many situations. These models are also approximate, but they provide knowledge that is useful to combine with data to gain accuracy for the design of numerical twins: ie use data to correct model bias and use the model to correct measurement bias. We will present the basics of this approach together with the associated theory and we will illustrate through a few examples the progress and achievements in this area and will draw some perspectives.

IPL02 **15:45-16:30**

ICIAM Collatz Prize

Chair Person: Heike Fassbender — TU Braunschweig

15:45-16:30

On the convergence of numerical schemes for hyperbolic systems of conservation laws

Siddhartha Mishra — Department of Mathematics, ETH Zürich

Abstract: We survey convergence results for numerical methods approximating hyperbolic systems of conservation laws, a large class of nonlinear PDEs that arise in physics and engineering. We introduce a novel solution concept, that of statistical solutions, which are more appropriate as a framework for solutions and uncertainty quantificatio for multi-dimensional systems of conservation laws. An ensemble averaging Monte Carlo type algorithm is proposed and proved to converge to statistical solutions on mesh refinement.

MS A3-2-1 1 **17:00-19:00**

Cartesian CFD Methods for Complex Applications - Part 1

For Part 2 see: MS A3-2-1 2
For Part 3 see: MS A3-2-1 3
For Part 4 see: MS A3-2-1 4

Organizer: Ralf Deiterding — University of Southampton
Organizer: Margarete Oliveira Domingues — National Institute for Space Research
Organizer: Kai Schneider — Aix-Marseille Université, I2M

MS Organized by: SIAG/CSE

Abstract: Cartesian discretization approaches are ubiquitous in computational fluid dynamics. When applied to problems in geometrically complex domains or fluid-structure coupling problems, Cartesian schemes allow for automatic and scalable meshing; however, order-consistent immersed boundary conditions and efficient dynamic mesh adaptation take forefront roles. This symposium will highlight cutting-edge applications of Cartesian CFD methods and describe the employed algorithms and numerical schemes. An emphasis will be laid on complex multi-physics applications like magnetohydrodynamics, combustion, aerodynamics with fluid-structure interaction, solved with various discretizations, e.g. finite difference, finite volume, multiresolution or lattice Boltzmann CFD schemes. Software design and parallelization challenges will be addressed briefly.

17:00-17:30

An immersed boundary method on adaptive Cartesian grids for compressible flows around complex geometries

Stephanie Peron — ONERA
BENOIT Christophe — ONERA
RENAUD Thomas — ONERA
MARY Ivan — ONERA
TERRACOL Marc — ONERA

Abstract: ONERA is developping an immersed boundary method (IBM) on Cartesian adaptive grids to perform compressible flow simulations around complex geometries. This method relies on a ghost cell direct forcing approach, which is used in combination with a wall model to solve high-Reynolds number flows. In the presentation, we will present the method developed in ONERA Cassiopee pre and post-processing package. Some applications performed with ONERA FastS solver will be presented.

17:30-18:00

Does the formal accuracy really matter?

Sylvain Laizet — Imperial College

Abstract: It is now well-established that high-order finite-difference schemes can provide an efficient route to performing scale-resolving simulations of turbulent flows. In this talk, we will demonstrate that high-order finite-difference schemes can be combined to a low-order customized Immersed Boundary Method for turbulent flows with fixed and moving objects. We will show that the formal accuracy of the solution is not a relevant metric to discuss about the quality of the simulations.

18:00-18:30

ExaHyPE: An open-source engine for wave problems

Anne Reinarz — Technical University Munich
Michael Bader — Technical University of Munich
Tobias Weinzierl — University of Durham

Abstract: ExaHyPE is a hyperbolic PDE engine for solving systems of first order hyperbolic PDEs written in a conservative formulation. The two main applications currently tackled with this engine are long-range seismic risk assessment and the search for gravitational waves emitted by binary neutron stars. Problems are discretised on tree-structured fully adaptive Cartesian meshes. The formulation can be extended to allow the modelling of complex topography using a diffuse interface method or curvilinear meshes.

18:30-19:00

Parallel tree partitions for dynamic adaptive fluid dynamics

Carsten Burstedde — University Bonn
Donna Calhoun — Boise State University, USA

Abstract: Cartesian meshes may be adaptively refined and partitioned using tree structures. Since the tree must satisfy possibly non-local constraints in terms of depth of refinement between neighbor cells, partitioning and balancing it become non-trivial. As an example relevant to fluid simulations, it is often desired to smooth the refinement pattern beyond what is strictly required for well-posedness, which leads to a parallel algorithm of its own. We complement our algorithmic discussion with numerical examples.

MS GH-0-1 1 **17:00-19:00**

Modeling and simulation of materials defects and inhomogeneities - Part 1

For Part 2 see: MS GH-0-1 2
For Part 3 see: MS GH-0-1 3
For Part 4 see: MS GH-0-1 4
For Part 5 see: MS GH-0-1 5
For Part 6 see: MS GH-0-1 6

Organizer: Luchan Zhang National University of Singapore
Organizer: Shuyang Dai Wuhan University

Abstract: Materials defects and inhomogeneities, such as dislocations and grain boundaries in solids, fluid-solid and fluid-fluid interfaces, and fine microstructures within advanced materials, play essential roles in the mechanical and dynamical behaviors of the materials. The complexity of modeling microstructures of these defects and inhomogeneities, and their evolution at various length and time scales present new challenges for mathematical modeling and analysis. Multiscale and multiphysics models are required to accurately describe the complicated phenomenon associated with defects and inhomogeneities. Speakers in this minisymposium will discuss recent advances in modeling approaches and simulation methods, and new findings obtained in analysis and simulations.

17:00-17:30

Energy and dynamics of grain boundaries based on underlying microstructure

Yang Xiang Hong Kong University of Science and Technology

Abstract: We present continuum models for the energy and dynamics of grain boundaries based on the continuum distribution of the line defects (dislocations or disconnections) on them. The long-range elastic interaction between the line defects is included to maintain a stable grain boundary microstructure. The continuum models is able to describe both normal motion and tangential translation of the grain boundaries due to both coupling and sliding effects that were observed in atomistic simulations and experiments.

17:30-18:00

A hybrid method for multiscale problem

Pingbing Ming Chinese Academy of Sciences

Abstract: We shall discuss a bybrid strategy that is useful for design multiscale algorithms. Two examples will be presented: one comes from atomic and continuum coupling in solid; another comes from multiscale PDE. Both problems contain local defects.

18:00-18:30

Robust simulation of parameter dependent problems

Jun Hu Peking Universtiy

Abstract: In this talk, I will consider robust simulations of two kinds of parameter dependent problems. The fist one is the elasticity problem where there is a crucial parameter the Poisson ratio, the second one is the Reissner-Mindlin plate problem where there is a key parameter the thickness of the plate.

MS GH-3-5 1 **17:00-19:00**

Data Assimilation, Prediction, and Uncertainty Quantification for Complex Systems - Part 1

For Part 2 see: MS GH-3-5 2

Organizer: Samuel Stechmann University of Wisconsin-Madison
Organizer: Nan Chen University of Wisconsin-Madison

Abstract: Data assimilation (also known as state estimation) and prediction have significant science and society impacts on many areas including climate, geophysics, engineering, neuroscience and material science. Most of the underlying dynamical systems in these subjects are extremely complex. They typically have high dimensions, multiscale structures, non-Gaussian statistics and large uncertainties. Therefore, developing efficient and effective stochastic methods for data assimilation and prediction with accurate uncertainty quantification becomes important. This mini-symposium focuses on new ideas and advanced techniques in data assimilation, prediction and uncertainty quantification. Rigorous math theories, effective numerical algorithms and real-world applications will all be emphasized in this mini-symposium.

17:00-17:30

Challenges in Data Assimilation and Prediction of Tropical Weather and Climate

Samuel Stechmann University of Wisconsin-Madison
Ying Li University of Wisconsin-Madison

Abstract: Data assimilation is the process of combining (imperfect) observational data and (imperfect) model data in order to estimate the state of a complex system, such as the atmosphere. It is crucial to weather prediction as it provides the initial conditions for a forecast. In this talk, we describe the unique challenges that arise for tropical weather/climate, along with some recent results on estimating the intrinsic limits of predictability in the tropics using observational data.

17:30-18:00

MCMC for spatially localized systems

Xin Tong National University of Singapore
Matti Morzfeld University of Arizona
Youssef Marzouk Massachusetts Institute of Technology

Abstract: Applying MCMC for high dimensional distributions is usually challenging. We present two MCMC samplers that can exploit intrinsic spatial local structures. Their performance reveals to be dimension independent.

18:00-18:30

Analysis of nonlinear filters

Jana De Wiljes University of Potsdam
Xin Tong NUS
Sebastian Reich Universität Potsdam
Wilhelm Stannat TU Berlin

Abstract: The accuracy and stability of Monte Carlo type approximations of a class of continuous filters for finite number of particles is investigated. The considered filters are derived via different approximations to the gain function of the so called Feedback particle filter. Among others an analysis of the popular Ensemble Kalman Bucy Filter in a nonlinear setting will be discussed.

18:30-19:00

Rigorous analysis and numerical implementation of a data assimilation algorithm

Edriss Titi Texas A&M University

Abstract: In this talk I will introduce downscaling data assimilation algorithms for weather and climate prediction based on discrete coarse spatial scale measurements of the state variables (or only some of them, depending on the underlying model). Moreover, I will also demonstrate uniform in time error estimates of the numerical discretization of these algorithms, which makes them reliable upon implementation computationally. Furthermore, I will also present some recent results concerning a statistical version of these algorithms.

MS FT-2-6 1 **17:00-19:00**

Numerical approaches to blow-up in nonlinear differential equations

Organizer: Takiko Sasaki National Institute of Technology, Ibaraki Colledge

Abstract: This session is devoted to the numerical analysis for blow-up phenomena of nonlinear differential equations. It is often the case that we cannot obtain analytic evidence or predictions related to blow-up solutions. Therefore, numerical methods are an important approach for the study of blow-up phenomena. The aim of this session is to present recent developments in numerical analysis of blow-up phenomena. In particular, we will discuss the following topics: the blow-up curves for nonlinear wave equations, the finite difference and finite element approximation for blow-up axisymmetric solutions to higher-dimensional nonlinear heat equations, and numerical validation method for blow-up in ODEs.

17:00-17:30

Numerical and mathematical analysis for the blow-up curve of nonlinear wave equations

Takiko Sasaki National Institute of Technology, Ibaraki Colledge

Abstract: We consider a blow-up curve for the one dimensional wave equation. Merle–Zaag (2012) showed that there is a possibility that the blow-up curve is not differentiable. To show it, they use the variational structure of the equation. In this talk, we study the blow-up curve

$\partial_t^2 u - \partial_x^2 u = |\partial_t u|^p$ which does not have the variational structure. We state that the blow-up curve is not differentiable if the initial data satisfies some conditions.

17:30-18:00

Finite difference approximation for an axisymmetric nonlinear heat equation with blow-up

Chien-Hong Cho — National Chung Cheng University

Abstract: We consider two algorithms for the computation of axisymmetric blow-up solutions to the semilinear heat equation. One is to define the temporal increment adaptively while another uses a monitor function and computes with uniform time meshes. We use both methods to reproduce certain blow-up behaviors numerically. Although the convergence of numerical solution and numerical blow-up time is guaranteed, the aymptotic behavior for the numerical solution does not always coincide with that for the exact one.

18:00-18:30

Numerical analysis for radially symmetric solutions of semilinear heat equations

Toru Nakanishi — The University of Tokyo
Norikazu Saito — The University of Tokyo

Abstract: This talk presents error analysis of the finite element method for computing spherically symmetric solutions of semilinear heat equations. In particular, we establish optimal order error estimates in a weighted norm for the symmetric formulation and in the norm for the non-symmetric formulation.

18:30-19:00

Numerical validation of blow-up solutions of ODEs

Akitoshi Takayasu — University of Tsukuba

Abstract: Recently, we have constructed a numerical approach for validating blow-up solutions and their blow-up times, which is based on desingularization of space-time variables and the Lyapunov function validation method. In this talk, we introduce our validation approach for blow-up solutions and show several results of numerical validation. Furthermore, we would like to discuss future directions of this topic.

MS A1-3-1 1 — 17:00-19:00

Mathematical Systems Pharmacology to Demystify Diseases' Mechanisms and their Therapies

Organizer: Nekka Fahima — Université de Montréal
Organizer: Heiliö Matti — Lappeenranta Univerity of Technology

Abstract: Mechanistic understanding of the causal effect between drugs and their effects is progressively taking over other more empirical and expensive methodologies in drug research and development, exacerbated by the drop in newly developed molecules despite a skyrocketing in expenses. Mathematics lies at the very heart of this evolution. Quantitative Systems Pharmacology (QSP), that combines systems biology and pharmacometrics, uses mathematical modeling to translate biological and pharmacological knowledge, to make drug R&D more rational and predictable. This session will cover several therapeutic areas, where QSP models are concretely developed and used in tight connection with the clinical reality.

17:00-17:30

Modeling the dopaminergic system for a better use of Levodopa and psychostimulants in Parkinson

Véronneau-Veilleux Florence — Université de Montréal
Nekka Fahima — Université de Montréal

Abstract: Parkinson's disease affects the dopaminergic neurons in the basal ganglia. We will present a model integrating the neurotransmission pathways of the basal ganglia and the effect on these pathways of Levodopa, which is the gold-standard treatment. We want to understand why, as the disease progresses, Levodopa tends to be effective more quickly, but for a shorter amount of time. A pharmacokinetic model is combined with a neuro-computational model of the basal ganglia.

17:30-18:00

The Hindmarsh-rose Neuron Model: Global Homoclinic Structure and Spike-Adding Process

Perez Lucia — University of Oviedo
Santiago Ibáñez — University of Oviedo
Roberto Barrio — University of Zaragoza

Abstract: We focus on the Hindmarsh-Rose neuron model, a fast-slow system that exhibits the main behaviours of biological neurons: resting, spiking and bursting. We are interested in explaining the spike-adding process in the bursting regime. We analyze the homoclinic structure of the bifurcation diagram, since it acts as an organizing center of the spike-adding process, and we study how the global picture evolves as the system goes far from the fast-slow scenario.

18:00-18:30

Modelling optimal allocation of resources in the context of an incurable disease

Nannyonga Betty — Makerere University
David Sumpter — Uppsala University Sweden

Abstract: Nodding syndrome has affected and led to the deaths of children between the ages of 5 and 15 in Northern Uganda since 2009. There is no reliable explanation of the disease, and currently the only treatment is through a nutritional programme of vitamins, combined with medication to prevent symptoms. In the absence of a proper medical treatment, we develop a dynamic compartmental model to plan the management of the syndrome and to curb its effects.

MS GH-3-2 1 — 17:00-19:00

Preconditioners for Linear Algebra Methods in Large Scale Scientific Computing - Part 1

For Part 2 see: MS GH-3-2 2
For Part 3 see: MS GH-3-2 3
For Part 4 see: MS GH-3-2 4

Organizer: Luca Bergamaschi — University of Padua
Organizer: Jose Marin — Polytechnic University of Valencia
Organizer: Angeles Martinez — University of Padua

Abstract: Mathematical models of a high number of processes in Engineering and Applied Sciences once numerically discretized require the repeated solution of large (non)linear systems or eigenvalues problems. All these linear algebra problems are usually addressed by iterative methods which take into account the sparsity of the matrices involved. To provide an approximate solution in a reasonable amount of time, such iterative methods need to be accelerated by suitable preconditioners. The aim of this miniworkshop is to collect the most recent results in the construction of efficient preconditioners applied to discretizations of PDEs as well as constrained optimization problems.

17:00-17:30

Block preconditioners for boundary control of PDE

Daniel Loghin — University of Birmingham

Abstract: The discretization of optimal control of elliptic PDE yields optimality conditions in the form of large sparse linear systems with block structure. Boundary control problems yield structures which pose specific challenges: rank deficient blocks, intractable Schur complements and generally a lack of a strategy for preconditioner design. In this talk we introduce a novel approach based on a certain boundary preconditioning technique involving blocks of discrete fractional Sobolev norms on the boundary.

17:30-18:00

A unified framework of spectral, tuned, deflated preconditioners for sequences of linear systems

Luca Bergamaschi — University of Padua

Abstract: Correcting a given preconditioner by a low-rank update is a common procedure which aims at accelerating the iterative solution of linear systems by improving the condition number of the preconditioned matrix. In this communication we will review some existing techniques and put them in connection with the Quasi-Newton sequences of approximated Jacobians for the solution of nonlinear systems of equations.

18:00-18:30

Fast splitting preconditioner computation for interior point methods in linear programming

Luciana Casacio — Federal University of Paraná
Aurelio Ribeiro Leite Oliveira — University of Campinas (UNICAMP)

Abstract: This work proposes to adopt a new columns ordering for the splitting preconditioner computation, exploring the sparsity of the original matrix and using a groups approach. This preconditioner, designed specifically for the final interior point iterations, is then applied to a hybrid approach with the controlled Cholesky factorization preconditioner. Case studies show that the proposed methodology is competitive regarding the computational time when compared to previous reference approaches for solving large scale linear programing problems.

18:30-19:00

Preconditioners for Isogeometric Analysis of Almost Incompressible Elasticity

Luca Franco Pavarino	University of Pavia
Simone Scacchi	University of Milano
Olof B. Widlund	Courant Institute, NYU
Stefano Zampini	KAUST

Abstract: We introduce parallel deluxe FETI--DP/BDDC preconditioners for almost incompressible elasticity and Stokes problems discretized by mixed isogeometric analysis with continuous pressures. The convergence rate depends on the model inf-sup constant and the condition number of a closely related BDDC algorithm for compressible elasticity. This bound is scalable in the number of subdomains, polylogarithmic in the ratio of subdomain and element sizes, and robust with respect to material incompressibility and parameters discontinuities across subdomain interfaces.

MS ME-0-1 1 17:00-19:00

Polygonal and Polyhedral Methods in Applied Mathematics - Part 1

For Part 2 see: MS ME-0-1 2
For Part 3 see: MS ME-0-1 3
For Part 4 see: MS ME-0-1 4

Organizer: Marco Verani	Politecnico di Milano
Organizer: David Mora	Universidad del Bio-Bio

Abstract: Recently, there has been a great interest to the study of numerical methods for the solution of PDEs on polygonal/polyedral computational meshes. This is motivated on one hand by the flexibility of polytopal meshes that allows, e.g., to effectively deal with complex geometries or with refinement/derefinement strategies, and on the other hand by the versatility to accurately facing the numerical approximation of a variety of problems (from fluidynamics, to elasticity and electromagnetism). The goal of this MS is to present the recent developments in the field of polygonal numerical methods in facing the approximation of applied problems governed by PDEs

17:00-17:30

Virtual elements with curved edges

Alessandro Russo	University of Milano-Bicocca
Lourenco Beirao Da Veiga	University of Milano-Bicocca, Italy
Franco Brezzi	IMATI-CNR, Pavia, Italy
Luisa D. Marini	IMATI-CNR, Pavia, Italy
Giuseppe Vacca	University of Milano-Bicocca, Italy

Abstract: In the past couple of years there have been several attempts to take advantage of the flexibility of VEM in order to deal with elements with curved boundaries. In this talk I will present the pros and cons of the various approaches and discuss their relationship with classical FEM.

17:30-18:00

Discontinuous Galerkin methods on polygonal and polyhedral grids for seismic wave problems

Paola F. Antonietti	Politecnico di Milano
Ilario Mazzieri	Politecnico di Milano

Abstract: Physics-based numerical simulations of earthquake ground motion are a powerful tool to better understand the physics of earthquakes, improve the design of site-specific structures, and enhance seismic risk maps. In this talk we present a high-order discontinuous Galerkin method on polygonal and polyhedral grids for the approximate solution of wave propagation problems. We analyse the theretical properties of scheme and present some numerical results to verify the practical performance of the proposed approach.

18:00-18:30

Virtual element for the transmission eigenvalue problem

David Mora	Universidad del Bío-Bío

Abstract: In this talk, we analyze a virtual element method for solving a non-selfadjoint fourth-order eigenvalue problem derived from the transmission eigenvalue problem. We write a variational formulation and propose a conforming discretization by means of the VEM. We use the classical approximation theory for compact non-selfadjoint operators to obtain optimal order error estimates for the eigenfunctions and a double order for the eigenvalues. Finally, we present some numerical experiments illustrating the behavior of the scheme.

18:30-19:00

Adjoint-based super convergent Galerkin approximations of functionals

Shiqiang Xia	School of Mathematics, University of Minnesota

Abstract: We present a new technique for computing highly accurate approximations to linear functionals obtained in terms of Galerkin approximations. This technique is devised specifically for numerical methods satisfying a Galerkin orthogonality property. We illustrate the technique on a simple model problem of approximating J(u), where J is a smooth functional and u is the solution of a Poisson problem. Our numerical results show we can double the convergence order by just doubling the computational effort.

MS FE-1-1 1 17:00-19:00

Finite element exterior calculus and applications - Part 1

For Part 2 see: MS FE-1-1 2
For Part 3 see: MS FE-1-1 3
For Part 4 see: MS FE-1-1 4

Organizer: Snorre H. Christiansen	University of Oslo
Organizer: Kaibo Hu	University of Minnesota
Organizer: Shuo Zhang	Institute of Computational Mathematics, CAS

Abstract: Finite element exterior calculus (FEEC) and other compatible or structure-preserving discretization techniques have been drawing increased attention in both theoretical studies and applications. This minisymposium aims at a communication of recent developments for such nu- merical methods for electromagnetism, fluid and solid mechanics. In particular, sophisticated discretization techniques and solvers are required to meet the challenges raised in these areas, including conservative discretizations for fluid dynamics, inclusion of geometric structures in linear and nonlinear solid mechanics and modeling and simulation of defects.

17:00-17:30

Finite element systems for elasticity

Snorre H. Christiansen	University of Oslo
Kaibo Hu	University of Minnesota

Abstract: The framework of finite element systems was initially introduced to construct and analyse mixed finite elements for fields that can be interpreted as differential forms. Here we show how the framework can be generalized, so that it can treat elasticity complexes. In particular connections with flat vectorbundles, sheaf theory, and cochain complexes with values in rigid motions play a role. In this framework we can define new finite element complexes for prescribed curvature problems.

17:30-18:00

Complexes from complexes

Douglas Arnold	1954
Kaibo Hu	University of Minnesota

Abstract: The Hilbert complex is the fundamental structure underlying finite element exterior calculus. The case of the de Rham complex, with applications to Poisson and electromagnetic equations, has been deeply studied, and many fine results developed. The study of other complexes--such as those which arise in elasticity, dislocation theory, plate theory, Stokes flow, and general relativity--is less developed. We will discuss new results for these, emphasizing the derivation of new complexes from old.

18:00-18:30

Bernstein-Bezier techniques for linear differential operators on splines

Tatyana Sorokina	Towson University
Shangyou Zhang	

Abstract: Bernstein-Bezier techniques for analyzing continuous harmonic splines in n variables are developed. Dimension and a minimal determining set for special splits are obtained using the new techniques. We show that both dimension and bases strongly depend on the geometry of the underlying partition. In particular, the angles in the triangulation play an important role. We construct quadratic harmonic conforming FEMs on Clough-Tocher refinements and other special partitions.

18:30-19:00

Exact sequence on Powell-Sabin splits

Johnny Guzman	Brown University
Michael Neilan	University of Pittsburgh

Anna Lischke Brown University

Abstract: We define family of finite element spaces on Powell-Sabin splits. The lowest order space for zero forms coincides with the Powell-Sabin original piecewise quadratic space. We prove an exact sequence property. For two forms singular vertices are present and hence we need to enforce a type of continuity restriction for those functions. This is joint work with Anna Lischke and Michael Neilan.

MS ME-1-G 1 17:00-19:00

Women in Applied Mathematics: Recent Advances in Modeling and Applications - Part 1

For Part 2 see: MS ME-1-G 2
For Part 3 see: MS ME-1-G 3
For Part 4 see: MS ME-1-G 4

Organizer: Baasansuren Jadamba Rochester Institute of Technology
Organizer: Natasha S Sharma University of Texas at El Paso

Abstract: This minisymposium aims at bringing women mathematicians to share their recent progress and to inspire new ideas in applied mathematics. Talks may address modeling, theoretical and computational aspects of numerical methods for partial differential equations, as well as various applications arising from engineering, biology, medicine and material science etc. The fourth part of the minisymposium includes a career panel session, whose goal is to create a network platform for women mathematicians at different stages of career and career paths, to exchange experiences and advice in career advancement, and to discuss challenges and strategies for a successful career.

17:00-17:30

Adaptive weak Galerkin method for stationary linear convection-diffusion problem

Natasha S Sharma University of Texas at El Paso

Abstract: The accuracy of numerical solutions to convection-diffusion problems is often marred by the presence of layers in a convection dominated regime. A natural tool to overcome this difficulty is to adaptively refine the mesh in regions where these layers get formed. We present an adaptive weak Galerkin finite element method which serves this purpose. Results of numerical experiments are presented to illustrate the performance of this method especially in the presence of boundary layers.

17:30-18:00

An adaptive high-order piecewise polynomial based sparse grid collocation method with applications

Yingda Cheng Michigan State University

Abstract: In this talk, we present the construction of adaptive sparse grid collocation methods based on interpolatory MRA onto general arbitrary order piecewise polynomial space. The motivation is to compute high-dimensional problems with reduced computational cost, while achieving high order accuracy with a natural framework for adaptivity. Theoretical justification will be provided, and applications in stochastic and partial differential equations are considered.

18:00-18:30

Primal dual method for Wasserstein gradient flow

Li Wang University of Minnesota

Abstract: We develop a variational method for nonlinear equations with a gradient flow structure. Our method builds on the JKO framework, which evolves the equation as a gradient flow with respect to the Wasserstein metric. As a result, our method has built-in positivity preserving, entropy decreasing properties, and overcomes stability issue due to the strong nonlinearity and degeneracy. Furthermore, our method is massively parallelizable, and thus extremely efficient in high dimensions.

18:30-19:00

Mathematical modeling of tumorigenesis

Leili Shahriyari University of Texas Arlington

Abstract: One of the key components of the stochastic process of carcinogenesis is evolving tumors. Recently, several computational models have been developed to investigate such a complex phenomenon and to find potential therapeutic targets. We present novel computational models to gain some insight about the evolutionary dynamics of cancer. We then propose an innovative framework to systematically employ a combination of mathematical and bioinformatics techniques to model the process of tumorigenesis.

MS A1-2-3 1 17:00-19:00

Information extraction using the graph Laplacian

Organizer: Martin Stoll TU Chemnitz
Organizer: Michele Benzi Scuola Normale Superiore

Abstract: The graph Laplacian is at the heart of many applications ranging from data science to image processing. While some applications are naturally represented via networks, for others, the network representation is a crucial modelling aspect. The graph Laplacian then reflects the complex interactions between the nodes and from it a rich body of information can be extracted about, for example, the number of components of the graph, centrality measures, graph cuts, learning uncertainty, etc. Our minisymposium addresses recent developments extracting information from the standard and even more general Laplacians with modelling and numerical insights at its core.

17:00-17:30

Uncertainty quantification in graph models for machine learning

Andrea Bertozzi	UCLA
Hao Li	UCLA
Andrew Stuart	CalTech
Kevin Miller	UCLA
Xiyang Luo	UCLA

Abstract: Classification of high dimensional data finds wide-ranging applications. I discuss recent work that develops algorithms for, and investigate the properties of a variety of Bayesian models for the task of graph-based classification.

17:30-18:00

Spectral Clustering for Signed and Multilayer Graphs via Matrix Power Means

Pedro Mercado University of Tuebingen

Abstract: We present an extension of spectral clustering for the case when different kinds of interactions are present. We consider a one-parameter family of matrix functions, known as matrix power means, to merge the information encoded from different kinds of interactions. We show that different means identify clusters under different settings. For instance, we show that a limit case identifies clusters if at least one layer is informative and the remaining layers are potentially just noise.

18:00-18:30

Graph Laplacians for clustering and maximum cut computations

Yves Van Gennip Delft University of Technology

Abstract: Various graph Laplacians have been used for graph clustering in classic algorithms such as spectral clustering and in more recent approaches that use the graph Ginzburg--Landau functional or the Merriman--Bence--Osher scheme. We will discuss some of these approaches, as well as a variant of these techniques which allows for fast computation of maximum cuts on graphs.

18:30-19:00

NFFT Meets Krylov Methods: Fast Matrix-Vector Products for the Graph Laplacian of Fully Connected Networks

Martin Stoll TU Chemnitz
Stoll Martin TU Chemnitz

Abstract: Computations, in particular matrix-vector products, with the graph Laplacian are a hard task. A typical application is the computation of a number of its eigenvalues and eigenvectors. We propose the use of the fast summation based on the nonequispaced fast Fourier transform (NFFT) to perform the dense matrix-vector product with the graph Laplacian fast without ever forming the whole matrix.

MS FT-1-3 1 17:00-19:00

Nonlinear and multiparameter eigenvalue problems - Part 1

For Part 2 see: MS FT-1-1 2
For Part 3 see: MS FT-1-1 3
For Part 4 see: MS FT-1-1 4
For Part 5 see: MS FT-1-1 5
For Part 6 see: MS FT-1-1 6
For Part 7 see: MS FT-1-1 7

Organizer: Fernando De Terán Universidad Carlos III de Madrid
Organizer: Froilán M. Dopico Universidad Carlos III de Madrid

MS Organized by: SIAG/LA

Abstract: A nonlinear eigenvalue problem (NLEVP) is to find scalars x (eigenvalues) and nonzero vectors v,w (eigenvectors) satisfying F(x)v=0, w*F(x)=0, where F:C→Cnxn is a matrix-valued function.

NLEVPs can be extended to multiparameter eigenvalue problems (MPEPs) F(x1,...,xd)v=0, w*F(x1,...,xd)=0, with F:Cd→Cnxn. Important cases of NLEVPs are the polynomial and rational eigenvalue problems, where the entries of F(x) are polynomial or rational functions. NLEVPs and MPEPs arise in many applications, and much research on these problems has been performed in the last years from computational and theoretical perspectives. This minisymposium presents the most recent advances in NLEVPs and MPEPs, and on their applications.

17:00-17:30

A survey on NLEVPs and multiparameter eigenvalue problems

Fernando De Terán — Universidad Carlos III de Madrid

Abstract: In this talk, intended for a broad audience, we will first review the notion on NLEVP and multiparameter eigenvalue problem, together with some of their basic features. Then, we will review some of their applications. Finally, we will present a survey on the main different approaches, techinques, and tools for the solution of NLEVPs and multiparameter eigenvalue problems presented so far in the literature.

17:30-18:00

Distance Problems for Matrix Polynomials via Block Toeplitz matrices

Shreemayee Bora — IIT GUWAHATI

Biswajit Das — IIT GUWAHATI

Abstract: Given a regular matrix polynomial, the distance to a nearest regular matrix polynomial with a Jordan chain of specified minimum length, and also the one to a nearest matrix polynomial with specified maximum normal rank are considered. In the latter case, particular focus is on nearest singular matrix polynomials. It is shown that certain block Toeplitz matrices provide an understanding of the relationship between their solutions and the location of nearest polynomials of interest.

18:00-18:30

Accuracy and stability of polynomial eigenvalue solvers based on linearization

Javier Perez Alvaro — University of Montana

Froilan M. Dopico — Universidad Carlos III de Madrid

Paul Van Dooren — Universite catholique de Louvain

Abstract: The standard way of solving numerically a polynomial eigenvalue problem is to use a linearization and solve the corresponding generalized eigenvalue problem. A rich source of structured and unstructured linearizations is the family of block-Kronecker pencils, which contains the well-known families of Fiedler and generalized Fiedler linearizations. In this talk, we will analyze some recent resuts on how the linearization process influences the conditioning and the accuracy of computed eigenvalues and eigenvectors.

18:30-19:00

Nonlinear eigenvalue problems and contour integration

Simon Telen

Abstract: Based on contour integration, nonlinear eigenvalue problems involving analytic matrix functions can be transformed into generalized eigenvalue problems. The contour integrals are approximated numerically by a quadrature formula, which corresponds to a filter function. In this talk the properties of such a filter function as well as its implications on the nonlinear eigenvalue approximation problem will be investigated.

MS A6-5-3 1 — 17:00-19:00

Mathematics and Computation for Clinical Problems - Part 1

For Part 2 see: MS A6-5-3 2

For Part 3 see: MS A6-5-3 3

Organizer: Hiroshi Suito — Tohoku University, Japan

Organizer: Takuya Ueda — Tohoku University

Organizer: Norikazu Saito — The University of Tokyo

Abstract: We shall present several topics that have arisen through collaboration between mathematical science and clinical medicine. Our targets include leading-edge technologies in clinical applications from 4D-flow MRI to machine learning applications. Together with these studies, strong mathematical foundations are indispensable for reliable and efficient implementations. Through close collaboration with physicians, those analyses can yield greater understanding leading to better risk assessments. Throughout this mini-symposium, we seek discussion of how mathematical science might contribute to the clinical medicine of our present and future society. This mini-symposium comprises three parts: I. Clinical applications; II. Computational modeling; and III. Mathematical tools and foundations.

17:00-17:30

Medical Application of Mathematical tools: What doctors expect from mathematical analysis.

Takuya Ueda — Tohoku University

Abstract: In recent years, computational fluid dynamics (CFD) has attracted considerable attention in cardiovascular medicine. In addition to traditional assessment based on anatomical information, the CFD-based approach provides an opportunity to gain novel insights into vascular pathophysiology by exploring the relationship between structure and biomechanical forces in flow dynamics. In this session, we will discuss how physiological parameters that is analyzed by CFD modeling impacts on the clinical medicine, especially focusing of aortic diseases.

17:30-18:00

Machine learning in anemia control for hemodialysis patients

Yoshiki Sugitani — Tohoku University

Hiroshi Suito — Tohoku University

Viet Huynh — Tohoku University

Toshiaki Ohara — Okayama University

Kazufumi Sakurama — Okayama University

Masaru Kinomura — Okayama University

Hiroshi Ikeda — Shigei Medical Research Hospital

Abstract: Against anemia, a major difficulty for hemodialysis patients, erythropoiesis-stimulating agents and iron supplements are used as preventive measures. Such treatments are usually administered by specialized physicians, most of whom cannot keep up with the increasing number of hemodialysis patients. We developed the AI diagnosis system for these two forms of medication by neural networks. Since the data set is inbalanced, we introduced efficient training methods such as class weights and thresholds.

18:00-18:30

Clinical application of 4D flow MRI

Hideki Ota — Tohoku University

Abstract: With the development of MRI hardware and software, 4D flow MRI that acquires three-dimensional blood flow velocity and encodes volume coverage has been available for the evaluation of various cardiovascular diseases. 4D flow MRI allows retrospective flow measurement at any cross-sections and 3D flow visualization through postprocessing. More advanced flow parameters based on fluid dynamics can also be obtained. The basics of 4D flow MRI and its clinical applications will be discussed in this presentation.

18:30-19:00

On the complexity required for clinically-relevant computational analysis of coronary atherosclerosis

Ryo Torii — University College London

Christos Bourantas — Barts Heart Centre and University College London

Abstract: Computational models have been utilised to provide more in-depth information, on top of imaging and/or catheterisation data, for diagnostic and future risk prediction of atherosclerotic disease in coronary arteries. Considering clinical context, it is important to provide meaningful data within reasonably short analysis time, especially in large cohort studies. We discuss the complexity required in such models, to be able to achieve an optimal balance between physiological representation and computational cost.

MS ME-0-5 1 — 17:00-19:00

Integrable systems and beyond - Part 1

For Part 2 see: MS ME-0-5 5

For Part 3 see: MS ME-0-5 6

Organizer: Baofeng Feng — University of Texas Rio Grande Valley

Organizer: Peter Miller — University of Michigan

Organizer: Sara Lombardo — Mathematical Sciences, School of Science, Loughborough University

Abstract: Integrable systems arise in various branches of applied mathematics, notably in the study of nonlinear wave propagation and in integrable probability or mathematical physics. These applications have benefited from the use of functional analysis, asymptotic analysis, as well as algebraic and geometric reasoning to study the underlying integrable systems. This session aims to bring together researchers applying a wide range of tools to integrable models in order to solve important and interesting applied problems.

17:00-17:30

Extreme superposition: rogue waves of infinite order and the Painlevé-III hierarchy

Peter Miller — University of Michigan

Abstract: In joint work with Deniz Bilman and Liming Ling, we study a Riemann-Hilbert representation of the fundamental rogue wave solution of focusing NLS in the limit of large order, establishing the existence of a limiting profile in the near-field region where the solution has the largest amplitude. The limiting profile is a new solution of the same PDE which also satisfies ordinary differential equations of Painlevé type with respect to space and time.

17:30-18:00

Integrability and continuous wave instabilities: an algebraic-geometry approach

Matteo Sommacal — Northumbria University
Sara Lombardo — Loughborough University
Antonio Degasperis — University of Rome "La Sapienza"

Abstract: A simple, direct construction of the eigenmodes of the linearization of 1+1, multicomponent, nonlinear, integrable systems, is employed to study the instabilities of continuous waves, as well as to classify the stability spectra, providing a necessary condition in the parameters for the onset of rational solitons. The theory will be presented using the example of the vector nonlinear Schrödinger equation. The derivation of the stability spectra is completely algorithmic and makes use of elementary algebraic-geometry.

18:00-18:30

Rogue Wave Type Solutions and Spectra of Coupled Nonlinear Schroedinger Equations

Sara Lombardo — Loughborough University
Antonio Degasperis — Physics, “Sapienza” Università di Roma, Italy
Matteo Sommacal — Mathematics, Physics and Electrical Engineering, Northumbria University, Newcastle upon Tyne, UK

Abstract: We consider an integrable model describing the interaction of two waves, namely the system of two coupled nonlinear Schrödinger equations (Manakov model). We discuss linear stability properties by computing the stability spectrum and the gain function (or growth rate). In contrast with the nonlinear Schroedinger equation, different types of single rogue wave type solutions exist which correspond to different values of the spectral variable even in the same spectrum.

18:30-19:00

When J. Ginibre met E. Schroedinger

Thomas Bothner — King's College London
Jinho Baik — University of Michigan

Abstract: The real Ginibre ensemble consists of square real matrices whose entries are i.i.d. standard normal random variables. In sharp contrast to the complex and quaternion Ginibre ensemble, real eigenvalues in the real Ginibre ensemble attain positive likelihood. We will show that the limiting distribution of the largest real eigenvalue admits a closed form expression in terms of a distinguished solution to an inverse scattering problem for the Zakharov-Shabat system.

MS A3-S-C1 1 — 17:00-19:00

Deep Learning and Linear Algebra

Organizer: Alfred Peris — Universitat Politecnica de Valencia
Organizer: Gilbbert Strang — MIT

Abstract: Deep learning creates a function that (nearly) gives the known outputs from the sample inputs in the training data. This learning function F is a composition of affine functions and a standard nonlinear function: often ReLU(x) = max (0,x). The matrices A and bias vectors b in the affine functions Ax + b are the weights to be optimized in learning the data. The word "deep" indicates many layers of A, b, and ReLU in F. This session develops the mathematics, describes the software that has made deep learning so powerful, and shows some of its applications in biomedicine.

17:00-17:30

Deep Learning with Continuous Piecewise Linear Functions

Gilbert Strang — Massachusetts Institute of Technology

Abstract: Deep learning produces a function that matches known outputs on a training set and also succeeds on unseen data from the same population. The function is continuous piecewise linear: a composition F = F_L (F_L-1(... (F_1))) of functions max ((Av + b) , 0). The depth is L. The weights A and b minimize the error between F(v) and the known output --- the difference is small even for new test data.

17:30-18:00

A Round Trip between Linear Algebra and Neural Networks via High Performance Computing

Enrique Quintana — Universitat Politècnica de València

Abstract: This talk will review the connection between basic computational kernels from linear algebra, machine learning algorithms and deep learning frameworks. Among these kernels, we can find the general matrix-matrix multiplication as well as sparse variants of this operation. On the way back from our "trip", we will leverage machine learning techniques to i) estimate the execution time of linear algebra kernels on a computer and ii) select the best algorithm among several highly tuned implementations.

18:00-18:30

Community detection based architectures for deep learning: a fully automated framework for Likert-scales

Francisco Javier Pérez Benito Benito — Universitat Politécnica de Valencia
J. Alberto Conejero — Universitat Politécnica de Valencia
Juan Miguel García-Gómez — Universitat Politécnica de Valencia
Esperanza Navarro — Universitat de Valencia

Abstract: The principal disadvantage of models based on Deep Neural Networks (DNN) is that the architecture design requires prior knowledge in the study field. We present a methodology based on community detection within a conceptual-structured data framework to automatically construct the architecture. Results tested on a real database covering socio-demographic-data and the responses to four psychometric scales (COPE, EPQR-A, GHQ-28, MOS-SSS)-searching an estimation of happiness degree- showed better results compared to previous existing DNN architectures (D-SDNN).

18:30-19:00

Practical Deep Learning in the Classroom

Loren Shure — MathWorks

Abstract: Deep learning is quickly becoming embedded in everyday applications. It’s becoming essential for students to adopt this technology, almost regardless of what their future jobs are. We will highlight some of the mathematics needed to construct and understand deep learning solutions.

MS A3-3-L1 1 — 17:00-19:00

Recent advances on numerical methods and analysis of complex fluids - Part 1

For Part 2 see: MS A3-3-L1 2
For Part 3 see: MS A3-3-L1 3
For Part 4 see: MS A3-3-L1 4
For Part 5 see: MS A3-3-L1 5

Organizer: Zhonghua Qiao — The Hong Kong Polytechnic University
Organizer: Hui Zhang — Beijing Normal University

Abstract: The goal is to integrate advances in mathematics (theory, modeling, algorithms, simulations, high performance computing techniques) with new experimental data from complex fluids and biological systems, and targeted applications. The specific systems represented include liquid crystal flow, polymeric flow and magnetic fluids, phase-field and beyond these area.

17:00-17:30

Efficient numerical methods for a diffusive interface model with Peng-Robinson equation of state

Yuze Zhang — The Hong Hong Polytechnic University
Zhonghua Qiao — The Hongkong polytechnic university
Shuyu Sun — King Abdullah University of Science and Technology
Tao Zhang — King Abdullah University of Science and Technology

Abstract: A new multi-component diffuse interface model with the Peng-Robinson equation of state is developed. Initial values of mixtures are given through the NVT flash calculation. The scalar auxiliary variable (SAV) approach is employed to design numerical schemes. It reformulates the proposed model into a decoupled linear system with constant coefficients that can be solved by fast Fourier transform. Energy stability is obtained in the sense that the modified discrete energy is non-increasing in time.

17:30-18:00

Overlapping localized exponential time differencing methods for semilinear parabolic equations

Xiao Li — University of South Carolina

Abstract: We study the localized exponential time differencing method based on overlapping domain decomposition for a class of semilinear parabolic equations within the Allen-Cahn equation as a special case. We prove the equivalence of the multidomain and monodomain space-discrete problems and, by establishing the maximum-bound-principles, prove the convergence of the fully discrete solution to the exact space-discrete solution. Numerical experiments are carried out to verify the theoretical results and test the efficiency of the proposed schemes.

18:00-18:30

Approximation for two-phase flow problems by using Onsager Principle

Xianmin Xu — AMSS, Chinese Academy of Sciences

Abstract: Many two-phase flow problems are quite complicated due to the existence of moving contact lines and shape transition of two-phase interfaces. Both numerical simulations and analytical study for these problems are very challenging. In this talk, we will show that the Onsager principle could be used as a powerful approximation tool in these problems. This is illustrated by examples for sliding droplets on an inclined surface, capillary rising for a thin soap film, etc.

MS A6-3-4 1 **17:00-19:00**

Geometric inverse problems and parameter estimation

Organizer: BenAmeur Hend — LAMSIN-ENIT, University of Tunis El Manar and IPEST University of Carthage

Abstract: In the domain of mathematical physics, some problems are related by a sort of duality in the sense that one problem can be obtained from the other by exchanging the role of the data and that of the unknowns. Usually one of the two problems consists of computing the consequences of given causes sush as properties of the studied material, it's called direct problem. While the other consists of finding the unknown potential causes of known consequences, it's called inverse problem. In this session recent theoritical and numerical studies of some inverse problems with different applications will be presented.

17:00-17:30

Fractional Flow Reserve in a stenosed coronary artery

Habbal Abderrahmane — University Cote d'azur

Aboulaich Rajae — LERMA, Mohammadia Engineering School, Mohamed V University in Rabat, Morocco.

Abdelkhirane Cherif — Department of Interventional Cardiology, Clinique des specialites Achifaa, Casablanca, Morocco

Chahour Keltoum — University Cote d'Azur and LERMA, Mohammadia Engineering School, Mohamed V University in Rabat

Zemzemi Nejib — INRIA Bordeaux Sud Ouest, Carmen Project, France.

Abstract: Fractional flow reserve (FFR) has proved its efficiency in improving patients diagnosis. We consider a 2D reconstructed left coronary tree with lesions of different degrees. We use a generalized fluid model with a Carreau law and Windkessel boundary conditions. We compare the FFR results for Navier Stokes vs generalized flow models, and for Windkessel versus free outlets boundary conditions. Our results highlight the fact that free outlets BC are sensitive to the FFR sensor position.

17:30-18:00

Towards the estimation of the ionic model parameters in multi-scale modelling of the electrical

Zemzemi Nejib — INRIA

Abstract: We consider the inverse problem of determining multiple ionic parameters in a strongly coupled parabolic-elliptic reaction-diffusion system arising in cardiac electrophysiology modelling. We use the bidomain model coupled to a physiological model describing the ionic exchanges at the microscopic level. We prove the uniqueness and Lipschitz stability estimates of the ion channels conductance parameters of the model using observation on part of the domain. We also provide a strategy for the estimation of these parameters.

18:00-18:30

Some geometric inverse problems in elasticity and thermoelasticity

BenAmeur Hend — LAMSIN-ENIT, University of Tunis El Manar and IPEST University of Carthage

Abstract: We are interested on crack identification in thermoelasticity. The considered data are boundary measurements. We study the stability of this problem restricting our selfs to identification of a straight emergent crack in the static thermoelastic case.To identify such cracks numerically, we split the process into two steps; we identify the direction then the length of the crack. We study the uniqueness of the solution of the crack identification problem in a more general case.

MS FT-2-1 1 **17:00-19:00**

Computing with rational functions - Part 1

For Part 2 see: MS FT-2-1 2

For Part 3 see: MS FT-2-1 4

Organizer: Yuji Nakatsukasa — University of Oxford

Organizer: Stefan Guettel — The University of Manchester

Organizer: Nick Trefethen — University of Oxford

Abstract: Many numerical algorithms rely on rational functions, whether implicitly or explicitly, because of their power for approximation with singularities or on unbounded domains. This is an exciting time for this field, with many recent developments. In fundamental algorithms these include RKFIT, the AAA method, and advances in the Loewner framework. Application areas include fast solution of PDEs, rational filters for parallel eigensolvers, model order reduction, and nonlinear eigenvalue problems. There have even been recent surprises on the theoretical side of rational approximation. This minisymposium will discuss progress on these challenging methods, whose importance seems set to grow in the future.

17:00-17:30

The AAA algorithm for rational approximation

Yuji Nakatsukasa — University of Oxford

Olivier Sete — TU Berlin

Lloyd N. Trefethen — University of Oxford

Abstract: The AAA (adaptive Antoulas-Anderson) algorithm computes a rational approximation given real or complex sample points. The core ideas are (1) barycentric representation of the rational approximant, (2) greedy selection of the support points to facilitate convergence and avoid exponential instabilities, and (3) least-squares rather than interpolatory formulation of the overall problem. AAA often gives near-best approximants and can outperform previous methods even on simple domains, and can be applied to model order reduction.

17:30-18:00

Rational approximation in the Loewner framework

Ion Victor Gosea — Max Planck Institute

Athanasios C. Antoulas — Rice University

Abstract: The Loewner framework is a data-driven model identification and reduction method. It constructs rational functions which accurately interpolate the underlying function. This method relies on compressing the given data set and extracting meaningful quantities. It is a direct method which does not rely on iteration. The fitted rational function is written in barycentric representation. We apply the method to various non-rational functions typically encountered in approximation theory, such as the Heaviside and modulus functions.

18:00-18:30

Constructions and uses of rational approximations for computational quantum chemistry

Anil Damle — Cornell University

Abstract: Fermi operator expansions play a key role in accelerating Kohn-Sham density functional theory calculations. As the effectiveness of these expansions is captured by the number of terms in the representation, rational functions are a natural choice. In this talk we discuss recent work on building rational functions for Fermi operators and related functions simultaneously using the same set of poles and demonstrate the methods practical effectiveness for Kohn-Sham density functional theory calculations.

18:30-19:00

Rational approximation of the nonlinear eigenvalue problem

Karl Meerbergen — KU Leuven - Dept. Computer Science

Abstract: We solve nonlinear eigenvalue problems using the AAA rational approximation method. We present modifications of AAA that support the efficient solution of nonlinear eigenvalue problems. We also report on model order reduction of linear systems described by nonlinear matrix valued functions of the Laplace variable. We show that the same techniques can be used as for the nonlinear eigenvalue problem, but with a significantly lower computational cost than the sampling methods.

IM FT-4-2 1 — 17:00-19:00

Academia-industry case studies from MI-NET and ECMI

Organizer: Katerina Kaouri — Cardiff University, UK

Organizer: Marin Lujak — IMT LIlle Douai

Abstract: To highlight successful collaborations between academia, business and society, some Case Studies (CS) linked to the European Consortium for Mathematics in Industry (ECMI) and the Mathematics for Industry Network (MI-NET, COST Action TD1409) are presented. These CSs emanate from European Study Groups with Industry (ESGIs), Modelling Weeks, and research visits (STSMs). Speakers: D. Hömberg (DE): MI-NET overview, ECMI case studies, Marie Curie EID projects K. Kaouri (UK): MI-NET CS booklet L.J. Pérez-Pérez (ES): ESGI139 CS on mechanical modelling of ceramic cups in blast furnaces (supported by MI-NET) M. Lujak (FR): STSM on break assignment in emergency fleets (funded by MI-NET)

17:00-17:30

MSO for steel production and manufacturing

Dietmar Hömberg — Weierstrass Institute (WIAS)

Manuel Arenas — Weierstrass Institute

Prerana Das — EFD Induction

Abstract: In my presentation, I will illustrate the application of MSO concepts in production and manufacturing of steel presenting results from recent industrial collaborations in the framework of the MSC-EID project MIMESIS. Applications range from temporal mutliscale methods for multifrequency induction hardening to high frequency induction welding and the flame cutting of steel plates.

17:30-18:00

European Study Groups with Industry in Cyprus: a series of challenges

Katerina Kaouri — Cardiff University, UK

Margarita Zachariou — Cyprus Institute of Neurology and Genetics, Cyprus

Abstract: We will describe the initiation and evolution of European Study Groups with Industry in Cyprus, which were supported by the Mathematics for Industry Network (MI-NET), the European Consortium for Mathematics in Industry (ECMI), SciShops.eu and several other organisations and stakeholders. We will relay several successful collaborations between academia, businesses and society that emanated from the Cypriot Study Groups, ranging from optimizing water management in the Germasogeia aquifer to breaking barriers for women in science.

18:00-18:30

Equivalent mechanical modelling for the ceramic cup of a blast furnace

Luis Javier Pérez Pérez — Universidade de Santiago de Compostela

Patricia Barral Rodiño — Universidade de Santiago de Compostela

Peregrina Quintela Estévez — Universidade de Santiago de Compostela

Abstract: The ceramic cup is a masonry formed by refractory bricks and mortar joints located inside the wall of a Blast Furnace. In order to perform simulations of its thermo-mechanical behaviour, considering each individual brick and joint is computationally unfeasible. We propose a methodology that enables to reduce the computational cost by finding an equivalent material by solving numerical compression and shear tests on a representative unit cell of the masonry.

18:30-19:00

Break assignment in emergency fleets

Marin Lujak — IMT Lille Douai

Abstract: Emergency fleet break scheduling should consider both area coverage by idle vehicles and vehicle crews' service requirements for breaks to avoid fatigue. In this STSM, we address this issue proposing a break assignment problem considering area coverage (BAPCAC) for which we formulate a mathematical model. The BAPCAC model can be used to dimension a fleet’s size and to decide upon the strategies of break scheduling. The performance of the model is evaluated in simulation experiments.

MS GH-3-4 1 — 17:00-19:00

Nonlocal Modeling, Analysis, and Computation - Part 1

For Part 2 see: MS GH-3-4 2
For Part 3 see: MS GH-3-4 3
For Part 4 see: MS GH-3-4 4
For Part 5 see: MS GH-3-4 5

Organizer: Robert Lipton — Louisiana State University

Organizer: Pablo Seleson — Oak Ridge National Laboratory

Organizer: Qiang Du — Columbia University

Abstract: The past decade has seen a rapid growth in the development of nonlocal mathematical models. Nonlocal modeling is now being used in applications including continuum mechanics and fracture mechanics, anomalous diffusion and advection diffusion, and probability models. This minisymposium seeks to bring together mathematicians and domain scientists from different disciplines working on nonlocal modeling and is intended to serve as international forum for the state of the art in the modeling, analysis, and numerical aspects of nonlocal models.

17:00-17:30

The limit as $p\infty$ in free boundary problems with fractional p-Laplacians.

Julio Daniel Rossi — Universidad de Buenos Aires

Abstract: We deal with the p-fractional optimal design problem under volume constraint taking special care of the case when p is large, obtaining in the limit a free boundary problem modeled by the Hölder Infinity Laplacian operator.

17:30-18:00

Nonlocal convection-diffusion model and its numerical simulation

Hao Tian — Ocean University of China

Qiang Du — Columbia University

Lili Ju — University of South Carolina

Abstract: In this talk, we propose a non-local convection-diffusion model, in which the convection term is constructed in a special upwind manner so that mass conservation and maximum principle are maintained in any space dimension. The well-posedness of the proposed non-local model and its convergence to the classical local convection-diffusion model are established. Numerical experiments are also performed to complement the theoretical analysis.

18:00-18:30

Nonlocal Models with Nonstandard Interaction Domains.

Marta D'elia — Sandia National Laboratories

Abstract: Numerical solution of nonlocal models via FEM in 2 or 3D can be prohibitively expensive. This is due to the fact that points in a domain interact with a neighborhood of points. Standard neighborhoods are Euclidean balls; this creates computational challenges in terms of assembling and accuracy of FE matrices. We propose a new concept of neighborhood that makes the assembling process easier and faster. We analyze the new nonlocal model and present numerical results.

18:30-19:00

A probabilistic numerical scheme for nonlocal diffusion equations in 3D irregular domains with applications in groundwater flow

Guannan Zhang — Oak Ridge National Laboratory

Minglei Yang — Auburn University

Yanzhao Cao — Auburn University

Abstract: We developed a new probabilistic numerical scheme for a class of nonlocal diffusion equations with integrable kernels in 3D irregular domains. In our method, the nonlocal diffusion operator is firstly converted to its adjoint operator and then approximated by conditional expectation with respect to the associated SDE. As such, the proposed method does not require solving potentially dense linear systems. Error analysis and numerical examples will be presented to illustrate the effectiveness of our approach.

MS A6-2-2 1 17:00-19:00

New Trends on Toeplitz matrices and operators - Part 1

For Part 2 see: MS A6-2-2 2

Organizer: Natalia Bebiano	University of Coimbra
Organizer: Susana Furtado	Faculdade de Economia do Porto
Organizer: Rosário Fernandes	Universidade Nova de Lisboa

Abstract: Toeplitz matrices and operators is an important topic in mathematics, with applications in different areas of this science, as well as in other sciences, as engineering, chemistry and economics. Recently, with progress in the investigation of numerical methods, matrix polynomials and graph theory, theoretical advances, as well as new applications, have been obtained concerning the study of Toeplitz and other related structured matrices. The main aim of this MS is to bring together researchers from matrix numerical analysis and related areas, and to present emerging results at the frontiers of these fields, with emphasis in applications.

17:00-17:30

Nearness problems for Tridiagonal Complex Matrices

Susana Furtado	University of Porto and CEAFEL
Natália Bebiano	University of Coimbra

Abstract: In this talk we consider complex tridiagonal matrices and study the distance, measured in the Frobenius norm, of such matrices to normality. Characterization of the closest normal matrices is presented. Tridiagonal matrices with some additional structures are analyzed.

17:30-18:00

Fermionic chain model with a non-Hermitian Hamiltonian

Natália Bebiano	University of Coimbra and CMUC

Abstract: In this talk, we review the quantum mechanical setting of a fermionic system associated to {a non-Hermitian Hamiltonian with real eigenvalues}. Spectral properties of the Hamiltonian are investigated. The eigenfunctions associated to the real simple eigenvalues are shown to form complete systems. The fermionic normal modes are described by a 2-Toeplitz matrix. A new inner product, appropriate for the physical interpretation of the model, has been consistently introduced. The dynamics of the system is described.

18:00-18:30

On functions of quasi-Toeplitz matrices

Beatrice Meini	University of Pisa
Dario A. Bini	University of Pisa
Massei Stefano	EPFL Lausanne

Abstract: We consider the problem of computing a matrix function , where is a Quasi-Toeplitz matrix, i.e., where , for , is the semi-infinite Toeplitz matrix associated with the symbol , and is a compact operator in , with . We show that, under suitable assumptions on and , a Quasi-Toeplitz matrix of the kind . The special case of the exponential function is treated in detail. Computational issues are also taken into account.

MS A6-5-2 1 17:00-19:00

Mathematical modeling and scientific computing in life sciences - Part 1

For Part 2 see: MS A6-5-2 2

Organizer: Douglas Zhou	Shanghai Jiao Tong University
Organizer: Hao Ge	Peking University

Abstract: As advanced experimental tools have been developed and applied to life sciences, researchers are capable of obtaining massive data over scales ranging from the molecule, single cell, to network systems. How to integrate all these data to build efficient mathematical models becomes a challenging issue. As more realism is incorporated into models, novel dynamical features often arise which further enrich our understanding of the biological systems. This minisymposium explores this theme by discussing recent works in mathematical modeling and scientific computing in life sciences. The speakers will draw particular attention to new mathematical approaches in explaining various experimental observations.

17:00-17:30

Chaotic or nonchaotic dynamics in neuronal networks?

Douglas Zhou	Shanghai Jiao Tong University
Qinglong Gu	Shanghai Jiao Tong University
Aaditya Rangan	New York University
Yi Sun	New York University
Gregor Kovacic	Rensselaer Polytechnic Institute
David Cai	New York University

Abstract: In this talk, I will address two issues related to the dynamical stability of integrate-and-fire type neuronal networks. i) Whether there exists chaotic dynamics in I&F neuronal networks. ii) Whether the irregular firing activity of balanced neuronal networks arise from chaotic dynamics.

17:30-18:00

The Nonequilibrium Mechanism of Noise Enhancer synergizing with Activator in HIV Latency Reactivation

Hao Ge	Peking University
Lei Zhang	Peking University
Xiaolu Guo	Peking University
Tao Tang	Peking University

Abstract: Reactivating HIV latency and then simultaneously eliminating it by antiretroviral therapy has become a leading strategy in curing HIV. Recently single-cell screening experiments have shown the drug synergy between activator (AC) and noise enhancer (NE). We propose mechanistic models with both AC/NE-DNA binding kinetics and positive feedback of Tat circuit, which not only successfully reproduce all the known important experimental observations but also provide further mechanistic insights into the drug synergy.

18:00-18:30

Evolution of anisotropic diffusion in heterogeneous landscapes

Yuan Lou	The Ohio State University
Emeric Bouin	University Paris Dauphine
Guillaume Legendre	University Paris Dauphine
Nichole Slover	Ohio State University

Abstract: The competition of two species in a two-dimensional habitat is considered. We assume that two species are identical in competitive ability and the only difference is their tendency to move horizontally or vertically. We study how organisms should disperse horizontally and vertically in spatially heterogeneous environment. We find that the evolutionarily stable strategy is to move either vertically or horizontally, instead of a mixture of vertical and horizontal movement.

18:30-19:00

Reconstruct Single Cell Phenotypic Conversion Dynamics

Jianhua Xing	University of Pittsburgh
Weikang Wang	University of Pittsburgh
Jingyu Zhang	University of Pittsburgh
Simon Watkins	University of Pittsburgh
Callen Wallace	University of Pittsburgh

Abstract: Mammalian cells with the same genome can assume distinct phenotypes. Reconstruction of the single cell dynamical process of transforming between different phenotypes is of great biomedical and basic science importance, and is also a challenging problem in applied mathematics. Here we present a framework to extract single cell dynamical parameters from experimental data by combining live cell imaging and quantitative image analysis, as guided by nonlinear dynamical systems theories.

MS FT-4-7 1 17:00-19:00

Iterative processes for solving nonlinear problems: Convergence and Stability - Part 1

For Part 2 see: MS FT-4-7 2
For Part 3 see: MS FT-4-7 3
For Part 4 see: MS FT-4-7 5

Organizer: Juan Torregrosa	Universitat Politècnica de València

Abstract: Solving nonlinear equations and systems is a non-trivial task that involves many areas of Science and Technology. Usually it is not affordable in a direct way and iterative algorithms play a fundamental role in their approach. The main theme of this Special Issue, but not the unique, is the design, analysis of convergence and stability and application to practical problems of new iterative schemes for solving nonlinear problems. This includes methods with and without memory, with derivatives of derivative-free, the real or complex dynamics associated to them and an analysis of their convergence that can be local, semilocal or global.

17:00-17:30

Dynamical tools for analyzing the stability of iterative methods

Francisco I. Chicharro	Universidad Internacional de La Rioja

Abstract: The stability of iterative methods can be analyzed in a graphical way. Taking into account the basics of dynamical systems, several representations help to understand the stability and, therefore, the goodness of an iterative procedure. Several tools can be implemented depending whether the method has memory or not, or whether the method is applied on real or complex variable: the dynamical line or plane, the parameters line or plane, the unified line or plane…

17:30-18:00

Iterative solvers with memory for nonlinear problems

Javier G. Maimó	Instituto Tecnológico de Santo Domingo
Alicia Cordero	UPV
Juan R Torregrosa	UPV
Maria P Vassileva	INTEC

Abstract: Iterative methods for solving nonlinear equations are said to be with memory when the calculation of the next iterate requires the use of more than one previous iteration. With the right choice of parameters, iterative methods without memory can increase their order of convergence significantly, becoming schemes with memory. We extend a scalar method to the multidimensional case and show numerical tests and a dynamical study to show its stability

18:00-18:30

Iterative methods for approximating the pseudoinverse of a complex matrix

Juan R. Torregrosa	Universitat Politècnica de València
Santiago Artidiello	Instituto tecnológico de Santo Domingo
Alicia Cordero	Universitat Politècnica de València
María P. Vassileva	Instituto tecnológico de Santo Domingo

Abstract: A parametric class of fourth-order schemes for approximating the inverse and pseudoinverse of a complex matrix is designed. A particular value of the parameter allows us to reach order five. The convergence of the different methods is analyzed. A numerical comparison with others known schemes in terms of number of matrix multiplication and the mean of CPU time is done. The test examples used are large random matrices.

18:30-19:00

Stability of high-order iterative methods in the multidimensional context

Alicia Cordero	Universitat Politècnica de València
Juan R. Torregrosa	Universitat Politècnica de València
Javier G. Maimó	Instituto Tecnológico de Santo Domingo
María P. Vassileva	Instituto Tecnológico de Santo Domingo

Abstract: Iterative methods play an important role many nonlinear problems arising in Science and Engineering. In the last decade, the focus in this field has been in the design, paying special attention to the order of convergence and efficiency. Nevertheless, their stability in terms of dependence of the initial estimations used is of critical importance when they must be applied on real problems, where usually there are no hints about which can be the solution.

MS FE-1-3 1 17:00-19:00

Nonlinear optimization for inverse problems and applications

Organizer: Germana Landi	University of Bologna
Organizer: Elena Loli Piccolomini	university of Bologna

Abstract: Inverse problems involve the recovery of some characteristics of an object from indirect measurements. Solving inverse problems requires the development of accurate theoretical inverse models to make as close as possible real data and measurements obtained from the theoretical model. Moreover, regularization methods employ reliable optimization algorithms. Therefore, the inverse problem solution is a multi-disciplinary subject requiring both accurate modeling of the data and reliable optimization methods for their inversion. This mini-symposium aims to presents some applications where the quality of the inverse problem solution can be increased by accurately modeling the data and developing effective numerical optimization methods.

17:00-17:30

Efficient algorithms for nonlinear minimization in spectral tomography

Germana Landi	University of Bologna

Abstract: Image reconstruction in spectral digital breast tomosynthesis requires solving a large-scale nonlinear inverse problem. Most numerical approaches on real data use a simplified linear (and hence incorrect) mathematical model to reduce the computational costs. The aim of this work is to consider the use of nonlinear conjugate gradient, Limited Memory BFGS and scaled gradient methods for very large-scale nonlinear least squares problems, and compare their performance on a spectral digital breast tomosynthesis test problem.

17:30-18:00

Electrical impedance tomography and the diagnosis of stroke

Rashmi Murthy	University of Helsinki

Abstract: In the nonlinear and ill-posed inverse problem of Electrical Impedance Tomography (EIT), the Geometric Optics Solutions have proven to be a useful tool. In this talk we combine the Machine learning algorithms with the nonlinear PDE techniques in a novel way using Complex Geometrical Optics solution. As an example, simulated strokes are classified into hemorrhagic and ischemic using EIT measurements.

18:00-18:30

Sequential Monte Carlo samplers for sparse imaging of solar flares

Alberto Sorrentino	University of Genova
Federica Sciacchitano	Universita di Genova
Silvio Lugaro	Universita di Genova
Michele Piana	Universita di Genova
Anna Maria Massone	Universita di Genova

Abstract: The NASA RHESSI satellite records x-rays from the sun. Imaging from RHESSI data aims at reconstructing sections of solar flares, coming in specific geometric shapes. In this talk we present a model-based imaging method, where the imaging problem is phrased as a Bayesian inference problem for an unknown number of objects with unknown shapes. In addition to producing more interpretable images, the proposed method allows for uncertainty quantification of the estimated parameters.

18:30-19:00

Cubic regularisation methods for optimisation problems in machine learning

Gianmarco Gurioli	University of Firenze
Stefania Bellavia	Università degli Studi di Firenze
Benedetta Morini	Università degli Studi di Firenze

Abstract: ARC methods are Newton-type solvers for unconstrained, possibly nonconvex, optimisation problems. In this context, a novel variant based on dynamic inexact Hessian information is discussed. The approach preserves the optimal complexity of the basic framework and the main probabilistic results on the complexity and convergence analysis in the finite-sum setting will be shown. At the end, some numerical tests on machine learning and ill-conditioned databases will be given, in order to confirm the theoretical achievements.

MS GH-1-1 1 17:00-19:00

Advanced numerical tools for wave propagation simulation - Part 1

For Part 2 see: MS GH-1-1 2

Organizer: Julien Diaz	Inria
Organizer: Bendali Abderrahmane	INSA
Organizer: Tordeux Sébastien	Université de Pau et des Pays de l'Adour

Abstract: The objective of this mini-symposium is to report on the progress recently achieved on advanced tools for the numerical solution of problems related to wave propagation phenomena. These activities will be covered in two sessions dedicated to time-harmonic and time-domain problems. The time-harmonic session will address new techniques for reducing the so-called pollution effect, as well as efficient tools for the solution of the huge linear systems resulting from the discretization. The time-domain session is dedicated to some recent efficient techniques such as space-time Trefftz and multi-scale methods. New developments on visualization tools of wave propagation will be also presented.

17:00-17:30

Ultra-Weak Variational Formulation of harmonic acoustic waves in anisotropic media

Hélène Barucq	Inria
Bendali Abderrahmane	INSA
Diaz Julien	Inria
Tordeux Sébastien	UPPA

Abstract: We extend the Ultra-Weak Variational formulation to the Helmholtz equation with variable coefficients which represent a large variety of anisotropic media. It is based upon the construction of generalized plane waves and it keeps the mathematical properties formerly proven for standard UWVF. Our approach allows for coupling local plane wave approximation with different numerical methods including polynomial approximations which are particularly efficient in areas where the waves do not have a specific form.

17:30-18:00

On parallel scalable sparse linear solvers

Giraud Luc	Inria
Agullo Emmanuel	Inria
Lanteri Stephane	Inria
Poirel Louis	Inria
Samaniego Alvarado Cristobal	Inria

Abstract: For the solution of large sparse linear systems, we will review numerical techniques that exhibit natural parallelism for an effective implementation on large computing platforms. In particular, we will consider hybrid methods that exploit at the algebraic level ideas originally introduced by the domain decomposition community. Although fully algebraic approaches can be developed for symmetric positive defnite problems, a closer interaction with the underlying PDE should be introduced to tackle indefinite problems from wave equations.

18:00-18:30

Accurate, Automatic and Compressed Visualization of Radiated Fields from BEM solutions

Pernet Sébastien	Onera
Vincent Mouysset	ONERA
Matthieu Maunoury	INRIA
Christophe Besse	Université de Toulouse 3

Abstract: We propose an methodology to generate an accurate and efficient reconstruction of radiated fields based on directionnal high-order interpolation of Green kernel. The new basis functions, combining high order polynomials and plane waves, are constructed from an adaptive subdivision of the domain and the choice of smart directions. Finally, as standard visualization softwares are generally unable to represent such fields, a method to have a well-suited visualization of high order functions is used.

18:30-19:00

Operator Preconditioning for the Electric Field Integral Equation on Screens

Urzúa-Torres Carolina	University of Oxford
Ralf Hiptmair	ETH Zurich

Abstract: We consider the electric field integral equation (EFIE) arising from time-harmonic electromagnetic scattering at perfectly conducting screens. When discretizing the EFIE with low-order Galerkin BEM, one obtains linear systems that are ill-conditioned on fine meshes. Therefore, iterative solvers perform poorly and one needs preconditioning. We present a new preconditioner for the EFIE on screens that achieves mesh independent condition numbers, overcomes the low-frequency break-down, and works on locally refined meshes. Numerical results are also shown.

MS FT-0-2 1 17:00-19:00

Mean Field Games: New Trends and Applications - Part 6

For Part 1 see: MS FT-0-2 2
For Part 2 see: MS FT-0-2 3
For Part 3 see: MS FT-0-2 9
For Part 4 see: MS FT-0-2 4
For Part 5 see: MS FT-0-2 5

Organizer: Francisco José Silva Alvarez	Techniques Université de Limoges
Organizer: Adriano Festa	L'Aquila university
Organizer: Daniela Tonon	Paris Dauphine University

Abstract: Mean Field Games (MFGs) problems have been introduced by Lasry-Lions and Huang-Caines-Malhamé in 2006. This theory describes Nash equilibria of some differential games with infinitely many players. In light of the numerous applications of MFGs, which include Economics, Finance and Social Sciences, several mathematical techniques are currently employed for its development. The scope of this minisymposium is to bring together several specialists in MFGs in order to present recent progress on the area and open problems. Among the topics covered in the minisymposium sessions are: analytic, probabilistic and numerical aspects of MFGs, and the applications mentioned in the paragraph above.

17:00-17:30

The planning problem in Mean Field Games as regularized mass transport

Daniela Tonon	Université Paris Dauphine
P. Jameson Graber	
Alpar R. Mészáros	
Francisco J. Silva	

Abstract: The existence and uniqueness of weak solutions for first and second order degenerate Mean Field Games (MFG) have been proved through variational techniques by Cardaliaguet and collaborators. The idea consists in characterizing weak solutions as minimizers of two optimal control problems in duality. This strategy was introduced for the Monge-Kantorovich mass transfer problem by Benamou and Brenier. In this talk we discuss how these techniques can be applied to solve the planning problem in MFG.

17:30-18:00

A Mean Field Games approach to cluster analysis

Fabio Camilli	Sapienza Università di Roma

Abstract: Finite mixtures, describing data generated by a convex combination of probability density functions, are a powerful probabilistic tool for statistical modeling of data, with applications to pattern recognition, computer vision, signal and image analysis, machine learning, etc. Expectation-maximization (EM) is classical technique that incrementally converges to a maximum likelihood estimate of the mixture model's parameters. In this talk, I will discuss some multi-population Mean Field Games systems which mimic the EM algorithm.

18:00-18:30

On the long time convergence of potential Mean Field Games

Marco Masoero	Université Paris Dauphine

Abstract: We develop the counterpart of weak KAM theory for potential mean field games. This allows to describe the long time behavior of time-dependent potential mean field game systems. Potential MFGs are those models where the MFG systems associated can be derived as optimality conditions of suitable optimal control problems on the Fokker-Plank equation. In particular we analyze the relationship between the limit behavior of the time dependent one and the stationary one.

18:30-19:00

Optimal control of conditioned processes: a mean field control approach

Mathieu Laurière	Princeton University
Achdou Yves	Universite Paris Diderot

Abstract: We consider an optimal control problem for conditioned processes which was introduced by PL Lions in his lectures at College de France. The solution is characterized by a PDE system of mean field type. The long time asymptotics correspond to a control problem driven by the principal eigenvalue problem associated with a Fokker-Planck equation. Aspects of the theory and numerical results are discussed. Based on lectures by PL Lions and joint work with Yves Achdou.

MS A3-2-3 1 17:00-19:00

Kinetic modelling and multiscale simulation of nonequilibrium flow dynamics - Part 1

For Part 2 see: MS A3-2-3 2
For Part 3 see: MS A3-2-3 3
For Part 4 see: MS A3-2-3 4
For Part 5 see: MS A3-2-3 5
For Part 6 see: MS A3-2-3 6

Organizer: Lei Wu	UK/University of Strathclyde
Organizer: Song Jiang	Institute of Applied Physics and Comput. Math
Organizer: Kun Xu	Hong Kong University of Science and Technology

Abstract: The Boltzmann equation underpins a board range of applications ranging from high-altitude aerothermodynamics of space vehicles, gas dynamics in micro-electro-mechanical systems, and shale gas extractions. It has also been extended to different fields, such as granular gases, radiative transfer, phonon/electron transport, plasmas, and quantum/relativistic dynamics. However, the high-dimensional integro-differential equations pose great challenges to the numerical simulation of kinetic equations and their applications. The goal of this minisymposium is to explore recent trends and developments in the kinetic theory (simplification of Boltzmann equations, reactions) and multiscale numerical simulation of non-equilibrium dynamics from the continuum to free-molecular flow regimes.

17:00-17:30

The methodology and applications of unified gas kinetic schemes

Kun Xu	Hong Kong University of Science and Technology
Kun Xu	Hong Kong University of Science and Technology

Abstract: In this talk, we are going to review the concept of direct modeling and the construction of the unified gas-kinetic scheme (UGKS) for simulating multiscale transport directly in the discretized space and time. For gas dynamics, the UGKS can present accurate solution in different regimes from the free molecular transport to the Navier-Stokes solutions without the limitation on the cell size and time step being less than the particle mean free path and collision time.

17:30-18:00

Solving the Gas Kinetic Equation with Implicit Discontinuous Galerkin Method

Wei Su	University of Strathclyde
Peng Wang	University of Strathclyde
Yonghao Zhang	University of Strathclyde
Lei Wu	University of Strathclyde

Abstract: An implicit high-order discontinuous Galerkin (DG) method is developed to find steady-state solution of rarefied gas flow described by the Boltzmann equation. The fast spectral method (FSM) is incorporated into DG formulation to evaluate the full collision operator. A specific polynomial approximation is proposed to reduce computational cost of FSM. A sweeping technique is employed to solve DG linear systems in an element-by-element fashion to avoid solving large sparse linear equation in implicit iterative scheme.

18:00-18:30

Unsteady Flow Phenomena Under Rarefied Conditions

David Emerson	STFC Daresbury Laboratory
Xiaojun Gu	STFC Daresbury Laboratory

Abstract: An investigation into unsteady flows is discussed highlighting the challenges for capturing flow phenomena, such as vortex shedding, when the gas is in a rarefied state. Results for flow past a circular cylinder will be presented that illustrate the shedding frequency and the famous vortex street downstream of the cylinder and the subtle interplay between the Mach, Reynolds and Knudsen numbers.

18:30-19:00

An investigation of particle methods for multiscale flow simulations

Yajun Zhu	Northewestern Polytechnical University
Chang Liu	Hong Kong University of Science and Technology
Chengwen Zhong	Northewestern Polytechnical University
Kun Xu	Hong Kong University of Science and Technology

Abstract: We investigate the stochastic particle methods for multiscale flow simulations, including unified gas-kinetic particle (UGKP) method, unified gas-kinetic wave-particle (UGKWP) method, asymptotic preserving direct simulation Monte Carlo (AP-DSMC) method. Numerical test cases are computed to give a comparison between these methods in the aspects of multiscale property, numerical accuracy and computational cost.

MS ME-0-2 1 17:00-19:00

Cross-diffusion systems and applications - Part 1

For Part 2 see: MS ME-0-2 2
For Part 3 see: MS ME-0-2 3

Organizer: Virginie Ehrlacher	Ecole des Ponts Paristech & INRIA
Organizer: Cancès Clément	INRIA

Abstract: Cross-diffusion systems arise in various domains of applications such as crowd motion, physics, chemistry or biology. Despite their significant importance in a wide range of applications, these systems have attracted the attention of mathematicians only recently. They give rise to very interesting and difficult mathematical challenges, either on their theoretical analysis or on their numerical approximation. The aim of this minisymposium is to gather experts working in this field to present their recent contributions and foster new collaborations.

17:00-17:30

A degenerate Cahn-Hilliard model as constrained gradient flow

Daniel Matthes	TU München
Clement Cances	INRIA Lille
Flore Nabet	Ecole polytechnique Paris

Abstract: We give a variational proof for the existence of weak solutions to a Darcy-type non-local variant of the Cahn-Hilliard dynamics with degenerate mobility. That model has been proposed by E and Palffy-Muhoray for the demixing of polymers. The key idea is a formal representation of the dynamics as a constrained gradient flow in a combined Wasserstein metric for both components. Existence follows from the convergence of the corresponding time-discrete minimizing movement scheme.

17:30-18:00

Splitting Schemes and Segregation In Reaction-Cross-Diffusion Systems

Markus Schmidtchen	Imperial College London
Simone Fagioli	Università degli Studi dell'Aquila
Filippo Santambrogio	Université de Lyon
José Carrillo	Imperial College London

Abstract: A fascinating phenomenon observed in reaction diffusion systems is the emergence of segregated solutions, i.e., population densities with disjoint supports. In order to prove existence of solutions for a wide class of initial data without restriction of their supports or their positivity, we propose a variational splitting scheme combining ODEs with methods from optimal transport. This approach allows one to prove conservation of segregation for initially segregated data even in the presence of vacuum.

18:00-18:30

From non-local to classical cross-diffusion: a step toward the full derivation of SKT systems

Ayman Moussa	Sorbonne Université

Abstract: We will tackle the issue of the rigorous derivation of cross-diffusion systems à la Shigesada-Kawasaki-Teramoto, through the limit of relaxed systems in which the cross-diffusion and reaction coefficients are non-local. We will present a recent stabitilty result for the Kolmogorov equation and use it to give a partial answer to a question raised by Fontbona and Méléard.

MS GH-1-G 1 17:00-19:00

Advanced numerical methods for evolving manifolds - Part 1

For Part 2 see: MS GH-1-G 2
For Part 3 see: MS GH-1-G 3
For Part 4 see: MS GH-1-G 4

Organizer: Jooyoung Hahn	AVL List GmbH
Organizer: Karol Mikula	Slovak University of Technology
Organizer: Peter Frolkovič	Slovak University of Technology

Abstract: Advanced numerical methods for solving problems related to evolving curves and surfaces in 2D/3D are presented. We cover contemporary algorithms based on Lagrangian and Eulerian methods (level set or VOF approach) for manifolds approximated by discrete curves and surfaces, which are actively used not only in a research but also in an industrial area in computer-aided engineering. The presented algorithms are meant to be applied in state-of-the-art computations including complex computational domains (e.g. 3D polyhedron meshes), complicated physics (e.g. multiphase flows), nontrivial surface reconstructions, volume and surface reconstruction, and similar.

17:00-17:30

Semi-implicit level set methods for tracking of interfaces

Peter Frolkovic	Slovak University of Technology

Abstract: We present semi-implicit numerical schemes for level set equations that are at least 2nd order accurate in time and space having better stability properties of von Neumann type (including unconditional stability) than analogous fully implicit or explicit schemes. The schemes are analyzed for Cartesian grids and linear problems, but applied also for polyhedral grids and nonlinear problems. A main area of applications are problems defined on implicitly given (dynamic) computational domains.

17:30-18:00

High order extension of Face-offsetting method for interface tracking problems using WENO scheme

Heejae Han	Seoul National University
Hyeonuk Kim	Seoul National University
Myungjoo Kang	Seoul National University

Abstract: In this talk, we try to improve FOM(Faceoffsetting method) by combining with traditional WENO(Weighted Essentially Non-Oscillatory) scheme. In FOM, the determination of offsetting direction is quite similar to that of determining numerical fluxes at the interface of elements. Our new method approximates normal vectors at each node by using wider stencils of faces to get high order accuracy. We will numerically show that our method is less vulnerable to specific parameters.

18:00-18:30

Biomedical image segmentation by evolving surfaces

Seol Ah Park	Department of Mathematics and Descriptive Geometry, Slovak University of Technology
Zuzana Kriva	Department of Mathematics and Descriptive Geometry, Slovak University of Technology
Martin Ambroz	Department of Mathematics and Descriptive Geometry, Slovak University of Technology
Michal Kollár	Department of Mathematics and Descriptive Geometry, Slovak University of Technology
Tamara Sipka	DIMNP, CNRS, Univ Montpellier, Montpellier, France
Georges Lutfalla	DIMNP, CNRS, Univ Montpellier, Montpellier, France
Karol Mikula	Department of Mathematics and Descriptive Geometry, Slovak University of Technology

Abstract: We present two level-set approaches to segmentation of 2D macrophage images. One is based on Otsu thresholding and second on information entropy thresholding, both followed by the classical subjective surface (SUBSURF) method. Results of both methods are compared with the semi-automatic Lagrangian method in which the segmentation curve evolves along the edge of the macrophages. We present the comparison of all three method with respect to the Hausdorff distance of resulting segmentation curves.

18:30-19:00

Solving partial differential equations on surfaces with applications to geodetic data analysis

Michal Kollár	Slovak University of Technology

Abstract: The presentation deals with filtering of geodetic data on closed surfaces by using the linear, nonlinear and geometrical diffusion equations. Numerical experiments illustrate the behaviour of each proposed filter on real measurements, namely the GOCE satellite observations, which represent second derivatives of gravity potential, and the satellite-only mean dynamic topography data, which represent changes of the water mass in Earth's oceans.

MS FT-S-8 1 17:00-19:00

Recent advances in numerical methods for evolutionary partial differential equations - Part 1

For Part 2 see: MS FT-S-8 2
For Part 3 see: MS FT-S-8 4

Organizer: Sebastiano Boscarino	University of Catania
Organizer: Giovanni Russo	Università di Catania

Abstract: The purpose of the MS is to gather researchers interested in efficient methods for the numerical solution of evolutionary partial differential equations. Several issues will be considered, ranging from the proposition and analysis of new families of methods, including semi-implicit schemes for multiscale evolutionary problems, to applications in fluid dynamics, continuum mechanics and kinetic theory. The MS is structured in three parts: development and analysis of numerical schemes (part 1), innovative schemes for continuum mechanics, degenerate parabolic equations, and electromagnetism (part 2), semi-implicit schemes and applications to kinetic theory and fluid dynamics (part 3).

17:00-17:30

Compact approximate Taylor methods for systems of conservation laws

Carlos María Parés Madroñal	Universidad de Málaga
Hugo Alfredo Carrillo Serrano	Universidad de Málaga

Abstract: We present a family of high order methods for system of conservation laws that generalize the classical Lax-Wendroff method for linear systems. These methods are based on the approximate Taylor procedure. They use $(2p+1)$-point stencil and have order of accuracy $2p$, where p is any integer and they are linearly L^2- stable under a CFL-1 condition. Two different shock-capturing techniques are considered to cure the oscillations that appear near discontinuities.

17:30-18:00

Shock-capturing techniques for the Compact Approximate Taylor Methods

Hugo Alfredo Carrillo Serrano	Universidad de Málaga
Carlos Parés	Universidad de Málaga
David Zorio	Universidad de Concepción

Abstract: We presented an order-adaptive finite difference numerical method for systems of conservation laws, which uses centered stencils according to a family of smoothness indicators. The method is a combination between a robust first order scheme and the compact approximate Taylor Method 2P order CAT, so that it is first order near shocks and of order $2p$ in smooth regions

18:00-18:30

Central WENO reconstruction techniques in the discretization of hyperbolic PDEs

Matteo Semplice	Università degli Studi di Torino
Isabella Cravero	Università degli Studi di Torino
Giuseppe Visconti	RWTH Aachen University

Abstract: Reconstructions of the Central WENO class (CWENO and CWENOZ) allow the efficient computation of the reconstructions in the finite volume context for general grids and are particularly useful when a scheme requires a large number of evaluation points per cell (e.g. very high order schemes, source terms for balance laws, well-balanced schemes, etc) We will present the main idea behind these reconstructions and illustrate their advantages on several one- and multi-dimensional examples.

18:30-19:00

Finite-difference ghost-point methods for PDE in complex geometries using level-sets

Armando Coco	Oxford Brookes University
Giovanni Russo	Università di Catania
Matteo Semplice	Unversità di Torino
Stefano Serra-Capizzano	Università dell'Insubria

Abstract: PDEs in time-dependent domains are challenging as domain changes its shape with time. We present a numerical approach where the boundary is embedded in a steady grid, avoiding the computational burden of boundary-fitted grid methods where a mesh is generated at each time step. The domain is represented by levelset functions, allowing greater flexiblity. The method is based on ghost-point extrapolation and shows second order accuracy. Applications on fluid dynamics and monument degradation are presented.

MS A6-4-2 1 17:00-19:00

Recent Advances in Differential Equations. Control Theory. Numerical Simulation - Part 1

For Part 2 see: MS A6-4-2 2

Organizer: Concepción Muriel-Patino	University of Cadiz
Organizer: Carmen Pérez-Martínez	University of Cádiz

Abstract: Control theory has developed rapidly over the past decades, becoming nowdays an important area of contemporary mathematics. Control problems can appear in industrial complexes, electro-mechanical machines, biological systems, etc. Advances on switching control techniques are of a very high impact. Problems in control theory, as most engineering problems, are modelled by differential equations. Common techniques to obtain general solutions are usually insufficient and the development of new powerful tools is required. Recent geometric and analytical methods for the search of exact solutions for differential equations are investigated. Numerical simulations of problems in Naval Engineering and Oceanography are also presented.

17:00-17:30

Systems of vector fields in integrability procedures

Concepción Muriel-Patino	University of Cadiz
Juan Luis Romero	University of Cádiz
Adrián Ruiz	University of Cádiz

Abstract: In this work we investigate different classes of vector fields that can be used to find exact solutions of ordinary differential equations. The introduced procedures are based on the integrability by quadratures via solvable structures associated to integrable distributions. The methods are specially relevant for equations that lack enough Lie point symmetries or whose symmetry algebra is nonsolvable, because in such cases the classical Lie procedure cannot be applied to solve the equations by quadratures.

17:30-18:00

Control of switched systems and its application to converters

Carmen Pérez-Martínez	University of Cádiz
Francisco Benítez-Trujillo	University of Cádiz
Juan Bosco García-Gutiérrez	University of Huelva

Abstract: This work proposes a new approach to control switched systems when the subsystems have not a common equilibrium point. Hence, given a state reference, we define a switching law under which the solution of the switched system converges to this reference state. Furthermore, we employ these results about convergence of switched systems in order to control models of DC-DC converters. Hence, a switching law is designed and the convergence to a desired state is assured.

18:00-18:30

Successive reductions of order by using lambda-symmetries

Adrián Ruiz-Serván	University of Cádiz
Concepción Muriel Patino	Universidad de Cádiz

Abstract: In this work the concept of involutive pair of lambda-symmetries is established. It is explained how an involutive pair of lambda-symmetries can be used to reduce succesively the order of an nth-order ordinary differential equations by two. Besides, it is demonstrated that the general solution of the equation can be recovered from the general solution of the reduced equation by solving succesively two first-order ordinary differential equations.

MS GH-3-3 1 — 17:00-19:00

Multiphase Flow in Porous Media with Rate-Dependent Capillary Pressure

Organizer: Kimberly Spayd — Gettysburg College

Abstract: Important progress has been made in modeling multiphase flow in porous media by incorporating capillary pressure equations which include the rate of change of the wetting phase saturation. We will consider the current state of multiphase flow models that incorporate dynamic capillary pressure or, more generally, thermodynamically constrained averaging theory (TCAT) capillary pressure. The inclusion of the rate-dependent constitutive equations allows for more physically accurate models and a fuller catalogue of possible solutions in applications such as oil recovery and environmental remediation.

17:00-17:30

An Overview of Dynamic and TCAT Capillary Pressure Equations in Multiphase Flow Models

Kimberly Spayd	Gettysburg College

Abstract: Dynamic capillary pressure was introduced nearly thirty years ago and has led to many new questions for those who model fluid flow in porous media. More recently, thermodynamically constrained averaging theory has provided a more general framework for time-dependent capillary pressure. This talk will briefly outline how these constitutive equations have been used, identify some questions that have been asked and answered, then set a context for current areas of inquiry.

17:30-18:00

A New Generation of Models to Simulate Two-Fluid Flow in Porous Media

C.T. Miller	University of North Carolina
Christopher P. Fowler	University of North Carolina
William G. Gray	University of North Carolina

Abstract: The thermodynamically constrained averaging theory is summarized and used to derive a hierarchy of models to simulate two-fluid flow through porous medium systems. Closure relations for capillary pressure and curvature evolution are formulated using integral and differential geometry approaches, and these relations are evaluated using highly resolved microscale simulations. These results point toward a new generation of models for two-fluid flow in porous media.

18:00-18:30

Numerical Methods for Problems Involving Capillary Hysteresis and Dynamic Capillarity

Koondanibha Mitra	Eindhoven University of Technology
I.S. Pop	Hasselt University & University of Bergen
X. Cao	York University
C.J. Van Duijn	Eindhoven University of Technology and Utrecht University
T. Köppl	

Abstract: In this work, we propose a linearization scheme for nonlinear pseudo-parabolic problems, with the main focus on hysteresis and dynamic capillarity in two-phase/unsaturated porous media flow. Such problems are known to be difficult to implement numerically. We prove that the scheme is unconditionally and linearly convergent. Moreover, the convergence becomes faster as the time-step is made smaller. Numerical results show the robustness of the scheme. Finally, it is used to study fronts in porous media.

MS ME-1-6 1 — 17:00-19:00

Analysis and Computation of Interface Motion and Related Topics

Organizer: Takeshi Ohtsuka — Gunma University

Organizer: Tetsuya Ishiwata — Shibaura Institute of Technology

Abstract: Analyzing and computational methods for interfacial motion including some singularities or topological changes has been continued to develop, and applied to various fields. Recently, these methods are extended to the problems with L^1 type regularization, volume constraint, or coupling system of interfacial motion and other phenomena. In these developments, there has been high demand for fast and accurate computing on manifolds that are implicitly defined (like as level set method or phase field method). This minisymposium will feature the recent developments on modelling, computation and analysis for surface evolution equation involving the above motivation and related topics.

17:00-17:30

Constrained Curvature Flow

Michal Benes	Czech Technical University in Prague
Miroslav Kolář	Czech Technical University in Prague
Daniel Ševčovič	Comenius University in Bratislava
Shigetoshi Yazaki	Meiji University in Tokyo

Abstract: In the contribution we investigate the curvature flow with the area constraint. In our results, this type of curvature flow has been studied for closed curves and for open curves in plane, and for curves on a surface. The motion law is treated either by parametrization, or by means of the Allen-Cahn equation with non-local terms. We present quantitative evaluation of obtained results and demonstrate qualitative behavior of the solution.

17:30-18:00

On the behaviour of solutions to an exponential type curvature equation

Harunori Monobe	Okayama University

Abstract: An interface equation with exponential curvature appears in some mathematical models. A typical example is a mathematical model related to the development of groove profile in crystals due to evaportaion-condensation. In this talk, we consider a simplified model of it. In particular, we show the existence of traveling waves and analyze the behaviour of solutions to the equation with prescrived contact angle. This is based on a joint work with Tetsuya Ishiwata.

18:00-18:30

Evolution of spirals by crystalline eikonal-curvature flow

Takeshi Ohtsuka	Gunma University

Abstract: In this talk we give a brief introduction to minimizing movement approach for evolving spirals by the crystalline eikonal-curvature flow, and present some numerical results by our algorithm. Our algorithm is based on Chambolle's algorithm, which is a combination of the variational approach and the level set method with signed distance function. For the evolution of spirals, we introduce the revised algorithm using general level set functions instead of the signed distance function.

18:30-19:00

Asymptotic shape of solutions to the mean curvature flow equation with discontinuous source terms

Nao Hamamuki — Hokkaido University
Kuniyasu Misu — Hokkaido University

Abstract: Motivated by the two-dimensional nucleation in crystal growth phenomena, we consider the initial-value problem of the level-set mean curvature flow equation with discontinuous source terms. We discuss uniqueness and existence of viscosity solutions and study the asymptotic shape of solutions. A game-theoretic representation of solutions is also established. Applying this formula, we study the asymptotic speed of solutions. This talk is based on a joint work with K. Misu (Hokkaido University).

MS A3-3-1 1 — 17:00-19:00

Advances in numerical methods for the shallow-water equations and applications - Part 1

For Part 2 see: MS A3-3-1 2

Organizer: Ilya Timofeyev — University of Houston
Organizer: Dmitri Kuzmin — TU Dortmund University

Abstract: In this minisymposia we bring together experts working on numericl methods and applications for the shallow-water equations which arise in a variety of applications. In this minisymposia we bring together researchers working on different computational aspects of the SWE. There will be several talks focusing on developing novel numerical schemes and other presentations will discuss various applications, including coastal flooding and weather/climate studies. Therefore, this minisymposia will facilitate interaction between academic faculty and researchers outside of academia. In addition, this minisumposia will be of interest to a broad scientific community due to a large number of applications of the SWE.

17:00-17:30

Central-Upwind Schemes for Shallow Water Models

Alexander Kurganov — Southern University of Science & Technology

Abstract: Shallow water equations are widely used in many applications. I will review highly accurate and robust central-upwind schemes, which belong to the family of Riemann-problem-solver-free central schemes, but incorporate some upwinding information about the local speeds of propagation, which helps to reduce an excessive amount of numerical diffusion typically present in classical non-oscillatory central schemes. The designed schemes are well-balanced and positivity-preserving. Besides the classical Saint-Venant system, I will consider more advanced shallow water models.

17:30-18:00

Compatible finite element methods for the shallow water equations on the rotating sphere

Colin Cotter — Imperial College London
Jemma Shipton — Imperial College London
Thomas Gibson — Imperial College London

Abstract: I will describe how compatible finite element methods built from finite element spaces that form a discrete de Rham complex can be used to solve the shallow water equations on the rotating sphere. I will discuss the efficient solution of the linear systems arising from implicit discretisation using hybridisation techniques, energy-enstrophy conservation/dissipation, and the extension to domains with boundaries, illustrated with numerical results.

18:00-18:30

IMEX strategy, geometric preconditioners, and multilevel preconditioners for Hybridized discontinuous Galerkin methods, with application to the shallow water equation on the globe

Thanh Tan Bui — The University of Texas
Sriramkrishnan Muralikrishnan — The university of Texas at Austin
Shinhoo Kang — The university of Texas at Austin

Abstract: We propose IMEX HDG-DG schemes for planar and spherical shallow water systems. The proposed IMEX HDG-DG framework: 1) facilitates high-order solutions both in time and space; 2) avoids overly small time-step sizes; 3) requires only one linear system solve per time stage; We also present our recent work on geometric multigrid and multilevel solvers/preconditioners for the HDG trace systems.

18:30-19:00

Discontinous Galerkin method for flow and transport in coastal ocean applications

Vadim Aizinger — Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research
Reuter Balthasar — Universität Erlangen-Nürnberg

Abstract: We present an application of the discontinuous Galerkin finite element method for simulating flow and transport in three-dimensional coastal ocean applications. Our model UTBEST3D utilizes unstructured prismatic meshes and includes a full set of physical parametrizations. The specific goal of our work is to produce highly accurate simulations of cross-scale processes of coastal dynamics in detailed topographic and numerical resolution. The performance of the model is illustrated using real-life problems.

MS A1-2-4 1 — 17:00-19:00

Mathematical models for satellite imaging problems

Organizer: Bartomeu Coll — University of Balearic Islands

Abstract: This minisymposium is devoted to the study of some problems on satellite images, particularly 3D analysis and reconstruction of the landform by satellite stereoscopy. The session will be a sample of the different techniques used in these two main problems. On one side, the reconstruction of the earth's relief by using stereo computation and multi-view 3D mapping. On the other hand, deep learning techniques are used to learn in several regions of the earth to detect road networks or for mapping and denoising of height maps.

17:00-17:30

Using Deep Siamese Neural Network and Open source optical images to track road construction

Allioux Renaud — EARTHCUBE

Abstract: Tracking road consutruction can be painfull and very time consuming, however it is a key enabler to asses infrastructures policies. Using optical images from landsat and sentinel satellite we automatize road extraction and change detection evolution over 20 year period in South East Asia. To automatize the process we developped novel detection algorithms and siamese segmentation approach to both detect new road a asses there precesence in previous images and track changes.

17:30-18:00

Multi-View 3D mapping from satellite images

Carlo De Franchis — CMLA, ENS Cachan

Abstract: This talk will present an algorithm for computing a 3D digital elevation model from several satellite images of the same area. The method uses a local affine approximation of the RPC model which has become the standard camera model in the satellite imaging industry. This allows to use standard computer vision tools to process arbitrarily large satellite images in a scalable way.

18:00-18:30

VehSat: A Large-scale Dataset for Vehicle Detection in Satellite Images

Sébastien Drouyer — CMLA, ENS Cachan
Drouyer Sébastien — CMLA

Abstract: We introduce a large-scale dataset for VEHicle detection on SATellite images (VehSat). To this end, we collected 4544 crops of satellite images, from 4 different satellites and 8 different areas. In total, 36851 vehicles were annotated. To build a baseline for vehicle detection in satellite images, we also evaluate state-ofthe-art object detection algorithms on VehSat. Although performing better than human annotators on crowdsourcing platforms, machine learning algorithms still have a lot of room for improvement.

18:30-19:00

Stereo computation by combining local and global approaches

Julia Navarro — University of Balearic Islands

Abstract: We present novel stereo methods applied to satellite imaging. The proposed depth estimation comprises two steps, local image correspondences and depth filtering and interpolation. In the local stage, the adaptive support weights depend on the tested disparity and not only on the image configuration around the reference pixel. Then, three different methods for depth filtering and interpolation are introduced, a fast and simple approach and two variational methods.

MS ME-0-7 1 17:00-19:00

Partial Differential Equations in Fluid Dynamics - Part 1

For Part 2 see: MS ME-0-7 2
For Part 3 see: MS ME-0-7 3
For Part 4 see: MS ME-0-7 4

Organizer: Yachun Li	Shanghai Jiao Tong University
Organizer: Yue-Jun Peng	CNRS/UCA LMBP
Organizer: Ya-Guang Wang	Shanghai Jiao Tong University
Organizer: Tong Yang	City University of Hong Kong

Abstract: The purpose of this minisymposium is to bring together mathematicians from all over the world in the area of partial differential equations to present their recent research results in analysis and applications about related models in fluid dynamics, to exchange new ideas, to discuss current challenging issues, to explore new research directions and topics, and to foster new collaborations and connections.

17:00-17:30

Advective equation and rough compressible velocity fields

Didier Bresch	Université Grenoble Alpes, Université Savoie Mont-Blanc

Abstract: This talk concerns the question : How to get compactness for some PDEs occuring in compressible fluid mechanics ? I will show how a new tool introduced in collaboration with P.E. Jabin has been used on several models.

17:30-18:00

Exterior problem of the linear Vlasov-Poisson-Boltzmann system

Tong Yang	City University of Hong Kong
Hongjie Dong	Brown University
Mingying Zhong	Guangxi University

Abstract: We will present a linear theory on a flow under the effect of self-induced electric field past an obstacle governed by the Vlasov-Poisson-Boltzmann equation. The bulk velocity at infinity acts like a driving force on the flow so that some non-trivial stationary solution profile exists. Similar to Ukai-Asano's work for the Boltzmann equation, the spectrum structure is used. In addition, a new decomposition of the solution operator is needed to show the compactness.

18:00-18:30

Qualitaitve Studies on Radiation Hydrodynamics Equations

Yachun Li	Shanghai Jiao Tong University

Abstract: In this talk I will present some of our recent progress on the radiation hydrodynamics equations for viscous or inviscid compressible fluids in the presence of vacuum. Our results inclined the local existence of classical solutions, some blow-up results, and some regularity criteria. These are joint works with Hao Li, Shuai Xi, and Shengguo Zhu.

18:30-19:00

Compressible Navier-Stokes approximation to the Boltzmann equation in bounded domains

Renjun Duan	Chinese University of Hong Kong
Shuangqian Liu	Jinan University

Abstract: The goal of this talk is to justify the compressible Navier-Stokes approximation for the Boltzmann equation regarding the initial-boundary value problems in general bounded domains. We establish the uniform-in-time deviation of the Boltzmann solution with diffusive reflection boundary condition from a local Maxwellian with its fluid quantities given by the solutions to the corresponding compressible Navier-Stokes equations with consistent non-slip boundary conditions whenever the Knudsen number is small enough.

MS FT-1-SG 1 17:00-19:00

Nonlinear Subdivision Schemes and Multiscale Transforms - Part 1

For Part 2 see: MS FT-1-SG 2

Organizer: Rosa Donat	Matemàtiques, Facultat de Matemàtiques
Organizer: Nira Dyn	Tel Aviv University

Abstract: Subdivision schemes are algorithms which generate functions/curves/surfaces from discrete data by repeated simple local refinements. Linear subdivision schemes proved to be efficient tools to cope with homogeneous data in Euclidean spaces. Non-linear subdivision schemes were introduced to refine manifold-valued data, non-homogeneous data in Euclidean spaces and non-smooth scalar data. This mini-symposium brings together researchers from the three different communities, with the aim to generate scientific dialogue between them. The different analysis tools, developed quite independently by each community, will be presented and discussed, as well as multiscale transforms based on non-linear subdivision schemes.

17:00-17:30

Non-linear subdivsion schemes refining point-normal pairs

Nira Dyn	Tel Aviv University
Evgeny Lipovetsky	

Abstract: We present non-linear subdivision schemes refining point-normal pairs (PNPs), generated from linear converging SS in two steps: – Writing linear refinement rules in terms of repeated binary linear weighted averages. – Replacing each binary average by the circle average of two PNPs with the same weight. We discuss the construction of the circle average, its properties and the convergence of so-modified LR-algorithm and 4P scheme. C^1 smoothness is analyzed via "proximity" tools.

17:30-18:00

On approximation of manifold-valued functions based on refinement

Nir Sharon	Tel Aviv University

Abstract: Recent years gave rise to exciting developments in methods for approximating manifolds and manifold-valued objects. In this talk, we focus on the case of one-dimensional data series over manifolds and the use of univariate subdivision schemes for generating smooth curves on the manifold using refinement.

18:00-18:30

Multiscale Representations of Manifold-valued data and the Curvature tensor

Thomas P. Yu	Drexel University

Abstract: After reviewing the basics of wavelet and subdivision schemes for manifold-valued data, results in the regularity and approximation order of such schemes will be addressed. While certain ways to adapt a linear subdivision scheme to manifold-valued data possess an `unconditional' smoothness or approximation order equivalence property, a specific approach, one that is the most related to wavelet transforms, possesses a subtle `conditional' equivalence property in which the curvature tensor plays a fundamental role.

18:30-19:00

A self-adapting subdivision scheme reproducing exponential polynomials on the 3-directional grid

Costanza Conti	University of Florence
Sergio Lopez Urena	Universitat de Valencia, Spain
Lucia Romani	Universita'di Bologna, Italy

Abstract: We propose a non-linear subdivision scheme on the three-directional grid of the plane capable of reproducing bivariate functions that belong to a 5-dimensional space of exponential polynomials. The scheme is C1-regular and does not need either a pre-knowledge of the exponential polynomials to be reproduced or the edge orientation. The goal is reached by using annihilating operators for exponential polynomials which can be seen as the bivariate extension of the so called orthogonal rules.

MS A6-2-3 1 17:00-19:00

Machine Learning for Materials - Part 1

For Part 2 see: MS A6-2-3 2

Organizer: Katerine Isabel Saleme Ruiz	UNIVERSITY OF LUXEMBOURG
Organizer: Malena Espanol	The University of Akron

Abstract: Machine learning techniques have recently become a powerful tool in materials science, to understand and model the underlying physics of material's behavior and structure-property relations at different length scales. The goal of this minisymposium is to bring together experts from physics, materials, chemistry, mathematics, and computer science, to show their recent results in the application of machine learning to materials science as well as to provide a stage for discussing the extend and limitations of machine learning when applied to the modeling of physical systems.

17:00-17:30

Computer Vision and Machine Learning connecting materials structure, processing, and properties.

Elizabeth Holm	Carnegie Mellon University

Abstract: Artificial intelligence (AI) offers a new approach to extracting knowledge from multimodal image-based data, including experimental and simulated micrographs that include composition, processing, or properties metadata. Case studies will demonstrate how computer vision (CV) representations are developed and coupled with machine learning (ML) tools based on the characteristics of the data set and the desired outcome. The ultimate goal is to develop AI to connect microstructure, processing, and property data in materials science.

17:30-18:00

Learning Material Properties with Multiscale Wavelet Scattering Transforms

Matthew Hirn	Michigan State University
Xavier Brumwell	Michigan State University
Paul Sinz	Michigan State University
Kwang Jin Kim	Michigan State University
Jialin Liu	Michigan State University
Michael Swift	Michigan State University
Yue Qi	Michigan State University

Abstract: A wavelet scattering transform is a type of multiscale, multilayer convolutional neural network constructed with a cascade of wavelet transforms and nonlinear operators. Through these operations it encodes the appropriate invariants and regularity properties of atomistic systems with respect to the ground state energy and related properties. In this talk we describe the wavelet scattering transform for 3D atomic systems and its application to the efficient and accurate estimation of materials properties.

18:00-18:30

Improved learning for materials and chemical structures through symmetry, hierarchy and similarity

Wibe De Jong	Lawrence Berkeley National Lab
Tess Smidt	LBNL
Yu-Hang Tang	LBNL
Benjamin Bowen	LBNL

Abstract: We will discuss efforts to develop generative machine learning approaches that can predict properties from structural information, but more importantly can also tackle the 'inverse problem' deducing structural information given desired properties. To do this, we need to develop information-rich encoding decoding techniques for three-dimensional and hierarchical structures. Our efforts are centered around marginalized graph kernel approaches and autoencoders, and utilizing tensor field networks to discover new scientific knowledge about structure-function relationships in chemical sciences.

MS FT-S-7 1 **17:00-19:00**

Optimal Transport for Nonlinear Problems - Part 1

For Part 2 see: MS FT-S-7 2

For Part 3 see: MS FT-S-7 3

Organizer: Yunan Yang	New York University
Organizer: Wuchen Li	UCLA

Abstract: Optimal Transport provides particular statistical distances among histograms. They can compare datasets globally including both misfits in the signal intensities and the phase mismatches. The unique and advantageous way of measuring mismatches offer ideal convexity and stability in many nonlinear problems and also accelerate the iterative convergence. The series of mini-symposiums will present fast computational algorithms and recent waves of research efforts in translating attractive theoretical properties of Optimal Transport onto elegant and scalable tools for a wide variety of applications involving modern science and engineering, as well as machine learning.

17:00-17:30

On the Data Normalization for General Applications of Optimal Transport

Yunan Yang	New York University
Bjorn Engquist	The University of Texas at Austin

Abstract: The primary constraint for Optimal Transport is that the data are restricted to probability distributions, a significant limitation for many applications. We will present some analysis by analyzing different preparations or normalizations of data for the optimal transport step and discuss its connections to many useful techniques or features in optimization such as the Huber norm, low-frequency enhancement, increased regularity, and model extension. Good normalizations can further enhance the ideal properties of Optimal Transport.

17:30-18:00

Wasserstein Information Geometric Learning

Wuchen Li	University of California, Los Angeles

Abstract: Optimal transport, Wasserstein metric, nowadays play important roles in data science. In this talk, we briefly review its development and applications in machine learning. In particular, we will focus its induced differential structure. We introduce the Wasserstein natural gradient in parametric models. We derive the Wasserstein gradient flows and proximal operator in parameter space. We demonstrate that the Wasserstein natural gradient works efficiently in several statistical machine learning problems.

18:00-18:30

Multi-robot motion planning via optimal transport theory

Christina Frederick	NJIT
Haomin Zhou	Georgia Tech
Magnus Egerstedt	Georgia Tech

Abstract: We establish a simple yet effective strategy, based on optimal transport theory, for enabling a group of robots to accomplish complex tasks, such as shape formation and assembly. We demonstrate the feasibility of this approach and rigorously prove collision avoidance and convergence properties of the proposed algorithms.

MS A6-3-2 1 **17:00-19:00**

Mathematics Education in Engineering and Applied Sciences

Organizer: Cristina Solares	University of Castilla-La Mancha

Abstract: This minisymposium shows different research and experiences to improve mathematical teaching in engineering and applied sciences. From mentoring, high school relations, business collaborations, use of digital resources and didactic ways of teaching concrete subjects. The speakers have a wide teaching experience in engineering and they do research on engineering education.

17:00-17:30

Practical Teaching of Vector Spaces Under Problem Solving Perspective

Henar Herrero Sanz	Universidad de Castilla-La Mancha
Cristina Solares	Universidad de Castilla-La Mancha

Abstract: Theory of vector spaces is usualy presented to students in an abstract and meaningless fashion with few attempts to connect with other knowledge. We present a way to introduce the concepts of vector space and subspace starting by modelling realistic problems related with their studies. We propose questions to students to construct the concepts. Several tests, comparing groups where this methodology has been introduced with others without it, were performed with significant results.

17:30-18:00

Digital resources in mathematics teaching at university. Experiences and challenges.

Elena Esperanza Alvarez Saiz	Universidad de Cantabria

Abstract: The use of interactive digital educational resources in Higher Education enhances the visualization, analysis and exploration of complex mathematical concepts. Their possible use in theoretical explanations and practical simulations, along with their application in error diagnosis and correction, make these materials an efficient support tool for the learning process. This session discusses their practical implementation in several proposed activities for calculus subjects in Engineering degrees at Cantabria University

18:00-18:30

Dissemination, high-school relations and bussines collaborations in mathematical training

María Elena Vázquez Cendón	Universidad de Santiago de Compostela

Abstract: We will share different actions related to industrial mathematics that connect the university with the school and business. We share the Mathematical Stimulus Talent Project (ESTALMAT Project) in children from 12 years of age. We emphasize dissemination as a way to connect the secondary school and the society with research, and also to promote STEM studies within the framework of gender policy. These activities are often referred to as the secondary tertiary transition (STT).

18:30-19:00

Wireless participation devices to better teach in mathematics

Alicia Martínez González	Universidad de Castilla-La Mancha

Abstract: It is common to find overcrowded university classrooms where an individualized treatment is complicated. This study aims to enhance interaction, involvement and self-correction in learning through wireless participation devices (clickers). Clickers allow teachers to get immediate feedback on the class progress and to solve errors and difficulties. The students showed a high satisfaction, highlighting the improvement in their participation, an increase in attention and the possibility of recognizing errors and correcting them.

MS FE-1-4 1 17:00-19:00

Numerical methods for balance laws and non-conservative hyperbolic systems - Part 1

For Part 2 see: MS FE-1-4 2
For Part 3 see: MS FE-1-4 3
For Part 4 see: MS FE-1-4 4

Organizer: Carlos Parés Madroñal	Universidad de Málaga
Organizer: Manuel J. Castro	Universidad de Málaga

Abstract: Balance laws and non-conservative hyperbolic systems naturally appear in many real world applications and, in particular, in many fluid models in different contexts: shallow water models, multiphase flow models, gas dynamic, etc. The main goal of the mini-symposium will be the discussion and presentation of state-of-the-art computational and numerical methods for balance laws and non-conservative hyperbolic systems and their applications.

17:00-17:30

A general procedure to design high-order well-balanced finite volume schemes for balance laws

Manuel J. Castro	Universidad de Málaga
Carlos Parés Madroñal	Universidad de Málaga

Abstract: A strategy to design well-balanced reconstructions operator is recalled and applied to the design of well-balanced methods. The more difficult case of source terms involving discontinuities is also addressed: the Generalized Hydrostatic Reconstruction is used to discretize the discontinuities related to the singularities of the source term. Applications to the Burgers' equation with a nonlinear source term and the Euler equations with gravitational forces will be presented.

17:30-18:00

Semilagrangian conservative schemes for kinetic equations

SeungYeon Cho	Sungkyunkwan University
Sebastiano Boscarino	University of Catania
Giovanni Russo	University of Catania
Seok-Bae Yun	Sungkyunkwan University

Abstract: In this talk, we present a conservative semi-Lagrangian for the BGK model of the Boltzmann equation of rarefied gas dynamics. Semi-Lagrangian schemes combined with L-stable time discretizations enable to avoid restrictions on the time step. In order to construct a shock capturing semi-Lagrangian scheme in the Euler limit, it is important to maintain conservation at a discrete level. For this, we introduce a new conservative reconstruction for the construction of conservative semi-Lagrangian scheme.

18:00-18:30

On an efficient implementation of the Roe scheme for large hyperbolic systems

Ernesto Pimentel	Universidad de Málaga
Carlos Parés	University of Málaga
Manuel J. Castro	University of Málaga
Julian Koellermeier	Peking University

Abstract: The results obtained by Morales de Luna et al. (2014) concerning the relation between simple Riemann solvers and Polynomial Viscosity Matrix (PVM) methods are revisited and applied to the efficient implementation of the Roe method for large hyperbolic systems either conservative or non-conservative. This implementation, based on the Newton's form of the interpolation polynomial, will be applied to the multilayer shallow water model and a non-conservative model for rarefied gas flow.

18:30-19:00

A control-based well-balanced finite volume method for balance laws

Irene Gómez-Bueno	Universidad de Málaga
Carlos Parés	Universidad de Málaga
Manuel Jesús Castro	Universidad de Málaga

Abstract: The goal of this work is to develop high-order well-balanced schemes for systems of balance laws. We follow a general methodology for developing such numerical methods which requires the computation, at every cell and at every time step, of the stationary solution whose cell average is equal to the numerical approximation already obtained. Since solving these problems can be difficult and expensive, we introduce some optimization techniques to rewrite them as control problems.

MS A6-5-4 1 17:00-19:00

Analysis of High-Dimensional Big Data from Complex Biological Systems

Organizer: Lin Wan	Academy of Mathematics and Systems Science Chinese Academy of Sciences
Organizer: Li Xia	Stanford University

Abstract: Massive high-dimensional data originating from novel single-cell/molecule genome-wide survey of complex biological systems is currently driving forward new discoveries in life sciences, as well as our abilities to cure diseases. Meanwhile, the sophisticated structure, high dimensionality and the large-scale of these data also raise imminent mathematical and statistical challenges need to be addressed. This minisymposium intends to explore new mathematical and statistical techniques that can be used in the analysis of high dimensional big data in a variety of complex biological systems and settings, ranging from data visualization, heterogeneous structure inference,multiscale modeling, topological data analysis and high-performance computing.

17:00-17:30

Detection and estimation of local signals

David Siegmund	Stanford University
Xiao Fang	Chinese University of Hong Kong

Abstract: The maximum score statistic is used to detect and estimate local signals in the form of change-points in the level, slope, or other property of a sequence of observations, and to segment the sequence when there appear to be multiple changes. I use a first order autoregressive model to model serial dependence, but bias in estimating the autoregressive coefficient can lead to a loss of power. Applications illustrate the general theory

17:30-18:00

Statistical inference of virus-host interactions and the applications to metagenomic studies

Jie Ren	Google Inc.
Fengzhu Sun	University of Southern California
Weili Wang	University of Southern California
Jed Fuhrman	University of Southern California
Nathan Ahlgren	Clark University
Jonathan Braun	University of California, Los Angeles

Abstract: High-throughput metagenomic sequencing has profoundly increased the ability to identify viral genomic sequences. One of the most fundamental challenges is to predict viruses' hosts. We develop a network-based integrated framework for predicting virus-host interactions based on virus-virus similarity, virus-host similarity, and known virus-host interactions. We evaluate our method on a large benchmark dataset and the prediction accuracy was 61% at the genus level, representing a large improvement in host prediction accuracy over previous approaches.

18:00-18:30

Mixture modeling and network analysis with applications in characterizing human and environmental microbiomes

Li Xia	Stanford University

Abstract: Microbes are key contributors to sustainable environments and human health. Mixture model based statistical methods were developed for inferring the abundance of co-occurring microbes from high-throughput metagenomics data. Local association, liquid associaiton and Granger causality were developed for inferring dynamical co-occurring relationships among microbes. These methods were validated and applied to analyze the microbiome in ocean and within human body. The analysis revealed significant associations existing between ecological or health states and microbial systems.

18:30-19:00

Topological data analysis with application in visualizing and reconstructing cell complex developmental trajectories based on single cell data

Lin Wan	Academy of Mathematics and Systems Science Chinese Academy of Sciences

Abstract: Visualizing and reconstructing complex structures intrinsically embedded in high-dimensional expression profiles of single-cell RNA sequencing (scRNA-seq) data are computationally intriguing, but challenging. We report a topological data analysis algorithm, DensityPath, allowing (i) visualization of the intrinsic structure of scRNA-seq data on an embedded 2-d space and (ii) reconstruction of an optimal cell state-transition path. Based on elastic embedding and level-set methods, DensityPath powerfully handles high dimensionality and heterogeneity of scRNA-seq data.

IM FT-4-3 1 17:00-19:00

Mathematical Optimization and Gas Transport Networks: Industrial Collaborations - Part 1

For Part 2 see: IM FT-4-3 2

Organizer: Julio González-Díaz	University of Santiago de Compostela

Abstract: This minisymposium one of two minisymposia on Mathematical Optimization and Gas Transport Networks. The focus of this one is on works that are the result of collaborations between Academia and Industry, with a special focus on the applied aspects of the attained results. On the other hand, the other minisymposium will focus more on academic research on the topic, regardless of whether or not the research is part of a collaboration with Industry.

17:00-17:30

The GAPS derivative-free optimization algorithm applied to pipeline design

Richard G. Carter	DNV-GL

Abstract: We present an easily generalizable DFO algorithm that can be configured to map out entire regions of a search space rather than finding a single solution. We illustrate the algorithm by computing operational maps of two North American pipeline systems, and a capacity tradeoff analysis. Other generalizations include finding Pareto sets, and both multilocal and global optimization. The method is dimensionally limited but highly parallelizable with asynchronous computations allowed.

17:30-18:00

An efficient workflow for gas transport simulation and analysis

Tanja Clees	Fraunhofer Institut SCAI
Baldin Anton	Fraunhofer SCAI
Klaaßen Bernhard	Fraunhofer SCAI
Nikitina Lialia	Fraunhofer SCAI
Nikitin Igor	Fraunhofer SCAI
Torgovitskaia Inna	Fraunhofer SCAI

Abstract: Energy transition needs gas transport networks: natural gas and hydrogen. In this talk, we address several issues when addressing practical cross-sectoral energy applications with a focus on gas transport, including a new domain-specific language and translator, specific modeling aspects and global convergence, and acceleration by means of topological reduction and behavioural models. We outline novel methods, as realized in our multiphysical network simulation framework called MYNTS, and present results for practical applications.

18:00-18:30

Controlling transient gas flow in complex pipeline intersection areas

Felix Hennings	Zuse Institute Berlin

Abstract: In the GasLab of the research campus MODAL we've developed a prototype "navigation system" for gas operators. Based on future demands, the system suggests technical and non-technical control measures for stable network operation. In our algorithmic approach, we solve the above stated task for subnetworks encompassing big network intersection areas. This talk will introduce both our algorithm and preliminary results of its performance using real-world network data.

18:30-19:00

Optimal operation of macroscopic gas transport networks over time

Kai Hoppmann	Zuse Institute Berlin

Abstract: In the GasLab of the research campus MODAL we developed a prototype "navigation system" for gas grid operators. Based on future supplies and demands, it suggests technical and non-technical control measures to ensure stable network operation. Within the overall algorithmic approach, several MIPs using a simplified model for highly complex intersection areas are iteratively solved in order to approximate the transient gas flows. This talk introduces these models and presents some preliminary computational experiments.

MS FT-0-3 1 17:00-19:00

Numerical methods for electromagnetic problems and high perfomance computing - Part 1

For Part 2 see: MS FT-0-3 2
For Part 3 see: MS FT-0-3 7

Organizer: Liwei Xu	University of Electronic Science and Technology of China
Organizer: Chunxiong Zheng	Tsinghua University
Organizer: Xue Jiang	Beijing University of Posts and Telecommunications
Organizer: Tao Cui	AMSS, the Chinese Academy of Sciences

Abstract: The proposed minisymposium, titled by "numerical methods for electromagnetic problems and high performance computing", seeks to bring together researchers from the computational mathematics, the electromagnetic engineering and computer scientist, who investigate the mathematical modeling, the numerical analysis, and the efficient computation for electromagnetic problems. The main topics of this minisymposium will include, but not exclusively, novel numerical methods, fast solvers and their applications to large-scale engineering problems. The goal of this minisymposium is to promote new ideas and exchange recent developments on mathematical modeling, numerical discretization, solvers, parallel computing and engineering practices of computational electromagnetism, and to create new collaboration.

17:00-17:25

New developments in Trefftz methods for Maxwell's equations

Peter Monk	Delaware University

Abstract: We discuss the use of the Ultra Weak Variational Formulation (UWVF) for Maxwell's equations in an industrial code. We describe several developments including 1) the use of different element families (tetrahedra, hexahedra, prisms and pyramids), 2) initial developments for coupling discontinuous Galerkin methods to the UWVF, and 3) the use of very high order plane wave elements to allow the solution of Maxwell's equations on tetrahedral elements that are up to ten wavelengths in diameter.

17:30-18:00

Numerical solution for the quad-curl problem

Liwei Xu	University of Electronic Science and Technology of China

Abstract: The quad-curl problem arises in magnetohydrodynamics, inverse electromagnetic scattering and transform eigenvalue problems. In this paper we investigate a hybridizable discontinuous Galerkin method and a mix finite element method to solve the quad-curl problem. The divergence-free condition is enforced by introducing a Lagrange multiplier into the system. The analysis is performed for the model problem with low regularity, which is posed on a Lipschitz polyhedron domain. Collaborators include Gang Chen, Jintao Cui and Weifeng Qiu.

18:00-18:30

Adaptive FEM for Helmholtz equation with high wave number

Haijun Wu	Nanjing University
Songyao Duan	Nanjing University

Abstract: A posteriori error estimates of the linear FEM for the Helmholtz equation with high wave number are derived. Convergence and quasi-optimality of the adaptive finite element algorithm are proved.

MS ME-1-2 1 17:00-19:00

Wave propagation in multiple-scattering and multiple-scale media - Part 1

For Part 2 see: MS ME-1-2 2
For Part 3 see: MS ME-1-2 3

Organizer: Luke Bennetts	University of Adelaide
Organizer: Malte Peter	University of Augsburg

Abstract: Wave propagation in multiple-scattering and multiple-scale media is important for modelling and simulating the propagation of acoustic, electromagnetic, flexural and surface gravity waves in heterogeneous media. This minisymposium brings together researchers from all of these application areas. The talks will illustrate a variety of the current methods and the challenges that remain. These are derived from branches of applied mathematics ranging from applied analysis to semi-analytical large-scale simulation schemes. A central aim of the minisymposium is to promote the exchange of ideas and knowledge between the different application areas with respect to the underlying wave mechanisms and their computation.

17:00-17:30

Quantum-graph models for embedded eigenvalues in multi-scale media

Stephen Shipman — Louisiana State University

Abstract: We homogenize multi-layer quantum graphs with multiple scales. The layering allows defects to induce embedded eigenvalues into the continuous spectrum of a medium with microscopic periodicity. By repeating these defects at the meso-scale, a homogenized medium with a "resonant response" superimposed upon a "background" response is created.

17:30-18:00

Waves in sea ice

Ken Golden — University of Utah Department of Mathematics
Elena Cherkaev — University of Utah
Ben Murphy — University of Utah
Christian Sampson — University of North Carolina

Abstract: The interaction of electromagnetic waves with sea ice, a polycrystalline composite of pure ice with brine inclusions, is fundamental to remote sensing and monitoring climate change in Earth's polar regions. The interaction of ocean waves with the sea ice pack is critical to formation and break-up processes. I will discuss recent advances in developing integral representations for effective parameters in these problems, and a related Anderson transition displayed by spectral measures of composite microstructures.

18:00-18:30

Homogenized boundary conditions and resonance effects in Faraday cages

David Hewett — University College London

Abstract: We study homogenized interface conditions modelling electrostatic and electromagnetic shielding by a cage of conducting wires (the `Faraday cage effect'). At frequencies close to the natural frequencies of the domain enclosed by the cage, the cage actually amplifies the incident field, rather than shielding it, and we calculate to high precision the modified resonant frequencies, and their associated peak amplitudes. We also investigate the influence on solution accuracy of corners in the cage boundary.

18:30-19:00

On the effective transparency of dense metallic crystals

Ory Schnitzer — Imperial College London
Richard V. Craster — Imperial College London
Rodolfo Brandao — Imperial College London

Abstract: It has been recently demonstrated that crystals formed of nearly touching metallic cylinders are, surprisingly, highly transparent and optically dense for infrared TE-polarized radiation [S. Palmer et al., arxiv:1811.08796], thus potentially useful for numerous nanophotonics applications. We explain these anomalous properties based on "high-contrast homogenization" together with matched asymptotics for the "external cell problem" in the limit of nearly touching inclusions and the "internal cell problem" in the limits of thin and thick skin depths.

MS ME-1-4 1 — **17:00-19:00**

Recent advances in PDE-constrained optimization - Part 1

For Part 2 see: MS ME-1-4 2

Organizer: Irwin Yousept — University of Duisburg-Essen

Abstract: In the recent past, the theoretical and numerical analysis of PDE-constrained optimization has made substantial progress, which along with advances in scientific computing may provide powerful strategies for solving real-world problems. The goal of this minisymposium is to provide an open forum for exchanging knowledge among international leading experts and junior scientists from the emerging field of PDE-constrained optimization with real-world applications, including gas transport, electrical impedance tomography, and electromagnetic machines. The tentative speakers will give an overview of recent progresses in mathematical and numerical approaches concerning optimal control of PDEs, shape and topology optimization, isoperimetric problems, and others.

17:00-17:30

Generalized Nash Equilibrium Problems with PDEs Connected to Spot Markets with (Gas) Transport

Michael Hintermueller — Weierstrass Institute Berlin

Abstract: Existence results and numerical solvers for a class of GNEPs motivated by spot markets with transport are discussed and numerical results are presented. Further, analytical limitation and an outlook on further research are given.

17:30-18:00

A composite step method with inexact step computation for PDE-constrained optimization

Anton Schiela — University of Bayreuth
Schaller Manuel — Universität Bayreuth

Abstract: We consider a composite step algorithm for equality constrained optimization problems. The arising linear systems are inexactly solved with a cg method using a constraint preconditioner. The influence of the error on the damping parameters of the underlying Newton scheme and algorithmic parameters is discussed and specialized termination criteria for the cg method are given. Application to optimal control of a quasilinear heat equation and nonlinear elasticity illustrates the numerical performance of the resulting algorithm.

18:00-18:30

Variational source condition for the reconstruction of distributed fluxes

De-Han Chen — Central China Normal University

Abstract: This talk is devoted to the inverse problem of recovering the unknown distributed flux on an inaccessible part of boundary using measurement data on the accessible part. We establish a variational source condition for this inverse problem, leading to a logarithmic-type convergence rate for the corresponding Tikhonov regularization method under a low Sobolev regularity. Our proof is based on the conditional stability together with the complex interpolation theory on a proper Gelfand triplet.

18:30-19:00

Strong stationarity for the optimal control of a non-smooth coupled system

Livia Betz — University of Duisburg Essen

Abstract: This talk is concerned with an optimal control problem governed by a non-smooth coupled system of equations. The non-smooth nonlinearity is Lipschitz-continuous and directionally differentiable, but not Gâteaux-differentiable. We derive a strong stationary optimality system, i.e., an optimality system which is equivalent to the primal optimality condition saying that the directional derivative of the reduced objective in feasible directions is nonnegative.

MS FE-1-2 1 — **17:00-19:00**

Computational Methods for Inverse Problems - Part 1

For Part 2 see: MS FE-1-2 2
For Part 3 see: MS FE-1-2 3
For Part 4 see: MS FE-1-2 4

Organizer: Alessandro Buccini — Kent State University
Organizer: Lothar Reichel — Kent State University

Abstract: Inverse problems arise in most scientific fields. These problems are usually ill-posed and can be of very large dimension. Developing fast and accurate methods for their solution is of fundamental importance. Moreover, since most methods require the estimation of one or more regularization parameters, the development of automatic strategies for the selection of these parameters is of considerable importance, especially for real-world applications. This minisymposium presents new approaches to the solution of inverse problem and to the automatic estimation of regularization parameters.

17:00-17:30

Variational methods for inverse problems

Alessandro Buccini — Kent State University
Lothar Reichel — Kent State University

Abstract: Discrete ill-posed problems arise in many areas of science. Their solution requires regularization methods that replace the original problem with a minimization one two terms. The first aims at fitting the data, the latter enforces a priori information. The relative importance is determined by the regularization parameter. We construct data fitting and regularization terms and provide algorithms for the computation of a stationary point. We provide rules for the selection of the regularization parameter.

17:30-18:00

Acceleration strategies for iterative soft-thresholding algorithms

Marco Donatelli	University of Insubria
Davide Bianchi	University of Insubria
Yuantao Cai	University of Electronic Science and Technology of China
Ting-Zhu Huang	University of Electronic Science and Technology of China

Abstract: We explore the use of a regularizing preconditioner for a modification of the linearized Bregman iteration applied to the image deblurring problem with a 1-norm regularization term in the wavelet domain. We propose a preconditioning strategy, which improves the quality of the restoration and save some computational cost with respect to the standard preconditioning employed in the modified linearized Bregman algorithm. The Convergence and stability analysis of our algorithm are provided as well.

18:00-18:30

Adaptive parameter selection for weighted-TV image reconstruction problems

Fiorella Sgallari	University of Bologna
Luca Calatroni	CMAP, _Ecole Polytechnique, Palaiseau, 91128, Route de Saclay, France
Alessandro Lanza	University of Bologna, Piazza di Porta San Donato 5, Bologna, Italy
Monica Pragliola	University of Bologna, Piazza di Porta San Donato 5, Bologna, Italy

Abstract: We propose an efficient estimation technique for the automatic selection of locally adaptive Total Variation regularisation parameters based on an hybrid strategy which combines a local maximum-likelihood approach estimating space-variant image scales with a global discrepancy principle related to noise statistics. We verify the effectiveness of the proposed approach solving some exemplar image reconstruction problems and show its outperformance in comparison to state-of-the-art parameter estimation strategies.

18:30-19:00

Variable exponent Lebesgue spaces for multiplicative iterative regularization algorithms

Claudio Estatico	University of Genova

Abstract: An acceleration technique for iterative regularization algorithms useful for linear ill-posed problems with Poisson noise is proposed. The technique is developed in Banach spaces and we discuss the model setting of the proposal in variable exponent Lebesgue spaces, which allows us to obtain different convergence speeds, that is, different regularization levels, on different regions of the domain. The method is applied to a numerical model related to a remote sensing apparatus for atmospheric information retrieval.

MS GH-0-2 1 17:00-19:00

Mathematical Advances in Batteries - Part 1

For Part 2 see: MS GH-0-2 2
For Part 3 see: MS GH-0-2 3
For Part 4 see: MS GH-0-2 4

Organizer: Iain Moyles	York University
Organizer: Matthew Hennessy	Mathematical Institute, University of Oxford

Abstract: Batteries are ubiquitous in society with applications in portable electronics, transportation vehicles, and medical devices. An increasing demand for cheaper, longer-lasting, and safer batteries has driven research into understanding the fundamentals of their operation. Using techniques of mathematical modelling, analysis, and simulation, speakers in this session will address research questions of modern significance such as the effect of materials in electrode design, temperature distribution in an operating battery, and battery kinetics in a charge-discharge cycle. Advantages and limitations from geometrical assumptions and parameter scaling will be discussed as will extensions to general electrochemical systems.

17:00-17:30

Asymptotic simplification of Li-ion battery models

Jon Chapman	University of Oxford
Colin Please	University of Oxford
Robert Timms	University of Oxford
Toby Kirk	University of Oxford
Scott Marquis	University of Oxford
Valentino Sulzer	University of Oxford

Abstract: Starting with a detailed physics-based electrochemical model of lithium ion batteries a general asymptotic framework will be presented in which reduced-order models are systematically derived. Combinations of simplifications on the macroscale and microscale result in a suite of models of different complexity and fidelity. The approach can be extended to different chemistries and additional physical effects including mechanics and side reactions. We highlight how many of the talks which follow fit into this framework.

17:30-18:00

Asymptotic Analysis of Lithium-Ion Battery Models

Brian R. Wetton	University of British Columbia
Iain Moyles	York University
Matthew Hennessy	Imperial College
Timothy Myers	CRM Barcelona

Abstract: A model of a battery electrode will be presented. After scaling, the geometry of the model can be reduced to the so-called pseudo two-dimensional (P2D) model in the literature. Two potential sources of limiting current can be identified from the resulting simplified model, each depending on the remaining model parameters. A computational criterion is presented to determine what parameter values justify the various model simplifications. Progress on fast solvers for P2D models will be shown.

18:00-18:30

Modelling overcharge of lead-acid batteries

Valentin Sulzer	University of Oxford
Jon Chapman	University of Oxford
Colin Please	University of Oxford
Charles Monroe	University of Oxford
David Howey	University of Oxford

Abstract: Mathematical modelling of batteries provides a mechanism to manage them efficiently and maximise their lifetime. By using asymptotic methods to develop simplified models for batteries, we gain physical insight and solve the models efficiently. In this talk, we investigate the overcharge process of lead-acid batteries, during which side reactions occur that reduce charging efficiency and degrade the battery. Using simplified models, we can better understand these side reactions and hence optimise the charging process.

18:30-19:00

Asymptotic reduction of a porous electrode model for lithium-ion batteries

Iain Moyles	York University
Matthew Hennessy	University of Oxford
Brian Wetton	University of British Columbia
Tim Myers	Centre de Recerca Matemàtica

Abstract: We present a volume averaged porous electrode model and show how a systematic approach based on matched asymptotic expansions can be used to greatly simplify the governing equations, permitting analytical solutions. The analysis shows that the charging/discharging process can be decomposed into three main regimes and elucidates the key physical mechanisms that control battery performance. We compare our asymptotically reduced model to both experimental data and results from full-scale simulations which demonstrate excellent agreement.

MS ME-1-3 1 17:00-19:00

Emerging problems in the Homogenization of Partial Differential Equations - Part 1

For Part 2 see: MS ME-1-3 2

Organizer: Patrizia Donato	LMRS, Université de Rouen Normandie
Organizer: Manuel Luna-Laynez	University of Seville

Abstract: The mathematical homogenization models microscopically heterogeneous media providing macroscopic models describing their effective behavior. Although performant methods are nowadays well established, new challenging problems appear in the homogenization of partial differential equations. Indeed, researchers are currently interested in new and difficult situations, dealing with more realistic and complex models, as well as with more difficult mathematical problems, like complicated shapes of the domain, or singular nonlinear problems, or problem with weak regularity data. The aim of the minisymposium is to put together renowned specialists from all over the world overcovering a wide range of emerging challenging problems in the field.

17:00-17:30

Homogenization for a multi-scale model of magnetorheological suspension

Bogdan VERNESCU	Worcester Polytechnic Institute
Nika Grigor	Weierstrass Institute for Applied Analysis and Stochastics

Abstract: Using the homogenization method we obtain a model describing the behavior of a suspension of solid magnetizable particles in a viscous non-conducting fluid. The model generalizes the Neuringer and Rosensweig model for quasistatic phenomena. The macroscopic constitutive properties are given explicitly in terms of the solutions of the local problems. For an aqueous magnetorheological fluid we compute the effective coeffcients for particles distributed uniformly versus forming chain structures which introduce a nonlinear effect.

17:30-18:00

A-quasiconvexity with variable coefficients: relaxation and homogenization

Elisa Davoli	University of Vienna
Irene Fonseca	Carnegie Mellon University

Abstract: Constrained relaxation and homogenization problems are a central question in materials science. Mathematically, these phenomena rely on the analysis of non-convex integral energies evaluated on fields subject to partial differential constraint of the form Au=0, where A is a suitable differential operator. In this talk, I will discuss some recent results dealing with relaxation and homogenization in the framework of A-quasiconvexity, when the operator A has coefficients depending on the space variable.

18:00-18:30

Homogenization of the Brush Problem with a Source Term in L^1

Olivier Guibé	LMRS - Université de Rouen Normandie
Antonio Gaudiello	Università degli Studi di Napoli Federico II
François Murat	Laboratoire Jacques-Louis Lions, Sorbonne Université and CNRS, Paris

Abstract: We consider a domain like a brush in 3D, without any periodicity assumption. The diameter of the teeth is less of . We study the asymptotic behavior ()of a second-order elliptic Neumann problem in this domain with data. Working in the framework of renormalized solutions and introducing a definition of renormalized solutions for degenerate elliptic equations where only the vertical derivative is involved we identify the limit problem and prove a corrector result.

18:30-19:00

Asymptotics for spectral problems with strongly alternating boundary conditions

María Eugenia Pérez Martínez	Universidad de Cantabria

Abstract: We consider the homogenization of spectral problems for the Laplace and the elasticity operators in bounded domains. Alternating boundary conditions of Dirichlet and of Steklov type are imposed in small regions, of size O(ε), periodically placed along the boundary. Spectral perturbation theory and Floquet-Bloch theory are used to derive spectral convergence, as ε->0. Approximations to eigenfunctions associated with the low frequencies are currently the subject of research. We provide an overview and some new challenges.

MS FT-2-4 1 17:00-19:00

New trends in dimensionality reduction of parametrized and stochastic PDEs - Part 1

For Part 2 see: MS FT-2-4 2

Organizer: Andrea Manzoni	POLITECNICO DI MILANO - LABORATORIO MOX -
Organizer: Fabio Nobile	EPFL SB MATH CSQI

Abstract: Model reduction is an indispensable tool for simulation-based science, whenever multiple or real-time simulations are performed. Reduced order models (ROMs), such as the reduced basis method, and approximate response function techniques, such as sparse polynomial chaos expansions, kernel approximations, Gaussian process regression, provide efficient strategies to tackle parametrized or stochastic PDEs. Nonlinear dimensionality reduction techniques, such as local ROMs, manifold learning or machine learning, can provide new valuable tools to approximate the whole solution set of problems hardly reducible with current state-of-art methods. However, their use for predicting system outcomes in new scenarios is at the moment rather involved.

17:00-17:30

Nonlinear dimensionality reduction of parametrized PDEs using deep learning techniques

Andrea Manzoni	POLITECNICO DI MILANO - LABORATORIO MOX -

Abstract: We present state-of-art projection-based reduced order models (ROMs) for parametrized PDEs, with special emphasis on nonlinear time-dependent problems. We propose new strategies to construct ROMs exploiting deep learning techniques, namely convolutional neural networks. Both the construction of a reduced-order space and the solution of the resulting reduced-order problem exploit neural networks for the sake of computational efficiency. Numerical results deal with problems for which projection-based ROMs entail huge computational costs, like, e.g., in cardiac electrophysiology.

17:30-18:00

Learning Interaction kernels in agent-based systems

Mauro Maggioni	Johns Hopkins Univeresity
Fei Lu	Johns Hopkins University

Abstract: We consider a system of interacting agents: given only observed trajectories of the system, we estimate the interaction laws between the agents. We show that at least in particular setting where the interaction is governed by an (unknown) function of distances, statistically and computationally efficient estimators exist.

18:00-18:30

Optimal non-intrusive methods in high dimension

Albert Cohen	Sorbonne Universités

Abstract: Motivated by high-dimensional parametric PDEs, we consider the approximation of an arbirary function in any dimension from point samples. The approximants are picked from given or adaptively chosen finite dimensional spaces. Various recent works reveal that optimal approximation can be constructed at minimal sampling cost by least-squares methods with particular sampling measures. In this talk, we discuss strategies to construct these measures in the adaptive context and in non-tensor-product multivariate domains.

MS A1-2-1 1 17:00-19:00

Topological data analysis and deep learning: theory and signal applications - Part 1

For Part 2 see: MS A1-2-1 2
For Part 3 see: MS A1-2-1 3
For Part 4 see: MS A1-2-1 4

Organizer: Jae-Hun Jung	Ajou Univ/SUNY Buffalo
Organizer: Christopher Bresten	Ajou University
Organizer: Scott Field	University of Massachusetts Dartmouth

MS Organized by: SIAG/CSE

Abstract: Topological data analysis (TDA) emerged as an important analysis tool in data science. By considering topological features of data, TDA determines and predicts data characteristics, extracting hidden underlying knowledge. Deep learning approach is recently proven highly efficient together with TDA for a large set of data in various applications. This mini-symposium brings researchers together from various areas of TDA, deep learning, and their applications with a focus on signal analysis specialized to the gravitational wave detection problem. The mini-symposium provides an opportunity for researchers to share their expertise in theory, implementation, and applications to gravitational-wave detection.

17:00-17:30

Topological data analysis of time series data with TDA and CNN

Jae-Hun Jung	SUNY Buffalo/Ajou University
Christopher Bresten	Ajou University

Abstract: Anomalous behavior detection in time series analysis is important to understand the underlying physics. Deep learning approach using a convolutional neural network (CNN) has been proved to be an efficient tool. In this talk, we use topological data analysis (TDA) for the detection of anomalous signals with generalized correlation and projection methods on a sphere. We consider both the VLBI and black-hole signal data and show that the TDA approach with CNN improves the efficiency.

17:30-18:00

A General Neural Network Architecture for Persistence Diagrams and Graph Classification

Mathieu Carrière Columbia University

Abstract: In this presentation, we show that using the so-called heat kernel signatures and their associated extended persistence diagrams allows one to quickly and efficiently summarize graph structures. Then, we define an architecture for (extended) persistence diagrams which is modular and easy-to-use. Finally, we demonstrate the usefulness of our approach by validating our architecture on several graph datasets.

18:00-18:30

The theory of group equivariant non-expansive operators as a possible bridge between TDA and Deep Learning.

Patrizio Frosini University of Bologna
Mattia G. Bergomi Champalimaud Research, Champalimaud Center for the Unknown - Lisbon, Portugal
Daniela Giorgi Italian National Research Council, Institute of Information Science and Technologies, Italy
Nicola Quercioli Department of Mathematics and ARCES, University of Bologna, Italy

Abstract: In this talk we present a new mathematical framework for Machine Learning, based on the assumption that data cannot be studied directly, but only through the action of agents that transform them. In our model each agent is described by a group equivariant non-expansive operator acting on data. This approach allows us to endow the space of agents with a suitable metric and to study its topological and geometrical properties by means of TDA.

18:30-19:00

Topological properties of high dimensional data used in deep learning

Rocio Gonzalez-Diaz Universidad de Sevilla

Abstract: In this talk, the aim is to try to understand big data shapes using persistent homology techniques. For example, we will face the problem of "embeddings to lower dimensions" using a topological point of view or "reducing datasets to train a neural networks" using a notion of representativeness related with nearness.

MS A3-S-C2 1 **17:00-19:00**

Combinatorial scientific computing - Part 1

For Part 2 see: MS A3-S-C2 2
For Part 3 see: MS A3-S-C2 3

Organizer: Alex Pothen Purdue University
Organizer: Bora Uçar CNRS and LIP ENS Lyon
Organizer: Aydin Buluc Lawrence Berkeley National Lab

Abstract: Combinatorial algorithms and tools are used for enabling parallel scientific computing applications. The general approach is to identify performance issues in an application and design, analyze, and implement combinatorial algorithms to tackle those issues. The proposed three-piece minisymposium covers applications in bioinformatics, solvers of linear systems, and data analysis; and graph algorithms for those applications. The objective is to summarize the latest combinatorial algorithmic developments and the needs of the applications. The goal is to cross-fertilize both domains: the applications will raise new challenges to the combinatorial algorithms, and the combinatorial algorithms will address existing problems of the applications.

17:00-17:30

Matrix scaling and matching related problems

Ioannis Panagiotas Mr

Abstract: I will present probabilistic methods for approximating the maximum cardinality of a matching and the number of perfect matchings in graphs. Our methods are based on assigning probabilities to the edges of a given graph, which are chosen according to the entries of the scaled version of its adjacency matrix. The experimental analysis shows improvements in approximation over alternatives in both cases. This is joint work with Fanny Dufossé, Kamer Kaya and Bora Uçar.

17:30-18:00

Multi-dimensional cartesian partitioning for scalable sparse tensor decomposition

Cevdet Aykanat Bilkent University

Abstract: The successful distributed-memory SPLATT (DMS) tool distributes sparse tensors among processors using cartesian partitioning. We propose a hypergraph partitioning model which utilizes the sparsity patterns of tensors to correctly encapsulate the minimization of the total communication volume of cartesian tensor partitioning. Compared to DMS, the proposed model achieves an average reduction of 52% in total communication volume, which leads to average reductions of 43% and 24% in communication time and overall runtime of CPD-ALS, respectively.

18:00-18:30

High Quality (Hyper)graph Partitioning

Sebastian Schlag Karlsruhe Institute of Technology

Abstract: The problem of partitioning the vertex or edge set of a (hyper)graph into blocks of bounded size while minimizing an objective function defined on the edges/vertices has extensive applications in many areas including scientific computing, VLSI design, and distributed databases. In this talk, we will survey our recent results on high-quality hypergraph partitioning as well as vertex- and edge partitioning of graphs, and discuss methodological issues arising in the experimental evaluation of partitioning algorithms.

18:30-19:00

Approximate weight perfect matchings for pivoting in parallel sparse linear solvers

Johannes Langguth SIMULA

Abstract: The problem of finding good pivots in scalable sparse direct solvers before factorization has posed considerable algorithmic challenges in the past. Currently, sequential implementations of maximum weight perfect matching algorithms such MC64 are used due to the lack of alternatives. To overcome this limitation, we propose a fully parallel distributed memory algorithm and show how to derive a factor 2 approximation guarantee. We also discuss a heuristic version that generates perfect matchings of near-optimum weight.

MS A1-1-1 1 **17:00-19:00**

Geometry and Topology in Data Analysis - Part 1

For Part 2 see: MS A1-1-1 2
For Part 3 see: MS A1-1-1 3
For Part 4 see: MS A1-1-1 4

Organizer: Facundo Memoli The Ohio State University
Organizer: Washington Mio Florida State University
Organizer: Yasuaki Hiraoka Kyoto University

Abstract: Understanding the organization of data across spatial and temporal scales, extracting information and knowledge from data and making inferences are fundamental problems in data analysis that pose many challenges, particularly if the data objects are complex entities such as shapes, networks, or images. This mini-symposium will provide a forum for discussion and dissemination of recent advances based on topological and geometric methods. The presentations will address foundational questions, mathematical modeling and computation, as well as applications to the analysis of data arising in various domains of science and engineering.

17:00-17:30

Introduction on geometry and topology in data analysis

Yasuaki Hiraoka Kyoto University

Abstract: In this talk, I will survey our serises of mini-symposiums about geometry and topology in data analysis. The contents of the symposiums include persistent homology, machine learnings, image analysis, dimension reduction, dynamical systems and others. Some practical applicatioons such as materials science and life science are also discussed.

17:30-18:00

Gromov-Monge Quasimetrics and Distance Distributions

Tom Needham The Ohio State University
Facundo Mémoli

Abstract: In applications in computer graphics and computational anatomy, one seeks a measure-preserving map from one shape to another which preserves geometry as much as possible. Inspired by this, we consider a notion of distance between arbitrary compact metric measure spaces by blending the Monge formulation of optimal transport with the Gromov-Hausdorff construction. We explore theoretical properties of this metric as well as an application to shape analysis.

18:00-18:30

Local regularization of noisy point clouds: improved global geometric estimates and data analysis

Nicolas Garcia-Trillos	University of Wisconsin at Madison
Daniel Sanz-Alonso	University of Chicago
Ruiyi Yang	University of Chicago

Abstract: Several data analysis techniques employ similarity relationships between data points to uncover the intrinsic geometry of the data-generating mechanism. In our model assumption, data is made of perturbations of low-dimensional features lying on a manifold and explore mathematically and numerically two questions: how to define the similarity functions over noisy data, and what is the resulting impact of the choice of similarity in the extraction of global geometric information from the underlying manifold.

18:30-19:00

Geometry of Covariance Operators: Theory and Applications

Minh Ha Quang	Riken, Tokyo

Abstract: Symmetric positive definite (SPD) matrices, in particular covariance matrices, play important roles in many areas of mathematics, statistics, and their applications in machine learning, brain imaging, computer vision, etc. A lot of recent research has focused on exploiting the intrinsic geometrical structures of SPD matrices, particularly from the viewpoint of Riemannian geometry.This talk will survey recent developments in the generalization of the geometrical structures of covariance matrices to infinite-dimensional covariance operators, along with applications.

MS A1-2-6 1 17:00-19:00

Mathematical modelling and data analysis in Mars exploration

Organizer: M. Pilar Velasco	Universidad Politécnica de Madrid
Organizer: David Usero Mainer	Universidad Complutense de Madrid
Organizer: Salvador Jiménez	Universidad Politécnica de Madrid
Organizer: Luis Vázquez Martínez	Universidad Complutense de Madrid

Abstract: We have to take into account that the space exploration is a vital driving force for our society. The data analysis and modelling is a transversal issue that intersect with the challenges of science, technology and Innovation. So, the climatic change in Mars can provide useful information for the Earth. Precisely, one key line of research, at international centres associated to NASA, ESA, IKI and other universities, is to accommodate the Earth atmospheric models at different scales to Mars atmosphere.

17:00-17:30

Mathematical modelling for the Martian atmospheric dust dynamics

M. Pilar Velasco	Universidad Politécnica de Madrid
David Usero	Universidad Complutense de Madrid
Salvador Jiménez	Universidad Politécnica de Madrid
José L. Vázquez-Poletti	Universidad Complutense de Madrid
Luis Vázquez	Universidad Complutense de Madrid

Abstract: The theory of radiative transfer stablishes that the dust aerosols cause an attenuation of the solar radiation traversing the atmosphere, which is modeled by the Lambert-Beer-Bouguer law, where the aerosol optical thickness is approximated through Angstrom law. The dynamic of propagation of the solar radiation in the atmosphere is a complex diffusive process governed by different time/space scales and, thus, it is natural to think about integro-differential equations to describe a better modeling.

17:30-18:00

The big challenge of the Mars exploration

Luis Vázquez	Universidad Complutense de Madrid
M. Pilar Velasco	Universidad Politécnica de Madrid
David Usero	Universidad Complutense de Madrid
Salvador Jiménez	Universidad Politécnica de Madrid
José L. Vázquez-Poletti	Universidad Complutense de Madrid

Abstract: Mars exploration is a long-range scientific objective that supposes an active collaboration between researchers of the international community. Some basic questions to be determined regarding Mars are the physical and chemical characteristics of the Martian surface, the structure of the Martian atmosphere and the events that led to its composition, the nature and history of the Martian climate, the internal structure of Mars and to determine if some form of life could survive on Mars.

18:00-18:30

Generalization of some Numerical Methods to Fractional Derivative Operators

David Usero Mainer	Universidad Complutense de Madrid

Abstract: We analyze some generalizations of numerical methods to be used with fractional operators. Starting with a fractional-power expansion, numerical methods like Euler integration for ODEs or Newton method for solving nonlinear equation are generalized to the fractional case. This methods are tested with some fractional differential equations and some algebraic fractal. In this last case, it is shown the influence of the fractal dimension with the fractional power used to solve the fractal generating equation.

18:30-19:00

Retrieval of an induced magnetic field in Mars ionosphere

Salvador Jiménez	Universidad Politécnica de Madrid
María Ramírez-Nicolás	Universidad Complutense de Madrid
David Usero	Universidad Complutense de Madrid
Pedro J. Pascual	Universidad Autónoma de Madrid
María Pilar Velasco	Universidad Politécnica de Madrid
Luis Vázquez	Universidad Complutense de Madrid

Abstract: From measurements of MARSIS ionospheric sounding, dating from 2005 until 2016, we retrieve the intensity of the magnetic field at the spacecraft height. Considerations on the height of the orbit as well as on the local intensity of the Solar Wind allows us to discriminate between crustal and noncrustal fields.

MS A6-1-1 1 17:00-19:00

Algorithms for Numerically Optimizing Expensive Functions

Organizer: Jeffrey Larson	Argonne National Laboratory

MS Organized by: SIAG/CSE

Abstract: The speakers in this session will present mathematically rigorous methods for numerically optimizing functions that are expensive to evaluate.

17:00-17:30

A Method for Convex Black-Box Integer Global Optimization

Jeffrey Larson	Argonne National Laboratory
Prashant Palkar	IIT Bombay
Sven Leyffer	Argonne National Laboratory
Stefan Wild	Argonne National Laboratory

Abstract: We present a method for minimizing a convex function on the integer lattice when the function cannot be evaluated at noninteger points. We propose a new underestimator that does not require access to (sub)gradients of the objective but, rather, uses secant linear functions that interpolate the objective function at previously evaluated points. We prove that our method converges to a global minimum and discuss the noticeable difficulty of this problem class.

17:30-18:00

POLO - an Efficient Framework for Rapid Prototyping of Distributed Optimization Algorithms

Arda Aytekin	KTH Royal Institute of Technology
Martin Biel	KTH Royal Institute of Technology
Mikael Johansson	KTH Royal Institute of Technology

Abstract: POLO is a C++ library for large-scale parallel optimization research that emphasizes ease-of-use, flexibility and efficiency in algorithm design. With its clear separation between algorithm and execution policies, it provides researchers with a simple and powerful environment for prototyping ideas, evaluating them on different parallel computing architectures and hardware platforms, and generating compact and efficient production code. POLO enables users to move seamlessly from serial to multi-threaded shared-memory and multi-node distributed-memory executors.

18:00-18:30

Derivative-Free Robust Data-Fitting via Nonsmooth, Nonconvex Formulations

Matt Menickelly	Argonne National Laboratory
Stefan Wild	Argonne National Laboratory

Abstract: In data-driven optimization, it is sometimes the case that a subset of data is contaminated with outliers. In simulation-based optimization, not all runs of a simulation may produce reliable or useful output. I will discuss a novel method for learning least trimmed estimators, a robust variant of the SAA problems that arise in empirical risk minimization. This results in a particular nonsmooth nonconvex formulation of an optimization problem amenable to methods of (derivative-free) manifold sampling.

18:30-19:00

Improving flexibility, robustness and scalability of model-based derivative free methods

Coralia Cartis	Oxford University
Lindon Roberts	University of Oxford
Jan Fiala	NAG
Benjamin Marteau	NAG

Abstract: We present two software packages for derivative-free optimization (DFO): DFO-LS for nonlinear least-squares problems and Py-BOBYQA for general objectives. They employ model-based trust region methods, with efficient restarting mechanisms to deal with stagnation effects due to noise. We also discuss how to scale up these methods.

MS ME-1-9 1 **17:00-19:00**

Integrable systems and discrete dynamics - Part 1

For Part 2 see: MS ME-1-9 2

Organizer: Giorgio Gubbiotti	The University of Sydney
Organizer: Nalini Joshi	The University of Sydney
Organizer: David Gomez-Ullate Oteiza	Universidad Complutense de Madrid
Organizer: Nobutaka Nakazono	Aoyama Gakuin University

Abstract: There has been increasing interest in integrable systems in the last two decades, particularly due to the appearance of Painlevé equations in random matrix theory and the theory of orthogonal polynomials. In this mini-symposium, we bring together three important perspectives: geometric and algebraic aspects of integrable systems, discrete differential geometry and the theory of orthogonal polynomials. We expect that the mini-symposium will create connections across the boundaries of these fields.

17:00-17:30

Rational solutions to higher order Painlevé equations. Part I: characterization.

David Gomez-Ullate Oteiza	Universidad Complutense de Madrid

Abstract: We prove that all rational solutions to the A2k Painlevé system (a.k.a. Noumi-Yamada system) belong to the class of rational extensions of the harmonic oscillator, and are thus expressible as Wronskian determinants whose entries are Hermite polynomials.

17:30-18:00

Discrete integrable systems generated by Hermite-Padé approximants

Walter Van Assche	KU Leuven
Alexander Aptekarev	Keldysh Institute of Applied Mathematics, Moscow
Maxim Derevyagin	University of Connecticut, USA

Abstract: We consider Hermite-Padx approximants in the framework of discrete integrable systems defined on the lattice Z^2. We show that the concept of multiple orthogonality is intimately related to the Lax representations for the entries of the nearest neighbor recurrence relations and it thus gives rise to a discrete integrable system. We show that the converse statement is also true. As an application, a class of cross-shaped difference operators on a two-dimensional (2D) lattice is introduced.

18:00-18:30

Miquel dynamics on circle patterns and the dimer model

Sanjay Ramassamy	École normale supérieure
Richard Kenyon	Brown University
Wai Yeung Lam	Brown University
Marianna Russkikh	University of Geneva

Abstract: Circle patterns are a way to draw a graph in the plane such that every face is cyclic. Miquel dynamics is a discrete-time dynamical system on circle patterns defined by using the classical Miquel six-circles theorem. Its integrability is obtained by establishing a novel connection between circle patterns and the dimer model from statistical mechanics. Joint work with Richard Kenyon (Brown University), Wai Yeung Lam (Brown University) and Marianna Russkikh (University of Geneva).

18:30-19:00

Spatial pattern of ultradiscretizable discrete Gray-Scott model and Turing instabilities of its equilibrium solutions

Keisuke Matsuya	Musashino University
Mikio Murata Professor	Tokyo University of Agriculture and Technology, Tokyo

Abstract: Ultradiscretization is a limiting procedure transforming a given difference equation into a cellular automaton. In this talk, we propose a discretization and an ultradiscretization of Gray-Scott model which is a reaction-diffusion system and whose solutions give various spatial patterns. The ultradiscrete system is directly related to the elementary cellular automaton Rule 90 which gives a Sierpinski gasket pattern. We also discuss relation between spatial patterns of the discrete system and Turing instability.

MS A3-2-2 1 **17:00-19:00**

Mapping and managing hazards using Precursory Data, and Analysis

Organizer: E. Bruce Pitman	Univ at Buffalo
Organizer: Abani Patra	Univ at Buffalo

MS Organized by: SIAG/CSE

Abstract: The mitigation of hazard entails a end-to-end use of data, models and analysis. Precursory signals for are used to set alerts. Forecasts of event timing and magnitude building on the data and information in these signals (seismic, wind, acoustic, deformation etc.) are thus critical. However, many challenges associated with the poorly defined causality relationships between event and signal and the noisy data and lack of knowledge of physical processes leads to much uncertainty.

17:00-17:30

A SDE Framework for Material Failure

E. Bruce Pitman	Univ at Buffalo

Abstract: We introduce a stochastic model for studying material failure. The method extends the ideas of a simple but well-studied Failure Forecast Model (FFM) due to Voight and others, adding a stochastic forcing and a relaxation effect. Together these additions may be viewed as a characterization of “model uncertainty”, enabling prediction – together with confidence bounds – in spite of the FFM not capturing all the relevant physics.

17:30-18:00

A SDE Framework for Volcanic Precursors, Mapping and managing hazards using Precursory Data, and Analysis

Andrea Bevilacqua Bevilacqua	INGV

Abstract: We present two models using precursory information in the production of volcanic eruption forecasts. The first model enhances the well-established failure forecast method introducing an SDE in its formulation. The second model establishes a simple method to update prior spatial maps. The prior reproduce the two-dimensional distribution of past activity with a Gaussian Field. The likelihood relies on a one-dimensional variable characterizing the chance of material failure locally, based on the horizontal ground deformation.

18:00-18:30

Forecasting volcanic hazards with uncertainty: is it over? is it safe?

Elaine Spiller	Marquette University

Abstract: Communities situated near volcanos are often faced with intermittent threats as volcanic activity levels cycle on and off over years-decades. Unfortunately even if a volcano seems to have quieted, threats of a massive landslide from domes collapsing remains very real. We present hazard threat models for such low frequency, high consequence events. Further we produce emulator-based probabilistic hazard maps for civil authorities to understand the impact of model choices and uncertainties on hazard forecasts.

MS A6-4-3 1 **17:00-19:00**

Machine Learning in Finance - Part 1

For Part 2 see: MS A6-4-3 2

Organizer: Martin Larsson ETH Zurich

Organizer: Agostino Capponi Columbia University

MS Organized by: SIAG/FME

Abstract: This minisymposium aims to gather financial mathematics experts to present research at the intersection of Machine Learning and Finance. Machine learning has experienced tremendous growth and interest among financial mathematicians in recent years. The talks will illuminate important aspects of risk management and financial forecasting; applications of deep learning to optimal stopping, hedging, and limit order book modeling; statistical techniques based on rough paths theory; and universality for reservoir systems. The rich blend of topics is expected to stimulate discussion and spark research collaborations with high potential impact for the financial industry. This minisymposium is sponsored by the SIAG/FME.

17:00-17:30

The signature of a trading strategy: algorithms for 'blind' monitoring and forensic analysis of dynamic portfolios

Rama Cont University of Oxford

Abstract: Risk management in finance often involves the monitoring of portfolios whose exact composition is unknown and changes over time according to some trading rule, as a function of observable market variables. We introduce novel approach to the monitoring and forensic analysis of dynamic portfolios without access to portfolio positions, using the concept of signature of a trading strategy. Our approach combines analytical insights from rough path theory and tensor algebra with machine learning techniques.

17:30-18:00

Machine learning in financial valuation and risk management

Damir Filipovic EPFL and Swiss Finance Institute

Abstract: We apply kernel based machine learning to tackle computational challenges in financial valuation and risk management.

18:00-18:30

Deep Neural Networks for Large Samples: Relaxed Control and Gamma-Convergence

Agostino Capponi Columbia University

Abstract: We consider the performance of the deep neural network as the size of the training set grows large. We describe the training process via a nonconvex stochastic optimization problem and study its relaxed solution for a finite sample. We identify an explicit representation of the limit of the sampled objective functional. We prove that the minimizer of the sampled optimization problem converges to the minimizer of the limit optimization problem using the theory of Γ-convergence.

18:30-19:00

Neural Network Based Discrete Hedging

Johannes Ruf London School of Economics

Weiguan Wang LSE

Abstract: We design a neural network, named HedgeNet, that directly outputs a hedging strategy given relevant information as input. This network is trained to minimize the hedging error, instead of the usual difference between the market price and the predicted price. Training a HedgeNet on real S&P 500 options daily trading data, the network is able to reduce the mean squared hedging error by 15% compared to the Black-Sholes hedging evaluated at the implied volatility.

MS ME-1-5 1 **17:00-19:00**

Emerging trends in liquid crystals encompassing modelling, simulation and analysis - Part 1

For Part 2 see: MS ME-1-5 2

For Part 3 see: MS ME-1-5 3

For Part 4 see: MS ME-1-5 4

Organizer: Arghir Dani Zarnescu Basque Center for Applied Mathematics

Organizer: Pingwen Zhang Peking University

Abstract: Liquid crystals are modelled mathematically by functions taking values into a certain space of order parameters. Various spaces of order parameters correspond to different theories of liquid crystals. Initial mathematical explorations started in the 80s in connection with harmonic maps. The last decade has brought a surge in the mathematical study of liquid crystals, to the extent that the mathematical literature in the area has nearly doubled. The proposed minisymposium aims to explore the recent advances, and generate new directions, by bringing together major contributors from the modelling, simulation and analysis of liquid crystals.

17:00-17:30

Numerical Study of Defects in Liquid Crystals

Pingwen Zhang Peking University

Abstract: Defects in liquid crystals are of great practical importance in material science and theoretical interest in physics and mathematics. In this talk, I will review the representation, modeling and computation of defects in liquid crystals. Some conjectures and challenges are proposed to summarize the common characteristics of defects, in the hope of providing a deeper understanding of the defect pattern in nematic liquid crystals.

17:30-18:00

Minimizing properties of universal solutions in the Oseen-Frank theory

John Ball Heriot-Watt University

Epifanio Virga University of Pavia

Abstract: The talk will present some new results, together with new proofs of old results, concerning energy minimizing properties of universal solutions in the Oseen-Frank theory of nematic liquid crystals.

18:00-18:30

Physicality of Minimizers for the Anisotropic Landau-de Gennes/Maier-Saupe Constrained Q-Tensor Energy Including All Elasticity Terms

Patricia Bauman Purdue University

Patricia Bauman Purdue University

Daniel Phillips Purdue University

Abstract: We consider local minimizers of the Landau-de Gennes Q-tensor energy for liquid crystal crystals that includes all elasticity terms with a Maier-Saupe bulk term. Here Q-tensors of admissible functions have a representation related to statistical mechanics which ensures that eigenvalues are valued in the closed interval between -1/3 and 2/3 almost everywhere. We prove that local minimizers are continuous and their eigenvalues are strictly larger than -1/3 and smaller than 2/3 at all points.

18:30-19:00

Symmetry and multiplicity of solutions in a two-dimensional nematic liquid crystal model

Radu Ignat Institut de Mathematiques de Toulouse

Luc Nguyen Univ. of Oxford

Valeriy Slastikov Univ. of Bristol

Arghir Zarnescu BCAM Bilbao

Abstract: In this talk we focus on symmetric critical points in a variational 2D Landau-de Gennes model for liquid crystals. We prove the uniqueness (up to reflection) and the rotational symmetry of the global minimizer under the strong anchoring boundary condition which has a k/2 topological degree with even k. We also prove existence of (multiple) non-minimizing rotationally symmetric critical points.

MS ME-1-1 1 **17:00-19:00**

Recent developments in nonlinear PDEs of hydrodynamics and mathematical biology - Part 1

For Part 2 see: MS ME-1-1 2

For Part 3 see: MS ME-1-1 3

Organizer: Vincent Martinez City University of New York - Hunter College

Organizer: Michael Jolly Indiana University

Organizer: Kun Zhao Tulane University

Abstract: This session combines ideas from fluid dynamics, mathematical biology, and dynamical systems that address current issues in regularity of solutions, their growth and decay, as well as issues of stability and quantitative descriptions of their long-time behavior. Recent developments have successfully exploited various similarities between conservation laws, chemotaxis and aggregation models, and the equations of compressible or incompressible fluid motion. This session will bring together a diverse set of researchers, most at the early stage of their careers, who will share fresh expertise on gradient flows, flocking dynamics, conservation laws, fluid dynamics, and dissipative equations.

17:00-17:30

Studies in analyticity for hydrodynamic and chemotaxis equations

Vincent Martinez — City University of New York - Hunter College

Abstract: In 1987, Foias and Temam established analyticity of solutions of the 2D and 3D incompressible Navier-Stokes equations by developing the Gevrey-norm technique. This approach has since become standard for establishing analyticity of solutions to various PDEs. In this talk, we shed light on the relation between the structure of the equation and its well-posedness theory in various analytic Gevrey regularity classes by considering various hydrodynamic and chemotaxis models.

17:30-18:00

Statistical data assimilation via the determining map

Animikh Biswas — University of Maryland Baltimore County

Abstract: We discuss a statistical data assmilation algorithm for geophysical models with a random kick force where the (discrete in time) observations are possibly contaminated with stochastic noise. This algorithm is based on a recently developed data assimilation scheme by Azouani, Olson and Titi and employs a feedback control term.

18:00-18:30

Uniqueness and Regularity results for the Navier-Stokes-Cahn-Hilliard system

Andrea Giorgini — Indiana University
Alain Miranville — Université de Poitiers
Roger Temam — Indiana University

Abstract: A fundamental problem in fluid mechanics and materials science is the motion of fluids which gives rise to deformation and topological transitions of the interface. Typical examples are mixing and break-up or coalescence of droplets. In the diffuse interface theory for binary mixtures, the dynamics of incompressible and viscous fluids is described by the Navier-Stokes-Cahn-Hilliard equations. In this talk I will present some recent results of uniqueness and regularity of weak and strong solutions.

MS A6-1-2 1 — 17:00-19:00

Optimization methods and applications - Part 1

For Part 2 see: MS A6-1-2 2
For Part 3 see: MS A6-1-2 3
For Part 4 see: MS A6-1-2 4
For Part 5 see: MS A6-1-2 5
Organizer: Cong Sun — Beijing Univ. Posts and Telecommunications
Organizer: Xin Liu — Academy of Mathematics and Systems Science

Abstract: This multiple minisymposium is to address the recent progress in nonlinear optimization field. The topics include but not limit to: first-order methods, Newton-like methods, derivative free methods, stochastic optimization methods, methods for problems with orthogonality constraints and applications with optimization methods.

17:00-17:30

Newton-Type Stochastic Optimization Algorithms For Machine Learning

Zaiwen Wen — Peking University

Abstract: In this talk, we introduce 1) stochastic semismooth quasi-Newton methods for large-scale problems involving smooth nonconvex and nonsmooth convex terms in the objective function for deep learning; 2) a stochastic trust region method for reinforcement learning.

17:30-18:00

A low complexity algorithm for a special structured problem with quadratic constraint

Cong Sun — Beijing University of Posts and Telecommunications

Abstract: For a downlink network, a low complexity algorithm is proposed to solve the sum rate maximization problem. First we select the precoding beamforming vector to symmetrize the equivalent channel matrix. Then the KKT conditions are analyzed and approximated. It is proved that in both low and high Signal to Noise Ratio regimes, the approximation is nearly optimal. The new algorithm has very low computational complexity. Simulation results indicate the high efficiency of the propose algorithm.

18:00-18:30

Trust region method based on inaccurate gradients

Zaikun Zhang — The Hong Kong Polytechnic University
Serge Gratton — INPT/ENSEEIHT, University of Toulouse
Luis Nunes Vicente — Lehigh University

Abstract: We discuss the behavior of trust-region method assuming the objective function is smooth yet the gradient information available is inaccurate. We show trust-region method is robust with respect to gradient inaccuracy. It converges even if the gradient is evaluated with only one correct significant digit and encounters random failures with probability 1/2, and the worst case complexity of the method is essentially the same as when the gradient evaluation is accurate.

18:30-19:00

A Newton-like method with mixed factorizations and cubic regularization for unconstrained minimization

Ernesto G. Birgin — University of São Paulo
José Mario Martínez — State University of Campinas

Abstract: A Newton-like method with cubic regularization for unconstrained minimization, that uses a single cheap factorization per iteration, is introduced. When the Hessian is Lipschitz-continuous, the proposed method enjoys $O\left(\varepsilon^{-3/2}\right)$ evaluation complexity for first-order optimality and $O(\varepsilon^{-3})$ for second-order optimality as other recently introduced Newton method for unconstrained optimization based on cubic regularization or special trust-region procedures. Numerical results are presented.

MS FT-S-1 1 — 17:00-19:00

Back to the Future IV: Developments in Parallel-in-Time Integration - Part 1

For Part 2 see: MS FT-S-1 2
Organizer: Ben Southworth — University of Colorado at Boulder
Organizer: Stephanie Friedhoff — University of Wuppertal
MS Organized by: SIAG/CSE

Abstract: Evolutionary processes arise regularly in computation. The obvious case is evolution in time of time-dependent differential equations. However, other topics such as constrained optimization, training of neural networks, and iterative solution to nonlinearities, can also be seen as evolutionary processes. Traditionally, the computation associated with evolutionary processes is sequential in nature. But, for the efficient use of massively parallel supercomputers, new algorithms are required that can parallelize the process of evolution. Part I of this minisymposium features exciting theoretical and algorithmic developments in parallel-in-time methods, and Part II demonstrates the broad use of parallel-in-time techniques applied to complicated evolutionary processes.

17:00-17:30

Necessary and sufficient conditions for convergence of Parareal and MGRiT, and implications

Ben Southworth — University of Colorado at Boulder

Abstract: Despite significant research on Parareal and MGRIT, there remains a lack in understanding exactly when they converge. In this talk, we derive necessary and sufficient conditions for two-level convergence of linear Parareal and MGRIT, including exact bounds on two-level convergence in norm, based on an approximation property that fine- and coarse-level propagators must satisfy. After presenting an overview of the theoretical results, emphasis will be placed on how these results can be used in practice.

17:30-18:00

Convergence analysis for parallel-in-time solution of hyperbolic systems

Stephanie Friedhoff — University of Wuppertal
Hans De Sterck — University of Waterloo
Alexander J.M. Howse — Red Deer College
Scott MacLachlan — Memorial University of Newfoundland

Abstract: This talk focuses on the analysis of the convergence behavior of multigrid methods for parallel-in-time solution of hyperbolic problems. Three analysis tools are considered that differ, in particular, in the treatment of the time dimension: (1) space-time local Fourier analysis, (2) semi-algebraic mode analysis, and (3) a two-level reduction analysis. We discuss two model hyperbolic problems, the linear advection in one space dimension and linear elasticity in two space dimension.

18:00-18:30

On selecting coarse-grid operators for Parareal and MGRIT applied to linear advection

Oliver Krzysik	Monash University
Hans De Sterck	University of Waterloo
Scott MacLachlan	Memorial University
Stephanie Friedhoff	University of Wuppertal

Abstract: We consider the parallel time integration of the linear advection equation with the Parareal and two-level multigrid-reduction-in-time (MGRIT) algorithms, which are known to perform poorly for this problem. Using Fourier analysis, we gain insight into the origins of this poor performance. We also explore selection strategies for coarse-grid time-stepping operators. For several high-order discretizations, we demonstrate that there exist non-standard coarse-grid time-stepping operators that yield significant improvements over the standard choice of rediscretization.

18:30-19:00

Waveform relaxation with adaptive pipelining

Felix Kwok	Hong Kong Baptist University
Ben Ong	Michigan Technological University

Abstract: Waveform relaxation methods are domain decomposition methods for time-dependent PDEs in which subdomain problems are posed in space and time. In this talk, we introduce temporal parallelism in these methods, with different processors working on different time windows. Because the convergence rate of the new method is independent of the overall time horizon length, we obtain significant speedup relative to sequential time-stepping. Numerical examples are presented to illustrate the effectiveness of our approach.

MS ME-1-0 1 17:00-19:00

Recent Advances in Optimal Control Theory - Part 1

For Part 2 see: MS ME-1-0 2
For Part 3 see: MS ME-1-0 3
For Part 4 see: MS ME-1-0 4
For Part 5 see: MS ME-1-0 5

Organizer: Alexander Zaslavski	The Technion - Israel Institute of Technology
Organizer: Nobusumi Sagara	Hosei University
Organizer: Boris Mordukhovich	Wayne State University
Organizer: Monica Motta	University of Padua

Abstract: This minisimposium on new developments in optimal control theory and its applications will bring together a selected group of experts in this area. The growing importance of control and optimization has been realized in recent years. This is due not only to theoretical developments, but also because of numerous applications to engineering, economics and life sciences. The topics which will be discussed include optimal control of PDE, turnpike phenomenon, infinite horizon optimal control, necessary and sufficient optimality conditions, qualitative and quantitative aspects of optimal control and applications.

17:00-17:30

Necessary and sufficient turnpike conditions

Alexander Zaslavski	The Technion - Israel Institute of Technology

Abstract: We discuss the turnpike phenomenon discovered by P. Samuelson in 1948. To have the turnpike property means that the solutions of the problems are determined mainly by the objective function and are essentially independent of the choice of interval and endpoint conditions, except in regions close to the endpoints. We study sufficient and necessary conditions for the turnpike phenomenon, using the approach developed in our previous research, for continuous-time infinite dimensional optimal control problems.

17:30-18:00

The Turnpike Phenomenon for Problems of Optimal Boundary Control

Martin Gugat	Friedrich-Alexander Universität Erlangen-Nürn

Abstract: Turnpike results are presented for optimal Dirichlet boundary-control problems for systems that are governed by linear hyperbolic partial differential equations. We consider convex objective functions that depend on the boundary traces of the system states. We give conditions that imply that asymptotically for large T the L2-norm of the difference between the dynamic optimal controls and corresponding static optimal control remains uniformly bounded. As an application, we consider the control of gas pipeline flow.

18:00-18:30

Fast Solvers for Optimal Experimental Design Problems

Roland Herzog	TU Chemnitz
Eric Legler	TU Chemnitz

Abstract: The determination of unknown parameters in mathematical models is an important problem in applied mathematics. In practical applications, the achievable accuracy is limited by measurement errors. In optimal experimental design (OED), the goal is to adjust the experimental conditions in order to maximize the estimation accuracy. In this presentation, we address fast solvers for OED problems and present computational results.

18:30-19:00

Optimal Control of a nonsmooth perturbed sweeping process and its applications

Nguyen-Truc-Dao Nguyen	Wayne State University

Abstract: This talk addresses a new class of optimal control problems described by a controlled version of Moreau's sweeping process where measurable control actions enter additive nonsmooth perturbation in order to optimize the Mayer-type functional. To deal with the non-Lipschitzian of the unbounded differential inclusions with intrinsic state constraints, we develop a method of discrete approximations to derive the necessary optimality conditions of the Euler-Lagrange type for local minimizers. Application in robotic models will be considered.

IM FT-4-4 1 17:00-19:00

New international perspectives in industrial applied mathematics

Organizer: Chris Budd	University of Bath
Organizer: Huaxiong Huang	York University and Fields Institute

Abstract: Industrial mathematics has changed hugely in the last twenty years. Originally based on mathematical modeling, it has now expanded to include data, machine learning, stochastic methods and much more. Also the range of industry which mathematics can be applied has grown hugely. It is has a great international reach with much new activity worldwide. In this mini-symposium a set of internationally active workers in industrial mathematics will review and consider some of the many challenges that this brings, both in terms of scientific developments and also the opportunities and risks at the interface of academic and commercial research.

17:00-17:30

Does industry need maths, or does maths need industry?

Chris Budd	University of Bath

Abstract: Industrial mathematics focuses on problems from industry. It covers fields including mechanics, PDEs, statistics, signal processing, optimization, graphics, linear algebra, number theory, and numerical analysis. Industrial mathematicians work in interdisciplinary teams, dealing with issues such as NDAs, and IPR. Industrial problems frequently lead to mathematical questions of great complexity. I will discuss some ways that mathematics is used in industry. I will also show how the solution of industrial problems has stimulated new mathematics.

17:30-18:00

What can we (academic institutions) do to help industry and our students?

Huaxiong Huang	York University

Abstract: In this talk, we share our experience in Canada, and more sepcifically a recent initiative at the Fields Institute in Toronto.

18:00-18:30

DEEP CNN SPARSE CODING ANALYSIS: TOWARDS AVERAGE CASE

Jared Tanner	University of Oxford
Michael Murray	University of Oxford

Abstract: Deep convolutional sparse coding (D-CSC) is a framework reminiscent of deep convolutional neural nets (DCNN), but by omitting the learning of the dictionaries one can more transparently analyse the role of the activation function and its ability to recover activation paths through the layers. We extend the results of Papyan, Romano, and Elad and prove improved conditions under which a D-CSC is guaranteed to recover activation paths.

MS A3-3-3 1 **17:00-19:00**

Modelling and calibration in pedestrian dynamics - Part 1

For Part 2 see: MS A3-3-3 2

Organizer: Susana Gomes University of Warwick

Organizer: Marie-Therese Wolfram University of Warwick

Abstract: We aim to bring experts from applied mathematics and transportation research together to present recent developments in the respective fields and initiate intra- and interdisciplinary collaborations. There is a rich mathematical and engineering literature on mathematical models in pedestrian dynamics. With the ongoing developments more and more data such as pedestrian trajectories and velocities are available. Blending this data with models to calibrate and estimate parameters, is of great interest in the engineering and applied mathematics community. The proposed mini-symposium highlight the latest advancements and help to develop pathways from analytic and computational methods in real-world applications.

17:00-17:30

Modeling and calibration of PDE models for pedestrian dynamics

Susana Gomes University of Warwick

Andrew Stuart Caltech

Marie-Therese Wolfram University of Warwick

Abstract: We present a framework for estimating parameters in macroscopic models for crowd dynamics using data from individual trajectories. We use a coupling between a density dependent stochastic differential equation and a nonlinear partial differential equation for the density. The velocity of a pedestrian decreases with the density according to the fundamental diagram. We discuss identifiability of the parameters appearing in the fundamental diagram and analyse the performance of the proposed methodology in various realistic situations.

17:30-18:00

Non-local macroscopic models for crowd motion: analysis and numerics

Paola Goatin Inria

Abstract: Non-local interactions can be described through macroscopic models based on integro-differential equations. In particular, conservation laws with non-local flux have been recently introduced in traffic flow modeling to account for the reaction of drivers or pedestrians to the surrounding density of other individuals. In this talk, I will present some 1D and 2D models, their analytical properties and some numerical simulation illustrating solutions characteristics.

18:00-18:30

A new anisotropic model for pedestrian dynamics

Claudia Totzeck Technische Universität Kaiserslautern

Abstract: We discuss a new model for pedestrian dynamics which incorporates evasive action with the help of an anisotropy. In fact, the anisotropy is caused by a rotation of the axis of interaction of the pedestrians. We introduce an ODE model for particle simulations of the pedestrians and employ a scaling to obtain a mean-field model. Numerical results show that the model is capable to reproduce well-known structrues, for example lane formation.

18:30-19:00

Optimal control for a regularized Hughes model

Jan-Frederik Pietschmann Technische Universität Chemnitz

Abstract: We present some results on the optimal control problem related to Hughes' crowd motion model. In particular, we present several numerical examples based on a DG discretization of the problem.

MS FT-2-3 1 **17:00-19:00**

Efficient time-stepping for PDE problems with fast time scales

Organizer: David Ketcheson KAUST

Organizer: Benjamin Seibold Temple University

Abstract: Many initial boundary value problems impose unique challenges on initial value ODE solvers, caused by stiffness or fast time scales. Sometimes the fastest scales must be resolved, but only in a fraction of the spatial domain. In other situations, the fast scales need not be resolved, but are a source of instability or loss of accuracy. Numerical methods must ensure that the computational cost of the solution is not dictated by the fast time scales. This session presents time stepping methods whose stability, accuracy, and efficiency are based on fundamental considerations of the spatial aspects of the problem at hand.

17:00-17:30

DIRK Schemes with High Weak Stage Order

Benjamin Seibold Temple University

Abstract: High stage-order can prevent order reduction in Runge-Kutta methods; but stage order beyond two is not possible in the context of DIRK schemes. We outline strategies to construct concrete schemes with high weak stage order (WSO) and discuss, for ODE and PDE problems, which forms of order reduction are remedied by WSO, and which are not.

17:30-18:00

Adaptive parallel partitioned multirate time integrators for coupled PDE models

Philipp Birken Lund University

Peter Meisrimel Lund University

Abstract: We consider coupled systems of PDEs. Our aim is an efficient high order adaptive multirate method that reuses existing codes, and solves subproblems efficiently in parallel. We suggest a novel waveform-iteration using continuous data exchange. Classical methods prescribe interface data over a time window and exchange new data at the end. These are slow (Jacobi) or sequential (Gauss-Seidel). Instead, we solve in parallel, but exchange data continuously. We present analysis, an implementation and demonstrate efficiency.

18:00-18:30

Unconditional stability for multistep ImEx schemes

David Shirokoff New Jersey Institute of Technology

Rodolfo Ruben Rosales Massachusetts Institute of Technology

Benjamin Seibold Temple University

Dong Zhou California State University, Los Angeles

Abstract: We present a new unconditional stability theory for the integration of differential equations via multistep ImEx schemes for problems where some explicit terms are stiff. We introduce an unconditional stability region, which plays a role analogous to that of the stability region in conventional absolute stability; and quantify the trade-off between having good stability and high-order. We use the theory to construct efficient high-order schemes for the nonlinear diffusion, advection diffusion, and Navier-Stokes equations.

18:30-19:00

Spatial manifestations of order reduction in PDE IBVP

Rodolfo Rosales MIT

Benjamin Seibold Temple U.

David Shirokoff NJIT

Dong Zhou California State University, Los Angeles

Abstract: The phenomenon of order reduction (OR) for time step integrators has been of interest for many years. Here we will describe the space structure associated with OR for PDE IVBP that occurs with many Runge-Kutta schemes. We will: illustrate the phenomena with some numerical examples, introduce a geometric explanation of the mechanics of the phenomenon, and describe some fundamental differences between OR for pde and for stiff ode's. In particular, why the reduction orders differ.

MS ME-0-8 1 **17:00-19:00**

Dirac Hamiltonians with critical singularities - Part 1

For Part 2 see: MS ME-0-8 2

For Part 3 see: MS ME-0-8 3

Organizer: Naiara Arrizabalaga University of the Basque Country, UPV/EHU

Organizer: Luis Vega BCAM-BASQUE CENTER FOR APPLIED MATHEMATICS

Organizer: Albert Mas Universitat Politècnica de Catalunya

Abstract: Dirac operators perturbed by potentials with critical singularities have recieved a renewed attention since the beginning of the century. Plenty of works concerning the well posedness of Coulomb type perturbations appeared in the 70's thanks to the work of Rellich, Kato, Nenciu, and Wüst, among others. In this minisimposia we will present recent results in this direction. Our main interest will be to highlight the features of the relativistic setting absent in the non-relativistic one. Special attention will be paid to the shell interactions and its relation to the MIT bag model for quark confinement.

17:00-17:30

Recent results on critical perturbations of Dirac operators

Luis Vega	BCAM-BASQUE CENTER FOR APPLIED MATHEMATICS

Abstract: In the talk we will present some recent results on perturbations of Dirac operators asthe MIT-Bag Model and delta-shell interactions. Some open problems will be also considered.

17:30-18:00

Minimax methods for atomic Dirac operators

Mathieu Lewin	CEREMADE, Université Paris Dauphine

Abstract: I discuss minimax formulas for the eigenvalues of Dirac operators with a potential V having a strong Coulomb singularity at 0. Such operators admit a distinguished self-adjoint extension. Our minimax formulas are valid in simple function spaces independent of V, whereas the domain itself depends on V. Collaboration with Maria J. Esteban and Eric Sxrx (Paris-Dauphine). Supported by ERC CoG grant MDFT.

18:00-18:30

Polarization of the Dirac vacuum: the semi-classical limit

Eric Séré	CEREMADE, Université Paris Dauphine
Philippe Gravejat	Université de Cergy-Pontoise
Mathieu Lewin	CEREMADE, CNRS et Université Paris-Dauphine

Abstract: The Euler-Heisenberg model provides a nonlinear system of equations for the electromagnetic field, taking into account its interaction with the quantum vacuum. In most situations the linear (Maxwell) approximation is extremely accurate, but nonlinear effects cannot be neglected in very strong fields, as for instance on the surface of some neutron stars. We give the first rigorous derivation of the Euler-Heisenberg magnetic energy in the semi-classical limit of slowly varying, time-independent, magnetic fields.

18:30-19:00

Dirac operators with electrostatic delta-shell interactions: spectral and scattering properties

Pavel Exner	Doppler Institute for Mathematical Physics and Applied Mathematics, Czech Technical University and Nuclear Physics Institute

Abstract: We discuss spectral and scattering properties of Dirac operators with a singular constant-strength interaction of electrostatic type supported by a compact smooth surface on R^3. Using the boundary triple technique we demonstrate that the interaction gives rise to a finite discrete spectrum in the spectral gap of the free Dirac operator. We also prove the existence of the corresponding wave operators and discuss the nonrelativistic limit of such systems.

MS FT-S-6 1 17:00-19:00

Eigenvalue Problems: Analysis, Algorithms and Applications - Part 1

For Part 2 see: MS FT-S-6 2
For Part 3 see: MS FT-S-6 3
For Part 4 see: MS FT-S-6 4

Organizer: Xiaoying Dai	Academy of Mathematics and Systems Science
Organizer: Huajie Chen	Beijing Normal University
Organizer: Xin Liu	Academy of Mathematics and Systems Science

Abstract: Eigenvalue problems are widely used in many fields such as physics, materials sciences, chemistry, biology and image sciences. The research on eigenvalue problems, including its mathematical theory analysis, efficient algorithm design, practical applications, and many unresolved issues, is a challenging topic. This minisymposium aims to provide a platform for experts in this field to exchange the latest developments and explore the topic of further research and cooperations.

17:00-17:30

Towards Scalable Computation of Many Eigenpairs of Hermitian Matrices

Zhaojun Bai	University of California, Davis
Jack Dongarra	The University of Tennessee, Knoxville
Ding Lu	University of California, Davis
Ichitaro Yamazaki	The University of Tennessee, Knoxville

Abstract: There are continual and compelling needs for computing many eigenpairs of a large sparse Hermitian matrix in computational science and engineering and data analysis. Most of codes developed in the past are not adequate or efficient for such needs, even when vast computing resources are available. We will first review the current efforts, and then discuss a number of practical techniques we are working on for numerical stability and robustness, communication-avoiding and scalability.

17:30-18:00

Eigenvalues of an Infinite Tensor Ring

Chao Yang	Lawrence Berkeley National Laboratory
Roel Van Beeumen	LBNL
Lana Perisa	EPFL
Daniel Kressner	EPFL

Abstract: We are interested in computing eigenvalues of an infinite dimensional matrix that can be written as an infinite sum of Kronecker products of infinite number of matrices. One way to solve such a problem is to use an infinite translational invariant tensor ring to represent the approximation to the eigenvector and update such a tensor ring through a flexible power iteration. We discuss approximations made in each step and how these approximations affect the convergence.

18:00-18:30

Eigenfunction Behaviors and Adaptive Finite Element Approximations of Nonlinear Eigenvalue Problems

Aihui Zhou	Academy of Mathematics and Systems Science, Chinese Academy of Sciences

Abstract: In this presentation, we talk about the eigenfunction behaviors of eigenvalue problems in quantum physics. We first prove that the eigenfunction cannot be a polynomial in any open set. Then we apply non-polynomial behaviors of eigenfunctions to show that the adaptive finite element approximation is convergent even if the initial mesh is not fine enough. We finally remark that the adaptive finite element method has linear convergence rate and optimal complexity.

IM FT-2-2 1 17:00-19:00

Mathematical modeling, simulations and theories related to biological phenomena - Part 1

For Part 2 see: IM FT-2-2 2

Organizer: Yoshihisa Morita	Ryukoku University
Organizer: Masaharu Nagayama Male	Hokkaido University
Organizer: Shin-Ichiro Ei	Hokkaido University

Abstract: By recent various developments in the fields of biology, including cell adhesion, cellular differentiation, morphogenesis, a huge number of researches based on modeling and simulations are reported. On contrast to modeling and simulations there are not so many significant contributions by mathematical analysis. In order to encourage interdisciplinary studies we organize a minsyomosium consist of speakers on modelings, simulations and mathematical analysis in related to biological phenomena. Every invited speakers are experts in their fields and new contributions to those fields would be expected through exchanging their ideas.

17:00-17:30

Patterns induced by diffusion in reaction-diffusion systems with mass conservation

Yoshihisa Morita	Ryukoku University

Abstract: There are a number of mathematical models related to cell polarization and emergence of localized patterns is observed in those models. In this talk we are concerned with a model of coupled bulk-membrane diffusion equations with mass conservation. We investigate a Turing-type instability in the equations and show a localized pattern in the shadow system. This talk is based on a joint work with K. Sakamoto.

17:30-18:00

A general property for in-phase and anti-phase cell polarities in asymmetric cell division

Sungrim Seirin-Lee	Hiroshima University
Tsubasa Sukekawa	Hokkaido University
Tomohiro Nakahara	Hiroshima University
Hiroshi Ishii	Hokkaido University
Shin-ichiro Ei	Hokkaido University

Abstract: In this talk, we introduce a general mechanism for the relative positioning between up- and down- streams polarities through the biological example of PARs, MEX5/6 and PIE-1 that plays an important role in asymmetric cell division process. Using the conceptional modeling and model reductions, we find that the positional relation of polarities is determined by a contrasting role of regulation by upstream polarity protein on the transition process of diffusion dynamics of downstream proteins.

18:00-18:30

Numerical analysis of the pattern formation of run-and-tumble bacteria based on a kinetic chemotaxis model

Shugo Yasuda	University of Hyogo

Abstract: Chemotactic bacteria such as Escherichia coli create a continuous reorientation by runs and tumbles, where the length of run is determined by a stiff response to a chemical sensing along the pathway. The instability analysis of a kinetic transport model has clarified that the pattern formation of chemotactic bacteria stems from the stiff chemotactic response. This talk presents numerical results of the pattern formation based on the kinetic transport model.

18:30-19:00

Modeling and numerical analysis for cell-cell adhesion

Hideki Murakawa	Ryukoku University

Abstract: Cell-cell adhesion and cell sorting processes are essential in organ formation during embryonic development. We proposed a nonlocal advection-diffusion problem as a possible continuous model for these phenomena. In this talk, we briefly give a derivation of the model. And then, we provide and analyze a numerical scheme for the model. This talk is based on joint works with Rafael Bailo, Jose A. Carrillo, Hideki Murakawa, Makoto Sato, Markus Schmidtchen, Hideru Togashi and Olena Trush.

MS FT-1-10 1 17:00-19:00

Numerical methods for interfacial dynamics - Part 1

For Part 2 see: MS FT-1-10 2
For Part 3 see: MS FT-1-10 3
For Part 4 see: MS FT-1-10 4

Organizer: Weiying Zheng	Chinese Academy of Sciences
Organizer: Qinghai Zhang	Zhejiang University
Organizer: Zhilin Li	North Carolina State University

Abstract: We propose a mini-symposium on interfacial problems and dynamics in ICIAM2019 that concerns different aspects of this important topic such as mathematical modeling, theoretical analysis, and numerical methods. An important goal of this workshop is to foster collaboration between mathematicians, computational scientists, and engineers. Numerical methods include but are not restricted to interface tracking methods, immersed boundary/interface methods, extended finite element methods, arbitrary Lagrange-Euler methods, and so on. The nature of this workshop will be mathematics centered with multi-disciplinary multi-physics applications, particularly for free-surface flows, fluid-structure interaction, and other related multiphase flows.

17:00-17:30

Vector penalty-projection methods for incompressible multiphase flows under strong constraints or with open boundary conditions

Philippe Angot	Aix-Marseille Université
Jean-Paul Caltagirone	Université de Bordeaux & IPB
Rima Cheaytou	Aix-Marseille Université
Pierre Fabrie	Université de Bordeaux & IPB

Abstract: We discuss the efficiency of the vector penalty-projection methods including the kinematic version which uses fast discrete Helmholtz-Hodge decompositions on edge-based generalized MAC-type unstructured meshes. These methods are especially designed for the computation of incompressible or low-Mach multiphase flows under strong constraints (large density or viscosity ratios, large surface tension) and with Dirichlet or open boundary conditions. The simulation of air bubbles arising in a liquid melted steel will be shown.

17:30-18:00

The Immersed Boundary Smooth Extension Method: A High-order IB Method

Robert Guy	University of California Davis

Abstract: The classical Immersed Boundary method is simple and robust for solving PDE in general domains, yet it only achieves first-order accuracy. We introduce the Immersed Boundary Smooth Extension (IBSE) method, which achieves high-order accuracy by smoothly extending the unknown solution from a given smooth domain to a larger computational domain, enabling the use of simple Cartesian-grid discretizations. We demonstrate up to fourth-order pointwise convergence for Dirichlet problems for a variety of equations.

18:00-18:30

Ghost Fluid Method for Moving Interface with Acceleration

Tiegang Liu	Beihang University

Abstract: The MGFM might suffer overheating when applied to treat a moving interface with acceleration in long time simulation. We disclose the insightful reasons and develop a technique to take into account the effect of interface acceleration on the definition of ghost fluid states based on a generalized Riemann problem. Theoretical analysis and numerical results show that the modified ghost fluid method with acceleration correction (MGFM/AC) can overcome such difficulty effectively.

18:30-19:00

High Order Numerical Quadrature for FEM and XFEM on Tetrahedral Meshes

Linbo Zhang	Chinese Academy of Sciences

Abstract: In this talk, high order numerical quadrature algorithms for finite element methods on triangular and tetrahedral meshes will be presented. The related codes and resources, including high order symmetric numerical quadrature rules, tools for generating arbitrary order numerical quadrature rules, and a general purpose high order numerical quadrature function for XFEM on tetrahedral meshes with an arbitrary smooth interface, are freely available and can be found in the open source toolbox Parallel Hierarchical Grid (http://lsec.cc.ac.cn/phg/index_en.htm).

MS A1-1-3 1 17:00-19:00

Mining and modeling evolving and higher-order complex data and networks - Part 1

For Part 2 see: MS A1-1-3 2
For Part 3 see: MS A1-1-3 3
For Part 4 see: MS A1-1-3 4

Organizer: Francesco Tudisco	University of Strathclyde
Organizer: Eisha Nathan	Lawrence Livermore National Laboratory
Organizer: Christine Klymko	Lawrence Livermore National Laboratory
Organizer: Austin Benson	Cornell University

Abstract: The analysis of complex networks is a rapidly growing field with applications in many diverse areas. A typical computational paradigm is to reduce the system to a set of pairwise relationships modeled by a graph (matrix) and employ tools within this framework. However, many real-world networks feature temporally evolving structures and higher-order interactions. Such components are often missed when using static and lower-order methods. This minisymposium explores recent advances in models, theory, and algorithms for dynamic and higher-order interactions and data, spanning a broad range of topics including persistent homology, tensor analysis, random walks with memory, and higher-order network analysis.

17:00-17:30

Improving seed set expansion with semi-supervised information

Christine Klymko	Lawrence Livermore National Laboratory
Nate Veldt	Purdue University
David Gleich	Purdue University

Abstract: We present two improvements for flow-based methods for local graph clustering in semi-supervised clustering problems. First, a generalized objective function that allows placement of strict and soft penalties on excluding specific seed nodes from the output set, avoiding the tendency to contract large seed sets into small sets that exclude most seeds. Second, an algorithm for minimizing our generalized objective function which is faster than previous flow-based methods and more robust in detecting ground-truth regions.

17:30-18:00

Representing the Evolution of Communities in Dynamic Networks

Timothy M. La Fond — Lawrence Livermore National Laboratory
Geoff Sanders — Lawrence Livermore National Labs

Abstract: Dynamic networks are networks of entities (people, machines, etc.) that experience changes in their interconnections over time. These changes can lead to the emergence of new graph structures and communities. In some cases the changes are driven by malicious activity or other critical events; tracking the graph community structure and graph motifs can detect when these events occur which has applications in cyberdefense and other domains.

18:00-18:30

Algorithmic Advances in Higher-Order Correlation Clustering

Nate Veldt — Purdue University

Abstract: Correlation clustering is a well-studied framework for partitioning signed graphs. In recent work we developed constant factor approximations for a higher-order variant of the objective, though this relies on solving an expensive linear programming relaxation. In this talk we will briefly discuss previous results, and then consider a few directions for more practical techniques for clustering higher-order signed networks.

18:30-19:00

Generative model for mesoscale structure in multilayer networks

Marya Bazzi — Alan Turing Institute

Abstract: Multilayer networks are a way to represent dependent connectivity patterns that arise in many applications and which are difficult to incorporate into standard network representations. It is important to investigate mesoscale structures in multilayer networks to discover features that lie between the microscale and the macroscale. We introduce a generative model for mesoscale structure in multilayer networks that can admit many features of empirical multilayer networks and that explicitly incorporates a user-specified interlayer dependency structure.

MS ME-1-I1 1 — 17:00-19:00

Recent advances in nonlinear time series analysis - Part 1

For Part 2 see: MS ME-1-I1 2
For Part 3 see: MS ME-1-I1 3
Organizer: Yoshito Hirata — The University of Tokyo
Organizer: Michael Small — University of Western Australia
Organizer: José María Amigó — Universidad Miguel Hernández

Abstract: Nonlinear time series analysis, or time series analysis on dynamical systems, literally began in 1980s, when delay coordinates were proposed. The initial targets for nonlinear time series analysis were stationary, nonlinear, deterministic, isolated, low-dimensoinal systems without assuming knowledge about the underlying systems. One can easily find books describing such developments up to year 2000. But, the recent targets include also non-stationary, stochastic, or high-dimensional systems with or without partial models or couplings. The purpose of this mini-symposium is to showcase and summarize the recent advancements of nonlinear time series anlaysis, and provide a platform for discussing its future directions.

17:00-17:30

Using network construction techniques to unravel deterministic structure

Michael Small — University of Western Australia

Abstract: We consider methods to uncover deterministic structure and nonlinear dynamics observed through scalar time series via network construction methods. Time series are used to estimate proxies for state and the network adjacency matrix is a representation of the state transition probability. This method allows for accurate estimation of dynamic invariants of the underlying dynamics and may even provide a proxy for model simulation. Several competing methods exist, we focus on the ordinal network construction.

17:30-18:00

Calculation of Edit Distance for Marked Point Process by Using Coherent Ising Machine

Hiroyuki Yasuda — The University of Tokyo
Yoshito Hirata — The University of Tokyo
Kazuyuki Aihara — The University of Tokyo

Abstract: A marked point process is a series of events each of which has some marking values. Several distances are proposed for a marked point process. The edit distance is one of such distances and formulated as binary integer programming. Thus, this distance can be implemented in coherent Ising machine (CIM), that can solve combinatorial optimization problems efficiently. On this presentation, we evaluate the performance of the CIM implementation by the simulation.

18:00-18:30

Causality and information flow analysis in the presence of hidden processes

X. San Liang — Nanjing Institute of Meteorology

Abstract: Recently a rigorous formalism was developed to unravel the causality between time series (Liang 2014; 2016). Here we show that, for a system, the causality between two components is invariant upon nonlinear transformation of the remaining coordinates. So the hidden processes represented by these coordinates are made unessential if the attractor up to a diffeomorphism is reconstructed, while this is guaranteed by Takens' theorem. Some applications to climate, financial, and neuroscience series will be presented.

18:30-19:00

Separating nonlinear stochasticity from linear stochasticity and nonlinear determinism

Yoshito Hirata — The University of Tokyo
Masanori Shiro — Mathematical Neuroinformatics Group, Advanced Industrial Science and Technology
José M. Amigó — Centro de Investigación Operativa, Universidad Miguel Hernández

Abstract: Identifying properties for the underlying dynamics is the first step for modeling it. Popular properties discussed so far include whether it is linear or nonlinear, and whether it is deterministic or stochastic. But, because the common approach has been trying to distinguish linear stochasticity from nonlinear determinism, nonlinear stochasticity has not been characterized well. This talk will cover our attempts for separating nonlinear stochastic systems from linear stochastic systems and nonlinear deterministic systems.

MS GH-1-3 1 — 17:00-19:00

Current Developments in Wavelett- Fractal Methods with Applications - Part 1

For Part 2 see: MS GH-1-3 2
For Part 3 see: MS GH-1-3 3
For Part 4 see: MS GH-1-3 4
Organizer: Abul Hasan Siddiqi Siddiqi — Sharda University
Organizer: Nekka Fahima — Université de Montréal
Organizer: Akhtar A. Khan — Rochester Institute of Technology Rochester, New York
Organizer: Pammy Manchanda — Guru Nanak Dev University

Abstract: Wavelet and Fractal Methods were invented in early eighties. The basic work of the initial stages are very well documented in the book of Daubechies 1992 and Y. Meyer 1993, SIAM. An updated historical development has been presented in chapter 12 of a recent book by the organizer of the symposium published by Springer in 2018. This symposium in three parts is devoted to certain topics dicussed in three monographs by Springer in recent past namely multivariate wavelet frames, 2016, industrial mathematics and complex systems, 2017 & wavelets constructed by Walsh functions, 2018.

17:00-17:30

Approximation by Wavelets constructed through Walsh functions

Abul Hasan Siddiqi Siddiqi — Sharda University

Abstract: Walsh function has been studied extensively Schipp, Wade and Simon, 1990; Maquisi 1981; Golubov, Efimov, Skvortsov, 1981; Beauchamp, 1975 & Siddiqi, 1978. Fridli, Manchanda, Siddiqi , 2008 have published fairly general results in the setting of homogenous Banach Spaces, see Th. 2.27 & 2.28 of Farkov, Manchanda and Siddiqi (Construction of Wavelets through Walsh Functions, Springer Nature,2019).Variants of these theorems for classes of wavelets will be discussed. Results may be extended to multivariate wavelet frames.

17:30-18:00

Vector Valued Wavelets on Positive Line

Pammy Manchanda — Guru Nanak Dev University

Abstract: The concept of Multiresolution analysis (MRA) for scalar functions has been extended to vector valued functions by Xia and Suter; Farkov, Manchanda, Siddiqi (Construction of Wavelets through

Walsh Functions, Chapter-9, Springer Nature, April, 2019). In this talk orthogonal vector valued wavelets will be presented along with the scope of future research work. Interaction of results of the book cited and that of Skopina, Krivoshein, Protasov, (Multivariate Wavelet Frames, Springer, 2016) may open new avenues.

18:00-18:30

Multivariate generalized Kantorovich-Kotelnikov operators and their approximation properties

Мария Скопина — Saint Petersburg State University, Russia

Abstract: A wide class of generalized Kantorovich-Kotelnikov operators is studied. This class includes operators generated by non-integrable band-limited functions as well as compactly supported functions. Under some mild assumptions, error estimates in the L_p-norm are given in terms of the classical moduli of smoothness. Error estimates in the norm of weighted L_p-spaces with submultiplicative weights are also obtained. This allows to deal with signals whose decay is not enough to belong to L_p.

18:30-19:00

Wavelets on Vilenkin Groups

Yu A Farkov Farkov — Russian Presidential Academy of National Economy and Public Administration , Russia

Abstract: The main results on wavelets for Vilenkin groups are reflected in [1] and the references therein. In this talk, we will present MRA-based wavelet tight frames on Vilenkin groups and the corresponding algorithm for constructing Parseval frames. We will also discuss a new method for constructing finite tight frames associated with the Walsh functions and their generalizations. [1] Farkov, Yu.A., Wavelet frames related to Walsh functions, European Journal of Mathematics, doi: 10.1007/s40879-018-0220-6.

MS A6-3-3 1 17:00-19:00

Multiscale and Asymptotic Analysis, Modeling, and Simulation for Materials Science - Part 1

For Part 2 see: MS A6-3-3 2
For Part 3 see: MS A6-3-3 3
For Part 4 see: MS A6-3-3 4
For Part 5 see: MS A6-3-3 5

Organizer: Silvia Jimenez Bolanos — Colgate University
Organizer: Miao-Jung Yvonne Ou — University of Delaware
Organizer: Lyudmyla Barannyk — University of Idaho

Abstract: Multiscale in space and time continues to be an active and challenging area of research in mathematical materials science. The aim of this minisymposium is to focus on multiscale modeling, analysis and simulation of the problems arising in fluids, composites and other heterogeneous media. In particular, topics that will be discussed include but are not limited to asymptotic analysis, homogenization, inverse problems, and computational tools for complex fluid and inhomogeneous media. The purpose of this minisimposium is to enable contact between researchers working on fluid modeling and multiscale methods with an update on recent progress in this field.

17:00-17:30

Multiscale homogenization for sea ice and other composite materials

Ken Golden	University of Utah Department of Mathematics
Noa Kraitzman	University of Utah
Rebecca Hardenbrook	University of Utah
Ben Murphy	University of Utah
Elena Cherkaev	University of Utah
Court Strong	University of Utah
Ivan Sudakov	University of Dayton
Yiping Ma	Northumbria University

Abstract: Polar sea ice is a key component of the Earth's climate system. It exhibits complex composite structure on scales ranging over ten orders of magnitude. I will address key questions in sea ice homogenization and the rigorous analysis of effective properties, such as fluid flow through the porous brine microstructure, advection enhanced diffusion, and melt pond evolution. This work is helping to advance how sea ice is represented in climate models and improve climate projections.

17:30-18:00

On Stefan problem with internal heat generation and constant heat flux in cylindrical geometry

Lyudmyla Barannyk	University of Idaho
Sidney D. V. Williams	Moscow High School, Moscow, Idaho, 83843, USA
Olufolahan Irene Ogidan	University of Idaho, Moscow, Idaho, 83843, USA
John C. Crepeau	University of Idaho, Moscow, Idaho, 83843, USA
Alexey Sakhnov	Kutateladze Institute of Thermophysics SB RAS, Novosibirsk, 630090, Russia

Abstract: We study evolution of solid-liquid interface during melting and solidification of a material with constant internal heat generation and prescribed heat flux at the boundary of a cylinder. We derive an ODE for interface with infinite series. Numerical solutions are compared to previously published quasi-static solutions. Difference between internal heat generation and heat flux can be used to control motion and speed of the interface. Problem has applications for a nuclear fuel rod during meltdown.

18:00-18:30

Surface energy approaches in modeling of nano-objects.

Anna Zemlyanova — Kansas State University

Abstract: In this talk, surface energy model proposed by Steigmann and Ogden will be applied to fracture problems and contact problems in two-dimensional setting. The mechanical problems are reduced to systems of singular integro-differential equations which are further reduced to systems of weakly-singular equations. The existence and uniqueness of the solution for almost all the values of the parameters is proved.

IM FT-4-1 1 17:00-19:00

EU-MATHS-IN: Success Stories of Mathematics in Societal Challenges and Industry - Part 1

For Part 2 see: IM FT-4-1 2
For Part 3 see: IM FT-4-1 3
For Part 4 see: IM FT-4-1 4

Organizer: Carlos Parés Madroñal — Universidad de Málaga
Organizer: Manuel Cruz — PT-MATHS-IN | LEMA-ISEP/IPP

Abstract: The European Service Network of Mathematics for Industry and Innovation (EU-MATHS-IN) is an organization promoted by several European research networks following the recommendations of the European Science Foundation. Its main purpose is to increase the impact of mathematics on innovations in key technologies and to foster the development of new modeling, simulation and optimization tools. The goal of this mini-symposium is to present to the attendees some success stories of application of mathematical technologies in industry developed by researchers belonging to the national networks that are members of EU-MATHS-IN. The sessions are organized according to the addressed societal challenges.

17:00-17:30

Reducing the computational time in the steady-state simulation of induction machines

Dolores Gómez	University of Santiago de Compostela & ITMATI
Alfredo Bermúdez	Universidade de Santiago de Compostela & ITMATI
Marta Piñeiro	Universidade de Santiago de Compostela
Mª Del Pilar Salgado	Universidade de Santiago de Compostela

Abstract: This work present a novel and efficient procedure to reduce the time needed to reach the steady-state in the finite element simulation of induction machines with squirrel cage rotor. It is based on approximating suitable initial currents in the rotor bars. The numerical results show important computational savings in comparison with assuming zero initial conditions. This represents a great advantage in terms of competitiveness when incorporated as a pre-computation to any motor-oriented transient simulation tool.

17:30-18:00

Assessment and Optimization of Candidate Materials for Energy Applications

Elena Akhmatskaya	BCAM-BASQUE CENTER FOR APPLIED MATHEMATICS
Mauricio R. Bonilla	BCAM, Basque Country
Fabian Garcia	BCAM, Basque Country
Javier Carrasco	CIC energiGUNE, Basque Country
Liliana Lopez	CIDEMAT, Colombia
Guo-Dong Zhao	Shanghai University, China
Franklyn Jaramillo	CIDEMAT, Colombia
Jorge A. Calderon	CIDEMAT, Colombia

Abstract: Development of efficient strategies for the rational design of materials involved in the production and storage of renewable energy is essential for accelerating the transition to a low-carbon economy. To contribute to this goal, we propose a novel workflow for assessment and optimization of battery materials. The approach effectively combines quantum and atomistic modelling/simulations, enhanced by efficient sampling, Bayesian parameterization and experimental information. It is implemented to study prospective materials for lithium and sodium ion batteries.

18:00-18:30

Hybrid importance sampling Monte Carlo approach for yield estimation in circuit design

Wil Schilders	Eindhoven University of Technology

Abstract: We study the problem of estimating yield of an integrated circuit through elecronic circuit simulation. Standard MC simulations are too costly, hence we use importance samping so as to estimate rare events much better. We create a surrogate model that can be used in most cases; the original simulator is only used close to the failure threshold. In this way, simulations times are speeded up enormously, making the desired estimation possible.

18:30-19:00

Energy consumption analysis

Jean-Baptiste Wahl	Universite de Strasbourg

Abstract: Energy demand control has been an issue for a while. Reducing the consumption of households, buildings, territories countries is a key environmental issue: we would reduce fossils resources consumption and obviously CO2 emission. To advance toward reducing energy consumption, we need to work to understand energy consumption. In order to better understand energy consumption from an energy distributor’s clients, load curves from each client were saved. This information was then crossed with external temperature measurements.

MS ME-0-6 1 **17:00-19:00**

Novel Concepts in Model-driven Optimization and Control of Agent-based Systems - Part 2

For Part 1 see: MS ME-0-6 2
For Part 3 see: MS ME-0-6 3
For Part 4 see: MS ME-0-6 4

Organizer: Dante Kalise	University of Nottingham
Organizer: Giuseppe Visconti	RWTH Aachen University
Organizer: Herty Michael	RWTH Aachen University
Organizer: Giacomo Albi	University of Verona

Abstract: This minisymposium features recent developments in optimization and control of agent-based dynamics arising in collective behaviour phenomena across different spatio-temporal scales, with particular emphasis on the interplay between multiscale modelling and optimal control. The talks will focus on different techniques stemming from multiscale modelling, nonlinear optimal control, Hamilton-Jacobi Equations and uncertainty quantification, and will incorporate recent breakthroughs in model-driven optimization, high-dimensional approximation and learning. This minisymposium will also address different applications in learning and control of animal and human crowd motion, social dynamics, and the control of autonomous vehicles.

17:00-17:30

Kinetic models for optimal control of wealth inequalities

Bertram Düring	University of Sussex

Abstract: We discuss optimal control strategies for kinetic models for wealth distribution in a simple market economy, which are designed to reduce the variance of the wealth density among the population. Our analysis is based on a finite time horizon approximation, or model predictive control, of the corresponding control problem for the microscopic agents' dynamic and results in an alternative theoretical approach to the taxation and redistribution policy at a global level.

17:30-18:00

Mean field control for fluid dynamics

Torsten Trimborn	RWTH Aachen University

Abstract: Starting from controlled microscopic dynamamics we derive the corresponding mean field equation. We are able to show that in our case the mean field limit of the controlled microscopic dynamics is identical to the mean field control of our kinetic equation. Finally, we consider the hydrodynamic limit of our mesoscopic equation. Especially we study possible closure laws and the connection to the mean field model. We visualize our findings with several numerical examples.

18:00-18:30

Kinetic-controlled hydrodynamics

Mattia Zanella	Politecnico di Torino

Abstract: In this talk we present recent results for kinetic-controlled hydrodynamics. We develop a hierarchical description of controlled systems by means of kinetic-type strategies with applications to traffic dynamics. Feedback controls are designed at the level of agent-to-agent interactions and then upscaled to the global flow via a kinetic approach based on the Boltzmann equation. The passage to hydrodynamic equations for constrained kinetic models of collective behavior is discussed taking into account several closure methods.

18:30-19:00

Hamilton Jacobi approach for traffic flows on networks

Adriano Festa	L'Aquila university
Elisabetta Carlini	Sapienza University of Rome
Nicolas Forcadel	INSA Rouen

Abstract: We present a semi-Lagrangian scheme for the approximation of a class of Hamilton-Jacobi-Bellman equations on networks. The scheme is ex- plicit and stable under some technical conditions. We prove a convergence theorem and some error estimates. Additionally, the theoretical results are validated by numerical tests. Finally, we apply the scheme to simulate traffic flows modeling problems.

MS A6-2-1 1 **17:00-19:00**

Multiscale seismic modelling and imaging - Part 1

For Part 2 see: MS A6-2-1 2
For Part 3 see: MS A6-2-1 3

Organizer: Lihui Chai	Sun Yat-Sen University
Organizer: Xu Yang	University of California, Santa Barbara
Organizer: Jianwei Ma	Harbin Institute of Technology
Organizer: Ping Tong	Nanyang Technological University

Abstract: Seismic modeling and imaging are widely used and powerful tools to investigate subsurface structures on a variety of scales, namely, from the global to industrial scales. This session will bring together academic and industrial researchers with recent advances in theoretical developments, computational methods and practical applications of multiscale seismic modelling and imaging. The session will place particular emphasis on new numerical modelling, migration, tomography, and inversion methods. Specific topic will include fast algorithms for 3D seismic wave simulation; full waveform inversion; optimal transport; model reduction; and applications at a variety of scales.

17:00-17:30

A numer. method for an Inverse BVP for the Schrodinger eq. w. finite number of measurements

Shingyu Leung	The Hong Kong University of Science and Technology

Abstract: We present a simple algorithm for solving an inverse problem for the Schrödinger equation. The idea is to apply the gradient descent and the adjoint state technique. We observe that since the forward operator is self-adjoint, the approach simply requires to solve the same partial differential equation for both the forward problem and the adjoint problem. This inverse problem can be linked to the standard Calderón inverse problem for the electrical impedance tomography (EIT).

17:30-18:00

Frozen Gaussian approximation based seismic tomography

Lihui Chai	Sun Yat-Sen University
Xu Yang	
Ping Tong	
James Hateley	

Abstract: In this talk, we present some recent applications of using Frozen Gaussian approximation (FGA) in seismic tomography. We develop the FGA as an efficient parallel asymptotic solver for high-frequency seismic wave propagation and apply it in full-waveform seismic inversion. Results on the earthquake simulation under the IASP91 model and the synthetic test of the imaging problem under the cross-well experiment setup using an elastic wave model are presented.

18:00-18:30

$O(Nlog^{\alpha}N)$ matvec and preconditioners for highly oscillatory kernels

Haizhao Yang National University of Singapore

Abstract: This talk introduces several $O(Nlog^{\alpha}N)$ algorithms for dense matrix multiplications and solving linear systems from highly oscillatory phenomena, e.g, evaluating forward and inverse oscillatory integrals, solving boundary integral equations in the high-frequency regime, etc. Based on recent advances of randomized algorithms and matrix recovery, we are able to approximate these dense matrices and their inverse in $O(Nlog^{\alpha}N)$ operations, leading to efficient matvec and preconditioners for highly oscillatory integral transforms.

18:30-19:00

Elastic scattering of multiple particles and its inverse problems

Jun Lai Zhejiang University

Abstract: Efficient algorithms for evaluating the elastic scattering from multiple particles are important in seismic imaging. In this talk, we propose a fast hybrid method to evaluate the elastic multi-particle scattering. The main ingredients of the algorithm are Helmholtz decomposition, boundary integral equations and fast multiple method. Numerical simulation for a large number of elastic particles will be presented. We will also show its applications in the inverse elastic scattering with phaseless far field data.

MS FE-1-G 1 17:00-19:00

Mathematical and numerical modeling of the human heart - Part 1

For Part 2 see: MS FE-1-G 2

Organizer: Luca Dedé POLITECNICO DI MILANO - LABORATORIO MOX

Organizer: Andrea Manzoni POLITECNICO DI MILANO - LABORATORIO MOX -

Organizer: Alfio Quarteroni EPFL, Lausanne, Switzerland & Politecnico di Milano, Italy

Abstract: The mathematical modeling and numerical simulation of the heart function are fascinating, but significantly challenging tasks. A fully integrated heart model is indeed a complex multiphysics and multiscale differential problem, which embeds several core cardiac models, that is electrophysiology, active and passive mechanics, fluid dynamics, and valve dynamics. This minisymposium aims at gathering mathematicians, engineers, and researchers working on the mathematical and numerical modeling of the heart. Topics may include, but are not limited to, coupled cardiac models, electrophysiology, mechanical activation, fluid dynamics, valve modeling, translational medicine, scientific computing and large-scale simulations, as well as other computational aspects.

17:00-17:30

Mathematical and numerical models for cardiac electromechanics: numerical coupling and simulation

Luca Dede' POLITECNICO DI MILANO - LABORATORIO MOX

Abstract: We develop multiscale and multiphysics models for cardiac electromechanics by integrating electrophysiology and mechanical models, including a reduced model for miscroscopic active force generation exploiting Machine Learning. We solve the coupled problem by means of monolithic and staggered approaches; then, we present several numerical results for the human heart. This project has received funding from the European Research Council under the European Union's Horizon 2020 research and innovation program: grant agreement No 74013, iHEART, 2017-2022.

17:30-18:00

Machine learning of active force generation models for the efficient multiscale simulation of the cardiac function

Francesco Regazzoni	Politecnico di Milano
Luca Dedè	Politecnico di Milano
Alfio Quarteroni	Politecnico di Milano

Abstract: We propose a machine learning technique that builds a reduced model from a collection of input-output pairs generated with a high-fidelity model, with the aim of drastically reducing the computational burden of cardiac force generation models, which typically feature a large number of state variables to capture the intrinsically complex subcellular mechanisms. This project was founded from the European Research Council under the EU's Horizon 2020 research and innovation program: grant agreement No.74013, iHEART, 2017-2022

18:00-18:30

Numerical simulation of cardiac hemodynamics with iso-volumetric phases

Miguel A. Fernández	Inria
Alexandre This	Medisys, Philips Research
Ludovic Boilevin-Kayl	Inria Paris, Sorbonne Université & CNRS
Jean-Frédéric Gerbeau	Inria Paris, Sorbonne Université & CNRS

Abstract: In order to reduce the complexity of heart hemodynamics simulations, uncoupling approaches are often considered as an alternative to fluid-structure interaction models. A well-known shortcoming of these simplified approaches is the difficulty to correctly capture the pressure dynamics during the isovolumetric phases. We propose an enhanced resistive immersed surfaces model of cardiac valves which overcomes this issue. The benefits of the model are investigated and tested in blood flow simulations of the left heart.

18:30-19:00

Modeling the fluid-dynamics of the heart including moving cardiac valves.

Marco Fedele	FDLMRC87S12G273H
Ivan Fumagalli	Politecnico di Milano
Luca Dedè	Politecnico di Milano
Alfio Quarteroni	Politecnico di Milano

Abstract: The fluid-dynamics of the heart and neighboring vessels is influenced by the heart valves and their movement. We develop a flexible immersed approach - named Resistive Immersed Implicit Surface (RIIS) - to model the fluid-dynamics of the heart including moving valves. Numerical and stabilization aspects will be detailed. This project has received funding from the European Research Council under the European Union's Horizon 2020 research and innovation program: grant agreement No 74013, iHEART, 2017-2022.

MS ME-0-3 1 17:00-19:00

Nonlinear waves, singularities, and turbulence in physical and biological systems - Part 1

For Part 2 see: MS ME-0-3 2

For Part 3 see: MS ME-0-3 3

For Part 4 see: MS ME-0-3 4

For Part 5 see: MS ME-0-3 5

Organizer: Pavel Lushnikov University of New Mexico

Organizer: Alexander Korotkevich University of New Mexico

Abstract: Appearance of waves and formation of singularities are important problems in many physical, hydrodynamical and biological systems as well as for the applied mathematics in general. Waves of finite amplitude require solutions beyond linear approximation by taking into account nonlinear effects. Solutions of nonlinear equations usually result in the formation of singularities, coherent structures or solitary waves. Examples of the corresponding phenomena can be observed in filamentation of laser beams in nonlinear media, wave breaking in hydrodynamics and aggregation of bacterial colonies. The minisymposium is devoted to new advances in the theory of nonlinear waves.

17:00-17:30

Accelerated Simulation for Plasma Kinetics

Russel Caflisch	Courant Institute of Mathematical Sciences
Denis Silantyev	Courant Institute, NYU
Bokai Yann	Bank of America

Abstract: Kinetics of Coulomb collisions in plasmas are described by the Landau-Fokker-Planck equation, which is solved using a Direct Simulation Monte Carlo (DSMC) method. Acceleration of this method is achieved by coupling the particle method to a continuum fluid description. Efficiency is greatly increased by inclusion of particles with negative weights. This complicates the simulation, but this talk will describe significant progress that has been made in overcoming those difficulties.

17:30-18:00

Water waves over multiply-connected domains

Jon Wilkening	UC Berkeley
David Ambrose	Drexel University
Jeremy Marzuola	University of North Carolina, Chapel Hill
Roberto Camassa	University of North Carolina, Chapel Hill
Richard McLaughlin	University of North Carolina, Chapel Hill
Quentin Robinson	North Carolina Central University

Abstract: We present a spectrally accurate algorithm for solving the incompressible, irrotational Euler equations with a free surface over multiple stationary obstacles and variable bottom topography in two dimensions. The spacing of gridpoints on the free surface evolves dynamically to efficiently resolve regions of high curvature as they develop. The velocity potential is represented using Cauchy integrals. We study singularity formation and capillary effects and compare our numerical results with lab experiments.

18:00-18:30

Nonlinear Waves over Vortex Patches

Christopher Curtis	San Diego State University
Henrik Kalisch	University of Bergen

Abstract: We present a method for simulating freely evolving surface waves over patches of vorticity. This is done via point-vortex approximations. We present results which show the impact of various types of vortex patches on nonlinear-wave propagation. A key result is that the more nonlinear a surface wave, the more robust it is with respect to the influence of eddies. In contrast, nearly linear waves can be strongly deformed, possibly to the point of breaking.

18:30-19:00

Frequency Downshift in the Ocean

John Carter	Seattle University
Camille Zaug	Seattle University
Isabelle Butterfield	Seattle University
Alex Govan	Seattle University

Abstract: A wave train is said to exhibit frequency downshifting if either the spectral peak or the spectral mean decrease monotonically as it evolves. Generalizations of the cubic nonlinear Schrodinger equation have been shown to accurately predict frequency downshift in laboratory experiments. In this talk, we use these models to determine how accurately they model the evolution of wave trains (and frequency downshift) in the ocean.

CP FT-4-5 1 — 17:00-19:00

Applied Mathematics for Industry and Engineering I

Chair Person: Prabir Daripa — Texas A&M University

CP FT-4-5 1 1 — 17:00-17:20

Mathematical and computational challenges for multi-phase porous media flows in chemical EOR

Prabir Daripa	Texas A&M University

Abstract: We will give an overview of recent progress made by our team in the modeling, simulation and stability studies of multi-component multi-phase fluid flows arising in the context of chemical Enhanced Oil Recovery. Then we will discuss current ongoing work in this area involving non-Newtonian fluids. We will discuss challenges including stability of such flows. This work has been possible due to financial support from the U.S. NSF grant DMS-1522782.

CP FT-4-5 1 2 — 17:20-17:40

A note on the controllability of the semilinear heat equation with multiplicative control

Imad El Harraki	Mines Of Rabat
Boutoulout Ali	Faculty of sciences Meknes
Najib Khalid	Mines Of Rabat

Abstract: In this work, we study the controllability for the semilinear heat equation by a multi- plicative control. The first part concerns the approximate controllability. We construct a multiplicative control, conducting the solution of the system to a neighbourhood of the desired state. The second part treats the exact controllability. We provide a bilinear control using the approximate controllability and the controllability with additive control. Finally, we give simulations for the semilinear monodimensional heat equation.

CP FT-4-5 1 3 — 17:40-18:00

Justification of an asymptotic model describing a curved-pipe flow in a time-dependent domain

Gonzalo Castiñeira	University of Cádiz
Eduard Marusić-Paloka	University of Zagreb
Igor Pažanin	University of Zagreb
José Manuel Rodríguez	University of A Coruña

Abstract: This contribution is devoted to the mathematical justification of an asymptotic model of a viscous flow in a curved tube with moving walls, by proving error estimates. Due to the boundary layer phenomenon, we first construct the space correctors near the pipe's inlet and outlet. Then, by deriving a Poincaré's type inequality and other estimates for boundary value problems, we evaluate the difference between the asymptotic approximation and the exact solution of the problem.

CP FT-4-5 1 4 — 18:00-18:20

Onset to Shutdown of Radial Viscous Fingering Dynamics

Vandita Sharma	Indian Institute of Technology Ropar
Manoranjan Mishra	Indian Institute of Technology Ropar

Abstract: A less viscous fluid radially displacing a more viscous one in a porous medium, deforms the interface into finger like patterns; a hydrodynamic instability termed as radial viscous fingering (VF). To capture the competition between convective and diffusive forces in radial VF, a linear stability analysis and full non linear simulations using compact finite difference and pseudo spectral method are performed. We find a critical radius after which no instability is observed.

CP FT-4-5 1 5 — 18:20-18:40

Hydrodynamic instabilities of flows through vegetation

Clint Wong	University of Oxford
Aggelos Dimakopoulos	HR Wallingford
Chris Kees	US Army ERDC
Philippe Trinh	University of Bath
Jon Chapman	University of Oxford

Abstract: The study of fluid flows interacting with vegetative structures presents a significant theoretical and numerical challenge on account of its inherently multi-scale nature. In this talk, we will discuss the mathematical modelling of this fluid-structure problem. Our analysis suggests new insights into how plant deformation affects vortex generation and the global flow field. These findings aid in managing large-scale flows and nature-based defences. This study is in collaboration with US Army ERDC and HR Wallingford.

CP FT-4-5 1 6 — 18:40-19:00

Numerical simulation of three-dimensional free surface flows with sediment dynamics

Alexandre Caboussat	Geneva School of Business Administration, HES-SO
Arwa Mrad	EPFL
Marco Picasso	EPFL

Abstract: Sediment transport is important in hydraulic and environmental engineering. We present a numerical model based on a mixture model for multiphase incompressible flows. It couples the Navier-Stokes equations with the dynamics of particles' concentration (deposition and resuspension). A volume-of-fluid approach allows to track free surfaces. The numerical algorithm relies on an operator-splitting method, and a well-chosen mix of finite elements, finite volumes and characteristics methods. The numerical model is validated through 3D numerical experiments.

CP FT-1-1 1 — 17:00-19:00

Numerical Analysis II

Chair Person: Jeongho Kim — Seoul National University

CP FT-1-1 1 1 — 17:00-17:20

An efficient MILU preconditioning for solving the 2D Poisson equation with Neumann boundary condition.

Jeongho Kim	Seoul National University
Chohong Min	Ewha Woman's university
Yesom Park	Ewha Woman's university
Jinwook Jung	Seoul National University
Euntaek Lee	Seoul National University

Abstract: In this presentation, we consider a standard finite volume method for solving the Poisson equation with Neumann boundary condition in general domains, and introduce a new and efficient MILU preconditioning in two dimensional general domains. Our new MILU preconditioning achieved the order O(h^-1) in our empirical tests. In addition, in a circular domain with a fine grid, the CG method preconditioned with the proposed MILU runs about two times faster than the CG with ILU.

CP FT-1-1 1 2 **17:20-17:40**

Existence of best low rank approximations for tensors of order 3.

Eric Evert	KU Leuven
Lieven De Lathauwer	KU Leuven

Abstract: Low rank tensor decomposition is a fundamental tool in many applications, including data analysis and machine learning. In practice we work with a measurement of a low rank tensor which is corrupted by additive noise. Generically, this measurement has high rank. High rank tensors may fail to have best low rank approximations, and low rank decompositions are uninterpretable when this failure occurs. We provide guarantees for the existence of best low rank approximations over .

CP FT-1-1 1 3 **17:40-18:00**

Binary Matrix Completion for Drug Discovery

Melanie Beckerleg	Oxford University
Andrew Thompson	Oxford University

Abstract: Matrix completion is an area of great mathematical interest with numerous applications, including recommender systems. Within the realm of drug discovery, we seek to predict interactions between drug compounds and target proteins. Finding a low rank binary factorisation offers predictive power whilst also clustering in the row-column space. We propose an algorithm based on recursive partitioning, then modify our objective to account for known relationships in chemical feature space, and compare with other clustering techniques.

CP FT-1-1 1 4 **18:00-18:20**

A dynamic low-rank integrator for the Vlasov-Maxwell equations

Lukas Einkemmer	University of Innsbruck
Alexander Ostermann	University of Innsbruck
Chiara Piazzola	University of Innsbruck

Abstract: The Vlasov equation is used for the kinetic description of plasmas in an up to six-dimensional position-velocity space. The evolution of the associated electromagnetic field is given by Maxwell's equations. We propose a dynamic low-rank integrator based on the projector-splitting integrator considered by C. Lubich and I. V. Oseledets, BIT 2014. The dynamics of the system is represented by the low-rank factors of the solution which are determined by solving lower-dimensional partial differential equations.

CP FT-1-1 1 5 **18:20-18:40**

Backward error analysis of Krylov approximations for computing the action of the matrix exponential

Marco Caliari	University of Verona
Franco Zivcovich	University of Trento

Abstract: When it comes to the approximation of the action of the matrix exponential some of the most powerful methods are those based on the Krylov method. We equipped these methods with a backward error analysis tool allowing to determine in run time certain crucial parameters as it was not possible before. In order to exploit this innovation we developed a new method based on Hermite interpolation at Ritz's values that has shown to be successful.

CP FT-1-1 1 6 **18:40-19:00**

A p-version Finite Element Multigrid Solver using a Space Decomposition Smoother

Janitha Gunatilake	University of Peradeniya

Abstract: We present a newly developed finite element multigrid solver for the p-version. Here, smoothing inside each multigrid V-cycle is performed using a space decomposition method. As the function spaces, space decomposition and the multigrid levels are p-hierarchical, this solver is particularly advantageous on p-nonconforming meshes. We discuss the first convergence results and the role of Strengthened Cauchy-Buniakowskii-Schwarz Inequality in establishing the convergence estimates. Furthermore, we present numerical results to demonstrate the effectiveness of this solver.

CP A1-3-5 1 **17:00-19:00**

Biology, Medicine and other natural sciences I

Chair Person: Eliete Biasotto Hauser	BraIns -PUCRS

CP A1-3-5 1 1 **17:00-17:20**

Rational function as a mathematical model of Pittsburgh Compound-B time activity curves

Eliete Biasotto Hauser	BraIns -PUCRS
Wyllians V. Borelli	PUCRS
Jaderson Costa Da Costa	Brain Institute of Rio Grande do Sul (BraIns)

Abstract: Systems of ordinary differential equations can be used to quantify the tissue absorption marker of Pittsburgh Compound-B. To avoid invasive forms, using reverse engineering techniques, we generate the input function from images generated by positron emission tomography. We apply nonlinear regression to determine the parameters of the activity curve in the cerebellum, a rational model, and, afterwards, we solve a first order ordinary differential equation that has the input function as solution.

CP A1-3-5 1 2 **17:20-17:40**

A simple multi-chain approach for approximate Bayesian computation

Erick Eduardo Ramirez Torres	Universidad de Oriente
Luis Enrique Bergues Cabrales	Universidad de Oriente
Juan Ignacio Montijano Torcar	Universidad de Zaragoza
Kimberly Rowland	Lynn University

Abstract: Approximate Bayesian computation (ABC) has been widely used to estimate parameters of biological models where likelihood is analytically intractable. We developed an easy-to-implement new ABC algorithm based on multiple chains with different sampling schemes. This new approach was tested in several biological models with both simulated and real data. Adequate results were achieved in less time compared to two other established ABC algorithms: the sequential Monte Carlo (ABC SMC) and the parallel tempering (ABC PT).

CP A1-3-5 1 3 **17:40-18:00**

Modeling to mediate the bystander-killing effect from the released payload in ADCs

Jong Hyuk Byun	Pusan National University
Il Hyo Jung	Pusan National University
YongKuk Kim	National Institute for Mathematical Sciences

Abstract: Antibody-drug conjugates (ADCs) are intended to bind to specific positive target antigens and eradicate only tumor cells from an intracellular released payload through the lysosomal protease. Payloads, such as MMAE, have the capacity to kill adjacent antigen-negative (Ag–) tumor cells, which is called the bystander-killing effect, as well as directly kill antigen-positive (Ag+) tumor cells. We propose that a dose-response curve is applied independently considered to account for the Ag+/Ag- tumor cells.

CP A1-3-5 1 4 **18:00-18:20**

Mathematical analysis of an age-structured PDE model for HCV infection

Kosaku Kitagawa	Mathematical Biology Laboratory, Kyushu University
Toshikazu Kuniya	Graduate School of System Informatics, Kobe University
Shinji Nakaoka	Faculty of Advanced Life Science, Hokkaido University
Yusuke Asai	Graduate School of Medicine, Hokkaido University
Koichi Watashi	Department of Virology II, Natural Institute of Infectious Disease
Shingo Iwami	Mathematical Biology Laboratory, Kyushu University

Abstract: An age-structured PDE model of Hepatitis C Virus (HCV) describes intercellular and intracellular viral infection dynamics. Although PDE can describe more precisely virus dynamics, handling PDE is mathematically difficult in general. Therefore, we firstly transformed the PDE to a mathematically identical ODE. Then from this ODE, we derived the basic reproduction number R0 an important index about viral infection and we showed equilibriums of this ODE are global asymptotically stable with conditions depends on R0.

CP A1-3-5 1 5 **18:20-18:40**

Multiplicity of steady states of a reaction diffusion model arising in Medicine.

Lourdes TELLO	Universidad Politecnica de Madrid
Arturo HIDALGO	Universidad Politecnica de Madrid

Abstract: We are concerned with a reaction diffusion system describing the atherosclerosis as an inflammatory process. Concentrations of immune cells and cytokines are the unknowns in this nonlinear model. Under some assumptions of the parameters we find multiple steady states and we prove some qualitative properties. This is a work in collaboration with A. Hidalgo (UPM).

CP FT-S-3 1 **17:00-19:00**

Partial Differential Equations I

Chair Person: Ben Muatjetjeja North-West University

CP FT-S-3 1 1 **17:00-17:20**

Lie group classification of a generalized coupled Lane-Emden-Klein-Gordon-Fock system with central symmetry

Ben Muatjetjeja	North-West University
Abdullahi Adem	North-West University

Abstract: In this talk, we perform a complete symmetry analysis of a general- ized Lane-Emden-Klein-Fock system with central symmetry. Several cases for the non-equivalent forms of the arbitrary elements are obtained. Moreover, a symmetry reduction for some cases is performed.

CP FT-S-3 1 2 **17:20-17:40**

Symmetry analysis of a Lane-Emden-Klein-Gordon-Fock system with central symmetry

Ben Muatjetjeja	North-West University

Abstract: In this paper we introduce a sort of Lane-Emden system derived from the Klein-Gordon-Fock equation with central symmetry. Point symmetries are obtained and, since the system can be derived as the Euler-Lagrange equation of a certain functional, a Noether symmetry classification is also considered and conservation laws are derived from the point

CP FT-S-3 1 3 **17:40-18:00**

Numerical solutions of fractional heat equation with variable coefficients with Dirichlet boundary condition

Prakash Periasamy	Periyar University, Salem

Abstract: We consider the two dimensional space and time fractional heat equation with variable coefficients with Dirichlet boundary condition. By using a second order discretization for spatial derivative, we transform the fractional heat equation into a system of fractional ordinary differential equations which can be expressed in integral form. Further the integral equation is transformed into a difference equation by modified trapezoidal method. Numerical results are provided to verify the accuracy and efficiency of the method.

CP FT-S-3 1 4 **18:00-18:20**

Numerical simulation of concentration dispersion in the blood flow through Bio-Absorbable Nanoparticles – An application to target drug delivery

J V Ramana Reddy	Indian Institute of Technology Madras
S Sundar	Indian Institute of Technology Madras

Abstract: The concentration dispersion from the temperature sensitive drug-coated bio-absorbable nanoparticles in the dynamic arterial wall is understood in detail. The resultant highly non-linear coupled modelled equations are simulated by the Marker and Cell algorithm along with the biologically suitable choice of the boundary and initial conditions. The amount of drug release is controlled by the temperature provided by the catheter in the targeted region. The investigation is useful in Biomedical and Pharmaceutical industry applications.

CP FT-S-3 1 5 **18:20-18:40**

Numerical methods for district heating networks

Matthias Eimer	Fraunhofer ITWM
Raul Borsche	TU Kaiserslautern
Norbert Siedow	Fraunhofer ITWM

Abstract: As an effective and sustainable alternative to conventional heating systems, district heating has a huge potential, especially in urban areas. In order to optimally control the use of resources, a fast and accurate forward simulation is important. In this talk we present high order accurate and conservative methods for the corresponding hyperbolic equations. We illustrate the efficiency of the method on larger district heating networks.

CP FT-S-3 1 6 **18:40-19:00**

Numerical simulation of a two-dimensional atherosclerosis model

Arturo Hidalgo	Universidad Politecnica de Madrid
Lourdes Tello	Universidad Politecnica de Madrid

Abstract: This work is focused on the study of the first stages of atherosclerosis development as an inflammatory disease. The mathematical model on which this research is based is given by a system of two-dimensional nonlinear reaction-diffusion equations with a nonlinear source term in one of the equations.The model is solved using a finite volume scheme with WENO reconstruction in space and ADER approach for time integration.

CP A1-1-2 1 **17:00-19:00**

Real and Complex Analysis and Ordinary Differential Equations

Chair Person: Jeremy Schiff Bar-Ilan University

CP A1-1-2 1 1 **17:00-17:20**

A Dynamical Systems Approach to Painleve IV

Jeremy Schiff	Bar-Ilan University

Abstract: The six Painleve equations appear in numerous applications, and while much is known about their symmetries, special solutions, asymptotic behavior of solutions etc., little is known about the behavior of generic real solutions for generic parameter values. A dynamical systems approach is described for the fourth Painleve equation, which provides a framework for qualitative description and classification of generic real solutions. For generic parameter values there exist solutions analytic on the entire real axis.

CP A1-1-2 1 2 **17:20-17:40**

Conditions for collision avoidance in Cucker-Smale flocking models under hierarchical leadership coupling

Yu-Hao Liang	National University of Kaohsiung

Abstract: Phenomena of collective dynamics such as flocking of birds and schooling of fishes are ubiquitous in the world. Several models have been established to study these. Among them, the one introduced by Cucker and Smale has gained much attention. In this talk, we will discuss the conditions for Cucker-Smale flocking models under hierarchical leadership coupling, which is an asymmetric network topology. Moreover, some open issues such as pattern formation and cluster flocking shall be addressed.

CP A1-1-2 1 3 **17:40-18:00**

On a nonlinear Euler-Bernoulli Beam type equation

Rabah Khaldi	Badji Mokhtar Annaba University
Assia Guezane Lakoud	Badji Mokhtar Annaba University

Abstract: In this talk, we discuss the existence and localization of solutions for a nonlinear Euler-Bernoulli Beam type ordinary differential equation of a non classical order. Differently from the other approaches where the existence of solution for the linear Euler-Bernoulli Beam type equation is obtained numerically, we use the lower and upper solutions method with some fixed point theorems. A numerical example is given to illustrate the obtained results.

CP A1-1-2 1 4 **18:00-18:20**

Mean value theorems for polyanalytic functions and their generalizations

Olha Trofymenko	Vasyl' Stus Donetsk National University

Abstract: The work is devoted to the mean value theorems for solutions of homogeneous linear partial differential equations with constant coefficients in the complex plane whose left hand side is represented in the form of the product of some non-negative integer powers of the formal Cauchy derivatives. We consider systems of special type homogeneous convolution equations defined on smooth functions in a disk, which generalize the classical mean value property over disks for harmonic functions.

CP A1-3-2 1 **17:00-19:00**

Dynamical Systems I

Chair Person: Thomas Bellsky University of Maine

CP A1-3-2 1 1 **17:00-17:20**

A shadowing-based inflation scheme for ensemble data assimilation.

Thomas Bellsky	University of Maine
Lewis Mitchell	University of Adelaide

Abstract: Ensemble data assimilation methods rely on the periodic artificial inflation of forecast ensembles. This research has developed a systematic inflation method that uses techniques from mathematical shadowing theory, which only inflates ensembles in contracting (overconfident) directions. We have shown this methodology to outperform other currently operational methodologies. This talk will discuss the development and implementation of this inflation technique, referred to as shadowing inflation, and present results that support using shadowing inflation.

CP A1-3-2 1 2 **17:20-17:40**

Dual Combination Synchronization Scheme for Fractional Order Complex Chaotic Systems

Vijay Kumar Yadav	IIT(BHU)

Abstract: In this article, we have proposed a novel scheme for the dual combination synchronization among four master systems and two slave systems for the fractional order complex chaotic systems. Due to the complexity and presence of additional variable, it will be more secure and interesting to transmit and receive signals in communication theory. Based on the Lyapunov stability theory, six complex chaotic systems are considered and corresponding controllers are designed to achieve synchronization.

CP A1-3-2 1 3 **17:40-18:00**

About the dynamics of a non-autonomous scalar Chafee-Infante problem

José Valero	Universidad Miguel Hernández de Elche
Rita De Cassia D. S. Broche	Universidad Federal de Lavras
Alexandre N. Carvalho	Universidade de São Paulo-Campus de São Carlos

Abstract: We study the structure of the pulback attractor of a nonautonomous scalar Chafee-Infante equation, showing that there exist special complete bounded solutions, the so-called "nonautonomous equilibria", and proving the existence of connections between the zero solution and these equilibria. Moreover, we show that the omega and alfa-limit sets of any bounded complete trajectory belong in some sense to one of the nonautonomous equilibria.

CP A1-3-2 1 4 **18:00-18:20**

Analytic integrability around a nilpotent singularity: the non-generic case.

Maria Diaz Garcia	Universidad de Huelva
Antonio Algaba Durán	Universidad de Huelva
Cristóbal Garcia Garcia	Universidad de Huelva
Jaume Giné	Universitart de LLeida

Abstract: Recently, in [1] solved the analytic integrability problem around a nilpotent singularity for diferential systems in the plane under generic conditions. In this work we solve the remaining case completing the analytic integrability problem for such singularity. [1] A. Algaba, C. García, J. Giné, The analytic integrability problem for perturbation of non-hamiltonian quasi-homogeneous nilpotent systems, arXiv:1805.01726 [math.DS] (04 May 2018).

CP A1-3-2 1 5 **18:20-18:40**

Chaotic dynamics in disordered nonlinear lattices

Bob Senyange	University of Cape Town
Bertin Many	University of Cape Town
Haris Skokos	University of Cape Town

Abstract: We extend the findings of Skokos et al (Phys. Rev. E, 2013), and study the chaotic behaviour of two typical disordered nonlinear lattices, the Klein-Gordon (KG) model and Discrete Nonlinear Schrodinger Equation (DNLS), for different initial excitations. We compute the most commonly used chaos indicator, i.e. the maximum Lyapunov Characteristic Exponent (mLCE) and classify the different dynamical behaviours of the models according to the time evolution of the mLCE and the corresponding deviation vector distribution.

CP A1-3-2 1 6 **18:40-19:00**

Evolutionary dynamics in public goods games with individual disguise and pool punishment

Qiang Wang	School of Mathematical Sciences, University of Electronic Science and Technology of China
Xiaojie Chen	School of Mathematical Sciences, University of Electronic Science and Technology of China

Abstract: In this work we consider individual disguise into public goods games with pool punishment and study its role in the evolution of cooperation. We show that disguise hinders public cooperation for low fine and low disguise cost no matter whether second-order punishment is considered or not. Besides, we find that the positive role of punishment is completely undermined in the absence of second-order punishment, whereas the situation is improved in the presence of second-order punishment.

CP A1-3-3 1 17:00-19:00

Numerical Analysis I

Chair Person: James Lambers	The University of Southern Mississippi

CP A1-3-3 1 1 **17:00-17:20**

Matrices, Moments, Quadrature and PDEs

James Lambers	The University of Southern Mississippi

Abstract: Krylov subspace spectral (KSS) methods are high-order accurate, explicit time-stepping methods with stability characteristic of implicit methods. This ``best-of-both-worlds'' compromise is achieved by computing Fourier coefficients of the solution using individualized approximations, using techniques from ``matrices, moments and quadrature'' for computing bilinear forms involving matrix functions. The result is superior scalability to that of other time-stepping approaches. This talk will present an overview of their essential properties, including new theoretical results, and recent developments.

CP A1-3-3 1 2 **17:20-17:40**

Numerical Solution of Nonlinear Elliptic Partial Differential Equations Using Finite Element Method

Manoj Kumar	MNNIT Allahabad

Abstract: In this talk, a higher order Newton-type iterative method for solving nonlinear equations will be discussed which is seventh order convergent with an efficiency index 1.476. Various numerical comparisons are made in MATLAB to demonstrate the performance of the developed methods will be presented. Finally, application of our seventh order Newton-type iterative method to solve the nonlinear system of equations obtained in the finite element solution of nonlinear elliptic partial differential equations will be discussed

CP A1-3-3 1 4 **17:40-18:00**

Superconvergent IMEX Peer Methods with Variable Step Sizes

Moritz Schneider	Technische Universität Darmstadt
Jens Lang	Technische Universität Darmstadt
Rüdiger Weiner	Martin-Luther-Universität Halle-Wittenberg

Abstract: We discuss the numerical solution of systems of ODEs with a stiff and non-stiff part. Hence, we consider implicit-explicit (IMEX) Peer methods that combine favorable stability properties (e.g. A-stability) of implicit and the low computational costs of explicit schemes. Due to the special Peer structure, superconvergent methods can be constructed. We derive necessary and sufficient conditions that guarantee superconvergence, even for variable step sizes, and demonstrate the performance of our new methods in numerical examples.

CP A1-3-3 1 5 **18:00-18:20**

Optimally zero stable explicit two-step peer methods reusing stages

Luis Randez	IUMA-Universidad de Zaragoza
Alicia Saenz De La Torre	IUMA-Universidad de Zaragoza

Abstract: In this paper, we present explicit two-step peer schemes in which some stages of the previous step are reused. In particular, the cases $s = 3$ and $s = 4$ are studied. Some numerical experiments done show the efficiency of the proposed methods. This work was supported by MINECO project MTM2016-77735-C3-1-P

CP A1-3-3 1 6 **18:20-18:40**

On the generalization of the triangular Shepard method to trivariate functions

Francesco Dell'Accio	University of Calabria
Filomena Di Tommaso	University of Calabria

Abstract: For the generalization of the triangular Shepard method to the problem of approximation of trivariate functions from scattered data, in this talk we study the approximation order and introduce an efficient algorithm for its computation.

CP A1-3-4 1 17:00-19:00

Mathematical Topics and their Applications I

Chair Person: Peter Jantsch	Texas A&M University

CP A1-3-4 1 1 **17:00-17:20**

Polynomial Approximation of Anisotropic Analytic Functions of Several Variables

Peter Jantsch — Texas A&M University

Abstract: Motivated by numerical methods for solving parametric partial differential equations, we discuss the approximation of anisotropic analytic multivariate functions by algebraic polynomials. Given a budget n for the dimension of the approximating space, we provide a simple, numerically feasible description of spaces with certifiable approximation error that is close to optimal.

CP A1-3-4 1 2 — **17:20-17:40**

Eigenvalues in inverse scattering for a fluid-solid interaction

Michael Levitin — University of Reading
Peter Monk — University of Delaware
Virginia Selgas — University of Oviedo

Abstract: We investigate two sets of eigenvalues (Stekloff eigenvalues and certain modified interior transmission eigenvalues) in the interaction of a linearly elastic solid and an acoustic fluid. For both kinds of eigenvalues, we define them for the problem at hand and characterize them by suitable operators; we also analyze their location and accumulation points, and discuss their approximation from modified far-field equations. We finally undertake numerical experiments to study the information they provide about the solid.

CP A1-3-4 1 3 — **17:40-18:00**

Numerical approximation of an inverse problem for the Helmholtz Equation

Chakir TAJANI — Polydisciplinary faculty of Larache

Abstract: We consider an ill-posed Cauchy problem for Helmholtz equation arising in several areas of science and engineering. It consists to find the missing conditions on an inaccessible part of the boundary from additional conditions on the other part of the boundary. we propose an iterative algorithm based on the KMF algorithm to reduce the number of iterations required to achieve convergence with better accuracy. Numerical results are presented showing the effectiveness of the proposed algorithm.

CP A1-3-4 1 4 — **18:00-18:20**

Strong decision making based algorithm for robust global optimization

Darakhshan Jabeen Syeda — Birla Institute of Technology, Mesra

Abstract: We develop a new hybrid algorithm based on heuristics to solve complex box constrained optimization problems. We implement chaotic maps to enhance the search performance and escape from local optima. Moreover, interval ranking rule defined with respect to the optimistic decision makers' point of view has been incorporated for robust decision making and in choosing the promising solution(s). The proposed scheme can be used to solve tough problems in industrial engineering, operations research and management.

CP A1-3-4 1 5 — **18:20-18:40**

Numerical Simulation of Blood Flow in a Stenosed Bifurcated Artery Concerning the Effect of Heat Transfer

Zuhaila Ismail — Universiti Teknologi Malaysia
Muhammad Sabaruddin Ahmad Jamali — Universiti Teknologi Malaysia

Abstract: The formation of stenosis with high probability of rupture can be characterized by the changing of the temperature distribution in the bifurcated artery. Therefore, the aim of this research is to investigate the dynamic response of heat transfer in blood flow through bifurcated artery under stenotic condition. Results concerning the effect of heat transfer influence on the blood flow characteristics such as the velocity and temperature profiles, and streamline pattern are discussed.

CP FT-1-8 1 — **17:00-19:00**

Mathematical Topics and their Applications II

Chair Person: Robert Link — Universität Duisburg-Essen

CP FT-1-8 1 1 — **17:00-17:20**

Existence and Uniqueness of infinite-dimensional Kolmogorov equations for stochastic partial differential equations

Robert Link — Universität Duisburg-Essen
Martin Hutzenthaler — Universität Duisburg-Essen

Abstract: In 2015 Hairer, Hutzenthaler, and Jentzen have proven that even if the coefficient are smooth the Kolmogorov equations can admit non-smooth viscosity solutions. In the talk we will generalize this result to infinite-dimensional Hilbert spaces and SPDEs. Using Ishiis notation of viscosity solutions we will show that under suitable assumptions the Kolmogorov equations admit unique viscosity solutions which can be represented as the expectation of solutions of SPDEs.

CP FT-1-8 1 2 — **17:20-17:40**

Manipulating Einstein equations in the FCF: numerical accuracy and stability.

Samuel Santos — University of Valencia
Isabel Cordero-Carrión — University of Valencia
Pablo Cerdá-Durán — University of Valencia

Abstract: We will present Einstein equations in the so-called Fully Constrained Formulation (FCF). This formulation has two different sectors: the elliptic sector formed by the Hamiltonian and Momentum constraints together with the derived equations from the chosen gauge, and the hyperbolic sector which encodes the evolution of the metric of the spacetime. We will present a modification of both sectors that keeps local uniqueness properties but has the correct relativistic expansion in the source terms.

CP FT-1-8 1 3 — **17:40-18:00**

Finding Optimal Graph Cuts via Semidefinite Relaxation: A Performance Guarantee for Spectral Clustering

Shuyang Ling — New York University
Thomas Strohmer — University of California Davis

Abstract: Spectral clustering has become one of the most popular clustering techniques despite its limited theoretic guarantees. We study the theoretical foundations of spectral clustering and graph cuts by considering a convex relaxation of graph cuts. We derive deterministic bounds for successful spectral clustering via a spectral proximity condition that naturally depends on the algebraic connectivity of each cluster and the inter-cluster connectivity. Our findings are fundamental and apply to data clustering and community detection.

CP FT-1-8 1 4 — **18:00-18:20**

Numerical approximation of parabolic PDEs with random discontinuities

Andreas Stein — University of Stuttgart
Andrea Barth — University of Stuttgart

Abstract: We consider parabolic problems with random coefficients build from a continuous Gaussian field and a (discontinuous) jump part to model subsurface flows in heterogeneous/fractured/porous media. To obtain pathwise approximations of the exact solution we combine a sample-adaptive Finite Element approach for the spatial discretization with a suitable time stepping scheme and coefficient approximations. This entails an increase in the spatial order of convergence and allows us to derive a-priori estimates on the overall approximation error.

CP FT-1-8 1 5 — **18:20-18:40**

Time Independent Solutions of some Queuing processes having Balking and Reneging due to long queue and some urgent message in the Limited Space

Meenu Gupta — Dr. B.R.A.Government College, Kaithal, Haryana
Man Singh — (Retd. Prof.)C.C.S.H.A.U.Hisar
Deepak Gupta — M.M.E.C., M.M.U. Mullana, Ambala, Haryana, India

Abstract: The Steady- state solutions of a queuing process are derived in which M serial service channels are linked with N non-serial service channels both having identical multiple parallel channels and balking and reneging cdue to long queue and some urgent message/ call .The input process is Poisson, depends upon the queue size in serial and non-serial channels with finite waiting space.The service time distribution is exponential and the service discipline follows SIRO-rule instead of FIFO-rule.

CP FT-1-8 1 6 — **18:40-19:00**

How Does Vector Feeding Preference Through an Infectious Host Relates to a Periodic Environment

Rocio Marilyn Caja Rivera — University of Notre Dame

Abstract: Vector-borne diseases show periodic fluctuations in their prevalence. The results of this research show the relationship between the vector feeding preference for an infectious host and the annual seasonal transmission through a vector-host mathematical model. Numerical simulations illustrate that by increasing the vector feeding preference value in the transmission dynamics, periodic fluctuations accentuates and the endemic equilibrium average increases in vector and host populations.

CP FT-1-7 1 17:00-19:00

Numerical Analysis III

Chair Person: Eloy Romero Alcalde — The College of William & Mary

CP FT-1-7 1 1 **17:00-17:20**

Multigrid deflation for reducing the variance of a trace estimator in Lattice QCD applications

Eloy Romero Alcalde — The College of William & Mary
Andreas Stathopoulos — The College of William & Mary

Abstract: In Lattice QCD the stochastic estimation of the trace of the inverse of large matrices can be significantly sped up by combining probing with deflation against the lower part of the matrix spectrum. However, the rank of the deflated space scales with the matrix dimension, making iterative eigensolvers expensive in time and storage. We show that the local coherence of the eigenvectors can be exploited, similarly to Adaptive Multigrid, for computing efficiently the deflation space.

CP FT-1-7 1 2 **17:20-17:40**

A contour integral method for the solution of nonlinear eigenvalue problems

Felix Binkowski — Zuse Institute Berlin
Lin Zschiedrich — JCMwave GmbH
Sven Burger — Zuse Institute Berlin

Abstract: We report on an algorithm for the solution of general nonlinear eigenvalue problems. Data for eigenvalues located in a chosen contour are generated by contour integration and fitted to a nonlinear model. The corresponding eigenvectors are computed by applying Riesz projections. We apply a numerical realization of the approach to compute optical resonances which are eigensolutions to Maxwell's equations for systems with material dispersion.

CP FT-1-7 1 3 **17:40-18:00**

Convergence region of Newton's method for the matrix pth root

Chun-Hua Guo — University of Regina

Abstract: For a square matrix with all eigenvalues in a suitable region in the complex plane, its principal pth root is defined and can be approximated by the quadratically convergent sequence generated by Newton's method (starting from the identity matrix). Such a region is called a convergence region for Newton's method. In this talk, we present a convergence region that is much larger than the existing ones.

CP FT-1-7 1 4 **18:00-18:20**

Affine spaces of strong linearizations for rational matrices and the recovery of eigenvectors and minimal bases

Ranjan Kumar Das — Indian Institute of Technology Guwahati
Rafikul Alam — Indian Institute of Technology Guwahati

Abstract: Linearization of rational matrices is a new emerging area of research. By utilizing the vector spaces of linearizations of matrix polynomials defined and analyzed by Mackey et al. (2006), we introduce two affine spaces of matrix pencils of a rational matrix $R(\lambda)$ and show that almost all of these pencils are strong linearizations of $R(\lambda)$. We also describe recovery of eigenvectors, minimal bases and indices of $R(\lambda)$ from those of the strong linearizations of $R(\lambda)$.

CP FT-1-7 1 5 **18:20-18:40**

Transparent Realizations of Structural Data for Matrix Polynomials

D. Steven Mackey — Western Michigan University
Richard Hollister — Western Michigan University

Abstract: The key structural data of a matrix polynomial needed in many applications are its finite and infinite eigenvalues and elementary divisors, and its right and left minimal indices. Necessary and sufficient conditions for the polynomial realizability of a given list of structural data have recently been obtained, but the constructed realizations do not transparently display the given structural data. In this talk we describe some techniques useful for constructing such transparent polynomial realizations.

CP FT-1-7 1 6 **18:40-19:00**

Recent developments on an inverse problem for rational matrices

Richard Hollister — Western Michigan University
D. Steven Mackey — Western Michigan University

Abstract: Given a list of poles, zeros, and their respective multiplicities along with left and right minimal indices, does there exist a rational matrix that realizes these data? This was recently answered by giving a simple necessary and sufficient condition--the rational index sum theorem. In this talk we discuss how to build realizations that are sparse and transparently reveal the given data. Similar developments for polynomial matrices are discussed in a related talk by Steve Mackey.

SL02 19:15-20:00

Peter Henrici Prize Lecture

Chair Person: Lisa Fauci — Tulane University

Machine Learning: Mathematical Theory and Scientific Applications

E. Weinan — Princeton University

Abstract: This prize honors Peter Henrici, a Swiss numerical analyst and teacher at the Eidgenössische Technische Hochschule-Zürich (ETH Zurich) for 25 years. The prize is awarded by SIAM and ETH Zurich for contributions to applied analysis and numerical analysis and/or for exposition appropriate for applied mathematics and scientific computing. Weinan E is a professor in the Department of Mathematics and the Program in Applied and Computational Mathematics at Princeton. He received his Ph.D. from the University of California, Los Angeles in 1989, after which he held visiting positions at New York University (NYU) and the Institute for Advanced Study. He was a member of the faculty of NYU's Courant Institute of Mathematical Sciences from 1994 to 1999. E was awarded the Collatz Prize of the International Council for Industrial and Applied Mathematics in 2003, and SIAM's Ralph E. Kleinman Prize and Theodore von Kármán Prize in 2009 and 2014 respectively. He became a fellow of the Institute of Physics in 2005, an inaugural SIAM Fellow in 2009, and a fellow of the American Mathematical Society in 2012. He was also elected as a member of the Chinese Academy of Sciences in 2011. Modern machine learning has had remarkable success in all kinds of AI applications, and is also poised to change fundamentally the way we do research in traditional areas of science and engineering. In this talk, Weinan E will give an overview on some of the theoretical and practical issues that are most important in this new exciting area.

Tuesday sessions
July, 16

IL02 08:30-09:15

Carlos Conca

Chair Person: Luis Vega — BCAM-BASQUE CENTER FOR APPLIED MATHEMATICS

08:30-09:15

Modeling Our Sense of Smell

Carlos Conca — Universidad de Chile, Santiago

Abstract: In this Conference we study an integral inverse problem arising in the biology of the olfactory system. The transduction of an odor into an electrical signal is accomplished by a depolarising influx of ions through cyclic-nucleotide-gated (CNG for short) channels on the cilium membrane. The inverse problem studied in this paper consists in finding the spatial distribution of the CNG channels from the measured transduce electrical signals. The Mellin transform allows us to write an explicit formula for its solution. Proving observability and continuity inequalities is then a question of estimating the Mellin transform of the kernel of this integral equation on vertical lines. New estimates using arguments in the spirit of the stationary phase method are proven and a numerical scheme is proposed to reconstruct the density of CNG channels from modeled current representing experimental data, for an approximated model. For the original model an identifiability and a non observability (in some weighted L2 spaces) results are proven.

IL03 08:30-09:15

Xiao-Ping Wang

Chair Person: Liliana Borcea — University of Michigan

08:30-09:15

An iterative thresholding method for topology optimization

Xiao-Ping Wang — Hong Kong University Of Science And Technology, China

Abstract: Topology optimization (TO) is a promising numerical technique for designing optimal engineering designs in many industrial applications as well as many new rising technologies such as the additive manufacturing or metal 3D printing. We propose an efficient and robust iterative thresholding method for topology optimization with applications to fluids and heat transfer system. We show that the proposed iteration scheme is robust, efficient and insensitive to the initial guess and the parameters in the model.

IL01 **08:30-09:15**

James Sethian

Chair Person: Maurizio Falcone Università di Roma "La Sapienza"

08:30-09:15

Advances in Advancing Interfaces: The Mathematics of Manufacturing of Industrial Foams, Fluidic Devices, and Automobile Painting

James Sethian Uc Berkeley, Us

Abstract: Complex dynamics underlying industrial manufacturing depend in part on multiphase multiphysics, in which fluids and materials interact across orders of magnitude variations in time and space. In this talk, we will discuss the development and application of a host of numerical methods for these problems, including Voronoi Implicit Interface Methods, implicit adaptive representations, and multiphase discontinuous Galerkin Methods. Applications for industrial problems will include modeling how foams evolve, how electro-fluid jetting devices work, and the physics and dynamics of rotary bell spray painting across the automotive industry.

IL06 **09:30-10:15**

Isabelle Gallagher

Chair Person: Carlos Kenig University of Chicago

09:30-10:15

From particle systems to the Boltzmann equation

Isabelle Gallagher Univ. Paris Diderot (P7) and Ecole Normale Supérieure de Paris, France

Abstract: We shall report on recent work, joint with Thierry Bodineau, Laure Saint-Raymond and Sergio Simonella. We study the limit of particle systems when the number of particles goes to infinity. At leading order the dynamics is driven by the Boltzmann equation which may be seen as a law of large numbers. We prove the central limit theorem for the fluctuation field of the hard sphere gas, and that the process converges to a Ornstein-Uhlenbeck process.

IL04 **09:30-10:15**

Donald Goldfarb

Chair Person: Qiang Du Columbia University

09:30-10:15

The Alternating Direction Method of Multipliers: Recent Advances and Applications

Donald Goldfarb Columbia University, Us

Abstract: After reviewing developments in the Alternating Direction Method of Multipliers (ADMM) over the last 45 years, we present some recent advances in and applications of these methods. Originally, ADMM theory only applied to the minimization of convex functions of two blocks of variables coupled by linear equations. In the last few years ADMM theory has been extended to non-smooth and non-convex functions of multiple blocks of variables. Recently, we have been able to extend these results to multiaffine constrained blocks of variables, enabling ADMM to be applied to problems such as nonnegative matrix factorization, sparse learning, risk parity portfolio selection, polynomial optimization, nonconvex formulations of convex problems, and neural network training. In each case, our multiaffine ADMM approach encounters only sub-problems that have closed-form solutions.

IL05 **09:30-10:15**

Ruo Li

Chair Person: Manuel J. Castro Universidad de Málaga

09:30-10:15

Globally hyperbolic regularization to Grad's moment system

Ruo Li Peking University, China

Abstract: The Grad's moment method, as a kind of approximation to the Boltzmann equation, has been introduced more than sixty years ago. The method systematically derives a sequence of high order macroscopic hydrodynamic models, including for example the famous 13-moment system. However the basic method suffers from some drawbacks which limit its implementation, most notably its lack of hyperbolicity in some regions. It is well-know that the 13-moment system in 1D case is hyperbolic around the local equilibrium. We revealed amazingly that for 3D case the 13-moment system do NOT admit the local equilibrium as the interior point of its hyperbolicity region. Furthermore, a new theory was developed to regularize the Grad's moment system for arbitrary order to achieve global hyperbolicity. The regularized system is an elegant extension of Euler equations, with all its wave speeds and characteristic fields fully clarified, and formally preserving the spectral convergence of Grad's expansion.

MS ME-1-2 2 **11:00-13:00**

Wave propagation in multiple-scattering and multiple-scale media - Part 2

For Part 1 see: MS ME-1-2 1

For Part 3 see: MS ME-1-2 3

Organizer: Luke Bennetts University of Adelaide

Organizer: Malte Peter University of Augsburg

Abstract: Wave propagation in multiple-scattering and multiple-scale media is important for modelling and simulating the propagation of acoustic, electromagnetic, flexural and surface gravity waves in heterogeneous media. This minisymposium brings together researchers from all of these application areas. The talks will illustrate a variety of the current methods and the challenges that remain. These are derived from branches of applied mathematics ranging from applied analysis to semi-analytical large-scale simulation schemes. A central aim of the minisymposium is to promote the exchange of ideas and knowledge between the different application areas with respect to the underlying wave mechanisms and their computation.

11:00-11:30

Time-harmonic scattering of P-SV waves from arrays of cylinders; asymptotic `tail-ends' of the quasi-periodic Green's function

Georgia Lynott University of Manchester

Abstract: We consider time-harmonic P-SV waves scattering from an infinite periodic array of aligned cylinders via BEM and the quasi-periodic Green's function. The slow convergence of the typical quasi-periodic Green's function is well known; we present a novel means of calculation that allows for rapid and accurate approximation of the function. This method combined with BEM allows us to calculate the transmission and reflection coefficients for arrays of cylinders of different cross-sections and varying aspect ratios.

11:30-12:00

Hybrid numerical–asymptotic boundary element methods for multiple scattering problems

Stephen Langdon University of Reading
Andrew Gibbs K. U. Leuven
Simon Chandler-Wilde University of Reading
Andrea Moiola University of Pavia

Abstract: We propose a boundary element method for time-harmonic acoustic scattering by multiple obstacles in two dimensions. We combine a Hybrid Numerical Asymptotic (HNA) approximation space on one obstacle with standard approximation spaces on the other obstacles and show that the number of degrees of freedom required in the HNA space to maintain a given accuracy need grow only logarithmically with respect to frequency, compared to the (at least) linear growth required by standard schemes.

12:00-12:30

Transport equation models for water waves in ice-covered oceans

Fabien Montiel University of Otago
Johannes Mosig
Vernon Squire University of Otago

Abstract: Transport equation models are broadly for global wave forecast. In polar oceans, the scattering of ocean waves by an inhomogeneous sea ice cover is introduced in the transport equation as a phenomenological source term which causes the wave energy to decay and spread directionally. Here, we demonstrate how such a transport equation can be derived for ocean wave packets in one horizontal dimension being scattered by a continuous ice cover with spatially varying thickness.

12:30-13:00

Multiple waves propagate in particulate materials

Artur Gower	University of Sheffield
William Parnell	University of Manchester
I. David Abrahams	University of Cambridge

Abstract: Particulate materials such as powders and emulsions are everywhere. Waves, such as sound and light, are ideal to characterise these materials. Yet many mysteries remain due to the effects of multiple scattering beyond the low frequency regime. To date, the prevailing method assumes that the (ensemble averaged) material has only one wavespeed and attenuation. However, I will show that there are an infinite number of wavespeeds and attenuations all coexisting at the same time.

MS A3-2-3 2 11:00-13:00

Kinetic modelling and multiscale simulation of nonequilibrium flow dynamics - Part 2

For Part 1 see: MS A3-2-3 1
For Part 3 see: MS A3-2-3 3
For Part 4 see: MS A3-2-3 4
For Part 5 see: MS A3-2-3 5
For Part 6 see: MS A3-2-3 6

Organizer: Lei Wu	UK/University of Strathclyde
Organizer: Kun Xu	Hong Kong University of Science and Technology
Organizer: Song Jiang	Institute of Applied Physics and Comput. Math

Abstract: The Boltzmann equation underpins a board range of applications ranging from high-altitude aerothermodynamics of space vehicles, gas dynamics in micro-electro-mechanical systems, and shale gas extractions. It has also been extended to different fields, such as granular gases, radiative transfer, phonon/electron transport, plasmas, and quantum/relativistic dynamics. However, the high-dimensional integro-differential equations pose great challenges to the numerical simulation of kinetic equations and their applications. The goal of this minisymposium is to explore recent trends and developments in the kinetic theory (simplification of Boltzmann equations, reactions) and multiscale numerical simulation of non-equilibrium dynamics from the continuum to free-molecular flow regimes.

11:00-11:30

A multi-scale particle method for modelling of non-equilibrium gas flows

Jun Zhang	Beihang University
Fei Fei	Huazhong University of science and technology

Abstract: We present a unified stochastic particle ESBGK method by combining the molecular convection and collision effects. In the continuum regime, the proposed method can be applied using large temporal-spatial discretization and approaches to the Navier-Stokes solutions accurately. In the rarefied regime, it recovers the traditional particle ESBGK method. The applications of USP-ESBGK method to a variety of benchmark problems demonstrated that it is a promising tool to simulate multiscale gas flows.

11:30-12:00

From Jumps to Random Walks: Models and Methods for Stochastic Particle Systems

Hossein Gorji	EPFL

Abstract: Closure problems arising from molecular systems, continue to be one of the main challenges in simulations of fluids far from the continuum. Two issues undermine stochastic particle simulations based on kinetic models: dense operations near continuum and statistical errors. Recently, Fokker-Planck based particle methods were derived from the Boltzmann operator. In this talk, such Fokker-Planck models for rarefied neutral gases are reviewed. Different technical aspects such as the entropy law are discussed.

12:00-12:30

A unified gas kinetic particle method for multiscale plasma transport

Chang Liu	Hong Kong University of Science and Technolog

Abstract: We are going to present the unified gas kinetic wave-particle method and its application in multiscale plasma transport. The UGKWP in a particle-based multiscale method which not only recovers the flow physics from the rarefied regime to the continuum regime but also optimizes the computational cost in different regimes. The UGKWP is also extended to the multiscale plasma transport by considering the evolution of electron and ion coupling with the evolution of the electromagnetic field.

MS FT-S-5 2 11:00-13:00

Recent advances in matrix equations with applications - Part 1

For Part 2 see: MS FT-S-5 3
For Part 3 see: MS FT-S-5 4

Organizer: Davide Palitta	Max Planck Institute
Organizer: Patrick Kürschner	KU Leuven

Abstract: Matrix equations like Lyapunov, Sylvester, and Riccati equations, are an important tool in systems and control theory as they are related to, e.g., stability analysis, controller design, and model order reduction (MOR). In particular, with the advent of MOR the demand for efficient algorithms for large-scale matrix equations increased tremendously over the last decades. The goal of this minisymposium is to present new developments w.r.t. theory and numerical methods for matrix equations, together with emerging applications where such equations play an important role like image reconstruction, signal processing, and discretization of certain PDEs.

11:00-11:30

Inexact rational Krylov methods for large matrix equations

Patrick Kürschner	Electrical Engineering (ESAT), Kulak Kortrijk Campus, Katholieke Universiteit Leuven
Melina Freitag	Uni Bath, UK

Abstract: We discuss the numerical solution of large matrix equations by means of rational Krylov subspace methods.In each iteration step of rational Krylov subspace methods a large linear system of equations has to be solved. We consider the inexact solution of the arising linear systems and propose criteria for prescribing mimimally required solve accuracies to ensure functionality of the rational Krylov method. Numerical experiments indicate substantial reductions in the computing times for the considered low-rank methods

11:30-12:00

Projection methods for large-scale differential matrix Riccati equations

Gerhard Kirsten	Alma Mater Studiorum - Università di Bologna
Valeria Simoncini	University of Bologna

Abstract: We consider the numerical solution of large-scale, differential matrix Riccati equations (DRE). Projection methods have recently arisen as a promising class of solution strategies. Existing approaches in this class focus on polynomial or extended Krylov subspaces as approximation space. We show that great computational and memory advantages are obtained with fully rational Krylov subspaces and we discuss several crucial issues such as efficient time stepping and stopping criteria. Numerical experiments illustrate the procedure's effectiveness.

12:00-12:30

Low-rank updates for matrix equations

Leonardo Robol	Univeristà di Pisa
Daniel Kressner	EPFL
Stefano Massei	EPFL

Abstract: Sylvester and Lyapunov equations play an important role in applications. We present an algorithm, using tensorized Krylov subspaces, for updating the solution of such equations when its coefficients undergo low-rank changes. The algorithm can be used to accelerate the Newton method for solving continuous-time algebraic Riccati equations, and to devise a divide-and-conquer approach when the coefficients have hierarchical low-rank structure (HODLR, HSS, or banded). Numerical experiments demonstrate the advantages of divide-and-conquer over existing approaches.

12:30-13:00

Residual-based iterations for the generalized Lyapunov equation

Emil Ringh	KTH - Royal Institute of Technology

Tobias Breiten — Institute for Mathematics and Scientific Computing, Karl-Franzens-Universität

Abstract: We consider iterative methods for the generalized Lyapunov equation and propose a residual-based generalized rational-Krylov-type subspace. Moreover, we extend the theoretical justification for the alternating linear scheme (ALS), from the stable Lyapunov equation to the stable generalized Lyapunov equation. We also interpret the ALS-based approach as iteratively constructing rank-1 model reduction subspaces for bilinear systems associated with the residual, and connect the energy-norm minimization in ALS to the theory of H2-optimality of such systems.

MS A6-3-4 2 — 11:00-13:00

Discrepancy and Minimal Energy - Part 1

For Part 2 see: MS A6-3-4 3

For Part 3 see: MS A6-3-4 4

Organizer: Johann Brauchart — Graz University of Technology

MS Organized by: SIAG/CSE

Abstract: The arrangement of point configurations on manifolds, whether deterministic or random, is an interdisciplinary topic of great interest in applied mathematics and engineering, physics and computer science. In this three-part minisymposium the talks will explore recent key developments in quality quantification and its asymptotic analysis (low discrepancy, minimal energy, hyperuniformity), application in numerical integration, manifold discretization driven by self-organization by local interaction (Riesz and Green potentials and soft sticky disc interactions), and explicit constructions and sampling.

11:00-11:30

Constructing Good Point Sets on the Sphere: Small Discrepancy and Numerical Integration Error

Johann Brauchart — Graz University of Technology

Abstract: Deterministically obtained good point sets on the sphere (in three dimensions or higher) are of great interest in applied mathematics and engineering, physics and computer science. We consider constructions with small discrepancy, a measure quantifying deviation from uniform distribution, and small error of numerical integration when using Quasi-Monte Carlo methods, which are equal weight numerical integration formulas with deterministic node sets, from a numerical and theoretical point of view.

11:30-12:00

Hyperuniformity on Flat Tori

Tetiana Stepaniuk — Johann Radon Institute for Computational and Applied Mathematics (RICAM)

Abstract: We study hyperuniformity on flat tori. The concept of hyperuniformity has been introduced by S.Torquato and F.Stillinger to measure regularity of distributions of infinite particle systems in Rn. Hyperuniformity on the unit sphere has been studied by J.Brauchart, P.Grabner, W.Kusner and J.Ziefle. We show that point sets which are hyperuniform in any of three regimes are uniformly distributed. We also show that QMC-designs sequences for Sobolev classes and some probabilistic point sets are hyperuniform.

12:00-12:30

Optimal Asymptotic Bounds for Designs on Manifolds

Giacomo Gigante — University of Bergamo
Bianca Gariboldi — University of Bergamo

Abstract: We extend to the case of a d-dimensional compact connected oriented Riemannian manifold M the theorem of A. Bondarenko, D. Radchenko and M. Viazovska on the existence of L-designs consisting of N nodes, for any N > C L^d. For this, we need to prove a version of the Marcinkiewicz-Zygmund inequality for the gradient of diffusion polynomials.

12:30-13:00

Approximating probability measures by measures with thinner support

Martin Ehler — University of Vienna

Abstract: We shall discuss the approximation of compactly supported probability measures by more elementary measures with “thinner” support. We use a distance between probability measures that is induced by reproducing kernels and their spectral decomposition. In numerical experiments, we approximate probability measures by measures supported on a finite set of points or supported on closed curves of finite length.

MS A6-2-1 2 — 11:00-13:00

Multiscale seismic modelling and imaging - Part 2

For Part 1 see: MS A6-2-1 1

For Part 3 see: MS A6-2-1 3

Organizer: Lihui Chai — Sun Yat-Sen University
Organizer: Ping Tong — Nanyang Technological University
Organizer: Jianwei Ma — Harbin Institute of Technology
Organizer: Xu Yang — University of California, Santa Barbara

Abstract: Seismic modeling and imaging are widely used and powerful tools to investigate subsurface structures on a variety of scales, namely, from the global to industrial scales. This session will bring together academic and industrial researchers with recent advances in theoretical developments, computational methods and practical applications of multiscale seismic modelling and imaging. The session will place particular emphasis on new numerical modelling, migration, tomography, and inversion methods. Specific topic will include fast algorithms for 3D seismic wave simulation; full waveform inversion; optimal transport; model reduction; and applications at a variety of scales.

11:00-11:30

Multiscale relative geologic time in seismic interpretation

Sergey Fomel — The University of Texas at Austin

Abstract: In a 3D seismic volume, relative geologic time (RGT) is a measure of shift of each trace with respect to the reference trace. Measuring shifts between neighboring traces by plane-wave destruction, one can construct an RGT volume recursively using the process of predictive painting. We show that multiscale analysis can be used to improve to improve the RGT extraction and to perform efficient compression of seismic data by the seislet transform.

11:30-12:00

3D visco-acoustic Full Waveform Inversion: from theory to practice

Ludovic Métivier — CNRS/University Grenoble Alpes
Romain Brossier — Univ. Grenoble Alpes
Nishant Kamath — Univ. Grenoble Alpes
Arnaud Pladys — Univ. Grenoble Alpes
Jean Virieux — Univ. Grenoble Alpes

Abstract: Full waveform inversion (FWI) is a high resolution seismic imaging technique based on an iterative data fitting procedure. We review the necessary methodological developments for the successfull application of FWI to 3D inversion of marine data: (1) time-domain visco-acoustic approximation, (2) checkpointing based algorithms for gradient computation (3) OpenMP/MPI implementation, (4) preconditioning for multi-parameter reconstruction (5) random source subsampling. An application to 3D Valhall data serves to illustrate the proposed approach.

MS A6-4-3 2 — 11:00-13:00

Machine Learning in Finance - Part 2

For Part 1 see: MS A6-4-3 1

Organizer: Martin Larsson — ETH Zurich
Organizer: Agostino Capponi — Columbia University

MS Organized by: SIAG/FME

Abstract: This minisymposium aims to gather financial mathematics experts to present research at the intersection of Machine Learning and Finance. Machine learning has experienced tremendous growth and interest among financial mathematicians in recent years. The talks will illuminate important aspects of risk management and financial forecasting; applications of deep learning to optimal stopping, hedging, and limit order book modeling; statistical techniques based on rough paths theory; and universality for reservoir systems. The rich blend of topics is expected to stimulate discussion and spark research collaborations with high potential impact for the financial industry. This minisymposium is sponsored by the SIAG/FME.

11:00-11:30

Deep Optimal Stopping

Patrick Cheridito — ETH Zurich
Sebastian Becker — Zenai

Arnulf Jentzen	ETH Zurich

Abstract: I present a deep learning method for optimal stopping problems which directly learns the optimal stopping rule from Monte Carlo samples. As such, it is broadly applicable in situations where the underlying randomness can efficiently be simulated. The approach is tested in three high-dimensional examples. In all of them it produces very accurate results with short computing times.

11:30-12:00

The universality problem in dynamic machine learning with applications to the forecasting of financial covolatilities

Juan-Pablo Ortega	University St. Gallen
Lukas Gonon	University of St. Gallen
Lyudmila Grigoryeva	Universität Konstanz

Abstract: We show how a family of dynamic machine learning paradigms known collectively as xreservoir computingx are capable of unprecedented performances in the forecasting of deterministic (chaotic attractors) and stochastic processes (financial realized covariance matrices). We then focus on the universal approximation properties with respect to uniform and L^p criteria of the most widely used families of reservoir computers in applications. These results are a much awaited dynamic generalization of well-known theorems by Cybenko and Hornik.

12:00-12:30

Modelling the Effects of Data Streams using the Rough Paths Theory and its Applications in Finance

Hao Ni	University College London

Abstract: Supervised learning problems with sequential input data is an important question due to various applications. One main challenge is the overfitting issue caused the functional type of the input. Motivated by the numerical approximation theory of SDEs, we propose a novel and effective algorithm (Logsig-RNN model) to tackle this problem by combining the rough path theory and RNN. I'll present numerical examples of high frequency financial data to validate the superior performance of our method.

12:30-13:00

Machine Learning of Dynamics in Mathematical Finance

Josef Teichmann	ETH Zurich

Abstract: Many dynamical features in mathematical finance are expressed by Ito stochastic differential equations. By stochastic Taylor expansion and the Johnson-Lindenstrauss Lemma we shall construct an efficient algorithm to learn the dynamics of such equations without estimating its characteristics.

IM FT-2-2 2 11:00-13:00

Mathematical modeling, simulations and theories related to biological phenomena - Part 2

For Part 1 see: IM FT-2-2 1

Organizer: Yoshihisa Morita	Ryukoku University
Organizer: Shin-Ichiro Ei	Hokkaido University
Organizer: Masaharu Nagayama Male	Hokkaido University

Abstract: By recent various developments in the fields of biology, including cell adhesion, cellular differentiation, morphogenesis, a huge number of researches based on modeling and simulations are reported. On contrast to modeling and simulations there are not so many significant contributions by mathematical analysis. In order to encourage interdisciplinary studies we organize a minsyomosium consist of speakers on modelings, simulations and mathematical analysis in related to biological phenomena. Every invited speakers are experts in their fields and new contributions to those fields would be expected through exchanging their ideas.

11:00-11:30

Effective nonlocal kernels on Reaction-diffusion networks

Shin-Ichiro Ei	Hokkaido University

Abstract: The derivation of effective integral kernels is introduced for general network systems in biology, which can reduce original complicated systems to very simple integro-differential equations with nonlocal terms of convolution type. The efficiency is demonstrated for proneural waves appearing in a visual center of drosophila together with numerical simulations. Some mathematical results are also shown for the reduced equations.

11:30-12:00

Mathematical modeling for the homeostasis of the epidermal barrier function

Masaharu Nagayama	Hokkaido University
Yasuaki Kobayashi Male	Hokkaido University
Masaaki Uesaka Male	University of Tokyo
Takeshi Gotoda Male	Nagoya University
Yusuke Yasugahira Male	Hokkaido University
Hiroyuki Kitahata Male	Chiba University
Mitsuhiro Denda Male	Siseido

Abstract: In this study, we developed a mathematical model of the epidermis. It consists of cell dynamics, including cell division, differentiation, deformation and kinetics, and intracellular calcium ion dynamics, which are known to affect the homeostasis of the barrier function. As the result of our study, we found that the localization of calcium ions and cell division plays a particularly important role in the barrier function.

12:00-12:30

The continuation method for spatially discretized models with nonlocal interactions

Yoshitaro Tanaka	Future University Hakodate
Tetsuo Yasugi	Kanazawa University
Makoto Sato	Kanazawa University
Shin-Ichiro Ei	Hokkaido University

Abstract: During development of multicellular organisms, spatially discretized structures such as cell shape and distribution of cells affect developmental processes. To investigate these phenomena lots of models of which spatially independent variable is discrete have been proposed. Motivated by the analysis we propose a continuation method for spatially discretized models with convolutions remaining the size and shapes of cells. We numerically show that the derived continuous models are capable of reproducing the patterns in discretized models.

12:30-13:00

The tiling mechanism of the compound eye

Makoto Sato	Kanazawa University
Takashi Hayashi	Kanazawa University
Masakazu Akiyama	Hokkaido University
Shin-Ichiro Ei	Hokkaido University
Takamichi Sushida	Hokkaido University

Abstract: Tiling is a common phenomenon in nature, and the compound eye is an interesting example. Hexagonal tiling patterns are common in insect retina, but some aquatic crustaceans develop tetragonal patterns. In the case of the fruit fly, the wild type eyes show the hexagonal patterns. However, some mutant fly strains develop tetragonal patterns. In this talk, we will propose a key mechanism that establishes the diverse types of tiling patterns in the compound eye.

MS FT-2-1 2 11:00-13:00

Computing with rational functions - Part 2

For Part 1 see: MS FT-2-1 1

For Part 3 see: MS FT-2-1 4

Organizer: Yuji Nakatsukasa	University of Oxford
Organizer: Nick Trefethen	University of Oxford
Organizer: Stefan Guettel	The University of Manchester

Abstract: Many numerical algorithms rely on rational functions, whether implicitly or explicitly, because of their power for approximation with singularities or on unbounded domains. This is an exciting time for this field, with many recent developments. In fundamental algorithms these include RKFIT, the AAA method, and advances in the Loewner framework. Application areas include fast solution of PDEs, rational filters for parallel eigensolvers, model order reduction, and nonlinear eigenvalue problems. There have even been recent surprises on the theoretical side of rational approximation. This minisymposium will discuss progress on these challenging methods, whose importance seems set to grow in the future.

11:00-11:30

AAA-Lawson for rational minimax approximation

Lloyd N. Trefethen	Oxford University

Abstract: The AAA algorithm has proved remarkably fast and robust for computing good rational approximations. We have found that by extending it by a phase of iteratively reweighted least-squares in a barycentric representation, also known as Lawson's method, we can in fact make the approximations optimal in the supremum norm. There is no theory yet, but the experiments are striking. Previously, rational minimax approximation has been a difficult problem numerically.

11:30-12:00

Handling algebraic branch points in nonlinear eigenvalue problems

Roel Van Beeumen Lawrence Berkeley National Laboratory
Meiyue Shao Lawrence Berkeley National Laboratory
Chao Yang Lawrence Berkeley National Laboratory

Abstract: Most nonlinear eigensolvers proposed in the recent literature require the region of the complex plane in which we want to compute eigenvalues to be analytic. This restriction is often a limitation when we aim for eigenvalues in the neighborhood of branch points and branch cuts. In this talk, we propose a way to efficiently handle algebraic branch cuts in nonlinear eigenvalue problems and illustrate it for a problem with multiple square roots.

12:00-12:30

A multishift, multipole rational QZ method for the generalized eigenvalue problem

Daan Camps KU Leuven - Dept. Computer Science

Abstract: We present a multishift, multipole rational QZ iteration for block Hessenberg pencils in this talk. We show that its convergence behavior is governed by rational functions. The aggressive early deflation strategy is incorporated in the algorithm and we pay special attention to the numerical stability of the pole swaps. Numerical experiments exemplify the competitiveness and accuracy of the resulting methods. This is joint work with Raf Vandebril and Karl Meerbergen.

12:30-13:00

Solving the 2D Laplace equation with rational functions

Abinand Gopal Oxford University
Lloyd N. Trefethen University of Oxford

Abstract: Solving the planar Laplace equation in domains with corners is a fundamental challenge in numerical PDEs. The solution to such a problem will generically have singularities at the corners which can pose difficulties for numerical methods. I will present a new method, related to the method of fundamental solutions, which represents the solution by the real part of a rational function and can achieve root-exponential accuracy with respect to the number of degrees of freedom.

MS A6-2-2 2 11:00-13:00

New Trends on Toeplitz matrices and operators - Part 2

For Part 1 see: MS A6-2-2 1
Organizer: Natalia Bebiano UNIVERSITY OF COIMBRA
Organizer: Rosário Fernandes Universidade Nova de Lisboa
Organizer: Susana Furtado Faculdade de Economia do Porto

Abstract: Toeplitz matrices and operators is an important topic in mathematics, with applications in different areas of this science, as well as in other sciences, as engineering, chemistry and economics. Recently, with progress in the investigation of numerical methods, matrix polynomials and graph theory, theoretical advances, as well as new applications, have been obtained concerning the study of Toeplitz and other related structured matrices. The main aim of this MS is to bring together researchers from matrix numerical analysis and related areas, and to present emerging results at the frontiers of these fields, with emphasis in applications.

11:00-11:30

Eigenvector sensitivity under general and structured perturbations of tridiagonal Toeplitz-type matrices

Silvia Noschese SAPIENZA Università di Roma
Lothar Reichel Department of Mathematical Sciences, Kent State University, Kent, OH 44242, USA

Abstract: The sensitivity of eigenvalues of structured matrices under general or structured perturbations of the matrix entries has been thoroughly studied in the literature. Error bounds are available and the pseudospectrum can be computed to gain insight. Few investigations have focused on analyzing the sensitivity of eigenvectors under general or structured perturbations. It is the purpose of the talk to discuss this sensitivity for tridiagonal Toeplitz and Toeplitz-type matrices.

11:30-12:00

Schroedinger' s tridiagonal matrix

Alexander Kovacec UNIVERSITY OF COIMBRA

Abstract: In the 1926 that formulated his famous equation, Schrödinger came across a parametrized family of determinants of certain tridiagonal matrices whose values he conjectured but for which he could not find a proof. We report about the recent solution of the problem and also about related tridiagonal matrices like the better known Sylvester Kac matrix and the combinatorial identities which can be derived from comparing Schroedinger's determinants with Sylvester Kac determinants.

12:00-12:30

Fast and accurate matrix-less methods for spectral analysis

Sven-Erik Ekström Athens University of Economics and Business

Abstract: The spectra of Toeplitz-like matrices, for example from PDE or FDE discretizations, are of both theoretical and practical importance. Böttcher et al. described an asymptotic expansion of the approximation errors when sampling the spectral symbol to approximate the spectrum. The so-called "matrix-less" methods have been developed to approximate these expansions, using only a few small matrices, resulting in highly efficient and accurate eigensolvers, for arbitrary order of the matrices of interest.

MS FT-S-3 2 11:00-13:30

Advances in Fractional Partial Differential Equations: Modeling, Theory and Computation

Organizer: Abdul Qayyum Khaliq Middle Tennessee State University, USA
Organizer: Jorge Macias-Diaz Universidad Autónoma de Aguascalientes, Mexico
Organizer: Roberto Garrappa University of Bari, Italy

Abstract: Operators of fractional (i.e. non integer) order are gaining an increasing interest in physical, engineering and industrial applications since they are able to capture non-local effects commonly observed in complex systems. The spread of new knowledge about theoretical and computational aspects of partial differential equations of fractional order is therefore of fundamental importance for an advanced modeling of these systems. This Mini-symposium aims to bring together researchers working on modeling, theory and computation of fractional partial differential equations in order to create a bridge among these areas, present findings from recent studies and stimulate new connections.

11:00-11:30

Numerical computation of electromagnetic fields in systems with special fractional-order operators

Roberto Garrappa University of Bari, Italy

Abstract: Polarization processes in anomalous dielectric materials are described in the frequency domain by nonlinear models with one or more fractional powers. The simulation in the time domain of Maxwell's systems for these materials involves non-standard differential or pseudo-differential operators of fractional order whose numerical approximation requires specifically devised methods. In this talk we consider polarization processes of Havriliak-Negami type and we discuss some approaches for the efficient and accurate numerical simulation.

11:30-12:00

Application of space-fractional PDEs in electrocardiological modeling

Luca Gerardo-Giorda BCAM-BASQUE CENTER FOR APPLIED MATHEMATICS
Nicole Cusimano BCAM-Basque Center for Applied Mathematics

Abstract: We consider a modification of the monodomain model of cardiac electrophysiology by replacing the diffusive term of the classical formulation with a fractional power of the diffusion operator. With the resulting nonlocal model we successfully account for anisotropy and fiber directionality, while describing different levels of tissue heterogeneity as the fractional exponent is varied. We show the versatility of our approach by performing numerical tests on unstructured grids for both regular and realistic irregular geometries.

12:00-12:30

Matrix function methods for solving fractional partial differential equations

Marina Popolizio Polytechnic University of Bari, Italy

Roberto Garrappa	University of Bari

Abstract: In this talk we discuss some techniques based on the use of matrix functions for the accurate and stable solution of partial differential equations with time-derivatives of fractional order. We will describe generalized exponential integrators for fractional-order problems which exploit the computation of the Mittag-Leffler function with matrix arguments and we will discuss the derivation of efficient and accurate methods for the computation of this matrix function.

12:30-13:00

Tensor FEM for spectral fractional diffusion

Enrique Otárola Pastén	Universidad Tecnica Federico Santa Maria, Chile
Lehel Banjai	Heriot-Watt University
Jens M. Melenk	Technische Universitat Wien
Ricardo H. Nochetto	University of Maryland
Abner J. Salgado	University of Tennessee
Christoph Schwab	ETH Zurich

Abstract: We consider the spectral fractional Laplacian in bounded domains Ω and present solution techniques for the nonuniformly elliptic problem, posed on $\Omega \times (0|\infty)$, that localizes it. We establish regularity estimates for the solution of this problem; in particular, the analytic regularity with respect to the extended variable. We present a first-degree tensor product FEM and the tensorization of a first-degree FEM in Ω with a suitable hp-FEM in the extended variable.

13:00-13:30

Split-step methods for space fractional reaction-diffusion equations

Abdul Qayyum Khaliq	Middle Tennessee State University, USA

Abstract: A split-step predictor-corrector time-stepping method for space-fractional Reaction-diffusion equations with nonhomogeneous Neumann and Robin boundary conditions is presented and analyzed for stability and convergence with Matrix Transfer Technique used for spatial discretization. The method is shown to be unconditionally stable and second order convergent. Numerical experiments are performed to demonstrate the stability, efficiency and reliability of the method on examples with smooth and non-smooth initial data.

MS FT-S-7 2 11:00-13:00

Optimal Transport for Nonlinear Problems - Part 2

For Part 1 see: MS FT-S-7 1
For Part 3 see: MS FT-S-7 3

Organizer: Yunan Yang	New York University
Organizer: Wuchen Li	UCLA

Abstract: Optimal Transport provides particular statistical distances among histograms. They can compare datasets globally including both misfits in the signal intensities and the phase mismatches. The unique and advantageous way of measuring mismatches offer ideal convexity and stability in many nonlinear problems and also accelerate the iterative convergence. The series of mini-symposiums will present fast computational algorithms and recent waves of research efforts in translating attractive theoretical properties of Optimal Transport onto elegant and scalable tools for a wide variety of applications involving modern science and engineering, as well as machine learning.

11:00-11:30

The Wasserstein Natural Proximal in Deep Learning

Alex Lin	University of California, Los Angeles
Wuchen Li	UCLA
Stanley Osher	UCLA
Guido Montufar	UCLA, MPI

Abstract: We introduce a method for training GANs by applying the Wasserstein-2 metric proximal on the generator. The approach is based on Wasserstein information geometry. It defines a parametrization invariant natural gradient by pulling back optimal transport structures from probability space to parameter space. We obtain easy-to-implement regularizers for GANs, and our experiments demonstrate that this method improves the speed and stability of training in terms of wall-clock time and Fréchet Inception Distance (FID) learning curves.

11:30-12:00

Fast Optimal Transport

Matthew Jacobs	UCLA
Flavien Leger	UCLA

Abstract: In this talk, we present a new method to efficiently solve the optimal transportation problem for a general class of transportation costs. Given two probability measures supported on a discrete grid with n points, our method computes the optimal transport map in O(n log(n)) operations and O(n) storage space. This allows us to solve optimal transportation problems on spatial grids as large as 4096x4096 and 256x256x256 in less than 3 minutes on a personal computer.

12:00-12:30

Wasserstein Information Geometry for Learning from Data

Guido Montúfar	University of California, Los Angeles

Abstract: Wasserstein Information Geometry is an active area that combines Information Geometry and Wasserstein Geometry in order to capture two important aspects of learning: the geometry of the learning model and the geometry of the data under consideration. First we introduce Information Geometry, which emphasises the geometry of the learning model. Then we introduce Wasserstein Geometry, which departs from the geometry of the data space. We discuss consequences, computation, applications, and topics of current research.

MS A6-1-2 2 11:00-13:00

Optimization methods and applications - Part 2

For Part 1 see: MS A6-1-2 1
For Part 3 see: MS A6-1-2 3
For Part 4 see: MS A6-1-2 4
For Part 5 see: MS A6-1-2 5

Organizer: Cong Sun	Beijing Univ. Posts and Telecommunications
Organizer: Xin Liu	Academy of Mathematics and Systems Science

Abstract: This multiple minisymposium is to address the recent progress in nonlinear optimization field. The topics include but not limit to: first-order methods, Newton-like methods, derivative free methods, stochastic optimization methods, methods for problems with orthogonality constraints and applications with optimization methods.

11:00-11:30

Analysis of steplength rules in gradient projection methods for constrained optimization

Federica Porta	University of Modena and Reggio Emilia
Serena Crisci	Università di Ferrara
Valeria Ruggiero	Università di Ferrara
Luca Zanni	Università di Modena e Reggio Emilia

Abstract: The Barzilai and Borwein (BB) rules are effective tools to accelerate gradient projection methods since they allow to encode some second order information without computing the Hessian matrix. In this talk we will try to understand how the presence of a feasible set can influence the spectral properties of the BB strategies and if their redefinition to better account for the constraints can be convenient to improve the performance of gradient projection algorithms.

11:30-12:00

Regularized solution of gravity-magnetic cross-gradient joint inverse problem based on structural coupling

Yanfei Wang	Chinese Academy of Sciences
Yuanping Zhang	University of Chinese Academy of Sciences

Abstract: We propose a gravity-magnetic joint inversion scheme based on the total variation and the cross-gradient structural coupling constraint. A fast gradient decent algorithm is applied to solve the minimization problem. We apply the joint inversion scheme to the gravity-magnetic inverse problem and compare it with the single inversion scheme. It shows that the gravity-magnetic cross-gradient joint inversion method can effectively improve the position and numerical accuracy of anomalies compared with the single physical inversion method.

12:00-12:30

Spectral methods for linear monotone equations, saddle point and KKT problems

Oleg Burdakov	Linkoping University
Yu-Hong Dai	Chinese Academy of Sciences
Na Huang	China Agricultural University

Abstract: We present spectral methods for solving linear monotone equations, saddle point and KKT problems. We present also results of numerical experiments which show that our spectral methods are competing with the standard ones in case of solving large linear systems with nonsymmetric positive definite matrices.

MS A1-1-2 2 11:00-13:00

Recent advancements in fluid-structure interaction problems

Organizer: Anand Oza New Jersey Institute of Technology
Organizer: Jinzi Mac Huang University of California San Diego

Abstract: Fluid-structure interaction problems are fascinating due to their physical relevance and mathematical complexity. From the small-scale motion of nanoswimmers to the planetary scale of plate tectonics, fluid-structure interaction problems span more than fifteen decades of dimension, and involve the complex interaction between dynamic boundaries and fluid flows. In this minisymposium, we will discuss advancements in the study of collective swimming; bubble formation; geophysical fluid dynamics and the stochastic modeling of plate tectonics. With results from complementary experimental and theoretical studies, this session will inspire the development of mathematical models, and analytical and numerical methods for studying them.

11:00-11:30

A free-streamline model for a liquid film in a fast flow

Anand Oza	New Jersey Institute of Technology
Likhit Ganedi	Carnegie Mellon University
Michael Shelley	Courant Institute of Mathematical Sciences
Leif Ristroph	Courant Institute of Mathematical Sciences

Abstract: We present a combined experimental and theoretical investigation of a suspended liquid film deformed by an external flow. We identify a family of equilibrium shapes for flow speeds up to a critical value. A model based on free-streamline theory provides evidence of a saddle-node bifurcation, suggesting that bubble formation at high speeds results from the loss of equilibrium, and at low speeds from the loss of stability for overly inflated shapes.

11:30-12:00

Bacterial spread in porous media

Enkeleida Lushi	NJIT

Abstract: While bacterial motility is well-studied for motion on flat surfaces or in unconfined liquid media, bacterial migration and spread through heterogenous media is still unclear. I will present a coarse-grained mathematical model of the dynamics of bacterial motion in a porous medium, the linear stability analysis and numerical simulations of the system. I will discuss simulations and experiments of the spread of an initial drop of bacteria through media of various porosity.

12:00-12:30

Droplets walking on a vibrating bath: quantization, chaos, and emergent statistics

Matthew Durey	Massachusetts Institute of Technology
Paul Milewski	

Abstract: A droplet may 'walk' on the surface of a vertically vibrating fluid bath, propelled at each impact by the Faraday waves generated by all prior impacts. This 'path memory' increases with the amplitude of the subcritical vibrational forcing, yielding chaotic motion in the long-path-memory limit. We compare the chaotic dynamics and emergent statistics of this hydrodynamic pilot-wave system in a number of settings, including confinement due to a harmonic potential and a circular corral.

12:30-13:00

Effects of Pore Morphology and Nutrient Depletion on Tissue Growth in a Tissue-Engineering Scaffold Pore

Pejman Sanaei	New York University
Xinyu Li	Courant Institute of Mathematical Sciences, New York University
Zeshun Zong	Courant Institute of Mathematical Sciences, New York University
Ian M. Griffiths	Mathematical Institute, University of Oxford
Sarah L. Waters	Mathematical Institute, University of Oxford
Linda J. Cummings	Department of Mathematical Sciences, New Jersey Institute of Technology

Abstract: Cell proliferation within a fluid-filled porous tissue-engineering scaffold depends on a sensitive choice of pore geometry and flow rates. Therefore, determining appropriate tissue-engineering-construct geometries and operating regimes poses a significant challenge that cannot be addressed by experimentation alone. In this work, I present a mathematical theory for the fluid flow within a pore of a tissue-engineering scaffold, coupled to the growth of cells on the pore walls.

MS FT-S-1 2 11:00-13:00

Back to the Future IV: Developments in Parallel-in-Time Integration - Part 2

For Part 1 see: MS FT-S-1 1

Organizer: Ben Southworth University of Colorado at Boulder
Organizer: Stephanie Friedhoff University of Wuppertal

MS Organized by: SIAG/CSE

Abstract: Evolutionary processes arise regularly in computation. The obvious case is evolution in time of time-dependent differential equations. However, other topics such as constrained optimization, training of neural networks, and iterative solution to nonlinearities, can also be seen as evolutionary processes. Traditionally, the computation associated with evolutionary processes is sequential in nature. But, for the efficient use of massively parallel supercomputers, new algorithms are required that can parallelize the process of evolution. Part I of this minisymposium features exciting theoretical and algorithmic developments in parallel-in-time methods, and Part II demonstrates the broad use of parallel-in-time techniques applied to complicated evolutionary processes.

11:00-11:30

A Parallel-in-time Preconditioner for solving KKT Systems Arising in Transient PDE-Constrained Optimization

Eric Cyr	Sandia National Laboratories
Denis Ridzal	Sandia National Laboratories

Abstract: Transient PDE constrained optimization algorithms, like SQP, often require solve multiple KKT systems. Solving this massive system for transient PDE systems represents a substantial bottleneck. We propose a parallel-in-time multigrid preconditioner for solving these systems. Our preconditioner uses a domain decomposition smoother for multigrid by exposing and relaxing time continuity constraints. This talk presents speedups obtained by using the multigrid preconditioner in a Krylov method to solve KKT systems associated with two-dimensional PDE constraints.

11:30-12:00

Parallel-in-Layer Training of Deep Residual Neural Networks

Stefanie Gunther	Lawrence Livermore National Laboratory
Lars Ruthotto	Emory University, USA
Jacob Schroder	University of New Mexico, USA
Eric Cyr	Sandia National Laboratory, USA
Nicolas Gauger	TU Kaiserslautern, Germany

Abstract: We present an approach for parallelizing the training with residual neural networks (ResNets) across the network layers. Since ResNets can be interpreted as discretizations of an initial value problem, we apply a parallel-in-time multigrid method to replace the network propagation. The new approach breaks the serial forward and backward locking and yields runtime speedup through greater concurrency. Further, it allows for simultaneous training where network weight updates are based on inexact gradient evaluation.

12:00-12:30

Parallel in Time Using Exponential Integrators and PFASST

Michael Minion	Lawrence Berkeley National Laboratory
Tommaso Buvoli	UC Merced

Abstract: Exponential integrators for the temporal integration of ODEs utilize the matrix exponential to integrate a linear part of the equation exactly. Nonlinear terms are typically included using an operator splitting approach. I will describe a serial approach for exponential integrators where the nonlinear terms are treated using an extension of Spectral Deferred Corrections to achieve high order. I will then discuss parallelization using the PFASST algorithm and demonstrate the effectiveness of the resultant schemes.

12:30-13:00

Parallel-in-time integration of dynamo simulations

Andrew Clarke	University of Leeds

Abstract: Numerical dynamo simulations are used to study the mechanisms responsible for planetary and stellar magnetic fields. These simulations are computationally expensive, and do not scale optimally to very large HPC systems. Using the spectral code Dedalus, we investigate the ability of the parareal algorithm to speed up two subsets of this problem; kinematic dynamos, where we have found speed ups of ~300 with 1600 processors, and Rayleigh-Benard convection, where preliminary results will be presented.

MS A6-2-3 2 11:00-13:00

Machine Learning for Materials - Part 2

For Part 1 see: MS A6-2-3 1

Organizer: Katerine Isabel Saleme Ruiz UNIVERSITY OF LUXEMBOURG

Organizer: Malena Espanol The University of Akron

Abstract: Machine learning techniques have recently become a powerful tool in materials science, to understand and model the underlying physics of material's behavior and structure-property relations at different length scales. The goal of this minisymposium is to bring together experts from physics, materials, chemistry, mathematics, and computer science, to show their recent results in the application of machine learning to materials science as well as to provide a stage for discussing the extend and limitations of machine learning when applied to the modeling of physical systems.

11:00-11:30

Machine-learned energy landscape of 1D chains with pairwise and many-body treatment of van der W

Katerine Saleme Ruiz	Université du Luxembourg
Alexander Tkatchenko	University of Luxembourg
Stephane Bordas	University of Luxembourg

Abstract: We develop a framework to understand the many-body treatment of van der Waals interactions beyond the standard pairwise model for 1D systems. Meaningful qualitative and quantitative differences between pairwise and many-body dispersion approaches have been found when exploring the energy landscape of 1D chain of atoms by using a machine learning approach as well as atomic-macro scale coupling for property prediction has been studied for those systems.

11:30-12:00

Multi-fidelity surrogate modeling of electrolyte components for Lithium ion batteries

Xin (Cindy) Wang	University of Colorado Colorado Springs (UCCS)
Kenneth Leiter	U.S. Army Research Laboratory
Oleg Borodin	U.S. Army Research Laboratory
Jaroslaw Knap	U.S. Army Research Laboratory

Abstract: A key feature that characterizes a viable electrolyte component for Li-ion batteries is electrochemical stability. There are many computational studies of redox-stability of electrolyte components using quantum chemical (QC) models and molecular dynamics. This talk is focused on building multi-fidelity surrogate models using Gaussian process regression (GPR) for predicting the electrolyte redox-stability. This approach allows one to combine hierarchical physics-based models using a stochastic regression method in order to reduce computational cost.

12:00-12:30

Learning the structure-function landscapes of molecular materials

Graeme Day	University of Southampton

Abstract: Crystal structure prediction methods are based on a global search of the lattice energy surface and a ranking of local energy minima according to their calculated relative stabilities. We have combined these methods with property prediction simulations to guide the discovery of novel functional materials. This talk will discuss how machine learning has been used to accelerate these predictions and help analyse the resulting landscapes for structure-property relationships.

12:30-13:00

Boltzmann Generators: Statistical mechanics meets deep learning

Frank Noe	Freie Universität Berlin
Simon Olsson	FU Berlin
Jonas Köhler	FU Berlin
Hao Wu	Tongji University Shanghai

Abstract: Computing equilibrium states in condensed-matter many-body systems, such as solvated proteins, is a long-standing challenge. Here we develop Boltzmann Generators, a deep learning method that can generate unbiased one-shot samples of equilibrium states of many-body condensed matter systems and macromolecules. Boltzmann Generators learn a coordinate transformation of the complex configurational equilibrium distribution to a distribution that can be easily sampled. Accurate computation of free energy differences, and discovery of new system states are demonstrated. https://arxiv.org/abs/1812.01729

MS ME-1-5 2 11:00-13:00

Emerging trends in liquid crystals encompassing modelling, simulation and analysis - Part 2

For Part 1 see: MS ME-1-5 1

For Part 3 see: MS ME-1-5 3

For Part 4 see: MS ME-1-5 4

Organizer: Arghir Dani Zarnescu Basque Center for Applied Mathematics

Organizer: Pingwen Zhang Peking University

Abstract: Liquid crystals are modelled mathematically by functions taking values into a certain space of order parameters. Various spaces of order parameters correspond to different theories of liquid crystals. Initial mathematical explorations started in the 80s in connection with harmonic maps. The last decade has brought a surge in the mathematical study of liquid crystals, to the extent that the mathematical literature in the area has nearly doubled. The proposed minisymposium aims to explore the recent advances, and generate new directions, by bringing together major contributors from the modelling, simulation and analysis of liquid crystals.

11:00-11:30

Landau-de Gennes corrections to the Oseen-Frank theory of nematic liquid crystals

Valeriy Slastikov	University of Bristol
Giovanni Di Fratta	TU Wien
Jonathan Robbins	University of Bristol
Arghir Zarnescu	BCAM

Abstract: We study the asymptotic behavior of the minimisers of the Landau-de Gennes model for nematic liquid crystals in the regime of small elastic constant. At leading order in the elasticity constant, the minimum-energy configurations can be described by the simpler Oseen-Frank theory. Using a refined notion of Gamma-development we recover Landau-de Gennes corrections to the Oseen-Frank energy. We provide a characterisation of minimizing Q-tensors in terms of optimal Oseen-Frank directors and observe the emerging biaxiality.

11:30-12:00

A generalized Landau-de Gennes model for nematic/isotropic phase transitions

Dmitry Golovaty	University of Akron
Michael Novack	Indiana University
Peter Sternberg	Indiana University
Oleg Lavrentovich	Kent State University
Young-Ki Kim	Cornell University

Abstract: I will describe a model based on collecting appropriate fourth-order elastic terms from the generalized LdG theory proposed by Longa and collaborators in the 1980s. The corresponding variational model uses the standard LdG potential, is well-posed, and reduces to the general OF model when the nematic correlation length tends to zero. The model allows us to consider nematic-to-isotopic transitions for highly disparate elastic constants. Numerical simulations demonstrate that theoretical predictions match well with experimental observations.

12:00-12:30

Nematic Liquid Crystal Defects in Slabs

Daniel Phillips	Purdue University
Patricia Bauman	Purdue University

Abstract: We examine minimizers for the Landau - de Gennes energy in a slab $\Omega \times (-\delta,\delta)$ where the cross section Ω is a bounded simply connected domain in R2. The minimizers are to satisfy tangential boundary conditions on the top and bottom faces and prescribed boundary conditions on the lateral surface. We determine the defect structures, textures and estimates on the energies for minimizers highlighting how they depend on the L-dG parameter ε and δ.

12:30-13:00

Chromonic liquid crystals: modeling and analysis

Maria-Carme Calderer University of Minnesota

Abstract: This presentation deals with analysis of free boundary problems for lyotropic chromonic liquid crystalas, arising in the study of DNA condensates in free solution as well as encapsidated configurations of bacteriophage viruses. The central mathematical problem is formulated as a free boundary problem for the constrained Oseen-Frank and Ericksen's energies, where the domain and the vector field are unknown. We will also present a numerical algorithm aimed at the design of viruses for medical applications.

MS ME-0-3 2 11:00-13:00

Nonlinear waves, singularities, and turbulence in physical and biological systems - Part 2

For Part 1 see: MS ME-0-3 1
For Part 3 see: MS ME-0-3 3
For Part 4 see: MS ME-0-3 4
For Part 5 see: MS ME-0-3 5

Organizer: Pavel Lushnikov University of New Mexico
Organizer: Alexander Korotkevich University of New Mexico

Abstract: Appearance of waves and formation of singularities are important problems in many physical, hydrodynamical and biological systems as well as for the applied mathematics in general. Waves of finite amplitude require solutions beyond linear approximation by taking into account nonlinear effects. Solutions of nonlinear equations usually result in the formation of singularities, coherent structures or solitary waves. Examples of the corresponding phenomena can be observed in filamentation of laser beams in nonlinear media, wave breaking in hydrodynamics and aggregation of bacterial colonies. The minisymposium is devoted to new advances in the theory of nonlinear waves.

11:00-11:30

Hydrodynamic models and boundary confinement effects

Roberto Camassa University of North Carolina at Chapel Hill

Abstract: Confinement effects by rigid boundaries in the dynamics of ideal fluids are considered, with the focus on the consequences of establishing contacts of material surfaces with confining horizontal boundaries, which can lead to singularities developing in finite time. The conditions and the nature of these singularities are illustrated in several cases, from a single layer homogeneous fluid, to two-fluid systems, and, through numerical simulations, to the full Euler stratified system.

11:30-12:00

Extreme event quantification for systems with randomness: Rogue waves in the deep sea

Tobias Grafke University of Warwick

Abstract: In stochastic systems, extreme events are known to be described by "instantons", saddle point configurations of the action of the associated stochastic field theory. I will present experimental evidence of a hydrodynamic instanton from a wave channel experiment in order to observe so-called rogue waves, realisations of extreme surface elevation. I show that the instanton approach, which is rigorously grounded in large deviation theory, offers a unified description of rogue waves in the water tank.

12:00-12:30

Family of Potentials with Power-Law Kink Tails

Avadh Saxena Los Alamos National Laboratory
Avinash Khare Savitribai Phule Pune University, India

Abstract: We provide examples of a large class of one dimensional higher order field theories with kink solutions which asymptotically have a power-law tail either at one end or at both ends. We provide analytic solutions for the kinks in a few cases but mostly provide implicit solutions. We also provide examples of a family of potentials with two kinks, both of which have power law tails either at both ends or at one end.

12:30-13:00

The Computation of differential equations with singularities in the complex plane

Marco Fasondini University of Kent

Abstract: Computational methods in the complex plane are presented for (i) the Gauss hypergeometric function (defined by a linear ODE), (ii) the Painlevé transcendents (defined by nonlinear ODEs) and (iii) (1+1)-dimensional nonlinear PDEs. The computational tools include spectral methods, Padé approximation and Hermite-Padé approximation. The numerical methods are used to study pole-free (tronquée) solutions to the third Painlevé equation as well as blow-up and shock formation in nonlinear PDEs.

MS ME-0-6 2 11:00-13:00

Novel Concepts in Model-driven Optimization and Control of Agent-based Systems - Part 1

For Part 2 see: MS ME-0-6 1
For Part 3 see: MS ME-0-6 3
For Part 4 see: MS ME-0-6 4

Organizer: Dante Kalise University of Nottingham
Organizer: Giacomo Albi University of Verona
Organizer: Herty Michael RWTH Aachen University
Organizer: Giuseppe Visconti RWTH Aachen University

Abstract: This minisymposium features recent developments in optimization and control of agent-based dynamics arising in collective behaviour phenomena across different spatio-temporal scales, with particular emphasis on the interplay between multiscale modelling and optimal control. The talks will focus on different techniques stemming from multiscale modelling, nonlinear optimal control, Hamilton-Jacobi Equations and uncertainty quantification, and will incorporate recent breakthroughs in model-driven optimization, high-dimensional approximation and learning. This minisymposium will also address different applications in learning and control of animal and human crowd motion, social dynamics, and the control of autonomous vehicles.

11:00-11:30

Consistent meanfield control: Novel concepts and theoretical results

Herty Michael RWTH Aachen University

Abstract: We are interested in the derivation of optimality conditions for controlled interacting agent systems. We establish the relation between mean field optimality conditions and the optimality condition of the mean field control problem. e multipliers in the mean field limit.

11:30-12:00

Spectral methods for linear and nonlinear Fokker-Planck equations

Grigorios Pavliotis Imperial College
Urbain Vaes Imperial College London
Susana Gomes Warwick University

Abstract: In this talk I will present some recent results on spectral numerical methods for the numerical solution on Fokker-Planck equations. We consider both linear and nonlocal/nonlinear, McKean-Vlasov PDEs, that arise in the mean field limit of weakly interacting diffusions. A main feature of the spectral numerical method is that no gradient structure is required. We illustrate the performance of our method by studying phase transitions for mean field models of interacting diffusions with collored noise.

12:00-12:30

Some machine learning methods for mean field control and mean field games

Mathieu Laurière Princeton University

Abstract: We present three probabilistic numerical methods for mean field type problems based on machine learning. The first method solves mean field control problems by learning the optimal control using Monte-Carlo samples and SGD. The second and the third methods tackle respectively the FBSDE and PDE systems of optimality for MFG or MFC. Aspects of the theory and numerical results are discussed. Joint work with René Carmona.

12:30-13:00

Nash equilibria and bargaining solutions of quantum-dynamical game problems

Alfio Borzi University of Wuerzburg

Abstract: A theoretical and numerical investigation of Nash equilibria (NE) and Nash bargaining (NB) problems governed by quantum models is presented. These models arise in e.g. spin systems with control potentials. In a Nash game, different potentials are associated to different players having non-cooperative objectives. Existence of NE is proved and computed with a Newton scheme and a relaxation method. A NB problem is discussed aiming at determining an improvement of all pay-offs.

MS FE-1-1 2 11:00-13:00

Finite element exterior calculus and applications - Part 2

For Part 1 see: MS FE-1-1 1
For Part 3 see: MS FE-1-1 3
For Part 4 see: MS FE-1-1 4
Organizer: Snorre H. Christiansen — University of Oslo
Organizer: Shuo Zhang — Institute of Computational Mathematics, CAS
Organizer: Kaibo Hu — University of Minnesota

Abstract: Finite element exterior calculus (FEEC) and other compatible or structure-preserving discretization techniques have been drawing increased attention in both theoretical studies and applications. This minisymposium aims at a communication of recent developments for such nu- merical methods for electromagnetism, fluid and solid mechanics. In particular, sophisticated discretization techniques and solvers are required to meet the challenges raised in these areas, including conservative discretizations for fluid dynamics, inclusion of geometric structures in linear and nonlinear solid mechanics and modeling and simulation of defects.

11:00-11:30

Commuting, polynomial extension operators for differential forms

Richard Falk — Rutgers University
Ragnar Winther — University of Oslo

Abstract: The method of blending is used to construct polynomial preserving extension operators for differential k-forms whose traces are given on the boundary of a simplex in n. These extension operators are defined so that they commute with the exterior derivative.

11:30-12:00

The bubble transform and the de Rham complex

Ragnar Winther — University of Oslo
Richard S Falk — Rutgers University

Abstract: In the paper called "The bubble transform: A new tool for finite element analysis" (2015) we described a finite element theory without finite element spaces. Based on a given spatial mesh we showed how to decompose scalar functions into "local bubbles" in such a way that the decomposition preserves all the corresponding continuous piecewise polynomial spaces. In present talk we will discuss generalizations of this theory to the setting of the de Rham complex.

12:00-12:30

The divDiv-Complex: Analytical Foundations

Dirk Pauly — Universität Duisburg-Essen

Abstract: We investigate the Hilbert complex for the biharmonic operator, i.e., the divDiv-complex. (Related well known complexes are, e.g., the de Rham complex and the complex of elasticity.) We show closed ranges, Friedrichs/Poincare type estimates, Helmholtz type decompositions, regular decompositions, regular potentials, finite cohomology groups, and, most importantly, new compact embedding results. Our results hold for general bounded strong Lipschitz domains of arbitrary topology and rely on a general functional analysis framework (FA-ToolBox).

12:30-13:00

The divDiv-complex: A construction based on the Bernstein-Gelfand-Gelfand resolution

Walter Zulehner — Johannes Kepler University Linz
Dirk Pauly — University of Duisburg-Essen

Abstract: The divDiv-complex is a differential complex closely related to the elasticity complex. We will show how the divDiv-complex can be constructively derived from six copies of the de Rham complex for smooth functions. Here we follow closely the article "Mixed Finite Element Methods for Linear Elasticity with Weakly Imposed Symmetry" by D. Arnold, R. Falk and R. Winther, where this approach was used to construct new finite element methods for linear elasticity.

MS A3-3-1 2 11:00-13:00

Advances in numerical methods for the shallow-water equations and applications - Part 2

For Part 1 see: MS A3-3-1 1
Organizer: Ilya Timofeyev — University of Houston
Organizer: Dmitri Kuzmin — TU Dortmund University

Abstract: In this minisymposia we bring together experts working on numericl methods and applications for the shallow-water equations which arise in a variety of applications. In this minisymposia we bring together researchers working on different computational aspects of the SWE. There will be several talks focusing on developing novel numerical schemes and other presentations will discuss various applications, including coastal flooding and weather/climate studies. Therefore, this minisymposia will facilitate interaction between academic faculty and researchers outside of academia. In addition, this minisumposia will be of interest to a broad scientific community due to a large number of applications of the SWE.

11:00-11:30

Verification and Validation of Numerical Water Wave Models Based on Entropy Viscosity Methods with Convex Limiting

Christopher Kees — US Army Engineer Research & Development Center

Abstract: Numerical wave models include well-known two-dimensional models, such as the shallow water equations, and also evolving higher-fidelity formulations with dispersive and three-dimensional processes. In this context it is critical to have both reliable, rapid convergence and preservation of qualitiative properties of the underlying model, such as correct behavior near dry states and exact solution of simple constant and linear free-surface states. This presentation presents the application of convex limiting with entropy viscosity to these problems.

11:30-12:00

Frame-invariant directional vector limiters for discontinuous Galerkin shallow water models

Hennes Hajduk — TU Dortmund
Dmitri Kuzmin — TU Dortmund University
Vadym Aizinger — Alfred Wegener Institute

Abstract: In this talk, I will motivate the use of directional limiters for vector-valued unknowns of the shallow water equations. Our methodology enforces local maximum principles for scalar products of vector fields with a frame-invariant orthogonal basis. Furthermore, I will describe, how a sequential limiting strategy can be carried out, in order to preserve maximum principles for velocity, rather than momentum. Numerical examples in 1D and 2D are presented, to illustrate the effectiveness of our schemes.

12:00-12:30

Effective dispersion and solitary waves in the shallow water equations over periodic bathymetry

Manuel Quezada De Luna — KAUST
David I Ketcheson — KAUST

Abstract: We study water waves and demonstrate via a linearized asymptotic analysis that dispersive effects are introduced in the presence of periodic bathymetry. This dispersion can be balanced with nonlinear effects to create solitary waves. Afterwards, we solve numerically the shallow water system with variable-bathymetry and obtain solitary waves and study their properties. Finally, we conduct computational experiments in different water wave models to assess the feasibility of a physical experimental observation of these solitary waves.

12:30-13:00

Stochastic parameterization of subgrid-scales in one-dimensional shallow water equations

Ilya Timofeyev — University of Houston
Matthias Zacharuk — Johann Wolfgang Goethe-Universität Frankfurt/Main
Stamen Dolaptchiev — Johann Wolfgang Goethe-Universität Frankfurt/Main
Ulrich Achatz — Johann Wolfgang Goethe-Universität Frankfurt/Main

Abstract: We address the question of parameterizing the subgrid scales in simulations of geophysical flows by applying stochastic mode reduction to the one-dimensional stochastically forced shallow water equations. Resolved variables are defined as local spatial averages and unresolved variables as corresponding residuals. Based on the assumption of a time-scale separation we obtain a low-resolution stochastic model for the resolved variables alone. The closure improves the results of the low-resolution model and outperforms empirical stochastic parameterizations.

MS A6-4-2 2 11:00-13:00

Recent Advances in Differential Equations. Control Theory. Numerical Simulation - Part 2

For Part 1 see: MS A6-4-2 1

Organizer: Concepción Muriel-Patino	University of Cadiz
Organizer: Carmen Pérez-Martínez	University of Cádiz

Abstract: Control theory has developed rapidly over the past decades, becoming nowdays an important area of contemporary mathematics. Control problems can appear in industrial complexes, electro-mechanical machines, biological systems, etc. Advances on switching control techniques are of a very high impact. Problems in control theory, as most engineering problems, are modelled by differential equations. Common techniques to obtain general solutions are usually insufficient and the development of new powerful tools is required. Recent geometric and analytical methods for the search of exact solutions for differential equations are investigated. Numerical simulations of problems in Naval Engineering and Oceanography are also presented.

11:00-11:30

A stabilization result on third order switched systems.

Juan Bosco García Gutierrez	Universidad de Huelva
Francisco Benítez Trujillo	University of Cádiz
Carmen Pérez Martínez	University of Cádiz

Abstract: In this work the problem of stabilization of a third order switched linear systems is handled. We provide sufficient conditions for stabilization of a class of third order switched systems. This class of switched system have an invariant set.

11:30-12:00

Prediction of the upwelling events in the peninsula of Guajira (Colombia) through MODIS images

Juan Manuel Vidal Perez	Escuela de Ingeniería Naval y Oceánica

Abstract: The Caribbean Sea has been monitorized for years. One of the mail tools has been the satellite remote sensing imagery. Authors have used a set of 10 years of monthly MODIS-SST imagery to predict the sea surface temperature of the whole Caribbean Sea. The methodology is based on the Hotelling transform combined with the harmonic synthesis.

12:00-12:30

Upwelling prediction in the Guajira península from MODIS-SST imagery

Elizabeth Blázquez Gómez	Facultad de Ciencias del Mar y Ambientales
José Juan Alonso Del Rosario	Universidad de Cádiz
Juan Manuel Vidal Pérez	Universidad de Cádiz

Abstract: The Caribbean Sea has been monitorized for years. One of the mail tools has been the satellite remote sensing imagery. Authors have used a set of 10 years of monthly MODIS-SST imagery to predict the sea surface temperature of the whole Caribbean Sea. The methodology is based on the Hotelling transform combined with the harmonic synthesis.

MS FT-S-6 2 11:00-13:00

Eigenvalue Problems: Analysis, Algorithms and Applications - Part 2

For Part 1 see: MS FT-S-6 1
For Part 3 see: MS FT-S-6 3
For Part 4 see: MS FT-S-6 4

Organizer: Xiaoying Dai	Academy of Mathematics and Systems Science
Organizer: Xin Liu	Academy of Mathematics and Systems Science
Organizer: Huajie Chen	Beijing Normal University

Abstract: Eigenvalue problems are widely used in many fields such as physics, materials sciences, chemistry, biology and image sciences. The research on eigenvalue problems, including its mathematical theory analysis, efficient algorithm design, practical applications, and many unresolved issues, is a challenging topic. This minisymposium aims to provide a platform for experts in this field to exchange the latest developments and explore the topic of further research and cooperations.

11:00-11:30

Adaptive Step Size Strategies for Line Search Methods and Their Application on Electronic Structure Calculations

Xiaoying Dai	Academy of Mathematics and Systems Science
Liwei Zhang	Academy of Mathematics and Systems Science, Chinese Academy of Sciences
Aihui Zhou	Academy of Mathematics and Systems Science, Chinese Academy of Sciences

Abstract: In this talk, we propose an adaptive step size strategy for a class of line search methods for orthogonality constrained minimization problems. We prove the convergence of the adaptive algorithm under some mild assumptions. We apply our adaptive algorithm to electronic structure calculations of some typical systems, which show that our algorithm is efficient and recommended. This is a joint work with Liwei Zhang and Aihui Zhou.

11:30-12:00

The adaptive self-consistent field iteration for solving the Kohn-Sham equation

Xingyu Gao	IAPCM
Yuzhi Zhou	Institute of Applied Physics and Computational Mathematics, Beijing, China
Haifeng Song	Institute of Applied Physics and Computational Mathematics, Beijing, China

Abstract: Solving the Kohn-Sham equation is most computationally demanding in the first-principles calculations. The self-consistent field (SCF) iteration is used to solve such a nonlinear eigenvalue problem. For situations without a priori knowledge of the system, we design the a posteriori indicator to monitor if the preconditioner has suppressed charge sloshing during the iterations. Based on the a posteriori indicator, we demonstrate two schemes of the self-adaptive configuration for the SCF iteration.

12:00-12:30

On Approximation of Dirichlet Boundary Optimal Control Problem using Energy Spaces

Thirupathi Gudi	Indian Institute of Science Bangalore
A K Nandakumaran	Indian Institute of Science Bangalore
Sudipto Chowdhury	Indian Institute of Technology Bombay

Abstract: An energy space based approach is proposed for formulating a Dirichlet boundary optimal control problem. We analysis a finite element method for the proposed approach and derive optimal order error estimates both in energy norm and L2 norm. Numerical experiments illustrating theoretical results will be presented.

IM FT-4-1 2 11:00-13:00

EU-MATHS-IN: Success Stories of Mathematics in Societal Challenges and Industry - Part 2

For Part 1 see: IM FT-4-1 1
For Part 3 see: IM FT-4-1 3
For Part 4 see: IM FT-4-1 4

Organizer: Carlos Parés Madroñal	Universidad de Málaga
Organizer: Manuel Cruz	PT-MATHS-IN | LEMA-ISEP/IPP

Abstract: The European Service Network of Mathematics for Industry and Innovation (EU-MATHS-IN) is an organization promoted by several European research networks following the recommendations of the European Science Foundation. Its main purpose is to increase the impact of mathematics on innovations in key technologies and to foster the development of new modeling, simulation and optimization tools. The goal of this mini-symposium is to present to the attendees some success stories of application of mathematical technologies in industry developed by researchers belonging to the national networks that are members of EU-MATHS-IN. The sessions are organized according to the addressed societal challenges.

11:00-11:30

Optimization of the scheduling of the compound production machines in a tires factory

Carlos Gorria	University of the Basque Country
Mikel Lezaun	UPV/EHU

Abstract: This project consists on finding a mathematical formulation and implementing a computational code for optimizing the assignment of machines in the scheduling of the rubber components manufacturing of Bridgestone Hispania Company. The huge number of references, the order of the production sequences, the skills of each machine and the occasional unavailability makes it a complex problem. In this scenario,linear programming tools become crucial for improving the production and the competitiveness.

11:30-12:00

Multiobjective Traveling Salesman Problem in a Geographic Information Management System

José Luis Santos — University of Coimbra

Abstract: In this presentation, we focus on the optimization of the routes of mobile agents using multicriteria optimization algorithms in which parameters were introduced to allow exploring specific regions of the efficiency frontier. The problem was modeled using a multicriteria version of the multiple traveling salesman problem with multiple depots, including new heuristics and new dominance criteria to obtain efficient routes.

12:00-12:30

Order and stock costs optimization in an automotive spare parts wholesaler

Manuel Cruz — LEMA / ISEP / IPP and PT-MATHS-IN
Margarida Pina — Nors Group
Sandra Ramos — LEMA/ISEP/IPP and CEAUL/FCUL

Abstract: Nors is a Portuguese group within the transport sector. One of Nors companies works in the automotive spare part business dealing with hundreds of thousand references. The stock value and operational costs have great impact on its operational results. LEMA, a research group from ISEP-IPP, developed a mixed methodology for the forecasting problem and coupled it with an optimization model to decide the buying batches. This work presents the mathematical model developed and its implementation.

12:30-13:00

Topological index analysis and its application to fluid networks in system simulation software

Andreas Binder — MathConsult GmbH
Michael Kolmbauer — MathConsult GmbH
Guenter Offner — AVL List GmbH
Ann-Kristin Baum — RICAM

Abstract: We consider the analysis of dynamical systems stemming from automated modeling processes in system simulation software. The governing equations of fluid networks are derived by representing the network as a linear graph. The combination of algebraic graph theory and differential-algebraic equation theory allows establishing existence and uniqueness results as well as index considerations based on easy-to check graph theoretical conditions on the network. We use this approach to increase the usability of system simulation processes.

MS GH-3-4 2 — 11:00-13:00

Nonlocal Modeling, Analysis, and Computation - Part 2

For Part 1 see: MS GH-3-4 1
For Part 3 see: MS GH-3-4 3
For Part 4 see: MS GH-3-4 4
For Part 5 see: MS GH-3-4 5
Organizer: Robert Lipton — Louisiana State University
Organizer: Qiang Du — Columbia University
Organizer: Pablo Seleson — Oak Ridge National Laboratory

Abstract: The past decade has seen a rapid growth in the development of nonlocal mathematical models. Nonlocal modeling is now being used in applications including continuum mechanics and fracture mechanics, anomalous diffusion and advection diffusion, and probability models. This minisymposium seeks to bring together mathematicians and domain scientists from different disciplines working on nonlocal modeling and is intended to serve as international forum for the state of the art in the modeling, analysis, and numerical aspects of nonlocal models.

11:00-11:30

A fractional Korn-type inequality

Tadele Mengesha — University of Tennessee, Knoxville

Abstract: We show that a class of spaces of vector fields whose semi-norms involve the magnitude of "directional" difference quotients is in fact equivalent to the class of fractional Sobolev spaces. The equivalence can be considered a Korn-type characterization of fractional Sobolev spaces. The equivalence permits us to apply classical space embeddings in proving that weak solutions to the nonlocal system enjoy both improved differentiability and improved integrability. This is a joint work with James Scott.

11:30-12:00

Asymptotically compatible reproducing kernel collocation and mesh-free integration for nonlocal diffusion

Yu Leng — The University of Texas at Austin

Abstract: We present an asymptotically compatible reproducing kernel collocation method for nonlocal diffusion model. Stability of collocation methods on integral equations is not a trivial task because of the lack of discrete maximum principle. We provide stability analysis of this collocation scheme by restricting on Cartesian grids with varying resolution in each dimension. Moreover, we introduce a quasi-discrete nonlocal diffusion operator which combined with mesh-free integration technique converges to the correct local limit.

12:00-12:30

Nonlocal gradients and their applications to SPH and peridynamics

Qiang Du — Columbia University
Hwi Lee — Columbia University
Xiaochuan Tian — University of Texas, Austin

Abstract: Nonlocality is ubiquitous in nature and is attracting more mathematical studies. Nonlocal gradients are basic elements of nonlocal vector calculus that play important roles in nonlocal modeling, analysis and computation. We present their basic properties and illustrative applications such as a nonlocal analog of Helmholtz decomposition, stable nonlocal models of peridynamics for elasticity and fracture, and nonlocal relaxations to fluid mechanics models for robust numerical discreizations in the spirit of smoothed particle hydrodynamics (SPH).

12:30-13:00

Fourier multipliers for peridynamic models

Bacim Alali — Kansas State University

Abstract: Fourier multiplier analysis is developed for peridynamic Laplace operators. The Fourier multipliers are given through an integral representation, which is recognized explicitly through a unified and general formula in terms of the hypergeometric function _2F_3 in any spatial dimension. Asymptotic behavior of the Fourier multipliers m(v) as |v| goes to infinity is provided. The asymptotic analysis is utilized in the periodic setting to prove a regularity result for the peridynamic Poisson equation.

MS A1-3-1 2 — 11:00-13:00

Mathematical models and methods in phenomenological thermodynamics of continuous media - Part 1

For Part 2 see: MS A1-3-1 3
For Part 3 see: MS A1-3-1 4
Organizer: Josef Malek — Charles University, Faculty of Mathematics and Physics
Organizer: Boyaval Sébastien — Ecole des Ponts / Inria
Organizer: Vít Průša — Charles University, Faculty of Mathematics and Physics
Organizer: Sergey Gavrilyuk — CNRS - IUSTI - AMU

Abstract: Biological fluids, all kinds of foams, granular materials, suspensions and emulsions, polymeric materials etc. are complex fluid-like materials that are of interest in many areas of science and engineering. Understanding the physical background of the models as well as the analysis of the corresponding initial and boundary value problems is crucial in the development of tools for efficient and robust numerical simulations of flows of these materials. The minisymposium aims to bring together physicists, PDE and numerical analysts and code developers working in the field of thermodynamics and mathematics for complex fluid flows and help them share different perspectives.

11:00-11:30

Thermodynamical and mathematical analysis of rate-type viscoelastic fluid with stress diffusion

Josef Malek — Charles University, Faculty of Mathematics and Physics
Vít Průša — Charles University, Faculty of Mathematics and Physics

Abstract: We present results concerning thermodynamic underpinnings and PDE analysis for viscoelastic rate type fluids with/without stress diffusion. In particular, we state the results regarding long-time and large-data existence of solutions and the stability analysis. Attention is devoted to models in a full thermomechanical setting where energy transfer mechanisms are fully characterized, and where the specific forms of energy, entropy and entropy production lead to suitable a priori estimates and Lyapunov functionals.

11:30-12:00

Numerical simulation techniques for flows with complex rheology

Patrick Westervoß	TU Dortmund
Stefan Turek	TU Dortmund

Abstract: In viscoelastic fluids, described by differential or integral models, additional numerical challenges besides the well-known HWNP arise for negligible or vanishing solvent part. This "no solvent"-case requires numerically special care, particularly w.r.t. the involved solution methods, i.e. operator-splitting or fully monolithic approaches. In this talk, we present the new "Tensor Diffusion"-approach modelling the velocity-stress coupling via a tensor diffusion. We motivate this approach via several examples and present preliminary computational results for prototypical test configurations.

12:00-12:30

Thermodynamics of two-phase granular fluids

Vladimir Shelukhin	Lavrentyev Institute of Hydrodynamics

Abstract: Starting from basic thermodynamic principles, we derive equations for a two-phase granular fluid. The phases differ in velocities, densities and viscosities. The first phase is described with the use of notion of the Cosserat continuum. To illustrate the model, we study how rotation of particles impacts their lateral migration in pipe and channel flows. We explain the Boycott effect and the tubular pinch effect of Ségre-Silberberg. We address anisotropic fluid flows for rod-shaped particles.

12:30-13:00

Finite-energy solutions for compressible two-fluid Stokes system

Ewelina Zatorska	University College London
Didier Bresch	
Piotr Mucha	

Abstract: I will present the recent developments in the topic of existence of solutions to the two-fluid systems. A particular example of such a model is two-fluids Stokes system with single velocity field and two densities, and with an algebraic pressure law closure. The existence result uses the compactness criterion introduced by D. Bresch and P.-E. Jabin and stability estimates for the transport equation by G. Crippa and C. DeLellis.

IM FT-2-3 2 **11:00-13:00**

Modeling, Simulation and Optimization in Electrical Engineering - Part 1

For Part 2 see: IM FT-2-3 3
For Part 3 see: IM FT-2-3 4

Organizer: Kurz Stefan	Robert Bosch GmbH
Organizer: Nella Rotundo	Weierstrass Institute for Applied Analysis
Organizer: M. Pilar Salgado Rodríguez	Universidade de Santiago de Compostela

Abstract: Electrical engineering is an important technology for many recent societal and industrial developments. It includes the investigation and application of electricity, electronics, and electromagnetism. This mini symposium discusses mathematical challenges driven by industrial needs, which are related to classical and new emerging topics of applied mathematics and scientific computing. It is organized in the framework of ECMI's Special Interest Group on Modeling, Simulation and Optimization in Electrical Engineering. Its history goes back more than 20 years, where it was established as part of ECMI's endeavor to strengthen the ties between applied mathematics and the electrical industry.

11:00-11:30

Dual spline complex for structure preserving isogeometric methods

Vázquez Hernández Rafael	EPFL
Annalisa Buffa	Ecole Polytechnique Fédérale de Lausanne

Abstract: Structure preserving isogeometric methods are based on the construction of a de Rham complex of B-spline spaces, in a generalization of edge and face finite elements with higher continuity. In the present paper we develop a dual spline complex for isogeometric methods, that generalizes the dual finite element complex by baricentric refinement introduced by Buffa and Christiansen in 2007. The dual spline complex is much easier to construct, thanks to the tensor-product structure of B-splines.

11:30-12:00

Isogeometric BEM-FEM coupling for the simulation of electric machines

Elasmi Mehdi	TU Darmstadt
Christoph Erath	Department of Mathematics, Technische Universität Darmstadt
Stefan Kurz	Centre for Computational Engineering and TEMF, Technische Universität Darmstadt

Abstract: For the simulation of electric machines, we consider an isogeometric BEM-FEM coupling, i.e., NURBS are utilised for the parametrisation of multi-patch domains, and B-splines as Ansatz functions, respectively. This method allows an exact geometry representation and facilitates the incorporation of movements. Besides, a volume discretisation of thin and/or unbounded domains is avoided, and the regularity of derived quantities such as forces and torques is not deteriorated after differentiations. Some numerical experiments are presented, too.

12:00-12:30

New applications of the mortar element method on composite meshes

Francesca Rapetti	Universite Cote d'Azur

Abstract: The MEM on overlapping meshes have been determinant in several contexts, as eddy current non-destructive testing and free-boundary axisymmetric plasma equilibria. Two meshes can either fully or partially overlap. This approach gives the flexibility to deal with the free movement of one subdomain or to achieve easily higher order regularity while preserving accurate meshing of the geometry. The continuity of the numerical solution in the overlap is weakly enforced by a suitable L2 projection.

12:30-13:00

Applications of the Virtual Element Method to Electromagnetism

Alessandro Russo	University of Milano-Bicocca
Lourenco Beirao Da Veiga	University of Milano-Bicocca
Franco Brezzi	IMATI CNR, Pavia, Italy
Luisa D. Marini	IMATI CNR, Pavia, Italy

Abstract: In my talk I will present a survey of the applications of the Virtual Element Method to Magnetostatics developed so far.

MS ME-1-9 2 **11:00-13:00**

Integrable systems and discrete dynamics - Part 2

For Part 1 see: MS ME-1-9 1

Organizer: Giorgio Gubbiotti	The University of Sydney
Organizer: Nalini Joshi	The University of Sydney
Organizer: Nobutaka Nakazono	Aoyama Gakuin University
Organizer: David Gomez-Ullate Oteiza	Universidad Complutense de Madrid

Abstract: There has been increasing interest in integrable systems in the last two decades, particularly due to the appearance of Painlevé equations in random matrix theory and the theory of orthogonal polynomials. In this mini-symposium, we bring together three important perspectives: geometric and algebraic aspects of integrable systems, discrete differential geometry and the theory of orthogonal polynomials. We expect that the mini-symposium will create connections across the boundaries of these fields.

11:00-11:30

On the inverse problem of the discrete calculus of variations

Giorgio Gubbiotti	The University of Sydney

Abstract: In this talk we present the solution of the inverse problem of Calculus of Variations for a scalar difference equation of arbitrary even order 2k, with k > 1. This solution is obtained through the introduction of a set of differential operators called annihilation operators. Using these operators we reduce the functional equation governing of existence of a Lagrangian to the solution of an overdetermined system of linear partial differential equations.

11:30-12:00

Coxeter groups and discrete integrable systems

Yang Shi	Flinders University

Abstract: We explore some unique properties of Coxeter groups in the context of discrete integrable sys- tems. In particular, we look at the applications of Normalizer theory of parabolic subgroups in the studies of discrete Painleve equations.

12:00-12:30

The discrete integrable systems associated with LU factorizations

Masato Shinjo	Doshisha University

Abstract: The Toda equation is well-known as famous soliton equation was originally developed as a mathematical model of nonlinear springs in the study of integrable systems. The Lax dynamics of Toda equation plays an important role in elucidating interesting relationships between matrix eigenvalues. A skillful discretization of Toda equation contributes to computing eigenvalues of tridiagonal matrices based on LU factorization. In this talk, we show the discretizations of extensions of Toda equation associated with LU factorization.

12:30-13:00

A generalisation of tau-functions for the elliptic difference Painleve equation of type E_8

Andrew Kels	SISSA
Masahito Yamazaki	IPMU

Abstract: I will present a generalisation of the ORG (Ohta-Ramani-Grammaticos) tau-functions that were recently given by Noumi, depending on an additional 8 independent discrete parameters taking values from the E_8 root lattice. Using elliptic hypergeometric sum/integrals, I will show how to construct hypergeometric solutions which are defined on an infinite sequence of parallel hyperplanes, where the restriction of the hypergeometric tau-function to each individual hyperplane is invariant under the action of the Weyl group of E_7.

IM FT-4-4 2 — 11:00-13:00

Industrial Math Problems Based on Big Data

Organizer: Hyun-Min Kim	Pusan National University

Abstract: In the age of the fourth industrial revolution, many industrial problems based on big data have emerged, such as risk assessment in finance, machine learning in stock classi?cation, etc. Due to the high dimensionality and the complexity or heterogeneity of the data from industrial problems, mathematical techniques are needed for data visualization and for the design of efficient algorithms to solve these problems. This minisymposium aims at bringing together people working in the field of industrial mathematics, coming both from “academy” and from “industry” to present current industrial problems, exchange ideas on encountered challenges and possible mathematical approaches.

11:00-11:30

A model for collaboration on big data between local industries and university math departments

Hyun-Min Kim	Pusan National University
Dawoon Jung	Pusan National University
Semin Oh	Pusan National University
Young-Jin Kim	Pusan National University
Jeong Rye Park	Pusan National University
Garam Kim	Pusan National University
Juneho Lee	Pusan National University

Abstract: In this talk, we will introduce industrial mathematics problems solved with the companies which are KOMAX (Special Printing Company), Animal and Plant Quarantine Agency, NFRDI, KHFC, and so on. Finally, we will consider the direction of research on industrial mathematics in Korea and how to promote exchanges with other areas in the future. Based on this, we want to investigate what kind of desirable roles and talents mathematics, which form the basis of Big Data.

11:30-12:00

An optimal route recommendation system for ships based on A* search algorithm

Taehyeong Kim	Pusan National University
Sangil Kim	Pusan National University
Giphil Cho	Pusan National University
YiCheng Hong	Pusan National University
Jie Meng	Pusan National University
SeungHeon Yi	Pusan National University
Geunsoo Jang	Pusan National University
Meiyan Jiang	Pusan National University
Seonguk Nam	Pusan National University

Abstract: In this study, an optimal route recommendation algorithm for ships has been developed with the starting and ending information of time and locations. The algorithm calculates optimal route considering various data such as marine climate and weather forecast from Copernicus and ECMWF. We employ A* search algorithm with weight depended on the data we obtained. Our numerical results are compared with the actual route of a ship.

12:00-12:30

Analysis of the Interictal and Ictal Pattern Dynamics from EEG Data by Dynamic Mode Decomposition

Jonghyeon Seo	Chubu University Academy of Emerging Sciences
Jong-Hyeon Seo	Chubu University / Academy of Emerging Science

Abstract: There have been many studies to interpret the brain dynamics from the viewpoint of nonlinear dynamical systems. Especially, the studies using the analysis tools have been attempted to reliably detect epileptic seizures. In this work, we investigate the possibility of predicting epileptic seizers by applying dynamic mode decomposition, an algorithm originally developed for studying fluid physics, to neural recording samples.

12:30-13:00

Prediction of credit card delinquency using Machine Learning

Shin Won Yun	Pusan National University
Seong Uk Nam	Pusan National University
Hyun Chae	Busan Bank
Suk Kyo Ko	Busan Bank

Abstract: The purpose of this study is to predict the delinquent over 30 days of credit card customers using machine learning methods. Drawing from a one-year dataset(September 2017 to August 2018) from Bank B, Korea, researchers identified significant variables for the purpose of delinquent forecast. Classification Techniques in Machine Learning was adopted to compare the performance of each model for this study: 1) Logistic Regression, 2) Neural Network, 3) Random Forest, and 4) Gradient Boosting.

MS FT-2-4 2 — 11:00-13:00

New trends in dimensionality reduction of parametrized and stochastic PDEs - Part 2

For Part 1 see: MS FT-2-4 1

Organizer: Andrea Manzoni	POLITECNICO DI MILANO - LABORATORIO MOX -
Organizer: Fabio Nobile	EPFL SB MATH CSQI

Abstract: Model reduction is an indispensable tool for simulation-based science, whenever multiple or real-time simulations are performed. Reduced order models (ROMs), such as the reduced basis method, and approximate response function techniques, such as sparse polynomial chaos expansions, kernel approximations, Gaussian process regression, provide efficient strategies to tackle parametrized or stochastic PDEs. Nonlinear dimensionality reduction techniques, such as local ROMs, manifold learning or machine learning, can provide new valuable tools to approximate the whole solution set of problems hardly reducible with current state-of-art methods. However, their use for predicting system outcomes in new scenarios is at the moment rather involved.

11:00-11:30

Adaptive multi-scale methods for machine learning

Stefano Vigogna	Universita' degli Studi di Genova

Abstract: We describe learning techniques based on processing data in a coarse to fine fashion, to adaptively achieve a desired accuracy level. The methods we consider can be seen as an extension of wavelet methods beyond regular domains. On the other hand, they draw inspiration from classical decision trees beyond vectorial data. The properties of the proposed methods are analyzed within a statistical learning framework and characterized in terms of finite sample bounds in high probability.

11:30-12:00

Parametric Model Reduction based on Shifted POD Modes

Schulze Philipp	TU Berlin

Abstract: In this talk we address model reduction of systems whose dynamics are dominated by the advection of high-gradient structures, as shock waves. We present the shifted POD which extends the classical POD by introducing coordinate transformations for describing the advection in an efficient way. Especially, we demonstrate how to use the shifted POD modes for obtaining a parametric reduced-order model while achieving an efficient offline/online decomposition. Numerical experiments illustrate the effectiveness of this new approach.

12:00-12:30

Optimal sampling for approximation in tree-based tensor format

Cécile Habertisch CEA, DAM, DIF, F-91297 Arpajon, France

Abstract: We propose a strategy to construct approximations of high-dimensional functions in subspace-based Tucker formats. It relies on an extension of principal component analysis to multivariate functions and the use of least-squares projections of partial evaluations of the function. A boosted optimal least-squares method is presented for the projection of partial evaluations on subspaces, which allows to guarantee the stability of the projection with a number of evaluations close to the dimension of the subspace.

12:30-13:00

Randomized linear algebra for model order reduction

Oleg Balabanov Ecole Centrale Nantes

Anthony Nouy Centrale Nantes, LMJL UMR 6629

Abstract: We propose a methodology to construct a reduced model for parameter-dependent equations from a small, efficiently computable random object called a sketch of a reduced model, which is a set of low-dimensional random projections of the reduced approximation space and the spaces of associated residuals. Our approach can provide drastic improvement of the efficiency and numerical stability of classical Galerkin and minimal residual methods. Furthermore, it makes computationally feasible a dictionary-based approximation method.

MS ME-1-0 2 **11:00-13:00**

Recent Advances in Optimal Control Theory - Part 2

For Part 1 see: MS ME-1-0 1
For Part 3 see: MS ME-1-0 3
For Part 4 see: MS ME-1-0 4
For Part 5 see: MS ME-1-0 5

Organizer: Alexander Zaslavski The Technion - Israel Institute of Technology
Organizer: Monica Motta University of Padua
Organizer: Boris Mordukhovich Wayne State University
Organizer: Nobusumi Sagara Hosei University

Abstract: This minisimposium on new developments in optimal control theory and its applications will bring together a selected group of experts in this area. The growing importance of control and optimization has been realized in recent years. This is due not only to theoretical developments, but also because of numerous applications to engineering, economics and life sciences. The topics which will be discussed include optimal control of PDE, turnpike phenomenon, infinite horizon optimal control, necessary and sufficient optimality conditions, qualitative and quantitative aspects of optimal control and applications.

11:00-11:30

On the use of the turnpike property in Model Predictive Control

Lars Gruene University of Bayreuth

Abstract: Model predictive control (MPC) is a method for synthesizing a control input from pieces of finite horizon optimal control sequences on moving time horizons. In many cases, the control obtained this way produces a trajectory which is approximately optimal on an infinite horizon. In this talk we show that the turnpike property from optimal control can be used in order to rigorously establish near optimality of the trajectories generated by MPC.

11:30-12:00

Infinite Horizon Optimal Control and Polynomial Approximations

Sabine Pickenhain BTU Cottbus-Senftenberg

Abstract: We consider a class of infinite horizon variational and control problems arising from economics, quantum mechanics and stabilization. The objective is of regulator type. The problem setting implies a weighted Sobolev space as the state space. We establish necessary optimality conditions in form of a Pontryagin type maximum principle. A duality concept of convex analysis is provided and used to find sufficient optimality conditions and to motivate a dual approximation scheme.

12:00-12:30

Linear Programming Approach to the Analysis of the Value Function in Infinite Horizon Optimal Control Problems with Time Averaging and Time Discounting Criteria

Ilya Shvartsman Pennsylvania State University - Harrisburg

Abstract: This talk is devoted to analysis of the optimal value function in infinite horizon optimal control problems with time averaging and time discounting criteria. To carry out this analysis, we introduce and study an infinite dimensional linear programming problem. We focus on the general non-ergodic case, where the optimal value functions may depend on the initial condition of the system. The talk is based on the joint work with V. Borkar and V. Gaitsgory.

MS ME-1-4 2 **11:00-13:00**

Recent advances in PDE-constrained optimization - Part 2

For Part 1 see: MS ME-1-4 1

Organizer: Irwin Yousept University of Duisburg-Essen

Abstract: In the recent past, the theoretical and numerical analysis of PDE-constrained optimization has made substantial progress, which along with advances in scientific computing may provide powerful strategies for solving real-world problems. The goal of this minisymposium is to provide an open forum for exchanging knowledge among international leading experts and junior scientists from the emerging field of PDE-constrained optimization with real-world applications, including gas transport, electrical impedance tomography, and electromagnetic machines. The tentative speakers will give an overview of recent progresses in mathematical and numerical approaches concerning optimal control of PDEs, shape and topology optimization, isoperimetric problems, and others.

11:00-11:30

Beltrami fields, the Biot-Savart operator and the isoperimetric problem for the helicity

Alberto Valli Università degli Studi di Trento

Abstract: A Beltrami field is parallel to its curl: an interesting example is given by the eigenvectors of the curl operator. The helicity of a vector field is given by its scalar product with the Biot--Savart operator applied to it. The helicity of a domain is computed determining the eigenvalue of maximum absolute value for a saddle-point variational formulation of the Biot--Savart operator. This opens the way for finding the domain which maximizes helicity.

11:30-12:00

A shape optimization approach for electrical impedance tomography with pointwise measurements

Antoine Laurain University of São Paulo

Abstract: We consider the inverse problem of electrical impedance tomography with pointwise boundary measurements. The reconstruction of piecewise constant conductivities leads to a shape optimization problem. We define a cost functional measuring the misfit between experimental observations and the numerical model. The existence of a distributed expression of the shape derivative for shapes with low regularity is shown and the shape derivative is computed. Numerical results showing the relevance of the approach will be presented.

12:00-12:30

Variational inequalities in electromagnetism

Irwin Yousept University of Duisburg-Essen

Abstract: We present recent mathematical results on the existence, uniqueness and regularity for hyperbolic Maxwell variational inequalities of the second kind.

12:30-13:00

Multimaterial Topology Optimization in Electromagnetics

Peter Gangl TU Graz

Abstract: We present a topology optimization method for multiple materials which is based on the concept of topological derivatives. Here, the design, which consists of more than two materials, is represented in an implicit way by a vector-valued level set function. We show a sufficient optimality condition and an iterative algorithm which is based on this condition. Finally, we show numerical results obtained by applying the algorithm to the optimization of an electric motor.

MS A3-S-C2 2 **11:00-13:00**

Combinatorial scientific computing - Part 2

For Part 1 see: MS A3-S-C2 1
For Part 3 see: MS A3-S-C2 3

Organizer: Alex Pothen	Purdue University
Organizer: Bora Uçar	CNRS and LIP ENS Lyon
Organizer: Aydin Buluc	Lawrence Berkeley National Lab

Abstract: Combinatorial algorithms and tools are used for enabling parallel scientific computing applications. The general approach is to identify performance issues in an application and design, analyze, and implement combinatorial algorithms to tackle those issues. The proposed three-piece minisymposium covers applications in bioinformatics, solvers of linear systems, and data analysis; and graph algorithms for those applications. The objective is to summarize the latest combinatorial algorithmic developments and the needs of the applications. The goal is to cross-fertilize both domains: the applications will raise new challenges to the combinatorial algorithms, and the combinatorial algorithms will address existing problems of the applications.

11:00-11:30

Approximation Algorithms for Combinatorial Scientific Computing

Alex Pothen	Purdue University
S M Ferdous	Purdue University
Arif Khan	Pacific Northwest National Lab

Abstract: We describe a paradigm for designing parallel algorithms on massive graphs by employing approximation techniques. We seek algorithms with provable approximation guarantees while possessing high degrees of concurrency. The computation of degree-constrained subgraphs, b-matchings and b-edge covers, are two examples of this paradigm. These algorithms scale to tens of thousands of cores on distributed memory computers. We also describe applications problems in machine learning and data privacy.

11:30-12:00

Streaming Hypergraph Partitioning

Kamer Kaya	Sabancı University, Turkey

Abstract: In this talk, we will focus on the streaming hypergraph partitioning problem. In this setting, one needs to partition the streaming hypergraph into a given number of parts while using a limited memory and satisfying the load balancing constraint after each decision. Depending on the application, the partitioner also needs to handle fast data rates. We will discuss various approaches using sketching and hashing and compare their performances with some preliminary experiments.

12:00-12:30

Almost-linear time algorithms for Markov chains and new spectral primitives for directed graphs

Richard Peng	Georgia Institute of Technology
Michael Cohen	MIT
Jon Kelner	MIT
Rasmus Kyng	Harvard
John Peebles	MIT
Anup Rao	Adobe
Aaron Sidford	Stanford
Adrian Vladu	Boston University

Abstract: We provide almost-linear time algorithms for computing fundamental quantities associated with random walks on directed graphs, including stationary distributions, personalized PageRank vectors, hitting times, and escape probabilities. In doing so, we introduce several tools that may be of more general interest, including: (1) a reduction from solving linear systems in arbitrary strongly connected directed graphs to Eulerian graphs, (2) spectral approximations of directed Eulerian graphs, and (3) approximate Gaussian elimination of directed Laplacians.

12:30-13:00

Towards high-performance processing, storage, and analytics of extreme-scale graphs

Maciej Besta	ETH Zurich
Torsten Hoefler	ETH Zurich

Abstract: Large graphs are behind many problems in today's processing landscape. The growing sizes of such graphs, reaching 12 trillion edges recently, require unprecedented amounts of compute power, storage, and energy. In this talk, we illustrate how to effectively process such extreme-scale graphs. Our solutions are related to various forms of graph compression, vectorizable graph representations, communication avoidance, effective utilization of massively parallel hardware, and others.

IM FT-4-3 2 11:00-13:00

Mathematical Optimization and Gas Transport Networks: Industrial Collaborations - Part 2

For Part 1 see: IM FT-4-3 1

Organizer: Julio González-Díaz	University of Santiago de Compostela

Abstract: This minisymposium one of two minisymposia on Mathematical Optimization and Gas Transport Networks. The focus of this one is on works that are the result of collaborations between Academia and Industry, with a special focus on the applied aspects of the attained results. On the other hand, the other minisymposium will focus more on academic research on the topic, regardless of whether or not the research is part of a collaboration with Industry.

11:00-11:30

Financing the gas transmission network - Analyzing the effects of duration dependent tariffs

Dominic Lencz	Institute of Energy Economics at the University of Cologne
Eren Çam	Institute of Energy Economics
Simon Schulte	Institute of Energy Economics

Abstract: Gas transmission within the European Union is associated with costs of around 7 billion euros per year. The corresponding tariff structure has a major impact on market results. In most countries' tariffs for short-term transmission capacity are higher than for long-term products. This approach may have economic merits. However, analyses of the gas dispatch with the gas market model TIGER show that such tariff structures reduce short-term efficiency and increase price differences among market areas.

11:30-12:00

GANESO: A tool for GAs NEtwork Simulation and Optimization

Julio González-Díaz	University of Santiago de Compostela
Alfredo Bermúdez De Castro	University of Santiago de Compostela
Ángel Manuel González-Rueda	University of A Coruña
Diego Rodríguez-Martínez	ITMATI
Gabriel Capeáns-García	ITMATI
Adolfo Nuñez-Fernández	ITMATI
Damián Pallas-Carrillo	ITMATI

Abstract: In this talk we will present an overview of the software GANESO, a tool developed to simulate and optimize gas transport networks and that is currently in use by Reganosa Company, a TSO in Spanish Gas Network. We will discuss the main functionalities of this tool, including its user interface, along with the most salient mathematical aspects of the underlying algorithms.

12:00-12:30

High-precision gas flow forecasting in complex transmission networks

Milena Petkovic	Zuse Institute Berlin

Abstract: The main goal of the study we present is to compute accurate hourly forecast of gas flow for more than 1,000 entry and exit nodes of the complex transmission network in order to support different operational decisions and provide network stability. Our results are based on real world data of Open Grid Europe, Germany's largest TSO, and compared to some classical benchmarks for time series forecasting.

12:30-13:00

A modelling approach for the German gas grid using spatial, temporal, and sectoral highly resolved data (GAMAMOD-DE)

Philipp Hauser	Technische Universität Dresden

Abstract: While sector coupling gains in importance in energy system modlleing, models for heat and gas with detailed representation of infrastructure are missing. Additionally, the German gas sector faces crucial changes. Hence, a Gas Market Model for Germany (GAMAMOD-DE) is proposed. Following a linear optimization approach, the model considers a highly spatial resolved gas infrastructure. The spatial and temporal resolved gas demand is distinguished among three different sectors, industry, heating and electricity.

MS FT-0-2 2 **11:00-13:00**

Mean Field Games: New Trends and Applications - Part 1

For Part 2 see: MS FT-0-2 3
For Part 3 see: MS FT-0-2 9
For Part 4 see: MS FT-0-2 4
For Part 5 see: MS FT-0-2 5
For Part 6 see: MS FT-0-2 1

Organizer: Francisco José Silva Alvarez	Techniques Université de Limoges
Organizer: Daniela Tonon	Paris Dauphine University
Organizer: Adriano Festa	L'Aquila university

Abstract: Mean Field Games (MFGs) problems have been introduced by Lasry-Lions and Huang-Caines-Malhamé in 2006. This theory describes Nash equilibria of some differential games with infinitely many players. In light of the numerous applications of MFGs, which include Economics, Finance and Social Sciences, several mathematical techniques are currently employed for its development. The scope of this minisymposium is to bring together several specialists in MFGs in order to present recent progress on the area and open problems. Among the topics covered in the minisymposium sessions are: analytic, probabilistic and numerical aspects of MFGs, and the applications mentioned in the paragraph above.

11:00-11:30

Boundary conditions in first-order mean-field games.

Diogo Gomes	King Abdullah University of Science and Technology
Rita Ferreira	KAUST
Teruo Tada	KAUST

Abstract: We study first-order stationary monotone MFGs with Dirichlet conditions. We establish the existence of solutions to MFGs that satisfy those conditions. We introduce a monotone regularized problem and using Schaefer's fixed-point theorem and monotonicity, we prove the existence of a unique weak solution to the regularized problem. Finally, we take the limit of this solution and, using Minty's method, we show the existence of weak solutions to the original MFG.

11:30-12:00

Non-coercive first order Mean Field Games.

Claudio Marchi	Università degli Studi di Padova
Paola Mannucci	University of Padova (Italy)
Carlo Mariconda	University of Padova (Italy)
Nicoletta Tchou	University of Rennes (France)

Abstract: We study first order evolutive Mean Field Games where the Hamiltonian is non-coercive. We establish the existence of a weak solution of the system via a vanishing viscosity method and, mainly, we prove that the evolution of the population's density is the push-forward of the initial density through the flow characterized almost everywhere by the optimal trajectories of the control problem underlying the Hamilton-Jacobi equation.

MS FT-0-3 2 **11:00-13:00**

Numerical methods for electromagnetic problems and high perfomance computing - Part 2

For Part 1 see: MS FT-0-3 1
For Part 3 see: MS FT-0-3 7

Organizer: Liwei Xu	University of Electronic Science and Technology of China
Organizer: Tao Cui	AMSS, the Chinese Academy of Sciences
Organizer: Xue Jiang	Beijing University of Posts and Telecommunications
Organizer: Chunxiong Zheng	Tsinghua University

Abstract: The proposed minisymposium, titled by "numerical methods for electromagnetic problems and high performance computing", seeks to bring together researchers from the computational mathematics, the electromagnetic engineering and computer scientist, who investigate the mathematical modeling, the numerical analysis, and the efficient computation for electromagnetic problems. The main topics of this minisymposium will include, but not exclusively, novel numerical methods, fast solvers and their applications to large-scale engineering problems. The goal of this minisymposium is to promote new ideas and exchange recent developments on mathematical modeling, numerical discretization, solvers, parallel computing and engineering practices of computational electromagnetism, and to create new collaboration.

11:00-11:30

Material derivatives of boundary integral operators in electromagnetism and their application to 3D imaging problems

Frédérique Le Louër	Université de Technologie de Compiègne
Ivanyshyn Yaman Olha	Izmir Institute of Technology, Turkey
Rapun Maria-Luisa	Universidad Politécnica de Madrid

Abstract: Combining topological and shape optimization tools by means of converging Gauss-Newton iterations generates full automatic algorithms for solving imaging problems. In a first part, we present the ingredients of this hybrid adaptive algorithm. The second part of the talk is dedicated to an alternative approach relying on material derivatives of boundary integral operators. The resulting algorithm has the interesting feature to avoid the numerous numerical solution of boundary value problems at each Gauss-Newton iteration step.

11:30-12:00

Cartesian PML method for Maxwell's equations in a two-layer medium

Xue Jiang	Beijing University of Posts and Telecommunications
Xiaoqi Duan	Academy of Mathematics and Systems Science, Chinese Academy of Sciences
Weiying Zheng	Academy of Mathematics and Systems Science, Chinese Academy of Sciences

Abstract: The perfectly matched layer (PML) method is a very efficient approach for solving exterior scattering problems. It provides a highly-accurate approximation to the radiation condition on the truncation boundary. This talk presents the Cartesian PML method for solving electromagnetic scattering problem in a two-layer medium. By extending the Cagniard-de Hoop transformation to complex coordinates and using the reflection extension of function, we proved the stability and exponential convergence of the solution of the PML problem.

12:00-12:30

HDG methods for the Maxwell equations

Huangxin Chen	Xiamen University

Abstract: We will introduce a new HDG method for the Maxwell equations based on a mixed curl-curl formulation. We use a non-trivial subspace of polynomials to approximate the numerical tangential trace of the electric field on the faces and get the optimal convergence rate. For the Maxwell equations with low regularity of electric field, another HDG method and its a priori and a posteriori error estimates will further be discussed.

MS GH-0-2 2 **11:00-13:00**

Mathematical Advances in Batteries - Part 2

For Part 1 see: MS GH-0-2 1
For Part 3 see: MS GH-0-2 3
For Part 4 see: MS GH-0-2 4

Organizer: Iain Moyles	York University
Organizer: Matthew Hennessy	Mathematical Institute, University of Oxford

Abstract: Batteries are ubiquitous in society with applications in portable electronics, transportation vehicles, and medical devices. An increasing demand for cheaper, longer-lasting, and safer batteries has driven research into understanding the fundamentals of their operation. Using techniques of mathematical modelling, analysis, and simulation, speakers in this session will address research questions of modern significance such as the effect of materials in electrode design, temperature distribution in an operating battery, and battery kinetics in a charge-discharge cycle. Advantages and limitations from geometrical assumptions and parameter scaling will be discussed as will extensions to general electrochemical systems.

11:00-11:30

Insights into the mechanisms of heat generation and thermal runaway in lithium-ion batteries

Matthew Hennessy	Mathematical Institute, University of Oxford
Iain Moyles	York University

Abstract: A detailed thermal-electrochemical model for a lithium-ion battery is reduced to a system of nonlinear ordinary differential equations using asymptotic analysis. The reduction elucidates the dominant mechanisms of heat transport, gives insight into how the capacity of the battery can be inferred from its instantaneous thermal response, and used to investigate the onset of thermal runaway. Furthermore, the reduced thermal model is ideal for use in real-time battery management systems.

11:30-12:00

An asymptotic approach to the generation of thermal hot spots in electrochemical cells

Robert Timms	University of Oxford
Scott Marquis	University of Oxford
Valentin Sulzer	University of Oxford
Colin Please	University of Oxford
Jon Chapman	University of Oxford

Abstract: Larger sized batteries, such as those used in the electric vehicle sector, can exhibit non-uniform behaviour in the current and temperature distribution, which may adversely affect battery performance and lifetime. By exploiting the typically small aspect ratio found in commercial cells, we develop a simplified electrochemical-thermal model describing cell behaviour. We identify physically relevant asymptotic limits in which the model simplifies further, allowing for efficient evaluation of the impact cell design has on battery operation.

12:00-12:30

Asymptotic reduction of a thermal-electrochemical model for lithium-ion batteries

Ferran Brosa Planella	University of Warwick
W. Dhammika Widanage	University of Warwick

Abstract: Understanding the thermal-electrochemical behaviour of lithium-ion batteries is crucial to design a new generation of batteries. The Newman model is widely used to describe the electrochemical behaviour but is computationally expensive, so not suitable for optimisation and control. Here we present an asymptotically reduced thermal-electrochemical model that can be used to obtain fast predictions of the battery temperature. The model presented is compared with experimental data for commercial lithium-ion batteries.

MS FE-1-4 2 11:00-13:00

Numerical methods for balance laws and non-conservative hyperbolic systems - Part 2

For Part 1 see: MS FE-1-4 1
For Part 3 see: MS FE-1-4 3
For Part 4 see: MS FE-1-4 4

Organizer: Carlos Parés Madroñal	Universidad de Málaga
Organizer: Manuel J. Castro	Universidad de Málaga

Abstract: Balance laws and non-conservative hyperbolic systems naturally appear in many real world applications and, in particular, in many fluid models in different contexts: shallow water models, multiphase flow models, gas dynamic, etc. The main goal of the mini-symposium will be the discussion and presentation of state-of-the-art computational and numerical methods for balance laws and non-conservative hyperbolic systems and their applications.

11:00-11:30

Kinetic schemes for the Saint-Venant system (explicit and implicit in time)

Jacques Sainte-Marie	Inria & Sorbonne Univeristy
Bristeau Marie-Odile	Inria & Sorbonne University
Audusse Emmanuel	University Paris-North
Bouchut François	University Paris-East
Lance Gontran	Sorbonne University

Abstract: Kinetic theory is widely used for the modeling of physical phenomena (biology, geophysics) and the analysis of the obtained PDEs e.g. conservation laws. Here we use the kinetic interpretation of some models arising in geosciences (typically the shallow water equations) in order to obtain numerical schemes (explicit and implicit in time) for their approximation. The kinetic description is also used to solve data assimilation, control and optimization problems for conservation laws with source terms.

11:30-12:00

Low Mach number asymptotic preserving finite volume methods for the Euler equations

Christian Klingenberg	Wuerzburg University

Abstract: We consider astrophysical systems that are modeled by the multidimensional Euler equations with gravity. First we present low Mach number asymptotic preserving schemes. Next we present well-balanced methods. We will then present work in progress where we combine the two methods above and show the application in the astrophysical problem that inspired this work. This is joint work among others with Fritz Roepke, Wasilij Barsukow and Christophe Berthon.

12:00-12:30

Asymptotic preserving schemes for the shallow-water equations with maning friction

Solene Bulteau	University of Nantes
Berthon Christophe	LMJL
Bessemoulin-Chatard Marianne	LMJL

Abstract: This work concerns the development of asymptotic preserving schemes for the shallow-water equations. We present the extension of the technic proposed by Berthon and Turpault and then we present the fully well- balanced of Michel-Dansac and we prove that it is also asymptotic preserving. This result is very important since it shows that an accurate discretization of the source term to preserve the steady states can also give the correct asymptotic regime.

12:30-13:00

Well-balanced schemes for the Euler equations with gravity

Elena Gaburro	University of Trento, ITALY
Manuel J. Castro	University of Malaga, Spain
Michael Dumbser	University of Trento, Italy

Abstract: We present a novel second order accurate direct Arbitrary-Lagrangian-Eulerian (ALE) Finite Volume scheme for nonlinear hyperbolic systems, written in non-conservative form, whose peculiarities are the nonconforming motion of interfaces and the exact preservation of equilibria. Nontrivial test problems in rotating Keplerian disks, described by the Euler equations of compressible gas dynamics with gravity, show the greatly reduced dissipation and the significant improvements of our new scheme compared with well established software for astrophysical fluid dynamics.

MS FT-1-SG 2 11:00-13:00

Nonlinear Subdivision Schemes and Multiscale Transforms - Part 2

For Part 1 see: MS FT-1-SG 1

Organizer: Rosa Donat	Matemàtiques, Facultat de Matemàtiques
Organizer: Nira Dyn	Tel Aviv University

Abstract: Subdivision schemes are algorithms which generate functions/curves/surfaces from discrete data by repeated simple local refinements. Linear subdivision schemes proved to be efficient tools to cope with homogeneous data in Euclidean spaces. Non-linear subdivision schemes were introduced to refine manifold-valued data, non-homogeneous data in Euclidean spaces and non-smooth scalar data. This mini-symposium brings together researchers from the three different communities, with the aim to generate scientific dialogue between them. The different analysis tools, developed quite independently by each community, will be presented and discussed, as well as multiscale transforms based on non-linear subdivision schemes.

11:00-11:30

Studying non-linear schemes using analysis tools for non-uniform schemes

DAVID LEVIN	CITIZEN. RETIRED

Abstract: We suggest some analysis tools for proving the smoothness of non-linear schemes. The first tool is a perturbation theorem for subdivision schemes. The second is the use of Laurent series representation for non-uniform schemes. The third idea is to represent the non-linear scheme as a perturbation of a non-uniform linear scheme. Application of these tools is demonstrated for interpolatory subdivision reproducing an extended Tchebicheff system, and for non-linear versions of Lane-Riesenfeld algorithm.

11:30-12:00

On a nonlinear and noninterpolatory subdivision scheme reducing diffusion near discontinuities

Sofiane Zouaoui	Ecole Supérieure des Sciences Appliquées d'Alger
Sergio Amat Plata	Universidad Politécnica de Cartagena (Spain)
Juan Ruiz	Universidad Politécnica de Cartagena (Spain)

Abstract: A nonlinear binary 3-point non-interpolatory subdivision scheme is presented. It is based on a subdivision scheme studied in

S.S.Siddiqi and A.Nadeem (2007): A new three point approximating C^2 subdivision scheme, AML, 707-711. If the initial control points come from the discretization of a piecewise continuous function, it can be interesting that the subdivision scheme produces a piecewise continuous limit function. The nonlinear modification introduced in this work allows to attain this objective reducing the diffusion.

12:00-12:30

Nonlinear multiresolution schemes for discontinuous functions using correction terms

Sergio Amat	U.P. Cartagena

Abstract: Lagrange polynomials are not adapted to discontinuities. They round off corner discontinuities and they introduce diffusion and Gibbs effect around jump discontinuities. ENO-SR already solves the problem but it is not centered due to the stencil selection strategy. It is unstable because it uses the stencil selection strategy. Our objective is to design a centered algorithm. We can reach our objective using Newton polynomials and correcting the divided differences when the stencil crosses any discontinuity.

12:30-13:00

Nonlinear subdivision as a tool in uncertainty quantification for hyperbolic conservation laws

Sergio Lopez-Ureña	Universitat de València
Antonio Baeza Manzanares	Universitat de València

Abstract: This work deals with a non-intrusive method for partial differential equations (more precisely hyperbolic conservation laws) in uncertainty quantification. The approach is based on Harten's Multiresolution Framework and follows the truncate-and-encode idea. We explore the use of certain nonlinear subdivision operators to enhance the performance of the algorithm when applied to this problem. We show that subdivision operators with higher order of approximation are able reduce the computational cost.

MS A3-2-1 2 11:00-13:00

Cartesian CFD Methods for Complex Applications - Part 2

For Part 1 see: MS A3-2-1 1
For Part 3 see: MS A3-2-1 3
For Part 4 see: MS A3-2-1 4

Organizer: Ralf Deiterding	University of Southampton
Organizer: Kai Schneider	Aix-Marseille Université, I2M
Organizer: Margarete Oliveira Domingues	National Institute for Space Research

MS Organized by: SIAG/CSE

Abstract: Cartesian discretization approaches are ubiquitous in computational fluid dynamics. When applied to problems in geometrically complex domains or fluid-structure coupling problems, Cartesian schemes allow for automatic and scalable meshing; however, order-consistent immersed boundary conditions and efficient dynamic mesh adaptation take forefront roles. This symposium will highlight cutting-edge applications of Cartesian CFD methods and describe the employed algorithms and numerical schemes. An emphasis will be laid on complex multi-physics applications like magnetohydrodynamics, combustion, aerodynamics with fluid-structure interaction, solved with various discretizations, e.g. finite difference, finite volume, multiresolution or lattice Boltzmann CFD schemes. Software design and parallelization challenges will be addressed briefly.

11:00-11:30

Volume penalization for heat transfer in complex geometry with inhomogeneous Neumann boundary conditions

Kai Schneider	Aix-Marseille Université, I2M
Teluo Sakurai	Nagoya University
Katsunori Yoshimatsu	Nagoya University
Naoya Okamoto	Nagoya University

Abstract: We present a volume penalization method for inhomogeneous Neumann boundary conditions, generalizing the flux-based volume penalization method for homogeneous Neumann boundary condition, proposed by Kadoch et al. [J. Comput. Phys. 231 (2012) 4365]. The generalized method allows us to model scalar flux through walls in geometries of complex shape using simple, e.g. Cartesian, domains for solving the governing equations. Further details can be found in Sakurai et al. [J. Comput. Phys., 390 (2019) 452].

11:30-12:00

High-order time stepping for the Navier-Stokes equations via pressure Poisson reformulations

David Shirokoff	New Jersey Institute of Technology
Rodolfo Ruben Rosales	Massachusetts Institute of Technology
Benjamin Seibold	Temple University
Dong Zhou	California State University, Los Angeles

Abstract: We present semi-implicit high-order time stepping strategies for recent pressure Poisson equation (PPE) reformulations of the incompressible Navier-Stokes equations. PPE reformulations allow for the implicit treatment of the viscosity and explicit treatment of the pressure thereby avoiding large computational saddle point systems in fully implicit methods; or splitting errors commonly incurred by projection or fractional-step methods. We provide third-order time discretizations and discuss stability issues that arise in high order schemes.

12:00-12:30

Fluid-structure interaction using the volume penalization and mass-spring models with application in insect flight

Hung Truong	Aix-Marseille University

Abstract: Fundamental characteristics of insect flight are flexible wings, which play an important role for their aerodynamics. A mass-spring system is developed to model the flexibility of bumblebee wings and coupled with the fluid solver FLUSI, a pseudo-spectral discretization of the incompressible 3d Navier-Stokes equations with volume penalization. By means of high-resolution simulations, we investigate the effect of wing flexibility on the aerodynamic performance and compare it with that of rigid wings.

12:30-13:00

A quadtree-based solver for fluid-structure interaction simulations in complex geometries

Antoine Fondaneche	University Bordeaux
Michel Bergmann	Inria, Memphis team, F-33400 Talence, France
Angelo Iollo	Inria, Memphis team, F-33400 Talence, France

Abstract: The interaction between elastic structures and incompressible flows is mostly modeled within the so-called partitioned ALE approach. We propose a more versatile method, known as the monolithic framework. Fluid and structure models (Navier-Stokes equations and Mooney-Rivlin) are numerically discretized on AMR octree grids where the fluid/structures interfaces are embedded and tracked with level-set functions. This FSI solver is dedicated to biomedical applications such as ventricular assist devices.

MS FT-S-8 2 11:00-13:00

Recent advances in numerical methods for evolutionary partial differential equations - Part 2

For Part 1 see: MS FT-S-8 1
For Part 3 see: MS FT-S-8 4

Organizer: Sebastiano Boscarino	University of Catania
Organizer: Giovanni Russo	Università di Catania

Abstract: The purpose of the MS is to gather researchers interested in efficient methods for the numerical solution of evolutionary partial differential equations. Several issues will be considered, ranging from the proposition and analysis of new families of methods, including semi-implicit schemes for multiscale evolutionary problems, to applications in fluid dynamics, continuum mechanics and kinetic theory. The MS is structured in three parts: development and analysis of numerical schemes (part 1), innovative schemes for continuum mechanics, degenerate parabolic equations, and electromagnetism (part 2), semi-implicit schemes and applications to kinetic theory and fluid dynamics (part 3).

11:00-11:30

Staggered semi-implicit space-time discontinuous Galerkin finite element schemes for continuum mechanics

Michael Dumbser	University of Trento

Abstract: We present a completely new class of staggered semi-implicit space-time discontinuous Galerkin finite element methods for the solution of the compressible and incompressible Navier-Stokes equations and of the equations of linear elasticity. As in staggered finite difference schemes our new staggered DG scheme defines some quantities on a primary simplex mesh, while other quantities are defined on a face-based dual grid. We show a large set of numerical results and compare with available reference solutions.

11:30-12:00

So, What is New in Computational Electrodynamics?

Dinshaw Balsara University of Notre Dame

Abstract: In this talk we present Finite Volume Time Domain (FVDT) and Discontinuous Galerkin Time Domain (DGTD) methods for solving Maxwell's equations that draws on recent advances in higher order Godunov methods while retaining all the beneficial aspects of the FDTD method. The method is built around three recent and fundamental advances:- 1) Constraint-preserving reconstruction. 2) A fast ADER predictor step. 3) A multidimensional Riemann solver for CED.

12:00-12:30

On a linearly implicit scheme for strongly degenerate diffusion equations

Raimund Bürger Universidad de Concepción
Stefan Diehl Lund University, Sweden
Julio Careaga Lund University, Sweden

Abstract: The zero-flux initial-boundary value problem for a strongly degenerate parabolic equation is a fundamental model for batch settling of a flocculated solid-suspension. We report work on progress related to proving that a linearly implicit difference method for solving this problem converges to an entropy solution.

12:30-13:00

Implicit-explicit schemes for some nonlocal degenerate diffusion partial differential equations

Pep Mulet Universitat de València

Abstract: We present recent work on implicit-explicit methods for nonlinear nonlocal equations with a gradient flow structure that arise in models for collective behavior. These numerical methods overcome the computational burden imposed by the spatial convolution in the convective numerical flux and the disadvantageous CFL condition incurred by the diffusion term. Although these schemes entail solving nonlinear algebraic systems in every time step, numerical experiments illustrate the relative efficiency of this proposal.

MS FT-2-6 2 11:00-13:00

Fast algorithms for integral equations and their applications - Part 1

For Part 2 see: MS FT-2-6 3
For Part 3 see: MS FT-2-6 4
Organizer: Carlos Eduardo Cardoso Borges University of Central Florida
Organizer: Min Hyung Cho University of Massachusetts Lowell
MS Organized by: SIAG/CSE

Abstract: The recent advances in integral equations and its fast numerical methods have provided useful tools for many applications ranging from nano-optics to medical imaging and geosciences. This mini-symposium will discuss challenges in the formulation of the problem, cutting-edge fast algorithms and their efficient implementation, their applications in various fields. At the same time, it will provide opportunities to promote interdisciplinary research collaboration between computational scientists and other fields.

11:00-11:20

Domain decomposition preconditioning for the integral forms of the forward and inverse scattering problems

Carlos Borges University of Central Florida
George Biros University of Texas at Austin

Abstract: We propose domain decomposition preconditioners for the integral equation formulation of forward and inverse acoustic scattering problems with points scatterers. First, in the forward scattering case, we extend to integral equations domain decomposition preconditioning techniques. We combine this preconditioner with a low-rank correction forming a new preconditioner. In the inverse scattering case, we use the low-rank corrected preconditioner for the forward problem as the building block for a preconditioner for the Gauss-Newton Hessian.

11:30-12:00

Integral equation methods for parabolic PDEs

Leslie Greengard Flatiron Institute/Courant Institute
Jun Wang Flatiron Institute
Shidong Jiang NJIT
Shravan Veerapaneni U. Michigan

Abstract: We will review the state of the art in integral equation methods for the solution of the heat equation in moving geometries. With suitable fast algorithms, such methods achieve optimal complexity and, in the homogeneous case, require the discretization of the space-time boundary alone. They achieve high order accuracy with suitable quadratures and are straightforward to implement adaptively in space-time.

12:00-12:30

High order methods for the evaluation of layer potentials in three dimensions

Zydrunas Gimbutas NIST

Abstract: We will discuss high order discretization and evaluation tools for the layer potentials within the context of Fast Multipole Method (FMM). Recently, lots of progress has been made in applying the Quadrature by Expansion (QBX) schemes in two-dimensions, but many open questions remain in R^3. We will compare the QBX scheme with the generalized Gaussian quadrature based panel scheme and show how the above methods can be incorporated with the existing FMM libraries.

MS A3-3-L1 2 11:00-13:00

Recent advances on numerical methods and analysis of complex fluids - Part 2

For Part 1 see: MS A3-3-L1 1
For Part 3 see: MS A3-3-L1 3
For Part 4 see: MS A3-3-L1 4
For Part 5 see: MS A3-3-L1 5
Organizer: Zhonghua Qiao The Hong Kong Polytechnic University
Organizer: Hui Zhang Beijing Normal University

Abstract: The goal is to integrate advances in mathematics (theory, modeling, algorithms, simulations, high performance computing techniques) with new experimental data from complex fluids and biological systems, and targeted applications. The specific systems represented include liquid crystal flow, polymeric flow and magnetic fluids, phase-field and beyond these area.

11:00-11:30

Modelling and numerical simulation of one-component two-phase flow with partial miscibility using generalized slip boundary condition

Qiaolin He Sichuan University
Xiaolin Fan Kaust
Shuyu Sun Kaust

Abstract: We propose a diffuse interface model with the Van der Waals equation of state considering the slip effect at the interface. For numerical simulation of the proposed model, we introduce a numerical scheme that satisfies a discrete energy law which is consistent with energy law of the model. Numerical tests are carried out to verify the effectiveness of the proposed method.

11:30-12:00

UNCONDITIONALLY ENERGY STABLE DG SCHEMES FOR THE SWIFT-HOHENBERG EQUATION

Hailiang Liu Iowa State University
Peimeng YIN Iowa State University

Abstract: The Swift–Hohenberg equation as a central nonlinear model in modern physics has a gradient flow structure. Here we introduce fully discrete discontinuous Galerkin schemes for a class of fourth order gradient flow problems to produce free-energy-decaying discrete solutions, irrespective of the time step and the mesh size. The resulting algorithms are linear, and they can be efficiently solved without resorting to any iteration method.

12:00-12:30

The focus computing method

Hao Wu Tsinghua University

Abstract: In this study, we propose a novel direct numerical method with O(λ^{−d/2}−1) computational cost to simulate the wave equation in the seismic inverse problem. It based on the fact that the computation of the entire wave filed may not be necessary here. Thus, we only need to evaluate the wave equation around the waveform of interest and the computational cost is significantly saved here.

MS A1-2-3 2 11:00-13:00

Data and geometry - Part 1

For Part 2 see: MS A1-2-3 3
Organizer: Santiago Mazuelas BCAM

Abstract: Very often data presents an intrinsic geometry, and data models have rich geometric structure. The use of algebraic and geometric tools for data processing is enabling novel techniques for several data-based problems including parameter estimation, supervised classification, model selection, and hypothesis testing. This minisymposium will bring together researchers exploiting different geometric techniques for data processing, and will enable cross-disciplinary discussions around the interplay between geometry and data.

11:00-11:30

Projective geometry of probabilistic transformations

Santiago Mazuelas	BCAM-Basque center of applied mathematics

Abstract: Natural transformations in machine learning such as Markov transitions and Bayesian updates are projective transformations between probability simplexes. Therefore, the consideration of probability distributions as projective points leads to a linear representation of the most relevant transformations for machine learning. This talk will describe such projective framework showing how crucial concepts for learning algorithms (e.g., convexity) can be defined and used in the projective space.

11:30-12:00

Density Estimation on Simplicial 1-Complexes

Robert Bassett	Naval Postgraduate School
James Sharpnack	University of California Davis

Abstract: In this talk we introduce a method for nonparametric density estimation on simplicial 1-complexes. We define fused density estimators as solutions to a total variation regularized maximum-likelihood density estimation problem. We provide theoretical support for fused density estimation by proving that the squared Hellinger rate of convergence for the estimator achieves the minimax bound over univariate densities of log-bounded variation, and further show that its computation reduces to a tractable, finite-dimensional quadratic program.

12:00-12:30

Tropical Foundations for Probability & Statistics on Phylogenetic Tree Space

Ruriko Yoshida	University of Kentucky College of Arts & Sciences
Bo Lin	Georgia Institute of Technology
Anthea Monod	Columbia University

Abstract: We introduce a novel framework for the statistical analysis of phylogenetic trees: Palm tree space is constructed on principles of tropical algebraic geometry, and represents phylogenetic trees as a point in a space endowed with the tropical metric. We show that palm tree space possesses a variety of properties that allow for the definition of probability measures, and thus expectations, variances, and other fundamental statistical quantities.

12:30-13:00

Spatiotemporal evolution of localization information

Yuan Shen	Tsinghua University

Abstract: Cooperation among nodes can provide significant coverage and accuracy improvements for location-aware networks. However, it also incurs complex coupling of position information among nodes. We develop a graph-theoretical approach to the analysis of information coupling, and show that the efficiency of cooperation for a specific node depends on the number of routes spanning from itself to the anchors, which implies that the popular sequential position estimators may be far from optimal in large networks.

MS ME-1-6 2 — 11:00-13:00

DIFFERENTIAL MODELS INVOLVING NON-SMOOTH VECTOR FIELDS

Organizer: Graziano Crasta	Sapienza University of Rome
Organizer: Annalisa Malusa	Sapienza Università di Roma
Organizer: Virginia De Cicco	Sapienza università di Roma

Abstract: In recent years there have been many efforts in the analysis of differential models involving, at some stage, non-smooth vector fields. In this workshop we have gathered experts in the analysis of divergence-measure vector fields and in transport equations with rough coefficients (in the spirit of the Ambrosio-Di Perna-Lions theory). The applications range from, among others, conservation laws, fluid mechanics, models of capillarity in perfectly wetting fluids, and the total variation flow.

11:00-11:30

The Dirichlet-to-Neumann map associated with the 1-Laplace

José M. Mazón	Universitat de Valencia
Daniel Hauter	University Sydney

Abstract: We study Dirichlet-to-Neumann map associated with the 1-Laplace. One of its difficulties is to give its correct definition due to the nonuniqueness of the Dirichlet problem for the 1-Laplacian. We give the correct definition of this operator and we prove the well-posedness of the Cauchy problem associated with this operator. As consequence we get that the elliptic problem associated with the 1-Laplacian with dynamical boundary conditions has a unique strong solution for any initial datum.

11:30-12:00

On the limit, as $p1$, of the higher eigenvalues problems for the p-Laplacian operator

Sergio Segura De Leon	University of Valencia
José C. Sabina De Lis	University of La Laguna

Abstract: We provide a direct proof of the existence for each $n \in N$ of the limit of the n-th Ljusternik-Schnirelman Dirichlet eigenvalue of $-\Delta_p$ in a bounded Lipschitz-continuous domain Ω. More importantly, it is shown that the limit defines an eigenvalue of the 1-Laplacian operator $-\Delta_1$, with a well-defined associated eigenfunction. In the main results, the radial LS eigenvalues of $-\Delta_1$ are fully described, together with a detailed account on the profiles of their associated eigenfunctions.

12:00-12:30

Some issues about traces of vector fields with measure divergence

Gian Paolo Leonardi	University of Trento
Giorgio Saracco	University of Pavia

Abstract: It is well-known that any bounded vector field ξ with measure divergence admits a normal trace in a suitably weak sense on any oriented (n-1)-rectifiable set S. Our main goal is to show that, whenever this "weak normal trace" is locally maximal at a point x of S, then ξ admits a full trace at x for almost all x in S. This problem is motivated by the study of capillarity for perfectly wetting fluids.

12:30-13:00

Untangling of trajectories for non-smooth vector fields and Bressan's Compactness Conjecture

Paolo Bonicatto	Universität Basel
Stefano Bianchini	SISSA

Abstract: Given $d \geq 1$, $T > 0$ and a vector field $b[0|T] \times R^d R^d$, we consider the transport equation $\partial_t u + b \cdot \nabla u = 0$ where u is a scalar function defined on $[0|T] \times R^d$. We present a new uniqueness result for weak solutions when the vector field has bounded variation and is nearly incompressible. Joint work with S. Bianchini.

MS A6-5-4 2 — 11:00-13:00

Advances in Data Assimilation - Part 1

For Part 2 see: MS A6-5-4 3

Organizer: Daniele Bigoni	MIT
Organizer: Kody Law	University of Manchester
Organizer: Jana De Wiljes	University of Potsdam

Abstract: The inherent limits of mathematical models resulting from the trade-off between complexity and accuracy, often lead to significant uncertainties which have the effect of restricting their applicability. The increasing availability of distributed and heterogeneous data has driven research toward data assimilation methodologies able to integrate such additional information to the end of better characterizing these uncertainties. This mini-symposium aims to provide a venue for the interaction between researchers in data assimilation, focusing on theoretical analysis, novel methodologies and their application to relevant scientific problems.

11:00-11:30

Multilevel Monte Carlo for Data Assimilation

Kody Law	University of Manchester

Abstract: The multilevel Monte Carlo method provides a way of optimally balancing discretization and sampling error on a hierarchy of approximation levels, such that cost is optimized. Recently this method has been applied to computationally intensive inference. This talk will review 3 primary strategies which have been successfully employed to achieve faster convergence than i.i.d. sampling at the finest discretization level. Some of the specific resulting algorithms, and applications, will be presented.

11:30-12:00

Ensemble Kalman filter for inverse problems

Xin Tong	National University of Singapore
Andrew Stuart	California Institute of Technology
Neil Chada	National University of Singapore

Abstract: Ensemble Kalman filter (EnKF) is a popular data assimilation algorithm. Its formulation is gradient-free, so it can be applied to black-box problems. We investigate the application of EnKF on Bayesian inverse problems and analyze its dynamical properties as an optimizer.

12:00-12:30

High-dimensional estimation of nonlinear transformations for Bayesian filtering

Ricardo Baptista	Massachusetts Institute of Technology
Alessio Spantini	Massachusetts Institute of Technology
Youssef Marzouk	Massachusetts Institute of Technology
Daniele Bigoni	Massachusetts Institute of Technology

Abstract: We consider the Bayesian filtering problem for non-Gaussian state-space models with nonlinear chaotic dynamics and sparse observations. To generalize the EnKF, we propose a methodology that transforms the forecast ensemble at each assimilation step into samples from the filtering distribution via a sequence of local nonlinear couplings based on transport maps. We explore the low-dimensional structure inherited by these maps (e.g., correlation decay, conditional independence) and use it to regularize their estimation in high dimensions.

12:30-13:00

Data assimilation using adaptive, non-conservative, moving mesh models

Alberto Carrassi	Nansen Environmental and Remote Sensing Center and University of Bergen
Ali Aydogdu	NERSC
Colin Guider	University of North Carolina in Chapel Hill
Chris Jones	University of North Carolina in Chapel Hill
Pierre Rampal	NERSC
Sukun Cheng	NERSC
Laurent Bertino	NERSC
Christian Sampson	University of North Carolina in Chapel Hill

Abstract: Numerical models on moving meshes are used to study fluids in a Lagrangian frame or for localized structures such as shock waves. Lagrangian solvers move the mesh nodes with the dynamics, while adaptation can include remeshing that adds or removes nodes according to constraints in the solver. The number of nodes changes, and the dimension of the model's state is not conserved. We present a novel approach to perform ensemble data assimilation in this scenario

MS A6-3-3 2 11:00-13:00

Multiscale and Asymptotic Analysis, Modeling, and Simulation for Materials Science - Part 2

For Part 1 see: MS A6-3-3 1
For Part 3 see: MS A6-3-3 3
For Part 4 see: MS A6-3-3 4
For Part 5 see: MS A6-3-3 5

Organizer: Silvia Jimenez Bolanos	Colgate University
Organizer: Lyudmyla Barannyk	University of Idaho
Organizer: Miao-Jung Yvonne Ou	University of Delaware

Abstract: Multiscale in space and time continues to be an active and challenging area of research in mathematical materials science. The aim of this minisymposium is to focus on multiscale modeling, analysis and simulation of the problems arising in fluids, composites and other heterogeneous media. In particular, topics that will be discussed include but are not limited to asymptotic analysis, homogenization, inverse problems, and computational tools for complex fluid and inhomogeneous media. The purpose of this minisimposium is to enable contact between researchers working on fluid modeling and multiscale methods with an update on recent progress in this field.

11:00-11:30

Relation between microstucture and permeability tensor of porous media.

Miao-Jung Yvonne Ou	University of Delaware

Abstract: Permeability plays an important role in quantifying a macroscopic description of transport in porous media. The results are based on the homogenization theory, where the cell problem defines the permeability. We will show what the current techniques are able to inform us about the microstructure's influence on permeability. The method is based on treating the cell problem as a limit case of the two-fluid mixture case, where the integral representation formula can be derived.

11:30-12:00

Thermopheresis effects in electrokinetically-driven liquid-cooled electronics applications

Silvia Jimenez Bolanos	Colgate University
Burt S. Tilley	Worcester Polytechnic Institute
Bogdan M. Vernescu	Worcester Polytechnic Institute

Abstract: We extended classical asymptotic approaches to allow for the spatial pattern wavenumber to vary on the macroscale variables and to find how changes in microstructure geometry affect macroscopic properties and transport. We consider here the thermal transport of a weakly dielectric coolant through nonuniformly spaced laminates, under an applied electric field, as a simple model for heat sinks in electronics.

12:00-12:30

Stieltjes representation, hidden variables, and internal scales in materials with microstructure

Elena Cherkaev	University of Utah

Abstract: Fields in media with microstructure are often described using internal or hidden variables that model the processes on the microstructural level. The talk discusses an analytic Stieltjes representation which links the microgeometry of the medium to its effective properties and provides a set of internal variables related to the structure of the material. These hidden variables determine the characteristic internal scales corresponding to the microlevel processes of different characteristic wavelengths.

12:30-13:00

Modeling adsorption hysteresis in porous media across the scales.

Malgorzata Peszynska	Oregon State University
Ralph Showalter	Oregon State University

Abstract: We discuss hysteresis, a situation when the evolution of a process depends on its history. Our focus is on adsorption, a surface phenomenon with a plethora of applications in engineering, medicine, and geosciences, where hysteresis has been shown experimentally. With microscale models we explain adsorption hysteresis conceptually. At macroscale, we build a hysteresis model with an auxiliary system of nonlinear ordinary differential equations. We present well-posedness analysis and approximation.

MS ME-1-I1 2 11:00-13:00

Recent advances in nonlinear time series analysis - Part 2

For Part 1 see: MS ME-1-I1 1
For Part 3 see: MS ME-1-I1 3

Organizer: Yoshito Hirata	The University of Tokyo
Organizer: José María Amigó	Universidad Miguel Hernández
Organizer: Michael Small	University of Western Australia

Abstract: Nonlinear time series analysis, or time series analysis on dynamical systems, literally began in 1980s, when delay coordinates were proposed. The initial targets for nonlinear time series analysis were stationary, nonlinear, deterministic, isolated, low-dimensoinal systems without assuming knowledge about the underlying systems. One can easily find books describing such developments up to year 2000. But, the recent targets include also non-stationary, stochastic, or high-dimensional systems with or without partial models or couplings. The purpose of this mini-symposium is to showcase and summarize the recent advancements of nonlinear time series anlaysis, and provide a platform for discussing its future directions.

11:00-11:30

Data-driven forecasting for projections of complex systems

Tyrus Berry George Mason University

Abstract: Given a time series of observations of a dynamical system (possibly stochastic), the Diffusion Forecast is a data-driven approach to forecasting the probability distribution of future observations. The approach is applicable when the system is low-dimensional and can be reconstructed via time-delay embeddings. We first review the Diffusion Forecast algorithm and then, motivated by the Mori-Zwanzig formalism, generalize the approach to projected systems where the full dynamical system is too high-dimensional to be fully reconstructed.

11:30-12:00

Detecting causal associations in large nonlinear time series datasets

Jakob Runge German Aerospace Center (DLR)

Abstract: Identifying causal relationships from observational time series data is a key problem in disciplines such as climate science or neuroscience, where experiments are often not possible. Data-driven causal inference is challenging since datasets are often high-dimensional and nonlinear with limited sample sizes. Here we introduce a novel method that flexibly combines linear or nonlinear conditional independence tests with a causal discovery algorithm that allows to reconstruct causal networks from large-scale time series datasets.

12:00-12:30

Stochastic bifurcation in a turbulent swirling flow

Yuzuru Sato Hokkaido University

Abstract: We report the experimental evidence of the existence of a random strange attractor in a fully developed turbulent swirling flow. By defining a global observable which tracks the asymmetry in the flux of angular momentum, we reconstruct the associated turbulent attractor modeled by stochastic Duffing equations. A random map extracted from the data exhibits qualitatively same bifurcation as the experiments. Our findings open the way to low-dimensional modeling of systems with large degrees of freedom.

12:30-13:00

Methodological advances and challenges for recurrence analysis of complex real-world time series

Reik V. Donner Magdeburg-Stendal University of Applied Sciences

Abstract: This talk presents a general introduction into recurrence network analysis and its recent theoretical achievements as well as selected real-world applications. Specific emphasis will be put on the interpretation of network transitivity as a generalized fractal dimension concept, together with selected theoretical and practical challenges arising from it. In addition, recent achievements regarding the associated threshold selection problem will be reviewed and critically discussed.

MS ME-0-2 2 11:00-13:00

Cross-diffusion systems and applications - Part 2

For Part 1 see: MS ME-0-2 1

For Part 3 see: MS ME-0-2 3

Organizer: Virginie Ehrlacher Ecole des Ponts Paristech & INRIA

Organizer: Cancès Clément INRIA

Abstract: Cross-diffusion systems arise in various domains of applications such as crowd motion, physics, chemistry or biology. Despite their significant importance in a wide range of applications, these systems have attracted the attention of mathematicians only recently. They give rise to very interesting and difficult mathematical challenges, either on their theoretical analysis or on their numerical approximation. The aim of this minisymposium is to gather experts working in this field to present their recent contributions and foster new collaborations.

11:00-11:30

Pattern formation for cross-diffusion systems with nonlocal interactions

Martin Burger FAU Erlangen-Nürnberg

Abstract: We will discuss some aspects of pattern formation for multispecies systems with nonlocal interactions, which can be derived from microscopic stochastic models. We discuss some mathematical challenges in the analysis of the arising cross-diffusion systems. In particular we highlight unexpected phase separation effects, that can appear even in the case of mutual nonlocal attraction.

11:30-12:00

Global existence of very weak solutions: impact of duality structure on cross diffusion models

Thomas Lepoutre Inria Rhone Alpes and Université Lyon 1

Desvillettes Laurent Univ. Paris Diderot

Moussa Ayman Univ. Paris Sorbonne

Trescases Ariane CNRS, Univ. Paul Sabatier Toulouse

Abstract: We consider cross diffusion systems with an entropic structure and a laplacian form. This allows an interplay between estimates coming from entropic structure and parabolic dual estimates that potentially give higher integrability of solutions. This leads to general existence results at the cost of a very weak notion of solutions.

12:00-12:30

Asymptotic gradient flows for interacting particle systems

Maria Bruna University of Cambridge

Martin Burger Friedrich-Alexander-University of Erlangen-Nürnberg

Helene Ranetbauer University of Vienna

Marie-Therese Wolfram University of Warwick

Abstract: In this talk we will introduce the concept of an asymptotic gradient flow. This is a generalisation of gradient flows for nonlinear partial differential equations with asymptotically small terms that lack a full gradient flow structure. I will illustrate their properties with an example, namely a cross-diffusion model describing interactions between two distinct populations.

MS A1-1-3 2 11:00-13:00

Mining and modeling evolving and higher-order complex data and networks - Part 2

For Part 1 see: MS A1-1-3 1

For Part 3 see: MS A1-1-3 3

For Part 4 see: MS A1-1-3 4

Organizer: Francesco Tudisco University of Strathclyde

Organizer: Austin Benson Cornell University

Organizer: Christine Klymko Lawrence Livermore National Laboratory

Organizer: Eisha Nathan Lawrence Livermore National Laboratory

Abstract: The analysis of complex networks is a rapidly growing field with applications in many diverse areas. A typical computational paradigm is to reduce the system to a set of pairwise relationships modeled by a graph (matrix) and employ tools within this framework. However, many real-world networks feature temporally evolving structures and higher-order interactions. Such components are often missed when using static and lower-order methods. This minisymposium explores recent advances in models, theory, and algorithms for dynamic and higher-order interactions and data, spanning a broad range of topics including persistent homology, tensor analysis, random walks with memory, and higher-order network analysis.

11:00-11:30

Topological data analysis for investigation of dynamics and biological networks

Heather Harrington University of Oxford

Abstract: Persistent homology (PH) is a technique in topological data analysis that allows one to examine features in data across multiple scales in a robust and mathematically principled manner, and it is being applied to an increasingly diverse set of applications. We investigate applications of PH to dynamic biological networks.

11:30-12:00

Null hypothesis for simplicial complexes

Alice Patania Indiana University

Jean-Gabriel Young University of Michigan

Giovanni Petri I.S.I. Foundation

Francesco Vaccarino Politecnico di Torino

Abstract: We propose a randomized model of simplicial complexes that fixes the facet size distribution and the generalized degree of the nodes of real systems. The core of our contribution is an efficient and uniform Markov chain Monte Carlo sampler for this model. We demonstrate its usefulness in a short case study by investigating the topology of three real systems and their randomized counterparts (using their Betti numbers).

12:00-12:30

Simplicial closure and higher-order link prediction

Austin Benson — Cornell University

Abstract: Much of the structure within complex systems involves interactions that take place among more than two nodes at once. While these higher-order interactions are ubiquitous, an evaluation of the basic properties and organizational principles in such systems is missing. Here we study 19 datasets from biomedicine, social networks, and the Web to characterize how higher-order structure emerges and differs between domains. We then propose a framework for evaluating higher-order data models based on link prediction.

MS ME-0-8 2 — **11:00-13:00**

Dirac Hamiltonians with critical singularities - Part 2

For Part 1 see: MS ME-0-8 1
For Part 3 see: MS ME-0-8 3

Organizer: Naiara Arrizabalaga — University of the Basque Country, UPV/EHU
Organizer: Albert Mas — Universitat Politècnica de Catalunya
Organizer: Luis Vega — BCAM-BASQUE CENTER FOR APPLIED MATHEMATICS

Abstract: Dirac operators perturbed by potentials with critical singularities have recieved a renewed attention since the beginning of the century. Plenty of works concerning the well posedness of Coulomb type perturbations appeared in the 70's thanks to the work of Rellich, Kato, Nenciu, and Wüst, among others. In this minisimposia we will present recent results in this direction. Our main interest will be to highlight the features of the relativistic setting absent in the non-relativistic one. Special attention will be paid to the shell interactions and its relation to the MIT bag model for quark confinement.

11:00-11:30

Minimax methods for molecular Dirac operators

Maria J. Esteban — CEREMADE, Université Paris Dauphine
Mathieu Lewin — CNRS
Eric Séré — Université Paris-Dauphine

Abstract: In this talk I will discuss how to use very general min-max methods to characterize and compute the eigenvalues of multi-center Dirac operators, used in the description of relativistic molecules. The passage from the atomic to the molecular case is not straightforward. The cases when the atoms in the molecule are very close to each other or when the sum of their charges is large are particularly delicate (collaboration with M. Lewin and E. Séré).

11:30-12:00

Spectral properties of selfadjoint Dirac operators on domains in R^2 and R^3

Jussi Behrndt — Technische Universität Graz
Markus Holzmann — Graz University of Technology
Albert Mas — Universitat de Barcelona
Konstantin Pankrashkin — Université Paris-Sud

Abstract: In this talk we study Dirac operators on domains in R^2 and R^3 by means of boundary triples and Weyl functions. We derive a useful resolvent formula and discuss spectral properties of different selfadjoint realizations.

12:00-12:30

Spectral Gaps of Dirac Operators Describing Graphene Quantum Dots

Rafael Benguria — Pontificia Universidad Católica de Chile

Abstract: The two-dimensional Dirac operator describes low-energy excitations in graphene. Different choices for the boundary conditions give rise to qualitative differences in the spectrum of the resulting operator. For a family of boundary conditions, we find a lower bound to the spectral gap around zero, proportional to $-\Omega|^{-1/2}$, where *Ω* is the bounded region where the Dirac operator acts (joint work with S. Fournais, E.Stockmeyer and H. Van Den Bosch).

MS GH-3-3 2 — **11:00-13:00**

Model order reduction methods and their broad applications in engineering - Part 1

For Part 2 see: MS GH-3-3 3
For Part 3 see: MS GH-3-3 4

Organizer: Lihong Feng — Max Planck Institute for DCTS
Organizer: Valentin De La Rubia — Universidad Politecnica de Madrid
Organizer: Francesco Ferranti — Institut Mines-Télécom Atlantique

Abstract: Model order reduction (MOR) is a methodology aiming at constructing reduced order models (ROMs) based on very large-scale complex mathematical models/data arising from many engineering applications. The ROMs are used to replace the large-scale systems in multi-query tasks, e.g., design exploration, optimization, uncertainty quantifications, etc., and finally to reduce the overall computational time, thanks to their reduced complexities. This minisymposium aims to bring together most recent results of MOR developed in mathematics and various engineering fields, and to provide an excellent platform for brainstorm, so as to further push forward the development of MOR for very challenging applications.

11:00-11:30

Model reduction and physics-based machine learning: applications in engineering

Laura Mainini — Politecnico di Torino/Massachusetts Institute of Technology

Abstract: The synergies between model reduction and machine learning techniques can be leveraged to obtain physics-informed, computationally efficient representations of large-scale engineering systems. We propose formulations and methods to exploit these synergies and learn models suitable for multi-query and time-constrained computational tasks (design optimization, system identification, state/situational awareness). Different mechanical and aerospace engineering applications will be discussed, including real-time diagnostics and prognostics of dynamical systems, and optimal sensor placement and data selection to inform decisions.

11:30-12:00

Data-driven reduced-order modeling of nonlinear systems in the Loewner framework

Ion Victor Gosea — Max Planck Institute
Athanasios C. Antoulas — Rice University
Matthias Heinkenschloss — Rice University

Abstract: The Volterra series is a mathematical description of the input-output relationship, valid for a wide class of nonlinear systems. Using this approach, one can identify invariant mappings of the nonlinear system. The proposed model reduction procedure, the Loewner framework, is based on matching some of these mappings in the frequency domain. It constructs reduced-order systems directly from data. The target applications are partial differential equations from computational fluid dynamics, e.g. the Burgers' equation.

12:00-12:30

Automated grey-box RLC modeling from measured responses

Sanda Lefteriu — Institut Mines-Télécom Lille Douai
Stefano Grivet Talocia — Politecnico di Torino
Marco De Stefano — Politecnico di Torino

Abstract: This contribution focuses on generating automated resistor-inductor-capacitor (RLC) circuits as models for a given data set of measured responses. Such a model will be stable and passive by construction and, moreover, will have a physical interpretation. Applications include electrical or electronic systems but also translational or rotational mechanical systems and acoustics, for which RLC models provide templates for the representation of the underlying dynamics.

12:30-13:00

Extracting Design Information from Reduced-Basis Approximations in Electromagnetics

Valentin De La Rubia — Universidad Politecnica de Madrid
David Young — Huawei Technologies Sweden AB

Abstract: In this work, extraction of design information from full-wave electromagnetic analysis of microwave circuits is detailed. Appropriate Reduced-Basis Approximations to time-harmonic Maxwell's equations in the frequency band of interest is involved and a reliable reduced-order model is obtained. Then, the electromagnetic behavior in the microwave device is rearranged and described in terms of circuit theory, giving rise to the coupling matrix representation in the actual coupling topology of the original Maxwell problem.

MS FT-1-1 2 — **11:00-13:00**

Nonlinear and multiparameter eigenvalue problems - Part 2

For Part 1 see: MS FT-1-3 1
For Part 3 see: MS FT-1-1 3
For Part 4 see: MS FT-1-1 4
For Part 5 see: MS FT-1-1 5
For Part 6 see: MS FT-1-1 6
For Part 7 see: MS FT-1-1 7

Organizer: Fernando De Terán — Universidad Carlos III de Madrid
Organizer: Froilán M. Dopico — Universidad Carlos III de Madrid

MS Organized by: SIAG/LA

Abstract: A nonlinear eigenvalue problem (NLEVP) is to find scalars x (eigenvalues) and nonzero vectors v,w (eigenvectors) satisfying F(x)v=0, w*F(x)=0, where F:C→Cnxn is a matrix-valued function. NLEVPs can be extended to multiparameter eigenvalue problems (MPEPs) F(x1,...,xd)v=0, w*F(x1,...,xd)=0, with F:Cd→Cnxn. Important cases of NLEVPs are the polynomial and rational eigenvalue problems, where the entries of F(x) are polynomial or rational functions. NLEVPs and MPEPs arise in many applications, and much research on these problems has been performed in the last years from computational and theoretical perspectives. This minisymposium presents the most recent advances in NLEVPs and MPEPs, and on their applications.

11:00-11:30

Structured first order formulations of parametric NLEVPs and differential-algebraic systems

Volker Mehrmann — TU Berlin

Abstract: We consider dissipative Hamiltonian first order formulations of nonlinear eigenvalue problems arising in the stability analysis of dick brakes. It turns out that this formulations allows to identify the reasons for disk brake squeal from the structure of the system and immediately suggest an optimization procedure to remove the squeal via appropriate damping devices. The results are illustrated via real industrial examples.

11:30-12:00

Sensitivity and backward perturbation analysis of nonlinear multiparameter eigenvalue problems

Rafikul Alam — Indian Institute of Technology Guwahati

Abstract: We present a general framework for the sensitivity and backward perturbation analysis of nonlinear MEPs. We consider the condition number $cond(\lambda|W)$ of a simple eigenvalue λ of an MEP W and derive three equivalent representations of $cond(\lambda|W)$ of which two are eigenvector-free. For $\lambda \in C^m$, we consider the backward error $\eta(\lambda|W)$ and construct an optimal ΔW such that λ is an eigenvalue of $W + \Delta W$ and v ΔW vv $\eta(\lambda|W)$.

12:00-12:30

Connection between algebraic nonlinear eigenvalue problems and multiparameter eigenvalue problems

Meiyue Shao — Fudan University
Weiguo Gao — Fudan University

Abstract: An algebraic nonlinear eigenvalue problem (ANEP) is an eigenvalue problem of the form , where is a matrix-valued function whose entries are algebraic functions. To solve an ANEP, we introduce a multiparameter polynomial eigenvalue problem , which is linear in the auxiliary parameters 's. Eliminating the auxiliary variables yields a univariate polynomial eigenvalue problem in . This is a general linearization approach to transform an ANEP to a polynomial eigenvalue problem.

12:30-13:00

Nonlinear eigenvalue localization for damping bounds

David Bindel — Cornell University

Abstract: Nonlinear eigenvalue problems arise from transform analysis of linear differential and functional differential equations. But just as linear eigenvalue analysis tells us about asymptotic stability without providing a full picture of the transient behavior, nonlinear eigenvalue analysis give an incomplete picture of the dynamics of the associated system. In this talk, we describe how nonlinear pseudospectra and related inclusion regions provide information about the non-asymptotic dynamics of systems with radiation and delay.

MS ME-1-G 2 — 11:00-13:00

Women in Applied Mathematics: Recent Advances in Modeling and Applications - Part 2

For Part 1 see: MS ME-1-G 1
For Part 3 see: MS ME-1-G 3
For Part 4 see: MS ME-1-G 4

Organizer: Baasansuren Jadamba — Rochester Institute of Technology
Organizer: Natasha S Sharma — University of Texas at El Paso

Abstract: This minisymposium aims at bringing women mathematicians to share their recent progress and to inspire new ideas in applied mathematics. Talks may address modeling, theoretical and computational aspects of numerical methods for partial differential equations, as well as various applications arising from engineering, biology, medicine and material science etc. The fourth part of the minisymposium includes a career panel session, whose goal is to create a network platform for women mathematicians at different stages of career and career paths, to exchange experiences and advice in career advancement, and to discuss challenges and strategies for a successful career.

11:00-11:30

Robust solvers for FEMs for the Cahn-Hilliard equation

Amanda Diegel — Mississippi State University
Susanne C. Brenner — Louisiana State University
Li-Yeng Sung — Louisiana State University

Abstract: The Cahn-Hilliard equation is one of the most important and widely used equations in modeling two-phase phenomena. In this talk, we will explore the development of an iterative solver for both a first and second order finite element method for the Cahn-Hilliard equation. Both solvers rely on minimal residual and multigrid methods. We will furthermore demonstrate the advantages of these new solvers to the traditional ones.

11:30-12:00

Clamping Interior Points of Vibrating Rods and Plates

Chiu-Yen Kao — Claremont McKenna College

Abstract: Studying eigenvalues of biharmonic operators play essential roles in understanding the mechanical vibration of rods and plates. In this talk, we discuss how vibration frequencies vary with respect to clamped location at interior points of Rods and Plates. In one dimension, with (n-1) interior clamped points, the optimal location to maximize the first eigenvalue could be possibly achieved by clamping nodal points of n-th eigenfunction of unclamped rod. We also demonstrate similar behaviors in plates.

12:00-12:30

Spectral approximation to the discrete delta function in the immersed boundary method

Wanda Strychalski — Case Western Reserve University
Robert D. Guy — University of California, Davis
David Hartenstine — Western Washington University

Abstract: In immersed boundary methods, the fluid and structure communicate through smoothed approximate delta functions with small spatial support. We take a different approach and construct highly accurate approximations to the delta function directly in Fourier space. This method leads to high-order accuracy away from the boundary and significantly smaller errors near the boundary. We present accuracy tests and simulation results from an application in cell biology where the traditional the traditional approach produces unphysical results.

12:30-13:00

Two-compartment ODE model for inflammatory cell activity in atherosclerosis

Rebecca Segal — Virginia Commonwealth University
Marcella Torres — Virginia Commonwealth University
Jing Wang — Virginia Commonwealth University
Paul Yannie — Virginia Commonwealth University
Shobha Ghosh — Virginia Commonwealth University
Angela Reynolds — Virginia Commonwealth University

Abstract: Atherosclerotic cardiovascular disease is a leading cause of morbidity and mortality despite advances in lipid management. Cellular interactions occur within the artery wall between immune cells and lipoproteins and lead to the progression of an atherosclerotic plaque. We developed an ODE model for the influx of immune cells in the peritoneal cavity in response to bacterial stimulus, calibrated using experimental data. The two-compartment model describes plaque formation arising from inflammation, including local and systemic dynamics.

MS GH-1-3 2 — 11:00-13:00

Current Developments in Wavelett- Fractal Methods with Applications - Part 2

For Part 1 see: MS GH-1-3 1

For Part 3 see: MS GH-1-3 3
For Part 4 see: MS GH-1-3 4

Organizer: Abul Hasan Siddiqi Siddiqi	Sharda University
Organizer: Nekka Fahima	Université de Montréal
Organizer: Akhtar A. Khan	Rochester Institute of Technology Rochester, New York
Organizer: Pammy Manchanda	Guru Nanak Dev University

Abstract: Wavelet and Fractal Methods were invented in early eighties. The basic work of the initial stages are very well documented in the book of Daubechies 1992 and Y. Meyer 1993, SIAM. An updated historical development has been presented in chapter 12 of a recent book by the organizer of the symposium published by Springer in 2018. This symposium in three parts is devoted to certain topics dicussed in three monographs by Springer in recent past namely multivariate wavelet frames, 2016, industrial mathematics and complex systems, 2017 & wavelets constructed by walsh functions, 2018.

11:00-11:30

The Mathematics of Pharmacology: A New Pillar for an Old Discipline

Nekka Fahima	Université de Montréal

Abstract: The pharmaceutical field, where the complex relationship of dose-exposure-effect further challenges the pathophysiological aspects, the need for mathematical modeling often arises from problematics that cannot be addressed with traditional methods. This complementarity aspect of mathematical pharmacology is now well recognized for its compelling advantage in reducing costs, minimizing animals use and exploring different scenarios. I will emphasise the recent development in this direction and illustrate by case studies concretized in clinical decision tools.

11:30-12:00

Bifurcation and Wavelet Simulation Inference of Nanoparticles

Rashmi Bhardwaj Bhardwaj	Guru Govind Singh Inderprastha University

Abstract: Modelling of Fe3O4 fluid flow nanoparticles through blood vessels along with cholesterol decomposition in rectangular cavity system for magnetic and temperature variability is discussed in the present study. SALI, FLI, DLI simulate ordered and chaotic orbits of the dynamical system. It is concluded that value of Rayleigh number at which chaos begins is quite high, thus, patient has more chance to survive as disorder occurs for extreme conditions, there exist narrow passages which provide flow.

12:00-12:30

Mathematical Modelling of Alzeimer

Noore Zahra	Princess Nourah bint Abdulrahman University

Abstract: Alzeihmer ,the common form of dementia is irreversible brain disorder which destroys memory. Mathematical model which is needed for the disease interpretation would be discussed here. The major challenge is to keep in site the variability of brain structure. Tau protein , neurons , astrocytes, microglia ,macrophages and amyloid β aggregation are the main lead , their reaction with each other and changes which lead to disease are represented by set of mathematical equations.

MS A6-5-3 2 11:00-13:00

Mathematics and Computation for Clinical Problems - Part 2

For Part 1 see: MS A6-5-3 1
For Part 3 see: MS A6-5-3 3

Organizer: Hiroshi Suito	Tohoku University, Japan
Organizer: Norikazu Saito	The University of Tokyo
Organizer: Takuya Ueda	Tohoku University

Abstract: We shall present several topics that have arisen through collaboration between mathematical science and clinical medicine. Our targets include leading-edge technologies in clinical applications from 4D-flow MRI to machine learning applications. Together with these studies, strong mathematical foundations are indispensable for reliable and efficient implementations. Through close collaboration with physicians, those analyses can yield greater understanding leading to better risk assessments. Throughout this mini-symposium, we seek discussion of how mathematical science might contribute to the clinical medicine of our present and future society. This mini-symposium comprises three parts: I. Clinical applications; II. Computational modeling; and III. Mathematical tools and foundations.

11:00-11:30

Graph theoretical approach to diagnosis for bronchiectasis

Hiroshi Suito	Tohoku University, Japan
Junya Tominaga	Tohoku University Hospital, Japan

Abstract: Diagnoses for bronchiectasis, which is usually performed by examining slices of CT-scans by specialist. We present a new method to the diagnosis based on graph theoretical approach. After careful segmentation, graph structure is constructed through extraction of centerlines of bronchi. Cross-sectional area, curvature, torsion, etc. are assigned to each edge (bronchus) and used for classification of disease states and progression stages. Such systematic and simplified mathematical approach is much useful for clinical medicine.

11:30-12:00

Numerical methods for cardiac simulation

Alfio Quarteroni	EPFL, Lausanne, Switzerland & Politecnico di Milano, Italy

Abstract: In this presentation I will report some recent advances on the simulation of the human heart. Some instances of clinical relevance will be addressed.

12:00-12:30

Heart Valve Fluid–Structure Interaction and Blood Flow Analysis

Kenji Takizawa	Waseda University
Takuya Terahara	Waseda University
Tayfun E. Tezduyar	Rice University

Abstract: Heart valve flow analysis requires accurate representation of boundary layers near moving surfaces, even when the leaflets come into contact. We address this computational challenge with a space–time (ST) method that integrates three ST methods in the framework of the ST variational multiscale method: the ST Slip Interface and ST Topology Change methods and ST Isogeometric Analysis. Here we focus on how we deal with TC and contact location change and contact sliding.

12:30-13:00

Diffusion MRI parameter inference by deep regression neural network

Yoshitaka Masutani	Hiroshima City University

Abstract: Diffusion MRI can characterize and quantify the local properties of microstructures of the living organism such as the brain white matter, based on the parameters of various signal models. Recent reports revealed that machine learning approaches are promising for inferring the parameters instead of conventional model fitting approaches. In this talk, the basics of diffusion MRI parameter inference by using deep neural networks are introduced and the characteristics of the approach are discussed.

MS GH-3-5 2 11:00-13:00

Data Assimilation, Prediction, and Uncertainty Quantification for Complex Systems - Part 2

For Part 1 see: MS GH-3-5 1

Organizer: Samuel Stechmann	University of Wisconsin-Madison
Organizer: Nan Chen	University of Wisconsin-Madison

Abstract: Data assimilation (also known as state estimation) and prediction have significant science and society impacts on many areas including climate, geophysics, engineering, neuroscience and material science. Most of the underlying dynamical systems in these subjects are extremely complex. They typically have high dimensions, multiscale structures, non-Gaussian statistics and large uncertainties. Therefore, developing efficient and effective stochastic methods for data assimilation and prediction with accurate uncertainty quantification becomes important. This mini-symposium focuses on new ideas and advanced techniques in data assimilation, prediction and uncertainty quantification. Rigorous math theories, effective numerical algorithms and real-world applications will all be emphasized in this mini-symposium.

11:00-11:30

A Conditional Gaussian Framework for Uncertainty Quantification, Data Assimilation & Prediction

Nan Chen	University of Wisconsin-Madison
Andrew Majda	Courant Institute of Mathematical Sciences
Xin Tong	National University of Singapore

Abstract: A conditional Gaussian nonlinear modeling framework will be developed. A gallery of the models in complex dynamical systems will be introduced. This is followed by applying this framework for assimilating turbulent ocean flows using noisy Lagrangian tracers, where rigorous theory shows a practical information barrier in recovering the velocity field. This framework can also be applied to solve high-dimensional Fokker-Planck equation, which facilitates non-Gaussian data assimilation and ensemble prediction in practice.

11:30-12:00

Statistical bounds in uncertainty quantification for turbulent geophysical flows

Di Qi	New York University

Abstract: Statistical bounds controlling the total fluctuations in mean and variance are developed. The evolution of an ensemble of trajectories is considered in the statistical instability analysis. The maximum growth of the total statistics in fluctuations is derived relying on the statistical conservation principle of the pseudo-energy. Two cases with dependence on initial statistical uncertainty and on external forcing and dissipation are compared and unified with a consistent statistical stability framework.

12:00-12:30

A surrogate based approach to nonlinear, non-Gaussian joint state-parameter data assimilation

Elaine Spiller	Marquette University
John Maclean	University of Adelaide

Abstract: Many approaches to joint state-parameter data assimilation work in cases where the parameters' posterior is near Gaussian, but not bimodal. This excludes cases where disjoints sets of parameters can lead to similar model results/observations. To do so, we build Gaussian processes that model state variables as functions of the input parameters which can then be used to efficiently sample parameter posteriors without Gaussian or unique-true-parameter-value assumptions. We apply this approach to the Lorenz-96 equations.

12:30-13:00

Duality between nonlinear filtering and optimal control

Prashant MEHTA	Dr.

Abstract: Duality between optimal estimation and optimal control is a problem of rich historical significance. The first duality principle appears in the paper of Kalman-Bucy, where the problem of minimum variance estimation is shown to be dual to a linear quadratic optimal control problem. This paper generalizes the classical duality result to the nonlinear filter: Explicit expressions for the Lagrangian and the Hamiltonian are described. The classical Kalman-Bucy duality is shown to be a special case.

MS A1-2-1 2 11:00-13:00

Topological data analysis and deep learning: theory and signal applications - Part 2

For Part 1 see: MS A1-2-1 1
For Part 3 see: MS A1-2-1 3
For Part 4 see: MS A1-2-1 4

Organizer: Jae-Hun Jung	Ajou Univ/SUNY Buffalo
Organizer: Scott Field	University of Massachusetts Dartmouth
Organizer: Christopher Bresten	Ajou University

MS Organized by: SIAG/CSE

Abstract: Topological data analysis (TDA) emerged as an important analysis tool in data science. By considering topological features of data, TDA determines and predicts data characteristics, extracting hidden underlying knowledge. Deep learning approach is recently proven highly efficient together with TDA for a large set of data in various applications. This mini-symposium brings researchers together from various areas of TDA, deep learning, and their applications with a focus on signal analysis specialized to the gravitational wave detection problem. The mini-symposium provides an opportunity for researchers to share their expertise in theory, implementation, and applications to gravitational-wave detection.

11:00-11:30

Optimized convolutional neural networks for the detection of multimodal gravitational wave signals

Scott Field	University of Massachusetts Dartmouth
Dwyer Deighan	University of Massachusetts Dartmouth
Gaurav Khanna	University of Massachusetts Dartmouth
Collin Capano	Max Planck Institute for Gravitational Physics

Abstract: Gravitational wave astronomy can benefit from the rapid classification of gravitational wave signals buried deep in instrumentation noise. In this talk, I will describe optimized convolutional neural networks for classification. In particular, we discuss automated evolutionary-based strategies to optimize the hyperparameters of our network, in an attempt to make our networks as compact and effective as possible. Results will be discussed for training data using models with dominant and subdominant modes.

11:30-12:00

Topological data analysis for signal detection and classification

Christopher Bresten	Ajou University

Abstract: Topological data analysis has a relatively short history compared to other subfields. We explore new applications of TDA to time-series analysis; including classification and signal detection problems in astronomy, geophysics, medicine.

12:00-12:30

Convolutional neural networks: a magic bullet for gravitational-wave detection?

Timothy Gebhard	Max Planck Institute for Intelligent Systems & ETH Zurich
Kilbertus Niki	Max Planck Institute for Intelligent Systems
Harry Ian	Institute for Cosmology and Gravitation, University of Portsmouth
Schölkopf Bernhard	Max Planck Institute for Intelligent Systems

Abstract: In our recent work, we analyze the limitations (e.g., statistical significances) and potential opportunities (e.g., speed, scalability) of using CNNs to search for gravitational-wave signals from binary coalescences. We propose a new architecture and metrics and demonstrate how our model might be used as a rapid “trigger generator” to flag interesting points in time for a detailed follow-up with classical matched filtering. Finally, we initiate the discussion about the adversarial robustness of such a system.

MS A1-2-6 2 11:00-13:00

Molecular simulation: dynamics, statistics, learning, and high-performance computing - Part 1

For Part 2 see: MS A1-2-6 3
For Part 3 see: MS A1-2-6 4

Organizer: Eric Cancès	Ecole des Ponts ParisTech and Inria Paris
Organizer: Laura Grigori	Inria Paris
Organizer: Tony Lelièvre	Ecole des Ponts ParisTech and Inria Paris
Organizer: Yvon Maday	Laboratoire Jacques-Louis Lions, Sorbonne Université, Paris, Roscoff, France and Institut Universitaire de France

Abstract: Molecular simulation is widely used in the fields of theoretical, experimental, and industrial chemistry and physics, molecular biology, pharmacology, electronics, and energy production and storage, for the study of molecular systems ranging from small chemical systems to large biological molecules and materials. Molecular simulation is also key for the development of the emerging technology of atomic-scale engineering of controllable nanodevices. The amount of resources devoted to molecular simulation in supercomputing centers often exceeds 40%. The five sessions of the Molecular Simulation minisymposia will illustrate the diversity and richness of the modeling, mathematical and numerical problems arising in this vibrant field.

11:00-11:30

Atomic Permutation-Invariant Potentials (aPIPs): A potential for materials based on polynomial fits

Genevieve Dusson	University of Warwick
Gabor Csanyi	University of Cambrigde
Christoph Ortner	University of Warwick

Cas Van Der Oord University of Cambrigde

Abstract: For many applications ab initio computations are too expensive, so that interatomic potentials, often cheap to compute but less accurate, are in use. Originally derived from empirical models, these potentials have over the past few years mainly been developed from data-driven methods. I will present the construction of potentials for materials using linear polynomial fits based on a body-order expansion, and present convergence tests illustrating the low computational cost and systematic improvability of the potential.

11:30-12:00

Statistically Robust Multi-Reference Alignment with Wavelet Invariants

Matthew Hirn Michigan State University
Anna Little Michigan State University

Abstract: The multi-reference alignment (MRA) problem is a useful model for several signal processing problems, including inverse imaging problems that arise in cryo-electron microscopy. We consider a generalization of the MRA problem in which one aims to reconstruct a signal from observations that are random translations, dilations and additive noise corruptions of the signal. To solve this problem, we propose a nonlinear, wavelet-based representation that is translation invariant and robust to additive noise and random dilations.

12:00-12:30

Mathematics+Physics+Data-Driven Interatomic Potentials

Christoph Ortner University of Warwick

Abstract: The past decade has seen a revival of interatomic potentials, re-casting their construction as an approximation problem (or, “machine learning”). I will motivate our own strategy which pursues a partial return to classical potentials. I will construct systematically improvable MLIPs based on a cluster expansion and symmetric polynomials. This adherence to "simple" (low-dimensional) functional forms allows us to effectively regularise our IPs, to obtain “transferrable” potentials.

12:30-13:00

Accelerating atomistic simulations with machine-learning interatomic potentials

Alexandre Shapeev Skolkovo Institute of Science and Technology (Skoltech)
Konstantin Gubaev Skoltech
Evgeny Podryabinkin Skoltech

Abstract: Machine-learning interatomic potentials have recently been proposed as a way of combining the quantum-mechanical accuracy and the efficiency of interatomic potentials. Often, however, the purpose is to explore the underlying multidimensional potential energy surface. This creates a challenge for machine-learning-based approaches: representative atomistic configurations for the training dataset are not known a priori. I will show how this is resolved by active learning and present active-learning algorithms for crystal structure prediction and free energy calculation.

MS GH-1-A 2 11:00-13:00

Recent trends in the mathematics of images - Part 1

For Part 2 see: MS GH-1-A 3
For Part 3 see: MS GH-1-A 4
Organizer: Chambolle Antonin CMAP, Ecole Polytechnique, CNRS
Organizer: Kristian Bredies University of Graz
Organizer: Jalal Fadili CNRS and ENSICAEN
Organizer: Chambolle Antonin CMAP, Ecole Polytechnique, CNRS

MS Organized by: SIAG/IS

Abstract: Mathematical imaging relies on many different mathematical disciplines including linear algebra, differential geometry, harmonic analysis, functional analysis, mathematical physics, numerical analysis, optimisation, PDEs, stochastic and statistical methods, machine learning. The fields of application encompass medical and astronomical imaging, radar, optics, etc. The goal of this 3-part mini-symposium is to present recent theoretical, numerical and applicative trends by young researchers in these fields, with a stress put on modeling, optimisation and theoretical recovery results.

11:00-11:30

On the structure of solutions of convex regularization: gradient TV minimization and co

Claire Boyer Sorbonne Université

Abstract: We establish a result which states that regularizing an inverse problem with the gauge of a convex set C yields solutions which are linear combinations of a few extreme points or elements of the extreme rays of C. We then explicit that general principle by using a few popular applications, as in total gradient minimization.

11:30-11:55

A scheme for solving the infinite-dimensional TV-minimization problem.

Axel Flinth U. Toulouse III Paul Sabatier and CNRS

Abstract: The topic of this talk is a Frank-Wolfe-type algorithm for minimization problems over certain measure spaces, regularized with a total variation norm-term. We will present an eventual linear convergence rate guarantee, which holds under smoothness assumption on the data fidelity term, and a (not too far-fetched) regularity condition on the solution. Possible applications include super-resolution.

12:00-12:30

Superresolution in Microscopy

Emmanuel Soubies CNRS

Abstract: The field of fluorescent microscopy has experienced an important revolution during the past decade with the emergence of super-resolution techniques that bypass the diffraction limit so as to reach unprecedented nanoscale resolution. The principle behind these methods relies on a combined use of optics and numerics, commonly called computational imaging. In this talk, we shall discuss specific modalities, namely SIM and SMLM, and describe recent advances in reconstruction algorithm to solve the associated inverse problems.

12:30-13:00

On convergence of Total Variation regularized inverse problems

Gwenael Mercier University of Vienna

Abstract: We investigate the convergence, as both the regularization parameter and the noise go to zero at a controlled speed, of total variation regularized linear inverse problems in R^n with a L^p fidelity term. More precisely, we show the convergence with respect to the Hausdorff distance of level-sets of the the regularized solution to the level-sets of the true solution when p is carefully chosen with respect to the dimension.

MS A1-1-1 2 11:00-13:00

Geometry and Topology in Data Analysis - Part 2

For Part 1 see: MS A1-1-1 1
For Part 3 see: MS A1-1-1 3
For Part 4 see: MS A1-1-1 4
Organizer: Facundo Memoli The Ohio State University
Organizer: Yasuaki Hiraoka Kyoto University
Organizer: Washington Mio Florida State University

Abstract: Understanding the organization of data across spatial and temporal scales, extracting information and knowledge from data and making inferences are fundamental problems in data analysis that pose many challenges, particularly if the data objects are complex entities such as shapes, networks, or images. This mini-symposium will provide a forum for discussion and dissemination of recent advances based on topological and geometric methods. The presentations will address foundational questions, mathematical modeling and computation, as well as applications to the analysis of data arising in various domains of science and engineering.

11:00-11:30

What can discrete Morse theory tell us about multi-parameter persistence?

Claudia Landi University of Modena e Reggio Emilia
Sara Scaramuccia Università di Genova
Andrea Guidolin Basque Center for Applied Mathematics

Abstract: Discrete Morse theory permits reducing a cell complex to its critical cells. Critical cells carry the relevant homological information as their number bounds Betti numbers. Recently, the reduction aspect of discrete Morse theory was leveraged in connection to persistent homology with the purpose of speeding up algorithms. In this talk, we present inequalities involving the number of critical cells of a vector field consistent with a multi-filtration and the Betti tables of its persistence module.

11:30-12:00

Every 1D Persistence Module is a Restriction of Some Indecomposable 2D Persistence Module

Emerson Escolar	RIKEN Center for Advanced Intelligence Project / Kyoto University Institute for Advanced Study
Buchet Micka¨el	TU Graz

Abstract: A recent work by Lesnick and Wright proposed a visualisation of 2D persistence modules by using their restrictions onto lines, giving a family of 1D persistence modules. We give a constructive proof that any 1D persistence module can in fact be found as a restriction of some indecomposable 2D persistence module to a line. As a consequence of our construction, we are able to exhibit indecomposable persistence modules whose support has holes.

12:00-12:30

The Persistent Homology of a Sampled Map: From a Viewpoint of Quiver Representations

Hiroshi Takeuchi	Chubu University

Abstract: The theory of homology induced maps of correspondences proposed by Shaun Harker et al. is a powerful tool which allows the retrieval of underlying homological information from sampled maps. In this talk, we redefine induced maps of correspondences within the framework of quiver representations. With this point of view, we extend these ideas to filtration analysis based on persistent homology, which provides new methods for analyzing sampled maps, and moreover 2-D persistent homology.

12:30-13:00

Computing a Minimal Presentation of 2-Parameter Persistent Homology in Cubic Time

Michael Lesnick	Albany

Abstract: Motivated by applications to TDA, we give an algorithm for computing a (minimal) presentation of a bigraded K[x,y]-module M, for K a field. The algorithm takes as input a short chain complex of free modules F2-->F-->F0 whose homology is isomorphic to M. It runs in time O(n3) and requires O(n2) memory, where ni is the size of a basis for Fi and n=n1+n2+n3. Given the presentation, the bigraded Betti numbers of M are readily computed.

MS A3-3-3 2 — 11:00-13:00

Multigrid solvers for partially structured meshes and for advanced architectures

Organizer: Luc Berger-Vergiat	Sandia National Laboratory
Organizer: Raymond Tuminaro	Sandia National Labs

Abstract: Multigrid methods are an important class of iterative solvers and preconditioners as they provide fast convergence rates with O(n) complexity on specific classes of problems such as elliptic problems with uniform coefficients. While their implementation on distributed memory system has been shown to scale well both weakly and strongly, the advent of new mixed architectures requires a redesign of some core kernels of these methods. This mini-symposium aims at exploring methods leveraging fully or partially structured grids and parallel shared memory implementations of the multigrid method to extend its scalability on new architectures and toward exascale computations.

11:00-11:30

Multigrid methods for partially structured grids: framework & structured performance

Ray Tuminaro	Sandia National Laboratories

Abstract: Hierarchical hybrid grids (HHG) promote the efficient multigrid utilization of modern architectures. These HHG meshes are constructed by uniformly refining an unstructured grid so that most multigrid calculations are performed with structured grid kernels. We introduce a mathematical framework for general block structured meshes, illustrating the relationship between partially structured and unstructured MG algorithms. We additionally modify the solver to permit for some unstructured regions, allowing limited use of unstructured meshes in areas where needed.

11:30-12:00

Extending hypre's semi-structured capabilities

Ulrike Yang	Lawrence Livermore National Laboratory
Robert Falgout	Lawrence Livermore National Laboratory

Abstract: Since current architecture trends are favoring regular compute patterns to achieve high performance, the ability to express structure has become much more important. The hypre software library provides (semi-)structured interfaces and solvers. We have designed a new structured-grid matrix class that supports rectangular matrices and a semi-structured-grid matrix class that builds on it. These new capabilities enable the development of a new semi-structured algebraic multigrid. We will discuss these new developments in hypre.

12:00-12:30

Multigrid methods for hybrid structured/unstructured grids

Matthias Mayr	University of the Bundeswehr
Luc Berger-Vergiat	Sandia National Laboratories
Peter Ohm	Tufts University
Ray Tuminaro	Sandia National Laboratories

Abstract: Globally unstructured grids can often be decomposed into several locally fully structured grids and a few locally unstructured grids. Various multigrid algorithms are available for both fully structured and unstructured grids. We aim at leveraging both type of algorithms to deal with such hybrid structured/unstructured meshes. The key challenge is to enable the interplay across the interfaces between structured and unstructured parts of the overall grid by an appropriate coarsening strategy along these interfaces.

12:30-13:00

Hybrid implementation of matrix free MG for 3D image based numerical simulation

Xiaodong Liu	Ecole Centrale Nantes
Julien RÉTHORÉ	GeM, CNRS UMR 6183, École Centrale de Nantes
Marie-Christine Baietto	Univ Lyon, INSA-Lyon, CNRS UMR5259, LaMCoS
Philippe Sainsot	Univ Lyon, INSA-Lyon, CNRS UMR5259, LaMCoS
Antonius Adrianus Lubrecht	Univ Lyon, INSA-Lyon, CNRS UMR5259, LaMCoS

Abstract: This work introduces a strategy of using a Matrix Free MultiGrid method coupled with a proposed homogenization technique, to employ numerical simulations on large scale tomographical images of heterogeneous materials. The size of image can reach more than 8 billion elements. A hybrid MPI-OpenMP parallel programming is applied to improve the computational perfermence. The effective material propety is obtained by the homogenization method.

MS FT-4-7 2 — 11:00-13:00

Iterative processes for solving nonlinear problems: Convergence and Stability - Part 2

For Part 1 see: MS FT-4-7 1
For Part 3 see: MS FT-4-7 3
For Part 4 see: MS FT-4-7 5

Organizer: Juan Torregrosa	Universitat Politècnica de València

Abstract: Solving nonlinear equations and systems is a non-trivial task that involves many areas of Science and Technology. Usually it is not affordable in a direct way and iterative algorithms play a fundamental role in their approach. The main theme of this Special Issue, but not the unique, is the design, analysis of convergence and stability and application to practical problems of new iterative schemes for solving nonlinear problems. This includes methods with and without memory, with derivatives of derivative-free, the real or complex dynamics associated to them and an analysis of their convergence that can be local, semilocal or global.

11:00-11:30

A Newton-Moser type method for solving integral equations

José Manuel Gutiérrez	Universidad de La Rioja
Miguel A. Hernández-Verón	University of La Rioja

Abstract: We present some iterative methods for numerically solving nonlinear equations defined in functional spaces. Our target is to avoid the dependence of inverse operators in the expression of the considered methods. In this way we construct a couple of sequences, one of them for approaching the solution itself and the other for approaching the inverse of the involved linear operator. We apply our theoretical results to the solution of integral equations of Fredholm type.

11:30-12:00

New results for the fast approximation of the SVD

Jean-Claude Yakoubsohn	Universite Paul Sabatier

Joris Van Der Hoeven	Laboratoire LIX Ecole Polytechnique

Abstract: We present high order methods to fast approximate the singular value decomposition of a complex matrix in the general case. By general case we mean that the singular values are agregated in clusters. We will give theoretical results of convergence with respect the condition number squared of this problem which is defined as in the minimum distance between twe clusters of singular values. We will show numerical experiments that confirms the theory.

12:00-12:30

Gradient-free high order methods for ill conditioned equations

Vicente F. Candela	Universitat de València
Rosa M. Peris	Universitat de València

Abstract: Previously, the authors introduced an operator, called rate of multiplicity as a global estimation of the multiplicity of the roots of a function, allowing to accelerate iterative methods for nonlinear equations. In order to obtain good approximations, evaluations of high order derivatives of the function are needed. Here, we analyze the behaviour of rates, and we propose alternative formulations to reduce their computational cost while keeping the quality of the results.

12:30-13:00

On quadratic matrix equations

Ángel Alberto Magreñán Ruiz	Universidad de la Rioja
Miguel Ángel Hernández-Verón	University of La Rioja
Natalia Romero	Universidad de La Rioja

Abstract: Quadratic matrix equation arises in numerous applications and is of intrinsic interest as one of the simplest nonlinear matrix equations. A natural contender for solving the quadratic matrix equation is the Newton method, which has been investigated for several authors. We show an effcient third order iterative scheme for solving quadratic matrix equation. Numerical experiments confirm the very good performance of this scheme.

MS FE-1-3 2 11:00-13:30

Mathematical and Numerical Modeling in Biomechanics - Part 1

For Part 2 see: MS FE-1-3 4

Organizer: Rongliang Chen	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences
Organizer: Xiao-Chuan Cai	University of Colorado
Organizer: Luca F. Pavarino	University of Pavia
Organizer: Stefano Zampini	KAUST

Abstract: The numerical modeling of biological systems, such as blood flows, arteries, and heart deformation takes the form of partial differential equations (PDEs). Some of the PDEs are highly nonlinear and some have to be solved as a coupled system (as in the case of blood-flow-artery interaction). The focus of this minisymposium is on efficient numerical methods and high performance software for solving PDEs arising in the study of biofluid dynamics and biostructural mechanics. Patient-specific problems will be discussed and issues related to the performance of the algorithms on supercomputers with a large number of processing cores will also be addressed.

11:00-11:30

Recent Results on Domain Decomposition Algorithms for Almost Incompressible Elasticity

Olof Widlund	Courant Institute
Luca Pavarino	University of Pavia
Simone Scacchi	University of Milano
Stefano Zampini	KAUST

Abstract: The development of domain decomposition algorithms for mixed methods for incompressible Stokes equations and almost incompressible elasticity remained an important and open problem until fairly recently for the case when the pressure field is continuous. Our work, joint with Pavarino, Scacchi, and Zampini, extends important results by Xuemin Tu and Jing Li, SINUM 53, 2015, to almost incompressible elasticity and isogeometric analysis.

11:30-12:00

Parallel Methods for Patient-specific Blood Flow Simulations with Impedance Boundary Conditions

Rongliang Chen	Shenzhen Institutes of Advanced Technology
Wen-Shin Shiu	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences
Zaiheng Cheng	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences
Bokai Wu	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences
Zhengzheng Yan	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences
Xiao-Chuan Cai	University of Colorado Boulder

Abstract: Numerical simulation of blood flows in compliant arteries based on patient-specific geometry and parameters can be clinically helpful for physicians or researchers to study vascular diseases and plan surgery procedures. In this talk, we will discuss some scalable parallel domain decomposition methods for the simulation of blood flow in compliant arteries on large scale supercomputers. Several mathematical and supercomputing issues will be discussed in detail, and some numerical experiments for patient-specific arteries will be presented.

12:00-12:30

Optimized Schwarz Methods for Hemodynamic Problems

Christian Vergara	Politecnico di Milano
Giacomo Gigante	Università degli Studi di Bergamo
Giulia Sambataro	Politecnico di Milano

Abstract: We address the numerical solution of the fluid-structure interaction problem by means of a partitioned method based on Robin interface conditions. To select suitable values of the interface Robin parameters, we consider the Optimized Schwarz method set up for specific shapes of the fluid-structure interface. In particular, we consider the convergence analysis for cylindrical and spherical interfaces, useful for the solution of 3D blood dynamics problems in arteries. Funded by H2020-MSCA-ITN-2017, EU project 765374 "ROMSOC"

12:30-13:00

Non-linear Scalable Solvers for Cardiac Reaction-diffusion Models

Ngoc Mai Monica Huynh	University of Pavia
Simone Scacchi	University of Milan
Luca Pavarino	University of Pavia

Abstract: We present a class of non-linear Domain Decomposition methods (known as non-linear FETI-DP methods) for finite element discretizations of the non-linear parabolic PDEs describing the propagation of the electric impulse in the cardiac tissue, coupled with a simple ionic membrane model. The obtained preliminary results provide a basis for an extension of this study to the inclusion of more complex membrane models and to monolithic discretizations of cardiac electro-mechanical models.

13:00-13:30

Parallel Scalable Algebraic Monolithic Preconditioners for Applications in Cardiovascular Mechanics

Axel Klawonn	Universität zu Köln
Alexander Heinlein	University of Cologne
Christian Hochmuth	University of Cologne

Abstract: Monolithic overlapping Schwarz preconditioners for saddle point problems of Stokes and Navier-Stokes type are presented. In order to obtain numerically scalable algorithms, coarse spaces obtained from the GDSW (Generalized Dryja–Smith–Widlund) approach are used. Numerical results of our parallel implementation are presented for various incompressible fluid flow problems with applications to cardiovascular mechanics. Parallel scalability results for several thousand cores for Stokes and Navier- Stokes model problems are reported.

MS A3-S-C1 2 11:00-13:00

Systems, patterns and data engineering with geometric calculi - Part 1

For Part 2 see: MS A3-S-C1 3

Organizer: Sebastià Xambó-Descamps	Universitat Politècnica de Catalunya

Abstract: First develop as a language for physics (mechanics, space-time physics, electromagnetism), in the last two decades there has been an explosion of applications of Geometric Calculus in a great variety of areas, maily in the guise of Conformal Geometric Algebra, like general relativity, cosmology, robotics, computer graphics, computer vision, molecular geometry, quantum computing, etc. Now the development of applications of multivector wavelets to deep learning, much as scalar wavelets are beeing used with great success for that purpouse, is a very promissing research opportunity and the goal of the mini-symposium is to overview the main ideals of this large endeavour.

11:00-11:30

Geometric calculus techniques in science and engineering

Sebastià Xambó-Descamps	Universitat Politècnica de Catalunya

Abstract: First developed as a language for physics, recently there has been an explosion of applications of Geometric Calculus in a great variety of areas, like general relativity, cosmology, robotics, computer graphics, computer vision, molecular geometry, quantum computing, etc. Now the development of applications to deep learning is a very promising research opportunity and the goal of the mini-symposium is to overview the main ideas of this large endeavor and to point out some outstanding problems.

11:30-12:00

Bringing new perspectives to robotics and computer vision

Isiah Zaplana	Istituto Italiano Di Tecnologia (iit)

Abstract: One of the most successful applications of geometric calculus to engineering refers to robotics and computer vision. In this line, this talk presents an overview of the main classical problems in robot kinematics, motion planning and pose estimation and explains how geometric calculus has been used to solve them. Besides, it also introduces recent open problems in these fields and how geometric calculus is being used and can be used to contribute to their solutions.

12:00-12:30

Geometric algebra and distance geometry

Carlile Lavor	Universidade Estadual de Campinas

Abstract: Geometric Algebra (GA) is a generalization of the hypercomplex number systems based on the concept of multivector and Distance Geometry (DG) is the study of geometry based on the concept of distance. We will explain how GA and DG can be combined to model problems related to 3D protein structure calculations using Nuclear Magnetic Resonance data.

12:30-13:00

Embedded Coprocessors for Native Execution of Geometric Algebra Operations

Salvatore Vitabile	University of Palermo

Abstract: Geometric algebra (GA) is a simple and intuitive way to model geometric objects and their transformations. Its practical use requires dedicated software and hardware architectures to directly support Clifford data types and operators. In this talk, a family of embedded coprocessors for the native execution of GA operations is presented. It will be shown the evolution of the coprocessor family focusing on their direct hardware support to up to five-dimensional Clifford operations.

MS ME-0-1 2 11:00-13:00

Polygonal and Polyhedral Methods in Applied Mathematics - Part 2

For Part 1 see: MS ME-0-1 1
For Part 3 see: MS ME-0-1 3
For Part 4 see: MS ME-0-1 4

Organizer: Marco Verani	Politecnico di Milano
Organizer: David Mora	Universidad del Bio-Bio

Abstract: Recently, there has been a great interest to the study of numerical methods for the solution of PDEs on polygonal/polyedral computational meshes. This is motivated on one hand by the flexibility of polytopal meshes that allows, e.g., to effectively deal with complex geometries or with refinement/derefinement strategies, and on the other hand by the versatility to accurately facing the numerical approximation of a variety of problems (from fluidynamics, to elasticity and electromagnetism). The goal of this MS is to present the recent developments in the field of polygonal numerical methods in facing the approximation of applied problems governed by PDEs

11:00-11:30

The conforming virtual element method for polyharmonic problems

Marco Verani	Politecnico di Milano
Paola F. Antonietti	Politecnico di Milano
Gianmarco Manzini	Los Alamos and IMATI-CNR

Abstract: In this talk, we exploit the capability of virtual element methods in accommodating approximation spaces featuring high-order continuity to numerically approximate polyharmonic boundary value problems, and prove a priori error estimates in different norms.

11:30-12:00

hp-version discontinuous Galerkin methods on general meshes

Andrea Cangiani	University of Nottingham
Zhaonan Dong	IACM-FORTH
Emmanuil H. Georgoulis	University of Leicester & NTUA
Paul Houston	University of Nottingham
Younis Sabawi	Koya University

Abstract: We review recent work on the generalisation of the hp-version interior penalty discontinuous Galerkin finite element method (hp-DGFEM) to extremely general meshes, including elements with rough and curved boundaries. We will present the stability, a priori analysis, and a posteriori error analysis of hp-DGFEM for the discretisation of advection-diffusion-reaction problems, including multi-domain problems. Finally, the exploitation of general meshes within mesh adaptation algorithms will be discussed.

12:00-12:30

Virtual Element Methods for Elastiticy Problem

Carlo Lovadina	Università degli Studi di Milano
Edoardo Artioli	University of Rome Tor Vergata
Franco Dassi	University of Milano Bicocca
Stefano De Miranda	University of Bologna
Luca Patruno	University of Bologna
Michele Visinoni	Univesrity of Milano Bicocca

Abstract: We report our results about the Virtual Element dicretization of elasticity problems, when using the Hellinger-Reissner variational formulation. Imposing both the symmetry of the stress tensor and the continuity of the tractions at the inter-element is typically a great source of troubles in the framework of classical Galerkin schemes, for example in FEM. We exploit the great flexibility of VEM to present alternative methods, which provide symmetric stresses, continuous tractions but are nonetheless reasonably cheap.

12:30-13:00

The virtual element method for curved polygons

Giuseppe Vacca	University of Milano-Bicocca
Lourenco Beirao Da Veiga	University of Milano Bicocca
Alessandro Russo	University of Milano Bicocca

Abstract: In this talk we introduce the analysis of Virtual Elements in the presence of curved faces. We consider in particular the case of a fixed curved boundary in two dimensions, as it happens in the approximation of problems posed on a curved domain. We show (both theoretically and numerically) that the proposed curved VEM lead to an optimal rate of convergence, without any approximation of the boundary.

MS ME-0-7 2 11:00-13:00

Partial Differential Equations in Fluid Dynamics - Part 2

For Part 1 see: MS ME-0-7 1
For Part 3 see: MS ME-0-7 3
For Part 4 see: MS ME-0-7 4

Organizer: Yachun Li	Shanghai Jiao Tong University
Organizer: Tong Yang	City University of Hong Kong
Organizer: Ya-Guang Wang	Shanghai Jiao Tong University
Organizer: Yue-Jun Peng	CNRS/UCA LMBP

Abstract: The purpose of this minisymposium is to bring together mathematicians from all over the world in the area of partial differential equations to present their recent research results in analysis and applications about related models in fluid dynamics, to exchange new ideas, to discuss current challenging issues, to explore new research directions and topics, and to foster new collaborations and connections.

11:00-11:30

Compressible Vortex Sheets and Free Boundary Problems for the Multidimensional Euler Equations for Compressible Fluids

Gui-Qiang G. Chen	University of Oxford

Abstract: We are concerned with nonlinear stability/instability of compressible vortex sheets for the Euler equations in fluid dynamics. Such problems can be formulated as characteristic free boundary problems. In this talk, we discuss some recent efforts in the analysis of their nonlinear stability and related problems, including the stability of vortex sheets in steady or dynamic Euler flows under steady or initial perturbations, and explorations of stabilization mechanisms such as magnetic and relativistic effects, among others.

11:30-12:00

L^1 convergence to the Barenblatt solution for compressible Euler equation with damping

Feimin Huang AMSS, Chinese Academy of Sciences

Abstract: In this lecture, I will present recent works on the convergence rate to the Barenblatt solution for compressible Euler equation with damping.

12:00-12:30

From the Nash Kuiper theorem to the Euler equations of fluid dynamics

Marshall Slemrod University of Wisconsin, Madison

Abstract: C.DeLellis and L.Szekelyhidi, Jr. and their co-authors have shown how Gromov's theory of convex integration may be used to produce "wild" solutions of both the compressible and incompressible Euler equations. Gromov's theory in fact is a generalisation of the work of J.Nash and N.Kuiper for the C1 isometric embedding problem of Riemannian geometry. In this talk I will illustrate a possible direct link from the Nash-Kuiper result to the Euler equations.

12:30-13:00

Uniqueness of regular shock reflection

Wei Xiang City University of Hong Kong
Gui-qiang Chen University of Oxford
Feldman Mikhail University of Wisconsin-Madison

Abstract: We will talk about our recent results on the uniqueness of regular reflection solutions for potential flow equation in a natural class of self-similar solutions. The approach is based on a nonlinear version of method of continuity. An important property of solutions for the proof of uniqueness is the convexity of the free boundary. Actually, we show that convexity is a sufficient and necessary condition for the monotonicity of the psudo-potential.

MS A3-2-2 2 11:00-13:00

Molecular simulation: quantum mechanical models - Part 1

For Part 2 see: MS A3-2-2 3

Organizer: Gero Friesecke Technical Unversity of Munich
Organizer: Stamm Benjamin RWTH Aachen University

MS organized by the acitivity group Modelling, Analysis and Simulation of Molecular Systems (MOANSI)

Abstract: Molecular simulation is widely used in the fields of theoretical, experimental, and industrial chemistry and physics, molecular biology, pharmacology, electronics, and energy production and storage, for the study of molecular systems ranging from small chemical systems to large biological molecules and materials. Molecular simulation is also key for the development of the emerging technology of atomic-scale engineering of controllable nanodevices. The amount of resources devoted to molecular simulation in supercomputing centers often exceeds 40%. The five sessions of the Molecular Simulation minisymposia will illustrate the diversity and richness of the modeling, mathematical and numerical problems arising in this vibrant field.

11:00-11:30

A comprehensive overview of a posteriori error analysis for nonlinear eigenvalue problems: application to ab initio electronic structure calculations

Yvon Maday Sorbonne University, Paris, France

Abstract: Nonlinear eigenvalue problems occur in many mathematical models used in science and engineering such as the calculation of the vibration modes of a mechanical structure in the framework of nonlinear elasticity, the ground state of the Gross--Pitaevskii equation describing the steady states of Bose—Einstein condensates, or of the Hartree--Fock and Kohn--Sham equations used to calculate ground state electronic structures of molecular systems in quantum chemistry and materials science. The exact solutions being unknown, The approximation of the solutions to these problems is of major importance. Different methods to compute them are proposed depending on the various applications at stake. These approximations are based on different ingredients. First comes the notion of degrees of freedom, associated with the basis sets used to approximate the solutions of these problems, which leads to discrete problems that can be solved, hopefully, on a computer. Second, the discrete problems are, per force nonlinear, hence efficient algorithms must be designed to solve these problems accurately with a reasonable computational cost. In this presentation, we shall propose in an unified way an overview of some of the existing results for the a priori and a posteriori analysis for this class of nonlinear eigenvalue problems.

11:30-12:00

Error estimates of the tensor train format in quantum chemisty

Mi-Song Dupuy Technical University of Munich

Abstract: The N-body ground-state eigenfunction of a Schrödinger equation is usually discretized in the Fock space of antisymmetrized tensors of one-particle functions. This basis however grows exponentially with the number of one-particle functions. Recently, tensor train representations (or matrix product states) were found to numerically give sparse approximations of the ground-state. In the talk, results on the approximability of Slater determinants by tensor trains will be presented with precise statements on matricizations of the ground-state tensor.

12:00-12:30

Semidefinite relaxation of multi-marginal optimal transport, with application to strictly correlated electrons in second quantization

Michael Lindsey University of California Berkeley
Yuehaw Khoo Stanford University
Lin Lin University of California, Berkeley
Lexing Ying Stanford University

Abstract: We consider the strictly correlated electron (SCE) limit of the fermionic quantum many-body problem in the second-quantized formalism. This limit gives rise to a multi-marginal optimal transport (MMOT) problem. We propose efficient semidefinite relaxation methods for this problem, yielding lower bounds for the optimal cost (i.e., the SCE energy) that are approximately tight in practice. We demonstrate the effectiveness of our methods on various model problems.

MS GH-1-G 2 11:00-13:00

Advanced numerical methods for evolving manifolds - Part 2

For Part 1 see: MS GH-1-G 1
For Part 3 see: MS GH-1-G 3
For Part 4 see: MS GH-1-G 4

Organizer: Jooyoung Hahn AVL List GmbH
Organizer: Peter Frolkovič Slovak University of Technology
Organizer: Karol Mikula Slovak University of Technology

Abstract: Advanced numerical methods for solving problems related to evolving curves and surfaces in 2D/3D are presented. We cover contemporary algorithms based on Lagrangian and Eulerian methods (level set or VOF approach) for manifolds approximated by discrete curves and surfaces, which are actively used not only in a research but also in an industrial area in computer-aided engineering. The presented algorithms are meant to be applied in state-of-the-art computations including complex computational domains (e.g. 3D polyhedron meshes), complicated physics (e.g. multiphase flows), nontrivial surface reconstructions, volume and surface reconstruction, and similar.

11:00-11:30

Three-dimensional volume reconstruction using two-dimensional parallel slices

Chang-Ock Lee KAIST
Junwoo Kim KAIST

Abstract: We propose a PDE model for 3-D volume reconstruction from 2-D slices. The method is based on the modified Cahn-Hilliard equation for 3-D binary inpainting. To satisfy the constraints while obtaining a smooth result, we apply a presmoothing procedure based on anisotropic diffusion to the slices. After splitting a grayscale image into binary channels, we perform multichannel Cahn-Hilliard inpainting. Then we adopt smoothing and a shock filter as postprocessing to combine the binary inpainting results.

11:30-12:00

Coronary artery reconstruction

Kiwan Jeon National Institute for Mathematical Sciences
Kyungsang Kim Gordon Center for Medical Imaging, MGH and HMC, Boston, MA, USA
Quanzheng Li Gordon Center for Medical Imaging, MGH and HMC, Boston, MA, USA

Abstract: Coronary artery disease is one of the leading causes of death in developed countries. In the area of diagnosis and treatement, indeed, it is essential that accurate blood vessel status can be provided to the medical staff with visualized information. In this presentation, we discuss the mathematical problems required for 4- dimensional coronary artery image reconstruction considering 3-D or time-based motion using C-arm based 2D images.

12:00-12:30

Point clouds and image segmentation by level set method

Balazs Kosa — Slovak University of Technology

Abstract: In this talk, we deal with 3D image segmentation where the segmented surface is reconstructed by using 3D point cloud data and 3D digital image information. We apply a mathematical model and numerical method based on the level set algorithm. The method solves surface reconstruction by the application of advection equation with a curvature term. The advective velocity in this equation is defined as the weighted sum of distance function and edge detector function gradients.

12:30-13:00

Lagrangian surface evolutions in computational geometry

Matej Medľa — Slovak University of Technology

Karol Mikula — Slovak University of Technology, Bratislava

Abstract: The talk presents remeshing method of triangulated mesh into the 2D quadrilateral mesh. An initial surface evolves in a velocity field (a gradient of a distance function from the target) and is regularized by a mean curvature evolution. Such an evolution results in a mesh copying the target triangulated mesh. This is partially a common work with Martin Húska and Serena Morigi from the University of Bologna.

MS A6-3-2 2 — 11:00-13:00

Modeling and Simulations for Morphological Evolution of Nanoscale Crystal Growth - Part 1

For Part 2 see: MS A6-3-2 3

For Part 3 see: MS A6-3-2 4

Organizer: Chaozhen Wei — Hong Kong University of Science and Technology

Organizer: Dong Wang — University of Utah

Abstract: This minisymposium focuses on the mathematical modeling, analysis, and numerical simulations of the diverse phenomena in nanoscale crystal growth. The research is interdisciplinary, spanning the fields of mathematics, materials science, physics, and chemistry. The speakers will talk about their recent work on the corresponding experiment, theory, model, and numerical simulations of a range of interesting phenomena including but not limited to the morphological evolution, solid-state wetting/de-wetting, coarsening dynamics, space-time microstructure, and epitaxial growth.

11:00-11:30

Surface diffusion and grain migration: evolution and steady states

Amy Novick-Cohen — Technion IIT

Abstract: Coupled surface diffusion motion and grain migration impact the structures that appear in thin polycrystalline systems. Important phenomena include thermal grooving, wetting and dewetting, and hillock and hole formation. Models typically couple fourth and second order motions. We outline some results in this direction by considering travelling wave solutions, self-similar solutions, and stable as well as metastable steady states.

11:30-12:00

Numerical methods for solid-state dewetting of thin films

Yan Wang — Central China Normal University

Abstract: This talk is devoted to numerical methods for solid-state dewetting of thin films. We first review several methods for solving its sharp-interface model. Then a new ϴ-L approach is proposed. The new method can both reduce the stiffness from surface diffusion and improve the performance in mesh equi-distribution.

12:00-12:30

Microstructural entropy and its role in grain growth and microstructure-property relation

Maria Emelianenko — George Mason University

Katerine Saleme Ruiz — University of Luxembourg

Abstract: While empirical laws like Hall-Petch have long been known to give inverse relationship between average grain size and polycrystalline material strength, complete understanding of the role microstructure geometry and topology play in coarsening and mechanical deformations is still missing. This talk compares different types of entropy measures that may be used to characterize microstructure disorder based on their ability to capture deviations in certain mechanical and kinetic properties estimated via large scale numerical simulations.

12:30-13:00

An efficient threshold dynamics method for wetting dynamics

Dong Wang — The University of Utah

Abstract: In this talk, we develop an efficient volume preserving threshold dynamics method for simulating wetting on rough surfaces. This method is based on the minimization of the weighted surface area functional over an extended domain that includes the solid phase. The method is simple, stable with O(NlogN) complexity per time step and is not sensitive to the inhomogeneity or roughness of the solid boundary.

MS FT-1-10 2 — 11:00-13:00

Numerical methods for interfacial dynamics - Part 2

For Part 1 see: MS FT-1-10 1

For Part 3 see: MS FT-1-10 3

For Part 4 see: MS FT-1-10 4

Organizer: Weiying Zheng — Chinese Academy of Sciences

Organizer: Zhilin Li — North Carolina State University

Organizer: Qinghai Zhang — Zhejiang University

Abstract: We propose a mini-symposium on interfacial problems and dynamics in ICIAM2019 that concerns different aspects of this important topic such as mathematical modeling, theoretical analysis, and numerical methods. An important goal of this workshop is to foster collaboration between mathematicians, computational scientists, and engineers. Numerical methods include but are not restricted to interface tracking methods, immersed boundary/interface methods, extended finite element methods, arbitrary Lagrange-Euler methods, and so on. The nature of this workshop will be mathematics centered with multi-disciplinary multi-physics applications, particularly for free-surface flows, fluid-structure interaction, and other related multiphase flows.

11:00-11:30

The IIM for the solution of hyperbolic conservation laws

Juan Ruiz Álvarez — Universidad Politécnica de Cartagena

Abstract: This work is devoted to the construction and analysis of a new finite volumen algorithm for the solution of hyperbolic conservation laws. It is inspired by Harten’s ENO subcell resolution strategy. The reconstruction of the fluxes is performed using the high order accuracy interpolation based on the IIM introduced in S. Amat, Z. Li, J. Ruiz, Journal of Scientific Computing (2014), which allows to prevent the smearing of contact discontinuities without using extrapolation.

11:30-12:00

A Regularized Least Squares Radial Basis Function Method for Partial Differential Equations

Shingyu Leung — The Hong Kong University of Science and Technology

Abstract: We present recent numerical methods for solving partial differential equations on manifolds and point clouds. We present a local regularized least squares radial basis function (RLS-RBF) method for solving partial differential equations on irregular domains or on manifolds. The idea extends the standard RBF method by replacing the interpolation in the reconstruction with the least squares fitting approximation.

12:00-12:30

A Dynamical Multi-scale Computational Model in Cancer Invasion of Tissue

Ping Lin — University of Dundee

Abstract: We introduce a dynamical multiscale model describing the process of cancer invasion of tissue. It includes the macroscopic dynamics of the distributions of cancer cells and of the surrounding extracellular matrix, and the microscale dynamics of the matrix degrading enzymes. These microscale dynamics take place at the interface of the cancer cells and the extracellular matrix. We have also developed computational schemes for both the micro scale and the macro scale equations.

12:30-13:00

Mathematical model for charge transport in nanofluidic problems

Zhenli Xu — Shanghai Jiao Tong University

Manman Ma Tongji University
Liwei Zhang Shanghai Jiao Tong University

Abstract: We studied dynamics of ions in a nanofluidic device, where dielectric effect plays important role. The ionic cloud surrounding a mobile ion near an interface is tunable due to the force from image charges, thus, the ionic mobility is significantly different from that in region far from the interface. We developed a new mathematical model to describe the so-called relaxation force. Numerical results and analysis are present to show the performance.

MS A3-3-3 2 11:00-13:00

Modelling and calibration in pedestrian dynamics - Part 2

For Part 1 see: MS A3-3-3 1
Organizer: Susana Gomes University of Warwick
Organizer: Marie-Therese Wolfram University of Warwick

Abstract: We aim to bring experts from applied mathematics and transportation research together to present recent developments in the respective fields and initiate intra- and interdisciplinary collaborations. There is a rich mathematical and engineering literature on mathematical models in pedestrian dynamics. With the ongoing developments more and more data such as pedestrian trajectories and velocities are available. Blending this data with models to calibrate and estimate parameters, is of great interest in the engineering and applied mathematics community. The proposed mini-symposium highlight the latest advancements and help to develop pathways from analytic and computational methods in real-world applications.

11:00-11:30

Pedestrian and material flow problems: similarities and differences

Simone Göttlich University of Mannheim

Abstract: We introduce a hierarchy of models enabling to consider different levels of simulation accuracy. Our intention is to develop a hybrid framework which is able to switch between the scales. This allows for either a fine or coarse resolution to detect collisions or identify free flow regimes. Based on the discretization, the switching is able to interpret information on individual particles as density distributions and vice versa. Simulation results are presented to demonstrate the performance.

11:30-12:00

Parameter Calibration in Crowd Simulation Models using Approximate Bayesian Computation

Nikolai Bode University of Bristol

Abstract: One of the crucial challenges in pedestrian dynamics is to relate theoretical models to data. I will give two examples for fitting models to data and for comparing different models based on data using a Likelihood-free technique called Approximate Bayesian Computation. The first example is concerned with macroscopic models for streams of intersecting pedestrians at crossings and the second example considers microscopic models that describe the movement of individual pedestrians.

12:00-12:30

High statistics measurements of pedestrian dynamics, modeling and control

Alessandro Corbetta Technische Universiteit Eindhoven

Abstract: Pedestrians motion features huge variability: despite individual unpredictability, ensemble-level universal physical features emerge. Reaching their quantitative understanding is a scientific challenge with deep societal impact. We investigate such features via real-life observational experiments (in stations, museums...). Through home-made high-fidelity tracking systems, we acquire datasets including millions of trajectories, and we evaluate PDFs of velocities, positions, "social-forces", etc. - possibly in combination with crowd control measures. We propose a statistically quantitative Langevin-like model of the dynamics.

12:30-13:00

Pedestrian Models based on Rational Behaviour

Rafael Bailo Imperial College London
José Antonio Carrillo De La Plata Imperial College London
Pierre Degond Imperial College London

Abstract: As a response to the mechanistic pedestrian dynamics literature, we consider a model for pedestrian dynamics that attempts to reproduce the rational behaviour of individual agents through the means of anticipation. Each pedestrian undergoes a two-step time evolution based on a perception stage and a decision stage. We discuss the validity of the model in regimes with varying degrees of congestion, ultimately presenting a correction to achieve realistic high-density dynamics.

MS FE-1-2 2 11:00-13:00

Computational Methods for Inverse Problems - Part 2

For Part 1 see: MS FE-1-2 1
For Part 3 see: MS FE-1-2 3
For Part 4 see: MS FE-1-2 4
Organizer: Alessandro Buccini Kent State University
Organizer: Lothar Reichel Kent State University

Abstract: Inverse problems arise in most scientific fields. These problems are usually ill-posed and can be of very large dimension. Developing fast and accurate methods for their solution is of fundamental importance. Moreover, since most methods require the estimation of one or more regularization parameters, the development of automatic strategies for the selection of these parameters is of considerable importance, especially for real-world applications. This minisymposium presents new approaches to the solution of inverse problem and to the automatic estimation of regularization parameters.

11:00-11:30

Non-convex optimization for 3D point source localization using a rotating point spread function

Raymond Chan The City University of Hong Kong
Chao Wang University of Texas at Dallas
Mila Nikolova ENS, Cachan
Robert Plemmons Wake Forest University
Sudhaker Prasad University of New Mexico

Abstract: We consider the high-resolution imaging problem of 3D point source image recovery from 2D data using a method based on point spread function (PSF) engineering. The method involves the use of a rotating PSF with a single lobe to obtain depth from defocus. A new nonconvex regularization method with a data-fitting term based on Kullback-Leibler (KL) divergence is proposed. Numerical experiments illustrate the efficiency and stability of the algorithms.

11:30-12:00

Unmixing spectral micrographs via sparse affine nonnegative matrix factorization

Blair Rossetti Emory University

Abstract: Spectral microscopy is a technique for measuring the spectral characteristics of micron-scale objects. The inverse problem, called spectral unmixing, attempts to determine the concentrations of fluorescent molecules based on the observed spectral signatures. Unfortunately, real-world images are often contaminated by unknown autofluorescence that degrades the unmixing results. We will discuss a sparse affine nonnegative matrix factorization method for unmixing contaminated spectral micrographs.

12:00-12:30

Fourier mesh and graph-Laplacian combined with Tikhonov-regularization for signal deblurring

Davide Bianchi University of Insubria

Abstract: This talk deals with inverse problems regularization that arise from compact integral operators or self-adjoint differential operators, embedded in a graph setting enviroment. Discretizing the model problem by means of graphs helps to exploit the geometry of the underlying continuous space. In particular, the standard Tikhonov-type regularization with respect to an appropriate graph-Laplacian provides a significant improvement of the signal reconstruction, avoiding the difficult issue of estimating the regularization parameters.

12:30-13:00

Recovering the electromagnetic features of the subsoli via linear and nonlinear models

Giuseppe Rodriguez University of Cagliari

Abstract: Electromagnetic induction techniques are often used to ascertain the presence of conductive substances in the subsoil. Measuring devices detect the secondary electromagnetic field which is produced by eddy currents induced by the instrument generated field. Inverting the sensed data to obtain the electrical conductivity w.r.to depth is an ill-posed problem. We discuss the regularized inversion of linear and nonlinear models for EM data propagation, and show numerical simulations on synthetic and real-world data sets.

MS GH-3-2 2 **11:00-13:00**

Preconditioners for Linear Algebra Methods in Large Scale Scientific Computing - Part 2

For Part 1 see: MS GH-3-2 1
For Part 3 see: MS GH-3-2 3
For Part 4 see: MS GH-3-2 4

Organizer: Luca Bergamaschi University of Padua
Organizer: Angeles Martinez University of Padua
Organizer: Jose Marin Polytechnic University of Valencia

Abstract: Mathematical models of a high number of processes in Engineering and Applied Sciences once numerically discretized require the repeated solution of large (non)linear systems or eigenvalues problems. All these linear algebra problems are usually addressed by iterative methods which take into account the sparsity of the matrices involved. To provide an approximate solution in a reasonable amount of time, such iterative methods need to be accelerated by suitable preconditioners. The aim of this miniworkshop is to collect the most recent results in the construction of efficient preconditioners applied to discretizations of PDEs as well as constrained optimization problems.

11:00-11:30

Iterative solution of linear systems with double saddle point structure

Michele Benzi Scuola Normale Superiore

Abstract: Large linear systems with double saddle point structure arise in several applications, in particular from finite element modelling of fluid flow problems and of liquid crystals. Exploitation of the block structure of suche nested saddle point problems is crucial in order to develop scalable solvers. Several block preconditioners for Krylov subspace methods for the solution of double saddle point systems will be discussed and analzyed. This is joint work with Fatemeh Beik.

11:30-12:00

Multilevel Variable-Block Schur-Complement Based Preconditioning for General Linear Systems

Bruno Carpentieri Free University of Bozen-Bolzano
Masha Sosonkina Old Dominion University

Abstract: Sparse matrices arising from the solution of systems of partial differential equations often exhibit fine-grained block structures in the pattern when several unknown quantities are associated with the same grid point. We present a class of multilevel incomplete factorization preconditioners that incorporates compression techniques during the factorization to detect fine-grained dense structures in the linear system automatically, without the user’s knowledge of the underlying problem, and exploits them to improve the solver performance.

12:00-12:30

PDE-Constrained Optimization in Scientific Processes: Linear Algebra and Preconditioning for Huge-Scale Systems

John Pearson University of Edinburgh

Abstract: PDE-constrained optimization problems have a wide variety of applications across mathematics and the applied sciences, so it is important to develop fast and feasible numerical linear algebra methods to obtain accurate solutions. We employ preconditioned iterative schemes to tackle the large and sparse matrix systems that arise from the discretization of such problems, highlighting applications in physics (fluid flow control), chemistry (reaction-diffusion equations modelling chemical processes), and biology (pattern formation and bacterial chemotaxis).

12:30-13:00

Accelerating the iterative solution of convection-diffusion problems using SVD

Luca Heltai Luca Heltai
Giuseppe Pitton Imperial College, London

Abstract: Recycling Krylov space methods are often used to speed up the solution of time dependent advection-diffusion problems. These methods are often based on the selection and retention of some Arnoldi vectors from previous iterations. We propose a recycling strategy based on a singular value decomposition selection of previous solutions and exploit this information in classical and new augmentation and deflation methods, that show promising results in high order discretisations of scalar nonlinear convection–diffusion problems.

MS A6-1-1 2 **11:00-13:30**

Fast algorithms for wave propagation and its applications

Organizer: Manas Rachh Flatiron Institute
Organizer: Jeremy Hoskins Yale University
Organizer: Howard Levinson University of Michigan

Abstract: The development of efficient numerical tools for modeling wave propagation is of practical importance in the design of electronic, photonic and optical devices such as waveguides, optical transistors, high-energy lasers etc. Optimizing the performance of these devices requires the development of efficient algorithms capable of achieving high accuracy in complex geometries. We focus on two particular aspects in this minisyposium --- the development of novel techniques in difficult regimes such as Schrodinger's equation and radiative transfer equations; and improved efficiency of fast algorithms for the solution of Helmholtz and Maxwell equations (both forward and inverse problems) in complex geometries.

11:00-11:30

Fast T-matrix methods for forward and inverse problems

Howard Levinson University of Michigan

Abstract: The T-matrix, or transition operator, is a well defined operator of interest in scattering processes. Using a T-matrix approach to solve forward problems has several advantages, including fast computation for arbitrary configuration of sources and detectors, and natural adaptive mesh generation. Moreover, by exploiting the one-to-one correspondence between the T-matrix and the unknown scattering potential, one can develop fast algorithms for the related inverse problem. Numerical simulations will be shown.

11:30-12:00

Fast algorithm for radiative transfer equation

Yimin Zhong University of California, Irvine
Kui Ren Columbia University
Rongting Zhang University of Texas at Austin

Abstract: We present in this work a simple fast computational algorithm for solving the ERT in isotropic media. We solve a volume integral equation for the angularly-averaged ERT solution using iterative schemes such as the GMRES method. The computation in this step is accelerated with a fast multipole method (FMM). Then we solve a scattering-free transport equation to recover the angular dependence of the ERT solution.

12:00-12:30

Fluorescence Ultrasound Modulated Optical Tomography in the Diffusive Regime

Yang Yang Michigan State University
Wei Li Louisiana State University
Yimin Zhong University of California, Irvine

Abstract: We study a hybrid imaging modality known as fluorescence ultrasound-modulated optical tomography (fUMOT) which combines the fluorescence optical tomography with ultrasound to achieve both high resolution and high contrast. We will set up a mathematical model for fUMOT, prove well-posedness for certain choices of parameters, and present reconstruction algorithms and numerical experiments for the well-posed cases. This is joint work with Wei Li and Yimin Zhong.

12:30-13:00

Fast evaluation of Helmholtz and Maxwell layer potentials in three dimensions using Quadrature by expansion (QBX)

Manas Rachh Flatiron Institute
Michael O'Neil Courant Institute of Mathematical Sciences
Leslie Greengard Flatiron Institute/Courant Institute of Mathematical Sciences

Abstract: The practical application of integral equation methods requires the evaluation of singular or weakly singular integrals on complex geometries. When solving integral equations using iterative methods, the layer potentials need to be evaluated on the same geometry but with densities. In this setup, many local quantities can be precomputed to further accelerate subsequent evaluation of the layer potentials. In this talk, we apply this approach for linear CPU time layer potential evaluators using QBX.

MS A6-5-2 2 **11:00-13:00**

Mathematical modeling and scientific computing in life sciences - Part 2

For Part 1 see: MS A6-5-2 1

Organizer: Douglas Zhou Shanghai Jiao Tong University

Organizer: Hao Ge	Peking University

Abstract: As advanced experimental tools have been developed and applied to life sciences, researchers are capable of obtaining massive data over scales ranging from the molecule, single cell, to network systems. How to integrate all these data to build efficient mathematical models becomes a challenging issue. As more realism is incorporated into models, novel dynamical features often arise which further enrich our understanding of the biological systems. This minisymposium explores this theme by discussing recent works in mathematical modeling and scientific computing in life sciences. The speakers will draw particular attention to new mathematical approaches in explaining various experimental observations.

11:00-11:30

Weighted Least Square Analysis Method for Free Energy Calculation and Its Applications

Dan Hu	Shanghai Jiao Tong University
Xiaoqing Guan	Shanghai Jiao Tong University
Yukun Wang	Shanghai Jiao Tong University

Abstract: Here we develop a WEighted Least Square Analysis Method (Welsam) for free energy analysis of complex rare event dynamics. In Welsam, bin segmentation is decoupled from application of umbrella potentials, which allows us to perform one-dimensional bin segmentation and calculate one-dimensional potential of mean force along transition paths. Welsam has a comparable statistical error with Wham and can be used to reduce waste of sample data obtained during exploration of reaction coordinates.

11:30-12:00

Mathematical modeling of single-neuron dynamics with dendritic computation

Songting Li	Shanghai Jiao Tong University
Douglas Zhou	Shanghai Jiao Tong University
David Cai	the Courant Institute
David McLaughlin	the Courant Institute

Abstract: Dendrites are crucial for neuronal information processing. To capture the function of dendrites, by using theoretical analysis, realistic simulations, and electrophysiological experiments, here we develop a neuron model being capable of performing comprehensive dendritic computations. In contrast to prevailing models which are either biologically detailed but computationally expensive or computationally efficient but biologically oversimplified, the developed model will greatly reduce the computational cost in large-scale neuronal network simulations without the loss of dendritic functions.

MS ME-1-1 2 11:00-13:00

Recent developments in nonlinear PDEs of hydrodynamics and mathematical biology - Part 2

For Part 1 see: MS ME-1-1 1
For Part 3 see: MS ME-1-1 3

Organizer: Vincent Martinez	City University of New York - Hunter College
Organizer: Kun Zhao	Tulane University
Organizer: Michael Jolly	Indiana University

Abstract: This session combines ideas from fluid dynamics, mathematical biology, and dynamical systems that address current issues in regularity of solutions, their growth and decay, as well as issues of stability and quantitative descriptions of their long-time behavior. Recent developments have successfully exploited various similarities between conservation laws, chemotaxis and aggregation models, and the equations of compressible or incompressible fluid motion. This session will bring together a diverse set of researchers, most at the early stage of their careers, who will share fresh expertise on gradient flows, flocking dynamics, conservation laws, fluid dynamics, and dissipative equations.

11:00-11:30

Inertial manifolds for 1D reaction-diffusion-advection (RDA) problems

Anna Kostianko	University of Surrey

Abstract: The main aim of this talk is a comprehensive study of RDA equations in 1D with different boundary conditions. I will mainly concentrate on Dirichlet and Neumann BC and show the existence of inertial manifolds (IMs) for them using a specially designed non-local in space diffeomorphism which transforms the equations into new ones for which the spectral gap conditions are satisfied, and therefore IMs exist.

11:30-12:00

Global regularity for a rapidly rotating convection model of tall columnar structure with weak dissipation

Yanqiu Guo	Florida International University
Chongsheng Cao	Florida International University
Edriss Titi	Texas A&M University

Abstract: This presentation is based on our analysis of a three-dimensional fluid model describing rapidly rotating convection that takes place in tall columnar structures. Global well-posedness for strong solutions is shown provided the model is regularized by a weak dissipation term. The main difficulty lies in the fact that the physical domain is three-dimensional, whereas the regularizing viscosity acts only on the horizontal variables. This is a joint project with C. Cao and E. Titi.

12:00-12:30

Plant Dynamics, Birth-Jump Processes, and Sharp Traveling Waves

Nancy Rodriguez	University of Colorado-Boulder

Abstract: Motivated by the importance of understanding the dynamics of the growth and dispersal of plants in various environments we introduce and analyze a discrete agent-based-model based on a birth-jump process, which exhibit wave-like solutions. We derive the diffusion-limit of the discrete model and prove the existence of traveling wave solutions assuming a logarithmic-type growth. Furthermore, we provide a variational speed for the minimum speed of the waves and perform numerical experiments that confirm our results.

12:30-13:00

The McKean–Vlasov equation on the torus: Stationary solutions, phase transitions, and mountain passes

Rishabh Gvalani	Imperial College

Abstract: We study the McKean–Vlasov equation on the torus which is obtained as the mean field limit of a system of interacting diffusion processes enclosed in a periodic box. We focus our attention on the stationary problem - under certain assumptions on the interaction potential, we show that the system exhibits multiple equilibria. We classify continuous and discontinuous phase transitions for this system and obtain conditions under which the free energy possesses a mountain pass point.

MS GH-1-1 2 11:00-13:00

Advanced numerical tools for wave propagation simulation - Part 2

For Part 1 see: MS GH-1-1 1

Organizer: Julien Diaz	Inria
Organizer: Tordeux Sébastien	Université de Pau et des Pays de l'Adour
Organizer: Bendali Abderrahmane	INSA

Abstract: The objective, in this mini-symposium, is to report on the progress recently achieved on advanced tools for the numerical solution of problems related to wave propagation phenomena. These activities will be covered in two sessions dedicated to time-harmonic and time-domain problems. The time-harmonic session will address new techniques for reducing the so-called pollution effect, as well as efficient tools for the solution of the huge linear systems resulting from the discretization. The time-domain session is dedicated to some recent efficient techniques such as space-time Trefftz and multi-scale methods. New developments on visualization tools of wave propagation will be also presented.

11:00-11:30

Hybridizable Discontinuous Galerkin schemes for elastic waves.

Shukai Du	University of Delaware

Abstract: We present a semi-discrete Hybridizable Discontinuous Galerkin (HDG) method for transient elastic waves and prove its uniform-in-time optimal convergence. The core in the design and the analysis of the method is a newly devised tailored projection for the Lehrenfeld-Schöberl type HDG (HDG+). The projection enables us to recycle existing projection-based error analysis techniques and render the analysis of our method simple and concise. We show some numerical experiments at the end to support our analysis.

11:30-12:00

A space-time Trefftz discontinuous Galerkin method for the acoustic wave equation

Paul Stocker	University of Vienna
Ilaria Perugia	University of Vienna

Joachim Schöberl Vienna University of Technology
Christoph Wintersteiger Vienna University of Technology

Abstract: We present a space-time Trefftz discontinuous Galerkin (DG) method for the approximation of the acoustic wave equation on space-time tent-pitched meshes. Tent-pitching is a front-advancing mesh technique that allows to completely localize the solution of the discrete system. Trefftz basis functions are local solutions to the wave equation, that allow to simply advance the solution from the bottom to the top of each tent-element. The method has been implemented in NGSolve, solving elements in parallel.

12:00-12:30

New Results on the MHM method for Elastic Wave Propagation in Complex Media

Frédéric Valentin National Laboratory for Scientific Computing - LNCC
Weslley Pereira LNCC - National Laboratory for Scientific Computing

Abstract: We present a family of multiscale finite element methods for the linear elastodynamic model with highly heterogeneous coefficients, named Multiscale Hybrid-Mixed (MHM) methods. The MHM method consists of a strategy that naturally incorporates multiple scales in the numerical solutions while providing solutions with high-order precision for the primal and dual variables. Numerical results verify the theoretical optimal convergence of the method, and its capacity to incorporate heterogeneity and high-contrast coefficients in the numerical solutions.

MS GH-0-1 2 **11:00-13:00**

Modeling and simulation of materials defects and inhomogeneities - Part 2

For Part 1 see: MS GH-0-1 1
For Part 3 see: MS GH-0-1 3
For Part 4 see: MS GH-0-1 4
For Part 5 see: MS GH-0-1 5
For Part 6 see: MS GH-0-1 6
Organizer: Luchan Zhang National University of Singapore
Organizer: Shuyang Dai Wuhan University

Abstract: Materials defects and inhomogeneities, such as dislocations and grain boundaries in solids, fluid-solid and fluid-fluid interfaces, and fine microstructures within advanced materials, play essential roles in the mechanical and dynamical behaviors of the materials. The complexity of modeling microstructures of these defects and inhomogeneities, and their evolution at various length and time scales present new challenges for mathematical modeling and analysis. Multiscale and multiphysics models are required to accurately describe the complicated phenomenon associated with defects and inhomogeneities. Speakers in this minisymposium will discuss recent advances in modeling approaches and simulation methods, and new findings obtained in analysis and simulations.

11:00-11:30

A threshold dynamics method for wetting dynamics

Xiao-Ping Wang Hong Kong University Of Science And Technology, China

Abstract: We propose a threshold dynamics method for wetting dynamics. The new method is also based on minimizing the functional consisting of weighted interface areas over an extended domain including the solid phase. The method is simple, unconditionally stable with $O(NlogN)$ computational complexity per time step. Numerical examples have shown significant improvements in the accuracy of the contact angle and the hysteresis behavior of the contact angle.

11:30-12:00

Computing committor functions for the study of rare events using deep learning

Weiqing Ren National University of Singapore
Qianxiao Li Institute of High Performance Computing, A*STAR
Bo Lin National University of Singapore

Abstract: The committor function is a central object in understanding transition events in complex systems. Computing the committor function at low temperatures is a challenging task due to the high dimensionality. In this talk, I will present a computational approach that overcomes these issues and achieves good performance on practical problems. The method combines deep learning, importance sampling and feature engineering techniques. The work was supported by Singapore MOE AcRF grants and NSFC (No.11871365, NUSRI(Suzhou)).

12:00-12:30

Discrete Kernel Preserving Model for 1D Electron-Phonon Scattering

Ruo Li Peking University, China

Abstract: We investigate the discretization of of an electron-optical phonon scattering using a finite volume method. The discretization is conservative in mass and is essentially based on an energy point of view. This results in a discrete scattering system with elegant mathematical features, which are fully clarified. We point out that this is closely related to the famous Perron-Frobinius theorem.

12:30-13:00

Nonperiodic multiscale problems: Some recent numerical advances

Legoll Frederic Ecole des Ponts and Inria
Claude Le Bris ENPC and Inria
Francois Madiot ENPC and Inria

Abstract: The Multiscale Finite Element Method is a Finite Element type approach for multiscale PDEs, where the basis functions of the approximation space are specifically adapted to the problem at hand and are precomputed during an offline stage. We will review some recent progresses on the approach, aiming at developping a more robust method (less sensitive to the geometry of the heterogeneities) and understanding the approach in contexts more general than the classical purely diffusive context.

MS ME-1-3 2 **11:00-13:00**

Emerging problems in the Homogenization of Partial Differential Equations - Part 2

For Part 1 see: MS ME-1-3 1
Organizer: Patrizia Donato LMRS, Université de Rouen Normandie
Organizer: Manuel Luna-Laynez University of Seville

Abstract: The mathematical homogenization models microscopically heterogeneous media providing macroscopic models describing their effective behavior. Although performant methods are nowadays well established, new challenging problems appear in the homogenization of partial differential equations. Indeed, researchers are currently interested in new and difficult situations, dealing with more realistic and complex models, as well as with more difficult mathematical problems, like complicated shapes of the domain, or singular nonlinear problems, or problem with weak regularity data. The aim of the minisymposium is to put together renowned specialists from all over the world overcovering a wide range of emerging challenging problems in the field.

11:00-11:30

Effective Helmholtz equation for domains with a perforation along an interface

Ben SCHWEIZER Fakultät für Mathematik, TU Dortmund

Abstract: We investigate the Helmholtz equation in a perforated domain. The analysis starts with the lowest order approximation: We find that the Neumann sieve perforation along an interface is invisible to leading order. Non-trivial transmission conditions occur for the corrector. We derive these conditions with a direct method, which relies on L^1-estimates and the study of limit measures. We generalize results of Delourme, Haddar, and Joly, and require only second order equations in the derivation.

11:30-12:00

Derivation of cable equation by multiscale analysis for a model of myelinated axons

Irina PETTERSSON University of Gävle
Carlos Jerez-Hanckes Universidad Adolfo Ibáñez, Santiago, Chile
Volodymyr Rybalko Institute for Low Temperature Physics and Engineering, Ukraine

Abstract: We derive a one-dimensional nonlinear cable model for the electrical potential propagation along myelinated axons using multiscale analysis. A typical thickness of a neuron is much smaller than its length, and the myelin sheath is distributed periodically, so we arrive at a homogenization problem with alternating boundary conditions. The myelin conductivity is assumed to be small but not zero, which leads to an additional potential in the limit cable equation.

12:00-12:30

The influence of a strongly oscillating magnetic field in an elastic body

Juan Casado-Díaz	University of Seville
Marc Briane	INSA Rennes, France

Abstract: We deal with the homogenization of a magneto-elastodynamics equation satisfied by the displacement of an elastic body subjected to an oscillating magnetic field. We show that these oscillations induce an increase of mass in the homogenized equation and the apparition of a nonlocal Lorentz force the range of which is limited to a light cone at each point (t,x).

12:30-13:00

Homogenization of semilinear elliptic problems singular at u=0

Daniela GIACHETTI	Sapienza, Università di Roma LA Sapienza

Abstract: We introduce a notion of (nonnegative) solution for a class of semi linear elliptic problems having lower order terms which are singular on the set where the solution vanishes. We prove the existence, stability and uniqueness if F(x,u) is nonincreasing in the u variable. We study the homogenization of these equations in perforated domains, with Dirichlet boundary conditions.

MS FE-1-G 2 11:00-13:00

Mathematical and numerical modeling of the human heart - Part 2

For Part 1 see: MS FE-1-G 1

Organizer: Luca Dedé	POLITECNICO DI MILANO - LABORATORIO MOX
Organizer: Alfio Quarteroni	EPFL, Lausanne, Switzerland & Politecnico di Milano, Italy
Organizer: Andrea Manzoni	POLITECNICO DI MILANO - LABORATORIO MOX -

Abstract: The mathematical modeling and numerical simulation of the heart function are fascinating, but significantly challenging tasks. A fully integrated heart model is indeed a complex multiphysics and multiscale differential problem, which embeds several core cardiac models, that is electrophysiology, active and passive mechanics, fluid dynamics, and valve dynamics. This minisymposium aims at gathering mathematicians, engineers, and researchers working on the mathematical and numerical modeling of the heart. Topics may include, but are not limited to, coupled cardiac models, electrophysiology, mechanical activation, fluid dynamics, valve modeling, translational medicine, scientific computing and large-scale simulations, as well as other computational aspects.

11:00-11:30

Viscoelastic Model of Human Myocardium

Renee Miller	Kings College London
David Nordsletten	University of Michigan, Ann Arbor, US; King's College London, London, UK
Gerhard Sommer	Institute of Biomechanics, Graz University of Technology, Graz, Austria
Ralph Sinkus	Inserm U1148, LVTS, University Paris Diderot, Paris, France; King's College London, London, UK
Gerhard Holzapfel	Institute of Biomechanics, Graz University of Technology, Graz, Austria

Abstract: Across species, myocardial tissue has been shown to exhibit viscoelastic behaviour, including significant hysteresis, stress relaxation, and frequency dependent stiffness. In this study, we develop a viscoelastic model for human myocardium based on a nonlinear viscoelastic anisotropic generalized power law and demonstrate it captures the viscoelastic features of myocardial tissue across shear relaxation, cyclic shear and biaxial experiments. The model also exhibits behaviours observed in animal studies, including frequency dependent stiffness and transitional nonlinearity.

11:30-12:00

A numerical validation of non-invasive mechanical markers of the cardiac function

Simone Scacchi	University of Milano
Piero Colli Franzone	University of Pavia
Luca F. Pavarino	University of Pavia

Abstract: The recent development of non-invasive cardiac imaging technologies have made it possible to measure longitudinal and circumferential strains at a high spatial resolution. Local mechanical activation times derived from these strains can be used as non-invasive estimates of electrical activation, in order to determine e.g. the pathway of reentrant circuits. The aim of this work is to assess the reliability of mechanical activation time markers by means of three-dimensional cardiac electromechanical simulations.

12:00-12:30

The inverse problem of cardiac biomechanics: estimating active stress distribution through imaging-driven computational modeling

Axel Loewe	Karlsruhe Institute of Technology (KIT)
Thomas Fritz	Institute of Biomedical Engineering, Karlsruhe Institute of Technology (KIT)
Ekaterina Kovacheva	Institute of Biomedical Engineering, Karlsruhe Institute of Technology (KIT)
Gunnar Seemann	Institute of Biomedical Engineering, Karlsruhe Institute of Technology (KIT)
Olaf Dössel	Institute of Biomedical Engineering, Karlsruhe Institute of Technology (KIT)

Abstract: The heart is driven by the active stress developed in individual cardic cells. The spatio-temporal active stress distribution could contain diagnostic information but cannot be measured in vivo. We introduce a method to estimate dynamic active stress fields from surface motion derived from e.g. MRI data. This ill-posed non-linear problem is solved using spatio-temporal Tikhonov in conjunction with a continuum mechanics forward model, accurately reproducing cardiac motion and identifying non-contracting regions due to myocardial infarction.

12:30-13:00

Merging clinical data within numerical models: ventricular tachycardia prediction

Stefano Pagani	Politecnico di Milano
Antonio Frontera	Ospedale San Raffaele
Paolo Della Bella	Ospedale San Raffaele
Alfio Quarteroni	Politecnico di Milano

Abstract: We present a new strategy for the integration of clinical data in numerical models for the electrophysiology, aimed at better understanding the mechanisms behind cardiac rhythm disorders. Our study of the initiation and sustainment of tachycardia analyses the underlying causes of this phenomenon by performing several numerical experiments for different patient-specific configurations. This project has received funding from the European Research Council under the European Union's Horizon 2020 research and innovation programme (grant n. 740132).

IM FT-4-2 2 11:00-13:30

Mathematics for Industry in the Asia Pacific Area - Part 1

For Part 2 see: IM FT-4-2 4

Organizer: Kenji Kajiwara	Kyushu University
Organizer: Yasuhide Fukumoto	Institute of Mathematics for Industry, Kyushu
Organizer: Osamu Saeki	Kyushu University
Organizer: Masato Wakayama	Kyushu University/ IMI

Abstract: This minisymposium is aimed at exposing various activities of "Mathematics for Industry" (MfI) in the Asia Pacific area, in particular, those which have been carried out by the members of the Asia Pacific Consortium of Mathematics for Industry (APCMfI), and at sharing the experiences with the worldwide communities. The topics will cover the comprehensive introduction of APCMfI, overview and historical remarks, the efforts to develop the relationship with industries such as the study groups, and the programs for young researchers and students. The current status of the preparation of ICIAM2023 will also be reported.

11:00-11:30

On the Asia-Pacific Consortium of Mathematics for Industry

Masato Wakayama Kyushu University

Abstract: The APCMfI was established in 2014 for aiming the development of mathematics and its applications to enhance the quality of life on the planet by creating new technologies, improve industrial mathematical research and stimulate the two-way interaction between mathematics and industry. This presentation aims to introduce various activities of the APCMfI including the annual conferences, “Forum Math-for-Industry (FMfI) 20**”, study group and journal publication. FMfI has been held in rotation in the Asia-Pacific region.

11:30-12:00

Maths in Industry in Australia – Early Days

Graeme Hocking Murdoch University

Abstract: I was at one of the first maths-in-industry sessions held in Australia – at the 1986 Applied Mathematics conference in Wirrina near Adelaide. This later grew into the Australian Mathematics-in-Industry study groups. I will discuss the early study groups and discus some interesting problems that were studied.

12:00-12:30

Quadruple helix model for Industrial Mathematics infrastructures in Malaysia

Zainal Abdul Aziz Universiti Teknologi Malaysia
ARIFAH BAHAR UTM Centre for Industrial and Applied Mathematics, Universiti Teknologi Malaysia

Abstract: In Malaysia, collaborations with industry and external parties in the realm of industrial mathematics bring benefits to applications of knowledge in industry, opportunities for talent and capacity development and access to funding from industry. Applying a Quadruple Helix model characterises the cooperation between the four main clusters involving interaction in the forms of relation, mobility, transfer and formality to produce innovations. This framework is shown to facilitate the workings of national innovative industrial mathematics infrastructures.

12:30-13:00

The role of mathematics in driving the industry in Thailand

Busayamas Pimpunchat King Mongkut’s Institute of Technology Ladkrabang

Abstract: Industrial Mathematics for Thailand is an important backlash to contribute in various national development such as industry, economy, environment or even medicine which use mathematical models to diagnose and treat diseases. Application in an industrial plant such as the research project on annealing system or using mathematics to see the transportation system, the supply chain management of cargo transportation. Including an Actuary, which helps manage the risks of various companies whether in securities, insurance, banking.

13:00-13:30

MINZ Plus: Mathematics in Industry Study Group activities in New Zealand and Ireland.

Mark McGuinness Victoria University of Wellington

Abstract: I will talk about recent developments in MINZ, the New Zealand style of Study Groups now in place every year since 2015. I will focus on two challenges of personal interest: weighing fast heavy fruit while it is still bouncing, first brought to an MISG at Massey Albany in Auckland in 2005, and using microwaves to continuously detect moisture content of bauxite on a conveyor belt.

CP FT-1-7 2 11:00-13:00

Applied Mathematics for Industry and Engineering III

Chair Person: Alfonso Carlos Casal Piga Universidad Politécnica de Madrid

CP FT-1-7 2 1 11:00-11:20

The time delay in a class of nonlinear traffic models. Analysis and applications

Alfonso Carlos Casal Piga Universidad Politécnica de Madrid
Juan Francisco Padial Molina Universidad Politécnica de Madrid

Abstract: The study of a class of time-continuous delay car-following models is refined by considering in the delay the effect of separated causes: the perception time of drivers on changes ahead, the processing of the information and the actions taken, and the different behavior of cars, the mechanic reaction time. The separated analysis of those causes allows a better understanding of real traffic behaviors, such as its dynamics, stability, stop and go and other patterns.

CP FT-1-7 2 2 11:20-11:40

A Solution of the Paraxial Wave Equation and its Relation to Laser Beam Propagation in Complex Media

Reza Malek-Madani US Naval Academy

Abstract: I will present an analytical and computational solution to the Paraxial Wave Equation with the goal of understanding how to model laser beam propagation through random media. The computational work will be motivated by our experimental effort where data is collected by propagating laser beams in the maritime domain defined by the Chesapeake Bay where aerosols and other scatterers in the air have significant impact on the shape of a beam traversing long distances.

CP FT-1-7 2 3 11:40-12:00

Deep Learning for Elastic Source Imaging

Abdul Wahab National University of Technology, Islamabad, Pakistan
Jaejun Yoo NAVER Corporation
Jong Chul Ye Korea Advanced Institute of Science and Technology

Abstract: We discuss an inverse elastic source problem with sparse measurements. Such inverse problems appear widely in engineering applications, e.g., medical imaging and geophysics. Conventional algorithms suffer from instability and furnish results with low-resolution when the measurements are sparse. We present a generic mathematical framework extending low-dimensional manifold regularization in conventional algorithms thereby enhancing their performance. We establish that the proposed framework is equivalent to the so-called deep convolutional framelet expansion in machine learning literature.

CP FT-1-7 2 4 12:00-12:20

Extraordinary transmission through a narrow slit

Jacob R. Holley Imperial College London
Ory Schnitzer Imperial College London

Abstract: The phenomenon of extraordinary transmission describes the enhanced transfer of wave energy through small apertures. We use matched asymptotic expansions, focusing on near-resonance frequencies, to study the prototypical problem of acoustic (electromagnetic) transmission through a slit in a rigid (perfectly conducting) wall. Our results are in excellent agreement with numerical and experimental data and correct the prevalent approximations in the literature which ignore end effects.

CP FT-1-7 2 5 12:20-12:40

An improvement of skin cancer detection using a new lesion segmentation method

Kiwoon Kwon Dongguk University
Hyunju Lee Dongguk University
Seungmin Park Dongguk University

Abstract: Malignat melanoma is known to be very dangerous skin cancer due to its fast metastasis. ABCD(Asymmetriy, Border regularity, Color Variegation, Diameter) criteria is known to be a well-known quantitative method to diagnose melanoma. The authors implemented a mathematical analysis about ABCD criteria in the previous work. In this talk, we suggest a new lesion segmentation method and address how the suggested method affects malignant melanoma detection. The method will be verified using many skin samples.

CP FT-1-7 2 6 12:40-13:00

An optimal RBF-kernel based non-intrusive reduced order model for the shallow water equations

Sourav Dutta ERDC - US Army Corps of Engineers
Emma Perracchione University of Padua-Italy
Matthew Farthing ERDC - US Army Corps of Engineers
Antonia Larese University of Padua-Italy
Mario Putti University of Padua-Italy

Abstract: Non-intrusive reduced order models (NIROM) offer a desirable alternative to a fully resolved CFD model for multi-query and fast replay applications. In this work, a multidimensional radial basis function (RBF) interpolant is used to develop a NIROM. We propose a greedy strategy for selecting the optimal quadrature points and a variable scaling function to replace the constant shape parameter. The accuracy, efficiency, and stability properties are evaluated across a wide range of fluid flow regimes.

CP A1-3-5 2 11:00-13:00

Numerical Analysis V

Chair Person: Svajunas Sajavicius Kaunas University of Technology

CP A1-3-5 2 1 11:00-11:20

Imposing nonlocal boundary conditions in Galerkin-based methods with non-interpolatory shape functions

Svajunas Sajavicius	Kaunas University of Technology

Abstract: Imposing inhomogeneous essential boundary conditions is a key challenge in Galerkin-type methods based on non-interpolatory shape functions. Such functions are used, for example, in various meshless methods and isogeometric analysis. We analyse a model problem which consists of Poisson's equation with Dirichlet- and Neumann-type nonlocal boundary conditions. We derive and compare variational formulations with strongly or weakly imposed Dirichlet-type nonlocal condition. The results of extensive numerical study in isogeometric framework are presented and discussed.

CP A1-3-5 2 2 11:20-11:40

HOMOTOPY ANALYSIS METHOD FOR THE VALUATION OF THE EUROEPAN CALL OPTION IN A TIME-FRACTIONAL BLACK-SCHOLES MODEL

Sunday Emmanuel Fadugba	Ekiti State Univesity

Abstract: In this paper, the solution of the time-fractional Black-Scholes model is calculated in the form of a convergent series with easily computable components via Homotopy Analysis Method (HAM) and has been numerically evaluated in the context of the exact solution. The result generated shows that HAM is explicit, effective, accurate and converges to the exact solution. Finally, HAM is a good approach for the valuation of the European call option in a time-fractional Black-Scholes model.

CP A1-3-5 2 3 11:40-12:00

Space-time discontinuous Galerkin method for the one-dimensional wave equation

Helmi Temimi	Gulf University for Science and Technology

Abstract: In this paper, we develop and analyze a space-time discontinuous Galerkin (DG) finite element method for second-order wave equation. The space-time DG discretization is presented, including definition of numerical fluxes, which are necessary to maintain stable and non-oscillatory solutions. The scheme can be made arbitrarily high-order accurate in space and time. We prove several a priori error estimates in space-time norms for the proposed scheme. Several numerical examples are provided to verify the theoretical estimates.

CP A1-3-5 2 4 12:00-12:20

Numerical method for the Fourier transform of hyperfunctions

Hidenori Ogata	The University of Electro-Communications

Abstract: We present a numerical method for the Fourier transforms of hyperfunctions, generalized functions given in terms of complex function theory. In our method, we obtain Fourier transforms as defined in hyperfunction theory, that is, by the analytic continuation of analytic functions given by Laplace transforms. Our method can also give Fourier transforms such that the integrals giving them are divergent in the conventional sense. Numerical examples show the effectiveness of our method.

CP A1-3-5 2 5 12:20-12:40

Positivity preserving finite difference WENO schemes for Ten-Moment fluid equations

Asha Kumari Meena	TIFR Centre for Applicable Mathematics
Rakesh Kumar	TIFR Centre for Applicable Mathematics
Praveen Chandrashekar	TIFR Centre for Applicable Mathematics

Abstract: We develop a positivity-preserving finite difference WENO scheme for Ten-Moment equations with body force term as source. A positive forward Euler scheme, where positivity is obtained by a scaling type limiter, is constructed and combined with an integrating factor based splitting, SSP RK scheme. Solution of source operator is performed exactly and is positive unconditionally. This method can be used with any WENO reconstruction. We perform numerical tests using fifth-order WENO-JS, WENO-Z and WENO-AO reconstructions.

CP A1-3-5 2 6 12:40-13:00

Robust a posteriori error estimates for locking free FEM of Biot's Consolidation model

Arbaz Khan	University of Manchester

Abstract: In this talk, we give an overview of some recent work based on mixed fem for Biot's Consolidation model. We discuss three novel a posteriori error estimators and show that all three a posteriori error estimators are reliable, efficient and robust. Finally, numerical results are presented to validate the theortical results.

CP A1-3-4 2 11:00-13:00

Numerical Analysis IV

Chair Person: Isabel Sánchez Muñoz University of Seville

CP A1-3-4 2 1 11:00-11:20

Numerical analysis of finite element approximation to a model for two-phase immiscible flows by level set method

Isabel Sánchez Muñoz	University of Seville
Tomás Chacón Rebollo	University of Seville
Macarena Gómez Mármol	University of Seville

Abstract: In this work we study a finite element discretization of a model for two-phase immiscible flow with constant densities. In this model a level set function is introduced to implicitly determine the free surface separating the two flows. We regularize the density and viscosity to avoid the discontinuity across the free surface. We prove stability in natural norms and optimal error estimates for smooth solutions. We present some numerical tests to confirm the theoretical analysis.

CP A1-3-4 2 2 11:20-11:40

Performance of numerical solution method of ordinary differential equations by Taylor series method

Hiroshi Hirayama	Kanagawa Institute of Technology

Abstract: Runge-Kutta method can not choose many degrees of calculation, but the Taylor series method can solve ODEs with an arbitrary degree. By using this Taylor series method we compare the performance in numerically solving ODEs of bad condition with many orders. Problems that can not be actually solved by the Rung-Kutta method, can be easily solved by the Taylor series method. it can be seen that by increasing the order of calculation, calculation efficiency improves.

CP A1-3-4 2 3 11:40-12:00

The Two-Stage Successive Over-Relaxation Iterative method for Solving Glioma Growth Models

Abida Hussain	Universiti Teknologi PETRONAS
Mohana Muthuvalu	Universiti Teknologi PETRONAS
Ibrahima Faye	Universiti Teknologi PETRONAS
Majid Khan Majahar Ali	Universiti Sains Malaysia
Ramoshweu Solomon Lebelo	Vaal University of Technology

Abstract: In this work, the performance of the two-stage Successive Over-Relaxation (TSSOR) iterative method to solve glioma growth models is investigated. The derivation and implementation of the proposed method are explained. Numerical results are included to verify the performance of the proposed method. Also, convergence analysis and computational complexity analysis of the TSSOR method are included.

CP A1-3-4 2 4 12:00-12:20

On the parallel domain decomposition methods and technologies

Valery Il'in	ICMMG SD RAS

Abstract: The parallel domain decomposition methods for solution of the sparse large SLAEs are considered. The procedure is presented by the two level multi-preconditioned iterative process in the Krylov subspaces. The upper level consists of the block Jacobi-Swarz or weighted Cimmino, or adaptive Chebyshev procedures with restarts accelerated on the base of the least squares approaches.

CP A1-3-4 2 5 12:20-12:40

Asymptotic behaviour of a Bingham fluid in a thin domain with a rough boundary

Manuel Villanueva	Universidad Pontificia Comillas
Giuseppe Cardone	University of Sannio
Carmen Perugia	University of Sanio

Abstract: We analyze the steady incompressible flow of a Bingham fluid in a thin domain with an oscillating boundary, under the action of external forces. Adapting the unfolding method we get the homogenized limit problem as the thickness of the domain tends to zero. We are interested in analyzing the influence of the geometry of the domains in the behavior of the fluid.

CP A1-3-4 2 6 12:40-13:00

WENO scheme with L_1-type smoothness indicators for nonlinear degenerate parabolic equations

Samala Rathan	IIT Bombay
Rakesh Kumar	TIFR-CAM
Ameya D. Jagtap	Brown University

Abstract: This article focus on construction of an efficient sixth-order finite difference weighted essentially non-oscillatory scheme to solve nonlinear degenerate parabolic equations. A new type of nonlinear weights are constructed with an introduction of a global and local smoothness indicator with the help of generalized undivided differences in L_1-norm. The third-order SSP-RK scheme is used to evaluate time derivative. Numerical tests are performed for scalar, 1D and 2D directions to demonstrate our theoretical claims.

CP A1-3-3 2 11:00-13:00

Probability and Statistics

Chair Person: Stefan Engelhardt	University of Jena

CP A1-3-3 2 1 11:00-11:20

The Skorokhod embedding problem for inhomogeneous diffusions

Stefan Engelhardt	University of Jena
Stefan Ankirchner	University of Jena
Alexander Fromm	University of Jena
Goncalo Dos Reis	University of Edinburgh

Abstract: We solve the Skorokhod embedding problem by providing sufficient conditions that for a given probability measure ν on there exist a bounded stopping time τ and an $a \in$ such that the solution (A_t) of the inhomogeneous SDE $dA_t = \mu(t|A_t)dt + \sigma(t|A_t)dW_t$ with initial value a satisfies $A_\tau \sim \nu$. Our construction of embedding stopping times is based on the solution of a fully coupled forward-backward SDE, whose existence and uniqueness we verify with the mehtod of decoupling fields.

CP A1-3-3 2 2 11:20-11:40

Accelerating Stein variational gradient descent

Ryan Murray	Penn State University

Abstract: Recently machine learning researchers have proposed an algorithm called Stein variational gradient descent in order to effectively approximate Bayesian posterior probabilities. This algorithm may be seen as a particle approximation of a non-linear, non-local, partial differential equation $\partial t\rho = \nabla \cdot (\rho(\nabla K * \rho + K * (\nabla V \rho)))$. This talk will demonstrate how ideas from the calculus of variations and partial differential equations can be used to dramatically improve performance of this algorithm.

CP A1-3-3 2 3 11:40-12:00

Effect of information on the social efficiency of a service system in the presence of strategic customers

Gopinath Panda	Singapore University of Technology and Design

Abstract: Consider a medical clinic offering specialized services to patients on arrival. The clinic provides real time delay information via mobile applications. There are two categories of patients: informed and uninformed. The joining strategy of informed patients is of threshold type and uninformed patients follow a mixed joining strategy. We are interested to study individual and socially optimal behavior of customers under the equilibrium of this game using the concepts of queueing games.

CP A1-3-3 2 4 12:00-12:20

Towards Doubly Direct Policy Search

Collet Jérôme	EDF R&D

Abstract: For Stochastic Programming, an increasingly popular way is Direct Policy Search, it implies the choice of a function space in which the search is performed. One may cite two possible choices, Linear Decision Rules (LDR) and Artificial Neural Networks (ANN): first one is too small to approximate many optimal policies, second one is so large that its fitting requires to simulate surrogate data. We propose here Binary Decision Trees as a good compromise.

CP A1-3-3 2 5 12:20-12:40

Bivariate Integer-Valued Autoregressive Process in Random Environment

Petra Laketa	Faculty of Sciences and Mathematics
Predrag Popovic	Faculty of Civil Engineering and Architecture
Aleksandar Nastic	Faculty of Sciences and Mathematics

Abstract: Here is presented a bivariate random environment integer-valued autoregressive process with r states. It can be used for modeling two correlated non-stationary counting time series where marginals parameter values depend on the random environments. The correlation and regression properties of the model and some non-parametric parameter estimators are given. Finally, by the real-life data fitting, model was checked and compared to some other competitive and possibly applicable models.

CP A1-3-3 2 6 12:40-13:00

On Classical and Bayesian Asymptotics in Stochastic Differential Equations with Random Effects having Mixture Normal Distributions

Trisha Maitra	Indian Statistical Institute, Kolkata
Sourabh Bhattacharya	Indian Statistical Institute, Kolkata

Abstract: We consider a system of stochastic differential equations in a random effects setup. Respecting the versatility of normal mixtures, we consider the random effects having finite mixture of normal distributions and prove asymptotic results in both frequentist and Bayesian paradigms, for both iid and non-iid situations, even when the number of mixture components is random. Ample simulation experiments and application to a stock market dataset reveal the importance of our methods even for small samples.

CP A1-3-2 2 11:00-13:00

Optimization and Operations Research I

Chair Person: Qi Yu	National University of Defense Technology

CP A1-3-2 2 1 11:00-11:20

A general overparameterized gradient descent framework and its applications in optimization

Qi Yu	National University of Defense Technology
Xintong Tan	National University of Defense Technology
Zelong Wang	National University of Defense Technology
Jiying Liu	National University of Defense Technology
Jubo Zhu	National University of Defense Technology

Abstract: Gradient descent (GD) has played a fundamental role in optimization algorithms. However, when the condition number of linear systems become large, vanilla gradient descent wastes a lot of iterations due to the poor optimization landscapes. We propose a general framework, namely overparameterized gradient descent (OGD), which addresses this problem by simply introducing some extra parameters. On solving the overparameterized linear system in a coordinate manner, ODG is faster and more robust than vanilla gradient descent.

CP A1-3-2 2 2 11:20-11:40

Joint replenishment policy for multi-item perishable inventory model with deterministic demands, return and all-units discount

Dharma Lesmono	Universitas Katolik Parahyangan
Taufik Limansyah	Universitas Katolik Parahyangan
Neilshan Loedy	Universitas Katolik Parahyangan

Abstract: We develop a multi-item perishable inventory model with deterministic demands and all-units discount. Demands are assumed to be deterministic following an inventory-dependent demand, supplier offers all-unit discounts to the retailer and retailer has an opportunity to returns deteriorated product to the supplier. The decision variables are the optimal return time and ordering quantity to minimize the total cost. Numerical examples are given to illustrate the model and the optimal joint replenishment policy are analyzed.

CP A1-3-2 2 3 11:40-12:00

Fast algorithms for Graph-Regularized Matrix Completion

Shuyu Dong	Université catholique de Louvain
P.-A. Absil	Université catholique de Louvain
Kyle A. Gallivan	Florida State University

Abstract: We consider a graph-regularized matrix completion problem and propose efficient algorithms to solve the underlying optimization problem via low-rank matrix factorization. Experiments on synthetic data show that our approach achieves significant speedup compared to an existing method based on alternating minimization for graph-regularized matrix factorization. Experimental results on real-world data also show that our methods provide low-rank solutions of similar quality in comparable or less time than the state-of-the-art method.

CP A1-3-2 2 4 12:00-12:20

Finite element methods applied to continuous data assimilation for the Navier-Stokes equations

Bosco García-Archilla	Universidad de Sevilla
Julia Novo	Universidad Autónoma de Madrid
Edriss S. Titi	Texa A & M University

Abstract: We analyze several finite element discretizations of a continuos data assimilation method for the Navier-Stokes equations. Data is incorporated in the model by means of a nudging term driving the computed approximations to the data. We present error bounds uniform in time. Contrary to the existing literature, we show that our error bounds have error constants independent of the Reynolds number. Numerical experiments confirm both rates of convergence and indpendence of the Reynolds Number.

CP A1-3-2 2 5 12:20-12:40

A Numerical Technique to Biological System Problems

Burcu Gürbüz	University of Nantes

Abstract: In this study, a numerical technique is purposed to obtain approximate solutions of nonlinear system of mass-action type kinetics in well mixed volume. This technique is based on truncated Laguerre series. Matrix representations with collocation points are introduced and the system of nonlinear algebraic equations is reduced by the technique. Illustrative examples are given to show the applicability and accuracy is shown by error analysis. All numerical computations are performed by using computer programs.

CP A1-3-2 2 6 12:40-13:00

Numerical analysis of method of fundamental solutions applied to Helmholtz-type equation

Koya Sakakibara	Kyoto University

Abstract: Method of fundamental solutions (MFS) is a mesh-free numerical solver for solving homogeneous linear partial differential equations, and it has been applied to solve Laplace equation, Helmholtz equation, modified Helmholtz equation, and so on. In this talk, I establish mathematical results on unique existence and exponential decay of approximation error of MFS for Helmholtz-type equation.

CP FT-4-5 2 11:00-13:00

Biology, Medicine and other natural sciences II

Chair Person: Giselle Couto Falcao	federal center of technological education of Minas Gerais

CP FT-4-5 2 1 11:00-11:20

ANALYSIS OF THE VOLUME OF PLUVIOMETRIC PRECIPITATIONS IN BELO HORIZONTE AND ITS FORECASTABILITY USING HURST EXPONENT

Giselle Couto Falcao	federal center of technological education of Minas Gerais
Edgar Lacerda Aguiar	federal center of technological education of Minas Gerais

Abstract: This research sought to analyze the forecasts of the maximum precipitation volume of the regions of Belo Horizonte, the observations of the data were made using multifractal analyzes of non - stationary time series, with seasonality. Using as a structural presentation model the simulation of the data in complex predictability and instability systems, which will be based on monthly historical data of the precipitation volumes of the months of January and December.

CP FT-4-5 2 2 11:20-11:40

Modeling the dynamics of sexually transmitted infections influenced by correlation between condom use and partner type.

Nao Yamamoto	Kyushu University
Keisuke Ejima	Indiana University
Hiroshi Nishiura	Hokkaido University

Abstract: Sexually active people are believed to be at a high risk of sexually transmitted infections (STI). However, they are likely to be more aware of the risk and use condom more consistently, and if so, their contribution to the disease dynamics might be smaller than that believed. We investigated the association between sexual contact pattern and condom use by systematic review and developed a mathematical model to examine how the association affects the disease dynamics.

CP FT-4-5 2 3 11:40-12:00

A quantitative comparison between hepatitis C virus JFH-1 and Jc1 by a PDE multiscale model of virus infection.

Shoya Iwanami	Kyushu University
Kosaku Kitagawa	Kyushu University
Hirofumi Ohashi	National Institute of Infectious Diseases
Yusuke Asai	Hokkaido University
Koichi Watashi	National Institute of Infectious Diseases
Shingo Iwami	Kyushu University

Abstract: We developed a mathematical model of virus dynamics by partial differential equations which is multi-scale model to simultaneously describe intercellular virus infection and intracellular virus replication. We analyzed the experimental data of hepatitis C virus (HCV) JFH-1 and Jc1 infection in cell culture using the mathematical model and estimated parameters which described characteristics of HCV strains. As a result of comparison of estimated parameters, we found that JFH-1 strain had higher fitness than Jc1 strain.

CP FT-4-5 2 4 12:00-12:20

Dynamics of an SEIR model for infectious diseases in random environment

Yusuke Asai	Hokkaido University

Abstract: An SEIR type infectious disease model is developed under random environment where the birth rate, transmission rate and recovery rate are modeled as random processes. The resulting system of random ordinary differential equations is investigated by the theory of random dynamical systems. After showing the existence, uniqueness, positiveness and boundedness of solutions are shown, its long term behavior as well as conditions for disease extinction and coexistence are discussed.

CP FT-4-5 2 5 12:20-12:40

Systems Biology of Alzeimer's Disease: Understanding How to Prevent or Delay Its Onset or Progression

Angelyn Lao	De La Salle University

Abstract: Systems biology approach is applied to study the factors that influence and cause Alzheimer's disease (AD). We established different types of (ODE and stochastic process algebra) models to understand the kinetics of amyloidogenic processing in AD. To explore on how to prevent or delay the onset or progression of AD, we made further investigations on the connection between AD and several other diseases. Moreover, we examined possible effects of ketones on the brain.

CP FT-4-5 2 6 12:40-13:00

Stability and sensitivity analysis of Be-CoDiS, an epidemiological model to predict the spread of human diseases between countries. Application to the Ebola Virus Disease.

Ivorra Benjamin	Universidad Complutense de Madrid
Ngom Diene	Université Assane SECK
Angel Ramos Del Olmo	Universidad Complutense de Madrid

Abstract: In this work, we propose an original deterministic spatial-temporal model, called Be-CoDiS (Between-Countries Disease Spread), to study the evolution of human diseases within and between countries. Then, we perform a stability analysis of Be-CoDiS to study its equilibrium states. Then, we perform a sensitivity analysis of the basic reproduction ratios regarding the model parameters. Finally, we validate the results by considering numerical experiments based on real data from recent Ebola virus disease outbreaks.

CP A1-2-4 2 11:00-13:00

Applied Mathematics for Industry and Engineering II

Chair Person: Ursula Iturraran-Viveros	Universidad Nacional Autonoma de Mexico

CP A1-2-4 2 1 11:00-11:20

Full-waveform inversion of velocities and densities obtained with Machine Learning in the Middle Magdalena Valley in Colombia

Ursula Iturraran-Viveros	Universidad Nacional Autonoma de Mexico
Andres M. Muñoz-Garcia	Universidad Nacional de Colombia

Abstract: We estimate densities and velocities using different Machine Learning techniques. From a 3D seismic data acquisition in the Middle Magdalena Valley in Colombia we compute seismic attirbutes (functions of the seismic traces) and combine this information with the well-log information to generate geo-cubes of densities and velocities and use them to produce synthetic seismograms, which will be compared to real traces and this error will be minimized during the inversion process.

CP A1-2-4 2 2 **11:20-11:40**

The Localized Regular Dual Reciprocity Method for the Solution of Multi-Zone Problems

Nahuel Caruso	CIFASIS-CONICET
Margarita Portapila	CIFASIS-CONICET

Abstract: The Localized Regular Dual Reciprocity Method (LRDRM) is an integral domain decomposition method where the boundary conditions are imposed at the local interpolation level, all the calculated integrals are regular and the local interpolation functions themselves satisfy the partial differential equation to be solved. The main aim of this presentation is to show numerical results of the LRDRM in multi-zone porous media, for transient problems.

CP A1-2-4 2 3 **11:40-12:00**

Goal-oriented a posteriori error estimation for conforming and nonconforming approximations with inexact solvers

Gouranga Mallik	Indian Institute of Science
Martin Vohralik	Inria
Soleiman Yousef	IFP Energies nouvelles

Abstract: A unified framework for goal-oriented a posteriori estimation for a model linear second-order elliptic equation will be presented that cover higher-order conforming, nonconforming and finite volume approximations with inexact solvers. The quantity of interest is given by a functional composed of source and surface flux terms. The estimates (guaranteed a posteriori) are based on equilibrated flux and potential reconstructions. Numerical results will be shown for the finite volume method applied to porous media flow problem.

CP A1-2-4 2 4 **12:00-12:20**

Vaso-Activity based Thermal Variations in Clean Incision and Infected Incision along the Circumference of Human Limb

Madhvi Shakya	Maulana Azad National Institute of Technology, Bhopal
Namrata Gupta	Maulana Azad National Institute of Technology, Bhopal

Abstract: Two dimensional model for thermal analysis in clean incision, infected incision and normal peripheral tissue of human arm during inflammation, is presented. Core temperature along circumference is dependent on polar angle. Physiological parameters are considered temperature dependent in Pennes' Bio-Heat equation. Finite element and Crank-Nicolson discretization is done. Sensitivity analysis is done w.r.t growth rate of physiological parameters. Graphical results are produced through MATLAB coding. Mean difference in temperature is validated from published experimental data.

CP A1-2-4 2 5 **12:20-12:40**

The effect of compression on filtration performance

Jakub Köry	University of Oxford
Ian Griffiths	University of Oxford
Armin Krupp	University of Oxford
Colin Please	University of Oxford

Abstract: Deformations arising from an applied pressure difference in filtration impact on a filter's permeability. How should we choose the initial permeability of a filter so that it performs at its best during operation? We study the effects of filter compression using a one-dimensional model consisting of Darcy's law (modelling fluid flow) and the Navier equation (modelling the poroelastic medium). We explore filtration performance and determine the required rest-state permeability that maximises flux during operation.

CP A1-2-4 2 6 **12:40-13:00**

Geometric Tweedie models for reliability

Rahma Abid	Faculty of Sciences
Célestin C. Kokonendji	University Franche Comté
Afif Masmoudi	Faculty of Sciences

Abstract: We introduce a class of regression models based on the Geometric Tweedie models (GTMs) for continuous and semicontinuous data. The power parameter of GTMs works as an automatic distribution selection. We establish properties, into the GTMs, of zero-mass and variation phenomena, in connection to reliability measures. Simulation studies show that the model highlights unbiased and consistent estimators. We illustrate applications on real datasets to a time to failure and time to repair in reliability.

CP FT-1-8 2 **11:00-13:00**

Numerical Analysis VI

Chair Person: Peter Junghanns Chemnitz University of Technology

CP FT-1-8 2 1 **11:00-11:20**

A note on Kalandiya's method for a special crack problem

Peter Junghanns	Chemnitz University of Technology
Robert Kaiser	Chemnitz University of Technology

Abstract: This contribution deals with the problem of the instability of the numerical method proposed by Kalandiya for the approximate solution of the two-dimensional elasticity problem of a crack at a circular cavity surface.

CP FT-1-8 2 2 **11:20-11:40**

Accuracy of Semi-implicit Discretisations of the Euler-Poisson system in the Quasi-neutral limit.

Saurav Samantaray	Indian Institute of Science Education and Research Thiruvananthapuram
Arun Koottungal Revi	Indian Institute of Science Education and Research Thiruvananthapuram

Abstract: The goal of this work is to analyse the accuracy of a semi-implicit discretisation of the Euler-Poisson system in the quasi-neutral limit (Degond, 2013). We use a wave equation system coupled with a Poisson equation as a simplified model and identify a well-prepared space of constant densities, divergence-free velocities and harmonic potentials. A sufficient condition ensuring accuracy is proposed based on the invariance of this subspace (Dellacherie, 2010).

CP FT-1-8 2 3 **11:40-12:00**

Convergence of adaptive mixed FEMs for general second-order linear elliptic problems based on separate marking

Asha Dond	Indian Institute of Science
Carsten Carstensen	Institut für Mathematik, Humboldt-Universität zu Berlin, 10099
Hella Rabus	Institut für Mathematik, Humboldt-Universität zu Berlin, 10099

Abstract:

An adaptive mesh-refinement strategy for the Raviart-Thomas mixed FEM for non-selfadjoint elliptic problems, faces difficulty of flux error control in H(div,

). It involves a data-approximation error $||f - fh||$ in the L_2-norm of the source term f and its approximation f_h. We exploit the separate marking strategy with a split of a Dxrfler marking for estimator and some optimal data approximation strategy for data approximation term. The convergence analysis studied for separate marking strategy.

CP FT-1-8 2 4 **12:00-12:20**

A viscosity-independent error estimate of a pressure-stabilized Lagrange-Galerkin scheme for the Oseen problem

Shinya Uchiumi	Gakushuin University

Abstract: We consider a pressure-stabilized Lagrange-Galerkin scheme for the transient Oseen problem with small viscosity. In the scheme we use the equal-order approximation of order k for both the velocity and pressure, and add a symmetric pressure stabilization term. We show an error estimate for the velocity with a constant independent of the viscosity if the exact solution is sufficiently smooth. We also show an error estimate of a discrete primitive of the pressure.

CP FT-1-8 2 5 **12:20-12:40**

Coefficient identification problems in the Euler-Bernoulli beam theory

Fabiana Travessini De Cezaro	Federal University of Rio Grande
Adriano De Cezaro	Federal University of Rio Grande
Elisa Medeiros	Federal University of Rio Grande

Abstract: In this contribution, we show the results of unique identification for the identification of the rigidity for the Euler-Bernoulli beam theory. Furthermore, we show that this inverse problem is ill-posed. Since in practice, the measurements in a beam are susceptible to error, we propose some regularization strategies and present numerical results.

CP FT-1-8 2 6 **12:40-13:00**

A meshless adaptive scheme based on radial basis function collocation for solving elliptic partial differential equations

Roberto Cavoretto	University of Turin
Alessandra De Rossi	University of Turin

Abstract: We present a new adaptive algorithm for solving elliptic partial differential equations via radial basis function collocation. Our adaptive scheme is based on two stages consisting in the use of a leave-one-out cross validation error indicator and of an adaptive meshless refinement technique. This approach allows us to detect the areas that need to be refined, also including the chance to further add or remove adaptively any points. Numerical experiments and applications support our study.

MS FE-1-4 3 14:30-16:30

Numerical methods for balance laws and non-conservative hyperbolic systems - Part 3

For Part 1 see: MS FE-1-4 1
For Part 2 see: MS FE-1-4 2
For Part 4 see: MS FE-1-4 4

Organizer: Carlos Parés Madroñal	Universidad de Málaga
Organizer: Manuel J. Castro	Universidad de Málaga

Abstract: Balance laws and non-conservative hyperbolic systems naturally appear in many real world applications and, in particular, in many fluid models in different contexts: shallow water models, multiphase flow models, gas dynamic, etc. The main goal of the mini-symposium will be the discussion and presentation of state-of-the-art computational and numerical methods for balance laws and non-conservative hyperbolic systems and their applications.

14:30-15:00

Numerical comparison of non-conservative schemes for the solution of hyperbolic moment models

Julian Köllermeier	Peking University

Abstract: Moment models for rarefied gases are large non-conservative, hyperbolic PDE systems. In this talk, I will briefly introduce the models and investigate the robustness of various numerical algorithms for their solution with emphasis on different ways to compute the non-conservative products, including central, upwind, and high-order schemes. Numerical tests show that all tested algorithms yield similar solutions and accurate high-order results can be obtained, despite the appearance of non-conservative terms in several equations.

15:00-15:30

Third and fourth order well-balanced CWENO schemes for the 2D shallow water equations

Matteo Semplice	Università degli Studi di Torino
Mauel Castro-Díaz	Universidad de Malaga

Abstract: We will describe third and fourth order accurate finite volume schemes for the shallow water equations. The schemes have the well-balanced property thanks to a path-conservative approach applied to an appropriate non-conservative reformulation of the equations. High order accuracy is achieved by designing truly two-dimensional reconstruction procedures of the Central WENO type. Tests for accuracy, well-balancing, posivity of the water height and finally the Tohoku 2011 tsunami event will be presented.

15:30-16:00

Semiconservative schemes for systems of conservation laws

Gabriella Puppo	La Sapienza Università di Roma
Rosa Maria Pidatella	Università di Catania
Giovanni Russo	Università di Catania
Pietro Santagati	Tass International, a Siemens Business

Abstract: We introduce a new class of high order conservative schemes to solve systems of conservation laws. We couple the conservation form of the system with, possibly simpler, alternative formulations, which can be used to speed up the time update. We show that, as long as the last update is carried out in conservative form, all internal stages can be computed using any consistent non conservative formulation, still ensuring the correct propagation of shock waves.

16:00-16:30

Well-balanced finite volume segregated schemes for hyperbolic nonlinear systems

María Elena Vázquez Cendón	Universidad de Santiago de Compostela
Alfredo Bermúdez	University of Santiago de Compostela
Saray Busto	University of Trento
Luis Cea	University of A Coruña
José Luis Ferrín	University of Santiago de Compostela
Xián López	University of Santiago de Compostela

Abstract: We present different well-balanced finite volume segregated schemes for hyperbolic nonlinear systems with source terms. We apply this methodology to shallow water models and also to mathematical model consists of Euler equations with source terms, coupled with the mass conservation equations of species. This methodology leads to a flux vector which depends not only on the conservative variables but also on time and space variables.

MS ME-1-2 3 14:30-16:30

Wave propagation in multiple-scattering and multiple-scale media - Part 3

For Part 1 see: MS ME-1-2 1
For Part 2 see: MS ME-1-2 2

Organizer: Luke Bennetts	University of Adelaide
Organizer: Malte Peter	University of Augsburg

Abstract: Wave propagation in multiple-scattering and multiple-scale media is important for modelling and simulating the propagation of acoustic, electromagnetic, flexural and surface gravity waves in heterogeneous media. This minisymposium brings together researchers from all of these application areas. The talks will illustrate a variety of the current methods and the challenges that remain. These are derived from branches of applied mathematics ranging from applied analysis to semi-analytical large-scale simulation schemes. A central aim of the minisymposium is to promote the exchange of ideas and knowledge between the different application areas with respect to the underlying wave mechanisms and their computation.

14:30-15:00

The influence of geometry, topology and grading upon wave propagation in structured media

Richard Craster	Imperial College
Mehul Makwana	Imperial College
Sebastien Guenneau	Aix Marseille University

Abstract: Beam splitters, i.e. devices that direct energy efficiently around corners and bends, will be described in the context of elastic plate, flexural, waves and electromagnetic waves. This topological effect will be described using mathematical techniques, both theory and experiment will be described. Most topological systems rely upon the properties of hexagonal systems, here we will also use square lattice systems and show how to use Dirac points that are accidental rather than symmetry induced.

15:00-15:30

Resonant metasurfaces in multi-physics systems

Daniel Colquitt	University of Liverpool
Elizabeth Skelton	Imperial College London
Andrea Colombi	ETH Zurich
Richard Craster	Imperial College London

Abstract: We will consider the use of graded arrays of resonators in the control and mode-conversion of surface waves in a multi-physics system. In particular we will show that, for a fluid-loaded elastic plate, it is possible to design a graded metasurface to enable to conversion of mechanical surface waves to bulk acoustic waves. We will also show that it is possible for such a system to exhibit rainbow trapping.

15:30-16:00

Effective medium theories for anisotropic metamaterials

Ying Wu	KAUST

Abstract: I this talk I will discuss effective medium approaches for anisotropic metmaterials. The anisotropy comes from either the scatterer or the arrangement of the scatterers. The scattering problems of a single scatters and collection of scatters will be addressed. For the anisotropic scatterers, the effective medium is derived from coherent potential approximation and for anisotropic lattices the effective medium is derived from multiple-scattering approach. Numerical simulations validate the theories will be presented.

16:00-16:30

Flexural-wave propagation across an area of irregularities in a floating plate

Hyuck Chung — Auckland University of Technology
Malte Peter — University of Augsburg

Abstract: We present an analytical method of computing the bending wave field across an area of irregular mass and rigidity in an elastic floating plate of infinite extent. The fully coupled system between the plate and the water makes this problem more difficult than decoupled ones such as spring-loaded plate or shallow-water problems. We show a method using a Green's function of the floating plate. Scattered flexural waves by a finite of irregular features are computed.

MS ME-0-2 3 — 14:30-16:30

Cross-diffusion systems and applications - Part 3

For Part 1 see: MS ME-0-2 1
For Part 2 see: MS ME-0-2 2
Organizer: Virginie Ehrlacher — Ecole des Ponts Paristech & INRIA
Organizer: Cancès Clément — INRIA

Abstract: Cross-diffusion systems arise in various domains of applications such as crowd motion, physics, chemistry or biology. Despite their significant importance in a wide range of applications, these systems have attracted the attention of mathematicians only recently. They give rise to very interesting and difficult mathematical challenges, either on their theoretical analysis or on their numerical approximation. The aim of this minisymposium is to gather experts working in this field to present their recent contributions and foster new collaborations.

14:30-15:00

A new model of multicomponent diffusion combining the Maxwell-Stefan theory and continuum mechanics

Jiří Mikyška — FJFI
Jan Franců — Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague.

Abstract: We present a theory of multicomponent mixtures which does not employ any splitting of component fluxes into convective and diffusive parts. Instead, momentum balance is formulated individually for each component in which both 1) viscous friction within a component and 2) momentum exchange among different components, are taken into account. The viscous friction is described by the Newtonian stress tensor, while the momentum exchange between different components is described by the Maxwell-Stefan theory.

15:00-15:30

Strong Solutions and Weak-Strong Uniqueness for a class of Cross-Diffusion-Equations

Jan-Frederik Pietschmann — TU Chemnitz

Abstract: We study a particular system of cross-diffusion equations and under assumptions on the value of the cross-diffusion coefficients, we are able to show the existence of strong solutions. The proof relies on the use of an appropriate approximation and a fixed-point argument. In addition, a weak-strong stability result is obtained for this system in dimension one which implies uniqueness.

15:30-16:00

Nonlinear cross-diffusion systems for multi-species crowd motion model

Maxime Laborde — McGill University

Abstract: In this talk, we investigate the existence of solution for systems of Fokker–Planck equations coupled through a common nonlinear congestion given by a porous media congestion or a hard congestion. We will show that these systems can be seen as gradient flows in a Wasserstein product space. Then we obtain a constructive method to prove the existence of solutions and we will use it to obtain numerical simulations.

16:00-16:30

Numerical approximation for an epidemic model with cross diffusion

Veronica Anaya — Universidad del Bio Bio
Mostafa Bendahmane — Institut de Mathématiques, Université de Bordeaux
Michel Langlais — Institut de Mathématiques, Université de Bordeaux
Mauricio Sepúlveda — CI2MA, Universidad de Concepción

Abstract: We are interested in a model related to the indirect transmission of an epidemic disease, the transmission ocurring through a contaminated environment. We will prove the existence of weak solution by using a regularization method. Aditionally, we propose a numerical scheme based on finite volume. We proved the convergence of the discrete solution. Moreover, we present some numerical examples.

MS A6-1-2 3 — 14:30-16:30

Optimization methods and applications - Part 3

For Part 1 see: MS A6-1-2 1
For Part 2 see: MS A6-1-2 2
For Part 4 see: MS A6-1-2 4
For Part 5 see: MS A6-1-2 5
Organizer: Cong Sun — Beijing Univ. Posts and Telecommunications
Organizer: Xin Liu — Academy of Mathematics and Systems Science

Abstract: This multiple minisymposium is to address the recent progress in nonlinear optimization field. The topics include but not limit to: first-order methods, Newton-like methods, derivative free methods, stochastic optimization methods, methods for problems with orthogonality constraints and applications with optimization methods.

14:30-15:00

Stochastic Trust Region Methods with Trust Region Radius Depending on Probabilistic Models

Yaxiang Yuan — AMSS, Chinese Academy of Sciences
Xiaoyu Wang — University of Chinese Academy of Sciences

Abstract: We present a generic stochastic trust region scheme, in which the trust radius depends on probabilitics models. We give a specific algorithm STRME in which the trust region radius is selected as depending linearly on the model gradient. The complexity of STRME method in nonconvex, convex and strongly convex settings has all been analyzed. Numerical experiments are reported to compare the proposed methods with existing stochastic trust region methods and other relavant stochastic gradient methods.

15:00-15:30

Decomposition Methods for Solving Two-Stage Distributionally Robust Optimization Problems

Hailin Sun — Nanjing Normal University
Yannan Chen — The Hong Kong Polytechnic University
Huifu Xu — University of Southampton

Abstract: In this paper, we propose an algorithmic framework based on the fundamental ideas of the methods for solving two-stage minimax distributionally robust optimization (DRO) problems where the underlying random variables take a finite number of distinct values. This is achieved by introducing nonanticipativity constraint for the first stage decision variables, rearranging the minimax problem through Lagrange decomposition and applying the well-known primal-dual hybrid gradient (PDHG) method to the new minimax problem.

15:30-16:00

A variant of primal-dual interior-point methods for nonlinear programming

Xinwei Liu — Hebei University of Technology
Yu-Hong Dai — AMSS, Chinese Academy of Sciences

Abstract: We present a primal-dual interior-point method for nonlinear programming. Our method is of the interior-point variety, but it does not require any primal or dual iterates to be interior-points. Without assuming any regularity condition, it is proved that our method has strong global convergence. Some preliminary numerical results are reported.

16:00-16:30

Two-phase gradient methods for Quadratic rogramming problems: a proportionality based approach

Gerardo Toraldo — Università di Napoli Federico II
Daniela Di Serafino — Università della Campania "Luigi Vanvitelli" , Dipartimento di Matematica e Fisica

Marco Viola Università degli Studi di Roma "Sapienza"

Abstract: We present a two-phase gradient-based method for QP problems. It alternates between an identification phase (P1), which performs Gradient Projection iterations to identify a promising active set, and an unconstrained minimization phase (P2), which reduces the objective function in the space defined by P1. The switch from P1 to P2 relies on a comparison between an optimality-measure in the reduced space and a bindingness-measure of the active variables. Global convergence to a stationary point holds.

MS A3-2-3 3 14:30-16:30

Kinetic modelling and multiscale simulation of nonequilibrium flow dynamics - Part 3

For Part 1 see: MS A3-2-3 1
For Part 2 see: MS A3-2-3 2
For Part 4 see: MS A3-2-3 4
For Part 5 see: MS A3-2-3 5
For Part 6 see: MS A3-2-3 6

Organizer: Lei Wu UK/University of Strathclyde
Organizer: Kun Xu Hong Kong University of Science and Technology
Organizer: Song Jiang Institute of Applied Physics and Comput. Math

Abstract: The Boltzmann equation underpins a board range of applications ranging from high-altitude aerothermodynamics of space vehicles, gas dynamics in micro-electro-mechanical systems, and shale gas extractions. It has also been extended to different fields, such as granular gases, radiative transfer, phonon/electron transport, plasmas, and quantum/relativistic dynamics. However, the high-dimensional integro-differential equations pose great challenges to the numerical simulation of kinetic equations and their applications. The goal of this minisymposium is to explore recent trends and developments in the kinetic theory (simplification of Boltzmann equations, reactions) and multiscale numerical simulation of non-equilibrium dynamics from the continuum to free-molecular flow regimes.

14:30-15:00

Hypocoercivity theory based local sensitivity analysis for multiscale kinetic equations with uncertainties

Shi Jin Shanghai Jiao Tong University

Abstract: We extend hypocoercivity analysis to linear and nonlinear kinetic equations with random uncertainties in initial data or collisional kernels, which allows us to establish regularity, local sensitivity with respect to uncertain random parameters, and long-time exponential decay of the solution toward the global equilibrium in the random space, as well as spectral convergence and long-time error decay of the polynomial chaos based stochastic Galerkin methods, a popular method used for uncertainty quantification.

15:00-15:30

An asymptotic preserving scheme for radiation-hydrodynamics

Wenjun Sun Institute of Applied Physics and Computational Mathematics
Song Jiang Institute of Applied Physics and Computational Mathematics,
Kun Xu Department of Mathematics, Hong Kong University of Science and Technology
Guiyu Cao Department of Mathematics, Hong Kong University of Science and Technology

Abstract: This talking targets on the simulation of multiple scale physics in the radiation-hydrodynamics system. the scheme has asymptotical preserving (AP) property, such as recovering the equilibrium diffusion limit for the radiation hydrodynamical equations in the optically thick region, where the cell size is not limited by photon’s mean free path. Radiative shock wave problems are used to validate the current approach.

15:30-16:00

Accurate front capturing asymptotic preserving method for the grey radiative transport equation

Min Tang Shanghai Jiaotong University

Abstract: We develop an asymptotic preserving scheme for the gray radiative transfer equation, which under a diffusive scaling results in a nonlinear diffusion equation for the material temperature. The benefit of this approach is that 1）the implicit system only requires a scalar Newton's solver; 2) it can use a hyperbolic CFL condition that is independent of the speed of light.

16:00-16:30

A second-order asymptotic-preserving and positivity-preserving method for a class of stiff kinetic equations

Jingwei Hu Purdue University
Ruiwen Shu University of Maryland

Abstract: We introduce a second-order time discretization method for stiff kinetic equations. The method is asymptotic-preserving (AP) -- can capture the Euler limit without numerically resolving the small Knudsen number; and positivity-preserving -- can preserve the non-negativity of the solution for arbitrary Knudsen numbers. The method can be applied to a large class of stiff kinetic equations including the BGK/ESBGK equation, the Fokker-Planck equation, and the full Boltzmann equation.

MS ME-0-3 3 14:30-16:30

Nonlinear waves, singularities, and turbulence in physical and biological systems - Part 3

For Part 1 see: MS ME-0-3 1
For Part 2 see: MS ME-0-3 2
For Part 4 see: MS ME-0-3 4
For Part 5 see: MS ME-0-3 5

Organizer: Pavel Lushnikov University of New Mexico
Organizer: Alexander Korotkevich University of New Mexico

Abstract: Appearance of waves and formation of singularities are important problems in many physical, hydrodynamical and biological systems as well as for the applied mathematics in general. Waves of finite amplitude require solutions beyond linear approximation by taking into account nonlinear effects. Solutions of nonlinear equations usually result in the formation of singularities, coherent structures or solitary waves. Examples of the corresponding phenomena can be observed in filamentation of laser beams in nonlinear media, wave breaking in hydrodynamics and aggregation of bacterial colonies. The minisymposium is devoted to new advances in the theory of nonlinear waves.

14:30-15:00

Loss of reversibility in reversible systems

Gadi Fibich Tel Aviv University

Abstract: We show that reversible systems that have a time-reversal symmetry and a universal attractor (such as the Nonlinear Schrodinger equation and the phi4 equation) can become ``physically irreversible". i.e., realistically-small experimental errors in measuring the output might lead to dramatic differences between the recovered input and the original one. Our results are relevant to various imaging and reversal applications in nonlinear optics

15:00-15:30

Modeling optical light filaments

Alejandro Aceves Southern Methodist University

Abstract: In this talk we will present models and numerical simulations aiming to explain and explore some of the rich dynamics and experimental observations of intense optical filament propagation in the atmosphere. Much is known on the theory since the early studies of singular collapse events in the 2-dimensional Nonlinear Schroedinger equation, but given the emergence of experiments with more intense and shorter spatio-temporal bullets, better models need to be considered.

15:30-16:00

Negative Impact of Nonlinearity on High Speed Optical Fiber Communications: New Approach to Address Old Challenge

Ildar Gabitov University of Arizona and Skoltech
Joseph Gibney University of Arizona

Abstract: Nonlinear distortion is one of the major problems in high speed optical fiber communications. To overcome this challenge there is an effort to utilize integrability of the nonlinear Schroedinger equation. Most of these efforts are based on solving the Gelfand-Levitan-Marchenko (GLM) equation. Here we propose another approach utilizing the associated Riemann-Hilbert problem. With this formulation, there is only one integral equation to be solved rather than two in the case of GLM equation.

MS FT-S-6 3 **14:30-16:30**

Eigenvalue Problems: Analysis, Algorithms and Applications - Part 3

For Part 1 see: MS FT-S-6 1
For Part 2 see: MS FT-S-6 2
For Part 4 see: MS FT-S-6 4

Organizer: Xiaoying Dai — Academy of Mathematics and Systems Science
Organizer: Xin Liu — Academy of Mathematics and Systems Science
Organizer: Huajie Chen — Beijing Normal University

Abstract: Eigenvalue problems are widely used in many fields such as physics, materials sciences, chemistry, biology and image sciences. The research on eigenvalue problems, including its mathematical theory analysis, efficient algorithm design, practical applications, and many unresolved issues, is a challenging topic. This minisymposium aims to provide a platform for experts in this field to exchange the latest developments and explore the topic of further research and cooperations.

14:30-15:00

Parallelizable Second-order Approach for Optimization Problems with Orthogonality Constraints

Xin Liu — Academy of Mathematics and Systems Science

Abstract: Updating the augmented Lagrangian multiplier by closed-form expression yields efficient infeasible approach for optimization problems with orthogonality constraints. To accelerate the local convergence, we propose a second-order approach under this framework. We prove its local quadratic convergence. In practice, the new second-order approach outperforms the existent algorithms. Last but not least, this new approach is completely orthonormalization-free and hence can be parallelized directly.

15:00-15:30

An Augmented Subspace Method for Eigenvalue Provblems

Xie Hehu — Academy of mathematics and Systems of Science, Chinese Academy of Sciences
Yunhui He — Department of Mathematics and Statistics, Memorial University of Newfoundland, Canada
Chunguang You — CAEP Software Center for High Performance Numerical Simulation, Beijing, China
Ning Zhang — Academy of Mathematics and Systems Science, Chinese Academy of Sciences

Abstract: In this lecture, we first introduce a type of error estimates for the subspace projection method for eigenvalue problems. Especially, we will concentrate on the relationship between the energy error and L2 error. Based on this relationship, we design an augmented subspace method for the eigenvalue problems. The corresponding theoretical analysis and numerical examples are provide to validate the efficiency of the proposed method. The parallel applications will also be introduced.

15:30-16:00

The SCF iteration for the rational quadratic programming over the Stiefel manifold

Leihong Zhang — Shanghai University of Finance and Economics
Michael Ng
Lizhi Liao
Rencang Li

Abstract: In this talk, we shall show that the rational quadratic programmings over the Stiefel manifold can be translated into nonlinear eigenvalue problems with eigenvector nonlinearity. We will focus on a specific problem, namely the trace ratio problem arising from the linear discriminant analysis. Theoretical results on the trace ratio problem will be presented and numerical behavior of a Self-Consistent-Field Iterations (SCF) will be discussed.

16:00-16:30

Gunanteed Lower Eigenvalue Bounds with the Weak Galerkin FEM

Ran Zhang — Jilin University

Abstract: This talk is devoted to studying eigenvalue problem by the weak Galerkin finite element method with an emphasis on obtaining lower bounds. As such it is more robust and flexible in solving eigenvalue problems since it finds eigenvalue as a min-max of Rayleigh quotient in a larger finite element space. This is in contrast with nonconforming FEM which can only provide the lower bound approximation by linear elements with only second order convergence.

MS A3-S-C2 3 **14:30-16:30**

Combinatorial scientific computing - Part 3

For Part 1 see: MS A3-S-C2 1
For Part 2 see: MS A3-S-C2 2

Organizer: Alex Pothen — Purdue University
Organizer: Bora Uçar — CNRS and LIP ENS Lyon
Organizer: Aydin Buluc — Lawrence Berkeley National Lab

Abstract: Combinatorial algorithms and tools are used for enabling parallel scientific computing applications. The general approach is to identify performance issues in an application and design, analyze, and implement combinatorial algorithms to tackle those issues. The proposed three-piece minisymposium covers applications in bioinformatics, solvers of linear systems, and data analysis; and graph algorithms for those applications. The objective is to summarize the latest combinatorial algorithmic developments and the needs of the applications. The goal is to cross-fertilize both domains: the applications will raise new challenges to the combinatorial algorithms, and the combinatorial algorithms will address existing problems of the applications.

14:30-15:00

GraphBLAS on different problem domains

Aydin Buluc — Lawrence Berkeley National Lab

Abstract: GraphBLAS consists of a standardized set of high-performance computational kernels that are based on sparse linear algebra. Initially targeting graph analytical problems, GraphBLAS proved capable of accelerating key computations from various other scientific domains such as machine learning and computational biology. In this task, I will present the basics of GraphBLAS, its current implementation and API status, as well its uses in both graph and non-graph domains.

15:00-15:30

Recent advances in the direct solution of sparse equations on parallel computers

Iain S. Duff — RAL and CERFACS
Sebastien Cayrols — STFC RAL
Florent Lopez — STFC RAL
Stojce Nakov — STFC RAL

Abstract: We discuss a range of algorithms and codes for the solution of sparse systems that we have developed in an EU Horizon 2020 Project, called NLAFET, that finished on 30 April 2019. Our methods include right-looking factorizations for unsymmetric matrices, block projection methods, and tree-based factorizations for symmetrically structured matrices using a task-based approach. In each case we show performance and scalability results on a parallel heterogeneous computer.

15:30-16:00

Interplay between algebraic multigrid and weighted matching in graphs

Panayot Vassilevski — Lawrence Livermore National Laboratory

Abstract: We demonstrate an interplay between the construction of coarse hierarchies in algebraic multigrid (AMG) solvers and weighted matching in graphs on one hand, and the use of constructed "algebraically smooth vectors" in adaptive AMG exploiting weighted matching for K-means clustering algorithms on the other hand. We illustrate this interplay by a number of examples in both multilevel preconditioning and graph clustering.

16:00-16:30

Parallel symbolic factorization in sparse direct solvers

Xiaoye Sherry Li — Lawrence Berkeley National Laboratory
Hang Liu — University of Massachusetts Lowell
Anil Gaihre — University of Massachusetts Lowell
Aydin Buluc — Lawrence Berkeley National Laboratory

Abstract: In sparse direct solvers, symbolic factorization refers to the step to find all the fill-ins in the sparse factored matrices based on graph connectivity. The mainstream algorithms resort to either Depth-First or Breadth-First Search, which have inefficiencies, particularly, the redundant workload and unnecessary synchronizations. We introduce a redesigned graph traversal algorithm that overcomes these shortcomings with exploration on trading extra memory for more parallelism. We demonstrate high performance on contemporary multi-core and many-core processors.

MS A6-2-1 3 **14:30-16:30**

Multiscale seismic modelling and imaging - Part 3

For Part 1 see: MS A6-2-1 1
For Part 2 see: MS A6-2-1 2

Organizer: Lihui Chai — Sun Yat-Sen University
Organizer: Ping Tong — Nanyang Technological University
Organizer: Jianwei Ma — Harbin Institute of Technology
Organizer: Xu Yang — University of California, Santa Barbara

Abstract: Seismic modeling and imaging are widely used and powerful tools to investigate subsurface structures on a variety of scales, namely, from the global to industrial scales. This session will bring together academic and industrial researchers with recent advances in theoretical developments, computational methods and practical applications of multiscale seismic modelling and imaging. The session will place particular emphasis on new numerical modelling, migration, tomography, and inversion methods. Specific topic will include fast algorithms for 3D seismic wave simulation; full waveform inversion; optimal transport; model reduction; and applications at a variety of scales.

14:30-15:00

Frozen Gaussian approximation theory for elastic wave propagation

Xu Yang — University of California, Santa Barbara

Abstract: In this talk, we systematically derive the frozen Gaussian approximation for three-dimensional elastic wave propagation in large scales and high-frequency regime. Rather than standard ray-based methods (e.g. geometric optics and Gaussian beam method), the derivation requires to do asymptotic expansion in the week sense (integral form) so that one is able to perform integration by parts. We rigorously prove that the asymptotic accuracy is inversely proportional to the wave number.

15:00-15:30

Model Recovery Below Reflectors Using Optimal Transport Based Reflection Inversion

Yunan Yang — New York University
Björn Engquist — The University of Texas at Austin

Abstract: Reflection-dominated full waveform inversion using the L2 norm as the objective function typically updates the high-wavenumber components of model parameter first. Further iterations only marginally improve the velocity model due to the extremely slow convergence. However, with an intrinsic "transport" property, the optimal transport based objective functions naturally exploit the low-frequency data and generates low-wavenumber model components, which enables efficient recovery of the wave velocity even below the reflecting interfaces based on pure reflection data.

15:30-16:00

Multiscale approaches for solving inverse problems: a quick review

Kui Ren — Columbia University

Abstract: In the past decades, several multiscale methods have been proposed for solving linear and nonlinear ill-posed inverse problems. This talk will try to provide a short review on the topic and present some recent ideas we have in this direction.

16:00-16:30

Variational Principle Based Method for Image Processing

Zhongyi Huang — Tsinghua University

Abstract: In this talk, we focus on image segmentation/restoration. We propose a novel model for image segmentation by using the Cahn-Hilliard equation. We then employ the tailored-finite-point method (TFPM), to solve the associated equation for image segmentation/restoration based on variational principle. Numerical experiments are presented to demonstrate the effectiveness of the proposed model and its features.

MS ME-0-8 3 **14:30-16:30**

Dirac Hamiltonians with critical singularities - Part 3

For Part 1 see: MS ME-0-8 1
For Part 2 see: MS ME-0-8 2

Organizer: Naiara Arrizabalaga — University of the Basque Country, UPV/EHU
Organizer: Albert Mas — Universitat Politècnica de Catalunya
Organizer: Luis Vega — BCAM-BASQUE CENTER FOR APPLIED MATHEMATICS

Abstract: Dirac operators perturbed by potentials with critical singularities have recieved a renewed attention since the beginning of the century. Plenty of works concerning the well posedness of Coulomb type perturbations appeared in the 70's thanks to the work of Rellich, Kato, Nenciu, and Wüst, among others. In this minisimposia we will present recent results in this direction. Our main interest will be to highlight the features of the relativistic setting absent in the non-relativistic one. Special attention will be paid to the shell interactions and its relation to the MIT bag model for quark confinement.

14:30-15:00

Linear and nonlinear Dirac equation on spherically symmetric manifolds

Federico Cacciafesta — Università degli Studi di Padova

Abstract: In this talk we will discuss the Dirac equation on spherically symmetric manifolds, showing in particular how it is possible to exploit the symmetric structure to obtain dispersive (in particular Strichartz) estimates. This is a joint work with Anne Sophie de Suzzoni.

15:00-15:30

On the semiclassical spectrum of the Dirichlet-Pauli operator

Nicolas Raymond — Université d'Angers

Abstract: This talk is devoted to the spectrum of the Dirichlet-Pauli operator on a bounded, regular, and simply-connected open set of the plane. We will show the crucial role of the magnetic Cauchy-Riemann operators (and of their ellipticity), of the Bergman-Hardy spaces, and of the Riemann mapping theorem in the description of the spectrum. This talk is based on a joint work with Jean-Marie Barbaroux, Loïc Le Treust, and Edgardo Stockmeyer.

15:30-16:00

The Hardy inequality and the Dirac-Coulomb Operator

Fabio Pizzichillo — CEREMADE, Université Paris Dauphine
Biagio Cassano — Nuclear Physics Institute of the Czech Academy of Sciences
Luis Vega — BCAM & UPV/EHU

Abstract: This talk aims to show the connection between Hardy-type inequalities and the Coulomb-Dirac operator. Firstly I will show how to define the distinguished self-adjoint extension of the Dirac-Coulomb operator. Then, I will focus on its spectral properties: I will characterise its eigenvalues using the Birman–Schwinger principle; I will show a bound from below of its spectrum, and I will prove that this bound is reached if and only if the potential verifies some rigidity conditions.

16:00-16:30

On spectral stability of the nonlinear Dirac equation

Nabile Boussaid — Université de France-Comté
Comech Andrew — Texas A&M University

Abstract: We study the point spectrum of the linearization at a solitary waves to the nonlinear Dirac equation in n+1 dimension, with Soler nonlinearity. We focus on the spectral stability (absence of eigenvalues with positive real part) in the non-relativistic limit. We prove the spectral stability of small amplitude solitary waves for the charge-subcritical and "charge-critical" cases. We analyze the birth of point eigenvalues with nonzero real part for the linearization.

MS A3-2-1 3 **14:30-16:30**

Cartesian CFD Methods for Complex Applications - Part 3

For Part 1 see: MS A3-2-1 1
For Part 2 see: MS A3-2-1 2
For Part 4 see: MS A3-2-1 4

Organizer: Ralf Deiterding — University of Southampton
Organizer: Kai Schneider — Aix-Marseille Université, I2M

Organizer: Margarete Oliveira Domingues	National Institute for Space Research

MS Organized by: SIAG/CSE

Abstract: Cartesian discretization approaches are ubiquitous in computational fluid dynamics. When applied to problems in geometrically complex domains or fluid-structure coupling problems, Cartesian schemes allow for automatic and scalable meshing; however, order-consistent immersed boundary conditions and efficient dynamic mesh adaptation take forefront roles. This symposium will highlight cutting-edge applications of Cartesian CFD methods and describe the employed algorithms and numerical schemes. An emphasis will be laid on complex multi-physics applications like magnetohydrodynamics, combustion, aerodynamics with fluid-structure interaction, solved with various discretizations, e.g. finite difference, finite volume, multiresolution or lattice Boltzmann CFD schemes. Software design and parallelization challenges will be addressed briefly.

14:30-15:00

Free slip divergence free wavelets on the hypercube : application to the simulation of incompressible flows and to the Dynamic Optimal Transport

Valerie Perrier	University of Grenoble Alpes
Kadri Harouna Souleymane	University of La Rochelle, France

Abstract: In the present talk, we present a new construction of free-slip divergence-free wavelets on the hypercube, which allows to handle physical boudary conditions. The novelty in the construction relies on the design of boundary wavelets, which makes diagonal the change of basis between standard vector wavelets and divergence free wavelets. Then we investigate the use of this new basis for the representation of incompressible flows : first in DNS simulation, then for optimal transport computation.

15:00-15:30

Wavelet-based adaptive computation of multiscale flows produced by complex time-dependent geometries: applications to flapping flight.

Thomas Engels	École normale supérieure
Schneider Kai	Aix-Marseille Université
Farge Marie	ENS Paris
Sesterhenn Jörn	TU Berlin

Abstract: We present a novel numerical method for computing the multiscale flow generated by complex obstacles, specifically flapping insects. Dynamic grid adaptation is performed based on bi-orthogonal wavelets. We model the obstacle and fluid flow using the method of artificial compressibility combined with the volume penalization method. Scaling laws for relevant numerical parameters are presented, and the performance of the novel open-source framework on massively parallel computers is discussed.

15:30-16:00

A sharp-interface phase-change model based on level set and homogeneous relaxation using the multiresolution framework ALPACA

Thomas Paula	Technical University Munich
Stefan Adami	Technical University Munich
Nikolaus A. Adams	Technical University Munich

Abstract: We combine a homogeneous-mixture relaxation model with a level-set based conservative interface-interaction method in order to capture phase change both within the bulk fluid as well as at the phase boundary. The mixture model allows for vapor to appear within the liquid phase. Larger clusters of vapor are transformed into a bulk vapor phase enclosed by a newly created level-set interface.

16:00-16:30

Discussions on the MHD adaptive solvers in the AMROC framework for space plasmas applications

Margarete Oliveira Domingues	National Institute for Space Research
Mueller Moreira Lopes	National Institute for Space Sciences
Ralf Deiterding	University of Southampton
Odim Mendes	National Institute for Space Sciences

Abstract: Plasma modelling is a significant issue in the context of space sciences in particular in the near-Earth-magnetosphere. Plasma disturbances can affect satellites and spacecrafts, and, cause problems in telecommunications and sensitive sensor-systems in Earth. The simulations of these disturbances present a challenge in special in multiresolution approach. We discuss our recent magnetohydrodynamic solver implemented in the MPI-parallel-AMROC-framework and how numerical procedures, like the automatic mesh adaptation, resolution and other approaches are developed and implemented.

IM FT-4-4 3 — 14:30-16:30

Geometrical inverse problems and Completion data

Organizer: Delvare Franck	UNIVERSITE CAEN , UMR6139 CNRS, LMNO
Organizer: Amel Ben Abda	Tunis - El Manar University

Abstract: Inverse problems play a preeminent role in various fields of applied science and engineering. They have been extensively investigated during the last decades with numerous successful applications such as geophysics, seismology, optics, and medical inspections. This mini-symposium seeks to bring together researchers in various fields that involve inverse analysis to present the developed approaches and to discuss new directions including treatment of geometrical inverse problems and data completion. The purpose of the talks relies on the use of relevant error functionals which allow designing efficient numerical identification procedure.

14:30-15:00

A non-iterative method for recovering partial Cauchy data

Boukari Yosra	ENSTAB, University of Carthage
Houssem Haddar	INRIA Saclay, Ecole Polytechnique
Matthieu Aussal	Ecole Polytechnique

Abstract: In this work, we present a data completion algorithm for recovering partial Cauchy data on the same boundary using an integral representation in the case of Helmholtz equation. The proposed method is a direct method, non-sensitive to adding noise since it uses a special formulation and a regularization method to tackle the ill-posedness of the problem, which leads to a convergent scheme. We conduct a numerical validation of our method in the 3d setting.

15:00-15:30

Evanescent regularization methods for the identification of boundary conditions from partial overprescribed data

Delvare Franck	UNIVERSITE CAEN , UMR6139 CNRS, LMNO
Caillé Laetitia	UNIVERSITE CAEN , UMR6139 CNRS, LMNO

Abstract: The purpose is to examine data completion problems. The first kind consists of recovering missing data on some part of the boundary from overspecified data on the remaining part. The second one consists of recovering the solution on the whole domain from partial and noisy data available on a part of the domain. A regularization technique, based on an iterative algorithm where the effect of regularization is vanishing, and numerical simulations are presented.

15:30-16:00

Topological sensitivity analysis for identification of voids under Navier's boundary conditions

Méjri Bochra	ENIT, Tunis - El Manar University
Amel Ben Abda	ENIT-University of Tunis El Manar

Abstract: This talk is concerned with a geometric inverse problem related to the 2D linear elasticity system. Thereby, voids under Navier's boundary conditions are reconstructed from the knowledge of partially over-determined boundary data. The topological derivative of the energy-like misfit functional is computed through the topological-shape sensitivity method. Numerical tests are performed in order to point out the efficiency of the developed approach.

MS A1-1-3 3 — 14:30-16:30

Mining and modeling evolving and higher-order complex data and networks - Part 3

For Part 1 see: MS A1-1-3 1
For Part 2 see: MS A1-1-3 2
For Part 4 see: MS A1-1-3 4

Organizer: Francesco Tudisco	University of Strathclyde
Organizer: Austin Benson	Cornell University
Organizer: Christine Klymko	Lawrence Livermore National Laboratory
Organizer: Eisha Nathan	Lawrence Livermore National Laboratory

Abstract: The analysis of complex networks is a rapidly growing field with applications in many diverse areas. A typical computational paradigm is to reduce the system to a set of pairwise relationships modeled by a graph (matrix) and employ tools within this framework. However, many real-world networks feature temporally evolving structures and higher-order interactions. Such components are often missed when using static and lower-order methods. This minisymposium explores recent advances in models, theory, and algorithms for dynamic and higher-order interactions and data, spanning a broad range of topics including persistent homology, tensor analysis, random walks with memory, and higher-order network analysis.

14:30-15:00

Eigenvector-based Centrality Measures in Multilayer Networks

Francesca Arrigo — University of Strathclyde

Abstract: A popular question that needs answered in complex networks is: which is the most important node in the network? One of the most successful answers builds on the idea that the importance of a node comes from that of its neighbors. The resulting vector of centrality is the Perron eigenvector of a suitable matrix. In this talk, we describe how to generalize this simple but effective idea to the more complicated setting of multi-layer networks.

15:00-15:30

Multi-Tensor Decompositions for Personalized Cancer Diagnostics, Prognostics, and Therapeutics

Orly Alter — University of Utah

Abstract: I will describe the development of novel, multi-tensor generalizations of the singular value decomposition, and their use in the comparisons of brain, lung, ovarian, and uterine cancer and normal genomes, to uncover patterns of DNA copy-number alterations that encode for transformation and predict survival and response to treatment, statistically better than, and independent of, the best indicators and laboratory tests, illustrating the universal ability of these decompositions to find what other methods miss.

15:30-16:00

A New Algorithm Model for Massive-Scale Streaming Graph Analysis

Chunxing Yin — Georgia Institute of Technology
Jason Riedy — Georgia Institute of Technology
David Bader — Georgia Institute of Technology

Abstract: Applications in many areas analyze an ever-changing environment. On billion vertices graphs, providing snapshots imposes a large performance cost. We propose the first formal model for graph analysis running concurrently with streaming data updates. We consider an algorithm valid if its output is correct for the initial graph plus some implicit subset of concurrent changes. We show theoretical properties of the model, demonstrate the model on various algorithms, and extend it to updating results incrementally.

16:00-16:30

Distributed Algorithms for Exact and Approximate Graph Pattern Matching

Tahsin Reza — University of British Columbia
Matei Ripeanu — University of British Columbi
Christine Klymko — Lawrence Livermore National Laboratory
Geoffrey Sanders — Lawrence Livermore National Laboratory
Roger Pearce — Lawrence Livermore National Laboratory

Abstract: We present an algorithmic-pipeline that bases pattern-matching on constraint-checking - each vertex/edge in a match has to meet a set of constrains specified by the search-template; it iteratively prunes the background graph to a solution with no false-positives or false-negatives; also, supports a class of approximate-matching problems. We demonstrate strong and weak-scaling on massive-scale real-world (128B-edges) and synthetic (2.2T-edges) graphs respectively, and at scales (1,024nodes/36,864cores) orders-of-magnitude larger than used in the past for similar problems.

MS ME-0-1 3 — 14:30-16:30

Polygonal and Polyhedral Methods in Applied Mathematics - Part 3

For Part 1 see: MS ME-0-1 1
For Part 2 see: MS ME-0-1 2
For Part 4 see: MS ME-0-1 4

Organizer: Marco Verani — Politecnico di Milano
Organizer: David Mora — Universidad del Bio-Bio

Abstract: Recently, there has been a great interest to the study of numerical methods for the solution of PDEs on polygonal/polyedral computational meshes. This is motivated on one hand by the flexibility of polytopal meshes that allows, e.g., to effectively deal with complex geometries or with refinement/derefinement strategies, and on the other hand by the versatility to accurately facing the numerical approximation of a variety of problems (from fluidynamics, to elasticity and electromagnetism). The goal of this MS is to present the recent developments in the field of polygonal numerical methods in facing the approximation of applied problems governed by PDEs

14:30-15:00

Virtual element for the elasticity eigenproblem

Gonzalo Rivera — Universidad de Los Lagos
David Mora — Universidad del Bío-Bío, Concepción, Chile

Abstract: This work present a priori and a posteriori error analyses of a virtual element method to approximate the vibration frequencies and modes of an elastic solid. We analyse a variational formulation relying only on the solid displacement and propose a discretization by means of the VEM. Under standard assumptions of the domain, the resulting scheme provides a correct apporoximation of the spectrum. We also derive a posteriori error estimator and prove its reliability and efficiency.

15:00-15:30

Conforming and nonconforming Virtual Element Methods for eigenvalue problems

Francesca Gardini — Università di Pavia
Giuseppe Vacca — Dipartimento di Matematica e Applicazioni, Università di Milano Bicocca
Gianmarco Manzini — Group T-5, Theoretical Division, Los Alamos National Laboratory and IMATI CNR Pavia
Ondřej Čertík — Group CCS-2, Computer, Computational and Statistical Division, Los Alamos National Laboratory

Abstract: We analyse the conforming and nonconforming Virtual Element Method for the approximation of second order elliptic eigenvalue problems. We present two discrete formulations, derived by a nonstabilized and stabilized approximation of the L2-inner product, and we study the convergence properties of the corresponding discrete problem. We prove optimal-order error estimates for the eigenfunctions and double order of convergence of the eigenvalues. Moreover, we show a large set of numerical tests supporting the theoretical results.

15:30-16:00

The p- and hp-virtual elements for elliptic eigenvalue problems

Lorenzo Mascotto — University of Wien
Ondřej Čertík — Los Alamos National Laboratory, CCS-2 Group
Francesca Gardini — University of Pavia, Department of Mathematics
Gianmarco Manzini — Los Alamos National Laboratory, CCS-2 Group
Giuseppe Vacca — University of Milano Bicocca,

Abstract: We discuss the p- and the hp-versions of the virtual element method for the approximation of eigenpairs of elliptic operators with a potential term on polygonal meshes. The p-version of the method results in exponential convergence in the case of analytic eigenfunctions. We also show numerically that, for finite Sobolev regularity eigenfunctions, exponential convergence in terms of the cubic root of the number of degrees of freedom is achieved by employing hp-refinements.

16:00-16:30

A nonconforming Trefftz virtual element method for the Helmholtz problem with (piecewise) constant wave number

Alexander Pichler — University of Wien
Lorenzo Mascotto — University of Wien
Ilaria Perugia — University of Wien

Abstract: We introduce a virtual element based method for the Helmholtz problem with (piecewise) constant wave number, having the feature that the employed basis functions are Trefftz, i.e. they lie elementwise in the kernel of the Helmholtz operator. Due to an edgewise definition of the basis functions and nonconforming interelement continuity constraints, a numerical scheme to significantly reduce the number of degrees of freedom can be constructed.

MS A6-1-1 3 **14:30-16:30**

Mathematical Optimization and Gas Transport Networks: Academic Developments - Part 1

For Part 2 see: MS A6-1-1 4

Organizer: Julio González-Díaz	University of Santiago de Compostela

Abstract: This minisymposium one of two minisymposia on Mathematical Optimization and Gas Transport Networks. The focus of this one on academic research on the topic, regardless of whether or not the research is part of a collaboration with Industry. On the other hand, the other minisymposium will focus more on works that are the result of collaborations between Academia and Industry, with a special focus on the applied aspects of the attained results.

14:30-15:00

Piecewise Smooth Dynamic Simulations of Actively Regulated Gas-Networks

Tom Streubel	Zuse Institute Berlin

Abstract: Mathematics also plays a key role in helping to cover an increasing gas demand of European nations in the future by optimizing procedures, analysis and high performance simulation. Active elements such as control valves with continuous but not necessarily smooth space of operation-modes in gas transmission networks require new strategies for their numerical treatment. In this talk we will explore techniques of automatic piecewise-linearization and generalized-Taylor-expansions towards the development of new simulation methodology.

15:00-15:30

MIP techniques for instationary gas transport optimization

Lars Schewe	University of Edinburgh
Robert Burlacu	FAU Erlangen-Nürnberg
Herbert Egger	TU Darmstadt
Martin Groß	RWTH Aachen
Alexander Martin	FAU Erlangen-Nürnberg
Marc E. Pfetsch	TU Darmstadt
Mathias Sirvent	FAU Erlangen-Nürnberg
Martin Skutella	TU Berlin

Abstract: We study the transient optimization of gas networks, especially maximizing the storage capacity of the network. Our model includes nonlinear gas physics and discrete decisions. The former is described by a coupled system of nonlinear parabolic PDE derived from the Euler equations. We tackle the problem by a first-discretize-then-optimize approach. For the solution of the MINLP, we algorithmically extend a well-known relaxation approach. We present two case studies that illustrate the applicability of our approach.

15:30-16:00

GasModels. Jl: Convex Relaxations for Gas System Modeling

Russell Bent	Los Alamos National Laboratory

Abstract: We discuss GasModels.jl , a Julia package for Steady-State Gas Network Optimization. It is designed to enable computational evaluation of emerging gas network formulations and algorithms in a common platform. The code decouples problem specifications (e.g. gas flow, expansion planning, etc.) from network formulations (e.g. MINLP, MISOCP-relaxation, etc). We discuss different formulations, computational performance, and how such models are used to address problems like maximum demand satisfaction, resilient design, and gas-grid modeling.

16:00-16:30

A 2-step SLP algorithm applied to stationary gas transmission networks under calorific power requirements

Ángel M. González-Rueda	University of Coruña
Julio González-Díaz	University of Santiago de Compostela

Abstract: In this talk we present a model for the optimal operation of a gas transmission network including some energy requirements of the customers. We consider gases with different quality attributes entering the network, and pooling constraints are included to track the calorific power. Futher, non-linear flow conservation constraints are needed to guarantee that the demand is satisfied in terms of energy. We propose different approaches to solve it using a 2-step Sequential Linear Programming algorithm.

MS GH-1-1 3 **14:30-16:30**

Inverse Problems in Wave Propagation - Part 1

For Part 2 see: MS GH-1-1 4

Organizer: Gang Bao	Zhejiang University
Organizer: Peijun Li	Purdue University

Abstract: The topics of this mini symposium include inverse problems in acoustic waves, seismic waves, electromagnetic waves, and elastic waves. It aims to address mathematical and computational issues, report recent developments in inverse scattering problems, and present their industrial applications.

14:30-15:00

Direct imaging methods for half-space elastic inverse scattering problems

Zhiming Chen	Academy of Mathematics and Systems Science

Abstract: We propose a direct imaging method based on the reverse time migration to reconstruct extended obstacles in the half space with finite aperture elastic scattering data at a fixed frequency. We prove the resolution of the reconstruction method in terms of the aperture and the depth of the obstacle embedded in the half space. Numerical examples are included to illustrate the effectiveness of the method. This talk is based on joint works with Shiqi Zhou.

15:00-15:30

Wave imaging in moving random media

Liliana Borcea	University of Michigan
Josselin Garnier	Ecole Polytechnique
Knut Solna	UC Irvine

Abstract: We describe an imaging methodology based on a novel transport theory for waves in a moving random medium. The medium is modeled by small temporal and spatial random fluctuations of the wave speed and mass density and it moves due to an ambient flow. We summarize the theory and show how to use it to image wave sources and to estimate the flow velocity.

15:30-16:00

Correction imaging in wide-field adaptive optics

Tapio Helin	LUT University

Abstract: Adaptive optics is a technology utilized in modern ground-based optical telescopes to compensate for the wavefront distortions caused by atmospheric turbulence. In this talk we discuss inverse problems appearing in next-generation adaptive optics modalities.

16:00-16:30

Locadiff: from theory to applications

Qi Xue	University of Grenoble
Eric LAROSE	ISTerre
Ludovic MOREAU	ISTerre

Abstract: Locadiff is an efficient method to detect localized change of a random medium. Due to the multirelrection of the random medium, the correlation of waveforms before and after the change is a stable and sensitive indicator of the change. In this talk we'll show how to relate the correlation with the localized change. Numerical and field experiments demonstrate the utility of this method.

MS GH-3-3 3 **14:30-16:30**

Model order reduction methods and their broad applications in engineering - Part 2

For Part 1 see: MS GH-3-3 2

For Part 3 see: MS GH-3-3 4

Organizer: Lihong Feng	Max Planck Institute for DCTS
Organizer: Francesco Ferranti	Institut Mines-Télécom Atlantique
Organizer: Valentin De La Rubia	Universidad Politecnica de Madrid

Abstract: Model order reduction (MOR) is a methodology aiming at constructing reduced order models (ROMs) based on very large-scale complex mathematical models/data arising from many engineering applications. The ROMs are used to replace the large-scale systems in multi-query tasks, e.g., design exploration, optimization, uncertainty quantifications, etc., and finally to reduce the overall computational time, thanks to their reduced complexities. This minisymposium aims to bring together most recent results of MOR developed in mathematics and various engineering fields, and to provide an excellent platform for brainstorm, so as to further push forward the development of MOR for very challenging applications.

14:30-15:00

Uncertainty Quantification of EM Systems Described by Delayed Differential Equations

Francesco Ferranti	Institut Mines-Télécom Atlantique
Luigi Lombardi	Università degli Studi dell'Aquila
Ye Tao	Carleton University
Behzad Nouri	Carleton University
Giulio Antonini	Università degli Studi dell'Aquila
Michel Nakhla	Carleton University
Daniele Romano	Università degli Studi dell'Aquila

Abstract: Novel methods to tackle the Uncertainty Quantification (UQ) of electromagnetic (EM) systems will be discussed. These EM systems are represented by a set of delayed differential equations (DDEs) that are suitable when the systems of interest are electrically large and therefore quasi-static approximations are not accurate anymore. Results based on nonintrusive and intrusive approaches will be presented for different examples. These techniques can also be used in other application domains with systems described by DDEs.

15:00-15:30

Model-order reduction of high-speed circuits and interconnects

Michel Nakhla — Carleton University

Abstract: One of the main challenges facing designers of high-speed integrated circuits and interconnects is predicting the effect of the variability of geometrical and physical parameters on the circuit performance. Conventional parametrized model-order techniques are in general ineffective in addressing this challenge due to the relatively large size of the parametrized reduced-model. Alternative approaches will be presented to tackle this issue.

15:30-16:00

Adaptive bases construction for model reduction of parametric nonlinear dynamical systems

Sridhar Chellappa	Max Planck Institute, Magdeburg, Germany
Lihong Feng	Max Planck Institute, Magdeburg, Germany
Peter Benner	Max Planck Institute, Magdeburg, Germany

Abstract: For the Reduced Basis Method, we propose a modified POD-Greedy algorithm that simultaneously and adaptively constructs the projection, interpolation basis for the state and nonlinear vectors respectively. The algorithm achieves convergence in fewer iterations while avoiding expensive full order solutions for the entire training set. Using an efficient output error estimator, we determine the number of bases to be added at each iteration. We show numerical examples to demonstrate the validity of our approach.

16:00-16:30

Compact Inverse Model of Large-Scale Integrated Circuit Layout

Dan Jiao — Purdue University

Abstract: We derive a closed-form model of the inverse of the fullwave Maxwell's equations in the physical layout of an integrated circuit, package, and board. In this model, we decompose the inverse rigorously into R-, C-, L- and full-wave components, with neither numerical computation nor approximation, and for an arbitrary physical layout. As a result, each component can be found independently, and then superposed to obtain the total response of a layout to any circuit stimuli.

MS A3-3-L1 3 — 14:30-16:30

Recent advances on numerical methods and analysis of complex fluids - Part 3

For Part 1 see: MS A3-3-L1 1
For Part 2 see: MS A3-3-L1 2
For Part 4 see: MS A3-3-L1 4
For Part 5 see: MS A3-3-L1 5

Organizer: Zhonghua Qiao	The Hong Kong Polytechnic University
Organizer: Hui Zhang	Beijing Normal University

Abstract: The goal is to integrate advances in mathematics (theory, modeling, algorithms, simulations, high performance computing techniques) with new experimental data from complex fluids and biological systems, and targeted applications. The specific systems represented include liquid crystal flow, polymeric flow and magnetic fluids, phase-field and beyond these area.

14:30-15:00

Simulation of moving contact lines in two-phase polymeric fluids

Zhen Zhang	Southern University of Science and Technology
Weiqing Ren	National University of Singapore

Abstract: We numerically study the influence of polymer additives on contact line dynamics using a sharp interface model under FENE-P assumption. The coupled dynamic equations are solved using the finite difference method with immersed boundary technique. Simulations in a Couette geometry showed that the large velocity gradient near the moving contact line results in large polymer stress, which retards the contact line motion.

15:00-15:30

Second Order Fully Discrete Energy Stable Schemes for Hydrodynamic Liquid-Crystal Models

Jia Zhao	Utah State University
Qi Wang	University of South Carolina

Abstract: The hydrodynamic liquid crystal models have been used for studying flows of liquid crystals and liquid crystal polymers. In this talk, I will present a generic numerical technique that could develop full discrete, second-order in time and space schemes, where only a linear system needs to be solved in each time step. These schemes are proved to be unconditionally energy stable so that a large time step is plausible. Several numerical examples will be presented.

15:30-16:00

Efficient Numerical Approximations for a Phase-Field Multi-Phase Fluid Model with Moving Contact Lines

Haijun Yu — Academy of Mathematics and Systems Science, CAS

Abstract: Phase-field model is one of the major tools to deal with multi-phase flow and moving contact line problem. We present several first and second order energy stable schemes for a phase-field moving contact line model proposed by Qian, Wang and Sheng in 2013. Those schemes are all linear and unconditional energy stable. Numerical results and a verification of the sharp-interface limits of the Qian-Wang-Sheng model will be presented.

16:00-16:30

Non-Isothermal Electrokinetic: Energetic Variational Approach

Pei Liu — Pennsylvania State University

Abstract: In order to understand how the temperature affects the electrokinetics, we develop a Poisson--Netnst--Planck--Fourier (PNPF) system through the energetic variational approach. With given form of the free energy functional and the entropy production, we achieve the mechanical equations and a temperature equation, which satisfy the laws of thermodynamics automatically. From the energy point of view, we also develop the numeric scheme which satisfy the discrete energy dissipation.

MS ME-0-6 3 — 14:30-16:30

Novel Concepts in Model-driven Optimization and Control of Agent-based Systems - Part 3

For Part 1 see: MS ME-0-6 2
For Part 2 see: MS ME-0-6 1
For Part 4 see: MS ME-0-6 4

Organizer: Dante Kalise	University of Nottingham
Organizer: Giuseppe Visconti	RWTH Aachen University
Organizer: Herty Michael	RWTH Aachen University
Organizer: Giacomo Albi	University of Verona

Abstract: This minisymposium features recent developments in optimization and control of agent-based dynamics arising in collective behaviour phenomena across different spatio-temporal scales, with particular emphasis on the interplay between multiscale modelling and optimal control. The talks will focus on different techniques stemming from multiscale modelling, nonlinear optimal control, Hamilton-Jacobi Equations and uncertainty quantification, and will incorporate recent breakthroughs in model-driven optimization, high-dimensional approximation and learning. This minisymposium will also address different applications in learning and control of animal and human crowd motion, social dynamics, and the control of autonomous vehicles.

14:30-15:00

A kinetic approach to uncertainty damping in traffic flow via driver-assist vehicles

Andrea Tosin	Politecnico di Torino
Mattia Zanella	Politecnico di Torino

Abstract: We introduce a kinetic description of control problems for vehicular traffic aimed at dampening some structural uncertainties responsible for scattered aggregate trends. In more detail, we model stochastic microscopic interactions among the vehicles, subject to an instantaneous control when they involve driver-assist vehicles. Then, we upscale them to the global flow via a kinetic Boltzmann-type equation. Our approach promotes the idea that multi-agent systems need to be controlled via bottom-up rather than via top-down strategies.

15:00-15:30

Controlling (stochastic) interacting particle systems

Claudia Totzeck	Technische Universität Kaiserslautern

Abstract: In this talk we discuss optimization techniques for interacting particle systems and their mean-field equations. We begin with a determinstic particle system and discuss when the process of passing to the mean-field limit and optimization commute. Then we add some random noise. In this case the standard schemes fail. We discuss the issues and propose an optimization approach based on space mapping. The results are illustrated by simulations.

15:30-16:00

Boltzmann control strategies in multi-agent systems

Giacomo Albi	University of Verona

Abstract: We are interested in a Boltzmann-type framework for the optimal control of large multi-agent systems. We will review suboptimal approaches as well as the optimal control of binary dynamics Boltzmann equation, and their relation with mean-field optimal control problems. Finally we will propose a stochastic hybrid algorithm, able to mitigate the numerical complexity of these problems. Numerical examples will be presented in the context of flocking and swarming models.

16:00-16:30

Qualitative Properties of a Continuous Model for Data Flow in Large Computer Systems

Giuseppe Visconti	RWTH Aachen University
Cory D. Hauck	CAM Group, Oak Ridge National Laboratory, USA
Michael Herty	IGPM, RWTH Aachen University, Germany

Abstract: Recently, a deterministic microscopic model of data processing and flow in an extreme scale computer with interprocessor communications and asynchronous executions has been proposed. In this talk, we reformulate the fluid-limit model as a conditioned hyperbolic system of PDEs and analyze weak solutions. Further, we investigate a control problem where the objective is the minimization of the processing time. The optimal control is then applied on the distribution of the processing rate among the processors.

MS A6-5-2 3 14:30-16:30

Modeling the mechanics of 2D materials

Organizer: Paul Cazeaux	University of Kansas
Organizer: Malena Espanol	The University of Akron

Abstract: The recent synthesis of free-standing graphene, a one-atom thick two-dimensional (2D) sheet of carbon atoms, was a revolution in material physics as long-range order in 2D structures was previously thought to be impossible. Since then, the field has blossomed with the discovery of a cornucopia of stable 2D materials with remarkable properties. This minisymposium aims to bring together researchers interested in the development and application of methods required to uncover new behaviors and properties of 2D materials. Areas of interest include: -Rippling and defect structures of 2D materials, -Mechanical, thermal, and electronic properties of 2D materials, -Mechanics of thin structures.

14:30-15:00

Gamma-convergence and dislocations in 2D materials

Dmitry Golovaty	University of Akron
Malena Espanol	Arizona State University
J. Patrick Wilber	University of Akron

Abstract: Recently, a rich collection of moire patterns was observed in graphene deposited over flat crystalline substrates. The primary source of these patterns is the lattice constant mismatch between graphene and the substrate. I will discuss models explaining formation of networks of dislocations accompanying the moire patterns as well as describe a Gamma-convergence result that establishes variational equivalence between these models.

15:00-15:30

From Modeling to Simulations of Bending Actuated Devices

Andrea Bonito	Texas A&M University
Soeren Bartels	

Abstract: The bending of bilayer plates is a mechanism which allows for large deformations via small externally induced lattice mismatches of the underlying materials. In this talk, we give a general overview on the model reduction procedure, mention the convergence of the iterative algorithm and explore the performances of the numerical algorithm as well as the reduced model capabilities via several insightful numerical experiments involving large (geometrically nonlinear) deformations.

15:30-16:00

The Role of Topology on the Structure-Property Relations of Polycrystalline Materials

Katerine Saleme Ruiz	Université du Luxembourg
Maria Emelianenko	George Mason University

Abstract: We describe measure(s) of the topological and geometrical information of 2D polycrystalline microstructures using Rényi entropy-based mesoscale approaches. We carry out sensitivity analysis to investigate dependence between materials mechanical response and mesoscale representations of microstructure networks by performing simulations using grain-level micro-mechanical discrete element model. The results allow us to make observations about the sensitivity of mechanical parameters and amount of microstructure damage to different entropy measures.

16:00-16:30

Spontaneous Thermal Fluctuations of Ripples in Suspended Graphene and Energy Harvesting

Antonio Lasanta	Universidad Carlos III de Madrid
Luis L. Bonilla	Universidad Carlos III de Madrid
Miguel Ruiz García	University of Pennsylvania
Paul Thibado	University of Arkansas
P Kumar	University of Arkansas
Surendra Singh	University of Arkansas

Abstract: At room temperature, micron-size sheets of freestanding graphene are in constant motion, even in the presence of an applied bias voltage. A key mechanism behind this result is the stochastic curvature inversion of ripples, during which thousands of atoms move coherently with long-time correlations. We present a Langevin model that captures this out-of-plane motion unique to two-dimensional materials and show that it reaches a stationary nonequilibrium state.

MS FT-2-6 3 14:30-16:30

Fast algorithms for integral equations and their applications - Part 2

For Part 1 see: MS FT-2-6 2

For Part 3 see: MS FT-2-6 4

Organizer: Carlos Eduardo Cardoso Borges	University of Central Florida
Organizer: Min Hyung Cho	University of Massachusetts Lowell

MS Organized by: SIAG/CSE

Abstract: The recent advances in integral equations and its fast numerical methods have provided useful tools for many applications ranging from nano-optics to medical imaging and geosciences. This mini-symposium will discuss challenges in the formulation of the problem, cutting-edge fast algorithms and their efficient implementation, their applications in various fields. At the same time, it will provide opportunities to promote interdisciplinary research collaboration between computational scientists and other fields.

14:30-15:00

A new mixed potential representation for the equations of unsteady, incompressible flow

Shidong Jiang	New Jersey Institute of Technology
Leslie Greengard	Courant Institute, New York University; Flatiron Institute, Simons Foundation

Abstract: We present a new integral representation for the unsteady, incompressible Stokes or Navier-Stokes equations, based on a linear combination of heat and harmonic potentials. The coupled system of integral equations can be solved in predictor-corrector fashion together with spectral deferred correction to achieve high-order accuracy. We refer to one unknown density as the vortex source, the other as the pressure source and the coupled system as the combined source integral equation.

15:00-15:30

Fast algorithms for waves in layered media

Min Hyung Cho University of Massachusetts Lowell

Abstract: Two numerical methods for wave scattering from layered media will be discussed. The first algorithm uses free-space Green's function with a periodizing algorithm for the periodically patterned layered media. It overcomes slow convergence and Wood anomaly issues of the quasi-periodic Green's function. The second algorithm uses layered media Green's function that is constructed using Sommerfeld integrals. With transformed basis, fast solver for planar layered media is developed by adapting the free-space fast multipole method.

15:30-16:00

A fast and accurate solver for acoustic scattering in three dimensions based on integral equations

Jun Lai Zhejiang University

Abstract: Fast, high-accuracy algorithms for acoustic scattering from three dimensional objects are of great importance when modeling physical phenomena in sesmics, optics and many other fields of applied science. In this talk, we develop an FFT-accelerated solver that can be used to efficiently and accurately invert integral equation formulations of Helmholtz equations for scattering from 3D smooth bodies. The solver is also extended to non-smooth geometries based on generalized Gaussian quadratures.

16:00-16:30

Causal electromagnetic scattering: bounds and sum rules via optical theorems

Owen Miller Yale University

Abstract: We develop an analytical framework to derive upper bounds to light-matter interactions in the optical near field, where applications ranging from spontaneous-emission amplification to greater-than-blackbody heat transfer show transformative potential. Our framework connects the classic complex-analytic properties of causal fields with newly developed energy-conservation principles, resulting in a new class of power-bandwidth limits. These limits demonstrate the possibility of orders-of-magnitude enhancement in near-field optical response with the right combination of material and geometry.

MS FT-2-4 3 14:30-16:30

Stochastic Computation and Complexity - Part 1

For Part 2 see: MS FT-2-4 4
For Part 3 see: MS FT-2-4 5
For Part 4 see: MS FT-2-4 6
Organizer: Raphael Kruse Technische Universität Berlin
Organizer: Stefan Heinrich University of Kaiserslautern

Abstract: The minisymposium is devoted to recent developments in stochastic numerics. This includes the numerical solution of stochastic differential equations, stochastic partial differential equations, stochastic integration and stochastic quadrature problems, as well as applications to the solution of partial differential equations. Deterministic, Monte Carlo, Multilevel Monte Carlo, quasi-Monte Carlo, and deep learning methods will be presented. Emphasis is laid on efficiency of algorithms, their convergence analysis, optimality, and the complexity of the underlying problems.

14:30-15:00

On the backward Euler-Maruyama method for SDEs with multivalued drift coefficients

Raphael Kruse Technische Universität Berlin
Monika Eisenmann Technische Universität Berlin
Mihaly Kovacs Pazmany Peter Catholic University Budapest
Stig Larsson Chalmers University of Technology

Abstract: In this talk we consider the numerical approximation of stochastic differential equations (SDEs) with a multivalued and maximal monotone drift. We present a new approach to the error analysis which is based on techniques proposed by Nochetto et.al. (2000) for deterministic problems. We show that the order of convergence is at least 1/4 in the strong sense. The results are applicable to a wide class of stochastic gradient flows with possibly discontinuous drift coefficients.

15:00-15:30

Probability density function of SDEs with unbounded and path-dependent drift

Dai Taguchi Osaka University
Akihiro Tanaka Osaka University

Abstract: In this talk, we prove that the existence and Gaussian two-sided bound for a probability density function of a solution of SDEs with unbounded and path-dependent drift coefficient. We also provide two explicit representations for the density. The first representation is an analogue of Levi's parametrix method and the second representation is related to Maruyama's proof of Girsanov Theorem. As an application of explicit representation, we provide the rate of convergence for the Euler--Maruyama approximation.

15:30-16:00

High Order Langevin Monte Carlo

Ying Zhang University of Edinburgh
Sotirios Sabanis University of Edinburgh

Abstract: We consider a problem of sampling from a high-dimensional target distribution, under the assumption that its density is known up to a normalizing constant. Crucially, the Langevin SDE associated with the target distribution is assumed to have a locally Lipschitz drift coefficient, such that its second derivative is locally Hölder continuous. In this talk, I will introduce a new (unadjusted) Langevin Monte Carlo algorithm with improved rates in total variation and Wasserstein distance.

16:00-16:30

Optimal approximation of stochastic Itô integrals in the presence of informational noise

Andrzej Kałuża AGH University of Science and Technology
Paweł Przybyłowicz AGH University of Science and Technology
Paweł M. Morkisz AGH University of Science and Technology

Abstract: We present results on approximation of stochastic integrals of the following form where T>0, W={W(t)}t⩾0 is a standard Wiener process, X={X(t)}t∈[0,T] belongs to some class of stochastic processes. We introduce suitable analytic noise model of standard noisy information about X and W. In this model we show that the upper bounds on the error of the Riemann-Maruyama quadrature are proportional to n-ϱ+δ1+δ2. We also report numerical experiments that confirm our theoretical findings.

MS FE-1-G 3 14:30-16:30

Numerical analysis for PDE constrained optimization - Part 1

For Part 2 see: MS FE-1-G 4
Organizer: Johannes Pfefferer Technical University of Munich
Organizer: Arnd Rösch Universität Duisburg-Essen

MS Organized by the GAMM activity group "Optimization with Partial Differential Equations" (OPDE)

Abstract: Optimal control problems with PDE constraints are of huge interest both from a theoretical point of view but also in practical applications. In order to solve such problems computationally, different approximation methods are under active research. This minisymposium will bring together young and experienced researchers working on different aspects in this field. For instance, this includes a priori and a posteriori analysis for optimal control problems subject to partial differential equations and inclusions, the numerical treatment of nonlinear terms in the PDE setting, or the coupling of partial differential equations and ordinary differential equations as additional constraint.

14:30-15:00

Optimal control problems in non-convex domains with regularity constraint

Johannes Pfefferer Technical University of Munich
Boris Vexler Technical University of Munich
Benedikt Berchtenbreiter Technical University of Munich

Abstract: This talk is concerned with tracking type optimal control problems in non-convex domains. Due to the appearance of singular terms (caused by the non-convex corners) the optimal states does not belong to $H^2(\Omega)$ in general. However, we are interested in optimal states which nevertheless have this regularity. Thus, we impose a regularity constraint on the state. We discuss existence and uniqueness of solutions to such problems, corresponding optimality conditions and discretization approaches.

15:00-15:30

Discretization error estimates for optimal control problems with functions of bounded variation

Ira Neitzel	University of Bonn
Dominik Hafemeyer	TU Muenchen
Florian Mannel	Universitaet Graz
Boris Vexler	TU Muenchen

Abstract: We discuss the finite element discretization of optimal control problems with control functions with bounded variation. The lack of coercivity of the BV semi-norm does not allow to use standard techniques. An assumption implying that the controls are piecewise constant and that the adjoint state has nonvanishing derivative at the jumps of the control is used to derive optimal error estimates in the case of variational discretization as well as piecewise constant control discretization.

15:30-16:00

Optimal control of a non-smooth quasilinear elliptic equation

Arnd Rösch	Universität Duisburg-Essen

Abstract: We discuss an optimal control problem governed by a non-smooth quasilinear elliptic equation with a nonlinear coefficient in the principal part that is locally Lipschitz continuous and directionally but not Gâteaux differentiable. This leads to a control-to-state operator that is directionally but not Gâteaux differentiable as well. Based on a suitable regularization scheme, we derive C- and strong stationarity conditions. This is a joint work with Christian Clason and Vu Huu Nhu.

16:00-16:30

Numerical Approximation for Rate-Independent Evolutions

Michael Sievers	Technische Universität Dortmund
Christian Meyer	TU Dortmund

Abstract: We present a discretization of a rate-independent evolution governed by a non-convex energy functional. While standard continuous and piecewise linear finite elements are used for the discretization in space, we employ a tailored local minimization algorithm for the discretization w.r.t. time. It is shown that sequences of discrete solutions converge to so called parametrized solutions, as the mesh size tends to zero. For the time discretization we additionally present an a-priori error estimate.

MS FT-0-3 3 14:30-16:30

Numerical Approximations of Geometric Partial Differential Equations - Part 1

For Part 2 see: MS FT-0-3 4
For Part 3 see: MS FT-0-3 5
For Part 4 see: MS FT-0-3 6
For Part 5 see: MS FT-0-3 8

Organizer: Alan Demlow	Texas A&M University
Organizer: Ricardo Nochetto	University of Maryland
Organizer: Andrea Bonito	Texas A&M University

Abstract: Geometric partial differential equations have received much attention recently due to their appearance in models for a wide range of physical processes. This mini-symposium focuses on their numerical approximation, which must overcome highly nonlinear interactions inherent to the approximation of partial differential equations defined on approximate geometries. Experts in modeling, numerical analysis, and scientific computation will discuss recent advances ranging from fundamental considerations concerning the design and analysis of numerical methods to applications in biology, materials science, and fluid dynamics.

14:30-15:00

Finite element methods for surface Stokes equations

Arnold Reusken	RWTH Aachen University

Abstract: In this presentation we consider a variational formulation of surface Stokes equations on a smooth closed two-dimensional surface. Well-posedness results of this formulation are briefly addressed. We propose and analyze several alternative variational formulations for this surface Stokes problem, including constrained and penalized formulations, which are convenient for Galerkin discretization methods. One of the penalized formulations is discretized based on trace finite elements. This method is explained and results of numerical experiments are presented.

15:00-15:30

The distance function and surface regularity in surface finite element methods

Alan Demlow	Texas A&M University
Andrea Bonito	Texas A&M University
Ricardo Nochetto	University of Maryland-College Park

Abstract: Surface finite element methods (SFEM) are widely used to solve the Laplace-Beltrami and related problems posed on surfaces. Error analysis of such methods relies heavily on the distance function and associated closest point projection. However, obtaining optimal error estimates using existing techniques requires more regularity of the surface than should be necessary. We present new error estimates for standard parametric, trace, and narrow band SFEM that require only minimal surface regularity.

15:30-16:00

A finite volume scheme for a Hamilton-Jacobi equation on an evolving surface

Klaus Deckelnick	University of Magdeburg
Charles M. Elliott	University of Warwick, UK
Tatsu-Hiko Miura	University of Tokyo, Japan
Vanessa Styles	University of Sussex, UK

Abstract: We consider a Hamilton--Jacobi equation on an evolving hypersurface. The notion of viscosity solution is extended in a natural way to evolving hypersurfaces and provides uniqueness by comparison. An explicit in time monotone numerical approximation is derived on interpolating triangulated surfaces. The scheme is stable and consistent leading to an existence proof via the proof of convergence. We also obtain an error bound that is of the same order as in the flat case.

16:00-16:30

Numerical approximations of a tractable mathematical model for tumour growth

Vanessa Styles	University of Sussex
John King	University of Nottingham
Joe Eyles	University of Sussex

Abstract: We consider a free boundary problem representing one of the simplest mathematical descriptions of the growth and death of a tumour. The mathematical model takes the form of a closed interface evolving via forced mean curvature flow where the forcing depends on the solution of a PDE that holds in the domain enclosed by the interface. We derive sharp interface and diffuse interface finite element approximations of this model and present some numerical results.

MS A3-3-3 3 14:30-16:30

Applied Mathematics for Environmental Problems - Part 1

For Part 2 see: MS A3-3-3 4

Organizer: María Isabel Asensio Sevilla	Universidad de Salamanca
Organizer: Albert Oliver	University of Las Palmas de Gran Canaria
Organizer: Josep Sarrate Ramos	Universitat Politècnica de Catalunya

Abstract: Climate change, air pollution, deforestation, soil degradation, are some of the world's biggest environmental problems that humanity needs to face. They are urgent challenges with large economic and social impacts that, if not addressed, will grow in the future. Mathematical models help us to understand, predict and quantify the consequences of these problems, allowing to design of potential solutions. The presentations cover several environmental models and its numerical and computational treatment. These models are based on partial differential equations and solved using different numerical methods, combined with efficient computational techniques to provide useful forecasting tools in decision-making and warning.

14:30-15:00

PhyFire: an online GIS integrated wildfire spread simulation tool based on a semiphysical model

María Isabel Asensio Sevilla	University of Salamanca
Luis Ferragut	University of Salamanca
José Manuel Cascón	University of Salamanca
Pablo Laiz	University of Salamanca
Gianni Pagnini	BCAM

Abstract: We present the latest improvements of the PhyFire-HDWind system, a GIS integrated wildfire spread simulation models developed by the research group SINUMCC at the University of Salamanca. It is based on a simplified physical fire spread model, that incorporates its own high definition windfield model. A new flame length submodel has been developed, and random phenomena such as fire spotting have been integrated, in collaboration with G. Pagnini. Some real fire simulations will be shown.

15:00-15:30

Combining statistical and ensemble methods for probabilistic wind field prediction

Albert Oliver Serra	University of Las Palmas de Gran Canaria
Luis Mazorra-Aguiar	University of Las Palmas de Gran Canaria
Eduardo Rodríguez	University of Las Palmas de Gran Canaria
Gustavo Montero	University of Las Palmas de Gran Canaria

Abstract: Probabilistic wind forecasting is a methodology to deal with uncertainties in numerical weather prediction models (NWP). In this work, we present a combination of statistical and ensemble methods designed for the downscaling wind model Wind3D coupled with the HARMONIE-AROME mesoscale model. The ensemble method is based on a Monte Carlo approach, and the statistical method is the linear model in quantile regression (LMQR). The combination of both results give a probabilistic forecasting.

15:30-16:00

Physical parametrisation of fire-spotting for operational wildfire simulators

Gianni Pagnini	Basque Center for Applied Mathematics BCAM
Vera Egorova	Universidad de Cantabria
Inderpreet Kaur	Max Planck Institute for Chemistry
Andrea Trucchia	BCAM

Abstract: We consider an approach based on the application of random fluctuations to the outputs of a generic operational simulator of wildfire propagation. By assuming a lognormal distribution for the random contribution corresponding to the landing distance of firebrands, a concurrent multi-scale physical parametrization of fire-spotting is derived and it takes into account features of the system both at the macro-scale, as mean wind and atmospheric stability, and at the meso-scale, as flame geometry.

16:00-16:30

Two-phase flow simulation using high-order HDG and fully implicit time integration

Josep Sarrate	Polytechnical University of Cataluña
Albert Costa-Solé	Universitat Politècnica de Catalunya
Eloi Ruiz-Gironés	Barcelona Supercomputing Center

Abstract: In this work, we focus on the water-flooding technique for oil recovery. The governing equations form a coupled, non-linear system of transient PDE's that are obtained after combining, for each phase, the mass balance equation and Darcy's law. We propose to combine a high-order hybridizablediscontinuous (HDG) discretization in space with a high-order full implicit Runge-Kutta scheme to perform the time integration. We will present several examples in 2D and 3D dealing with heterogeneous materials.

MS FT-4-7 3 14:30-16:30

Iterative processes for solving nonlinear problems: Convergence and Stability - Part 3

For Part 1 see: MS FT-4-7 1

For Part 2 see: MS FT-4-7 2

For Part 4 see: MS FT-4-7 5

Organizer: Juan Torregrosa — Universitat Politècnica de València

Abstract: Solving nonlinear equations and systems is a non-trivial task that involves many areas of Science and Technology. Usually it is not affordable in a direct way and iterative algorithms play a fundamental role in their approach. The main theme of this Special Issue, but not the unique, is the design, analysis of convergence and stability and application to practical problems of new iterative schemes for solving nonlinear problems. This includes methods with and without memory, with derivatives of derivative-free, the real or complex dynamics associated to them and an analysis of their convergence that can be local, semilocal or global.

14:30-15:00

Optimal fourth order methods with variable step for multuiple roots of nonlinear equations

Fiza Zafar	Bahauddin Zakariya University
Alicia Cordero	Instituto Universitario de Matematica Multidisciplinar, Universitat Politecnica de Valencia
Juan Ramon Torregrossa	Instituto Universitario de Matematica Multidisciplinar, Universitat Politecnica de Valencia

Abstract: Newton-Raphson method has always remained as a widely used method for finding simple as well as multiple roots of nonlinear equations and has mostly been used as a first step to develop higher order multistep methods. We develop a new two-step optimal fourth-order family of methods for multiple roots $(m > 1)$ that has the flexibility of choice at both substeps. The first step of the proposed method is capable of defining new choices of first step.

15:00-15:30

Numerical Solution of Non-Linear Differential Equations for Unsteady Flow of Micropolar Fluids in a Porous Stretching Domain With Joulean Dissipation

Farooq Ahmad	Nanyang Technological University
SAJJAD HUSSAIN	School of Mechanical & Aerospace Engineering, Nanyang Technological University, Singapore
SHAN-E FAROOQ	Math's Department, G.C. University, Lahore, Pakistan
MUHAMMAD ABDULLA EL HAKIEM	Mathematics Department, Faculty of Science in Aswan, Aswan University, Aswan Egypt
SIFAT HUSSAIN	Math's Department, Islamia University, Bahawalpur, Pakistan

Abstract: The numerical investigation has been carried out for coupled non-linear partial differential equations in higher orders that govern the heat transfer analysis for micropolar fluids flow passing through a porous medium. The temperature dissipation is augmented with thermal radiation, viscous dissipation and Joule heating. The boundary value problem (BVP) has been converted into third order ordinary differential equations (ODEs). Findings: The temperature function is increased with increase under Joulean as well as thermal dissipation effects.

15:30-16:00

A new family of efficient root-finding methods with memory based on Lagrange interpolation

Moin-ud-Din Junjua	Bahauddin Zakariya University
Zafar Fiza	Bahauddin Zakariya University

Abstract: In this paper, we have developed a new family of derivative-free optimal eighth order convergent root finding methods without-memory based on the Lagrange interpolation and extended it to with-memory one. The order of convergence of new family is 15.5156 and efficiency index is nearly two when it is converted into with-memory one. The presented methods have simple body structure, provide better accuracy and wide regions of convergence as compare to recent methods of same order.

MS ME-0-7 3 14:30-16:30

Partial Differential Equations in Fluid Dynamics - Part 3

For Part 1 see: MS ME-0-7 1

For Part 2 see: MS ME-0-7 2

For Part 4 see: MS ME-0-7 4

Organizer: Yachun Li	Shanghai Jiao Tong University
Organizer: Tong Yang	City University of Hong Kong
Organizer: Ya-Guang Wang	Shanghai Jiao Tong University
Organizer: Yue-Jun Peng	CNRS/UCA LMBP

Abstract: The purpose of this minisymposium is to bring together mathematicians from all over the world in the area of partial differential equations to present their recent research results in analysis and applications about related models in fluid dynamics, to exchange new ideas, to discuss current challenging issues, to explore new research directions and topics, and to foster new collaborations and connections.

14:30-15:00

Isentropic Approximation

Ronghua Pan	Georgia Institute of Technology

Abstract: In the study of compressible flows, the isentropic model was often used to replace the more complicated full system when the entropy is near a constant. We will discuss the mathematical justification of isentropic approximation in Euler flows and in Navier-Stokes-Fourier flows. This is based on the joint work with Y. Chen, J. Jia, and L. Tong.

15:00-15:30

Mean field limit of many particle system with non Lipschitz force

Li Chen	University of Mannheim
Simone Göttlich	Universität Mannheim
Qitao Yin	Universität Mannheim

Abstract: The interacting many particle system contains the mean field velocity allignment effect in pedestrian flow and convey band problems. For stochastic initial data, we prove the convergence in measure of the N-particle system to the solution of the Vlasov equation with properly chosen cut-off. Furthermore, the existence of weak solution of the Vlasov equation with velocity allignment effect are investigated, which is needed in obtaining the mean field limit.

15:30-16:00

On the inhibition of thermal convection by a magnetic field under zero resistivity

Song Jiang	Institute of Applied Physics and Comput. Math
Fei Jiang	Fuzhou University, Fujian Province, China

Abstract: We investigate the stability/instability of the magnetic Rayleigh-Bénard problem (RBP) with zero resistivity. A stability criterion is established, under which the magnetic BRP is stable. This verifies Chandrasekhar's assertion in 1955 that the thermal instability can be inhibited by a strong magnetic field in MHD fluids with zero resistivity. Furthermore, we also provide an instability criterion, under which the magnetic RBP is unstable. This means that the thermal instability still occurs for weak magnetic fields.

16:00-16:30

Modeling aurora type phenomena by short wave-long wave interactions in Multi-D large MHD Flows

Daniel Marroquin	IMPA
Hermano Frid	IMPA
Ronghua Pan	Georgia Institute of Technology

Abstract: We study a model for aurora type phenomena, where a short wave, obeying a nonlinear Schrodinger equation, propagates along the streamlines of a magnetohydrodynamic flow. Due to the possible occurrence of vacuum, the Lagrangian transformation, upon which the model is based, may become singular. To overcome these difficulties, we propose a regularized system and study existence of solutions and their convergence as the regularizing parameters vanish.

MS A6-3-4 3 14:30-16:30

Discrepancy and Minimal Energy - Part 2

For Part 1 see: MS A6-3-4 2
For Part 3 see: MS A6-3-4 4

Organizer: Johann Brauchart — Graz University of Technology

MS Organized by: SIAG/CSE

Abstract: The arrangement of point configurations on manifolds, whether deterministic or random, is an interdisciplinary topic of great interest in applied mathematics and engineering, physics and computer science. In this three-part minisymposium the talks will explore recent key developments in quality quantification and its asymptotic analysis (low discrepancy, minimal energy, hyperuniformity), application in numerical integration, manifold discretization driven by self-organization by local interaction (Riesz and Green potentials and soft sticky disc interactions), and explicit constructions and sampling.

14:30-15:00

The Asymptotic Distribution of Riesz' Energy

Raffaello Seri	Università degli Studi dell'Insubria

Abstract: We consider the asymptotic distribution of the Riesz' energy of a sample of independent and uniformly distributed points on the surface of an hypersphere, when the cardinality of the sample diverges. We identify three asymptotic regimes. In the first regime, both the mean and the variance of the energy exist. In the second regime, only the mean exists. In the third regime, no integer moment exists. We characterize the asymptotic distribution in the three regimes.

15:00-15:30

Discrepancy of Minimal Riesz Energy Points

Jordi Marzo	Universitat de Barcelona
Albert Mas	Universitat Politècnica de Catalunya

Abstract: I will talk about upper bounds for the spherical cap discrepancy of the set of minimizers of the Riesz energy on the sphere. Our arguments are based in estimates of a Sobolev discrepancy introduced by T. Wolff in an unpublished work. Our results improve some previously known bounds.

15:30-16:00

Separation Distance for Minimal Green Energy Points

Juan Criado Del Rey	KU Leuven

Abstract: The Green's function for the Laplacian is a natural energy kernel that can be used to define a discrete energy function on a compact Riemannian manifold. In this talk I will show that point configurations minimizing this energy have always optimal separation with respect to intrinsic geodesic distance. I will also comment on some related results about energy minimization on the sphere in the presence of an external field consisting of finitely many point charges.

16:00-16:30

Polarization problem on a higher-dimensional sphere for a simplex

Sergiy Borodachov	Towson University

Abstract: We prove the optimality of the set of vertices of a regular simplex for the maximal polarization problem on the unit sphere in a d-dimensional Euclidean space among condigurations of d+1 points. The points interact via the potential given by a function of the squared distance, which is decreasing and convex on (0,4] with concave first derivative and is continuous in the extended sense at 0. This result is new for d>3.

IM FT-4-3 3 14:30-16:30

Mathematical and numerical tools for Tsunami Early Warning Systems

Organizer: José Manuel González Vida — University of Málaga
Organizer: Diego Arcas — NOAA/PMEL

Abstract: Although, relatively infrequent, tsunamis have proven to be the most devastating natural disasters in recent history. After the catastrophic tsunami events of Sumatra 2004 and Japan 2011, a great amount of effort has been invested by the scientific community in interdisciplinary tsunami research that could result in a better understanding of the phenomena and lead to faster and more accurate forecast systems. This minisymposium is focused on recent developments in tsunami research and applications, geared towards improving our understanding of tsunamis and associated processes, enhancing current capabilities of Early Warning Systems and refining tsunami risk assessment studies for hazard mitigation.

14:30-15:00

HySEA: A family of numerical models developed for Tsunami early warning systems

José Manuel González Vida	Universidad de Málaga
Manuel J. Castro	University of Málaga
Cipriano Escalante	University of Málaga
Jorge Macías	University of Málaga
Marc De La Asunción	University of Málaga
Sergio Ortega	University of Málaga

Abstract: In this work we present a family of numerical models developed in the framework of non-conservative hyperbolic systems specifically designed for Tsunami Warning Systems. During the presentation we will visit our models designed for one-layer and multi-layer shallow-water free surface flows, dispersive shallow-water flows, coupled systems of landslide-fluid avalanches and sediment and turbidity multi-layer models. These models has been coded for multi-GPU architecture. Some examples and real applications will be shown.

15:00-15:30

Probabilistic Tsunami Forecast (PTF) for early warning

Jacopo Selva	Istituto Nazionale di Geofisica e Vulcanologia - Sezione di Bologna
Stefano Lorito	INGV, Roma, Italy
Paolo Perfetti	INGV, Bologna, Italy
Roberto Tonini	INGV, Roma, Italy
Fabrizio Romano	INGV, Roma, Italy
Fabrizio Bernardi	INGV, Roma, Italy
Alessio Piatanesi	INGV, Roma, Italy

Andrey Babeyko	GFZ, Potsdam, Germany
Manuela Volpe	INGV, Roma, Italy
Stefano Pintore	INGV, Roma, Italy
Francesco Mariano Mele	INGV, Roma, Italy
Alessandro Amato	INGV, Roma, Italy

Abstract: Tsunami forecasting for early warning is affected by large uncertainty, especially for coastlines close to the earthquake source. This uncertainty needs to be quantified and conveyed into suitable information for decision-making. We introduce probabilistic tsunami forecasting, which combines available uncertain seismic parameters, “long-term” probabilities for unavailable seismic parameters, from past seismicity and tectonic knowledge, and tsunami numerical simulations, to provide a probability distribution of the tsunami intensity. We describe the first prototype implementation for NEAMTWS.

15:30-16:00

Numerical modeling in the Spanish Tsunami Warning System

Juan Vicente Cantavella Nadal	Red Sísmica Nacional del Instituto Geográfico Nacional
Beatriz Gaite	National Geographic Institute
Juan Vicente Cantavella	National Geographic Institute
Carlos González	National Geographic Institute
Jaime Barco	National Geographic Institute
Resurrección Anton	National Geographic Institute
Luis Carlos Puertas	National Geographic Institute
Emilio Carreño	National Geographic Institute

Abstract: The Spanish Tsunami Warning System is triggered by a seismic alert with specific location and magnitude conditions. This system is composed by three main elements: Decision matrices and pre-computed scenario databases, real-time tsunami propagation simulations, and sea-level data. Each element provides information about the tsunami alert level. Current reductions in tsunami propagation computation times make real-time synthetics an effective option for tsunami early warning systems.

MS A1-2-1 3 14:30-16:30

Topological data analysis and deep learning: theory and signal applications - Part 3

For Part 1 see: MS A1-2-1 1
For Part 2 see: MS A1-2-1 2
For Part 4 see: MS A1-2-1 4

Organizer: Jae-Hun Jung	Ajou Univ/SUNY Buffalo
Organizer: Scott Field	University of Massachusetts Dartmouth
Organizer: Christopher Bresten	Ajou University

MS Organized by: SIAG/CSE

Abstract: Topological data analysis (TDA) emerged as an important analysis tool in data science. By considering topological features of data, TDA determines and predicts data characteristics, extracting hidden underlying knowledge. Deep learning approach is recently proven highly efficient together with TDA for a large set of data in various applications. This mini-symposium brings researchers together from various areas of TDA, deep learning, and their applications with a focus on signal analysis specialized to the gravitational wave detection problem. The mini-symposium provides an opportunity for researchers to share their expertise in theory, implementation, and applications to gravitational-wave detection.

14:30-15:00

Volume-optimal cycles for persistent homology

Ippei Obayashi	RIKEN

Abstract: Persistent homology enables us characterize the shape of data quantitatively and effectively. A persistence diagram, a multiset in R2, is used to visualize the information of persistent homology. Each point on the diagram corresponds a homological structure in the data, and we want to find such a structure for further analysis. We introduce volume-optimal cycles for that purpose. Homology optimization technique is used to define and compute volume-optimal cycles.

15:00-15:30

What does it mean to measure persistence?

Nina Otter	UCLA

Abstract: The use of methods from topological data analysis in applications is justified by the validity of certain stability results. At the core of such results is a notion of distance between the invariants that one associates to data sets. I will give an overview of distances used in persistent homology, and introduce a general framework in which to formulate questions about such distances. This talk is based on work in progress, joint with Lukas Waas.

15:30-16:00

Combinatorial Hodge theory and simplicial networks

Kook Woong	Seoul National University
Wonse Kim	Seoul National Uiversity
Younng-Jin Kim	Seoul National University
Kang-Ju Lee	Seoul National University

Abstract: Simplicial networks are used for modeling higher order relations among data points whose analysis requires both topological insight and combinatorial precision. These relations are encoded in combinatorial Laplacians from which one can extract homological invariants via combinatorial Hodge theory and network-related invariants via simplicial matrix-tree theorem. These invariants, which include harmonic cycles, simplicial tree-numbers, and effective resistance, provide important characteristic features. We will suggest how these features relate to shape, connectivity, and centrality for data.

MS A1-2-4 3 14:30-16:30

Lattice Boltzmann Method for CFD - Part 1

For Part 2 see: MS A1-2-4 4

Organizer: Li-Shi Luo	Computational Science Research Center (CSRC)
Organizer: Paul Dellar	University of Oxford
Organizer: Manfred Krafczyk	TU Braunschweig

MS Organized by: SIAG/CSE

Abstract: We propose to organize a minisymposium on ``Lattice Boltzmann Method for CFD'' at ICIAM~2019. Mesoscopic or kinetic methods have become versatile and competitive alternatives for computational fluid dynamics (CFD). The mesoscopic/kinetic methods are derived from the Boltzmann equation or microscopic dynamics, as opposed to the conventional CFD methods based on direct discretizations of the Navier-Stokes equations. Due to their kinetic basis, mesoscopic methods can model the extended hydrodynamics beyond the continuum regime.

14:30-15:00

Lattice Boltzmann formulations for complex and active fluids based on Jeffery's equation

Paul J. Dellar	Mathematical Institute, University of Oxford

Abstract: Jeffery's equation governs the rotation of axisymmetric particles in slow viscous flow. It underlies models of complex fluids ranging from fibres to liquid crystals to actively swimming rods. Exploiting connections with the magnetohydrodynamic induction equation gives a kinetic and lattice Boltzmann formulation using vector distribution functions to evolve the particle's orientations with no finite difference approximations. The suspension rheology is captured using an anisotropic collision operator in the kinetic equation for the suspending fluid.

15:00-15:30

A 2nd-order accurate 3D LBM model for simulation of dissolution and precipitation in porous medi

Manfred Krafczyk	TU Braunschweig
Hussein AliHussein	TU Braunschweig

Abstract: In this contribution we will present an extended Lattice-Boltzmann model (LBM) for modeling and simulation of precipitation and dissolution in 3D porous media. We will present convergence and validation studies to demonstrate the consistency and efficiency of the model for dissolution of concrete for a three-dimensional test case. The model is implemented into the massivel parallel LBM research code VirtualFluids.

15:30-16:00

A phase-field lattice Boltzmann model for two-phase flows with large density difference

Zhaoli Guo	Huazhong University of Science & Technology
Chunhua Zhang	Huazhong University of Science & Technology

Abstract: A lattice Boltzmann equation (LBE) model is proposed based on a modified Cahn-Hilliard phase-field theory which can maintain interface profile. With a correction step after the standard LBE evolution, the method is able to tracking the interface accurately, and the numerical stability is enhanced such that it can be applied to two-phase flows with density ratio up to 1000. Several tests are presented to validate the accuracy and capability of the model.

16:00-16:30

Mixed quadrature lattice Boltzmann models for the simulation of rarefied channel flows

Victor Ambrus	West University of Timisoara
Victor Sofonea	Romanian Academy, Timisoara Branch

Abstract: Due to the particle-wall interaction, a discontinuity between outgoing and incoming velocities arises at the level of the distribution function, giving rise to microfluidics specific effects (slip velocity, temperature jump). The discontinuity can be captured using a discretisation of the velocity space which allows the exact recovery of integrals of the distribution on each hemisphere separately. The efficacy of this concept is demonstrated using a finite-difference lattice Boltzmann implemenation based on the half-range Gauss-Hermite quadrature.

MS A6-4-3 3 14:30-16:30

Calibration, Training and Inverse Problems in Finance

Organizer: Jorge Zubelli	IMPA
Organizer: Vinicius Albani	UFSC
Organizer: Yuri Saporito	FGV

MS Organized by: SIAG/FME

Abstract: In recent years, the role of calibration and training became fundamental for the successful modeling of problems that arise in Financial Markets. Indeed, effective modeling of financial markets requires techniques from Inverse Problems and Statistics capable of handling massive quantities of data and unobservable variables that are fundamental in the model interpretation. This mini-symposium concerns large-scale and ill-posed problems arising or motivated by financial applications. Typical examples appear in risk management, derivative pricing and volatility calibration. We shall start with an overview of the relevant problems and then discuss advances that have impact on risk management and volatility modeling.

14:30-15:00

A Splitting Strategy for the Calibration of Jump-Diffusion Models

Vinicius Albani	UFSC
Jorge Zubelli	IMPA

Abstract: We present a splitting strategy to identify simultaneously the local-volatility surface and the jump-size distribution from quoted European prices. The underlying is a jump-diffusion driven asset with time and price dependent volatility. Our approach uses a forward partial-integro-differential equation for the option prices to produce a parameter-to-solution map. The corresponding inverse problem is then solved by Tikhonov-type regularization combined with a splitting strategy.

15:00-15:30

A Family of Maximum Entropy Densities Matching Call Option Prices

Lorenz Schneider	EM Lyon Business School

Abstract: We investigate the position of the Buchen-Kelly density in the family of entropy maximising densities from Neri and Schneider which all match European option prices for a given maturity. We show that it is both the unique continuous density in this family and the one with the greatest entropy. Given the call prices, arbitrage-free digital prices at the same strikes can only move within upper and lower boundaries given by left and right call spreads.

15:30-16:00

Calibration of rough volatility models to the VIX smile

Peter Tankov	ENSAE Paris Tech
Jacquier Antoine	Imperial College
Horvath Blanka	King's College

Abstract: We discuss the pricing of volatility options in some rough volatility models. First, we study models where log-volatility follows a Gaussian Volterra process. While providing a good fit for European options, these models are unable to reproduce the VIX option smile observed in the market, and are thus not suitable for VIX products. To accommodate these, we introduce the class of modulated Volterra processes, and show that they successfully capture the VIX smile.

16:00-16:30

Balance Sheet XVA by Deep Learning and GPU

Stephane Crepey	University of Evry
Hoskinson Rodney	ANZ Bank
Saadeddine Bouazza	Université Paris-Saclay in Evry

Abstract: Burgard and Kjaer once dismissed the Albanese and Crépey XVA model as being elegant but difficult to solve explicitly. We show that the model (set on a forward/backward SDE formulation) is not only elegant, but also able to be solved efficiently using GPU computing combined with AI methods in a whole bank balance sheet context. We generate the Mark-to-Market process using GPU computing and the XVA processes using Deep Learning VaR and ES Regression methods.

MS FT-1-1 3 14:30-16:30

Nonlinear and multiparameter eigenvalue problems - Part 3

For Part 1 see: MS FT-1-3 1
For Part 2 see: MS FT-1-1 2
For Part 4 see: MS FT-1-1 4
For Part 5 see: MS FT-1-1 5
For Part 6 see: MS FT-1-1 6
For Part 7 see: MS FT-1-1 7

Organizer: Fernando De Terán	Universidad Carlos III de Madrid
Organizer: Froilán M. Dopico	Universidad Carlos III de Madrid

MS Organized by: SIAG/LA

Abstract: A nonlinear eigenvalue problem (NLEVP) is to find scalars x (eigenvalues) and nonzero vectors v,w (eigenvectors) satisfying F(x)v=0, w*F(x)=0, where F:C→Cnxn is a matrix-valued function. NLEVPs can be extended to multiparameter eigenvalue problems (MPEPs) F(x1,...,xd)v=0, w*F(x1,...,xd)=0, with F:Cd→Cnxn. Important cases of NLEVPs are the polynomial and rational eigenvalue problems, where the entries of F(x) are polynomial or rational functions. NLEVPs and MPEPs arise in many applications, and much research on these problems has been performed in the last years from computational and theoretical perspectives. This minisymposium presents the most recent advances in NLEVPs and MPEPs, and on their applications.

14:30-15:00

Linear system matrices of rational transfer functions

Paul Van Dooren	UC Louvain
Froilan Dopico	Universidad Carlos III de Madrid
Maria Del Carmen Quintana	Universidad Carlos III de Madrid

Abstract: We derive new sufficient conditions for a linear system matrix S(s) to be strongly irreducible. A strongly irreducible system matrix has the same structural elements as the rational transfer matrix R(s) connected to the system matrix S(s). The pole structure, zero structure and null space structure of R(s) can be then computed with the staircase algorithm and the QZ algorithm applied to pencils derived from S(s).

15:00-15:30

Local Linearizations of Rational Matrices and their Applications to Nonlinear Eigenvalue Problems

Maria Del Carmen Quintana	Universidad Carlos III de Madrid
Froilán M. Dopico	Universidad Carlos III de Madrid
Silvia Marcaida	Universidad del País Vasco
Paul Van Dooren	Université catholique de Louvain

Abstract: In this talk we present the notion of local linearizations of rational matrices. A local linearization of a rational matrix R(z) preserves the zeros and poles of R(z) locally, that is, in subsets of the set of complex numbers and/or at infinity. By using this new notion of linearization, we study the structure of linearizations constructed in the literature for solving nonlinear eigenvalue problems by using rational approximation on a target set.

15:30-16:00

Inverse Problems for Polynomial and Rational Matrices

Richard Hollister	Western Michigan University
D. Steven Mackey	Western Michigan University

Abstract: Given a list of structural data, when does there exist a polynomial or rational matrix realizing exactly this structural data? Recent work has established simple necessary and sufficient conditions on the list of structural data for it to be realizable. In this talk we describe techniques that make it possible to construct a sparse matrix that transparently realizes the given data, in a sense analygous to the Kronecker canonical form for matrix pencils.

16:00-16:30

Linearizations for two-sided compact rational Krylov methods

Karl Meerbergen — KU Leuven - Dept. Computer Science

Abstract: We present a compact representation of Krylov vectors for two-sided (rational) Krylov methods for linearizations of nonlinear eigenvalue problems. We show that economical representations exist for CORK linearizations and symmetrically structured linearizations. Extensions of the CORK method to two-sided Krylov methods are not trivial. We present algorithms and numerical examples.

MS FT-S-7 3 — 14:30-16:30

Optimal Transport for Nonlinear Problems - Part 3

For Part 1 see: MS FT-S-7 1
For Part 2 see: MS FT-S-7 2
Organizer: Yunan Yang — New York University
Organizer: Wuchen Li — UCLA

Abstract: Optimal Transport provides particular statistical distances among histograms. They can compare datasets globally including both misfits in the signal intensities and the phase mismatches. The unique and advantageous way of measuring mismatches offer ideal convexity and stability in many nonlinear problems and also accelerate the iterative convergence. The series of mini-symposiums will present fast computational algorithms and recent waves of research efforts in translating attractive theoretical properties of Optimal Transport onto elegant and scalable tools for a wide variety of applications involving modern science and engineering, as well as machine learning.

14:30-15:00

The Wasserstein-Fisher-Rao Metric for Waveform Based Earthquake Location

Hao Wu — Tsinghua University

Abstract: In this work, the Wasserstein-Fisher-Rao (WFR) metric based on the unbalanced Optimal Transport (OT) theory is applied to the earthquake location problem. It introduces the wave amplitude as a new constraint, which overcomes the difficulty of the objective optimization functions degenerate since the wave signals are normalized by the balanced OT theory. Thus, we can expect more accurate location results from the WFR metric based earthquake location model under high-intensity noise.

15:00-15:30

Full Waveform Inversion with Unbalanced Optimal Transport

Lingyun Qiu — Tsinghua University

Abstract: The cycle-skipping problem in the seismic inversion is investigated. A novel approach is presented to generalize and impose the optimal transport (OT) metric on the seismic inversion problem. We advocate the use of the quadratic Wasserstein metric with an encoding procedure to measure the transport cost and a penalty term for the mass creation/destruction in the unbalanced mass case. This approach improves the convexity of the misfit function and mitigates the local minimum issue.

15:30-16:00

Optimal Transport for Full Waveform Inversion: A Graph Space Approach

Ludovic Métivier — CNRS/University Grenoble Alpes
Romain Brossier — Univ. Grenoble Alpes
Quentin Mérigot — Univ. Paris Sud
Edouard Oudet — Univ. Grenoble Alpes

Abstract: Optimal transport (OT) distances possess appealing properties, the most striking being its convexity with respect to shifted patterns. It is interesting for numerous data-fitting based inverse problems with non-convex misfit functions. However OT is developed for comparing positive and normalized data. We apply OT to the discrete graph-space of the data: we show how the resulting distance is an extension of Lp distances, with preserved OT properties. Examples of application to seismic imaging are presented.

16:00-16:30

Wasserstein Metric-Driven Deterministic and Bayesian Inversion for Elastic Wave Propagation

Daniel Appelo — University of Colorado, Boulder
Mohammad Motamed — University of New Mexico

Abstract: We present a Bayesian framework based on a new exponential likelihood function driven by the quadratic Wasserstein metric. Compared to conventional Bayesian models based on Gaussian likelihood functions driven by the least-squares norm, the new framework features several advantages. First, it does not rely on the likelihood of the measurement noise and can treat complicated noise structures. Second, unlike the normal likelihood function, the Wasserstein-based exponential likelihood function does not usually generate multiple local extrema.

MS A1-2-6 3 — 14:30-16:30

Molecular simulation: dynamics, statistics, learning, and high-performance computing - Part 2

For Part 1 see: MS A1-2-6 2
For Part 3 see: MS A1-2-6 4
Organizer: Eric Cancès — Ecole des Ponts ParisTech and Inria Paris
Organizer: Yvon Maday — Laboratoire Jacques-Louis Lions, Sorbonne Université, Paris, Roscoff, France and Institut Universitaire de France
Organizer: Tony Lelièvre — Ecole des Ponts ParisTech and Inria Paris
Organizer: Laura Grigori — Inria Paris

Abstract: Molecular simulation is widely used in the fields of theoretical, experimental, and industrial chemistry and physics, molecular biology, pharmacology, electronics, and energy production and storage, for the study of molecular systems ranging from small chemical systems to large biological molecules and materials. Molecular simulation is also key for the development of the emerging technology of atomic-scale engineering of controllable nanodevices. The amount of resources devoted to molecular simulation in supercomputing centers often exceeds 40%. The five sessions of the Molecular Simulation minisymposia will illustrate the diversity and richness of the modeling, mathematical and numerical problems arising in this vibrant field.

14:30-15:00

The Hill relation and quasi-stationary distributions: computation of transition times

Manon Baudel — Ecole des Ponts ParisTech and Inria Paris
Guyader Arnaud — Sorbonne Université
Lelièvre Tony — Ecole des Ponts ParisTech and Inria Paris,

Abstract: The Hill relation provides a relation between mean transition time and hitting probabilities. From this relation, computing transition times requires sampling a stationary distribution of a nonreversible process. This can be challenging or unreasonable when transitions are rare. A fruitful mathematical object to study processes with rare transitions are quasi-stationary distributions. We justify the approximation of the "uncomputable" stationary distribution by a quasi-stationary distribution and quantify the error induced by this approximation.

15:00-15:30

All-atom computations with irreversible Markov chains

Werner Krauth — Ecole Normale Supérieure

Abstract: The event-chain algorithm (ECMC) is an irreversible Markov chain with a number of applications in computational physics. Here, I prove that for one-dimensional hard-sphere models, ECMC mixing times scale better with system size than those of the local Metropolis or the heat-bath algorithms. ECMC need not evaluate the stationary measure (equivalently: the system energy). An efficient implementation of ECMC for particle systems with long-range (Coulomb) interactions is discussed. The JeLLyFysh open-source software project is outlined.

15:30-16:00

Tensor approximation in adaptive bias methods for free energy computations

Monmarché Pierre — Laboratoire Jacques-Louis Lions
Tony Lelièvre — Ecole des Ponts ParisTech
Virginie Ehrlacher — Ecole des Ponts ParisTech

Abstract: The free energy is a function of the reaction coordinates of a molecular system, which are a low-dimensional representation of the system. Adaptive biasing methods are based on an on-the-fly computation of this free energy during an MD simulation. When the number of reaction coordinates is larger than, say, 4, it becomes impossible to keep in memory the free energy on a grid, and a tensor approximation scheme have to be used.

IM FT-2-2 3 14:30-16:30

Molecular and Mesoscopic Modelling in Chemical Engineering Data Science - Part 1

For Part 2 see: IM FT-2-2 4

Organizer: Martin Thomas Horsch — UKRI Science and Technology Facilities Council

Organizer: Gianluca Boccardo — Politecnico di Torino

Abstract: Reaching quantitative agreement with available experimental data, and predicting properties where data are absent, molecular and mesoscopic modelling transforms chemical engineering data science. This minisymposium discusses virtual marketplaces and platforms by which the knowledge from multiscale modelling and simulation can be transferred to engineering practice. This requires an institutionalized collaboration between academic and industrial engineering, scientific computing, and applied mathematics, and jointly governed semantic assets to ensure the interoperability of models, numerical solvers, and databases. Initiatives working toward this (VIMMP, MARKETPLACE, MULTIMAT, COMPOSELECTOR, and FORCE) are represented at the minisymposium jointly with "translators" who connect method development with engineering practice.

14:30-15:00

From molecules to process-scale: Facilitating multiscale simulations in virtual marketplaces

Gianluca Boccardo — Politecnico di Torino
Antonio Buffo — DISAT, Politecnico di Torino
Daniele Marchisio — DISAT, Politecnico di Torino

Abstract: The VIMMP Project (https://vimmp.eu/) objective is building a web-based marketplace based on an ontological framework, linking different manufacturing industry sectors with relevant materials modelling activities, with the purpose to facilitate communication between model developers and end-users. In this contribution, an example of an industrial application (food emulsions production) of this integration is shown, where multi-scale CFD simulations and innovative “simulation-on-the-loop” machine learning strategies are used to aid in parameter estimation and increasing simulation accuracy.

15:00-15:30

Formulations and computational engineering: The FORCE project approach

Peter Klein — Fraunhofer Institute for Industrial Mathematics
Marcel Burgard — Fraunhofer ITWM

Abstract: In FORCE, we integrate materials modelling into Multi-Criteria Optimization (MCO) and make this approach available to industrial decision makers. To this end, we develop a platform on top of an interoperable materials modelling suite, materials data bases, cognitive computing and business related cost measures in order to model business related Key Performance Indicators. Decision Making is supported by interactive tools. This concept and its implementation is illustrated by an almost realistic chemical reactor process.

15:30-16:00

Building a marketplace for materials modelling services: Interoperable, integrated multiscale platforms

Arpit Singhal — Fraunhofer Institute for Mechanics of Materials
Adham Hashibon — Fraunhofer Institute for Mechanics of Materials

Abstract: MarketPlace project (https://www.the-marketplace-project.eu/) aims at developing an advanced semantic collaboration platform based on ontology that facilitates the integration of all materials modelling related services including databases of material properties, modelling workflows and translation of industrial problems into simulations and knowledge exchange. In this presentation, recent advances of the MarketPlace are demonstrated including novel services, Open Simulation Platform (OSP) approaches and standard wrapper design for interoperability between different material modelling services on MarketPlace.

MS A3-2-2 3 14:30-16:30

Molecular simulation: quantum mechanical models - Part 2

For Part 1 see: MS A3-2-2 2

Organizer: Gero Friesecke — Technical Unversity of Munich

Organizer: Stamm Benjamin — RWTH Aachen University

MS organized by the acitivity group Modelling, Analysis and Simulation of Molecular Systems (MOANSI)

Abstract: Molecular simulation is widely used in the fields of theoretical, experimental, and industrial chemistry and physics, molecular biology, pharmacology, electronics, and energy production and storage, for the study of molecular systems ranging from small chemical systems to large biological molecules and materials. Molecular simulation is also key for the development of the emerging technology of atomic-scale engineering of controllable nanodevices. The amount of resources devoted to molecular simulation in supercomputing centers often exceeds 40%. The five sessions of the Molecular Simulation minisymposia will illustrate the diversity and richness of the modeling, mathematical and numerical problems arising in this vibrant field.

14:30-15:00

Asymptotics of one-body reduced density matrices in density functional theory

Huajie Chen — Beijing Normal University

Abstract: In this talk, we investigate the one-body reduced density matrices in density functional theory. The exact kinetic energy of a many-electron system is determined by the one-body reduced density matrix, which is not well-approximated in standard Kohn–Sham density functional models for strongly correlated systems. We study the exact one-body reduced density matrices for one dimensional electron gas, and derive the asymptotic decay rate of the natural occupation spectrum for the one-dimensional finite wigner crystal.

15:00-15:30

Screening in the finite-temperature reduced Hartree-Fock model

Antoine Levitt — Inria

Abstract: When a positive charge is inserted in a metal, electrons flock towards it. This creates a reaction potential that effectively nullifies the Coulomb potential at long range. I will explain how this phenomenon occurs in the framework of the linear response of the reduced Hartree-Fock model of defects at finite temperature. The analysis also sheds light on the convergence of algorithms to solve the self-consistent equations of DFT, and the phenomenon of "charge sloshing".

15:30-16:00

Sharp asymptotics for Multimarginal Optimal Transport problems related to DFT

Mircea Petrache — PUC Chile
Codina Cotar — UCL London

Abstract: We consider two sharp next-order asymptotics problems for 1) the minimum energy for optimal point configurations, 2) the many-marginals Optimal Transport. In both cases the energy involves Coulomb and Riesz costs with inverse power-law long-range interactions, modelling the ground state of a Coulomb or Riesz gas, and the semi-classical limit of the Density Functional Theory for a quantum gas. We present new methods that allow to prove sharp asymptotics and compare the two problems.

16:00-16:30

Low scaling algorithm for the ppRPA correlation energy

Kyle Thicke — Duke University
Jianfeng Lu — Duke University

Abstract: We present a low-scaling algorithm for the computation of the ppRPA correlation energy in the context of density functional theory. We utilize the Hutchinson algorithm and a Chebyshev approximation; but, the real reduction in computational cost comes from creatively inserting the identity operator and structuring the randomness to match the structure of the problem. We end up with a Hutchinson algorithm whose cost per iteration grows merely quadratically in the system size.

MS GH-0-1 3 14:30-16:30

Modeling and simulation of materials defects and inhomogeneities - Part 3

For Part 1 see: MS GH-0-1 1
For Part 2 see: MS GH-0-1 2
For Part 4 see: MS GH-0-1 4
For Part 5 see: MS GH-0-1 5
For Part 6 see: MS GH-0-1 6

Organizer: Luchan Zhang — National University of Singapore

Organizer: Shuyang Dai — Wuhan University

Abstract: Materials defects and inhomogeneities, such as dislocations and grain boundaries in solids, fluid-solid and fluid-fluid interfaces, and fine microstructures within advanced materials, play essential roles in the mechanical and dynamical behaviors of the materials. The complexity of modeling microstructures of these defects and inhomogeneities, and their evolution at various length and time scales present new challenges for mathematical modeling and analysis. Multiscale and multiphysics models are required to accurately describe the complicated phenomenon associated with defects and inhomogeneities. Speakers in this minisymposium will discuss recent advances in modeling approaches and simulation methods, and new findings obtained in analysis and simulations.

14:30-15:00

Sharp interface models for solid-state dewetting problems

Weizhu Bao — Beijing Computational Science Research Center

Abstract: Sharp interface models with anisotropic surface energy are presented for simulating solid-state dewetting problems. An efficient and accurate parameteric finite element method (PFEM) is proposed for the sharp interface models. It is applied to study numerically different setups of solid-state dewetting including short and long island films, pinch-off, hole dynamics, semi-infinite film, tiny particle migration, etc. In addition, extension to curved substrate and three dimensions will be discussed.

15:00-15:30

Dislocation climb models from atomistic scheme to dislocation dynamics

Xiaohua Niu — School of Applied Mathematics, Xiamen University of Technology
Yang Xiang — The Hong Kong University of Science and Technology

Abstract: We develop a mesoscopic dislocation dynamics model for vacancy-assisted dislocation climb, which consists of vacancy bulk diffusion equation and a dislocation climb velocity formula. This new formulation is not only able to derive analytical climb velocity of a straight edge dislocation and a prismatic circular loop, but also able to quantitatively describe self-climb. Simulations for self-climb of prismatic loops are performed and show these results are in excellent agreement with available experimental and atomistic results.

15:30-16:00

A study of coarse-grained models for a large dynamical particle system

Ping Lin — University of Dundee

Abstract: Due to the huge number of atoms one ofter takes a coarse-grained approximation to simulate a dynamical atomistic chain. We shall mainly consider the consistency of such an approximation. The approximate solution is also compared with the continuum model solution to show how well the coarse-grained approximate model can imitate the macroscopic behaviour (e.g. location of a defect) of a material.

16:00-16:30

On energy dissipation theory and numerical stability for time-fractional phase field equations

Tao Zhou — Chinese Academy of Sciences
Tao Tang — Southern University of Science and Technology
Haijun Yu — Chinese Academy of Sciences

Abstract: We prove for the first time that the time-fractional phase field models admit an energy dissipation law of an integral type. In the discrete level, we propose a class of finite difference schemes that can inherit the energy stability. Moreover, a numerical study of the coarsening rate reveals that there are several coarsening stages for both the time-fractional Cahn-Hilliard equation and the time-fractional molecular beam epitaxy model.

MS A6-5-4 3 **14:30-16:30**

Advances in Data Assimilation - Part 2

For Part 1 see: MS A6-5-4 2
Organizer: Daniele Bigoni — MIT
Organizer: Jana De Wiljes — University of Potsdam
Organizer: Kody Law — University of Manchester

Abstract: The inherent limits of mathematical models resulting from the trade-off between complexity and accuracy, often lead to significant uncertainties which have the effect of restricting their applicability. The increasing availability of distributed and heterogeneous data has driven research toward data assimilation methodologies able to integrate such additional information to the end of better characterizing these uncertainties. This mini-symposium aims to provide a venue for the interaction between researchers in data assimilation, focusing on theoretical analysis, novel methodologies and their application to relevant scientific problems.

14:30-15:00

Data assimilation via low-rank couplings

Daniele Bigoni — MIT
Youssef Marzouk — MIT

Abstract: We use semi-parametric couplings between lag-1 smoothing distributions to devise a sequential algorithm for nonlinear Bayesian filtering and smoothing in high-dimensional state-space models, with a computational cost constant in time. We exploit the fact that many dynamical systems exhibit updates that act only on lower dimensional subspaces, allowing the construction of couplings that encode nonlinearities only in the interaction of a handful of important directions. The methodology will be showcased on chaotic dynamical systems.

15:00-15:30

On the consistency of local ensemble Kalman filters based on covariance tapering

Marc Bocquet — Ecole des Ponts ParisTech
Alban Farchi — Ecole des Ponts ParisTech

Abstract: We study the perturbation update in the ensemble Kalman filters (EnKFs) which rely on covariance localisation, and hence can assimilate non-local observations in geophysical models. We point to inconsistencies in the perturbation update of the local ensemble square root Kalman filter (LEnSRF). Building on that evidence, we propose a new update scheme for the LEnSRF. We numerically demonstrate that it is more accurate and much more robust than other flavors of deterministic local EnKFs.

15:30-16:00

Analysis of the Feedback Particle Filter

Sahani Pathiraja — University of Potsdam
Wilhelm Stannat — Technical University Berlin
Sebastian Reich — University of Potsdam
Jana De Wiljes — University of Potsdam

Abstract: The feedback particle filter has recently been proposed as a consistent data assimilation algorithm for filtering in nonlinear systems. It involves constructing a control law to steer particles such that the probability law matches the distribution of the optimal filter. Our focus is to examine its theoretical properties, namely, its well-posedness and accuracy for Brownian type Stochastic Differential Equations with some technical conditions on the drift.

16:00-16:30

A class of outer measures for uncertainty quantification: maximum likelihood estimation.

Jeremie Houssineau — University of Warwick
Neil Chada — National University of Singapore
Emmanuel Delande — University of Texas

Abstract: The role of uncertainty quantification has become apparent ranging within various mathematical disciplines. Techniques used to tackle uncertainty can be categorised as usually Bayesian or frequentist. In this talk we discuss a methodology that lies in-between both these approaches. This methodology will be based on the theory of outer measures, which can be described as an upper bound on probability measures. We present applications in a number of insightful areas including data assimilation.

MS A1-1-1 3 **14:30-16:30**

Geometry and Topology in Data Analysis - Part 3

For Part 1 see: MS A1-1-1 1
For Part 2 see: MS A1-1-1 2
For Part 4 see: MS A1-1-1 4
Organizer: Facundo Memoli — The Ohio State University
Organizer: Yasuaki Hiraoka — Kyoto University
Organizer: Washington Mio — Florida State University

Abstract: Understanding the organization of data across spatial and temporal scales, extracting information and knowledge from data and making inferences are fundamental problems in data analysis that pose many challenges, particularly if the data objects are complex entities such as shapes, networks, or images. This mini-symposium will provide a forum for discussion and dissemination of recent advances based on topological and geometric methods. The presentations will address foundational questions, mathematical modeling and computation, as well as applications to the analysis of data arising in various domains of science and engineering.

14:30-15:00

SqueezeFit: Label-aware dimensionality reduction

Soledad Villar New York University

Abstract: Given labeled points in a high-dimensional vector space, we seek a projection onto a low dimensional subspace that maintains the classification structure of the data. Taking inspiration from large margin nearest neighbor classification, this work introduces SqueezeFit, a semidefinite relaxation that is amenable to theoretical analysis. We provably recover a planted projection operator from the data. An LP version of SqueezeFit identifies the genetic markers that preserve the classification structure of single-cell RNA-seq data.

15:00-15:30

Homology assisted convolutional neural networks for image classification

Shizuo Kaji Kyushu University

Abstract: Tools in topological data analysis (TDA) look at global features of the data while convolutional neural networks (CNNs) are good at detecting local features. The question is how we can combine the power of these two. We report our attempt to make CNNs utilise the global information obtained by TDA for a practical task on non-destructive inspection using sensor images.

15:30-16:00

Homotopy Area and Other Observations about Curves in the Plane

Brittany Fasy Montana State University
Parker Evans Rice University
Selcuk Karakoc
Brad McCoy Montana State University
David L. Millman Montana State University
Carola Wenk Tulane University

Abstract: We study the problem of computing a homotopy from a planar curve to a point that minimizes the total area swept, and provide structural and geometric properties of these minimum homotopies that lead to an algorithm. In particular, we prove that for any curve there exists a minimum homotopy that consists entirely of contractions of self-overlapping sub-curves. Furthermore, we study various properties of these self-overlapping curves.

16:00-16:30

Topological Dimensionality Reduction.

Jose Perea García Michigan State University

Abstract: When dealing with complex high-dimensional data, several machine learning tasks rely on having appropriate low-dimensional representations. These reductions are often phrased in terms of preserving statistical or metric information. We will describe in this talk several schemes to take advantage of the underlying topology of a data set, in order to produce informative low-dimensional coordinates.

MS GH-3-4 3 14:30-16:30

Nonlocal Modeling, Analysis, and Computation - Part 3

For Part 1 see: MS GH-3-4 1
For Part 2 see: MS GH-3-4 2
For Part 4 see: MS GH-3-4 4
For Part 5 see: MS GH-3-4 5
Organizer: Robert Lipton Louisiana State University
Organizer: Qiang Du Columbia University
Organizer: Pablo Seleson Oak Ridge National Laboratory

Abstract: The past decade has seen a rapid growth in the development of nonlocal mathematical models. Nonlocal modeling is now being used in applications including continuum mechanics and fracture mechanics, anomalous diffusion and advection diffusion, and probability models. This minisymposium seeks to bring together mathematicians and domain scientists from different disciplines working on nonlocal modeling and is intended to serve as international forum for the state of the art in the modeling, analysis, and numerical aspects of nonlocal models.

14:30-15:00

On Neumann-type Boundary Conditions for Nonlocal Models

Michael Parks Sandia National Laboratories
Petronela Radu University of Nebraska Lincoln

Abstract: Abstract: Peridynamics is a nonlocal reformulation of continuum mechanics that is suitable for representing fracture and failure. For practical engineering applications, precise application of boundary conditions is essential. However, nonlocal boundary conditions (sometimes called volume constraints) of Neumann type remain poorly understood. We limit our discussion to nonlocal diffusion models, reviewing existing approaches to nonlocal Neumann-type boundary conditions, and presenting a new approach for nonlocal boundary conditions of Neumann-type.

15:00-15:30

Existence and regularity of solutions to nonlocal problems

Petronela Radu University of Nebraska-Lincoln
Radu Petronela University of Nebraska-Lincoln

Abstract: Nonlocal systems of equations appear in a variety of applications ranging from dynamic fracture (as modeled by peridynamics), nonlocal diffusion, to image processing. In this talk I will focus on integro-differential systems where the nonlocality is expressed through operators with integrable kernels, and as such, Sobolev embedding theorems are not available. However, using the convolution structure of the operators we show higher integrability and differentiability of solutions for nonlinear systems.

15:30-16:00

Time-fractional phase-field model: analysis and simulation

Zhi Zhou Hong Kong Polytechnic University
Qiang Du Columbia University
Jiang Yang Southern University of Science and Technology

Abstract: We consider a time-fractional Allen-Cahn equation, where the conventional time derivative is replaced with a fractional derivative with order . Like their conventional local in time counterpart, the time-fractional AC equation satisfies the maximum principle. We propose several stable time stepping schemes, study the discrete energy dissipation property and derive error estimates. Numerical simulation indicates that the fractional derivative will change the dynamic of evolution.

16:00-16:30

Nonlocal variational models in solid mechanics: existence results

Carlos Mora Corral Universidad Autonoma de Madrid, Spain
José C. Bellido Universidad de Castilla-La Mancha
Javier Cueto Universidad de Castilla-La Mancha
Pablo Pedregal Universidad de Castilla-La Mancha

Abstract: We review some models based on minimization of energy for the nonlocal modelling in solid mechanics. They are an evolved version of the original peridynamics formulation. We will focus on nonlinear elasticity. We show existence of minimizers for the functional proposed, as well as their convengence to classical elasticity. Nonlocal versions of classical tools are needed, such as Poincaré inequality, Sobolev embeddings and Piola identity.

MS ME-1-4 3 14:30-16:30

Dynamics and games - Part 1

For Part 2 see: MS ME-1-4 4
Organizer: Alberto Pinto LIAAD-INESC TEC and University of Porto
Organizer: José Martins LIAAD-INESC TEC and Polytechnic Institute of
Organizer: Abdelrahim Mousa Birzeit University

Abstract: The session aims to bring together world top researchers and practitioners from the fields of Dynamical Systems, Game Theory and applications to such areas as Biology, Economics, Engineering, Energy, Natural Resources and Social Sciences.

14:30-15:00

A Competition Model on a Network of Firms with Uncertainty on Production Costs

João Almeida Polytechnic Institute of Bragança
Alberto Pinto LIAAD-INESC TEC and University of Porto, Portugal

Abstract: We develop a theoretical framework to study the location-price competition under uncertainty of firms' production costs. Firms compete in a two-stage Hotelling- type network game, with linear transportation costs. We show the existence of a Bayesian-Nash equilibrium price if, and only if, some explicit conditions on the ex-pected production costs and on the network structure hold.

Furthermore, we prove that the local optimal location of the firms are at the nodes of the network.

15:00-15:30

Price formation in a random pairing market with bounded rationality

Bruno Oliveira	University of Porto & INESC TEC
Aliyu Yusuf	Dep. Matemática, FCUP, Universidade do Porto, Portugal and LIAAD-INESC TEC, Porto, Portugal
Athanasios N. Yannacopoulos	Dep. Statistics, Athens U. of Economics and Business, Greece
Bärbel F. Finkenstädt	Dep. Statistics, University of Warwick, United Kingdom
Alberto A. Pinto	Dep. Matemática, FCUP, Universidade do Porto, Portugal and LIAAD-INESC TEC, Porto, Portugal

Abstract: We study a random pairing economy, where at each time period two participants, with Cobb-Douglas utility, may trade two goods, being allowed to deviate from their bilateral equilibrium due to bounded rationality. Provided the appropriate symmetry conditions are met, we show that, at each period, the expectation of the logarithm of the trading price is equal to the expectation of the logarithm of the Walrasian price, being both fixed along the time.

15:30-16:00

Optimal Consumption, investment and life-insurance purchase under a stochastically fluctuating economy

Abdelrahim Mousa	Birzeit University

Abstract: We study an optimal consumption, investment and life-insurance purchase and selection strategies for a wage-earner with an uncertain lifetime with access to a financial market whose asset prices evolve according to linear diffusions modulated by a continuous-time stochastic process determined by an additional diffusive nonlinear stochastic differential equation. The life-insurance market consists of a fixed number of providers offering pairwise distinct contracts. We use dynamic programming techniques to characterize the solutions of this problem.

16:00-16:30

An ecnonomic model for international expansion with and without dumping

José Martins	Polytechnic Institute of Leiria & INESC TEC
Alberto Pinto	LIAAD-INESC TEC and University of Porto

Abstract: In this work, we study two possible strategies for international expansion with and without dumping: the firm increases the production quantities to decrease the selling prices in both countries and avoid dumping; the firm only increases the production quantity to decrease the selling price in the foreign country and makes dumping. To do our analysis we use a duopoly model and we characterize the parameters that define the more profitable strategies.

MS FT-S-3 3 14:30-16:30

Robust Numerical Methods for Singular Perturbation Problems

Organizer: Ramesh Venkadachalam Palani	Central University of Tamil Nadu
Organizer: Kapil K Sharma	South Asian University

Abstract: Due to the presence of exponential layer in the solution, it has attracted researchers to design layer-adapted meshes, to list a few, Bakhvalov, Shishkin meshes. In 1983, Vulanovic proposed a mesh replacing ln(q/q−t) in the mesh generating function by another function which increases faster than it namely t/(q-t). This replacement made the estimation of transition parameter much easier. In 2001, Vulanovic also proposed a modified mesh by decomposing the layer region into sub-domains by modifying the idea of Shishkin on estimating the transition parameter. We will cover topics covering the evolution of various numerical methods for SPPs.

14:30-15:00

Robust Hybrid Schemes of Higher Order for Singularly Perturbed Convection-Diffusion Problems.

Relja Vulanovic	Kent State University at Stark
Thai Anh Nhan	Holy Names University, Oakland, California

Abstract: A higher-order hybrid finite-difference scheme is proposed for a class of linear singularly perturbed convection-diffusion problems in one dimension. The scheme is used on the Shishkin mesh. Under appropriate conditions, it is proved that the maximum pointwise error of the numerical solution is of order almost 3 when the perturbation parameter ε is sufficiently small. This is done using the preconditioning approach, which enables the proof of ε-uniform pointwise consistency while preserving ε-uniform stability.

15:00-15:30

Robust Adaptive Numerical Methods for Singular Perturbation Problems

Vivek Kumar Agarwal	Delhi technological University

Abstract: In this paper, a new adaptive mesh strategy has been discussed for solving convection dominated singularly perturbed problems (SPP). The proposed strategy uses a novel, entropy-like variable as the adaptation parameter for convection diffusion SPP. Unlike the popular layer adapted meshes mainly by Bakhvalov (B-type) and Shishkin (S-type), no pre-knowledge of the location and width of the layers is needed. The method is completely free of arbitrary perturbation parameters and results in oscillation free solutions.

15:30-16:00

Various a priori estimates for boundary layers : comparison study

Ramesh Venkadachalam	Central University of Tamil Nadu

Abstract: We present a few a-priori estimates by Bakhvalov (B-type), Shishkin and Vulanovic $(S(\ell))$ for boundary layers along with the harmonic function based a-priori estimate $(H(\ell))$ having both computational advantages and improved accuracy. We also present the analysis of upwind based numerical method on these meshes and we compare the numerical results of $H(\ell)$ mesh with other layer adapted meshes namely Bakhvalov (B-type), Shishkin, Generalized Shishkin $(S(\ell))$ meshes demonstrating the efficiency of the harmonic mesh.

MS A1-3-1 3 14:30-16:30

Mathematical models and methods in phenomenological thermodynamics of continuous media - Part 2

For Part 1 see: MS A1-3-1 2

For Part 3 see: MS A1-3-1 4

Organizer: Josef Malek	Charles University, Faculty of Mathematics and Physics
Organizer: Sergey Gavrilyuk	CNRS - IUSTI - AMU
Organizer: Vít Pruša	Charles University, Faculty of Mathematics and Physics
Organizer: Boyaval Sébastien	Ecole des Ponts / Inria

Abstract: Biological fluids, all kinds of foams, granular materials, suspensions and emulsions, polymeric materials etc. are complex fluid-like materials that are of interest in many areas of science and engineering. Understanding the physical background of the models as well as the analysis of the corresponding initial and boundary value problems is crucial in the development of tools for efficient and robust numerical simulations of flows of these materials. The minisymposium aims to bring together physicists, PDE and numerical analysts and code developers working in the field of thermodynamics and mathematics for complex fluid flows and help them share different perspectives.

14:30-15:00

A wellposed hypoelastic model derived from a hyperelastic one

Sergey Gavrilyuk	CNRS - IUSTI - AMU
Nicolas Favrie	Aix-Marseille University

Abstract: Hypoelastic models are often used for the description of the non-newtonian fluids. The corresponding objective derivatives are sometimes mathematically inconsistent. We propose a link between hypoelastic and hyperelastic models. This link is related to the problem of inversion of stress - strain relation. However, an explicit inversion is needed for practical applications. We give here two explicit examples of a non-linear equation of state where such an inversion is performed.

15:00-15:30

Markov semiflow for the isentropic Euler system

Eduard Feireisl	Institute of Mathematics, Czech Acad. Sci.
Dominic Breit	Heriot-Watt University Edinburgh
Martina Hofmanova	University of Bielefeld

Abstract: We introduce a new concept of dissipative solutions to the isentropic Euler system. Using the technique of Markov semigroups, we show there is a selection generating a semigroup.

15:30-16:00

Relative Entropy, Weak-Strong Uniqueness, and Regularity for a Compressible Oldroyd-B Model

Yong Lyu	Department of Mathematics, Nanjing University
Zhifei Zhang	Peking University
Endre Suli	Oxford University
John Barrett	Imperial College London

Abstract: We formally derive a compressible Oldroyd mode. We then prove the existence of large data global-in-time weak solutions in two space dimensions. Again in two dimensional setting, we give a (refined) blow-up criterion involving only the upper bound of the fluid density. By exploring a relative entropy inequality, we show a weak-strong uniqueness result, and a conditional regularity result is given.

16:00-16:30

PDE analysis of a thermodynamicly compatible viscoelastic rate-type fluid with stress diffusion

Miroslav Bulíček	Charles University, Faculty of Mathematics and Physics

Abstract: We establish the long-time existence of large-data weak solutions to a system of nonlinear partial differential equations. The system of interest governs the motion of non-Newtonian fluids described by a viscoelastic rate-type model with a stress-diffusion term. We focus on the thermodynamical compatibility of the model and propose also the proper convergence scheme that will lead to the existsnec of a solution.

MS A1-1-2 3 14:30-16:30

In control of interfacial flows - Part 1

For Part 2 see: MS A1-1-2 4

Organizer: Radu Cimpeanu	University of Oxford
Organizer: Susana Gomes	University of Warwick

Abstract: Multi-fluid flow control underpins many fundamental and applied physical phenomena, from nano- to geophysical scales, and is required in state-of-the-art processes such as the manufacturing of microelectromechanical devices or the optimisation of heat exchangers. At the heart of these systems lies the understanding and subsequent manipulation of interfacial dynamics, which can be achieved through diverse means in both passive (stability analysis, geometry) and active (external fields) ways. This mini-symposium brings together specialists with expertise in analytical and computational techniques behind such manipulations, promoting cross-fertilisation of ideas to a wide range of related areas and extending further into applied mathematical contexts.

14:30-15:00

From model control towards real-life systems: surviving the full nonlinearity test

Radu Cimpeanu	University of Oxford
Susana Gomes	University of Warwick

Abstract: A thin liquid film flowing down an inclined plane is a canonical setup in fluid mechanics, pertaining to a wide range of industrial applications, from coating to heat transfer scenarios. This mathematically rich framework forms the platform for the discussion of recent successful methodologies in control theory and their migration from reduced order models to direct numerical simulations of the underlying Navier-Stokes equations, bringing us closer to their integration into real-life engineering designs.

15:00-15:30

The speed of rolling droplets

Ory Schnitzer	Imperial College London
Ehud Yariv	Technion—Israel Institute of Technology

Abstract: We analyse the rolling of 2D nonwetting droplets down a gently inclined plane. Following the 1999 scaling analysis of Mahadevan & Pomeau, we focus on the limit of small Bond numbers, where the drop shape is nearly circular. Our analysis yields a leading approximation for the drop speed, whose scaling with Bond number results from a surprising source of dissipation on the drop scale.

15:30-16:00

Controlling evaporating droplets on smooth topographies: snap dynamics and shape bifurcations

Marc Pradas	The Open University

Abstract: The evaporation of droplets on solid surfaces is important for a broad range of applications, and despite its apparent simplicity, it has proven notoriously difficult to predict and control. This is because droplet evaporation typically proceeds as a `stick-slip' sequence caused by microscopic structure of the solid. Here, we show how smooth, non-planar topographies give rise to a reproducible sequence of steps, triggered by shape bifurcations that obey a hierarchy dictated by the surface topography.

16:00-16:30

Cahn-Hilliard Navier-Stokes simulations for design of superhydrophobic surfaces

David Sibley	Loughborough University
Matthew Tranter	Loughborough University
Benjamin Aymard	Inria Sophia Antipolis Mediterranee

Abstract: The effect of varying the topography of a surface can aid the ability of droplets to bead-up and roll. To this end we consider the motion of a two-dimensional droplet on an inclined substrate and study the effect of varying topography on the motion using a gravity-driven Navier-Stokes-Cahn-Hilliard model. Droplet motion is analysed on various surfaces of different shapes and properties to allow conclusions to be drawn on surface designs.

MS GH-3-5 3 14:30-16:30

Mathematical Modelling of Coffee Roasting and Extraction Processes

Organizer: Nabil Fadai	Queensland University of Technology

Abstract: The coffee industry relies on fundamental research to improve the techniques and processes related to its products. However, the exploitation of mathematical models that provide insight into improving the roasting and extraction of coffee beans has been largely unexplored. In this mini-symposium, we develop mathematical models to understand specific processes pertaining to coffee beans that are crucial in flavour development and consistency. In particular, we examine phenomena observed within a single roasting coffee bean, homogenisation techniques to model a collective of roasting coffee beans, multiphase models describing espresso-style coffee extraction, and further coffee brewing methods that investigate bed extraction uniformity.

14:30-15:00

Modelling Structural Deformations in a Roasting Coffee Bean

Nabil Fadai	Queensland University of Technology
Robert Van Gorder	University of Otago
Colin Please	University of Oxford

Abstract: Macroscale deformations in a roasting coffee bean are important mechanisms in determining flavour development and consistency. In this talk, we model the stresses and strains in the cellulose structure of a roasting coffee bean via temperature-dependent poroviscoelastic equations. These equations are combined with previously derived heat and mass transfer models to determine when and where macroscale deformations of the cellular matrix are likely to occur, suggesting directions for possible improvement in standard industrial roasting techniques.

15:00-15:30

A homogenisation approach for the roasting of a collective of coffee beans

Rahil Sachak-Patwa	University of Oxford
Nabil Fadai	Queensland University of Technology
Robert Van Gorder	University of Otago

Abstract: We extend the work on modelling the roasting of a single coffee bean to look at the roasting of a collective of beans. Using homogenisation theory, we derive a macroscopic model for the air-bean medium within a roasting chamber in order to model the effective properties of a collective of beans, providing numerical solutions relating to parameter regimes of both a fluidised bed roaster and a drum roaster.

15:30-16:00

Some insights from multiscale modelling of espresso-style coffee extraction

Jamie Foster	University of Portsmouth
William Lee	University of Huddersfield
Christopher Hendon	University of Oregon
Kevin Moroney	University of Limerick

Abstract: We give a brief introduction to cafe-style espresso extraction. Making the tastiest cup is considered an art, however, processes can be made more systematic by better understanding the physical processes underlying brewing. We develop a physics-based mathematical model for the extraction process. We will show that the model is able to reproduce some of the trends that are observed in experimental data and in practice. We also discuss possible strategies to make espresso more efficiently.

16:00-16:30

Numerical models of coffee brewing to investigate bed extraction uniformity

Kevin Moroney	University of Limerick
Ken O'Connell	University of Limerick
Stephen O'Brien	University of Limerick
Gavin Walker	University of Limerick
Paul Meikle-Janney	Dark Woods Coffee
William Lee	University of Huddersfield

Abstract: Extraction of soluble material from roast and ground coffee grains is a complex process, depending on a multitude of parameters relating to the raw materials (coffee and water) and the extraction process design and settings. It is known that the extraction level is a key influencer of coffee taste. This work investigates flow and extraction models to consider the extraction uniformity within different coffee bed geometries. One-dimensional flow models are compared to CFD simulations.

MS A6-4-2 3 14:30-16:30

Applications of Multiresolution Analysis with Wavelets - Part 1

Organizer: Maria Ines Troparevsky — Universidad de Buenos Aires

Abstract: Since the publication of the famous article Cycle octave and related transforms in seismic signal analysis, wavelet theory has been intensely developed attracting great attention in various fields of applied sciences and mathematics. The discrete wavelet transform in a multiresolution analysis scheme plays the role of a filter bank and offers the possibility of time-frequency localization, making it attractive for signals and images processing and pattern recognition in different applications in medicine, quantum physics, data compression, radar, resolution of differential and integral equations, etc. In this symposium we will show several concrete implementations in different areas .

14:30-15:00

Wavelet Decomposition Methods for solving Fractional Partial Differential Equations

Maria Ines Troparevsky	Universidad de Buenos Aires
Silvia A. Seminara	Universidad de Buenos Aires
Marcela A. Fabio	Universidad de San Martin

Abstract: Fractional derivatives are integral operators, some of them having singular kernels, and calculations related to them may not be easy. In this work we combine the wavelet transform with the fractional derivatives of the wavelet basis by means of a Galerkin scheme, and build an approximate solution to Boundary Value Problems involving Caputo Fabrizio Fractional Derivatives. The numerical scheme is simple, stable and its accuracy can be easily improved. We present some numerical examples.

15:00-15:30

Wavelet B-splines bases on the interval for solving boundary value problems

Victoria Vampa	Universidad Nacional de La Plata
Maria Teresa Martín	
Lucila Calderón	

Abstract: The use of multiresolution techniques and wavelets has become increasingly popular in the development of numerical schemes for the solution of differential equations. Wavelet's properties make them useful for developing hierarchical solutions to many engineering problems. They are well localized, oscillatory functions which provide a basis of the real line. We show the construction of derivative-orthogonal B-spline wavelets on the interval –adapting multiresolution hierarchy- which have simple structure and provide sparse and well conditioned matrices.

15:30-16:00

Kalman-Wavelet combined filtering

Guillermo La Mura	Universidad de San Martin
Fabio Marcela	Universidad Nacional de San Martín, Centro de Matemática Aplicada
Sirne Ricardo	Universidad de Buenos Aires, Facultad de Ingeniería

Abstract: In the framework of noise filtering in signals, it is interesting to take advantage of the optimal estimation given by the Kalman filter and the possibility of filtering using wavelets on a multiresolution analysis (MRA) scheme. In this presentation, using discrete wavelet transform, we show the suppression of additive measurement noise by means of a systemic model which allows to apply the Kalman-Wavelet combined filtering on the coefficients of the MRA of the signal.

16:00-16:30

Using the Wavelet Transform for time series analysis

Victoria Vampa	Universidad Nacional de La Plata
María Belén Arouxet	
Verónica Pastor	

Abstract: Characterization of time series requires knowledge of certain parameters. One of those parameters is the Hurst exponent which is an indicator of those series with long-range correlation. Wavelet transform analysis reflects the nonlinear dynamics of the series of biological, climatic or economic nature better than statistical tools often used for this analysis. We have obtained promising results in rainfall series with this approach. Therefore, we apply it to time series of different nature.

MS ME-1-I1 3 14:30-16:30

Recent advances in nonlinear time series analysis - Part 3

For Part 1 see: MS ME-1-I1 1
For Part 2 see: MS ME-1-I1 2

Organizer: Yoshito Hirata — The University of Tokyo
Organizer: José María Amigó — Universidad Miguel Hernández
Organizer: Michael Small — University of Western Australia

Abstract: Nonlinear time series analysis, or time series analysis on dynamical systems, literally began in 1980s, when delay coordinates were proposed. The initial targets for nonlinear time series analysis were stationary, nonlinear, deterministic, isolated, low-dimensoinal systems without assuming knowledge about the underlying systems. One can easily find books describing such developments up to year 2000. But, the recent targets include also non-stationary, stochastic, or high-dimensional systems with or without partial models or couplings. The purpose of this mini-symposium is to showcase and summarize the recent advancements of nonlinear time series anlaysis, and provide a platform for discussing its future directions.

14:30-15:00

Detecting directional couplings in the presence of common hidden drivers

José M. Amigó	Universidad Miguel Hernández
Yoshito Hirata	University of Tokyo

Abstract: To find out directional couplings in a network via observations, various methods have been proposed ranging from the Granger causality to the transfer entropy and the convergent cross mapping. But a correct detection in the presence of common hidden drivers remains a difficult problem. We propose in our communication an approach called the method of the joint distance distribution to overcome this problem.

15:00-15:30

Two tests for dependence (linear or nonlinear) between stochastic temporal processes

Mariano Matilla	UNED

Abstract: We propose two new nonparametric tests for independence between time series. Both tests are based on permutation entropy measures, particularly on symbolic correlation integral. The first test is developed for a scenario in which each considered time series is independent and therefore, the interest is to investigate if two internally independent time series share a relationship of unknown form. The second tests for independence among variables allowing those time series to exhibit within-dependence.

15:30-16:00

Nonlinear time series analysis in terms of randomly transitional oscillations in chaotic attractors

Takaya Miyano	Ritsumeikan University
Aren Shinozaki	Ritsumeikan University
Kota Shiozawa	Ritsumeikan University

Abstract: According to Ueda's picture of chaos, we may view chaotic behavior as random transitional oscillations between minimal sets contained in chaotic attractors. In this view of chaos, deterministic chaotic orbits may have no physical reality. Instead, chaotic flows can be viewed as piecewise deterministic processes intervened by stochastic processes. Here, we show a method for estimating the largest Lyapunov exponent from the information entropy of symbolic dynamics without tracing the distance between chaotic trajectories.

MS ME-1-5 3 14:30-16:30

Emerging trends in liquid crystals encompassing modelling, simulation and analysis - Part 3

For Part 1 see: MS ME-1-5 1
For Part 2 see: MS ME-1-5 2
For Part 4 see: MS ME-1-5 4
Organizer: Arghir Dani Zarnescu Basque Center for Applied Mathematics
Organizer: Pingwen Zhang Peking University

Abstract: Liquid crystals are modelled mathematically by functions taking values into a certain space of order parameters. Various spaces of order parameters correspond to different theories of liquid crystals. Initial mathematical explorations started in the 80s in connection with harmonic maps. The last decade has brought a surge in the mathematical study of liquid crystals, to the extent that the mathematical literature in the area has nearly doubled. The proposed minisymposium aims to explore the recent advances, and generate new directions, by bringing together major contributors from the modelling, simulation and analysis of liquid crystals.

14:30-15:00

Thermal Effects and Boundary Conditions in Complex Fluids

Chun Liu Illinois Institute of Technology

Abstract: In this talk, I will introduce a general framework of combining the thermodynamical laws with the energetic variational approaches. The key is to demostrate the force bances in the conventional isothermal systems with the thermal effects. I will discuss both modeling and analysis difficulties and issues, such as the force balances and energy exchange on boudnaries.

15:00-15:30

Local minimizer for the Isotropic-Nematic interface problem

Zhifei Zhang Peking University

Abstract: In this talk, I will present some recent results and open questions on the local minimizer for the isotropic-nematic interface problem based on Landau de Gennes Q-tensor theory.

15:30-16:00

Stable decoupled schemes for nematic-isotropic fluids

Francisco Guillen Gonzalez Universidad de Sevilla
Rodríguez-Bellido María Ángeles Universidad de Sevilla
Tierra Giordano Temple university

Abstract: In this talk, we consider a differential problem to model nematic–isotropic mixtures, taking into account viscous, mixing, nematic, and anchoring effects and reformulating the corresponding stress tensors in order to derive a dissipative energy law. Then, we provide linear unconditionally energy-stable splitting schemes. Moreover, we present several numerical simulations in order to show the efficiency of the scheme and the influence of the different types of anchoring effects in the dynamics of the system.

16:00-16:30

Construct the Solution Landscape beyond the Energy Landscape

Lei Zhang Beijing International Center for Mathematical Research (BICMR)

Abstract: We propose an efficient algorithm to construct the solution landscape, which is a directed graph consisting of all critical points of the energy function. Solution landscape shows a global and intrinsic properties of the system that is beyond the energy landscape. Then we apply the Landau-de Gennes theory to study defects landscape of nematic liquid crystal in a 2D square to advance our understanding on the mathematical models.

MS A6-3-2 3 14:30-16:30

Modeling and Simulations for Morphological Evolution of Nanoscale Crystal Growth - Part 2

For Part 1 see: MS A6-3-2 2
For Part 3 see: MS A6-3-2 4
Organizer: Chaozhen Wei Hong Kong University of Science and Technology
Organizer: Dong Wang University of Utah

Abstract: This minisymposium focuses on the mathematical modeling, analysis, and numerical simulations of the diverse phenomena in nanoscale crystal growth. The research is interdisciplinary, spanning the fields of mathematics, materials science, physics, and chemistry. The speakers will talk about their recent work on the corresponding experiment, theory, model, and numerical simulations of a range of interesting phenomena including but not limited to the morphological evolution, solid-state wetting/de-wetting, coarsening dynamics, space-time microstructure, and epitaxial growth.

14:30-15:00

Corner wetting and drop shapes during vapor-liquid-solid growth of nanowires

Brian Spencer University at Buffalo

Abstract: We consider the corner wetting of faceted nanowires in the context of vapor-liquid-solid growth of nanowires. In particular, we numerically determine the equilibrium shape of a liquid drop on top of wires of hexagonal cross section. The behavior of the liquid surface near the corners of the wire is nearly singular, and we determine the scaling behavior for the drop shape in the vicinity of the corner.

15:00-15:30

The case for an inverse Stranski-Krastanov transition

Simon Gill University of Leicester

Abstract: The Stranski-Krastanov growth mode for heteroepitaxial systems is accompanied by a reduction in the volumetric energy (usually credited to elastic relaxation) and an increase in the surface energy when a 2D film undergoes a transition to 3D island growth. Using the results of first principles calculations, it is proposed that in some systems there is a case that these energetics could be inverted, leading to an alternative growth mode.

15:30-16:00

Kinetic breakdown for wetting-layer-free quantum dots

Jean-Noel Aqua Sorbonne Université
Schifani Guido InPhyNi
Frisch Thomas InPhyNi
Brault Julien CRHEA
Samuel Matta CRHEA
Korytov Maxim CRHEA
Damilano Benjamin CRHEA
Massies Jean CRHEA

Abstract: We exhibit both experimentally and theoretically a novel growth mode for the epitaxy of AlGaN quantum dots (QD), where they are eventually found without their usual surrounding wetting layer. Using a dedicated surface diffusion model accounting for elasticity, wetting and anisotropy, we evidence numerically different kinetic regimes as a function of the evaporation flux, that rationalize the experimental outcome.

16:00-16:30

Coupling of solid-state dewetting with the ATG instability

Francesco Boccardo UNIVERSITE CLAUDER BERNARD LYON I
Fabrizio Rovaris University of Milano-Bicocca, Italy
Francesco Montalenti University of Milano-Bicocca, Italy
Olivier Pierre-Louis Institut Lumière Matière (CNRS/University Lyon 1), France

Abstract: Solid-state dewetting shares similarities with liquid dewetting: both processes involve surface energy minimization. However, mass transport in solid films is mediated by surface diffusion. This can produce a periodic pinching process. Solids can also sustain elastic energy, which leads to the Asaro-Tiller-Grinfeld (ATG) instability. Studying the dewetting of solid films under elastic stress, we found an interplay between pinching and the ATG instability. Stress accelerates the pinching process and tunes the pinching time and wavelength.

MS A3-3-2 3 14:30-16:30

Uncertainty Quantification: Theory and Applications - Part 1

For Part 2 see: MS A3-3-2 4
Organizer: Juan Carlos Cortés Universitat Politècnica de València
Organizer: Rafael Villanueva Universitat Politècncia de Valéncia
Organizer: Carla M.A. Pinto Polytechnic Institute of Porto

Organizer: Amar Debbouche Guelma University

Abstract: Equations with randomness are useful tools to describe dynamic phenomena in Physics, Engineering, Epidemiology, etc. On the one hand, the area of Random Equations deals with the extension of deterministic results for fractional, ordinary, partial, integral, difference, etc., equations to the stochastic framework. On the other hand, a major goal when modelling real problems using Random Equations is to identify, quantify and reduce uncertainties associated with models, numerical algorithms and predicted outcomes of quantities of interest. The aim of this minisymposium is to create a meeting where advances related to Random Equations and Uncertainty Quantification can be presented and discussed.

14:30-15:00

Uncertainty and sensitivity analysis of a virus plant model

Benito Chen-Charpentier University of Texas at Arlington

Abstract: Plant viruses cause great damage to plants and are responsible for billions of dollars in damage to crops. Here we present a mathematical model of the interactions of plant viruses, vectors, plants and a vector-eating predator. Most of the parameters cannot be measured and have to be estimated. This causes uncertainties in the solution. Here we study local and global parameter sensitivities and their effects on the populations.

15:00-15:30

Mathematical modeling of viral dynamics under different uncertainty factors

Gilberto Gonzalez New Mexico Tech
Hana Dobrovolny Texas Christian University, Fort Worth, Texas, USA.
Abraham Arenas Universidad de Cordoba, Monteria, Colombia

Abstract: Mathematical modeling of viral dynamics is challenging due to the complexity and variation of the mechanisms involved in the viral processes within-host. There are several challenges that need to take into account such as uncertainty. We consider uncertainty in the viral data, mechanism of actions, and on the estimation of the parameters. We rely on mathematical and computational tools such as bootstrapping, profile-likelihood and Markov chain Monte Carlo, to tackle the aforementioned types of uncertainties.

15:30-16:00

Uncertainty Quantification for predictive models in real applications

Juan Alegre Sanahuja Deloitte

Abstract: The simulation of complex real-world phenomena by mathematical models always implies uncertainty that impacts in the outputs of the model due to the uncertainty of the inputs. In this talk, we will analyze real-world engineering problems where the uncertainty of the inputs for the predictive models has to be taken into account in order to estimate the goodness of the obtained results and the impact on the business case that has to be predicted.

16:00-16:30

Managing censored data in Markovian arrival processes

Cristina Santamaría Universitat Politècncia de València
Belén García-Mora Intituto de Matemática Multidisciplinar, Universitat Politècnica de València
Gregorio Rubio Navarro Intituto de Matemática Multidisciplinar, Universitat Politècnica de València

Abstract: Survival Analysis studies often manage correlated time data that moreover are censored. A censored time is one in which the event of interest has not yet occurred. The Markov Arrival Process is a stochastic process suited for dealing with not identically distributed and correlated inter-failure times. However, the management of censored data in MAPs is a problem that has not yet been well studied. Our goal is to provide an approach to this issue.

MS A3-S-C1 3 14:30-16:30

Systems, patterns and data engineering with geometric calculi - Part 2

For Part 1 see: MS A3-S-C1 2

Organizer: Sebastià Xambó-Descamps Universitat Politècnica de Catalunya

Abstract: First develop as a language for physics (mechanics, space-time physics, electromagnetism), in the last two decades there has been an explosion of applications of Geometric Calculus in a great variety of areas, maily in the guise of Conformal Geometric Algebra, like general relativity, cosmology, robotics, computer graphics, computer vision, molecular geometry, quantum computing, etc. Now the development of applications of multivector wavelets to deep learning, much as scalar wavelets are beeing used with great success for that purpouse, is a very promissing research opportunity and the goal of the mini-symposium is to overview the main ideals of this large endeavour.

14:30-15:00

Hypercomplex algebras for art investigation

Srdan Lazendic University of Ghent
Hendrik De Bie Ghent University
Aleksandra Pizurica Ghent University

Abstract: Rooted in Hamilton's seminal paper about quaternions published in 1843, the theory of hypercomplex algebras evolved, finding applications in many disciplines. A recent application of hypercomplex algebras in sparse image representation showed remarkable results in inverse problems of general multichannel images. In this talk, we will explain the potential of dictionary learning models in combination with hypercomplex algebra models for art investigation. Results compared to some more traditional or commonly used approaches will be presented.

15:00-15:30

Conformal Geometric Algebra for Medical Imaging

Salvatore Vitabile University of Palermo

Abstract: The practical use of CGA-based methods in medical imaging applications requires fast and efficient implementations to meet real-time processing constraints as well as accuracy and robustness requirements. The purpose of this talk is to present a novel implementation of CGA-based techniques that makes them effective and practically usable. A brief introduction on Radiomics, i.e. a comprehensive quantification of tumor phenotypes by applying a large number of quantitative image features, is also outlined.

15:30-16:00

Geometric bio-inspired deep learning

Eduardo Ulises Moya Sánchez Barcelona Supercomputing Center
Sebastià Xambó-Descamps Universitat Politècnica de Catalunya
Ulises Cortés Universitat Politècnica de Catalunya, Barcelona Supercomputing Center
Sebastian Salazar-Colores Universidad Autónoma de Queretaro
Abraham Sánchez Pérez Universidad Autónoma de Guadalajara

Abstract: Although Convolutional Neural Networks (CNN) are bio-inspired, they still are limited when compared to the mammalian visual system, for instance, with the equivariant response to some changes in lighting and rotations. One possible reason is that the CNN representation spaces are usually endowed with minimal internal structure, and this limits network performance. The main goal of this talk is to present recent results aimed at decreasing that gap.

16:00-16:30

Geometric Calculus meets Deep Learning

Sebastià Xambó-Descamps Universitat Politècnica de Catalunya

Abstract: Signal representation and processing is paramount for mathematical engineering. In recent years, wavelet theory has been used to power deep learning techniques and systems. In this talk, the geometric calculus representations of signals and the concomitant multivector wavelet theory will be outlined as background material. The core will be focused on a how these techniques can be used to strengthen deep learning in different areas and also on reporting on recent work on this direction.

MS GH-1-A 3 14:30-16:30

Recent trends in the mathematics of images - Part 2

For Part 1 see: MS GH-1-A 2
For Part 3 see: MS GH-1-A 4

Organizer: Chambolle Antonin CMAP, Ecole Polytechnique, CNRS
Organizer: Jalal Fadili CNRS and ENSICAEN
Organizer: Kristian Bredies University of Graz

MS Organized by: SIAG/IS

Abstract: Mathematical imaging relies on many different mathematical disciplines including linear algebra, differential geometry, harmonic analysis, functional analysis, mathematical physics, numerical analysis, optimisation, PDEs, stochastic and statistical methods, machine learning. The fields of application encompass medical and astronomical imaging, radar, optics, etc. The goal of this 3-part mini-symposium is to present recent theoretical, numerical and applicative trends by young researchers in these fields, with a stress put on modeling, optimisation and theoretical recovery results.

14:30-15:00

Fast image reconstruction for 4D magnetic particle imaging

Christina Brandt Universität Hamburg

Abstract: Magnetic particle imaging (MPI) is a new imaging modality which can capture fast dynamic processes in 3D volumes, based on the non-linear response of the magnetic particles to an applied magnetic field. For the Tikhonov regularized on-line reconstruction of the dynamic particle concentration, efficient numerical methods are necessary. We illustrate our reconstruction approach with real data of a prototypical application which is the tracking of a catheter during a in-vitro angioplasty.

15:00-15:30

A new iterative method for CT reconstruction with uncertain view angles

Yiqiu Dong Technical University of Denmark
Nicolai Andre Brogaard Riis Technical University of Denmark

Abstract: In this talk, I will introduce a new iterative algorithm for CT reconstruction when the problem has uncertainty in the view angles. The algorithm models this uncertainty by an additive model-discrepancy term leading to an estimate of the uncertainty in the likelihood function. This means we can combine regularization priors with this likelihood. Numerical experiments show that our method is able to improve the relative reconstruction error and visual quality.

15:30-16:00

Alternating Structured Adapted Proximal Gradient Descent Algorithm for Nonconvex Optimization

Pauline Tan Sorbonne Université and CNRS

Abstract: In this talk, I will present one of the latest work of Mila, the ASAP algorithm, which addresses the very challenging problem of nonsmooth and nonconvex optimization.

16:00-16:30

Proximal Markov chain Monte Carlo methods and application to Bayesian analysis

Alain Durmus ENS Paris-Saclay
Valentin De Bortoli ENS Paris-Saclay
Marcelo Pereyra Heriot Watt University & Maxwell Institute for Mathematical Sciences
Ana Fernandez Vidal Heriot Watt University & Maxwell Institute for Mathematical Sciences

Abstract: This presentation summarises some new developments in theory, methods, and algorithms for performing Bayesian inference in high-dimensional models that are log-concave, with application to mathematical and computational imaging in convex settings. These include new efficient stochastic simulation and optimisation Bayesian computation methods that tightly combine proximal convex optimisation with Markov chain Monte Carlo techniques.

MS FT-0-2 3 **14:30-16:30**

Mean Field Games: New Trends and Applications - Part 2

For Part 1 see: MS FT-0-2 2
For Part 3 see: MS FT-0-2 9
For Part 4 see: MS FT-0-2 4
For Part 5 see: MS FT-0-2 5
For Part 6 see: MS FT-0-2 1
Organizer: Francisco José Silva Alvarez Techniques Université de Limoges
Organizer: Adriano Festa L'Aquila university
Organizer: Daniela Tonon Paris Dauphine University

Abstract: Mean Field Games (MFGs) problems have been introduced by Lasry-Lions and Huang-Caines-Malhamé in 2006. This theory describes Nash equilibria of some differential games with infinitely many players. In light of the numerous applications of MFGs, which include Economics, Finance and Social Sciences, several mathematical techniques are currently employed for its development. The scope of this minisymposium is to bring together several specialists in MFGs in order to present recent progress on the area and open problems. Among the topics covered in the minisymposium sessions are: analytic, probabilistic and numerical aspects of MFGs, and the applications mentioned in the paragraph above.

14:30-15:00

Uniqueness for randomized MFG with a finite state space.

François Delarue Université de Nice Sophia-Antipolis

Abstract: We here discuss mean field games with a finite state space when subjected to a common noise. We explain how common noise may help for regularizing the master equation and hence forcing uniqueness. Joint work with Alekos Cecchin.

15:00-15:30

The mean field Schrödinger problem

Julio Backhoff-Veraguas University of Vienna
Giovani Conforti École polytechnique (Paris)
Christian Léonard Université Paris Ouest

Abstract: I will introduce the mean field Schrödinger problem, concerned with finding the most likely evolution of a cloud of interacting Brownian particles conditionally on their initial and final configurations. New energy dissipation estimates are shown, yielding exponential convergence to equilibrium as the time between initial and final observations grows to infinity. The method reveals novel functional inequalities involving the mean field entropic cost, as well as an interesting connection between FBSDEs and Otto calculus.

15:30-16:00

Mean field games for exhaustible resource production with jump processes

Jameson Graber Baylor University

Abstract: We present some results on existence and uniqueness of regular solutions to a system of PDEs arising in the study of oil production. The model is inspired by the work of Chan and Sircar (SIAM Review, 2017), among others, and it consists of a backward-in-time Hamilton-Jacobi equation coupled with a Fokker-Planck equation, with a nonlocal diffusion.

16:00-16:30

On the behavior of pedestrians near walls and the mean-field approach to crowd dynamics

Alexander Aurell Kungliga Tekniska Högskolan
Boualem Djehiche Royal Institute of Technology, Stockholm

Abstract: A system of SDEs of mean-field type is proposed which aims to resolve two concerns of the mean-field approach to pedestrian crowd modeling. The popular use of Neumann/no-flux conditions suggests reflection at walls, the proposed model allows pedestrians to move and interact while spending time at walls. Control of reflected paths under more elaborate mean-field couplings is not understood. The proposed model can be optimally controlled in the weak sense, using a Pontryagin's type MP.

MS FE-1-2 3 **14:30-16:30**

Computational Methods for Inverse Problems - Part 3

For Part 1 see: MS FE-1-2 1
For Part 2 see: MS FE-1-2 2
For Part 4 see: MS FE-1-2 4
Organizer: Alessandro Buccini Kent State University
Organizer: Lothar Reichel Kent State University

Abstract: Inverse problems arise in most scientific fields. These problems are usually ill-posed and can be of very large dimension. Developing fast and accurate methods for their solution is of fundamental importance. Moreover, since most methods require the estimation of one or more regularization parameters, the development of automatic strategies for the selection of these parameters is of considerable importance, especially for real-world applications. This minisymposium presents new approaches to the solution of inverse problem and to the automatic estimation of regularization parameters.

14:30-15:00

Robust PCA and Weizfeld's algorithm

Gabriele Steidl University of Kaiserslautern
Sebastian Neumayer TU Kaiserslautern
Max Nimmer TU Kaiserslautern
Simon Setzer Engineers Gate Landon

Abstract: We reinterpret the robust rotational invariant L1 PCA as conditional gradient algorithm and show moreover that it coincides with a gradient descent algorithm on Grassmannians. We prove convergence of the whole series of iterates to a critical point using the Kurdyka- Lojasiewicz property of the energy functional.

15:00-15:30

Bandwidth Selection for Kernel Principal Components Analysis

Omar De La Cruz Cabrera Kent State University

Abstract: Choosing the "correct" (or in some sense optimal) bandwidth is a crucial element in kernel methodology. For applications like prediction and classification, which have an objective criterion for success, the bandwidth is usually selected using some form of cross-validation. However, the criteria for success in exploratory analysis is less well defined. Here we present some approaches for interactive evaluation of Kernel Principal Components Analysis, and discuss some of the computational challenges that arise.

15:30-16:00

Vector extrapolation methods for nonlinear ill-posed problems

Hassane Sadok Université du Littoral Côte d'Opale

Abstract: This work is concerned with the study of application and theory of vector extrapolation to solutions of linear systems of equations and linear least-squares problems and non linear inverse problem, with a very ill-conditioned matrix or Jacobian and error-contaminated data. The solution of this kind of problems requires vector extrapolation methods by transforming a sequence of vectors generated by some process to a new one in order to get a best approximation of the limit.

16:00-16:30

Matrix Extrapolation Methods for Ill-posed Problems

Khalide Jbilou University, ULCO Calais France

Abstract: We present numerical methods for solving linear matrix ill-posed problems coming for example from the disretization of 2D Fredholm integral equations. This discretization leads to a linear matrix equation with a right-hand side contaminated by an unknown noise. Solving thi problem is equivalent to solve an ill-posed linear system with a large ill conditioned matrix. We apply some matrix extrapolation methods such the Matrix Reduced Rank Extrapolation combined with Truncated Singular Value Decomposition .

MS A6-3-3 3 **14:30-16:30**

Multiscale and Asymptotic Analysis, Modeling, and Simulation for Materials Science - Part 3

For Part 1 see: MS A6-3-3 1

For Part 2 see: MS A6-3-3 2

For Part 4 see: MS A6-3-3 4

For Part 5 see: MS A6-3-3 5

Organizer: Silvia Jimenez Bolanos Colgate University

Organizer: Lyudmyla Barannyk University of Idaho

Organizer: Miao-Jung Yvonne Ou University of Delaware

Abstract: Multiscale in space and time continues to be an active and challenging area of research in mathematical materials science. The aim of this minisysmposium is to focus on multiscale modeling, analysis and simulation of the problems arising in fluids, composites and other heterogeneous media. In particular, topics that will be discussed include but are not limited to asymptotic analysis, homogenization, inverse problems, and computational tools for complex fluid and inhomogeneous media. The purpose of this minisimposium is to enable contact between researchers working on fluid modeling and multiscale methods with an update on recent progress in this field.

14:30-15:00

A treecode-accelerated boundary integral Poisson-Boltzmann solver.

Weihua Geng Southern Methodist University

Robert Krasny University of Michigan

Abstract: The Poisson-Boltzmann model is an extension of the Gauss's law involving heterogeneous dielectrics and multiscale solute-solvent-electrolytes modeling. In this talk, we report our recent progresses in developing an accurate and efficient Poisson-Boltzmann solver using both the well-posed boundary integral formulation and the fast tree-code algorithms focusing on computing performance enhancement in parallelization and preconditioning. We will also demonstrate the solver's distinguished advantages in computing significant biological quantities such as binding energy and pKa values.

15:00-15:30

Efficient Numerical Treatment of High-Contrast Composite Materials.

Yuliya Gorb University of Houston

Abstract: This talk concerns a robust numerical treatment of an elliptic PDE with high contrast coefficients. We introduce a procedure by which a discrete system obtained from a linear finite element discretization of the given continuum problem is converted into an equivalent linear system of the saddle point type. Preconditioners for solving the derived saddle point problem that are robust with respect to the contrast parameter and the discretization scale are proposed and justified.

15:30-16:00

Optimal structures of multimaterial composites

Andrej Cherkaev University of Utah

Abstract: Optimization of composite microstructures is an essential present-day problem because technologies allow for fabrication an unlimited variety of structures. So far, the vast majority of results concerns two-material composites because of theoretical limitations. The paper extends the existing techniques for multilateral composites, describes various optimal multi-material structures, discusses the bounds of effective properties, and shows optimal designs from two elastic materials and void.

MS ME-1-0 3 **14:30-16:30**

Recent Advances in Optimal Control Theory - Part 3

For Part 1 see: MS ME-1-0 1

For Part 2 see: MS ME-1-0 2

For Part 4 see: MS ME-1-0 4

For Part 5 see: MS ME-1-0 5

Organizer: Alexander Zaslavski The Technion - Israel Institute of Technology

Organizer: Monica Motta University of Padua

Organizer: Boris Mordukhovich Wayne State University

Organizer: Nobusumi Sagara Hosei University

Abstract: This minisimposium on new developments in optimal control theory and its applications will bring together a selected group of experts in this area. The growing importance of control and optimization has been realized in recent years. This is due not only to theoretical developments, but also because of numerous applications to engineering, economics and life sciences. The topics which will be discussed include optimal control of PDE, turnpike phenomenon, infinite horizon optimal control, necessary and sufficient optimality conditions, qualitative and quantitative aspects of optimal control and applications.

14:30-15:00

Sample and Euler stability in optimal control

Monica Motta University of Padova

Anna Chiara Lai Università di Roma La Sapienza

Abstract: We extend the well-known concepts of sampling and Euler solutions for control systems associated to discontinuous feedbacks by considering also the corresponding costs. We establish sufficient conditions for the design of a stabilizing feedback control that satisfies an upper bound for the given cost, by means of a special kind of Control Lyapunov Functions. These results are also extended to control problems with unbounded data and to impulsive control problems.

15:00-15:30

A condition of optimality for convex functions in infinite dimension.

Mohammed Bachir Université Paris 1

Adrien Fabre Université Paris 1 Panthéon-Sorbonne

Sebastien Tapia-Garcia University of Chile

Abstract: We give a necessary and sufficient condition such that a convex function (in infinite dimension) attains its minimum on a convex set, by replacing the classical Gâteaux-differentiability assumption by a weaker notion of derivatives in the directions of a fixed basis. Application to discrete-time and infinite horizon problems is given.

15:30-16:00

Non-Smooth Integrability Theory

Yuhki Hosoya Chuo University

Abstract: We study a reverse calculation method for consumer's preference from demand function that is not necessarily differentiable, but locally Lipschitz. For this purpose, we treat existence results of both local and global solution of a partial differential equation (PDE), which is called Shephard's lemma in economics. Our solution of this PDE is the classical solution, and our local existence result is a "necessary and sufficient" result.

16:00-16:30

On the optimal control of non-linear control-affine problems

Vladimir Veliov — Vienna University of Technology

Abstract: The talk will be devoted to optimal control problems that are affine with respect to the control. Results on metric sub-regularity of the Pontryagin system will be presented. These results provide the base for error analysis of a recent discretization scheme suitable for affine problems. This scheme will also be presented and its implementation will be discussed. The talk will be partly based on joint papers with T. Scarinci and with N. Osmolovskii.

MS FT-1-SG 3 14:30-16:30

Manifold sensing and sparse recovery - Part 1

For Part 2 see: MS FT-1-SG 4

Organizer: Olga Mula — Paris Dauphine University

Organizer: Karen Veroy-Grepl — RWTH Aachen University

Organizer: James Nichols — Sorbonne Universités

MS Organized by: SIAG/CSE

Abstract: Across various communities there have been interesting recent developments in state estimation where we assume i) that the function to recover belongs to some lower-dimensional manifold or is sparse in some basis and ii) our only data is a limited number of noisy measurements. Open problems still abound in extending the theoretical foundations and bringing the methods to real-life applications. Interaction between numerical analysts, statisticians, and practitioners will be effective in addressing these challenges. In this minisymposium we gather experts from various fields to report on recent results, identify new research directions, and stimulate collaboration.

14:30-15:00

Reduced modeling for manifold sensing

Albert Cohen — Sorbonne Universités

Abstract: We consider the problem of reconstructing from m linear measurements the solution u to a partial differential equation where certain parameters are unknown, therefore lying on a solution manifold. Fast numerical recovery methods have been proposed based on approximation spaces of moderate dimension n which are taylored to the solution manifold, such as reduced bases and POD. These methods are inherently limited by their linear nature. Several non-linear counterparts are discussed in this talk.

15:00-15:30

The variance based joint sparsity method for multi-measurement vectors

Theresa Scarnati — Air Force Research Laboratory (AFRL)

Anne Gelb — Dartmouth College

Abstract: Much research has been devoted to recovering signals and images from multiple measurement vectors (MMV). The assumption that the underlying signals have some common features with sparse representation suggests that using a joint sparsity approach to simultaneously recover all signals is more effective than recovering each signal separately. The variance based joint sparsity (VBJS) algorithm introduced here is based on the observation that the pixel-wise variance of the siganls convey information about their shared support.

15:30-16:00

On the sparse recovery of measures

Clarice Poon — University of Bath

Nicolas Keriven — Ecole Normale Superieure

Gabriel Peyre — Ecole Normale Superieure

Abstract: Existing performance guarantees for the sparse spikesrecovery problem generally assume a separation of the spikes based on an ad-hoc minimum distance condition, which ignores the geometry of the problem. We study an off-the-grid version of LASSO regularization and show that the Fisher-Rao distance is the natural way to quantify support recovery, and a sparse measure can be stably recovered under a sampling complexity which is linear with sparsity (up to log factors).

16:00-16:30

Reduced basis approximation and a posteriori error bounds for data assimilation

Boyaval Sébastien — Ecole des Ponts / Inria

Abstract: Assimilating data in dynamical systems is always a costly computational task, whatever the objective (predicting, filtering or smoothing). Many techniques are used in practice to reduce that cost in the various existing approaches to assimilation, sequential or variational. We will discuss the opportunity of using error bounds to guide the construction of a reduced basis for the state space, when the model depends smoothly on parameters, especially in the case of linear time-independent parabolic PDEs.

MS ME-1-G 3 14:30-16:30

Women in Applied Mathematics: Recent Advances in Modeling and Applications - Part 3

For Part 1 see: MS ME-1-G 1

For Part 2 see: MS ME-1-G 2

For Part 4 see: MS ME-1-G 4

Organizer: Baasansuren Jadamba — Rochester Institute of Technology

Organizer: Natasha S Sharma — University of Texas at El Paso

Abstract: This minisymposium aims at bringing women mathematicians to share their recent progress and to inspire new ideas in applied mathematics. Talks may address modeling, theoretical and computational aspects of numerical methods for partial differential equations, as well as various applications arising from engineering, biology, medicine and material science etc. The fourth part of the minisymposium includes a career panel session, whose goal is to create a network platform for women mathematicians at different stages of career and career paths, to exchange experiences and advice in career advancement, and to discuss challenges and strategies for a successful career.

14:30-15:00

Polycrystalline materials and evolution of the grain boundary network: Modeling, Analysis and Simulation

Yekaterina Epshteyn — The University of Utah

Abstract: Most technologically useful materials are polycrystalline microstructures, composed of a myriad of small monocrystalline cells/grains, separated by interfaces, or grain boundaries. Grain boundaries play an essential role in determining the properties of materials across a wide range of scales. During grain growth, an initially random grain boundary arrangement reaches a steady state that is strongly correlated to the interfacial energy density. We will discuss recent progress on modeling and analysis of microstructure evolution in polycrystals.

15:00-15:30

Finite element methods for nematic liquid crystals

Neela Nataraj — IIT Bombay

Ruma Rani Maity — IIT Bombay

Apala Majumdar — University of Bath

Neela Nataraj — IIT Bombay

Abstract: Consider a system of second order non-linear elliptic partial differential equations with non-homogeneous Dirichlet boundary conditions modeling equilibrium configurations of a two dimensional planar bistable nematic liquid crystal device within Landau-de Gennes framework. Discontinuous Galerkin finite element methods are analyzed to approximate regular solutions. Existence and local uniqueness of discrete solution and a priori error estimates are derived. Numerical results that justify the theoretical estimates are presented.

15:30-16:00

A computational study of lateral phase separation in biological membranes

Annalisa Quaini — University of Houston

Vladimir Yushutin — University of Houston

Sheereen Majd — University of Houston

Maxim Olshanskii — University of Houston

Abstract: Conservative and non-conservative phase-field models are considered for the numerical simulation of lateral phase separation in biological membranes. An unfitted finite element method is devised to allow for a flexible treatment of complex shapes in the absence of an explicit surface parametrization. For a set of biologically relevant shapes and parameter values, we compare the dynamic coarsening produced by both numerical models, its dependence on certain geometric characteristics and convergence to the final equilibrium.

MS FT-2-1 3 14:30-16:30

Regularization techniques and exponential analysis

Organizer: Wen-shin Lee University of Stirling / University of Antwerp

Organizer: Miao-Jung Yvonne Ou University of Delaware

Abstract: The exponential and many related functions appear as building blocks of the solution of several inverse problems. Recently, a lot of progress was made in exponential analysis, mainly through its connection with sparse interpolation in computer algebra and approximation theory. We refer to numerical reconditioning possibilities, validated implementations, an optimally sparse multivariate generalisation, and the application of these results in practical problem statements. We now explore the link between exponential analysis and regularization in the framework of resolution enhancement.

14:30-15:00

A multi-regularization method for NMR relaxometry

Miao-Jung Yvonne Ou University of Delaware
Chuan Bi University of Delaware, USA
Richard Spencer National Institute of Aging, National Institute of Health, USA

Abstract: An NMR relaxometry amounts to inverting a truncated Laplace transform, which is known to be extremely ill-posed. In this talk, we present preliminary results from a method that can be conceptually regarded as a generalized GCV and the prior knowledge of SNR and that the solution is a normalized finite sum of Gaussian distributions. Comparison with GCV will also be presented.

15:00-15:30

Validated exponential analysis in one and higher dimensions

Wen-shin Lee University of Stirling / University of Antwerp
Annie Cuyt University of Antwerp, Belgium

Abstract: In the analysis of a complex-valued exponential signal from uniform samples, the sampling step needs to respect the Nyquist constraint to yield a unique result. Otherwise, it can be regularised by adding some samples at a smart location. The latter method also allows for the first time to analyse a multivariate exponential signal from the theoretical minimum number of samples, bilinear in the dimension of the problem and the size of the exponential sum.

15:30-16:00

Algorithms for structured sparsity promoting function regularized optimization problems

Lixin Shen Syracuse University

Abstract: In this talk we introduce a simple scheme to construct structured semiconvex sparsity promoting functions from convex sparsity promoting functions and their Moreau envelopes. Properties of these functions are developed by leveraging their structure. In particular, we provide sparsity guarantees for the general family of functions. To demonstrate usefullness of these properties, we apply these functions for image restroration problems.

16:00-16:30

Stable super-resolution of spike trains and beyond

Dmitry Batenkov Massachusetts Institute of Technology
Laurent Demanet MIT, USA
Gil Goldman Weizmann Institute of Science, Israel
Yosef Yomdin Weizmann Institute of Science, Israel

Abstract: I will discuss the problem of stable recovery of spike trains $f(x)=\sum_{j=1}^{d} a_j \delta(x-x_j)$ from inaccurate and bandlimited spectral data. I will review recent results on the minimax recovery rate under the assumption that some of the d nodes $\{x_j\}$ form a small cluster, and the related question of estimating small singular values of Vandermonde matrices with clustered nodes. I will also mention ongoing work on generalized spike trains. Joint work with L.Demanet, G.Goldman, Y.Yomdin.

MS A6-2-3 3 14:30-16:30

Metamaterials in the frequency and time domain - Part 1

For Part 2 see: MS A6-2-3 4

Organizer: Bonnetier Eric Université Grenoble-Alpes

Organizer: Nguyen Hoai-Minh Ecole polytechnique fédérale de Lausanne EPFL

Abstract: In optics, metamaterials are composite materials in which one of the phases has nearly negative indices. This feature lends them spectacular properties of localization and concentration of electromagnetic energy. A short list of applications includes cloaking via changes of variables, cloaking using complementary media, cloaking via anomalous localized resonance, superlensing using negative index materials and hyperbolic materials. The aim of this session is to report on recent work on metamaterials in both time and frequency domains.

14:30-15:00

Concentration of energy for time harmonic Maxwell's equations in magnetized plasmas

Després Bruno Université Paris 6, UPMC
Campos-Pinto Martin CNRS/Sorbonne University
Nicolopoulos Anouk Sorbonne University
Ciarlet Patrick Ensta

Abstract: The TM time-harmonic electromagnetic response of a pre-magnetized plasma can be modeled with the linear Maxwell equations with a non standard anisotropic dielectric tensor. The paradox is the non integrable normal component of the electric field. I will explain how the limiting absorption principle and the recently developped tool of manufactured solutions can be used to obtained mathematically well posed formulations which have a sound physical interpretation with concentration of energy.

15:00-15:30

Cloaking via transformation for the heat equation

Nguyen Tu Vietnam Academy of Science and Technology
Hoai-Minh Nguyen EPFL

Abstract: We study approximate cloaking for the heat equation via transformation optics with regularization parameter ε. It is shown that the degree of visibility is of order ε in three dimensions and 1/|ln ε| in two dimensions. This is joint work with Hoai-Minh Nguyen.

15:30-16:00

Mathematical models for dispersive electromagnetic waves

Maryna Kachanovska INRIA

Abstract: This talk is dedicated to time-domain modelling of wave propagation in dispersive media. Such phenomena are described by Maxwell's equations with dielectric permittivity and magnetic permeability that depend on the frequency. We will discuss connections between mathematical properties of models (e.g. stability) and physical assumptions on the parameters (e.g. passivity). We will present dispersion and spectral analysis of a rather general class of passive media, and provide conditions of the existence of backward propagating waves.

16:00-16:30

The Neumann-Poincaré spectrum of the bowtie antenna

Bonnetier Eric Université Grenoble-Alpes

Abstract: The Neumann-Poincaré operator is a boundary layer operator that allows the integral representation of solutions to PDE's in divergence form with piecewise constant coefficients. It naturally appears in the modeling of metamaterials, plasmonic resonances and cloaking. We investigate the spectral properties of the Neumann-Poincaré operator associated to a domain shaped as a bowtie antenna, where the presence of two touching or close to touching corners may enhance the concentration of the fields.

MS ME-1-1 3 14:30-16:30

Recent developments in nonlinear PDEs of hydrodynamics and mathematical biology - Part 3

For Part 1 see: MS ME-1-1 1

For Part 2 see: MS ME-1-1 2

Organizer: Vincent Martinez City University of New York - Hunter College

Organizer: Kun Zhao Tulane University

Organizer: Michael Jolly Indiana University

Abstract: This session combines ideas from fluid dynamics, mathematical biology, and dynamical systems that address current issues in regularity of solutions, their growth and decay, as well as issues of stability and quantitative descriptions of their long-time behavior. Recent developments have successfully exploited various similarities between conservation laws, chemotaxis and aggregation models, and the equations of compressible or incompressible fluid motion. This session will bring together a diverse set of researchers, most at the early stage of their careers, who will share fresh expertise on gradient flows, flocking dynamics, conservation laws, fluid dynamics, and dissipative equations.

14:30-15:00

Finite-energy solutions for compressible Euler and Navier-Stokes with nonlocal forces

Ewelina Zatorska University College London
Jose A. Carrillo
Aneta Wroblewska-Kaminska

Abstract: We show that pressureless Euler-Poisson equations with quadratic damping can be obtained as inviscid pressure limit of compressible Navier-Stokes equations wit degenerate viscosities. We develop the relative entropy method for the systems with two-velocity structure and nonlocal terms. It allows us to deduce that the weak solutions to compressible Navier-Stokes converge to the strong solutions of the Euler system as long as the latter exist.

15:00-15:30

Eulerian dynamics with alignment interactions

Changhui Tan University of South Carolina

Abstract: The Euler-Alignment system arises as a macroscopic representation of the Cucker-Smale model, which describes the flocking phenomenon in animal swarms. The nonlinear and nonlocal nature bring challenges in studying global regularity and long time behaviors. In this talk, I will discuss Euler-Alignment system with three types of nonlocal alignment interactions, which lead to different global behaviors. I will also discuss interesting connections to some fluid dynamics systems, including fractional Burgers equation and aggregation equation.

15:30-16:00

Strong ill-posedness of logarithmically regularized 2D Euler equations in the borderline Sobolev space

Hyunju Kwon University of British Columbia-Vancouver

Abstract: The well-posedness of the incompressible Euler equations in borderline spaces has attracted much attention in recent years. To understand the behavior of solutions in these spaces, the logarithmically regularized Euler equations were introduced. In borderline Sobolev spaces, local well-posedness was proved Chae-Wu when the regularization is sufficiently strong, while strong ill-posedness of the unregularized case was established by Bourgain-Li. In this talk, I will discuss the strong ill-posedness of the remaining intermediate regime of regularization.

16:00-16:30

Algebraic bounds on the Rayleigh-Benard attractor

Michael Jolly Indiana University
Yu Cao Indiana University
Edriss Titi Cambridge Univ., Texas A&M Univ., Weizmann Inst.
Jared Whitehead Brigham Young University

Abstract: The Rayleigh-Benard system with stress-free boundary conditions is shown to have a global attractor in each affine space where velocity has fixed spatial average. The temperature gradient and palinstrophy are found to satisfy bounds on the attractor that are algebraic in the Rayleigh number, a significant improvement over previously established estimates. The sharpness of the bounds are tested with numerical simulations and related to data assimilation by nudging, which is also tested.

MS A1-2-3 3 14:30-16:30

Data and geometry - Part 2

For Part 1 see: MS A1-2-3 2
Organizer: Santiago Mazuelas BCAM

Abstract: Very often data presents an intrinsic geometry, and data models have rich geometric structure. The use of algebraic and geometric tools for data processing is enabling novel techniques for several data-based problems including parameter estimation, supervised classification, model selection, and hypothesis testing. This minisymposium will bring together researchers exploiting different geometric techniques for data processing, and will enable cross-disciplinary discussions around the interplay between geometry and data.

14:30-15:00

Varieties of Signature Tensors

Carlos Amendola TU Munich
Peter Friz TU Berlin
Bernd Sturmfels MPI-MIS Leipzig, UC Berkeley

Abstract: In many applications, tensors are used to encode features of geometric data. One example is the signature method in Machine Learning. The signature of a path is a sequence of tensors whose entries are iterated integrals. We examine them through the lens of algebraic geometry. We introduce varieties of signature tensors for large families of paths, including piecewise linear and polynomial paths, and explore the natural inverse problem of recovering a path from its signature.

15:00-15:30

Brownian motion tree models are toric

Piotr Zwiernik Universitat Pompeu Fabra

Abstract: Felsenstein's classical model for Gaussian distributions on a phylogenetic tree is shown to be a toric variety in the space of concentration matrices. We present an exact semialgebraic characterization of this model, and we demonstrate how the toric structure leads to exact methods for maximum likelihood estimation. Our results also give new insights into the geometry of ultrametric matrices.

15:30-16:00

Data-discriminants of likelihood equations

Jose Israel Rodríguez University of Wisconsin --- Madison

Abstract: An algebraic approach to maximum likelihood estimation is to solve a very structured parameterized polynomial system given by the likelihood equations that have finitely many solutions. These solutions enumerate all possible local minima, and under reasonable hypothesis, one of which is the global minimum point of the likelihood function. In this talk, I will describe a way of classifying the data according to the number of real solutions of the likelihood equations by data-discriminants.

16:00-16:30

Learning decomposable graphical models

Aritz Pérez Basque Center for Applied Mathematics

Abstract: Decomposable (graphical) models (DM) represent probability distributions that factorize according to a decomposable undirected graph. DMs with a bounded clique size are particularly interesting because they can be used to exactly solve inference problems efficiently. Unfortunately, the problem of learning DMs with a bounded clique size is NP-hard. This work presents heuristic algorithms for learning these models by constructing a sequence of coarser decomposable graphs with increasing size of the maximum clique size.

MS GH-3-2 3 14:30-16:30

Preconditioners for Linear Algebra Methods in Large Scale Scientific Computing - Part 3

For Part 1 see: MS GH-3-2 1
For Part 2 see: MS GH-3-2 2
For Part 4 see: MS GH-3-2 4
Organizer: Luca Bergamaschi University of Padua
Organizer: Angeles Martinez University of Padua
Organizer: Jose Marin Polytechnic University of Valencia

Abstract: Mathematical models of a high number of processes in Engineering and Applied Sciences once numerically discretized require the repeated solution of large (non)linear systems or eigenvalues problems. All these linear algebra problems are usually addressed by iterative methods which take into account the sparsity of the matrices involved. To provide an approximate solution in a reasonable amount of time, such iterative methods need to be accelerated by suitable preconditioners. The aim of this miniworkshop is to collect the most recent results in the construction of efficient preconditioners applied to discretizations of PDEs as well as constrained optimization problems.

14:30-15:00

Optimal Transport Problem solution: preconditioning strategies for the Newton method

Angeles Martinez University of Padua

Abstract: The transient solution of the optimal transport problem can be modelled through a system of nonlinear PDEs whose integration in space (Finite Elements) and time (Backward Euler) requires the repeated solution of (non)linear systems of saddle-point type. We investigate sequences of preconditioners by starting from an initial preconditioner which takes into account the block structure of the problem and by correcting it by low-rank updates which exploit information from the nonlinear problem.

15:00-15:30

Parallel AMG preconditioners in large-scale energy applications

Pasqua D'Ambra	CNR-Institute for Applied Computing (IAC-CNR)
Salvatore Filippone	Cranfield University, UK

Abstract: Large-scale scientific applications often require solution of linear systems with millions or even billions of unknowns. The method of choice to efficiently solve the above systems on modern high-performance computers are the Krylov methods, whose convergence and scalability properties are related to the choice of suitable preconditioning techniques. We will present some activities aimed at the design, the implementation and the analysis of scalable algebraic multigrid preconditioners for energy applications arising in the EoCoE project.

15:30-16:00

Toward a black-box Algebraic Multigrid solver for structural problems

Carlo Janna	University of Padova
Andrea Franceschini	Stanford University
Victor Antonio Magri Paludetto	University of Padova
Gianluca Mazzucco	University of Padova
Giovanni Isotton	M3E S.r.l.
Nicolò Spiezia	M3E S.r.l.

Abstract: The numerical simulation of mechanical problems via FE requires the solution of large-size linear systems, which often represents the most time-consuming kernel. AMG preconditioners should exhibit linear complexity but their set-up requires experience and convergence may be slow in ill-conditioned problems. We present an effective AMG method tailored for structural problems, characterized by an approximate inverse smoother, a dynamic least-squares prolongation (DPLS) and a method for uncovering the matrix near-kernel.

16:00-16:30

Generalizing interpolation in parallel algebraic multigrid

Robert Falgout	Lawrence Livermore National Laboratory
Ruipeng Li	Lawrence Livermore National Laboratory

Abstract: Algebraic multigrid (AMG) methods are used in many application codes to solve large-scale linear systems because they have O(N) computational complexity (for a system of size N) and hence have excellent parallel weak scaling properties. A key ingredient of AMG is the interpolation operator. In this talk, we will discuss new theoretically-driven approaches for defining interpolation and present numerical results for difficult application problems such as elasticity and electromagnetics.

MS ME-1-6 3 **14:30-16:30**

Fractal applications in engineering: Theoretical aspects and Numerical approximations - Part 1

For Part 2 see: MS ME-1-6 4

Organizer: Maria Rosaria Lancia	Sapienza Università di Roma
Organizer: Anna Rozanova-Pierrat	CentraleSupélec

Abstract: Many natural and industrial processes lead to the formation of rough surfaces and interfaces. Computer simulations, analytical theories and experiments, led to significant advances , in modeling these phenomena across wild media. Fractals provide a good tool to describe such wild geometries, as well as in the case of those phenomena which take place in small volumes and large surfaces. We focus on the study of problems of mathematical physics in fractal domains both from a theoretical and a numerical point of view, having in mind further developments of fractal and prefractal geometries in industrial applications.

14:30-15:00

Laplace transport towards fractals or Dirichlet-to-Neuman operator on d-sets

Anna Rozanova Pierrat	CentraleSupélec
Kevin Arfi	CentraleSupélec

Abstract: In the framework of the Laplacian transport, described by a Robin boundary value problem in an exterior domain in ^{n}, we generalize the definition of the Poincaré-Steklov operator to d-set boundaries, $n-2<d<n$, and give its spectral properties to compare to the spectra of the interior domain and also of a truncated domain, considered as an approximation of the exterior case. The well-posedness of the Robin boundary value problems for the truncated and exterior domains is given in the general framework of n-sets. The results are obtained thanks to a generalization of the continuity and compactness properties of the trace and extension operators in Sobolev, Lebesgue and Besov spaces, in particular, by a generalization of the classical Rellich-Kondrachov Theorem of compact embeddings for n and d-sets.

15:00-15:30

A fully discrete sand pile model on synchronized infinite grids

Umberto Mosco	WPI - Worcester Polytechnic Institute

Abstract: We introduce a new discrete model for the self-organized-criticality behavior. The process is set as an impulsive anomalous diffusion on a countable spacial- temporal grid. The equations capture short-range interactions at high time-frequences. The system reaches the its critical state in a finite time. A priori estimate of this time are given. The model is of a kind between the finite cellular automaton models of physics and the mathematical models based on partial differential equations.

15:30-16:00

Non-linear diffusion equations and collapsing sandpiles.

Maria Agostina Vivaldi	Sapienza Università di Roma

Abstract: In this talk we deal with theoretical and numerical aspects of the evolution and time behavior of solutions to nonlinear diffusion equation involving the Heaviside function. According to the approach of V. Barbu (2013) and U. Mosco (2018) this equation describes the dynamics of self-organizing sandpile process with critical state.

16:00-16:30

Acoustic scattering by fractal screens I: functional analysis

David Hewett	University College London

Abstract: In this pair of talks we study acoustic scattering by a planar screen/crack with fractal boundary (e.g. a Koch snowflake or a Sierpinski triangle). In part I, we describe well-posed boundary value problem and boundary integral equation formulations for the scattering problems, and highlight some recent results concerning fractional Sobolev spaces on rough sets (density, duality, interpolation) which underpin them.

IM FT-2-3 3 **14:30-16:30**

Modeling, Simulation and Optimization in Electrical Engineering - Part 2

For Part 1 see: IM FT-2-3 2

For Part 3 see: IM FT-2-3 4

Organizer: Kurz Stefan	Robert Bosch GmbH
Organizer: M. Pilar Salgado Rodríguez	Universidade de Santiago de Compostela
Organizer: Nella Rotundo	Weierstrass Institute for Applied Analysis

Abstract: Electrical engineering is an important technology for many recent societal and industrial developments. It includes the investigation and application of electricity, electronics, and electromagnetism. This mini symposium discusses mathematical challenges driven by industrial needs, which are related to classical and new emerging topics of applied mathematics and scientific computing. It is organized in the framework of ECMI's Special Interest Group on Modeling, Simulation and Optimization in Electrical Engineering. Its history goes back more than 20 years, where it was established as part of ECMI's endeavor to strengthen the ties between applied mathematics and the electrical industry.

14:30-15:00

Numerical methods for simulating thin film solar cells

Peter Monk	Delaware University

Abstract: We describe a rigorously justified software tool for optimizing the efficiency of thin film solar cells. To evaluate the efficiency involves: 1) Solving Maxwell's equations to find the generation rate of electrons and holes. We use the Rigorous Coupled Wave Analysis (RCWA) method. 2) Solving the drift-diffusion model to simulate electron and hole transport. We use a Hybridizable Discontinuous Galerkin (HDG) schemes to discretize this system.

15:00-15:30

Yield optimization of high-frequency electromagnetic devices

Fuhrlaender Mona	TU Darmstadt
Sebastian Schöps	TEMF, TU Darmstadt
Niklas Georg	IDS, TU Braunschweig

Abstract: Deviations in the manufacturing process of electronic components may lead to rejections due to malfunctioning. We use a combination of Monte Carlo and stochastic collocation to estimate the yield, which is the probability that a product fulfills its performance specifications. Then we maximize the yield using a Newton's type approach. This work is supported by the 'Excellence Initiative' of the German Federal and State Governments and the Graduate School of Computational Engineering at TU Darmstadt.

15:30-16:00

Solution Theory and A Posteriori Error Estimates for Maxwell Type Problems

Dirk Pauly	Universität Duisburg-Essen

Abstract: We prove a comprehensive solution theory using tools from functional analysis, show corresponding variational formulations, and present functional a posteriori error estimates for general linear first order systems. As a prototypical application we will discuss the system of electro-magneto statics with mixed tangential and normal boundary conditions. Second order systems will be considered as well.

MS FT-1-10 3 14:30-16:30

Numerical methods for interfacial dynamics - Part 3

For Part 1 see: MS FT-1-10 1
For Part 2 see: MS FT-1-10 2
For Part 4 see: MS FT-1-10 4

Organizer: Weiying Zheng	Chinese Academy of Sciences
Organizer: Zhilin Li	North Carolina State University
Organizer: Qinghai Zhang	Zhejiang University

Abstract: We propose a mini-symposium on interfacial problems and dynamics in ICIAM2019 that concerns different aspects of this important topic such as mathematical modeling, theoretical analysis, and numerical methods. An important goal of this workshop is to foster collaboration between mathematicians, computational scientists, and engineers. Numerical methods include but are not restricted to interface tracking methods, immersed boundary/interface methods, extended finite element methods, arbitrary Lagrange-Euler methods, and so on. The nature of this workshop will be mathematics centered with multi-disciplinary multi-physics applications, particularly for free-surface flows, fluid-structure interaction, and other related multiphase flows.

14:30-15:00

Splitting schemes for the stress formulation of fluid-structure interaction problems

Peter D. Minev	University of Alberta

Abstract: A class of splitting schemes for fluid-structure interaction problems in stress formulation is presented. The main advantage of the approach is that it is easier to impose the boundary condition at the interface. At first glance the resulting tensorial problem is more difficult, if combined with a proper splitting, it yields locally one-dimensional schemes with attractive properties, that are very competitive to the the most widely used schemes for the formulation in primitive variables.

15:00-15:30

Convergence of a cartesian method for elliptic problems with immersed interfaces

Lisl Weynans	Bordeaux University

Abstract: We prove the convergence of a Cartesian method for elliptic problems with immersed interfaces, in two cases: the original second-order method in one dimension, and a first-order version in two dimensions. This method is based on additional unknowns located on the interface, used to express the jump conditions across the interface. The proof takes advantage of a discrete maximum principle to obtain estimates on the coefficients of the inverse matrix.

15:30-16:00

High-order XFEM for solving interface problems: theory and implementations

Yuanming Xiao	Nanjing University
Jinchao Xu	Department of Mathematics, Pennsylvania State University
Fei Wang	School of Mathematics and Statistics, Xi'an Jiaotong University

Abstract: In this talk, we present arbitrary order extended finite element (XFE) methods based DG schemes in order to solve elliptic interface problems in 2-d and 3-d. Optimal error estimates in H^1-norm and L^2-norm are proved. We also propose an optimal multigrid solver for the generated linear system, which converges uniformly with respect to the mesh size, and is independent of the location of the interface relative to the meshes. Numerical examples support theoretical results.

16:00-16:30

A conservative moment-of-fluid algorithm for simulating boiling in general geometries with special filament aware diffusion solver

Yang Liu	Florida State University
Mark Sussman	Florida State university
Yongsheng Lian	University of Louisville
M. Yousuff Hussaini	Florida State university

Abstract: Based on our conservative moment-of-fluid algorithm for simulating nucleate boiling, we apply our simple, robust, first-order accurate diffusion solver which can handle the diffusion problems in a multiple materials system with materials occupying highly complex geometry without the need of AMR into it. Stefan problem and nucleate boiling benchmark test results will be shown along with discussion of related problems such as the wetting properties and geometry of the substrate, contact line dynamic.

MS A6-5-3 3 14:30-16:30

Mathematics and Computation for Clinical Problems - Part 3

For Part 1 see: MS A6-5-3 1
For Part 2 see: MS A6-5-3 2

Organizer: Hiroshi Suito	Tohoku University, Japan
Organizer: Norikazu Saito	The University of Tokyo
Organizer: Takuya Ueda	Tohoku University

Abstract: We shall present several topics that have arisen through collaboration between mathematical science and clinical medicine. Our targets include leading-edge technologies in clinical applications from 4D-flow MRI to machine learning applications. Together with these studies, strong mathematical foundations are indispensable for reliable and efficient implementations. Through close collaboration with physicians, those analyses can yield greater understanding leading to better risk assessments. Throughout this mini-symposium, we seek discussion of how mathematical science might contribute to the clinical medicine of our present and future society. This mini-symposium comprises three parts: I. Clinical applications; II. Computational modeling; and III. Mathematical tools and foundations.

14:30-15:00

Outlet boundary conditions for the Navier--Stokes equations

Norikazu Saito	The University of Tokyo
Takahito Kashiwabara	University of Tokyo
Guanyu Zhou	Tokyo University of Science
Yoshiki Sugitani	Tohoku University

Abstract: One of the important issues of blood flow simulations is to set boundary conditions on the outlet boundary. We propose an energy-stable outlet boundary condition for the incompressible Navier--Stokes equations. The condition is a generalization of the standard free-traction condition. We also consider a penalty approximation, a kind of the nonlinear Robin condition, to deduce a suitable formulation for numerical computations. We examine their effectiveness using some numerical examples.

15:00-15:30

Finite element analysis for a generalized Robin boundary value problem in a smooth domain

Takahito Kashiwabara	The University of Tokyo

Abstract: We present finite element analysis to a generalized Robin boundary value problem in a smooth domain . It consists in solving an elliptic equation in , which is coupled with another elliptic equation given on the boundary , through the normal directional derivative. Taking into account the discrepancy of the original domain and its polygonal approximation , we derive an optimal error estimate for the case of linear finite element approximation.

15:30-16:00

Analysis on the fictitious domain method with penalty for the various types of PDEs

Guanyu Zhou	Tokyo University of Science

Abstract: The fictitious domain method with H^1 and L^2 penalty approaches are considered for the Poisson, heat and Stokes equations respectively, which is an efficient numerical method to solving the PDEs with moving boundary. For the continuous problems, we investigate the regularity depending on the fictitious domain and penalty parameter and prove the optimal error estimates. Moreover, the finite element/volume discretization is applied to the penalty approaches and convergence analysis is carried out.

16:00-16:30

Numerical methods for a mathematical model of arteriosclerosis

Feifei Jing	Northwest University of Technology
Zhanxin Chen	University of Calgary
Weimin Han	The University of Iowa
Jian Li	Shaanxi University of Science and Technology
Wenjing Yan	Xi'an Jiaotong University
Fei Wang	Xi'an Jiaotong University

Abstract: In this talk, a class of mathematical models with a nonlinear slip boundary condition of friction type is studied, which is used to describe the flow in the blood vessel of arteriosclerosis, as well as the possible slip phenomena. Due to the subdifferentiability of such boundary condition, these models can be characterized by variational or hemivariational inequalities. We will design stable and efficient numerical schemes, and establish priori error analyses for these variational inequalities.

MS GH-1-G 3 14:30-16:30

Advanced numerical methods for evolving manifolds - Part 3

For Part 1 see: MS GH-1-G 1
For Part 2 see: MS GH-1-G 2
For Part 4 see: MS GH-1-G 4

Organizer: Jooyoung Hahn	AVL List GmbH
Organizer: Peter Frolkovič	Slovak University of Technology
Organizer: Karol Mikula	Slovak University of Technology

Abstract: Advanced numerical methods for solving problems related to evolving curves and surfaces in 2D/3D are presented. We cover contemporary algorithms based on Lagrangian and Eulerian methods (level set or VOF approach) for manifolds approximated by discrete curves and surfaces, which are actively used not only in a research but also in an industrial area in computer-aided engineering. The presented algorithms are meant to be applied in state-of-the-art computations including complex computational domains (e.g. 3D polyhedron meshes), complicated physics (e.g. multiphase flows), nontrivial surface reconstructions, volume and surface reconstruction, and similar.

14:30-15:00

Industrial mathematics for G-equation combustion model

Jooyoung HAHN	AVL List GmbH

Abstract: A cell-centered finite volume method is proposed for advective, normal, and mean curvature flows on polyhedron meshes, which is a standard form of G-equation combustion model. An implicit time discretization of inflow fluxes and an explicit time discretization of outflow fluxes are used in an iterative procedure. An 1-ring face neighborhood structure and parallel computations can be easily applied for fast and efficient computations. Several numerical examples illustrate some advantages of the proposed methods.

15:00-15:30

Flame/smoldering front tracking to evolution equations for combustion of a paper sheet

Shigetoshi Yazaki	Meiji University
Kazunori Kuwana	Yamagata University
Yasuhide Uegata	Meiji University
Shunsuke Kobayashi	Meiji University
Maika Goto	Yamagata University

Abstract: We propose a simple and fast numerical method for solving an evolution equation for closed flame/smoldering fronts, equivalent to the Kuramoto-Sivashinsky equation in a scale. Comparison of numerical results and an experiment suggests that our model equation is valid for expanding smoldering fronts over paper sheets near-floor. We also study how to determine parameters arising in our equation by a technique of image segmentation for images taken from an experimental movie.

15:30-16:00

Lagrangian curve evolution with topological changes in forest fire propagation

Martin Ambroz	Slovak University of Technology
Karol Mikula	Slovak University of Technology
Martin Balažovjech	Slovak University of Technology
Matej Medľa	Slovak University of Technology

Abstract: In this talk, the forest fire propagation model based on the Lagrangian approach for curves evolving on the topography surface will be presented. The presented approach is fast compared to models based on the Eulerian approach, however, efficient treatment of topological changes, merging and splitting of fire perimeters, is necessary. We will present the mathematical model, its numerical discretization, efficient detection of the topological changes and model application on testing and real examples.

16:00-16:30

Direct discretization method for the phase field modeling on surfaces

Yibao Li	Xi'an Jiaotong University
Binhu Xia	Xi'an Jiaotong University
Junseok Kim	Korea University

Abstract: In this talk, we will describe several efficient direct discretization schemes for solving the phase field model including Cahn–Hilliard equation,phase field crystal equation on the surfaces. By using a conservation law and transport formulae, we derive the governing equation on evolving surfaces.The discrete governing equation is defined on the surface mesh and its dual surface polygonal tessellation. Several numerical experiments are presented to demonstrate the effectiveness of the proposed method.

IM FT-4-1 3 14:30-16:30

EU-MATHS-IN: Success Stories of Mathematics in Societal Challenges and Industry - Part 3

For Part 1 see: IM FT-4-1 1
For Part 2 see: IM FT-4-1 2
For Part 4 see: IM FT-4-1 4

Organizer: Carlos Parés Madroñal	Universidad de Málaga
Organizer: Manuel Cruz	PT-MATHS-IN | LEMA-ISEP/IPP

Abstract: The European Service Network of Mathematics for Industry and Innovation (EU-MATHS-IN) is an organization promoted by several European research networks following the recommendations of the European Science Foundation. Its main purpose is to increase the impact of mathematics on innovations in key technologies and to foster the development of new modeling, simulation and optimization tools. The goal of this mini-symposium is to present to the attendees some success stories of application of mathematical technologies in industry developed by researchers belonging to the national networks that are members of EU-MATHS-IN. The sessions are organized according to the addressed societal challenges.

14:30-15:00

Efficient and modular tools for acoustic imaging

Christophe Picard	Grenoble Institute of Technology

Abstract: Experimental localisation techniques for acoustic sources currently used in industries with limited capabilities in term of precision of measurement and quantification of fine details. There are only considered as complementary tools with no guarantee in term of reliability. Most of the methods used simplified hypothesis concerning the model and the nature of the source or the model of acoustic propagation. The goal is to build an efficient method for source identification and localozation.

15:00-15:30

Heavy-tailed-based approach in application to local damage detection in mining machines

Agnieszka Wylomanska	Wrocaw Univiersity of Science and Technology

Abstract: Problem of the local damage detection is a crucial task in modern condition monitoring. Till now, the most popular statistic used in this context was kurtosis for time-frequency representation of the signal. However, for many real signals the spectral kurtosis does not give expected results. In our study we propose to extend this approach. This talk is a synthesis of few years research activity related to development of new mathematical methods for local damage detection.

15:30-16:00

Cost modelling for aftermarket assistance contract in automotive industry

Sandra Faria Ramos LEMA - ISEP, CEAUL
Manuel Cruz LEMA - ISEP
Margarida Pina NORS

Abstract: NORS, a Portuguese group within the transport sector, has recently created an Applied Mathematics Laboratory (LabMI) in order to solve some of their challenges using Industrial Mathematics. This work presents mathematical modelling solutions built to solve industrial problems presented at LabMI. These impacted several areas of the business as Customers Satisfaction Analysis, Optimization of Service and Maintenance Contracts or Stockpile Management, among others. The results proved a good adherence of the mathematical modelling to reality.

16:00-16:30

Thermo-electromagnetic-mechanical simulation of an electric upsetting process

Pilar Salgado University of Santiago de Compostela
Alfredo Bermúdez Universidade de Santiago de Compostela
Branca García Technological Institute for Industrial Mathematics (ITMATI)
Salvador Pérez CIE Galfor S.A
Pedro Rodríguez Technological Institute for Industrial Mathematics (ITMATI)
Manuel Román CIE Galfor S.A

Abstract: The objective of this work is to describe the mathematical models developed to simulate the electric upsetting process used by a spanish company in the manufacturing of automotive pieces. Electric upsetting is a multiphysics process which involves large deformations and a strong and fast change in the temperature due to the electric heat generated in the workpiece. We will describe a thermo-electromagnetic-mechanic model to compute the temperature, the power and the deformation in axisymmetric pieces.

MS ME-1-3 3 14:30-16:30

Computational approaches for multiscale, possibly random problems - Part 1

For Part 2 see: MS ME-1-3 4
For Part 3 see: MS ME-1-3 5
For Part 4 see: MS ME-1-3 6
Organizer: Legoll Frederic Ecole des Ponts and Inria
Organizer: Claude Le Bris Ecole des Ponts & Inria
Organizer: Hoa Nguyen Trinity University

Abstract: This mini-symposium is motivated by the following observations. First, computational approaches dedicated to multiscale problems have recently witnessed very significant developments. Second, an increasing amount of probabilistic features is currently introduced in PDEs for the modelization of complex phenomena. The purpose of this mini-symposium is to review the recent advances in these two directions, and at the intersection of those.

14:30-15:00

Numerical homogenization of multiscale fault networks

Ralf Kornhuber FU Berlin
Heida Martin
Podlesny Joscha
Yserentant Harry

Abstract: We consider a scalar elliptic model problem with jump conditions on a multiscale network of interfaces and derive an associated asymptotic limit problem. The resulting “fractal” solution space is characterized in terms of generalized jumps and gradients, and we prove continuous embeddings into L^2 and H^2 , $s < 1/2$. We also present and analyze a numerical homogenization strategy in terms of subspace correction. Our theoretical findings are illustrated by numerical computations.

15:00-15:30

Using time averaged waves in multiscale computations

Olof Runborg KTH

Abstract: We consider the mapping from initial data of a wave-equation to the local time-average of the solution around the initial point. This mapping is easy to evaluate numerically by standard wavesolvers and it has some interesting properties for multiscale computations. It is local and approximates a projection operator on the lowest eigenmodes of the elliptic operator in the wave equation. We discuss how one can use this mapping in the numerical solution of multiscale PDEs.

15:30-16:00

Multiscale finite element method for heterogeneous plates

Adrien Lesage ENPC and Inria

Abstract: Composite plates are modelled by elliptic partial differential equations with highly oscillatory coefficients on a domain which has a dimension much smaller than the others. Numerical difficulties arise because of the different lengthscales involved, which can lead to prohibitive computational costs. We show here how to adapt the Multiscale Finite Element Method to this case of plates. Our approach allows to compute an accurate approximation of the 3D oscillatory solution using a 2D coarse mesh.

16:00-16:30

Computation of localized Schrödinger eigenstates under random potentials

Robert Altmann Augsburg University
Daniel Peterseim Augsburg University

Abstract: We consider the linear Schrödinger operator with oscillatory high-amplitude random potentials on bounded domains. In this case, the lowermost eigenstates localize in the sense that these eigenstates decay exponentially. This can be proven using iterative solvers in combination with an optimal local preconditioning. In this talk we apply these techniques also numerically in order to actually compute the first eigenstates of the random Schrödinger operator.

MS A3-3-1 3 14:30-16:30

Theory and Practice of meshless Fluid-Simulations - Part 1

For Part 2 see: MS A3-3-1 4
For Part 3 see: MS A3-3-1 5
Organizer: Christian Rieger RWTH Aachen
Organizer: Matthias Kirchhart MathCCES, RWTH Aachen University

Abstract: The aim of this minisyposium is to bring together researchers in both theoretical and applied aspects of meshless methods. We would especially like to focus on meshless simulations in fluid dynamical applications. This topic includes vortex methods, divergence free radial basis functions and SPH. From a theoretical perspective we would like to focus on the error analysis of such methods and on the analysis of new efficient methods. This includes localizing Lagrange functions, multilevel techniques, PUM and reduced basis methods. A common focus is on boundary effects of meshless methods which is a current challenge in many modern meshless methods.

14:30-15:00

Kernel methods for uncertain fluid dynamics

Christian Rieger RWTH Aachen

Abstract: In this talk, I will discuss recent progress in kernel based methods for uncertainty quantification. This includes the choice of problem adapted kernels as well as the identification of good collocation nodes. To this end, some connections to greedy methods will also be discussed. Moreover, we give some results for the error analysis. Applications include differential equations governing fluid flow problems.

15:00-15:30

Particles and Splines in Bounded Domains

Matthias Kirchhart MathCCES, RWTH Aachen University

Abstract: We propose numerical schemes that enable the application of particle methods for advection problems in general bounded domains. These schemes combine particle fields with Cartesian tensor product splines and a fictitious domain approach. Their implementation only requires a fitted mesh of the domain’s boundary, and not the domain itself, where an unfitted Cartesian grid is used. We establish the stability and consistency of these schemes in -norms, , .

15:30-16:00

Kernel-based stochastic collocation for Navier-Stokes

Peter Zaspel University of Basel
Christian Rieger University of Bonn, Germany
Michael Griebel University of Bonn, Germany

Abstract: We apply stochastic collocation methods with radial kernel basis functions for an uncertainty quantification of the random incompressible two-phase Navier–Stokes equations. Our approach is non-intrusive and we use the existing fluid dynamics solver NaSt3DGPF to solve the incompressible two-phase Navier–Stokes equation for each given realization. We are able to empirically show that the resulting kernel-based stochastic collocation is highly competitive in this setting and even outperforms some other standard methods.

MS A6-2-2 3 14:30-16:30

Generalized Inverses and its Applications - Part 1

For Part 2 see: MS A6-2-2 4

Organizer: Dragana Cvetkovic Ilic	University of Nis
Organizer: Yimin Wei	Fudan University
Organizer: Néstor Thome	Universitat Politècnica de València

Abstract: Generalized inverses was firsrt introduced on operators (Fredholm 1903, Hilbert 1904) and later on matrices (Moore 1920, Penrose 1955). The most important fact was its conection with least-squares method. Theory, applications, and computational methods have been lastly developed in important monographs by Rao-Mitra, Ben-Israel and Greville, Campbell-Meyer, Wang, Wei and Qiao. Generalized inverses cover a wide range of mathematical areas: matrix theory, operator theory, or rings. Recent studies focus on: numerical computation, reverse order law, perturbation theory, partial orders, etc. Numerous applications include areas such as: differential equations, Markov chains, cryptography, control and coding theories, incomplete data recovery and robotics.

14:30-15:00

Recent results on some completion problems on operator matrices and its applications

Dragana Cvetkovik Ilic — University of Nis

Abstract: We will discuss certain results addressing some completion problems on operator matrices as well as their application to the questions such as that of existence of a linear bounded operator X for which A+CX is of a certain type, when A and C are given bounded linear operators, properties of the sum of operators and reverse order laws for the operators.

15:00-15:30

About properties and representations on BT generalized inverses

Valentina Orquera	Universidad Nacional de Río Cuarto
David Eduardo Ferreyra	Universidad Nacional de Río Cuarto, FCEFQyN
Néstor Thome	Instituto Universitario de Matemática Multidisciplinar, Universitat Politècnica de València

Abstract: The BT inverse (initially called generalized core inverse) was introduced by Baksalary and Trenkler in [On a generalized core inverse, Applied Mathematics and Computation, 236 (2014) 450-457] for square matrices of an arbitrary index by extending the concept of core inverse for index 1 matrices. The main aim of this talk is to investigate some new propesties of the BT inverse by including representations by means of maximal classes for which its representation remains valid.

15:30-16:00

The group inverse matrix of a symmetric M-matrix through the inversion of a sub-matrix

Enric Monsó	Universitat Politècnica de Catalunya
Ángeles Carmona	UPC
Andrés M. Encinas	UPC
Margarida Mitjana	

Abstract: Given a positive semi-definite M-matrix, our result provides an element-wise closed-form calculation of its group-inverse matrix, in terms of the inverse matrix of an arbitrary smaller sub-matrix. By solving boundary value problems for Schrödinger's operators on the whole doubly weighted network and just on an arbitrary part of it, we find the relation between the group inverse of the M-matrix and the inverse of the submatrix (whose dimension is arbitrary reduced).

16:00-16:30

Reverse order laws for {1, 3}-generalized inverses

Jovana Milošević	Univeristy of Niš
Dragana Cvetković-Ilić	University of Nis

Abstract: In this talk I will present the paper in witch we solved an open problem related to the reverse order laws for {1, 3} and {1, 4}-generalized inverses in C*-algebras. It is interesting to note that before this paper this problem has only been solved for matrices while it still remained open for bounded linear operators. In this paper, we gave corresponding results for the case of linear-bounded operators on separable Hilbert spaces.

MS GH-1-3 3 14:30-16:30

Current Developments in Wavelett- Fractal Methods with Applications - Part 3

For Part 1 see: MS GH-1-3 1
For Part 2 see: MS GH-1-3 2
For Part 4 see: MS GH-1-3 4

Organizer: Abul Hasan Siddiqi Siddiqi	Sharda University
Organizer: Akhtar A. Khan	Rochester Institute of Technology Rochester, New York
Organizer: Nekka Fahima	Université de Montréal
Organizer: Pammy Manchanda	Guru Nanak Dev University

Abstract: Wavelet and Fractal Methods were invented in early eighties. The basic work of the initial stages are very well documented in the book of Daubechies 1992 and Y. Meyer 1993, SIAM. An updated historical development has been presented in chapter 12 of a recent book by the organizer of the symposium published by Springer in 2018. This symposium in three parts is devoted to certain topics dicussed in three monographs by Springer in recent past namely multivariate wavelet frames, 2016, industrial mathematics and complex systems, 2017 & wavelets constructed by walsh functions, 2018.

14:30-15:00

Parameter Identification Variational and Quasi Variational Inequalities

Akhtar A. Khan — Rochester Institute of Technology Rochester, New York

Abstract: This talk will discuss the inverse problem of identifying variable parameters in certain variational and quasi-variational inequalities. Optimization based strategies will be used. Applications and numerical results will be presented.

15:00-15:30

A Hybridized Discontinuous Galerkin Method for The Coupled Stokes-Darcy System

Aycil Cesmelioglu	Oakland University, Rochester, MI, USA
Sander Rhebergen	University of Waterloo
Garth N. Wells	University of Cambridge

Abstract: We propose a hybridized discontinuous Galerkin (HDG) method to solve the Stokes-Darcy problem monolithically. We approximate the fluid velocity and pressure in the entire domain, the velocity trace in the Stokes region only and Stokes and Darcy pressure traces in their respective domains. We prove that the method satisfies pointwise mass conservation, pressure-robustness and divergence-conformity properties while having a high order accuracy. We present numerical examples to demonstrate the theoretical results.

15:30-16:00

Role of Sparsity and Wavelets In Diffuse Optical Tomography Inverse Problem

Taufiquar R. Khan — Clemson University

Abstract: In this talk, we will discuss the role of sparsity in Diffuse Optical Tomography (DOT) as well as the importance of wavelets. We will provide overview of the inverse problem in DOT and discuss the application and instability of the inversion in DOT. We will present the sparsity approach to solve the invese problem in DOT and compare to other approaches such as Gauss Newton method, statistical inversion.

16:00-16:30

Conformable Fractional Derivative with Application

Masood Alam — Sultan Qaboos University

Abstract: Direct Problem of Projectile motion involving conformable derivative has been studied in a recent paper by Contreras et al [Analysis of Projectile Motion in view of conformable derivative, Open Phy., 2018 16:581-587]. Groetsch [Inverse Problems Activities for Undergraduate, Mathematical Association of America, 1999] has proposed and studied several inverse problems of classical derivative. In this talk we examine certaininverse problems involving conformable fractional derivative.

MS GH-0-2 3 14:30-16:30

Mathematical Advances in Batteries - Part 3

For Part 1 see: MS GH-0-2 1
For Part 2 see: MS GH-0-2 2
For Part 4 see: MS GH-0-2 4

Organizer: Iain Moyles	York University
Organizer: Matthew Hennessy	Mathematical Institute, University of Oxford

Abstract: Batteries are ubiquitous in society with applications in portable electronics, transportation vehicles, and medical devices. An increasing demand for cheaper, longer-lasting, and safer batteries has driven research into understanding the fundamentals of their operation. Using techniques of mathematical modelling, analysis, and simulation, speakers in this session will address research questions of modern significance such as the effect of materials in electrode design, temperature distribution in an operating battery, and battery kinetics in a charge-discharge cycle. Advantages and limitations from geometrical assumptions and parameter scaling will be discussed as will extensions to general electrochemical systems.

14:30-15:00

Silicon Anodes in Lithium-Ion Batteries

Ian Roper	University of Oxford
Jon Chapman	University of Oxford
Colin Please	University of Oxford
Bill Macklin	Nexeon Ltd

Abstract: Silicon has an extremely large capacity for lithium but expands up to four times its original size when charged, causing large stresses and cracking. We propose a simple chemomechanical model including the two-way coupling through lithiation-induced expansion and stress-assisted diffusion to find a multimaterial nano-particle design which utilises the high capacity of silicon while mitigating the large expansion. Finally, we upscale the particle model to find the macroscale effects on changes to the microscale structure.

15:00-15:30

Modelling and analysis of binder migration during drying of Li-Ion battery electrodes

Francesc Font	Centre de Recerca Matematica
Bartosz Protas	McMaster University
Giles Richardson	University of Southampton
Jamie M. Foster	University of Portsmouth

Abstract: Battery electrodes are manufactured by coating a current collector with a slurry mixture, comprised of active material particles, carbon nanoparticles, polymer binder and solvent. This mixture is then dried by exposure to heat, and sometimes reduced pressure conditions. The drying step is crucial as it can significantly affect the component distribution within the electrode. In this talk we present a model describing the drying process of the mixture and discuss solutions in several limiting situations.

15:30-16:00

Asymptotic Reduction of Lithium-ion Battery Models

Scott Marquis	University of Oxford
Jon Chapman	University of Oxford
Colin Please	University of Oxford

Abstract: Full order continuum models are too complex to employ on the limited data available in real world applications of lithium-ion batteries such as electric buses, ferries, and planes. By using asymptotic methods, we systematically derive simplified models which are faster and easier to parameterise than the full continuum models but are still fundamentally based upon the underlying physics.

MS FT-S-8 3 14:30-16:30

Advances in spectral methods for fluid dynamics problems

Organizer: Henar Herrero	Universidad de Castilla-La Mancha

Abstract: Fluid dynamics is present in a wide variety of technological applications, many of them related to water and air: aerodynamics, meteorology, oceanography, channeling or hydraulic power, and others related to important fluids such as fuels in thermal engines, lubricants or refrigerants. Their study requires the numerical resolution of systems of partial differential equations that model the physical phenomena. Spectral methods are common methods used to solve these problems. They are high order. The increasing size of the problems requieres strategies for meshing domains, model reduction, parallelization and advanced computing.

14:30-15:00

An alternating Schwarz method for a Rayleigh-Bénard problem

Francisco Pla Martos	University of Castilla-La Mancha
Henar Herrero	Universidad de Castilla-La Mancha
Miriam Ruiz-Ferrández	Universidad de Almería

Abstract: This work introduces a Schwarz domain decomposition numerical method (SDDM) for a stationary Rayleigh-Bénard convection problem defined in a two dimenensional rectangular domain. The nonlinearity of the problem is discretized by a Newton method and each step is solved using a SDDM such that appropriate interface conditions are considered. Their convergence properties are studied theoretically and the numerical resolution confirms the theoretical results. Computational advantages of SDDM is the parallelization and the high order.

15:00-15:30

Design of high order spectral/hp element methods for industrial flows

Spencer J Sherwin	Imperial College London

Abstract: A number of challenges exist in translating academic tools into engineering practice. These include meshing techniques for high order methods, the ability to simulate marginally resolved flows at high Reynolds numbers and finally maintaining computational efficiency is also clearly important. In this presentation we will discuss the numerical challenges which we have had to be overcome to make our academic open source tools more suitable for industry.

15:30-16:00

Null controllability for source Stokes problem with RBFs for Dirichlet and Navier-slip boundary

Pedro González Casanova	Universidad Nacional Autónoma de México
Louis Breton	UNAM, México
Cristhian Montoya	Universidad Técnica Federico Santa Maria, UTFSM, Chile.

Abstract: In this talk we introduce global and local divergency free radial basis function, RBFs, methods for the solution of both stationary and evolutionary control Stokes problems with few internal scalar controls. Both Dirichlet and Naviel-slip boundary conditions are considered. Using a Hermite anzatz, boundary operators are incorporated without needing of ghost nodes. Numerical test problems are used to prove the reliability of these RBFs techniques, which are compared with the equivalent results obtained by FEM.

16:00-16:30

Data-informed models via variational data assimilation and parametric model order reduction

Karen Veroy-Grepl	RWTH Aachen University
Sebastien Boyaval	RWTH Aachen University
Martin Grepl	École des ponts ParisTech
Mark Kärcher	NavVis GmbH

Abstract: We present an efficient method to use observational data to estimate unknown model inputs (here, the initial condition) as well as estimate the model error via (4D) variational data assimilation. The resulting optimization problem is solved efficiently through the reduced basis method for distributed optimal control problems. The method thus provides credible approximations to the state, adjoint, initial condition, and model error. We present an application of the method to a fluid flow example.

MS ME-0-5 3 14:30-16:30

Numerical approximation of stochastic problems - Part 1

For Part 2 see: MS ME-0-5 4

Organizer: Raffaele D'ambrosio	University of L'Aquila
Organizer: Hugo De La Cruz	Fundação Getúlio Vargas

Abstract: The Minisymposium, divided in two parts, is aimed to discuss recent advances in the efficient numerical approximation of various stochastic problems, including stochastic differential equations (SDEs), random differential equations (RDEs), stochastic Volterra integral equations (SVIEs) and stochastic fractional equations (SFDEs). We expect contributions with new developments in the area of stochastic numerics and potential applications to the development and analysis of reliable models in several fields of science, industry and engineering. Part 1 is devoted to the numerical integration of stochastic differential equations, with particular emphasis to stiff stochastic differential equations and related stability issues.

14:30-15:00

Explicit numerical methods for weak second order approximations to the solution of stiff Ito stochastic differential equations

Yoshio Komori Kyushu Institute of Technology

Abstract: We are concerned with explicit numerical methods which give weak second order approximations to the solution of stiff Ito stochastic differential equations (SDEs). Some classes of such methods have been recently proposed. They are a class of exponential stochastic Runge--Kutta methods, the class of SROCK methods proposed by Abdulle and his colleagues, and a class of modified SROCK methods. We will investigate these classes of the methods in a variety of numerical experiments.

15:00-15:30

MS-Stability of numerical methods for Stochastic Differential Equations

María Jesús Senosiain Aramendia Salamanca University
Ángel A. Tocino Salamanca University

Abstract: Using the criteria of MS-stability for two-dimensional stochastic differential systems given by the authors in a previous work, MS-stability of systems with non-normal drift coefficient is investigated. Explicit necessary and sufficient conditions in terms of the coefficients as well as geometrical representation of the stability regions are given. In particular, it is confirmed that systems with non-normal drift matrix can be destabilized with a small diffusion term when the perturbation acts orthogonally or laterally.

15:30-16:00

Numerical integrators for a class of multiplicative-noise Stochastic Differential Equations

Hugo De La Cruz Fundação Getúlio Vargas

Abstract: We consider an approach to construct explicit and easily implementable numerical integrators specially devised for Stochastic Differential Equations (SDEs) driven by linear multiplicative noise. The pathwise convergence -under non-standard assumptions on the coefficients of the SDE- is studied. Some questions related to the stability and the computational implementation of the proposed methods is also discussed.

MS FT-S-5 3 14:30-16:30

Recent advances in matrix equations with applications - Part 2

For Part 1 see: MS FT-S-5 2
For Part 3 see: MS FT-S-5 4
Organizer: Davide Palitta Max Planck Institute
Organizer: Patrick Kürschner KU Leuven

Abstract: Matrix equations like Lyapunov, Sylvester, and Riccati equations, are an important tool in systems and control theory as they are related to, e.g., stability analysis, controller design, and model order reduction (MOR). In particular, with the advent of MOR the demand for efficient algorithms for large-scale matrix equations increased tremendously over the last decades. The goal of this minisymposium is to present new developments w.r.t. theory and numerical methods for matrix equations, together with emerging applications where such equations play an important role like image reconstruction, signal processing, and discretization of certain PDEs.

14:30-15:00

The projected Newton-Kleinman method for the algebraic Riccati equation

Davide Palitta Max Planck Institute of Dynamics
of Complex Technical Systems

Abstract: The numerical solution of the algebraic Riccati equation AX+XAT-XBBTX+CTC=0 where A∈Rnxn, B∈Rnxm, C∈Rpxn, p+m<<n, is a challenging task especially when the problem dimension is very large, say n>104, as the dense solution X∈Rnxn cannot be stored and a memory-saving approximation has to be sought. In this talk we present a novel approach that combines the well-established convergence properties of the inexact Newton-Kleinman scheme with the appealing computational features of projection methods for matrix equations.

15:00-15:30

Low-rank methods for space-time differential Riccati equations

Martin Stoll TU Chemnitz
Breiten Tobias University of Graz

Abstract: Differential algebraic Riccati equations are time-depent, matrix-valued, and in particular nonlinear equations that require special methods for their solution. We propose the use of an all-at-once space-time solution leading to a large nonlinear space-time problem for which we propose the use of a Newton--Kleinman iteration. Approximating the space-time problem in low-rank tensor form requires fewer applicatons of the discretized differential operator and gives a low-rank approximation to the overall solution.

15:30-16:00

Quadratic matrix equations with infinite quasi-Toeplitz coefficients

Beatrice Meini University of Pisa
Dario A. Bini University of Pisa
Stefano Massei EPFL Lausanne
Jie Meng Pusan National University
Leonardo Robol University of Pisa

Abstract: We consider quadratic equations where the coefficients are semi-infinite matrices, which are Toeplitz except for a correction in a leading principal submatrix of small size. Such equations arise in the study of bidimentional random walks, where the coefficients have nonnegative entries and sum to a stochastic matrix, and the interest is in the minimal nonnegative solution. We present properties of such solution and propose numerical methods for its computation. A perturbation analysis is also presented.

16:00-16:30

Singular value decay of operator-valued differential Lyapunov and Riccati equations

Tony Stillfjord Max Planck Institute for Dynamics
of Complex Technical Systems
Magdeburg

Abstract: It is frequently observed in practice that the singular values of the solutions to differential Lyapunov and Riccati equations decay very quickly. This is the basis for the low-rank approach, which is often used in numerical methods for such equations. Theoretical justification, however, has so far been lacking. In this talk, I will discuss recent results that prove that a particular decay (exponential in the square-root) does occur in the infinite-dimensional case under common assumptions.

MS FE-1-1 3 14:30-16:30

Finite element exterior calculus and applications - Part 3

For Part 1 see: MS FE-1-1 1
For Part 2 see: MS FE-1-1 2
For Part 4 see: MS FE-1-1 4
Organizer: Snorre H. Christiansen University of Oslo
Organizer: Shuo Zhang Institute of Computational
Mathematics, CAS
Organizer: Kaibo Hu University of Minnesota

Abstract: Finite element exterior calculus (FEEC) and other compatible or structure-preserving discretization techniques have been drawing increased attention in both theoretical studies and applications. This minisymposium aims at a communication of recent developments for such nu- merical methods for electromagnetism, fluid and solid mechanics. In particular, sophisticated discretization techniques and solvers are required to meet the challenges raised in these areas, including conservative discretizations for fluid dynamics, inclusion of geometric structures in linear and nonlinear solid mechanics and modeling and simulation of defects.

14:30-15:00

Poincaré path integrals for elasticity

Kaibo Hu University of Minnesota
Snorre H. Christiansen University of Oslo
Espen Sande University of Oslo

Abstract: We derive null-homotopy operators for differential complexes based on the Bernstein-Gelfand-Gelfand (BGG) construction and properties of the de Rham complex. Focusing on the elasticity complex, we derive path integral operators P satisfying $DP + PD = id$ and $P^2 = 0$, where the differential operators D correspond to the linearized strain, the linearized curvature and the divergence, respectively. In general we derive path integral formulas in the presence of defects. As a special case, this gives the classical Cesxro-Volterra path integral.

15:00-15:30

The Hellan-Herrmann-Johnson Method for Nonlinear Shells

Michael Neunteufel TU Vienna
Joachim Schöberl TU Vienna

Abstract: For solving Kirchhoff plates the Hellan-Herrmann-Johnson method introduces a moment tensor for computing the fourth order equation as a mixed method. We present a generalization of these method to nonlinear shells, where we allow large strains and rotations. Focusing on the bending energy, we will use the finite element space H(divdiv) for the moments. Non-smooth surfaces and branching shells with kinks can be handled without rewriting terms. Numerical examples are presented using Netgen/NGSolve.

15:30-16:00

Exact smooth piecewise polynomial sequences on Alfeld splits

Michael Neilan	University of Pittsburgh

Abstract: We develop exact polynomial sequences on Alfeld splits in any spatial dimension and any polynomial degree. An Alfeld split of a simplex is obtained by connecting the vertices of an n-simplex with its barycenter. We show that, on these triangulations, the kernel of the exterior derivative has enhanced smoothness. Byproducts of this theory include characterizations of discrete divergence-free subspaces for the Stokes problem, commutative projections, and simple formulas for the dimensions of smooth polynomial spaces.

CP A1-3-5 3 14:30-16:30

Biology and Chemistry I

Chair Person: Fatma Zohra Nouri Badji Mokhtar Unversity

CP A1-3-5 3 1 **14:30-14:50**

Partial Differential Equations Models in Medecine

Fatma Zohra Nouri	Badji Mokhtar Unversity
Aymen Hadji	Mostef Ben Boulaid

Abstract: Mathematical models have started to attract more attention from the medical image analysis community.These models could help better understanding of the mechanical influence and the diffusion process of gliomas. For the clinical applications, they would provide tools to identify the invaded areas that are not visible in the MR images in order to better understand the process, perhaps predict its future evolution and find a solution. Here we present some models for different tumors.

CP A1-3-5 3 2 **14:50-15:10**

Bifurcation Analysis for Breast Cancer Model with Incremental Cost-effectiveness Ratio Strategies

Segun Oke	University of Zululand
Maba Matadi	University of Zululand
Sibusiso Xulu	University of Zululand

Abstract: We propose and analyse breast cancer model with combined anticancer drugs and ketogenic diet. Lyapunov function was constructed to prove that TFE is globally asymptotically stable. Pontryagin's Maximum Principle was applied to investigate the combination of anticancer drugs and ketogenic-diet for the optimal levels of the two different therapies. However, incremental cost-effectiveness ratio (ICER) were calculated to investigate the cost-effectiveness of all possible combinations of the control strategies and the most cost-effective combination.

CP A1-3-5 3 3 **15:10-15:30**

Stability deterioration of optical tomography in the optically thick regime

Kit Newton	University of Wisconsin-Madison
Qin Li	University of Wisconsin-Madison

Abstract: Optical tomography amounts to reconstructing tissue properties using light intensity measurements. The radiative transfer equation (RTE) models light propagation, and we reconstruct its scattering coefficient using boundary measurements. For strong scattering, the RTE is equivalent to the diffusion equation (DE). In the Bayesian framework, we examine the scattering coefficient's posterior distribution after measurement. Sampling from this distribution is expensive, so we employ two-level MCMC, using the DE distribution to feasibly sample from the RTE distribution.

CP A1-3-5 3 4 **15:30-15:50**

Investigation of neutrophil migration in a dual gradient diffusion model in a COPD environment

Pouye Sedighian	Claremont Graduate University
Daniel J. Bursch	California State University Long Beach
Tahani Al Bulushi	California State University Long Beach
Nikki N. Nguyen	California State University Long Beach
Sang M. Ngo	California State University Long Beach
David A. Stout	California State University Long Beach
Perla Ayala	California State University Long Beach

Abstract: As the only top ten leading causes of death to increase over the past ten years, Chronic obstructive pulmonary disease (COPD) is still largely misunderstood. Recent research has shown impaired immune system via external environmental exposure may explain this phenomenon, but no techniques are able to investigate this. Therefore, we designed an in-vitro 3D system to study the force generation of motile cells in presence of chemoattractants which may lead to predicting COPD immune behavior.

CP A1-3-5 3 5 **15:50-16:10**

Dynamic Modes of Ignition Phenomena: Learning Chemistry from Data

Cory Brown	University of California Santa Barbara
Ryan Mohr	University of California Santa Barbara
Mohammad Alaghemandi	University of Massachusetts Boston
Jason Green	University of Massachusetts Boston
Igor Mezic	University of California Santa Barbara

Abstract: There are no model-independent methods for the identification of the causal chemical mechanisms hidden within the emergent dynamics of ignition phenomena. Here, we demonstrate a machine learning methodology for dynamical processes, based on Koopman mode analysis, to extract dynamic modes from extensive atomistic simulations of hydrogen oxidation. By defining persistent dynamic modes, we have developed an automated means to extract persistent local (in time) effective reactions along with a fuel-agnostic measure of ignition-delay time.

CP A1-3-5 3 6 **16:10-16:30**

An impulsive AIDS-cancer model considering chemotherapy and HIV treatment

Joseph Páez Chávez	Escuela Superior Politécnica del Litoral (ESPOL)
Burcu Gürbüz	Üsküdar University
Carla Pinto	Polytechnic of Porto

Abstract: Clinical studies have revealed that cancer diseases tend to be more aggressive in HIV-positive individuals. In this presentation, we propose an impulsive ODE describing the dynamics of cancer and AIDS infection, in the presence of chemotherapy and HIV treatment. For the analysis, we employ continuation methods for hybrid dynamical systems. Our study reveals that the HIV control is deeply influenced by the presence of a codimension-one bifurcation of limit cycles, corresponding to a branching point.

CP A1-3-4 3 14:30-16:30

Biology, Medicine and other natural sciences III

Chair Person: Paulo Fernando De Arruda Mancera UNESP

CP A1-3-4 3 1 **14:30-14:50**

Chronic Lymphocytic Leukemia: A Simple Mathematical Model for Chemoimmunotherapy

Paulo Fernando De Arruda Mancera	UNESP
Diego Samuel Rodrigues	UNIFAL
Tiago De Carvalho	USP
Luiz Fernando Gonçalves	UNESP

Abstract: Immunotherapy is considered a promising treatment to cancer. This is true in the treatment of chronic lymphocytic leukemia (CLL), an indolent neoplastic disease of B-lymphocytes which eventually causes the immune system's failure. The action of the immune system and the chemoimmunotherapeutic role in promoting cancer cure are investigated via numerical simulations and stability analysis. The chemoimmunotherapeutic protocols can be effective in treating CLL provided that chemotherapy is not a limiting factor to the immunotherapy efficacy.

CP A1-3-4 3 2 **14:50-15:10**

Optimal Control Problem of Various Influenza Models with Some Constraints

Hee-Dae Kwon	Inha University

Abstract: This study considers an optimal intervention strategy for influenza outbreaks. Variations in the SEIAR model are considered to include age structure and control strategies include vaccination, antiviral treatment, and social distancing such as school closures. We investigate an optimal control problem of a SIR reaction-diffusion system to derive an efficient vaccination strategy for influenza outbreaks. The control problem reflect realistic restrictions associated with limited total vaccination coverage and the maximum daily vaccine administration.

CP A1-3-4 3 3 **15:10-15:30**

Inferring the Time Since Exposure to Influenza Infection via Transcriptomic Response of the Human Immune System

Manuchehr Aminian	Colorado State University
Kartikay Sharma	Colorado State University
Ariel Liu	Colorado State University
Shannon Stiverson	Colorado State University
Tomojit Ghosh	Colorado State University
Michael Kirby	Colorado State University

Abstract: We demonstrate the feasibility of inferring the time duration since inoculation to influenza and similar respiratory diseases. A collection of seven human challenge studies are used with sparse classification techniques to identify minimal, time-evolving transcriptomic signatures. We show that classification of prior- or post-2-days exposure can be done with a classification rate of 91%, while identification of detailed time of infection to the nearest eight-hour interval post-infection remains more challenging.

CP A1-3-4 3 4 **15:30-15:50**

Parameter fitting in mathematical models of biofilm resistance to antibiotics

Elena Cebrián	Universidad de Burgos
Ana Carpio	Universidad Complutense de Madrid

Abstract: Biofilms are bacterial aggregates. Bacteria are encased in a self-produced polymeric matrix which creates a favorable environment for their development and acts as a shield against external aggressions of disinfectants and antibiotics. We analyze antibiotic effects on some types of biofilms by means of an adapted Dynamic energy budget model. These models take into account the diversity of the mechanisms involved in biofilm resistance to antibiotics which should be controlled through parameter variations.

CP A1-3-4 3 5 **15:50-16:10**

Simulations of active surfaces for epithelial folds and cell adhesion

Diana Khoromskaia	The Francis Crick Institute
Guillaume Salbreux	The Francis Crick Institute

Abstract: The shapes of biological cells and tissues are largely driven by active force-generating processes. We use an active hydrodynamic theory to describe such processes on the strongly curved geometries found in biological settings and the mechanical response they induce. We study in simulations the consequences of differential active tension on dynamic deformations of single cells and cell doublets formed by adhesion, as well as on large-scale shape changes of monolayers of densely connected cells.

CP A1-3-4 3 6 **16:10-16:30**

Stage structured population persistence with fluctuating dispersal rates

Leah Shaw	William & Mary
Rachel Wilson	William & Mary
Junping Shi	William & Mary
Rom Lipcius	Virginia Institute of Marine Science

Abstract: Marine organisms such as oysters have a larval stage that is dispersed by water currents and a non-motile adult stage. We study a stage-structured differential equation model for population and extend to a metapopulation model in which populations are coupled by dispersal of larvae. Larval transport depends on rainfall, so we model stochastic fluctuations in connectivity due to fluctuating rainfall. Population persistence in the presence of fluctuating connectivity is explored.

CP A1-3-3 3 14:30-16:30

Numerical Analysis VII

Chair Person: Jeremy Schiff Bar-Ilan University

CP A1-3-3 3 1 **14:30-14:50**

New algorithms for convex interpolation

Jeremy Schiff	Bar-Ilan University

Abstract: In various settings, from computer graphics to financial mathematics, it is necessary to smoothly interpolate a convex curve from a set of data points. Standard interpolation schemes do not respect convexity, and existing special purpose methods require arbitrary choices and/or give interpolants that are very flat between data points. A new set of spline type schemes is presented to overcome these difficulties. Convexity is guaranteed if the spline function is infinitely differentiable but not analytic.

CP A1-3-3 3 2 **14:50-15:10**

Development of the method for calculating thermal parameters of multilayered structure

Bolatbek Rysbaiuly	INTERNATIONAL INFORMATION TECHNOLOGY UNIVERSITY
Nazerke Mukhametkaliyeva	INTERNATIONAL INFORMATION TECHNOLOGY UNIVERSITY
Korlan Rysbayeva	UNIVERSITY OF LORRAINE

Abstract: Defining thermo-physical parameters of material without destroying the structure is a relevant problem. As an experiment, two-layered rectangular design is studied, which is affected by two different ambient temperatures on both sides. The necessary data measuring works are carried out for several months. The system of methods for estimating thermo-physical parameters of the rectangular structure is developed based on the nonlinear heat conductivity equation. Numerical calculations are performed, and results are compared with experimental data.

CP A1-3-3 3 3 **15:10-15:30**

A Petrov-Galerkin multilayer discretization to the advection-diffusion problem

Daniel Franco Coronil	University of Sevilla
Tomás Chacón Rebollo	University of Sevilla
Fréderic Hecht	Université de Paris VI

Abstract: We study a multilayer Petrov-Galerkin discretization of an advection-diffusion problem. The trial functions are piecewise constant per horizontal layers, while the test functions are continuous piecewise linear, on a vertically shifted grid. We prove the well posedness and optimal error order estimates, based upon specific inf-sup conditions. We present some numerical tests with parallel computing of the solution based upon the multilayer structure of the discretization, with results in full agreement with the theory developed.

CP A1-3-3 3 4 **15:30-15:50**

A new a priori estimation of layer region for singularly perturbed boundary value problems

Ramesh V P	Central University of Tamil Nadu

Abstract: We present a few arithmetic functions traditionally used for a priori estimation of layer region for few classes of singularly perturbed problems namely with boundary or interior layer or turning point and further to generate the computational domain. We present a few functions which can do the estimation with both computational advantages and better estimate. The analysis of upwind scheme on a proposed mesh is presented and compared with other existing meshes like Bakhvalov(B-mesh), Shishkin.

CP A1-3-3 3 5 **15:50-16:10**

CROUZEIX-RAVIART MULTISCALE FINITE ELEMENT METHOD FOR NAVIER-STOKES FLOWS IN HETEROGENEOUS MEDIA

QINGQING FENG	Commissariat à l'énergie atomique et aux énergies alternatives (CEA)
GREGOIRE ALLAIRE	ECOLE POLYTECHNIQUE/CMAP
PASCAL OMNES	Commissariat à l'énergie atomique et aux énergies alternatives (CEA)

Abstract: A Crouzeix-Raviart MsFEM has been proposed in [B. P. Muljadi et al, 2015] to solve Stokes problems. The multiscale basis are constructed with weakly imposed continuity across element edges. This relaxes the sensitivity of the method to complex patterns of obstacles, without oversampling methods. Based on this, we extend the MsFEM for Navier-Stokes problems by constructing multiscale basis from

Oseen's problems and we compare various multiscale basis, with stabilized formulations to improve accuracy.

CP A1-3-3 3 6 **16:10-16:30**

Constructive error analysis of a full-discrete finite element method for the heat equation

Kouji Hashimoto	Nakamura Gakuen Junior College
Takuma Kimura	Saga University
Teruya Minamoto	Saga University
Mitsuhiro Nakao	Waseda University

Abstract: We present a new full-discrete finite element method for the heat equation, and show the numerical stability of the method by verified computations.Since, in the error analysis, we use the constructive error estimates proposed ny Nakao et. all in 2013, this work is considered as an extention of that paper.We emphasize that concerned scheme seems to be a quite normal Galerkin method and easy to implement for evolutionary equations comparing with previous one.

CP ME-1-9 3 **14:30-16:30**

Control and Optimization

Chair Person: Sakthivel Ramalingam	Anna University Regional Campus

CP ME-1-9 3 1 **14:30-14:50**

EID-based fault-tolerant control design for fractional-order multi-weights complex dynamical networks

Sakthivel Ramalingam	Anna University Regional Campus

Abstract: This work is concerned with the problem of fault-tolerant control design for fractional-order multi-weighted complex dynamical networks. By using indirect Lyapunov stability theory and some integral inequalities, a new set of sufficient conditions is derived in terms of linear matrix inequalities. Moreover, EID-based reliable control law is constructed to ensure the stability of the closed-loop system with satisfactory disturbance rejection performance. Finally, simulation results are provided to illustrate the effectiveness of the proposed control method.

CP ME-1-9 3 2 **14:50-15:10**

Regional Enlarged Observability of Caputo Fractional Differential Equations

Hayat Zouiten	University Moulay Ismail
Ali Boutoulout	University Moulay Ismail
Delfim Torres	University of Aveiro

Abstract: We consider the regional enlarged observability problem for fractional evolution differential equations involving Caputo derivatives. Using the Hilbert Uniqueness Method, we show that it is possible to rebuild the initial state between two prescribed functions only in an internal subregion of the whole domain. Finally, an example is provided to illustrate the theory.

CP ME-1-9 3 3 **15:10-15:30**

Null controllability of a penalized Stokes problem in dimension two with one scalar control.

Jon Asier Barcena Petisco	Sorbonne University

Abstract: In this paper we consider a penalized Stokes equation defined in a regular domain Ω ⊂ R^2 and with Dirichlet boundary conditions. We shall prove that our system is null controllable using a scalar control defined in an open subset inside Ω and whose cost is bounded uniformly with respect to the parameter that converges to 0. The control is obtained from some Carleman inequalities and some elliptic estimates that we prove.

CP ME-1-9 3 4 **15:30-15:50**

A Linear Quadratic Model based on Multistage Uncertain Random Systems

Xin Chen	Nanjing University of Science and Technology
Yuanguo Zhu	Nanjing Univercity of Science and Technology

Abstract: In this talk, an LQ optimal control model is studied for a multistage uncertain random system which is a complex system includes randomness and uncertainty. Based on Bellman's Principle, recurrence equations are presented for this model. With the aid of recurrence equations and chance theory, the analytical expressions of the model are deduced. Finally, a numerical example is provided to show the effectiveness of our results.

CP ME-1-9 3 5 **15:50-16:10**

On the observability of relative positions in left-invariant multi-agent control systems and its application to formation control

Leonardo Colombo	Instituto de Ciencias Matematicas (ICMAT)
Hector Garcia De Marina	University of Southern Denmark
Maria Barbero Liñan	Universidad Politecnica de Madrid
David Martin De Diego	Instituto de Ciencias Matematicas (ICMAT)

Abstract: We consider the localization problem between agents while they run a decentralized formation control algorithm. The agents need to solve an observability problem of reconstructing their relative positions based on measurements between them. We model the relative kinematics between agents as a left-invariant control system to solve the observability problem. We focus on agents running a distance-based algorithm where their relative positions aren't accessible but the distances between them. Several practical robustness issues are studied.

CP ME-1-9 3 6 **16:10-16:30**

A chance-constrained model for stochastic unit commitment

Bismark Singh	Sandia National Laboratories
Bernard Knueven	Sandia National Laboratories
Jean-Paul Watson	Sandia National Laboratories

Abstract: Chance constraints are a crucial tool of stochastic optimization; they form the backbone of many important national security data science applications. These include critical infrastructure resiliency, cyber security, power system operations, and disaster relief management. In this talk, we develop a novel optimization model with chance-constraints to a stochastic unit commitment model, and show how potentially billions of dollars can be saved annually by allowing a few controlled non-nominalities.

CP A1-3-2 3 **14:30-16:30**

Mathematical Topics and their Applications III

Chair Person: Hironori Kasai	Fukushima University

CP A1-3-2 3 1 **14:30-14:50**

Some notes for a gradient flow of energy functional with penalty term

Hironori Kasai	Fukushima University

Abstract: Penalty method is well-known approximation method for minimizing problem with some constraints. In some situations, penalty method is applied for time dependent problems such as a gradient problems with constrains. In this presentation, we consider the behavior of gradient flows of energy functional with a penalty term. Resently, we have found some rich examples of gradient flows with a penalty term that behave different way from corresponding gradient flows with constrains.

CP A1-3-2 3 2 **14:50-15:10**

Electroosmotic flow of a non newtonian fluid in a slit nanochannel with hydrophobic patches

Dipankar Kundu	INDIAN INSTITUTE OF TECHNOLOGY , KHARAGPUR
Somnath Bhattacharyya	INDIAN INSTITUTE OF TECHNOLOGY , KHARAGPUR

Abstract: Based on the Nernst–Planck model for ion transport, the electroosmotic flow of a non-Newtonian fluid in a slit channel with charged patches of vanishing slip velocity and uncharged patches of non zero slip is studied numerically by solving the coupled Poisson–Nernst–Planck Navier–Stokes system. The nonlinear effects are pronounced for a shear thinning liquid, whereas, the EOF is dominated by the diffusion mechanisms for the shear thickening fluid.

CP A1-3-2 3 3 **15:10-15:30**

A note on the numerical solution of the water wave problem involving an asymmetrical rectangular trench

Amandeep Kaur	Indian Institute of Technology Ropar Rupnagar Punjab
Subash Chandra Martha	Indian Institute of Technology Ropar Rupnagar
Aloknath Chakrabarti	IISc Bangalore

Abstract: The mathematical problem is handled for its numerical solution with the aid of a system of integral equations of first kind. The resulting integral equations are solved numerically by using suitably designed polynomial approximations of the unknown functions. The numerical values of scattered quantities associated with the original water wave problem are found to be in excellent agreement with the known results where a Galerkin type of approximation has been used to obtain the solutions.

CP A1-3-2 3 4 **15:30-15:50**

Development of a Method for Finding the Diffusion Coefficient of Soil Moisture based on the Principles of Non-destructive Testing

Abilmazhin Adamov	L.N.Gumilyov Eurasian National University
Zhanat Karashbayeva	L.N.Gumilyov Eurasian National University

Abstract: Prediction of soil water regime requires knowledge of diffusion coefficient of heterogeneous soil moisture. We use mathematical modeling method for finding the unknown coefficient. We developed an iterative method for calculating the diffusion coefficient based on a system of partial differential equations of the heat and moisture transfer. There were carried out numerical calculations and necessary measurements of temperature and moisture of the selected soil area. The calculation results were compared with experimental data.

CP A1-3-2 3 5 **15:50-16:10**

Resolution of partial differential equations of evolutions by means fractional step methods and applications.

Macarena Gómez Mármol	Universidad de Sevilla

Abstract: Some real problems corresponding to different disciplines of science are modeled through partial differential equations of evolution type. It is well known that in some cases as occurs in the stiff problems, numerical schemes are needed that are at least order two in time, as is the case with fractional step schemes of type Generalized-Alfa.

CP A1-3-2 3 6 **16:10-16:30**

DEVELOPMENT OF A METHOD FOR NUMERICAL CALCULATION OF THERMOPHYSICAL PROPERTIES OF THE FREEZING SOIL

Meiirzhan Ryskeldi	International Information Technology University
Nazerke Rysbayeva	UNIVERSITY OF LORRAINE

Abstract: Three zones are formed in freezing soil: frozen, phased and thawed zones. The border between thawed and phased zones, and between frozen and phased zones are free internal boundaries. It is required to develop an estimation method for thermophysical properties of a soil. The method of calculating thermophysical characteristics of a soil is developed using nonlinear equation of heat conductivity for a non-uniform environment. The results of numerical methods are compared to experimental data.

CP FT-1-8 3 14:30-16:30

Mathematical Topics and their Applications IV

Chair Person: Vassil Vassilev	Institute of Mechanics, Bulgarian Academy of Sciences

CP FT-1-8 3 1 **14:30-14:50**

Two-soliton solutions for a family of Boussinesq type equations

Vassil Vassilev	Institute of Mechanics, Bulgarian Academy of Sciences

Abstract: In this work, we consider a four-parameter family of fourth-order nonlinear equations of Boussinesq type describing the propagation of dispersive waves in fluids and solids. Using a simplified version of Hirota’s method, we obtain in explicit analytic form a large class of two-soliton solutions to the regarded equations and analyse their properties.

CP FT-1-8 3 2 **14:50-15:10**

Mixing Zone for Coastal Effluent Discharges due to a Step Change in Seabed Depth Profile

Huda Al-maamari	Sultan Qaboos University,
Anton Purnama	Sultan Qaboos University,

Abstract: Two-dimensional advection-diffusion equations with a point source are solved analytically using the method of image that models the spreading of coastal effluent discharges in the far field. A sudden step change in the simple seabed depth profiles of a uniformly sloping seabed and a flat seabed with constant water depth are considered. A concentration limit within the circular mixing boundary from the point source are formulated.

CP FT-1-8 3 3 **15:10-15:30**

Tracing Remittance Flows via Persistent Homology

Paul Samuel Ignacio	University of Iowa
Isabel Darcy	University of Iowa

Abstract: Patterns embedded within remittance flow networks can be useful in understanding economic and sociologic trends and phenomena and their implications both in regional and global settings. This, however, can be difficult because of the volume and complexity of simultaneous multiple country interactions. We present an interesting application of tools from algebraic topology that cleverly transforms pieces of the network into abstract mathematical objects from which signatures, corresponding to flow patterns, can simply be computed.

CP FT-1-8 3 4 **15:30-15:50**

Modified Szasz-Mirakjan operators that fix exponentials

Ankita DEVDHARA	Sardar Vallabhbhai National Institute of Technology

Abstract: In this research article, we present modified Szasz-Mirakjan operators that fix exponential spaces. We derive moments and central moments of the operators. We present convergence rate of the operators. We show approximation results in weighted exponential spaces. From the graphical analysis, we show that our operator gives better results with exponential functions.

CP FT-1-8 3 5 **15:50-16:10**

Thermodynamics with corrected entropies for a reconstruction scheme of f(T) Gravity in the framework of Interacting Variable-Generalised Chaplygin Gas

Surajit Chattopadhyay	Dept of Mathematics, Amity Institute of Applied Sciences, Amity University, Kolkata

Abstract: We report a study on variable-generalized Chaplygin gas (VGCG) in a scenario of interaction with pressureless dark matter with interaction term $Q = 3H\delta\rho\Lambda$, where $\rho\Lambda$ indicates the density of the VGCG. The equation of state (EoS) parameter has shown a quintom behaviour. A statefinder analysis has shown attainment of ΛCDM fixed point. Two different entropies have been associated with the cosmological horizons with a logarithmic correction term and a power-law correction term.

CP FT-1-8 3 6 **16:10-16:30**

The Application of Lagrangian Descriptors to the Real-Time Assessment and Effective Management of Oil Spills - The Oleg Naydenov Event

Víctor José García Garrido	Universidad de Alcalá
Antonio González Ramos	Universidad de Las Palmas de Gran Canaria
Ana María Mancho Sánchez	CSIC-ICMAT
Josep Coca Sáez De Albéniz	Universidad de Las Palmas de Gran Canaria
Stephen Wiggins	University of Bristol

Abstract: In this talk we will explore the application of Lagrangian Descriptors, a technique from Dynamical Systems Theory, to reveal the geometrical template of structures governing transport and mixing in phase space. We use this methodology to analyze the Oleg Naydenov oil spill that took place in Gran Canaria on April 2015. The study of the pollutant dispersal patterns in the ocean is crucial for the real-time assessment and effective management of these catasprophic environmental events.

CP FT-4-5 3 14:30-16:30

Mathematical Topics and their Applications V

Chair Person: Kaoutar SENHAJI	Faculty of Sciences and Technics, University Sidi Mohamed Ben Abdellah

CP FT-4-5 3 1 **14:30-14:50**

A multiojbective training modeling for Multilayer Perceptron complexity

Kaoutar SENHAJI	Faculty of Sciences and Technics, University Sidi Mohamed Ben Abdellah
Hassan RAMCHOUN	Faculty of Sciences and Technics, University Sidi Mohamed Ben Abdellah
Mohamed ETTAOUIL	Faculty of Sciences and Technics, University Sidi Mohamed Ben Abdellah

Abstract: The multilayer perceptron neural network is an efficient neural network capable to classify or approximate any data as far as it has a good generalization. In this respect, we propose a multiobjective optimization model, balancing between the multi-layer perceptron learning and complexity. The model is a minimization problem consisting of two objectives: the training objective (the multilayer perceptron error) and the regularization objective (number of connections), under constraints to ensure the communication between layers.

CP FT-4-5 3 3 **14:50-15:10**

Machine Learning for Fusion of Data and Models

Velimir Vesselinov	Los Alamos National Laboratory

Abstract: Machine Learning (ML) analyses are typically informed and constrained only by data. An alternative is to incorporate in the ML analyses information about the physics governing process embedded in the analyzed datasets. As a result, the physics informed ML leads to faster training and lower uncertainties in the ML predictions. We have developed a series of methods allowing the fusion of physics and data through ML.

CP FT-4-5 3 4 **15:10-15:30**

Dynamic Optimization with Convergence Guarantees

Martin Neuenhofen	University of British Columbia
Eric Kerrigan	Imperial College London

Abstract: We present a novel direct transcription method to solve optimization problems subject to differential and inequality constraints, where we follow a least-squares approach to finding approximate solutions to the differential equations. In order to provide numerical convergence guarantees, it is sufficient for the functions that define the problem to satisfy boundedness and Lipschitz conditions, even if components of solutions are discontinuous. Numerical examples demonstrate that the new approach can solve problems where collocation methods fail.

CP FT-4-5 3 5 **15:30-15:50**

An inverse problem in KdV equation with over determination data

GNANAVEL SOUNDARARAJAN	CENTRAL UNIVERSITY OF KERALA

Abstract: In this work, we study an inverse problem of reconstructing time independent coefficient in Korteweg-de Vries Equation from the over determined data using the optimization method. First the identification problem is transformed into an optimization problem by using optimal control framework and existence of a minimizer for the cost functional is established. Then we prove a stability estimate for retrieving the unknown coefficient in KdV equation with the upper bound of given measurements.

CP FT-4-5 3 6 **15:50-16:10**

Feature Enhancement for Multi SAR Images: A Novel Approach Based on PDE and Regularization

Xintong Tan	National University of Defense and Technology
Qi Yu	National University of Defense and Technology
Jubo Zhu	National University of Defense and Technology
Jiying Liu	National University of Defense and Technology
Zelong Wang	National University of Defense and Technology

Abstract: This paper aims at feature enhancement for multi SAR images. A novel approach based on PDE and regularization which is an extension of PDE and regularization is proposed. The PDE term for speckle suppression is established by combining the ROA detector and the amplitude. The regularization term for strong scatter enhancement contains the structural information and the sparsity. Experiments show that the proposed approach can efficiently suppress speckles and enhance features especially structures and edges.

CP FT-1-7 3 14:30-16:30

Simulation and Modelling I

Chair Person: Sanasam Sarat Singh Mizoram University

CP FT-1-7 3 1 **14:30-14:50**

Propagation of Stoneley and Rayleigh waves in thermoelastic materials with voids

Sanasam Sarat Singh	Mizoram University
Lalawmpuia Tlau	Mizoram University

Abstract: The present paper deals with the propagation of surface waves in thermoelastic materials with voids. The frequency equations of the Stoneley waves at the bonded and unbonded interfaces between two dissimilar half-spaces of thermoelastic materials with voids are obtained. The numerical values of the determinant for bonded and unbonded interface are calculated for a particular model. We also derived the frequency equation of Rayleigh wave in thermoelastic materials with voids.

CP FT-1-7 3 2 **14:50-15:10**

Effect of thermal relaxation time on the propagation of waves in the generalised theory of micropolar thermoelasticity

SS Singh	Mizoram University
R. Lianngenga	Mizoram University

Abstract: The propagation of plane waves in the generalised theory of micropolar thermoelasticity has been investigated. The effect of thermal relaxation time in the reflection due to incident coupled dilatational and coupled shear waves from a plane free boundary of generalised micropolar thermoelastic materials. The amplitude and energy ratios corresponding to the reflected coupled dilatational and coupled shear waves are derived by using appropriate boundary conditions.

CP FT-1-7 3 3 **15:10-15:30**

Exact Solutions of Magnetohydrodynamic Flow of Couple Stress Fluids near Stagnation Region

Gayathri Palanisamy	Bharathiar University

Abstract: Designing of solar arrays for energy harvesting under magnetic field is a fundamental application of stagnation point flows. The main concern is to analyze the exact solutions of reduced Navier-Stokes equations in closed form which may be unique or multiple. The associated heat flow solutions in closed form are obtained for differentially heated surface. A comprehensive interpretation of momentum and thermal boundary layers in terms of the shear stress and heat transfer rate is presented.

CP FT-1-7 3 4 **15:30-15:50**

Ebola: Impact of Hospital's Admission Policy in an Overwhelmed Scenario

Mondal Hasan Zahid	University of Texas at Arlington

Abstract: Infectious disease outbreaks sometimes overwhelm healthcare facilities with patients. The very recent case was Ebola outbreak in West Africa in 2014. In this type of scenario, how many patients can hospitals admit to minimize the burden of the epidemic? Here, we tried to find what type of admission policy by a hospital can better serve the community. Our result shows the determination of policy depends on the initial estimation of the basic reproduction number, ??0.

CP FT-1-7 3 5 **15:50-16:10**

Computational simulation of complex fine-scale heterogeneous flows using homogenization and coarse-graining approaches

Elliot Carr	Queensland University of Technology
Nathan March	Queensland University of Technology
Ian Turner	Queensland University of Technology

Abstract: A common approach to overcome the challenges associated with numerically simulating flows in domains with fine-scale heterogeneity is to coarse-grain the model by decomposing the domain into a number of smaller sub-domains and homogenizing the heterogeneous medium within each sub-domain. In this talk, I will present a new hybrid analytical-numerical approach for homogenizing block heterogeneous domains and show how this approach can be used to accurately and efficiently simulate complex fine-scale heterogeneous flows.

CP FT-1-7 3 6 **16:10-16:30**

Heat transfer in micropolar nanofluids with the suspension of multi-wall carbon nanotubes: A numerical study

Abid Hussanan	Shenzhen University
Zhi-Min Chen	Shenzhen University

Abstract: Nanofluid is the most promising gift of modern science to improve the heat transfer capabilities of conventional heat transfer fluids. However, one of the most crucial drawbacks for classical nanofluid models is that they cannot describe a class of fluids that have certain microscopic characters arising from micro-rotation and local structure of the fluid elements. Therefore, the present study discusses the effect of such types of characteristics on heat transfer flow of nanofluids.

MS FE-1-1 4 **17:00-19:00**

Finite element exterior calculus and applications - Part 4

For Part 1 see: MS FE-1-1 1
For Part 2 see: MS FE-1-1 2
For Part 3 see: MS FE-1-1 3
Organizer: Snorre H. Christiansen University of Oslo
Organizer: Shuo Zhang Institute of Computational Mathematics, CAS
Organizer: Kaibo Hu University of Minnesota

Abstract: Finite element exterior calculus (FEEC) and other compatible or structure-preserving discretization techniques have been drawing increased attention in both theoretical studies and applications. This minisymposium aims at a communication of recent developments for such nu- merical methods for electromagnetism, fluid and solid mechanics. In particular, sophisticated discretization techniques and solvers are required to meet the challenges raised in these areas, including conservative discretizations for fluid dynamics, inclusion of geometric structures in linear and nonlinear solid mechanics and modeling and simulation of defects.

17:00-17:30

A Multigrid Method for Biharmonic Eigenvalue Problem

Hehu Xie Academy of Mathematics and Systems Science

Abstract: In this talk, we start the equivalence of the biharmonic eigenvalue by the conforming C^1 finite element method and the mixed form by the C^0 finite element methods. Based on the conforming property of the C^0 elements, a type of multigrid method is designed for the eigenvalue problems based on the multilevel correction technique.

17:30-18:00

TDNNS mixed finite elements for non-linear elasto-dynamics

Joachim Schöberl Vienna University of Technology
Michael Neunteufel TU Wien

Abstract: In this talk we extend the tangential displacement normal-normal stress (TDNNS) continuous mixed method to nonlinear, time-dependent elasticity. While the displacement is searched for in H1, the velocity variable is now in H(curl). We present results on the space discretization, and discuss time-stepping schemes. Numerical examples show the advantag of the the proposed method.

18:00-18:30

Simplex-averaged Finite Element Methods and Robust Solvers for Convection-diffusion PDEs

Shuonan Wu Peking University
Jinchao Xu Pennsylvania State University

Abstract: In this talk, we present a robust discretization and solver developed for convection-dominated PDEs discretized on unstructured simplicial grids. The convection can be any one of the following operators: gradient, curl, and divergence. An essential feature of these constructions is to properly average the PDE coefficients on the sub-simplexes. Both theoretical analysis and numerical experiments show that the new finite element schemes provide an accurate and robust discretization and a fast solver for convection-dominated PDEs.

18:30-19:00

On discrete exact sequences and low-degree optimal finite element schemes

Shuo Zhang Institute of Computational Mathematics, Chinese Academy of Sciences

Abstract: We present finite element schemes on triangular and quadrilateral grids for the biharmonic equation, which involve the formulation of the (classical) nonconforming finite element scheme or the interior penalty discontinuous Galerkin (IPDG) scheme. The schemes uses piecewise polynomial spaces and can approximate solutions in the broken norm with accuracy; for the IPDG scheme, the accuracy does not deteriorate as the penalty parameter tends to infinity. A main technical ingredient is to use discretized Stokes complexes.

MS FT-1-SG 4 **17:00-19:00**

Manifold sensing and sparse recovery - Part 2

For Part 1 see: MS FT-1-SG 3
Organizer: Olga Mula Paris Dauphine University
Organizer: James Nichols Sorbonne Universités
Organizer: Karen Veroy-Grepl RWTH Aachen University

MS Organized by: SIAG/CSE

Abstract: Across various communities there have been interesting recent developments in state estimation where we assume i) that the function to recover belongs to some lower-dimensional manifold or is sparse in some basis and ii) our only data is a limited number of noisy measurements. Open problems still abound in extending the theoretical foundations and bringing the methods to real-life applications. Interaction between numerical analysts, statisticians, and practitioners will be effective in addressing these challenges. In this minisymposium we gather experts from various fields to report on recent results, identify new research directions, and stimulate collaboration.

17:00-17:30

A reduced order data assimilation method for real-time monitoring of urban flows

Rachida Chakir IFSTTAR
Hammond Janelle K. INRIA

Abstract: In this work we extend the PBDW method to the monitoring of urban air quality as an important test case for practical applications over large scales. Our focus here is a problem of pollutant dispersion at the urban scale which can provide insight on how to treat the practical problems associated to MOR and data assimilation of complex flows involved in many sophisticated methods of urban air quality modeling.

17:30-18:00

Fast reconstruction of time dependent flows

Damiano Lombardi INRIA

Abstract: Several methods were developed to perform state estimation based on optimal reconstruction methods. The aim is to combine models and data and retrieve quantities of interest in an optimal way. In the present work, a method is proposed to deal with state reconstruction for time dependent flows. A sequential approach is proposed, to perform state estimation by using sparse, partial, time repeated observations of the system state. The method is assessed on several numerical experiments.

18:00-18:30

A Variational Model for Data Fitting on Manifolds by Minimizing the Acceleration of a Bézier Curve

Ronny Bergmann Technische Universität Chemnitz
Pierre-Yves Gousenbourger Université catholique de Louvain

Abstract: We present a variational model to fit a composite Bézier curve to data points on a Riemannian manifold. The resulting curve has a minimal mean squared acceleration while also remaining close the data. We discretize the acceleration of the curve and derive an efficient algorithm to compute the gradient w.r.t. its control points, expressed as a concatenation of adjoint Jacobi fields. Several examples illustrate the capabilities of this approach for both interpolation and approximation.

18:30-19:00

Sparse surrogates with kernel methods

Gabriele Santin University of Stuttgart
Bernard Haasdonk University of Stuttgart

Abstract: Kernel methods provide powerful and flexible tools to approximate functions on general domains, with high-dimensional input and output spaces, and using samples at scattered locations. When multiple evaluations of the approximant are required, greedy methods have proven particularly effective to construct models based on a small set of points, thus enforcing sparsity in the approximant. We will describe the VKOGA algorithm and some recent extensions. Examples on real-time simulation scenarios and Uncertainty-Quantification will be discussed.

MS ME-0-5 4 **17:00-19:00**

Numerical approximation of stochastic problems - Part 2

For Part 1 see: MS ME-0-5 3
Organizer: Raffaele D'ambrosio University of L'Aquila
Organizer: Hugo De La Cruz Fundação Getúlio Vargas

Abstract: The Minisymposium, divided in two parts, is aimed to discuss recent advances in the efficient numerical approximation of various stochastic problems, including stochastic differential equations (SDEs), random differential equations (RDEs), stochastic Volterra integral equations (SVIEs) and stochastic fractional equations (SFDEs). We expect contributions with new developments in the area of stochastic numerics and potential applications to the development and analysis of reliable models in several fields of science, industry and engineering.

Part 2 is devoted to the numerical integration of stochastic integral and fractional equations, as well as to nonlinear stochastic models and their analysis.

17:00-17:30

Adaptive methods for nonlinear financial models

Cónall Kelly	University College Cork
Gabriel Lord	Heriot Watt University
Heru Maulana	University Collegel Cork
Fandi Sun	Heriot Watt University

Abstract: The Monte-Carlo approach to the pricing of financial derivatives provides flexibility in the choice of model for the underlying asset. If suitably convergent numerical methods exist, one is not limited to asset models with known distributions. We examine the strong convergence of adaptive methods for SDE models with non-Lipschitz coefficients. These strategies work by managing highly nonlinear coefficient responses via the timestep in order to control potential unbounded growth in solutions of the numerical scheme.

17:30-18:00

Stability analysis of theta-methods for stochastic Volterra integral equations

Dajana Conte	Dipartimento di Matematica, Univ. di Salerno
Beatrice Paternoster	University of Salerno (Italy)
Raffaele D'Ambrosio	University of L'Aquila (Italy)

Abstract: Stochastic Volterra integral equations are relevant in many applications, expecially those concerning stochastic dynamical systems with memory. We introduce an improved stochastic theta-method which can inherit the stability properties of the corresponding method for stochastic differential equations. The superiority of the improved method with respect to the existing theta-method is confirmed by a comparison of the stability regions.

18:00-18:30

A spectral method for stochastic fractional differential equations

Angelamaria Cardone	University of Salerno
Raffaele D'Ambrosio	University of L'Aquila
Beatrice Paternoster	University of Salerno

Abstract: The talk illustrates a spectral collocation numerical scheme for the approximation of the solutions of stochastic fractional differential equations. The discretization of the operator leads to a system of nonlinear algebraic equations, whose coefficient matrix can be computed by an automatic procedure, consisting of linear steps. A selection of numerical experiments confirming the effectiveness of the approach is given, with respect to various sets of function bases and of collocation points.

18:30-19:00

Nonlinear stability issues for stochastic multistep methods

Raffaele D'ambrosio	University of L'Aquila
Evelyn Buckwar	University of Linz

Abstract: We analyze conservation properties of numerical methods for nonlinear stochastic differential equations (SDEs), hidden behind proper conditional stability issues. We study the numerical approximation of nonlinear SDEs of Ito type with exponential mean-square contractive solutions by stochastic linear multistep methods, in order to provide stepsize restrictions ensuring similar exponential mean-square properties also numerically, without adding further constraints on the numerical method itself. A selection of numerical experiments confirms the sharpness of the estimates.

MS A6-3-4 4 17:00-19:00

Discrepancy and Minimal Energy - Part 3

For Part 1 see: MS A6-3-4 2

For Part 2 see: MS A6-3-4 3

Organizer: Johann Brauchart Graz University of Technology

MS Organized by: SIAG/CSE

Abstract: The arrangement of point configurations on manifolds, whether deterministic or random, is an interdisciplinary topic of great interest in applied mathematics and engineering, physics and computer science. In this three-part minisymposium the talks will explore recent key developments in quality quantification and its asymptotic analysis (low discrepancy, minimal energy, hyperuniformity), application in numerical integration, manifold discretization driven by self-organization by local interaction (Riesz and Green potentials and soft sticky disc interactions), and explicit constructions and sampling.

17:00-17:30

Improved Search Algorithms for Good Lattice Points

Peter Kritzer	Johann Radon Institute for Computational and Applied Mathematics (RICAM), Austrian Academy of Sciences
Adrian Ebert	KU Leuven
Dirk Nuyens	KU Leuven
Onyekachi Osisiogu	Austrian Academy of Sciences

Abstract: We discuss the problem of efficiently constructing node sets for rank-1 lattice rules. For such integration rules, it is in general not straightforward to identify node sets that yield a small integration error, as there are no explicit constructions known for dimensions $d>2$. Hence, one has to resort to computer search algorithms. We present selected results and algorithms for the construction of lattice rules. Under suitable conditions, these rules show almost optimal error convergence.

17:30-18:00

Error-correcting codes vs. low-dispersion point sets

Mario Ullrich	Johannes Kepler University
Jan Vybíral	Czech Technical University

Abstract: In the last years there was an increasing interest in point sets with 'small' dispersion, i.e., in point sets that intersect each axis-parallel box with 'large' volume, especially in high dimensions. Despite the many existence results, there was only some progress regarding the actual construction. Here, we show how to generate sets, whose size is optimal with respect to the dimension d, using certain error-correcting codes. The running-time of the procedure depends polynomially on d.

18:00-18:30

Minimal Soft Lattice Theta Functions

Laurent Bétermin	University of Copenhagen
Hans Knüpfer	Heidelberg University

Abstract: Minimizing lattice energies is a key point in the search of stable matter structures. In this talk, I will discuss the minimality properties of a new `soft lattice theta function' corresponding to the Gaussian interaction of masses (measures) located at the sites of a Bravais lattice. Many applications will be shown in dimensions 2 and 3.

18:30-19:00

Changing Geometry of Energy-Minimizing Clusters for a Simple Family of Soft Sticky Disc Interactions

Mircea Petrache	PUC Chile

Abstract: It is well known that in 2d the sticky-disc model of Heitmann-Radin produces triangular-lattice minimizers. We construct a simple one-parameter deformation of the sticky-disr potential which allows to prove a sharp phase transition for the minimizers. More precisely, the preferred crystal shape changes from a triangular lattice to a square lattice as we deform the interaction potential.

MS ME-1-0 4 17:00-19:00

Recent Advances in Optimal Control Theory - Part 4

For Part 1 see: MS ME-1-0 1

For Part 2 see: MS ME-1-0 2

For Part 3 see: MS ME-1-0 3

For Part 5 see: MS ME-1-0 5

Organizer: Alexander Zaslavski	The Technion - Israel Institute of Technology
Organizer: Monica Motta	University of Padua
Organizer: Boris Mordukhovich	Wayne State University
Organizer: Nobusumi Sagara	Hosei University

Abstract: This minisimposium on new developments in optimal control theory and its applications will bring together a selected group of experts in this area. The growing importance of control and optimization has been realized in recent years. This is due not only to theoretical developments, but also because of numerous applications to engineering, economics and life sciences. The topics which will be discussed include optimal control of PDE, turnpike phenomenon, infinite horizon optimal control, necessary and sufficient optimality conditions, qualitative and quantitative aspects of optimal control and applications.

17:00-17:30

Optimality conditions for nonconvex variational problems with integral constraints in Banach spaces

Nobusumi Sagara	Hosei University

Abstract: We exemplify that saturation is an indispensable structure on measure spaces to obtain the existence and characterization of solutions to nonconvex variational problems with integral constraints in Banach spaces. We provide a characterization of optimality via the maximum principle for the Hamiltonian and an existence result without the purification of relaxed controls. We demonstrate that the existence of solutions for certain class of primitives is necessary and sufficient for the measure space to be saturated.

17:30-18:00

Dependence results in Pontryagin principles in the piecewise continuous setting

Joël Blot — Université Paris 1
Hasan Yilmaz — Université paris-Diderot

Abstract: For problems of optimal control in continuous time governed by an ordinary differential equation, with piecewise continuous control functions and piecewise continuously differentiable state functions, we present results on the dependence of the optimal processes with respect to parameters. We use Pontryagin and tools of nonlinear functional analysis.

18:00-18:30

The validity of the DuBois-Reymond equation in the calculus of variations

Carlo Mariconda — University of Padova

Abstract: In a joint paper with P. Bettiol we establish the validity of the Du Bois-Reymond equation for Lagrangians L(t,x,v) for one-dimensional vectorial problems of the Calculus of Variations that satisfy a local Lipschitz condition on t , and just measurability in (x,v). It is expressed in terms of the convex subdifferential of L(t,x, .). As a byproduct, we obtain Lipschitzianity of the minimizers under a growth condition, weaker than superlinearity.

MS A3-2-3 4 — 17:00-19:00

Kinetic modelling and multiscale simulation of nonequilibrium flow dynamics - Part 4

For Part 1 see: MS A3-2-3 1
For Part 2 see: MS A3-2-3 2
For Part 3 see: MS A3-2-3 3
For Part 5 see: MS A3-2-3 5
For Part 6 see: MS A3-2-3 6

Organizer: Lei Wu — UK/University of Strathclyde
Organizer: Kun Xu — Hong Kong University of Science and Technology
Organizer: Song Jiang — Institute of Applied Physics and Comput. Math

Abstract: The Boltzmann equation underpins a board range of applications ranging from high-altitude aerothermodynamics of space vehicles, gas dynamics in micro-electro-mechanical systems, and shale gas extractions. It has also been extended to different fields, such as granular gases, radiative transfer, phonon/electron transport, plasmas, and quantum/relativistic dynamics. However, the high-dimensional integro-differential equations pose great challenges to the numerical simulation of kinetic equations and their applications. The goal of this minisymposium is to explore recent trends and developments in the kinetic theory (simplification of Boltzmann equations, reactions) and multiscale numerical simulation of non-equilibrium dynamics from the continuum to free-molecular flow regimes.

17:00-17:30

On unified preserving properties of kinetic schemes

Zhaoli Guo — Huazhong University of Science & Technology

Abstract: Kinetic schemes designed based on kinetic equations are potential approaches for simulating multiscale flows. It is critical for a kinetic scheme to capture correct hydrodynamic behaviors in the continuum limit without resolving the kinetic scales. To assess the asymptotic behavior of the asymptotic behavior of kinetic schemes, we will introduce the concept of unified preserving which can pick up the observed hydrodynamics from kinetic schemes. The concept is then used to analysis several typical schemes.

17:30-18:00

Implicit unified gas kinetic scheme for diatomic molecular flow

Chengwen Zhong — Northewestern Polytechnical University
Ruifeng Yuan — Northwestern Polytechnical University

Abstract: An efficient implicit scheme for steady state solutions of diatomic gas flow in all flow regimes is presented. The Rykov model equation is solved in the framework of finite volume discrete velocity method. The implicit macroscopic prediction technique is adopted to find a predicted equilibrium state at each time steps. Furthermore, an integral error compensation technique with negligible computational cost is proposed to reduce the number of unstructured velocity-space mesh significantly.

18:00-18:30

BGK models for polyatomic and reactive particles

Marzia Bisi — University of Parma

Abstract: In view of applications to physical problems, kinetic models should be able to describe mixtures of various constituents, monatomic or polyatomic, subject to bimolecular reactions or to dissociation and recombination processes. We have proposed equations of BGK type in which the polyatomic structure of particles is modelled by means of a (discrete or continuous) internal energy variable, and we have proven that such kinetic models reproduce collision invariants, equilibria and H-theorem of the Boltzmann equations.

18:30-19:00

An undecomposed hybrid algorithm for nonlinear coupled constitutive relations

Zhongzheng Jiang — Zhejiang University
Weifang Chen — School of aeronautics and astronautics, Zhejiang University

Abstract: To accurately and efficiently solve the rarefied non-equilibrium flows, a nonlinear coupled constitutive model (NCCR) was developed from Eu's generalized hydrodynamics. Subsequently, a reliable undecomposed hybrid algorithm is proposed for the complete solution of this model through combining the merits of fixed-point and Newton's iterations. The NCCR model is validated by hypersonic flows around a cylinder and a plate, Edney's IV-type shock interaction, cavity flows. The results demonstrate NCCR model's potential capability in non-equilibrium flows.

MS A6-2-3 4 — 17:00-19:00

Metamaterials in the frequency and time domain - Part 2

For Part 1 see: MS A6-2-3 3

Organizer: Bonnetier Eric — Université Grenoble-Alpes
Organizer: Nguyen Hoai-Minh — Ecole polytechnique fédérale de Lausanne EPFL

Abstract: In optics, metamaterials are composite materials in which one of the phases has nearly negative indices. This feature lends them spectacular properties of localization and concentration of electromagnetic energy. A short list of applications includes cloaking via changes of variables, cloaking using complementary media, cloaking via anomalous localized resonance, superlensing using negative index materials and hyperbolic materials. The aim of this session is to report on recent work on metamaterials in both time and frequency domains.

17:00-17:30

Field Patterns: waves in space-time microstructures with an infinitely degenerate band structure

Milton Graeme — University of Utah
Ornella Mattei — The University of Utah/San Francisco State University

Abstract: Field pattern materials (FP-materials) are space-time composites in which the spatial distribution of the constituents changes in time in such a special manner to give rise to a new type of waves, which we call field pattern waves. By applying Bloch-Floquet theory we find that the dispersion diagrams associated with these FP-materials are infinitely degenerate. The dynamics separates into independent dynamics on the different field patterns, each with the same dispersion relation.

17:30-18:00

Collective resonances of metallic particles via homogenization of the Neumann-Poincaré operator

Dapogny Charles — Université Grenoble-Alpes
Bonnetier Eric — Institut Fourier, Université Grenoble Alpes
Triki Faouzi — Laboratoire Jean Kuntzmann, Université Grenoble Alpes

Abstract: In this presentation, we investigate the spectrum of the Neumann-Poincaré operator associated to a periodic distribution of small inclusions with size ε, and its asymptotic behavior as the parameter ε vanishes. Borrowing techniques from homogenization and potential theory, we partially characterize this limiting spectrum, and infer a few consequences about the behavior of the two-phase conductivity equation when the inhomogeneity is a collection of small holes filled with a material with negative conductivity.

18:00-18:30

A two-dimensional metamaterial in elasto-dynamics

Briane Marc INSA de Rennes
Francfort Gilles LAGA, Université Paris-Nord and Courant Institute, New York University

Abstract: In linear elasticity, coercivity is not ensured through strong ellipticity so that the estimates that render homogenization meaningful break down unless very strong ellipticity. We present a L2-type homogenization result, very strong ellipticity notwithstanding, for a two-phase 2D laminate which derives from prior work establishing that one can lose strong ellipticity in such a setting. In the elasto-dynamic setting this material blocks longitudinal waves in the direction of lamination acting as a 2D Cauchy's aether.

MS GH-1-G 4 17:00-19:00

Advanced numerical methods for evolving manifolds - Part 4

For Part 1 see: MS GH-1-G 1
For Part 2 see: MS GH-1-G 2
For Part 3 see: MS GH-1-G 3
Organizer: Jooyoung Hahn AVL List GmbH
Organizer: Peter Frolkovič Slovak University of Technology
Organizer: Karol Mikula Slovak University of Technology

Abstract: Advanced numerical methods for solving problems related to evolving curves and surfaces in 2D/3D are presented. We cover contemporary algorithms based on Lagrangian and Eulerian methods (level set or VOF approach) for manifolds approximated by discrete curves and surfaces, which are actively used not only in a research but also in an industrial area in computer-aided engineering. The presented algorithms are meant to be applied in state-of-the-art computations including complex computational domains (e.g. 3D polyhedron meshes), complicated physics (e.g. multiphase flows), nontrivial surface reconstructions, volume and surface reconstruction, and similar.

17:00-17:30

Lagrangian and level set methods for moving interfaces

Karol Mikula Slovak University of Technology

Abstract: In this talk we outline Lagrangian and Eulerian (level set) methods for moving curves and surfaces, present numerical schemes, their pros and cons, and applications of these methods in various fields ranging from physics and biology to image processing and computer vision.

17:30-18:00

Energy stable compact scheme for Cahn-Hilliard equation with periodic boundary condition

Seunggyu Lee National Institute for Mathematical Sciences

Abstract: We present a compact scheme to solve the Cahn-Hilliard equation with a periodic boundary condition, which is fourth-order accurate in space. We introduce schemes for two and three dimensions, which are derived from the one-dimensional compact stencil. The energy stability is completely proven for the proposed scheme based on the application of the compact method and well-known convex splitting methods. Detailed proofs of the mass conservation and unique solvability are also established.

18:00-18:30

Natura 2000 biotopes segmentation from satellite images

Michal Kollár Slovak University of Technology

Abstract: The presentation deals with a mathematical model and numerical method designed for segmentation of satellite images, namely to obtain in an automated way borders of Natura 2000 habitats from Sentinel-2 optical data. The segmentation model is based on the evolving closed plane curve approach in Lagrangian formulation including the efficient treatment of topological changes. We present results from an area of Western Slovakia where the so-called riparian forests represent the important European Natura 2000 habitat.

18:30-19:00

Finite difference scheme for vortex filament motion

Tetsuya Ishiwata Shibaura Institute of Technology

Abstract: Finite difference scheme for the model equation of vortex filament in three dimensional fluid is proposed. We show that the scheme inherits length-preserving and energy structures from the original model. We also show that solvability of the scheme since the scheme is implicit and nonlinear and give an error estimate of the iteration. Finally, numerical results are shown.

MS A3-3-3 4 17:00-19:00

Applied Mathematics for Environmental Problems - Part 2

For Part 1 see: MS A3-3-3 3
Organizer: María Isabel Asensio Sevilla Universidad de Salamanca
Organizer: Josep Sarrate Ramos Universitat Politècnica de Catalunya
Organizer: Albert Oliver University of Las Palmas de Gran Canaria

Abstract: Climate change, air pollution, deforestation, soil degradation, are some of the world's biggest environmental problems that humanity needs to face. They are urgent challenges with large economic and social impacts that, if not addressed, will grow in the future. Mathematical models help us to understand, predict and quantify the consequences of these problems, allowing to design of potential solutions. The presentations cover several environmental models and its numerical and computational treatment. These models are based on partial differential equations and solved using different numerical methods, combined with efficient computational techniques to provide useful forecasting tools in decision-making and warning.

17:00-17:30

Windshear forecast in GCLP and GCTS

David Suarez Molina AEMET
Juan Carlos Suárez González AEMET

Abstract: Low level windshear is one of the most critical aviation hazards. Detecting it accurately, must be the main objective to guarantee flight safety. Terrain-induced windshear at Tenerife South (GCTS) and Gran Canaria airports (GCLP) could be hazardous to the landing and departing aircraft. This paper shows an experimental windshear alert system based in two different methodology. Both of them have been developed from u and v wind components of HARMONIE-AROME Model.

17:30-18:00

FEM for time-dependent ARD-equation with anisotropic diffusion in atmospheric pollution

María Alejandra Alvarado Peña
Erwin Hernández Technical University Federico Santa María

Abstract: We solve the time-dependent advection-reaction-diffusion equation with anisotropic diffusion. In order to have an acceptable computational cost, we use standard SUPG (Stream Upwind Petrov Galerkin) method for the space discretization and Euler scheme for the time discretization. We compare the strategy of temporal-spatial or spatial-temporal solution with different stabilization parameters, and present numerical tests. Finally, we present an example to describe the odor dispersion behavior in a real world scenario.

18:00-18:30

The meccano method for adaptive tetrahedral mesh generation over complex terrain

Rafael Montenegro Armas University of Las Palmas de Gran Canaria
José Manuel Cascón University of Salamanca
Albert Oliver University of Las Palmas de Gran Canaria
José Sarrate Universitat Politècnica de Catalunya - BarcelonaTech
José María Escobar University of Las Palmas de Gran Canaria
Eduardo Rodríguez University of Las Palmas de Gran Canaria
Gustavo Montero University of Las Palmas de Gran Canaria
Eloi Ruiz-Gironés Barcelona Supercomputing Center - Centro Nacional de Supercomputación

Domingo Benítez	University of Las Palmas de Gran Canaria
José Iván López	University of Las Palmas de Gran Canaria
Marina Brovka	University of Las Palmas de Gran Canaria

Abstract: A 3D domain that is limited in its lower part by a complex terrain, and a rectangle at the top, is meshed automatically by using the meccano method. A digital elevation map of the terrain and the required orography approximation are given as input data. The meccano (parametric space) consists on a simple cuboid whose upper face coincides with the top of the domain, and its lower face is placed at the minimum terrain height.

18:30-19:00

Improving satellite derived solar irradiance using site adaptation techniques

Luis Mazorra Aguiar	University of Las Palmas de Gran Canaria
Jesús Polo	CIEMAT
José María Vindel	CIEMAT
Albert Oliver	IUSIANI - ULPGC

Abstract: One of the most important issues to ensure the stability for solar power systems is the knowledge of solar radiation. This paper focuses in Gridded Satellite data suitability for modelling Global Horizontal Irradiation in islands with complicated orography. Moreover, this analysis presents the results of including a site-adaptation methodology for improving satellite suitability. We used different procedures to perform this site adaptation depending on the solar radiation conditions, the location and the season.

MS A1-2-6 4 17:00-19:00

Molecular simulation: dynamics, statistics, learning, and high-performance computing - Part 3

For Part 1 see: MS A1-2-6 2

For Part 2 see: MS A1-2-6 3

Organizer: Eric Cancès	Ecole des Ponts ParisTech and Inria Paris
Organizer: Yvon Maday	Laboratoire Jacques-Louis Lions, Sorbonne Université, Paris, Roscoff, France and Institut Universitaire de France
Organizer: Tony Lelièvre	Ecole des Ponts ParisTech and Inria Paris
Organizer: Laura Grigori	Inria Paris

Abstract: Molecular simulation is widely used in the fields of theoretical, experimental, and industrial chemistry and physics, molecular biology, pharmacology, electronics, and energy production and storage, for the study of molecular systems ranging from small chemical systems to large biological molecules and materials. Molecular simulation is also key for the development of the emerging technology of atomic-scale engineering of controllable nanodevices. The amount of resources devoted to molecular simulation in supercomputing centers often exceeds 40%. The five sessions of the Molecular Simulation minisymposia will illustrate the diversity and richness of the modeling, mathematical and numerical problems arising in this vibrant field.

17:00-17:30

Reduced models for electronic conductivity calculations in 2D heterostructures

Paul Cazeaux	University of Kansas

Abstract: Weak van der Waals interactions between 2D materials layers do not impose limitations on integrating disparate materials such as graphene, phosphorene, boron-nitride... This is both a blessing, allowing the realization of many stable assemblies, but also a computational curse due to the loss of periodicity. We will discuss how abstract C*-algebra representations of tight-binding electronic structure models can be implemented numerically, reducing the complexity of evaluating Kubo formulae to compute macroscopic observables such as conductivity.

17:30-18:00

Wannier functions: variational formulations, computation, and applications

Anil Damle	Cornell University

Abstract: The Wannier localization problem in quantum physics is analogous to finding a localized representation of a subspace and plays an important role in Kohn-Sham DFT calculations. In this talk we overview recently developed algorithms for robustly computing Wannier functions of systems with both isolated and entangled eigenvalues. We also discuss recent work extending our methodology to work with atomic orbital basis functions and efforts towards the construction of localized basis functions for virtual spaces.

18:00-18:30

Tensor-based modelling of the collective long-range electrostatic potentials in many-particle systems

Venera Khoromskaia	Max Planck Institute

Abstract: The recent method for grid-based assembled tensor calculation of the collective electrostatic potentials on 3D finite rectangular lattices provides the $O\left(N^{1/3}\right)$ computational complexity which is much less than $O(NlogN)$ in traditional approaches like Ewald-type summation. The novel range-separated (RS) tensor format for many-particle systems of general type represents the long range part of the collective potential of N charged particles as a low-rank canonical tensor, with the rank depending only logarithmically on N.

18:30-19:00

Recent progress in numerical methods for continuum solvation models

Benjamin Stamm	RWTH Aachen University

Abstract: We present the newest developments of the domain decomposition paradigm for continuum solvation models that are used to take long-range polarization effects of solvents into account. In particular, we present the extension to the linearized Poisson-Boltzmann equation that is solved based on a combination of integral equation formulation with Dirichlet-to-Neumann operators which are obtained via volumic domain decomposition schemes.

MS FE-1-2 4 17:00-19:00

Computational Methods for Inverse Problems - Part 4

For Part 1 see: MS FE-1-2 1

For Part 2 see: MS FE-1-2 2

For Part 3 see: MS FE-1-2 3

Organizer: Alessandro Buccini	Kent State University
Organizer: Lothar Reichel	Kent State University

Abstract: Inverse problems arise in most scientific fields. These problems are usually ill-posed and can be of very large dimension. Developing fast and accurate methods for their solution is of fundamental importance. Moreover, since most methods require the estimation of one or more regularization parameters, the development of automatic strategies for the selection of these parameters is of considerable importance, especially for real-world applications. This minisymposium presents new approaches to the solution of inverse problem and to the automatic estimation of regularization parameters.

17:00-17:30

A Group-Sparse Representation Method for Robust Face Recognition

Serena Morigi	University of Bologna

Abstract: In this talk we present a Group-Sparse Representation based method for Face Recognition (FR). The novel sparse representation variational model includes a non-convex group sparsity-inducing penalty and a robust non-convex loss function. chosen to make the algorithm robust to noise, occlusions and disguises. Extensive experiments on FR problem show the potentiality of the proposed model for structured as well as unstructured features.

17:30-18:00

Constrained Bregman method for inverse problems in Krylov subspaces

Mirjeta Pasha	Kent State University
Alessandro Buccini	Kent State University
Lothar Reichel	Kent State University

Abstract: Discrete ill-posed problems arise in many applications such as image recovery and compressed sensing. Bregman method imposes sparsity on the reconstruction. In this talk we describe a computationally fast version of the Bregman method obtained by projecting the problem in a Krylov subspace of small dimension. Moreover, we impose nonnegativity on the reconstructed solution by projecting in the nonnegative cone. We provide a proof of convergence and some selected numerical examples.

18:00-18:30

Regularization by Flexible Krylov Methods

Silvia Gazzola	University of Bath
Julianne Chung	Virginia Tech
Malena Sabaté Landman	University of Bath

Abstract: This talk presents new approaches that leverage flexible Krylov methods (based on both the Arnoldi and Golub-Kahan algorithms) to efficiently approximate the solution of regularized large-scale linear inverse problems with a total variation or a 1-norm penalization term (possibly involving a linear transform), reformulated within an iterative reweighted norm framework. Numerical results from imaging problems illustrate the benefits of these approaches with respect to other well-established methods.

18:30-19:00

Heuristic parameter choice rules for the regularisation of ill-posed problems

Kemal Raik	Johannes Kepler University
Stefan Kindermann	Johannes Kepler University Linz

Abstract: We discuss the convergence and performance of several classical and novel heuristic (a.k.a. noise-free) parameter choice rules for convex Tikhonov regularisation. The successful implementation of such methods depends on whether certain conditions on the noise are satisfied. In the linear theory, these conditions are well understood and hold for typically irregular deterministic noise. We postulate new noise conditions from which we prove convergence and provide a numerical exposition of the methods.

MS GH-3-2 4 17:00-19:00

Preconditioners for Linear Algebra Methods in Large Scale Scientific Computing - Part 4

For Part 1 see: MS GH-3-2 1
For Part 2 see: MS GH-3-2 2
For Part 3 see: MS GH-3-2 3

Organizer: Luca Bergamaschi	University of Padua
Organizer: Angeles Martinez	University of Padua
Organizer: Jose Marin	Polytechnic University of Valencia

Abstract: Mathematical models of a high number of processes in Engineering and Applied Sciences once numerically discretized require the repeated solution of large (non)linear systems or eigenvalues problems. All these linear algebra problems are usually addressed by iterative methods which take into account the sparsity of the matrices involved. To provide an approximate solution in a reasonable amount of time, such iterative methods need to be accelerated by suitable preconditioners. The aim of this miniworkshop is to collect the most recent results in the construction of efficient preconditioners applied to discretizations of PDEs as well as constrained optimization problems.

17:00-17:30

Preconditioners for the inexact-Newton based on compact LBFGS formulas

Jose Marin	Polytechnic University of Valencia
Luca Bergamaschi	Universita degli Studi di Padova
Ángeles Martínez	Universita degli Studi di Padova

Abstract: In this paper we study preconditioners for the solution of systems of nonlinear equations with inexact Newton methods. The linear systems in each nonlinear iteration are solved with the preconditioned conjugate gradient method. The preconditioner is based on different compact representations of the limited memory BFGS matrices (LBFGS) that approximate the Hessian or Jacobian matrix. The results of numerical experiments for problems arising in different scientific applications including unconstrained optimization will be presented.

17:30-18:00

A matrix-free preconditioner for the eigenvalue problem associated with the SPN

Amanda María Carreño Sanchez	Instituto de Seguridad Industrial: Radiofísica y Medioambiental
Antoni Vidal-Ferràndiz	Universitat Politècnica de València
Damian Ginestar	Universitat Politècnica de València
Gumersindo Verdú	Universitat Politècnica de València

Abstract: One of the main disadvantages to compute an accurate solution for some approximations of the neutron transport equation is the memory consumption required in the allocation of the involved matrices. The matrix-free strategy solves this problem, but eigenvalue solvers and preconditioners that do not require the assembly of the matrices are needed. In this work, we propose a matrix-free multilevel preconditioner based on different degrees of polynomials in the finite element method.

18:00-18:30

Improving nested task-parallelism in the LU Factorization of H-Matrices

Rocío Carratalá-Sáez	Universitat Jaume I
Enrique S. Quintana-Ortí	Universitat Politècnica de València

Abstract: Hierarchical matrices (H-matrices) lie in-between dense and sparse scenarios. Therefore, it is natural to tackle the H-LU factorization via a task-parallel approach, which has recently reported successful results for related linear algebra problems. In this work, we describe how to discover the data-flow parallelism intrinsic to the operation at execution time, analysing data dependencies based on the memory addresses of tasks' operands. This is especially challenging, as H-matrices data structures dimensions vary during the execution.

18:30-19:00

A multigrid-based approach for the Augmented Block Cimmino Distributed solver

Daniel Ruiz	Université de Toulouse
Philippe Leleux	CERFACS
Ulrich Ruede	FAU Erlangen and CERFACS

Abstract: For unsymmetric sparse linear systems, we propose a hybrid approach based on row-projection techniques, which embeds the original system into a larger one to enforce orthogonality between partitions. The solution is obtained in one iteration, but requires extra computations and memory needs. For large PDE problems, we investigate extensions of this approach, exploiting the prolongation operator from multigrids, in order to relax orthogonality between blocks and save computations, while still maintaining fast rate of convergence.

MS ME-1-1 4 17:00-19:00

Rigorous Numerics towards Characterization of Singular Nature in Dynamical Systems

Organizer: Kaname Matsue	Kyushu University
Organizer: Akitoshi Takayasu	University of Tsukuba

Abstract: Recently mathematical arguments with computer assistance (rigorous numerics) are applied in many problems of differential equations and dynamical systems. This symposium focuses on several recent works of rigorous numerics and related mathematical arguments for validating invariant objects in dynamical systems with "singular" and/or infinite-dimensional features such as blow-up problems, singular perturbation problems and topics involving singularities, and aims at discussing and sharing knowledge of approach as well as perspectives towards other invariant objects with singular nature in dynamical systems.

17:00-17:30

Rigorous numerics for finite-time singularities : fundamentals and perspectives

Kaname Matsue	Kyushu University

Abstract: This talk aims at providing rigorous numerical computation procedure for finite-time singularities in dynamical systems. Based on combination of time-scale desingularization as well as Lyapunov functions validation, we can validate trajectories of dynamical systems including concrete solution profiles, asymptotic behavior and rigorous times involvong finite-time singularity such as blow-up time and extinction time. The present procedure can reveal a universal aspect of mathematical and numerical characterization of various finite-time singularities under common machineries.

17:30-18:00

Rigorous numerics for a singular solution of advection equations with variable coefficients

Akitoshi Takayasu	University of Tsukuba

Abstract: This talk is concerned with a singular solution of advection equations with variable coefficients, which is typical partial differential equations of hyperbolic type. A transformation of space variable based on the characteristic curve eliminates a certain singularity of the solution. Combining semigroup theory with rigorous numerical computations, such a singular solution is obtained quantitatively. We will show numerical examples for illustrating our procedure.

18:00-18:30

Computer-assisted proofs for fast-slow systems

Aleksander Czechowski Delft University of Technology
Piotr Zgliczyński Jagiellonian University

Abstract: Fast-slow systems are notoriously difficult to analyze with rigorous numerics, since the qualitative properties of the solution space change fundamentally when the so-called small parameter is varied from 0 to small non-zero values. I will show how rigorous numerics can be effectively used in combination with topological methods for proving the existence of period and connecting orbits in the near-zero parameter regime.

18:30-19:00

Rigorous numerics for nonlinear heat equations in the complex plane of time

Jean-Philippe Lessard McGill University

Abstract: In this talk, we introduce a computational method to study blow-ups in a complex valued nonlinear heat equation. The blow-up is analyzed by performing a rigorous integration of the Cauchy problem in the complex plane. The constructive existence proof for the solution of the initial value problem is obtained by applying the contraction mapping theorem close to a numerically computed solution. This is joint work with Akitoshi Takayasu (Tsukuba, Japan) and Hisashi Okamoto (Kyoto, Japan).

MS FE-1-3 4 17:00-19:00

Mathematical and Numerical Modeling in Biomechanics - Part 2

For Part 1 see: MS FE-1-3 2

Organizer: Rongliang Chen Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences
Organizer: Stefano Zampini KAUST
Organizer: Luca F. Pavarino Universita` di Pavia
Organizer: Xiao-Chuan Cai University of Colorado

Abstract: The numerical modeling of biological systems, such as blood flows, arteries, and heart deformation takes the form of partial differential equations (PDEs). Some of the PDEs are highly nonlinear and some have to be solved as a coupled system (as in the case of blood-flow-artery interaction). The focus of this minisymposium is on efficient numerical methods and high performance software for solving PDEs arising in the study of biofluid dynamics and biostructural mechanics. Patient-specific problems will be discussed and issues related to the performance of the algorithms on supercomputers with a large number of processing cores will also be addressed.

17:00-17:30

Nonlinear Preconditioning and Its Application in Biomechanics Simulations

Xiao-Chuan Cai University of Colorado

Abstract: We consider nonlinear algebraic equations arising from computational fluid or solid mechanics. When the nonlinearities in the system is well-balanced, Newton's method works well, but when a small number of nonlinear functions in the system are much more nonlinear than the others, Newton may converge slowly or even stagnate. In such a situation, we introduce some nonlinear preconditioners to balance the nonlinearities, and in this talk we discuss some applications of nonlinear preconditioners in biomechanics.

17:30-18:00

IsoGeometric Solvers for Biomechanical Applications

Stefano Zampini KAUST

Abstract: In this talk, we will present results considering second-grade phase field models and generalizing stability analysis.

18:00-18:30

Parameter Identification of Brain Cleaning

Kent-Andre Mardal University of Oslo
Lars Magnus Valnes University of Oslo
Sebastian Mitusch Simula Research Laboratory
Geir Ringstad Oslo University Hospital
Per Kristian Eide Oslo University Hospital
Simon Funke Simula Research Laboratory

Abstract: The proposed glymphatic system suggests a new mechanism for waste clearance from the brain, and has sparked new research on Alzheimer's disease which is associated with metabolic waste accumulation. The glympahtic hypothesis is still controversial and there is urgent need for models. Therefore we will in evaluate to what extent partial differential constrained optimization methods can be used to identify modeling parameters for glymphatic transport. The observations are obtained from novel MRI techniques.

18:30-19:00

ALE Method for a Rotating Structure Immersed in the Fluid and Its Application to the Heart Pump

Wei Leng AMSS, Chinese Academy of Sciences

Abstract: A dynamic fluid-structure interaction (FSI) problem involving a rotational elastic turbine is studied, and an application to a hemodynamic FSI problem involving an artificial heart pump with a rotating rotor is presented. A monolithic mixed ALE finite element method is developed for the hemodynamic FSI system. Numerical simulations are carried out and the method are validated by comparing with a commercial CFD package.

MS GH-0-2 4 17:00-19:00

Mathematical Advances in Batteries - Part 4

For Part 1 see: MS GH-0-2 1
For Part 2 see: MS GH-0-2 2
For Part 3 see: MS GH-0-2 3

Organizer: Iain Moyles York University
Organizer: Matthew Hennessy Mathematical Institute, University of Oxford

Abstract: Batteries are ubiquitous in society with applications in portable electronics, transportation vehicles, and medical devices. An increasing demand for cheaper, longer-lasting, and safer batteries has driven research into understanding the fundamentals of their operation. Using techniques of mathematical modelling, analysis, and simulation, speakers in this session will address research questions of modern significance such as the effect of materials in electrode design, temperature distribution in an operating battery, and battery kinetics in a charge-discharge cycle. Advantages and limitations from geometrical assumptions and parameter scaling will be discussed as will extensions to general electrochemical systems.

17:00-17:30

Asymptotic analysis of electrode heterogeneity in lithium-ion batteries

Toby Kirk University of Oxford
S. Jon Chapman University of Oxford
Colin Please University of Oxford

Abstract: Mathematical models for lithium-ion batteries rely on homogenisation or volume averaging techniques which attempt to simplify the complex microscale structure of electrodes into effective porous-media models. Typically all particles are taken to be the same size out of computational necessity. Using asymptotic techniques, we consider heterogeneity in the electrode by extending the commonly used Single-Particle Model (SPM) to binary mixtures of particles and particle-size distributions, while retaining the simplicity of SPM.

17:30-18:00

Optimal reconstruction of constitutive relations of electrolytes via inverse modelling

Bartosz Protas McMaster University

Abstract: We consider the inverse problem of inferring concentration-dependent material properties of electrolytes, diffusivity and transference number of Lithium ions, from NMR concentration data. We demonstrate how this problem can be solved using adjoint-based methods of PDE optimization with the uncertainty of reconstructions quantified with a Bayesian technique. Judicious application of this framework to systems with increasing ion concentrations allows us to assess the limits of applicability of the Planck-Nernst equation as model for ion transport.

18:00-18:30

Improving lithium plating models in Li-ion batteries to include chemical intercalation

Simon O'Kane Imperial College London
Ian Campbell Imperial College London
Ivan Korotkin University of Southampton/The Faraday Institution
Mohammed Marzook Imperial College London
Giles Richardson University of Southampton/The Faraday Institution
Gregory Offer Imperial College London/The Faraday Institution

Monica Marinescu	Imperial College London/The Faraday Institution

Abstract: In 1999, the standard pseudo-2D continuum model of lithium-ion batteries was extended by Arora, Doyle and White to include lithium plating and stripping at the negative electrode, with incremental improvements being made in later publications. Here, a pseudo-2D model of lithium plating/stripping with chemical intercalation is presented and the results compared with charge/discharge cycle measurements at 273 K, which include CCCV charging at up to 5C.

18:30-19:00

Systematic derivation and limitations of single particle models for lithium-ion batteries

Jamie Foster	University of Portsmouth
Giles Richardson	University of Southampton
Ivan Korotkin	University of Southampton
Michael Castle	University of Portsmouth

Abstract: We show how single particle models (SPMs) can be derived from the pseudo two-dimensional Newman model (P2D) using asymptotic methods. We compare solutions of the SPM and P2D for common chemistries and identify regimes where the SPM gives good predictions, and where it does not. We then demonstrate how the SPM can be generalised to treat blended electrodes, and discuss the implications on how to design microstructired devices with increased performance.

MS GH-3-3 4 17:00-19:00

Model order reduction methods and their broad applications in engineering - Part 3

For Part 1 see: MS GH-3-3 2

For Part 2 see: MS GH-3-3 3

Organizer: Lihong Feng	Max Planck Institute for DCTS
Organizer: Francesco Ferranti	Institut Mines-Télécom Atlantique
Organizer: Valentin De La Rubia	Universidad Politecnica de Madrid

Abstract:

17:00-17:30

A technique for rational model order reduction of parametric problems lacking uniform inf-sup stability

Davide Pradovera	CSQI, EPFL
Fabio Nobile	CSQI, EPFL
Francesca Bonizzoni	University of Vienna
Ilaria Perugia	University of Vienna

Abstract: In this talk we consider parametric PDEs whose operators have meromorphic-like features. We describe an explicit moment-matching technique, named minimal rational interpolation, for model order reduction of such problems. This method does not rely on Galerkin projection of the original system, but instead builds an approximant by solving a small optimization problem, in a fashion somewhat reminiscent of vector fitting. We describe its theoretical convergence results and compare it with other MOR methods.

17:30-18:00

Vehicles Thermal Energy Management using a Machine Learning-based Reduced Bond Graph

Youssef Hammadi	Renault Group / MINES ParisTech
David Ryckelynck	MINES ParisTech
Amin El-Bakkali	Renault Group

Abstract: Renault Group is currently developing a vehicle system-level simulation platform based on the bond graph approach. In order to speed up simulations and accelerate energy optimisation cycles, we introduce here the Reduced Bond Graph method which relies on an unsupervised machine learning offline phase. This methodology is then employed to build a reduced cabin thermal model which is used for some case studies such as air conditioning system sizing, temperature control and thermal energy management.

18:00-18:30

Efficient error estimator for model order reduction of linear parametric systems

Lihong Feng	Max Planck Institute for DCTS
Peter Benner	Max Planck Institute for Dynamics of Complex Technical Systems, Germany

Abstract: We propose an error estimator for reduced-order modeling of linear non-parametric and parametric dynamical systems. The error estimator estimates the error of the reduced transfer function and can be easily extended to output error estimation for reduced-order models of steady linear parametric systems. Compared with an existing error bound, the proposed error estimator can be orders of magnitudes sharper and needs less computational time. It also outperforms an output error estimator based on randomized residual.

18:30-19:00

Reduced Modeling of Riemannian manifolds

Olga Mula	Paris Dauphine University

Abstract: Model reduction of transport-dominated PDEs requires the development of nonlinear approximation methods. We present a novel strategy in this direction which involves tangent spaces of Riemanian manifolds. We will show some theoretical and numerical results illustrating its efficiency on several one-dimensional conservative PDEs: pure transport problems, inviscous and viscous Burger's equations, Camassa-Holm and Korteveg de Vries.

MS GH-0-1 4 17:00-19:00

Modeling and simulation of materials defects and inhomogeneities - Part 4

For Part 1 see: MS GH-0-1 1

For Part 2 see: MS GH-0-1 2

For Part 3 see: MS GH-0-1 3

For Part 5 see: MS GH-0-1 5

For Part 6 see: MS GH-0-1 6

Organizer: Luchan Zhang	National University of Singapore
Organizer: Shuyang Dai	Wuhan University

Abstract: Materials defects and inhomogeneities, such as dislocations and grain boundaries in solids, fluid-solid and fluid-fluid interfaces, and fine microstructures within advanced materials, play essential roles in the mechanical and dynamical behaviors of the materials. The complexity of modeling microstructures of these defects and inhomogeneities, and their evolution at various length and time scales present new challenges for mathematical modeling and analysis. Multiscale and multiphysics models are required to accurately describe the complicated phenomenon associated with defects and inhomogeneities. Speakers in this minisymposium will discuss recent advances in modeling approaches and simulation methods, and new findings obtained in analysis and simulations.

17:00-17:30

Modeling and simulations of continuum dislocation array dynamics

Shuyang Dai	Wuhan University

Abstract: We present a simulation method for the dynamics of dislocation arrays. The driving force of the dislocation array surfaces comes from both the long-range interaction and their local curvature effect. Simulations are performed for dislocation arrays under applied stress. We also consider systems of parallel straight dislocation walls and the climb of dislocation in tilt boundary. We develop continuum descriptions for these short-range interactions of dislocations using asymptotic analysis.

17:30-18:00

Modeling the interatomic potentials by deep learning

Han Wang	IAPCM

Abstract: An active learning algorithm called Deep Potential Generator (DP-GEN) is proposed to automatically generate both accurate and transferable Deep Potential (DP) models for material systems. The algorithm is composed of training, exploration and labeling steps. The method is applied to an aluminum-magnesium alloy system and is demonstrated to generate uniformly accurate DP models with a minimal amount of data.

18:00-18:30

Numerical methods on simulating dynamics of the nonlinear Schrodinger equation with rotation and/or nonlocal interactions

Qinling Tang	Sichuan University

Abstract:

In this talk, we will present efficient numerical methods for simulating dynamics of the nonlinear Schrodinger equation (NLSE) with nonlocal potential and rotation term. The method consists two main merits: (i) a rotating Lagrangian coordinate transformation will be presented to eliminate the rotation term. (ii) efficient and accurate numerical methods will then be presented to evaluate nonlocal potential of different types. In addition, extension to other systems will also be considered.

18:30-19:00

A continuum model for the disconnection mechanism of grain boundary and triple junction motion

Chaozhen Wei	Hong Kong University of Science and Technology
Thomas Spencer	University of Pennsylvania, USA
Luchan Zhang	National University of Singapore, Singapore
Jian Han	University of Pennsylvania, USA
David Srolovitz	University of Pennsylvania, USA
Yang Xiang	The Hong Kong University of Science and Technology

Abstract: We propose a novel continuum description for grain boundary (GB) and triple junction (TJ) kinetics based upon a disconnection mechanism. Disconnections are line defects within a GB and are characterized by both a Burgers vector and a step height. This crystallography-respecting continuum model describes the GB and TJ migration via the thermally-activated nucleation and kinetically-driven motion of disconnections. The simulation results demonstrate the intrinsic coupling between stress, capillarity, and microstructure connectivity in microstructure evolution.

MS FT-0-3 4 17:00-19:00

Numerical Approximations of Geometric Partial Differential Equations - Part 2

For Part 1 see: MS FT-0-3 3
For Part 3 see: MS FT-0-3 5
For Part 4 see: MS FT-0-3 6
For Part 5 see: MS FT-0-3 8

Organizer: Alan Demlow	Texas A&M University
Organizer: Andrea Bonito	Texas A&M University
Organizer: Ricardo Nochetto	University of Maryland

Abstract: Geometric partial differential equations have received much attention recently due to their appearance in models for a wide range of physical processes. This mini-symposium focuses on their numerical approximation, which must overcome highly nonlinear interactions inherent to the approximation of partial differential equations defined on approximate geometries. Experts in modeling, numerical analysis, and scientific computation will discuss recent advances ranging from fundamental considerations concerning the design and analysis of numerical methods to applications in biology, materials science, and fluid dynamics.

17:00-17:30

Problems in cell biology

Charlie Elliott	University of Warwick

Abstract: Mathematical models in cell biology involving biomembranes and cells are of burgeoning interest within biophysical applications, analysis of geometric partial differential equations and numerical analysis. Models of biomembrane and vesicle configurations, receptor ligand dynamics, cell motility, protein interaction and phase separation involve surface and bulk PDEs on complex, evolving and unknown domains. In this talk we discuss the use of evolving finite spaces on evolving meshes in the numerical approximation of such systems.

17:30-18:00

Finite element approximation of two-phase biomembranes

Harald Garcke	University of Regensburg
John W. Barrett	Imperial College, London
Robert Nürnberg	Imperial College, London

Abstract: Biomembranes consisting of multiple phases can undergo complex shape transitions. We study a Cahn-Hilliard model on an evolving hypersurface coupled to Navier-Stokes equations on the surface and in the surrounding medium to model these phenomena. The evolution is driven by a curvature energy, modelling the elasticity of the membrane, and by a Cahn-Hilliard type energy, modelling line energy effects. A stable finite element approximation is introduced and several phenomena occurring for two-phase membranes are computed.

18:00-18:30

On a surface finite element method for cell blebbing

Björn Stinner	University of Warwick

Abstract: We present and discuss a finite element method for a parabolic semi-linear fourth order surface PDE. It is based on approximating the surface by a triangulated surface and a mixed approach involving operator splitting. Linearity in the leading order term yields strong convergence of the gradient so that the lower-order non-linearities can be dealt with. The approach can be used to simulate cell blebbing, for which convenient software is briefly presented.

18:30-19:00

Computational study of lateral phase separation in biological membranes

Maxim Olshanskii	University of Houston
Sheereen Majd	University of Houston
Annalisa Quaini	University of Houston
Vladimir Yushutin	University of Houston

Abstract: Conservative and non-conservative phase-field models are considered for the numerical simulation of lateral phase separation and coarsening in biological membranes. An unfitted finite element method is devised for these models to allow for a flexible treatment of complex shapes. For a set of biologically relevant shapes and parameter values, we compare the dynamic coarsening produced by conservative and non-conservative numerical models, its dependence on certain geometric characteristics and convergence to the final equilibrium.

MS ME-1-6 4 17:00-19:00

Fractal applications in engineering: Theoretical aspects and Numerical approximations - Part 2

For Part 1 see: MS ME-1-6 3

Organizer: Maria Rosaria Lancia	Sapienza Università di Roma
Organizer: Anna Rozanova-Pierrat	CentraleSupélec

Abstract: Many natural and industrial processes lead to the formation of rough surfaces and interfaces. Computer simulations, analytical theories and experiments, led to significant advances , in modeling these phenomena across wild media. Fractals provide a good tool to describe such wild geometries, as well as in the case of those phenomena which take place in small volumes and large surfaces. We focus on the study of problems of mathematical physics in fractal domains both from a theoretical and a numerical point of view, having in mind further developments of fractal and prefractal geometries in industrial applications.

17:00-17:30

Stokes flows in irregular domains

Maria Rosaria Lancia	Sapienza Università di Roma
Paola Vernole	Sapienza Università di Roma

Abstract:
We consider an unsteady Stokes problem with no slip boundary conditions in a three dimensional domain Q with fractal boundary and in the corresponding (smoother) approximating prefractal domains Q
h. We prove existence and uniqueness results for the mild solution via a semigroup approach in both cases. In view of the numerical approximation, it is crucial to study the asymptotic behaviour of the prefractal solution when $h \to +\infty$. We will discuss some results and open problems.

17:30-18:00

Dirichlet forms and vector analysis on fractal spaces

Alexander Teplyaev	University of Connecticut

Abstract: The talk will present theoretical aspects of vector analysis for Dirichlet forms, with applications to vector analysis on non-smooth spaces, such as fractals and fractal membranes in Euclidean space. This is a part of the broader research program with Michael Hinz, Maria Rosaria Lancia, Paola Vernole, Anna Rozanova-Pierrat.

18:00-18:30

ROBINEVOLUTION PROBLEMS IN IRREGULAR DOMAINS

Paola Vernole	Sapienza Rome University

Abstract: We consider parabolic problems, possibly nonlocal, with Robin Venttsel boundary conditions in irregular domains of fractal type. In view of numerical applications we consider the analogous problems in smoother domains approximating the fractal one. Existence, uniqueness of the solutions will be discussed as well as the asymptotic behaviour of the approximating solutions, if any. ,

18:30-19:00

Acoustic scattering by fractal screens II: numerical computations

Andrea Moiola	University of Pavia
Dave P. Hewett	University College London
Simon N. Chandler-Wilde	University of Reading

Abstract: In this pair of talks we study acoustic scattering by a planar screen/crack with fractal boundary (e.g. a Koch snowflake or a Sierpinski triangle). In part II, we discuss the numerical solution of the boundary integral equations using boundary element approximations on prefractals, and apply techniques of Mosco convergence to prove convergence to the solution on the limiting fractal under appropriate conditions on the boundary element meshes.

MS A6-5-3 4 **17:00-19:00**

Mathematical Models in the Systems Biology of Cancer - Part 1

For Part 2 see: MS A6-5-3 5

For Part 3 see: MS A6-5-3 6

Organizer: Juan Belmonte Beitia — UCLM

Organizer: Alicia Martínez González — Universidad de Castilla-La Mancha

Abstract: Recently, a new generation of mathematical and computational models of cancer has emerged that have been built in close collaboration with experimentalists and are primarily aimed at understanding aspects of cancer progression and treatment. For this minsymposium, we strongly encourage authors to submit their original studies in modeling, control and mathematical analysis of tumor growth

17:00-17:30

Modeling low-grade gliomas: natural evolution and response to treatment

Mathilde Badoual	Univ Paris Diderot
Leo Adenis	Paris Diderot University
Basile Grammaticos	CNRS
Christophe Deroulers	Paris Diderot University
Johan Pallud	Paris Descartes University/Sainte-Anne hospital

Abstract: Diffuse low-grade gliomas are slowly growing tumors that mainly affect young adults and are incurable. We present here a model of evolution of these tumors, based on a PDE that describes the evolution of the cell density. This model can describe the natural evolution of gliomas, their response to treatments such as radiotherapy and the changes in their dynamics in pregnant women. The results are quantitatively compared with clinical data.

17:30-18:00

Individual-based and continuum models of cancer invasion

Tommaso Lorenzi — University of St Andrews

Abstract: A growing body of literature supports the idea that mathematical modelling can complement experimental cancer research by offering alternative means of interpreting extant data and by enabling extrapolation beyond empirical observation. This talk deals with individual-based and continuum models of spatial dynamics of cancer cell populations. I will present a number of results which illustrate how analysis and numerical simulation of these models can help uncover fresh insights into the critical mechanisms underpinning cancer invasion.

18:00-18:30

Up close and personal with chemotherapy: embracing the complexity of the tumor microenvironment

Kasia Rejniak — H. Lee Moffitt Cancer Center & Research Institute

Abstract: Systemic chemotherapy is the main anticancer treatment for most kinds of clinically diagnosed solid tumors. However, after a good initial reaction, the tumors often become non-responsive to the drugs. We present a scenario in which tumor micrometastases are exposed to drug treatment in a heterogeneous microenvironment and discus the emergence of drug-induced resistance, the role of microenvironmental niches, refuges and protectorates, and the analysis based on cell viability trajectories and the three-dimensional lineage trees.

18:30-19:00

Mathematical analysis of a generalised model of chemotherapy for low grade gliomas

Monika Piotrowska	University of Warsaw
Marek Bodnar	University of Warsaw
Magdalena Bogdańska	University of Warsaw

Abstract: We present results concerning analysis of mathematical properties of a generalised version of the model proposed by Bogdańska et al. describing growth of low-grade gliomas and their response to chemotherapy. We discuss the stability of steady states, prove global stability of tumour-free state and, in some cases, the existence of periodic solutions. Under some simplifying assumption, we provide analytical estimates and calculate minimal doses of the drug that should eliminate the tumour for particular patients.

MS A6-1-1 4 **17:00-19:00**

Mathematical Optimization and Gas Transport Networks: Academic Developments - Part 2

For Part 1 see: MS A6-1-1 3

Organizer: Julio González-Díaz — University of Santiago de Compostela

Abstract: This minisymposium one of two minisymposia on Mathematical Optimization and Gas Transport Networks. The focus of this one on academic research on the topic, regardless of whether or not the research is part of a collaboration with Industry. On the other hand, the other minisymposium will focus more on works that are the result of collaborations between Academia and Industry, with a special focus on the applied aspects of the attained results.

17:00-17:30

Joint Planning and Operations of Electricity and Gas Networks

Geunyeong Byeon	University of Michigan
Pascal Van Hentenryck	Georgia Institute of Technology

Abstract: This study explores the idea of introducing gas network awareness into the standard unit commitment model. The problem is cast as a tri-level programming, and we reformulate the problem as a Mixed-Integer Second-Order Cone program which can then be solved using a dedicated Benders decomposition. The approach is validated on a case study for the Northeastern United States that can reproduce the gas and electricity price spikes experienced during the early winter of 2014.

17:30-18:00

On probabilistic capacity maximization in a stationary gas network

Holger Heitsch — Weierstrass Institute Berlin

Abstract: We represent a novel mathematical approach in order to assist gas network operators in managing increasing uncertainty with respect to customers gas nominations and in exposing free network capacities while reliability of transmission and supply is taken into account. The approach is based on the rigorous examination of optimization problems with nonlinear probabilistic constraints. Function and gradient evaluations of the involved probability function are performed by spheric-radial decomposition of Gaussian type random variables.

18:00-18:30

Hybrid System Theory for Gas Network Operation

Falk M. Hante — FAU Erlangen-Nürnberg

Abstract: We use the framework of hybrid dynamical systems to model, simulate and optimize transient operation of gas networks including discrete desicisions on valve positions and compressor routes. Posed as switching among abstract evolutions in Hilbert space, we apply descent methods to compute optimal switching sequences using switching time and mode insertion gradients. As one example application, we decompose networks into regions of transient and stationary behavior to balance numerical costs and accuracy.

18:30-19:00

Hydraulic Models for Transient Optimization and Estimation in Natural Gas Networks

Anatoly Zlotnik — Los Alamos National Laboratory

Abstract: Transient optimization, or optimal control of gas pipeline dynamics, was studied extensively and there is a recent resurgence in interest. Comprehensive modeling of components and network topologies; scalability, speed, and accuracy of computations; and data assimilation of state estimates and forecasts in industrial systems, all present ongoing challenges. We describe recently developed models and algorithms for transient optimization, state estimation, and flow forecasting that are promising decision support tools for intra-day gas pipeline operations.

MS FT-2-1 4 **17:00-19:00**

Computing with rational functions - Part 3

For Part 1 see: MS FT-2-1 1

For Part 2 see: MS FT-2-1 2

Organizer: Yuji Nakatsukasa — University of Oxford

Organizer: Nick Trefethen University of Oxford
Organizer: Stefan Guettel The University of Manchester

Abstract: Many numerical algorithms rely on rational functions, whether implicitly or explicitly, because of their power for approximation with singularities or on unbounded domains. This is an exciting time for this field, with many recent developments. In fundamental algorithms these include RKFIT, the AAA method, and advances in the Loewner framework. Application areas include fast solution of PDEs, rational filters for parallel eigensolvers, model order reduction, and nonlinear eigenvalue problems. There have even been recent surprises on the theoretical side of rational approximation. This minisymposium will discuss progress on these challenging methods, whose importance seems set to grow in the future.

17:00-17:30

A block-extension of the RKFUN calculus

Stefan Guettel The University of Manchester

Abstract: The RKFUN implementation in the RKToolbox provides basic methods to work numerically with scalar rational functions: simple arithmetic operations, root- and pole-finding, conversion to partial fraction and continued fraction form, etc. This talk will discuss some recent advances, but also difficulties, in extending the underlying rational Krylov framework to block rational functions.

17:30-18:00

Structural backward stability in rational eigenvalue problems solved via linearization

Froilán M. Dopico Universidad Carlos III de Madrid
María C. Quintana Universidad Carlos III de Madrid (Spain)
Paul Van Dooren Université catholique de Louvain (Belgium)

Abstract: The numerical solution of rational eigenvalue problems (REPs) attracts considerable attention as a consequence of two facts: REPs appear in many applications and are used to approximate other nonlinear eigenvalue problems. The most important method of solving REPs is via linearizations, i.e., by constructing a matrix linear eigenvalue problem with the same eigenvalues as the REP and solving this linear problem. This talk investigates the stability of such approach for a wide class of linearizations.

18:00-18:30

Using rational functions for efficient vector libm implementations

Silviu Filip INRIA Rennes
Anastasia Volkova Inria
Jean-Michel Muller CNRS

Abstract: Over the past decade, hardware platforms with increasing support for parallel execution have become common in the computing spectrum. As such, there is a growing need for mathematical libraries that work efficiently on vectors in an element-by-element basis. In this talk, I will discuss how rational function approximations can be used to design efficient vectorized implementations of various mathematical functions. The focus will be on the advantages and challenges rational functions bring to the table.

18:30-19:00

Bounds on tensor ranks using rational functions

Alex Townsend Cornell University
Tianyi Shi Cornell University

Abstract: Tensors that appear in computational mathematics are so often well-approximated by low-rank structures. In this talk, we will use a rational approximation problem to derive explicit bounds on the compressibility of tensors that have a displacement structure. Our bounds are constructive and lead to efficient solvers for tensor Sylvester equations.

MS A3-3-1 4 17:00-19:00

Theory and Practice of meshless Fluid-Simulations - Part 2

For Part 1 see: MS A3-3-1 3
For Part 3 see: MS A3-3-1 5
Organizer: Christian Rieger RWTH Aachen
Organizer: Matthias Kirchhart MathCCES, RWTH Aachen University

Abstract: The aim of this minisyposium is to bring together researchers in both theoretical and applied aspects of meshless methods. We would especially like to focus on meshless simulations in fluid dynamical applications. This topic includes vortex methods, divergence free radial basis functions and SPH. From a theoretical perspective we would like to focus on the error analysis of such methods and on the analysis of new efficient methods. This includes localizing Lagrange functions, multilevel techniques, PUM and reduced basis methods. A common focus is on boundary effects of meshless methods which is a current challenge in many modern meshless methods.

17:00-17:30

Reproducing kernels and series representations

Barbara Zwicknagl TU Berlin

Abstract: Variational meshless methods based on reproducing kernels are a well-established tool in generalized function reconstruction problems. However, problem-adapted kernel functions are often available only in terms of infinite series expansions. Furthermore, the coefficient vectors of best-approximants in standard basis representations are often non-sparse. I shall discuss analytical properties of regularizations to overcome these problems while maintaining the good approximation properties. This talk is based on joint works with M. Griebel, C. Rieger, and R. Schaback.

17:30-18:00

Nonlinear and anisotropic approximation with Gaussian mixtures

Thomas Hangelbroek University of Hawaii
Amos Ron University of Wisconsin - Madison
Wolfgang Erb University of Padua

Abstract: The dictionary of Gaussian mixtures is used pervasively in scientific applications thanks to the perception that it is universal: its members are sufficiently local in space and frequency to provide efficient approximation to "almost all objects of interest". However, only a handful of theoretical results are known comparing its performance to mainstream representation systems. This presentation discusses its suitability for solving problems in PDEs and fluid mechanics, and presents some recent theoretical results.

18:00-18:30

Method of Fundamental Solutions for Extended Gas Dynamics

Manuel Torrilhon RWTH Aachen

Abstract: The method of fundamental solution (MFS) uses Green's functions to numerically solve partial differential equations. We present continuum models for rarefied non-equilibrium gas dynamics derived from Boltzmann equation and discuss their properties and Green's function. MFS could allow to produce very accurate solutions of these equations efficiently.

MS A3-S-C2 4 17:00-19:00

Geometric shape generation: integrability, variational analysis and applications - Part 1

For Part 2 see: MS A3-S-C2 5
For Part 3 see: MS A3-S-C2 6
For Part 4 see: MS A3-S-C2 7
For Part 5 see: MS A3-S-C2 8
For Part 6 see: MS A3-S-C2 9
Organizer: Kenji Kajiwara Kyushu University
Organizer: Udo Hertrich-Jeromin TU Wien
Organizer: Miyuki Koiso Kyushu University
Organizer: Schief Wolfgang The University of New South Wales

Abstract: This minisymposium is aimed at the discovery of state of the art geometric shape generation, based on methods from smooth and discrete differential geometry. In response to needs and problems raised by industrial applications, various geometric methods to generate desirable or "good" shapes have been developed, that emphasize the underlying structure of an integrable systems or variational approach. The topics addressed will range from problems raised in architecture and industrial design to the mathematical framework used to tackle them, and the modeling and analysis of smooth or discrete curves and surfaces to be used in shape design.

17:00-17:30

Curves and Surfaces

Udo Hertrich-Jeromin Technical University of Vienna
Francis Burstall Univ of Bath
Maria Lara Miro TU Wien

Abstract: We will discuss how (semi-)discrete surfaces are generated using transformations of curves resp based on Bianchi permutabilty, and we will show how this approach allows to tackle a boundary value problem for (semi-)discrete principal nets.

17:30-18:00

Discrete integrable surface geometry

Francis Burstall University of Bath

Abstract: The most basic integrable surface geometry is that of isothermic nets in a quadric. By using a discrete exterior calculus, I shall sketch an approach to these nets that, when applied to the Lie quadric of 2-spheres in the 3-sphere, allows us to find a convincing discretisation of Demoulin's omega-surfaces and their specialisations.

18:00-18:30

Weierstrass-type representations

Mason Pember TU Wien

Abstract: The Weierstrass representation has been utilised effectively to create interesting examples of minimal surfaces in Euclidean 3-space. Since the 1980s several Weierstrass-type representations have been developed for creating surfaces with certain curvature in non-Euclidean space forms. In this talk we will show that the existence of these representations can be described in a unified way by using the classical transformation theory of Omega surfaces.

18:30-19:00

Discrete surfaces in Lie sphere geometry

Gudrun Szewieczek Technical University of Vienna

Abstract: In classical and integrable geometry, remarkable results have been achieved by considering smooth surfaces in Lie sphere geometry. Instead of thinking of a surface as a collection of points, one considers a 2-family of pencils of spheres tangent to the surface ('contact elements'). In this talk we discuss how this concept can be adopted for discrete surfaces and report on recent developments: the construction of discrete surfaces with circular ('channel surfaces') or spherical curvature lines.

MS GH-1-3 4 17:00-19:00

Current Developments in Wavelett- Fractal Methods with Applications - Part 4

For Part 1 see: MS GH-1-3 1
For Part 2 see: MS GH-1-3 2
For Part 3 see: MS GH-1-3 3
Organizer: Abul Hasan Siddiqi
Siddiqi Sharda University
Organizer: Nekka Fahima Université de Montréal
Organizer: Akhtar A. Khan Rochester Institute of Technology
Rochester, New York
Organizer: Pammy Manchanda Guru Nanak Dev University

Abstract: Wavelet and Fractal Methods were invented in early eighties. The basic work of the initial stages are very well documented in the book of Daubechies 1992 and Y. Meyer 1993, SIAM. An updated historical development has been presented in chapter 12 of a recent book by the organizer of the symposium published by Springer in 2018. This symposium in three parts is devoted to certain topics dicussed in three monographs by Springer in recent past namely multivariate wavelet frames, 2016, industrial mathematics and complex systems, 2017 & wavelets constructed by Walsh functions, 2018.

17:00-17:30

Recent results on a generalized residue theorem and its applications

Luis Manuel Sánchez Ruiz Universitat Politècnica de València, Spain

Matilde Legua Universidad de Zaragoza

Abstract: Glauert integrals involve an improper integral of an unbounded trigonometric function with some singularity within its interval of integration. These integrals do appear in Aerodynamics applications and consequently a number of authors have studied it. In this paper we show a straightforward method to evaluate this integral by adequately applying the classical residue theorem of complex variables and a generalization of Cauchy principal value to contour integrals of meromorphic functions.

17:30-18:00

Certain Problems in Computational Linguistics

Sana Arif Ansari ALIGARH MUSLIM UNIVERSITY

Abstract: Computational linguistics is the scientific discipline concerned with understanding written and spoken language from a computational perspective. The central task of computational linguistics is the development of cognitive machines which are capable of communicating in the natural languages of humans. As an interdisciplinary field, computational linguistics has relationship with wavelet and fractal methods this will be elaborated in the talk.

18:00-18:30

Current Developments on Analysis and Prediction of Epileptic Seizures

Pragati Tripathi Tripathi Sharda University
Abul Hasan Siddiqi Sharda University

Abstract: A human brain is an important organ which controls the functioning of the body. Seizures are sudden surge of electrical activity in the brain that affects how a person feels for a short duration of time. Epilepsy is a common neurological disorder characterized by recurrent seizures. Wavelet transform has emerged as favored tool for the study of epileptic brain activity. The talk is devoted to the study of wavelet analyzing and prediction of epileptic seizures.

MS GH-3-4 4 17:00-19:00

Nonlocal Modeling, Analysis, and Computation - Part 4

For Part 1 see: MS GH-3-4 1
For Part 2 see: MS GH-3-4 2
For Part 3 see: MS GH-3-4 3
For Part 5 see: MS GH-3-4 5
Organizer: Robert Lipton Louisiana State University
Organizer: Qiang Du Columbia University
Organizer: Pablo Seleson Oak Ridge National Laboratory

Abstract: The past decade has seen a rapid growth in the development of nonlocal mathematical models. Nonlocal modeling is now being used in applications including continuum mechanics and fracture mechanics, anomalous diffusion and advection diffusion, and probability models. This minisymposium seeks to bring together mathematicians and domain scientists from different disciplines working on nonlocal modeling and is intended to serve as international forum for the state of the art in the modeling, analysis, and numerical aspects of nonlocal models.

17:00-17:30

Nonlocal dispersive effective model for wave propagation in periodic media

Xiaochuan Tian The University of Texas at Austin

Abstract: We consider wave propagation in periodic media. Bloch wave expansion is used to get a spatially nonlocal wave equation as the effective model under small cell size, which is a global approximation of wave propagation in periodic media for all time. Such nonlocal model is necessary when global approximation is needed. The nonlocal effective model has a “horizon” — the length of nonlocal interaction — that is related to the cell size.

17:30-18:00

Poincare Type Inequalities for Convolution Operators

Mikil Foss University of Nebraska-Lincoln

Abstract: Convolution operators with weakly singular kernels have become an important component of models of phenomenon with discontinuities, such as fracture and tearing. For these models, existence and correspondence results often rely on coercivity properties of the operator in an appropriate space. I will present some new Poincare type inequalities for nonhomogeneous nonisotropic operators that provide coercivity in Lebesgue spaces.

18:00-18:30

Nonlocal models the localization of damage and dynamic brittle fracture in state based peridynamics

Robert Lipton Louisiana State University
Prashant Jha LSU

Abstract: We introduce a nonlocal model for calculating dynamic fracture. The force interaction is derived from a double well strain energy density function. The material properties change in response to evolving internal forces. The model can be viewed as a regularized fracture model. In the limit of zero nonlocal interaction, the model recovers a sharp interface evolution characterized by the classic Griffith free energy of brittle fracture. This is joint work with Prashant Jha.

MS ME-0-7 4 17:00-19:00

Partial Differential Equations in Fluid Dynamics - Part 4

For Part 1 see: MS ME-0-7 1
For Part 2 see: MS ME-0-7 2
For Part 3 see: MS ME-0-7 3

Organizer: Yachun Li Shanghai Jiao Tong University
Organizer: Tong Yang City University of Hong Kong
Organizer: Ya-Guang Wang Shanghai Jiao Tong University
Organizer: Yue-Jun Peng CNRS/UCA LMBP

Abstract: The purpose of this minisymposium is to bring together mathematicians from all over the world in the area of partial differential equations to present their recent research results in analysis and applications about related models in fluid dynamics, to exchange new ideas, to discuss current challenging issues, to explore new research directions and topics, and to foster new collaborations and connections.

17:00-17:30

Euler-Poisson equations for semiconductors with sonic boundary

Ming Mei McGill University

Abstract: In this talk, we consider a hydrodynamic system of semiconductors in the form of Euler-Poisson equations. When the boundary is subjected as sonic (a critical case with degeneracy), we first carify the structure of subsonic/supersonic/transonic steady-state solutions, then we further study the large-time behavior of solutions. This talk is based on a series of joint works with Jingyu Li, Guojing Zhang, and Kaijun Zhang.

17:30-18:00

Decay rates to isentropic compressible Navier-Stokes equations with discontinuous initial data

Xianpeng Hu City University of Hong Kong

Abstract: In this talk, we will discuss the recent progress on decay rates of isentropic compressible Navier-Stokes equations with discontinuous initial data.

18:00-18:30

Boundary layer equations in the kinetic theory of gases

Niclas Bernhoff Karlstad University

Abstract: Half-space problems are of great importance in the study of the asymptotic behavior of solutions of boundary value problems for the Boltzmann equation for small Knudsen numbers. They provide the boundary conditions for the fluid-dynamic-type equations and Knudsen-layer corrections to the solution of the fluid-dynamic-type equations in a neighborhood of the boundary. We will discuss a general half-space problem in kinetic theory, and its possible applications. This is based on joint work with F. Golse.

18:30-19:00

Relaxed Euler systems and convergence to Navier-Stokes equations

Yue-Jun Peng CNRS/UCA LMBP

Abstract: We consider the approximation of Navier-Stokes equations for a Newtonian fluid by Euler type systems with relaxation. This requires to decompose the second-order derivative terms of the velocity into first-order ones. Hurwitz-Radon matrices are used for this decomposition. We prove the convergence of the approximate systems to the Navier-Stokes equations locally in time for smooth initial data and globally in time for initial data near constant equilibrium states.

MS ME-1-I1 4 17:00-19:00

Time-delayed systems: analysis and applications

Organizer: Yuliya Kyrychko University of Sussex

Abstract: Time delays are an integral part of many 'real-world' systems owing to the finite speed of signal propagation, synaptic processing delays, reaction times etc. In communication and transport networks, delays are detrimental and cause multi-million pound losses. In other situations, time delays have been successfully used to encrypt information, to control unstable motion in engineering experiments, and to explain oscillations in animal populations. The inherent nature of delays makes delay differential equations an ideal tool to model many real-life processes. This mini-symposium will address the challenges of analysing time-delayed systems, and present latest developments across a number of application areas.

17:00-17:30

Dynamics of systems with distributed delays

Yuliya Kyrychko University of Sussex

Abstract: Many physical, biological and engineering processes can be represented mathematically by models of coupled systems with time delays. Time delays in such systems are often either hard to measure accurately, or they are changing over time, so it is more realistic to take time delays from particular distribution rather than assume them to be constant. In this talk, I will show how distributed time delays affect the stability of solutions in systems of coupled oscillators.

17:30-18:00

Travelling waves with small and large amplitude in an oscillatory system with time delay

Michael Stich Aston University

Abstract: In this presentation, we study how the combination of global and spatially distributed time delay feedback changes the dynamics of the complex Ginzburg-Landau equation, with a special emphasis on the stabilization of travelling waves. We discuss several kinds of travelling waves: plane waves similar to those in the complex Ginzburg-Landau equation without feedback, large-scale waves for purely local feeback, and small-scale waves close to parameter areas of vanishing oscillations.

18:00-18:30

Calculation of critical delay for feedback systems: the inverted double pendulum

Csenge Andrea Molnar Budapest University of Technology and Economics

Abstract: An analytical method is used for determining the critical time delay for two-degree-of-freedom undamped second-order systems with full-state feedback. The method is based on the maximal admissible multiplicity of the rightmost root of the characteristic equation. As a case study, balancing of a double inverted pendulum on a cart is analyzed. The results are confirmed by other numerical methods.

18:30-19:00

Pattern Forming Delay-Coupled Swarms and the Physics of Mixed Reality

Ira Schwartz US Naval Research Laboratory
Klimka Szwaykowska Georgia Tech Research Institute
Jason Hindes US Naval Research Laboratory
Ani Hsieh University of Pennsylvania

Abstract: Small-noise simulated models connected to more noisy physical experiments, as in mixed-reality systems, leads to systems having skewed distributed noise sources. We consider dynamics of mixed-reality delay-coupled swarms, and show how noise in the physical part of the system influences the virtual dynamics through large fluctuations. We quantify characteristic noise induced switching times as a function of coupling and delay, and show the virtual world switching probability scales inversely as the square of noise amplitude.

IM FT-4-4 4 17:00-19:00

ECMI SIG Mathematics for Big Data - Optimization and Statistics

Organizer: Natasa Krklec Jerinkic Faculty of Sciences, University of Novi Sad

Abstract: This session will present several application cases of optimization, statistical and machine learning-based data analytics methods. One of the applications predicts daily pollen concentrations as they represent an important issue of public health in Pannonian Plain. Forecasting includes optimization, time series and machine learning methods to form short-term and long-term predictions. On the other hand, land use distribution in agriculture is addressed by means of statistical analysis including both spatial and temporal aspects. Finally, application of big data algorithms on various problems such as forecasting emergency room affluence will be presented.

17:00-17:30

Predicting daily pollen concentrations via time series and optimization - RealForAll project

Natasa Krklec Jerinkic Faculty of Sciences, University of Novi Sad
Dusan Jakovetic Faculty of Sciences, University of Novi Sad
Natasa Krejic Faculty of Sciences, University of Novi Sad
Branko Sikoparija Biosense Institute, University of Novi Sad

Abstract: Daily pollen concentrations represent an important issue of public health in Pannonian Plain. Predicting pollen concentrations can help affected people planning their activities better and improve their quality of life. We present a model for obtaining long-term predictions based on historical data of pollen concentrations and relevant meteorological features such as average daily temperature. Results obtained on three major allergens in Novi Sad show that incorporating optimization techniques improves the prediction performance significantly.

17:30-18:00

Pattern matching method for the short-term pollen prediction

Slobodan Jelic J. J. Strossmayer University of Osijek Depart

Abstract: In this paper we present pattern matching methods for time-series forecasting. These methods aim to find a set of patterns which represent similar situations in time series. In order to predict target variable, different types of fitting methods can be applied to set of data that belongs to the same pattern. Our approach is applied to short-term prediction of airborne pollen concentrations. We give experimental results about comparison of our method to some common approaches.

18:00-18:30

Spatio-temporal statistical analysis of land use distribution in agriculture

Alessandra Micheletti	Università degli Studi di Milano
Giacomo Aletti	Università degli Studi di Milano
Danilo Bertoni	Università degli Studi di Milano
Davide Fugazza	Università degli Studi di Milano
Giulia Ferrandi	Technical University of Eindhoven
Daniele Cavicchioli	Università degli Studi di Milano
Roberto Pretolani	Università degli Studi di Milano

Abstract: This work represents a preliminary attempt to evaluate ex-post impact of the common agricultural policy (CAP) greening payment on farmland use changes. We analysed at a very detailed (parcel) level the temporal and spatial dynamics of farmland use transitions before and after the introduction of greening commitments, in Lombardy region in Italy. The system has been modelled as a Markov chain, evolving, from one year to the other, into one of 23 cultivation classes.

18:30-19:00

Big Data algorithms in the wild: predicting perceived safety from heterogeneous unintended data sources

Claudia Soares Larsys Instituto Superior Tecnico

Abstract: How citizens perceive safety has been a major concern in urban life, but perceptual measurements are not trivial to capture in a city-wide scale. We developed a stable, accurate estimator for space-time human perception based on crowdsourced comparisons, minimizing disagreement between comparisons, taking into account continuity of perception in space and disparity in time. We base our approach on a convex model of the data, combining human comparisons, walking distances between positions and data recency.

MS ME-1-2 4 17:00-19:00

Discrete Dynamics and Applications

Organizer: Pötzsche Christian Alpen-Adria-Universität Klagenfurt

Organizer: Eduardo Liz Universidade de Vigo

Abstract: This session focuses on Difference Equations and Discrete Dynamical Systems. Topics include stability, bifurcations, complex dynamics, periodicity and global behavior both for autonomous and nonautonomous equations. Applications are particularly welcome, with special attention to Mathematical Biology. Our speakers address contemporary questions dealing with the global behavior of discrete-time models relevant in applications.

17:00-17:30

Global stability in one-dimesional population models revisited

Daniel Franco Leis	Universidad Nacional de Educación a Distancia
Juan Perán	UNED
Juan Segura	U. Pompeu Fabra

Abstract: In the talk, we will present a new method to study the stability of one-dimensional discrete-time models. The method is based on studying the graph of a certain family of functions. We will study the relation between this new method and the enveloping technique introduced by P. Cull. Moreover, we will show that this method complements and extends some sufficient conditions for global stability in the literature.

17:30-18:00

On the dynamics of delay difference equations

Ábel Garab	University of Klagenfurt
Christian Pötzsche	University of Klagenfurt, Austria

Abstract: First we give sufficient conditions on the uniform boundedness and permanence of nonautonomous multiple-delay difference equations of the form where . This implies the existence of the global (pullback) attractor, provided the right-hand side is continuous. Then, based on an integer-valued Lyapunov function, we give a so-called Morse decomposition of the global attractor for the equation where fulfils certain feedback conditions. The results apply for models by Ricker, Pielou, Mackey–Glass, Wazewska–Lasota, and Clark.

18:00-18:30

Melnikov type results for some periodic non-autonomous discrete dynamical systems

Armengol Gasull Universitat Autònoma de Barcelona

Abstract: We study the number of periodic solutions of linear, Riccati and Abel differential or difference equations. We recover some known results for the corresponding differential equations and obtain new ones for the difference equations. We prove that there is no upper bound for the number of isolated periodic solutions of Abel difference equations by using a suitable discrete Melnikov function. Talk based on a joint work with M. Bohner and C. Valls.

18:30-19:00

Asymptotic Behavior of Positive Solutions of Nonautonomous Linear Difference Equations

Mihály Pituk University of Pannonia

Abstract: In this talk we will summarize our recent results on the asymptotic behavior of the positive solutions of nonautonomous linear difference equations. We will focus on results about the Lyapunov exponents and asymptotic formulas for the positive solutions.

MS A3-2-1 4 17:00-19:00

Cartesian CFD Methods for Complex Applications - Part 4

For Part 1 see: MS A3-2-1 1

For Part 2 see: MS A3-2-1 2

For Part 3 see: MS A3-2-1 3

Organizer: Ralf Deiterding University of Southampton

Organizer: Kai Schneider Aix-Marseille Université, I2M

Organizer: Margarete Oliveira Domingues National Institute for Space Research

MS Organized by: SIAG/CSE

Abstract: Cartesian discretization approaches are ubiquitous in computational fluid dynamics. When applied to problems in geometrically complex domains or fluid-structure coupling problems, Cartesian schemes allow for automatic and scalable meshing; however, order-consistent immersed boundary conditions and efficient dynamic mesh adaptation take forefront roles. This symposium will highlight cutting-edge applications of Cartesian CFD methods and describe the employed algorithms and numerical schemes. An emphasis will be laid on complex multi-physics applications like magnetohydrodynamics, combustion, aerodynamics with fluid-structure interaction, solved with various discretizations, e.g. finite difference, finite volume, multiresolution or lattice Boltzmann CFD schemes. Software design and parallelization challenges will be addressed briefly.

17:00-17:30

Lattice Boltzmann simulations of oscillating elastic plates in viscous flow

Alexander Alexeev	Georgia Institute of Technology
Ersan Demirer	Georgia Institute of Technology

Abstract: We examine oscillations of a flexible elastic plate in a viscous fluid using a fully coupled fluid-structure interaction three-dimensional computational method that is based on the lattice Boltzmann and lattice spring models for the hydrodynamics and solid mechanics, respectively. We probe the hydrodynamic forces and fluid structures generated by the plate to identify strategies for fish-like underwater locomotion. We show that plate thickness tapering leads to significant enhancement of the swimming efficiency.

17:30-18:00

Adaptive Cartesian lattice Boltzmann methods in the AMROC framework and comparison with a non-Cartesian approach

Ralf Deiterding	University of Southampton
Christos Gkoudesnes	University of Southampton
Juan Antonio Reyes Barraza	University of Southampton

Abstract: We describe the incorporation of lattice Boltzmann schemes into our parallel block-structured adaptive mesh refinement framework AMROC, which uses a level set to represent geometrically complex moving surfaces on the Cartesian mesh. Supplemented with large-eddy simulation (LES) turbulence models the software is capable of simulating realistic aerodynamics configurations at a fraction of the costs of conventional CFD solvers. A comparison with a novel non-Cartesian prototype illustrates the benefits of a planned extension for wall-resolved LES.

18:00-18:30

Semi-lagrangian particles, high performance computing and applications in CFD

Jean-Baptiste Keck	University of Grenoble
Cottet Georges-Henri	Univ. Grenoble Alpes, CNRS, Grenoble INP, LJK, 38000 Grenoble, France
Mortazavi Iraj	M2N, EPN6, CNAM, 2 rue Conté, 75003 Paris, France
Picard Christophe	Univ. Grenoble Alpes, CNRS, Grenoble INP, LJK, 38000 Grenoble, France

Abstract: We will present a high performance direct numerical solver for the resolution of fluid dynamics applied to a sedimentation problem. In a first part we will introduce the HySoP library, a framework that combines efficient numerical methods running on distributed hybrid CPU-GPU computing platforms. In a second part we will introduce and solve the problem by coupling the Navier-Stokes equations with two additional advection-diffusion equations modelling the transport of two scalars representing the sediment phases.

18:30-19:00

Why direct particle-fluid simulation?

Wolfgang Schroeder	RWTH Aachen
Schneiders Lennart	Institute of Aerodynamics, RWTH Aachen University, Wüllnerstr. 5a, 52062 Aachen, Germany
Meinke Matthias	Institute of Aerodynamics, RWTH Aachen University, Wüllnerstr. 5a, 52062 Aachen, Germany

Abstract: An unstructured-Cartesian-mesh method for viscous flows will be presented. A new explicit Runge-Kutta scheme is introduced which significantly reduces the computational time for tracking moving boundaries and reinitializing the solver without lowering stability or accuracy. The structural motion is computed by an implicit scheme with high stability due to an iterative strong-coupling strategy. The efficiency and accuracy of the method are demonstrated for a cloud of particles of Kolmomorov size in decaying isotropic turbulence.

MS FT-2-6 4 17:00-19:00

Fast algorithms for integral equations and their applications - Part 3

For Part 1 see: MS FT-2-6 2

For Part 2 see: MS FT-2-6 3

Organizer: Carlos Eduardo Cardoso Borges	University of Central Florida
Organizer: Min Hyung Cho	University of Massachusetts Lowell

MS Organized by: SIAG/CSE

Abstract: The recent advances in integral equations and its fast numerical methods have provided useful tools for many applications ranging from nano-optics to medical imaging and geosciences. This mini-symposium will discuss challenges in the formulation of the problem, cutting-edge fast algorithms and their efficient implementation, their applications in various fields. At the same time, it will provide opportunities to promote interdisciplinary research collaboration between computational scientists and other fields.

17:00-17:30

Fast direct solution techniques for quasi-periodic multilayered medium scattering problems

Adrianna Gillman	Rice University
Yabin Zhang	Rice University

Abstract: Being able to accurately and efficiently solve quasi-periodic scattering problems involving multi-layered medium is important for the design of composite materials. This talk presents a fast direct solver for the linear system that results from discetizing a robust integral equation. The direct solver scales linearly with respect to the number of discretization points and the precomputation is able to be reused for all right hand sides.

17:30-18:00

A Fast Boundary Integral Method for Generating High-order Meshes

Mike O'Neil	NYU
Felipe Vico	U. Valencia
Manas Rachh	Flatiron Institute
Leslie Greengard	Courant Institute, NYU

Abstract: In order to develop high-order integral equation-based solvers for boundary value problems in three dimensions, all aspects of the solver must be high-order: discretization of the unknown, quadratures, and importantly, the description of the underlying surface geometry. In this talk we will describe a recently developed algorithm for transforming a flat triangulation of a smooth boundary into a high-order curvilinear triangulation that can be coupled with high-order integral equation methods.

18:00-18:30

BIEST: A High-Order BIE Solver for Computing Taylor States in Stellarators

Dhairya Malhotra	New York University
Antoine Cerfon	New York University
Lise-Marie Imbert-Gerard	University of Maryland
Michael O'Neil	New York University

Abstract: We present BIEST (Boundary Integral Equation Solver for Taylor states), a fast high-order numerical solver for computing stepped pressure ideal magnetohydrodynamic equilibrium in stellarators. Our formulation is based on the generalized Debye representation for the time-harmonic Maxwell's equations which results in a second-kind boundary integral equation. We will discuss efficient parallel algorithms for solving these boundary integral equations and present numerical results on several challenging geometries to show the efficacy of our solver.

18:30-19:00

Integral equation formulations for electromagnetic scattering problems on smooth geometries

Felipe Vico	Universidad Politecnica de Valencia

Abstract: In this talk we present different formulations for the electromagnetic scattering of perfect electric conductors and dielectrics. The formulations are based on the boundary integral equation method. The integral equations presented are of the second kind and stable in low frequency. High order and adaptive discretization methods are used to solve the problems in complex smooth geometries. A theoretical and numerical study of the conditioning of the formulations is also presented.

MS ME-0-1 4 17:00-19:00

Polygonal and Polyhedral Methods in Applied Mathematics - Part 4

For Part 1 see: MS ME-0-1 1

For Part 2 see: MS ME-0-1 2

For Part 3 see: MS ME-0-1 3

Organizer: Marco Verani	Politecnico di Milano
Organizer: David Mora	Universidad del Bio-Bio

Abstract: Recently, there has been a great interest to the study of numerical methods for the solution of PDEs on polygonal/polyedral computational meshes. This is motivated on one hand by the flexibility of polytopal meshes that allows, e.g., to effectively deal with complex geometries or with refinement/derefinement strategies, and on the other hand by the versatility to accurately facing the numerical approximation of a variety of problems (from fluidynamics, to elasticity and electromagnetism). The goal of this MS is to present the recent developments in the field of polygonal numerical methods in facing the approximation of applied problems governed by PDEs

17:00-17:30

Stabilizing the Virtual Element Method by a Reduced Basis Approach

Silvia Bertoluzza	IMATI-CNR
Daniele Prada	CNR-IMATI

Abstract: We propose here to design the stabilization term for the Virtual Element Method by resorting to a Reduced Basis approach in order to compute very cheaply a rough approximation of the VEM basis functions. These are to be used only to compute an approximate stiffness matrix which enters the definition of a stabilization term, which, for very badly shaped elements will exhibit a much sharper spectral equivalence to the true local stiffness matrix.

17:30-18:00

Symplectic HDG methods for elastodynamics

Manuel Sánchez Sánchez	Pontificia Universidad Catolica de Chile
Bernardo Cockburn	School of Mathematics, University of Minnesota
Ngoc-Cuong Nguyen	Department of Aeronautics and Astronautics, Massachusetts Institute of Technology
Jaime Peraire	Department of Aeronautics and Astronautics, Massachusetts Institute of Technology

Abstract: We introduce the first symplectic hybridizable discontinuous Galerkin (HDG) method for linear and nonlinear elastodynamics. We derive the fully discrete method discretizing first in space by HDG methods preserving the Hamiltonian structure of the equations. We then use symplectic integrators to discretize in time. The fundamental feature of the resulting scheme is that the conservation of a discrete energy is guaranteed. We present numerical examples illustrating the optimal approximation and energy-conserving properties of the method.

18:00-18:30

Stabilizing DG methods on polygonal meshes via dual scalar products

Daniele Prada	IMATI CNR - Pavia

Abstract: We propose a Hybridized Discontinuous Galerkin method on polygonal tessellation, with a stabilization term penalizing, locally in each element K, a residual term involving the fluxes, measured in the norm of the dual of H1(K). The scalar product corresponding to such a norm is numerically realized by introducing auxiliary spaces that allow to achieve robustness either in presence of very small edges or for increasing order of approximation. Numerical tests confirm the theory.

18:30-19:00

Recent advances on Hybrid High-Order methods for problems in incompressible fluid mechanics

Daniele Di Pietro	University of Montpellier
Lorenzo Botti	University of Bergamo
Daniel Castanon-Quiroz	University of Montpellier
Jérôme Droniou	Monash University

Abstract: Hybrid High-Order methods provide a framework for the discretisation of PDE problems with features that set it apart from traditional ones: the support of polytopal meshes and arbitrary approximation orders in any space dimension; an enhanced compliance with the physics; a reduced computational cost thanks to the compact stencil along with the possibility to locally eliminate a large portion of the unknowns. We present recent developments concerning their applications to the incompressible Navier-Stokes equations.

MS FT-S-8 4 17:00-19:00

Recent advances in numerical methods for evolutionary partial differential equations - Part 3

For Part 1 see: MS FT-S-8 1

For Part 2 see: MS FT-S-8 2

Organizer: Sebastiano Boscarino	University of Catania
Organizer: Giovanni Russo	Università di Catania

Abstract: The purpose of the MS is to gather researchers interested in efficient methods for the numerical solution of evolutionary partial differential equations. Several issues will be considered, ranging from the proposition and analysis of new families of methods, including semi-implicit schemes for multiscale evolutionary problems, to applications in fluid dynamics, continuum mechanics and kinetic theory. The MS is structured in three parts: development and analysis of numerical schemes (part 1), innovative schemes for continuum mechanics, degenerate parabolic equations, and electromagnetism (part 2), semi-implicit schemes and applications to kinetic theory and fluid dynamics (part 3).

17:00-17:30

An explicit, semi-Lagrangian advection–diffusion solver for Navier–Stokes equations

Roberto Ferretti	Università Roma Tre
Luca Bonaventura	MOX - Politecnico di Milano
Elisa Calzola	Dipartimento di Matematica, "Sapienza" Università di Roma
Elisabetta Carlini	Dipartimento di Matematica, "Sapienza" Università di Roma

Abstract: We will discuss the construction of a fully Semi-Lagrangian advection–diffusion solver, and its use in the solution of Navier-Stokes equations. The scheme proves to be effective and computationally inexpensive; moreover, it allows for large Courant numbers, avoids the introduction of undue numerical viscosity and remains stable up the the hyperbolic limit. We will present the scheme, discuss the implementation issues (in particular, boundary conditions), and show numerical tests on classical benchmarks.

17:30-18:00

Error estimation for implicit-explicit general linear methods

Giuseppe Izzo	Università degli Studi di Napoli Federico II
Angelamaria Cardone	Università degli Studi di Salerno, Italy
Zdzislaw Jackiewicz	Arizona State University, Tempe, AZ, USA

Abstract: We investigate implicit-explicit general linear methods for differential systems with stiff and non-stiff parts. Stage order and order conditions are formulated and estimation of local discretization errors in fixed and variable stepsize environments is discussed. We also describe the construction of such methods with desirable accuracy and stability properties.

18:00-18:30

High order asymptotic preserving scheme for multi-scale kinetic equations

Tao Xiong	Xiamen University
Francis Filbet	University Toulouse III

Abstract: Kinetic equations which arise from dilute gas dynamics or plasma physics have a great challenge for numerical simulations. It is mainly due to its multi-scale structure and high dimensionality. Asymptotic preserving schemes have been proposed for the multi-scale structure. In our work, we propose a hybrid method, namely we solve the kinetic and CNS equations in regions where their corresponding models are appropriate. Numerical experiments demonstrate the efficiency and effectiveness of our proposed approach.

18:30-19:00

High order conservative semi-Lagrangian scheme for the BGK model of the Boltzmann

SeungYeon Cho	Sungkyunkwan University
Sebastiano Boscarino	University of Catania
Giovanni Russo	University of Catania
Seok-Bae Yun	Sungkyunkwan University

Abstract: In this work, we present a conservative semi-Lagrangian finite-difference scheme for the BGK model. Classical semi-Lagrangian finite-difference schemes allow large time steps, however, such schemes are not conservative. To treat this problem, we use the discrete Maxwellian introduced by Mieussens and implement a conservative correction procedure based on the flux difference form. As a consequence, we can construct a conservative semi-Lagrangian scheme which is Asymptotic Preserving (AP) for the underlying Euler limit.

MS A1-2-4 4 17:00-19:00

Lattice Boltzmann Method for CFD - Part 2

For Part 1 see: MS A1-2-4 3

Organizer: Li-Shi Luo	Computational Science Research Center (CSRC)
Organizer: Manfred Krafczyk	TU Braunschweig
Organizer: Paul Dellar	University of Oxford

MS Organized by: SIAG/CSE

Abstract: We propose to organize a minisymposium on ``Lattice Boltzmann Method for CFD'' at ICIAM~2019. Mesoscopic or kinetic methods have become versatile and competitive alternatives for computational fluid dynamics (CFD). The mesoscopic/kinetic methods are derived from the Boltzmann equation or microscopic dynamics, as opposed to the conventional CFD methods based on direct discretizations of the Navier-Stokes equations. Due to their kinetic basis, mesoscopic methods can model the extended hydrodynamics beyond the continuum regime.

17:00-17:30

Applications of the nonlinear Taylor expansion method at high order

Francois Dubois	l'Université Paris Sud à Orsay

Pierre Lallemand CSRC, Beijing, China

Abstract: We apply the Taylor expansion method to put in evidence Navier-Stokes type partial differential equations for two and three-dimensional lattice Boltzmann schemes. The remaining errors due to high order terms can be explicited. Several examples will be presented during the Iciam conference in July 2019 in Valencia.

17:30-18:00

Fluid structure interaction in biofluids using lattice Boltzmann method

Julien Favier Aix Marseille Université, M2P2 lab

Abstract: Recent numerical developments on the simulation of immersed structures in biofluids will be presented, involving the coupling of various boundary conditions (flexible, porous) in the presence of possibly multiphase fluids. The coupling of the immersed boundary method to the lattice Boltzmann method will be detailed. Applications to the study of mucus transport in human lungs by beating cilia will be presented.

18:00-18:30

Decaying Taylor Green vortex: implicit LES versus explicit LES with the cumulant lattice Boltzmann model

Martin Geier Technical University of Braunschweig

Abstract: We use the decaying three dimensional Taylor Green vortex as a benchmark for comparing implicit and explicit large eddy simulation (LES) with the cumulant lattice Boltzmann method. The implicit LES is conducted with different configurations of the cumulant lattice Boltzmann model. As a turbulence model for the explicit LES we use WALE. The overall effect of explicit turbulence model as compared to no model appears to be a reduction in enstrophy.

18:30-19:00

Comparing Lattice Boltzmann Method and Finite Element Front Tracking Method for bubble dynamics

Changjuan Zhang	Beijing Computational Science Research Center
Abbas Fakhari	University of Notre Dame
Jie Li	University of Cambridge
Li-Shi Luo	Beijing Computational Science Research Center
Tiezheng Qian	Hong Kong University of Science and Technology

Abstract: A comparative study for two simulation methods is conducted for interfacial flows in two dimensions: ALE-FEM on interface-conforming meshes and AMR-LBM on Cartesian meshes with quadtree adaptive mesh refinement. The methods are validated by simulations of a bubble without and with buoyancy force. The results obtained from both methods agree well with each other when the effects due to the numerical artifacts intrinsic to the diffuse interface method can be neglected.

MS ME-0-3 4 17:00-19:00

Nonlinear waves, singularities, and turbulence in physical and biological systems - Part 4

For Part 1 see: MS ME-0-3 1
For Part 2 see: MS ME-0-3 2
For Part 3 see: MS ME-0-3 3
For Part 5 see: MS ME-0-3 5

Organizer: Pavel Lushnikov University of New Mexico
Organizer: Alexander Korotkevich University of New Mexico

Abstract: Appearance of waves and formation of singularities are important problems in many physical, hydrodynamical and biological systems as well as for the applied mathematics in general. Waves of finite amplitude require solutions beyond linear approximation by taking into account nonlinear effects. Solutions of nonlinear equations usually result in the formation of singularities, coherent structures or solitary waves. Examples of the corresponding phenomena can be observed in filamentation of laser beams in nonlinear media, wave breaking in hydrodynamics and aggregation of bacterial colonies. The minisymposium is devoted to new advances in the theory of nonlinear waves.

17:00-17:30

Singularities and near singularities in the deformation of a viscous electrolyte drop

Michael Siegel	New Jersey Institute of Technology
Qiming Wang	NJIT
Manman Ma	Tongji University (China)

Abstract: We study the time evolution of an ideally polarizable, axisymmetric electrolyte drop in a dielectric fluid and subjected to an imposed electric field. An accurate and efficient boundary integral numerical method is developed to solve the low-Reynolds-number flow problem, for the linearized Poisson-Boltzmann or modified Helmholtz equation, in the case of arbitrary Debye layer thickness. Singular solutions with conical ends and `nearly singular‘ breakup solutions are investigated.

17:30-18:00

Storm in the MMT cup: Wave Turbulence Theory found alive and well

Benno Rumpf Southern Methodist University

Abstract: Numerical simulations of the Majda-McLaughlin-Tabak (MMT) equation seemed to indicate a failure of wave turbulence theory in one dimension by exhibiting a spectrum that is steeper than the Kolmogorov-Zakharov spectrum. I show that this behavior can be understood in detail by an instability that leads to the formation of radiating solitary waves which supersede the energy transfer of wave turbulence. Wave turbulence prevails in decaying turbulence and in two dimensions where this instability is absent.

18:00-18:30

Motion of complex singularities and integrability of 2D surface waves

Pavel Lushnikov	University of New Mexico
Alexandr I. Dyachenko	Landau Institute For Theoretical Physics, Russia
Sergey A. Dyachenko	Department of Mathematics, University of Illinois at Urbana-Champaign, USA
Vladmir E. Zakharov	Department of Mathematics, University of Arizona, USA

Abstract: Euler equations for potential flow of ideal incompressible fluid with free surface are fully characterized by the complex singularities outside of fluid. An infinite family of solutions with moving poles is found while coupled with moving branch points. Residues of poles are the constants of motion. These constants commute with each other in the sense of underlying non-canonical Hamiltonian dynamics. The existence of these constants of motion suggests a possibility of complete integrability of dynamics.

MS GH-1-1 4 17:00-19:00

Inverse Problems in Wave Propagation - Part 2

For Part 1 see: MS GH-1-1 3

Organizer: Gang Bao Zhejiang University
Organizer: Peijun Li Purdue University

Abstract: The topics of this mini-symposium include inverse problems in acoustic waves, seismic waves, electromagentic waves, and elastic waves. It aims to address mathematical and computational issues, report recent developments in inverse scattering problems, and present their industrial applications.

17:00-17:30

Direct sampling methods for coefficient determination inverse problems

Yat Tin Chow	University of California Riverside
Kazufumi Ito	North Carolina State University
Keji Liu	Shanghai University of Finance and Economics
Jun Zou	Chinese University of Hong Kong

Abstract: Direct Sampling Methods aim at providing a good location estimate of inhomogeneities representing various physical media with a single boundary measurement events under full or limited aperture. A family of probing functions is introduced and an indicator function is defined using a dual product between observed data and probing functions under an appropriate choice of Sobolev scale. Numerical results have illustrated the efficiency and robustness of the method in locating small abnormalities.

17:30-18:00

Time domain acoustic scattering problem by a smooth elastic obstacle

Lei Zhang	Heilongjiang University
PEIJUN LI	PURDUE UNIVERSITY

Abstract: This talk concerns the mathematical analysis of the fluid solid interaction problem in the time-domain. A compressed coordinate transformation approach is presented to reduce the problem in a bounded domain over a finite time interval. The reduced problem is shown to have a unique weak solution. The stability estimate and an a priori estimate with explicit time dependence are also given for the weak solution. I will also highlight some ongoing related projects.

IM FT-2-3 4 17:00-19:00

Modeling, Simulation and Optimization in Electrical Engineering - Part 3

For Part 1 see: IM FT-2-3 2
For Part 2 see: IM FT-2-3 3

Organizer: Kurz Stefan	Robert Bosch GmbH
Organizer: M. Pilar Salgado Rodríguez	Universidade de Santiago de Compostela
Organizer: Nella Rotundo	Weierstrass Institute for Applied Analysis

Abstract: Electrical engineering is an important technology for many recent societal and industrial developments. It includes the investigation and application of electricity, electronics, and electromagnetism. This mini symposium discusses mathematical challenges driven by industrial needs, which are related to classical and new emerging topics of applied mathematics and scientific computing. It is organized in the framework of ECMI's Special Interest Group on Modeling, Simulation and Optimization in Electrical Engineering. Its history goes back more than 20 years, where it was established as part of ECMI's endeavor to strengthen the ties between applied mathematics and the electrical industry.

17:00-17:30

SDAE models and analysis for simulating uncertainty in circuit design

Caren Tischendorf	Humboldt University of Berlin

Abstract: We present SDAE models for describing uncertainty in circuit design. They are already well-studied for index-1 SDAEs with uncertainty in the dynamic part reflected by a Wiener process. Here, we discuss a modelling for the simulation of index-2 systems that includes the Ornstein-Uhlenbeck process for the algebraic part. Finally, we demonstrate how to decouple index-2 DAEs in circuit systems such that a proper consideration of Wiener and Ornstein-Uhlenbeck processes is possible.

17:30-18:00

Uncertainty Quantification of Differential Algebraic Equations modelling Electric Circuits

Roland Pulch	University of Greifswald

Abstract: We consider mathematical models of electric circuits consisting of differential algebraic equations (DAEs). Random variables are included to quantify uncertainties in input parameters. Intrusive or non-intrusive numerical methods yield statistics for quantities of interest in transient simulations. We focus on the (intrusive) stochastic Galerkin method, which generates a larger coupled system of DAEs. The different qualities are investigated in comparison to Galerkin-projections of ordinary differential equations. We present results of numerical simulations.

18:00-18:30

Homogeneous modeling: A framework for circuit analysis in projective space

Ricardo Riaza	Universidad Politécnica de Madrid

Abstract: This talk presents an approach to circuit modeling which preserves the intrinsic symmetry of electrical circuit theory in the formulation of reduced models. The basic idea is to use a homogeneous form of Ohm's law to drive the impedance/resistance parameters to a projective line. This allows for a completely general reduction of both linear and nonlinear circuits (possibly including memristors). The results include an extension of the matrix-tree theorem to the projectively-weighted context. ORCID: https://orcid.org/0000-0003-0868-4446

18:30-19:00

Charge and phonon transport in graphene

Romano Vittorio	University of Catania
Giovanni Mascali	University of Calabria
Giovanni Nastasi	University of Catania
Marco Coco	University of Florence

Abstract: The last years have witnessed a great interest for 2D-materials due to their promising applications in nano-electronic and optoelectronic devices. Among these graphene is the most investigated. Charge and phonon transport in graphene can be described with several degrees of physical complexity. Here the main aspects will be discussed and recent results illustrated in the perspective of future developments, in particular the optimization of graphene field effect transistors.

MS A6-3-3 4 17:00-19:00

Multiscale and Asymptotic Analysis, Modeling, and Simulation for Materials Science - Part 4

For Part 1 see: MS A6-3-3 1
For Part 2 see: MS A6-3-3 2
For Part 3 see: MS A6-3-3 3
For Part 5 see: MS A6-3-3 5

Organizer: Silvia Jimenez Bolanos	Colgate University
Organizer: Lyudmyla Barannyk	University of Idaho
Organizer: Miao-Jung Yvonne Ou	University of Delaware

Abstract: Multiscale in space and time continues to be an active and challenging area of research in mathematical materials science. The aim of this minisymposium is to focus on multiscale modeling, analysis and simulation of the problems arising in fluids, composites and other heterogeneous media. In particular, topics that will be discussed include but are not limited to asymptotic analysis, homogenization, inverse problems, and computational tools for complex fluid and inhomogeneous media. The purpose of this minisimposium is to enable contact between researchers working on fluid modeling and multiscale methods with an update on recent progress in this field.

17:00-17:30

Averaged continuum modeling and emergent order in active particle systems

Alexander Panchenko	Washington State University
Eliot Fried	Okinawa Institute of Science and Technology
Denis HInz	Kastrup

Abstract: Continuum equations of active suspensions are derived from a mesoscopic Dissipative Particle Dynamics model by means of spatial averaging. The resulting continuum equations generalize the phenomenological equations of Toner and Tu. The obtained constitutive equaitons for pressure, viscosity, effective self-propulsion force depend on temperature-like parameters characterizing fluctuation strength of particle velocities and positions. In addition, the variance of the effective random force becomers a material parameter for which we derive a consitutive equation.

17:30-18:00

Uncertainty quantification in a statistical model of brittle fracture

Arkadz Kirshtein	University of Delaware
Petr Plechac	University of Delaware
Gideon Simpson	Drexel University

Abstract: Uncertainty in material properties can lead to undesirable responses to deformation. Defects in elastic materials can produce catastrophic failure. We present statistical model of fracture initiation in brittle materials. Uncertainty in the material strength is modeled by random field defining damage parameter for linear elasticity model. The focus of mathematical analysis and computations is on statistical estimation and uncertainty quantification of fracture distribution. We describe our numerical treatment of the model and present computational examples.

18:00-18:30

Continuum Limits of Stochastically Forced Dynamical Systems on Graphs

Gideon Simpson	Drexel University
Georgi Medvedev	Drexel University

Abstract: In this work, we examine the well-posedness and converge of the continuum limit of a system of coupled-oscillators of Kuramoto type. This system is driven by a Gaussian process, allowing for novel dynamics to emerge. Our convergence analysis provides insights into numerical simulation methods.

MS A3-3-2 4 17:00-19:00

Uncertainty Quantification: Theory and Applications - Part 2

For Part 1 see: MS A3-3-2 3
Organizer: Juan Carlos Cortés Universitat Politècnica de València
Organizer: Amar Debbouche Guelma University
Organizer: Carla M.A. Pinto Polytechnic Institute of Porto
Organizer: Rafael Villanueva Universitat Politècncia de Valéncia

Abstract: Equations with randomness are useful tools to describe dynamic phenomena in Physics, Engineering, Epidemiology, etc. On the one hand, the area of Random Equations deals with the extension of deterministic results for fractional, ordinary, partial, integral, difference, etc., equations to the stochastic framework. On the other hand, a major goal when modelling real problems using Random Equations is to identify, quantify and reduce uncertainties associated with models, numerical algorithms and predicted outcomes of quantities of interest. The aim of this minisymposium is to create a meeting where advances related to Random Equations and Uncertainty Quantification can be presented and discussed.

17:00-17:30

Numerical methods for random differential equations: theory and simulation

José Vicente Romero Universitat Politècnica de València
Juan Carlos Cortés Universitat Politècnica de València
Ana Navarro-Quiles Universitat Politècnica de València
María Dolores Roselló Universitat Politècnica de València

Abstract: In the modelization of real problems usually is more realistic to use random differential equations than deterministic equations. To give a complete solution to a random differential equation implies to obtain the probability density function of the solution. In this contribution we present a method to calculate approximately the first probability density function of this solution stochastic process taking advantage of the random variable transformation method.

17:30-18:00

A convergent splitting method for degenerate convection-diffusion equations with a random source

Silvia Jerez CIMAT
Roberto Díaz-Adame CIMAT

Abstract: In this work, we consider degenerate advection-diffusion equations in order to model transport processes in heterogeneous media and include a random source as a way to introduce the environmental uncertainty. We seek physically acceptable numerical solutions for such equations. Since degenerate equations have discontinuous solutions, we construct a time-splitting method and prove its convegence to the entropy weak solution. Finally, numerical simulations are presented.

18:00-18:30

Nonlocal diffusion equation with coupled delay applied to life tables

Francisco Morillas Universitat de València
José Valero Cuadra Universidad Miguel Heranández

Abstract: This work presents a system of ordinary differential equations with a non-local diffusion term (F. Morillas-J. Valero 2014) and incorporates previous information to the system on tendency evolution, similar to finite delays, via coupled equation. The system can be used in the actuarial and demographic field to modelling the evolution of the "probability of death" (age by age), incorporating the named "improvement rates". A numerical example is used to validate empirically the proposed model.

18:30-19:00

Predicting the amount of carbohydrates and insulin intake range in order to maintain the blood glucose level in healthy range.

David Martínez Universitat Politècnica de València
Clara Burgos-Simón Instituto Universitario de Matemática Multidisciplinar, Universitat Politècnica de València
Juan Carlos Cortés Instituto Universitario de Matemática Multidisciplinar, Universitat Politècnica de València
José Ignacio Hidalgo Departamento de Arquitectura de Computadores y Automática, Universidad Complutense de Madrir
Rafael J. Villanueva Instituto Universitario de Matemática Multidisciplinar, Universitat Politècnica de València

Abstract: In this work, we propose an approach to predict the amount and time of insulin and carbohydrates intake in order to maintain glucose level in healthy range. Considering the glucose model [1], we apply randomness in patients' data obtaining the appropriated parameters for each one. [1] L. Acedo, M. Botella, J.C. Cortés, J.I. Hidalgo, E. Maqueda, R.J. Villanueva, Swarm hybrid optimization for a piecewise model network modelling approach. Journal of Systems and Information Technology 2018;

MS A1-2-1 4 17:00-19:00

Topological data analysis and deep learning: theory and signal applications - Part 4

For Part 1 see: MS A1-2-1 1
For Part 2 see: MS A1-2-1 2
For Part 3 see: MS A1-2-1 3
Organizer: Jae-Hun Jung Ajou Univ/SUNY Buffalo
Organizer: Scott Field University of Massachusetts Dartmouth
Organizer: Christopher Bresten Ajou University

MS Organized by: SIAG/CSE

Abstract: Topological data analysis (TDA) emerged as an important analysis tool in data science. By considering topological features of data, TDA determines and predicts data characteristics, extracting hidden underlying knowledge. Deep learning approach is recently proven highly efficient together with TDA for a large set of data in various applications. This mini-symposium brings researchers together from various areas of TDA, deep learning, and their applications with a focus on signal analysis specialized to the gravitational wave detection problem. The mini-symposium provides an opportunity for researchers to share their expertise in theory, implementation, and applications to gravitational-wave detection.

17:00-17:30

Path space cochains for population time series analysis

Chad Giusti University of Delaware
Darrick Lee University of Pennsylvania

Abstract: Interactions among elements of complex systems are nonlinear, non-local, and noisy, and characterizing them effectively will require the development of new methods. We describe an approach to the study of population time series using path signatures, including semantic interpretations that are pertinent to description of structure in population activity such as the detection of cyclic but temporally irregular activity profiles, and discuss how to extend these techniques to other domains of interest.

17:30-18:00

Machine learning and its application towards the field of gravitational-wave astronomy

Hunter Gabbard University of Glasgow

Abstract: Machine learning is starting to transform the way data analysis is done in the physical sciences. One of the most popular and powerful approaches is the application of "neural networks" in order to solve classification and regression-like problems. I will try to describe the process of detecting a gravitational wave signal and show how machine learning techniques are being applied towards the search for gravitational waves.

18:00-18:30

Deep learning networks and gravitational wave signal recognition

He Wang Beijing Normal University

Abstract: Deep learning is a neural-inspired pattern recognition technique that has been shown to be as effective as conventional signal processing and has considerable potential to identify gravitational-wave signals. In this talk, I will first review some works on the detection and characterization of gravitational-wave signals, then present our related progress about the effect of deep neural networks on the recognition and identifying generalization properties of gravitational waves.

MS ME-0-8 4 17:00-19:00

Singular Limits in Fluid Dynamics, Related Equations, and Numerical Analysis - Part 1

For Part 2 see: MS ME-0-8 5
For Part 3 see: MS ME-0-8 6
For Part 4 see: MS ME-0-8 7

Organizer: Steve Schochet Tel Aviv University
Organizer: Qiangchang Ju IAPCM
Organizer: Bin Cheng University of Surrey

Abstract: Many areas of physics are described by two models, one derived from basic laws and the second simplified using additional assumptions. Prominent pairs include compressible and incompressible fluid or magneto-hydrodynamic models, kinetic and fluid models, and many-body systems and mean-field theories. Clarifying relationships between models increases understanding of corresponding physical systems and guides development of improved numerical methods. This minisymposium examines current techniques for justifying simplified models via singular limits, quantifying the difference between solutions to related models, and simulating them numerically. Techniques to be discussed include classical, relative, and discrete energy and entropy estimates, and averaging methods.

17:00-17:30

A survey of singular limits in fluid dynamics, related equations, and their numerical analysis

Steve Schochet Tel Aviv University

Abstract: This talk will serve as an introduction to the minisymposium. After a brief introduction to some fundamental results and techniques, the variety of topics to be discussed and results to be presented in the minisymposium will be surveyed. Recent results on three-scale singular limits of systems having two small parameters tending to zero at different rates will also be presented.

17:30-18:00

Vanishing viscosity limit for the compressible Navier-Stokes system

Eduard Feireisl Institute of Mathematics, Czech Acad. Sci.

Abstract: Adapting the concept of K-convergence, we show that Cesaro averages of solutions to the compressible (isentropic) Navier-Stokes system converge pointwise to a (generalized) dissipative solution of the Euler system in the vanishng viscosity limit. We also show that the set on which the convergence is strong cannot contain compact holes. The result suggests there might be vanishing viscosity limits that are not weak solutions of the Euler system

18:00-18:30

A bi-fidelity method for the Boltzmann equation with random parameters and multiple scales

Liu Liu University of Texas at Austin

Abstract: We study the multiscale Boltzmann equation with random parameters by a bi-fidelity stochastic collocation (SC) method. By choosing the compressible Euler equation as the low-fidelity model, we adapt the bi-fidelity SC method to combine efficiency of the low-fidelity model with high accuracy of the Boltzmann model, at a much reduced simulation cost. A priori error estimate and a convergence analysis is shown. Extensive numerical tests are presented. This is a joint work with Xueyu Zhu.

MS A6-3-2 4 17:00-19:00

Modeling and Simulations for Morphological Evolution of Nanoscale Crystal Growth - Part 3

For Part 1 see: MS A6-3-2 2
For Part 2 see: MS A6-3-2 3
Organizer: Chaozhen Wei Hong Kong University of Science and Technology
Organizer: Dong Wang University of Utah

Abstract: This minisymposium focuses on the mathematical modeling, analysis, and numerical simulations of the diverse phenomena in nanoscale crystal growth. The research is interdisciplinary, spanning the fields of mathematics, materials science, physics, and chemistry. The speakers will talk about their recent work on the corresponding experiment, theory, model, and numerical simulations of a range of interesting phenomena including but not limited to the morphological evolution, solid-state wetting/de-wetting, coarsening dynamics, space-time microstructure, and epitaxial growth.

17:00-17:30

A linear energy stable scheme for a Q-tensor model of nematic liquid crystal flows

Yana Di AMSS CAS

Abstract: We present a linear energy-stabled numerical scheme for the hydrodynamic Beris-Edwards model. Several numerical examples are shown to demonstrate the effectiveness of the model and the numerical scheme in simulating the dynamics of defects in flows of nematic liquid crystals.

17:30-18:00

A numerical study of three-dimensional droplets spreading on chemically patterned surfaces

Hua Zhong Guangxi Normal University
Xiao-Ping Wang The Hong Kong University of Science and Technology
Shuyu Sun King Abdullah University of Science and Technology

Abstract: We study numerically the three-dimensional droplets spreading on physically flat chemically patterned surfaces with periodic structures. Our model consists of the Navier-Stokes-Cahn-Hilliard equations with the generalized Navier boundary conditions. Stick-slip behavior and contact angle hysteresis are observed. Moreover, we also study the relationship between the effective advancing/receding angle and the two intrinsic angles of the surface patterns and the effect of the surface pattern property on the advancing motion of droplets.

MS ME-1-4 4 17:00-19:00

Dynamics and games - Part 2

For Part 1 see: MS ME-1-4 3
Organizer: Alberto Pinto LIAAD-INESC TEC and University of Porto
Organizer: Abdelrahim Mousa Birzeit University
Organizer: José Martins LIAAD-INESC TEC and Polytechnic Institute of

Abstract: The session aims to bring together world top researchers and practitioners from the fields of Dynamical Systems, Game Theory and applications to such areas as Biology, Economics, Engineering, Energy, Natural Resources and Social Sciences.

17:00-17:30

A new approach to the reinfection threshold in epidemiology

Alberto Pinto University of Porto & INESC TEC
José Martins LIAAD-INESC TEC and Polytechnic Institute of Leiria

Abstract: The reinfection SIRI model describes the spreading of an epidemics in a population of susceptible, infected and recovered individuals, where after an initial infection the recovered individuals only have partial immunity. Using the SIRI model, Gomes et al. introduced the reinfection threshold concept for epidemic models. In this work, we extend the previous notion of the reinfection threshold. Our definition is based on the maximum value of the positive curvature of the endemic state graph.

17:30-18:00

Suppression of autoimmune responses by T cells after pathogen infection

Bruno Oliveira University of Porto & INESC TEC
Ricard Trinchet Universidade de Santiago de Compostela, Spain and LIAAD-INESC TEC, Porto, Portugal
María Victoria Otero Espinar Universidade de Santiago de Compostela, Spain
Alberto A. Pinto Dep. Matemática, FCUP, Universidade do Porto, Portugal and LIAAD-INESC TEC, Porto, Portugal
Nigel J. Burroughs Systems Biology Centre, University of Warwick, United Kingdom

Abstract: We study a model with a clonotype of autoimmune T-cells, a clonotype of pathogen-responding T-cells and with regulatory T-cells (Treg) that inhibit interleukin 2 (IL-2) secretion. If the pathogen-responding T-cells increase to a large enough concentration, the competition for IL-2 and the increase in the death rates may lead to a depletion in the concentration of autoimmune T-cells. Provided this lasts for a sufficiently long time, autoimmunity may be suppressed.

18:00-18:30

Evolutionary dynamics of corruption

Filipe Martins University of Porto, Portugal and LIAAD-INESC
Elvio Accinelli Universidad Autónoma de San Luis Potosí, México

Bruno M. P. M. Oliveira	Universidade do Porto and LIAAD-INESC
Alberto Pinto	Universidade do Porto and LIAAD-INESC

Abstract: In this paper we propose a game theoretic model with three populations: a government, officials, and citizens, to analyse the trajectories evolution of corruption in a society. The influence of democracy in corruption is modelled through the action of the citizens who exercise influence in the government because of their elective power and where citizens may behave in a complacent manner towards corruption even if they oppose corruption.

18:30-19:00

Pure price equilibria with atomic consumer preferences

Renato Soeiro	INESC TEC

Abstract: We show that in a duopoly with homogeneous consumers, if these are negatively influenceable by each other behavior (e.g. through a congestion/ snob/ Veblen effect), a pure price equilibrium with positive profits for both firms exists. Furthermore, even in the case products are undifferentiated, an equilibrium where firms charge different (positive) prices and have different profits exists. In particular, such an equilibrium exists for atomic distributions of consumer preferences.

MS A3-S-C1 4 17:00-19:00

Tensor Methods - Part 1

For Part 2 see: MS A3-S-C1 5
For Part 3 see: MS A3-S-C1 6
For Part 4 see: MS A3-S-C1 7
For Part 5 see: MS A3-S-C1 8
For Part 6 see: MS A3-S-C1 9

Organizer: Lieven De Lathauwer	KULeuven
Organizer: André Uschmajew	MPI MiS
Organizer: Konstantin Usevich	CRAN - CNRS - Université de Lorraine

Abstract: A significant research effort is currently dedicated to the extension of linear to multilinear algebra. This work involves a rethinking of both theoretical concepts and numerical computation. The developments gradually allow a transition from classical vector and matrix based methods in applied mathematics and mathematical engineering to methods that involve tensors of arbitrary order. Tensor decompositions open up various new avenues beyond the realm of matrix methods. Important applications include efficient computation in high dimensions, the unique recovery of latent variables in data analysis, and large-scale system identification and machine learning.

17:00-17:30

Factorization of Implicitly Given Tensors

Lieven De Lathauwer	KULeuven
Martijn Boussé	KULeuven
Nico Vervliet	KULeuven
Otto Debals	KULeuven
Ignat Domanov	KULeuven

Abstract: We discuss solving linear systems under a low-rank tensor constraint. We aim at a single-step procedure, in which the linear system is not first solved as such. We present an algebraic method and a generic uniqueness condition for the rank-1 case. We discuss optimization-based algorithm for the general problem. We illustrate with applications in compressed sensing, pattern recognition and signal processing.

17:30-18:00

Distributed HT-Tensor Multigrid

Lars Grasedyck	RWTH Aachen
Christian Löbbert	IGPM, RWTH Aachen

Abstract: In this talk we present a distributed multigrid solver in the hierarchical Tucker format (includes the CP format). The tensor structure is present in both the system (typically the CP format) and the solution. In order to operate on high dimensional tensors efficiently, we use the hierarchical Tucker format for the iterates/solution and determine the rank structure on-the-fly. For p processors we obtain a speedup of p/log(p), which is close to but not optimal.

18:00-18:30

Remarks on Theory and Applications of Tensor-Train Algorithms

Eugene Tyrtyshnikov	Russian Academy of Sciences

Abstract: In this talk we consider optimization algorithms using tensor-train manifolds as a local search sets in successive iteration steps. We also discuss efficient implementations of the cross-tensor-train procedures and recent developments of theory explaing why these algorithms work so nice in practice. Besides that, we consider some applications, in particular the new advanced algorithms for numerical solution of the Smoluchowsky-type equations.

18:30-19:00

Algorithms for Tensor Decomposition

Alessandra Bernardi	University of Trento
Daniele Taufer	Università di Trento

Abstract: I will review the famous algorithm of Brachat, Common, Mourrain and Tsidgaridas on Symmetric tensor decomposition and I will present an algorithm for the computation of cactus rank and for a tangential decomposition.

MS FT-2-4 4 17:00-19:00

Stochastic Computation and Complexity - Part 2

For Part 1 see: MS FT-2-4 3
For Part 3 see: MS FT-2-4 5
For Part 4 see: MS FT-2-4 6

Organizer: Raphael Kruse	Technische Universität Berlin
Organizer: Stefan Heinrich	University of Kaiserslautern

Abstract: The minisymposium is devoted to recent developments in stochastic numerics. This includes the numerical solution of stochastic differential equations, stochastic partial differential equations, stochastic integration and stochastic quadrature problems, as well as applications to the solution of partial differential equations. Deterministic, Monte Carlo, Multilevel Monte Carlo, quasi-Monte Carlo, and deep learning methods will be presented. Emphasis is laid on efficiency of algorithms, their convergence analysis, optimality, and the complexity of the underlying problems.

17:00-17:30

Numerical approximation of the stochastic TV flow equation

Andre Wilke	Bielefeld University

Abstract: We study the stochastic total variation (TV) flow, which arises in image processing. The problem is a stochastic partial differential equation with a highly singular diffusivity term. It is convenient to formulate the problem as a stochastic variational inequality for the gradient flow of the corresponding energy. The main idea is to look at the regularized stochastic TV flow. We propose a fully discrete finite element method for the problem and show convergence.

17:30-18:00

Multilevel Picard approximation schemes

Timo Welti	ETH Zürich

Abstract: Recently, a new class of approximation algorithms for solving semilinear PDEs, called multilevel Picard algorithms, were introduced and proven to possess the power to overcome the curse of dimensionality for a general class of semilinear PDEs. Thereby it was established for the first time that this is indeed possible. In this talk we review the derivation and analysis of multilevel Picard methods and reveal the key features enabling them to overcome the curse of dimensionality.

18:00-18:30

Numerical solution of semilinear SPDEs with non-commutative noise by a Milstein scheme

Andreas Rößler	Universität zu Lübeck
Claudine Leonhard	CAU Kiel, Germany

Abstract: We consider the approximation of SPDEs without commutative noise by a Milstein scheme due to Jentzen and Röckner. Then, one has to simulate iterated stochastic integrals. Recently, approximation methods for iterated stochastic integrals in infinite dimensions have been introduced by the authors. We discuss the effective order of convergence of the Milstein when combined with one of these approximation methods for iterated stochastic integrals. Especially, we compare the Milstein scheme to the exponential Euler scheme.

18:30-19:00

Overcoming the curse of dimensionality in the numerical approximation of semilinear PDEs

Martin Hutzenthaler	Universität Duisburg-Essen
Arnulf Jentzen	ETH Zürich
Thomas Kruse	University of Giessen
Tuan Anh Nguyen	University of Duisburg-Essen
Phillippe Von Wurstemberger	ETH Zürich

Abstract: For a long time it is well-known that high-dimensional linear parabolic partial differential equations (PDEs) can be approximated by Monte Carlo methods with computational effort which grows polynomially both in the dimension and in the reciprocal of the prescribed accuracy. In other words, linear PDEs do not suffer from the curse of dimensionality. We present a new algorithm which overcomes the curse of dimensionality in the approximation of general semilinear heat equations with gradient-independent nonlinearities.

MS A6-5-2 4 **17:00-19:00**

Tensor methods for model reduction of dynamical systems - Part 1

For Part 2 see: MS A6-2-3 5

Organizer: Billaud Friess Marie — Centrale Nantes

Organizer: Anthony Nouy — Centrale Nantes

Organizer: Antonio Falcó Montesinos — Universidad CEU Cardenal Herrera

Abstract: High-dimensional dynamical systems arise in various applications as quantum chemistry, physics, and uncertainty quantification. Solving such problems with traditional numerical methods is usually untractable, especially when depending on parameters. Tensor-based model reduction methods aim at reducing the complexity by projecting the solution onto low-dimensional tensor manifolds, using either a global variational approach or a dynamical approach, possibly exploiting the geometrical structures of these manifolds. The symposium aims at gathering experts to present their recent work in this field, including: -Variational and geometrical approaches for model reduction -Integration schemes for reduced dynamical systems -Low-rank tensor format approximation

17:00-17:30

The geometry and topology of tensor formats

Antonio Falcó Montesinos — Universidad CEU Cardenal Herrera

Abstract: The main goal of this talk is to study the topological properties of tensors in tree-based Tucker format. These formats include the Tucker format and the Hierarchical Tucker format. A property of the so-called minimal subspaces is used for obtaining a representation of tensors with either bounded or fixed tree-based rank in the underlying algebraic tensor space. We will provide a complete characterization of the tensor formats based in subspaces.

17:30-18:00

On critical points of quadratic low-rank matrix optimization problems

Bart Vandereycken — University of Geneva

Uschmajew André — MPI MIS, Leipzig

Abstract: The absence of spurious local minima in non-convex minimization problems is of interest due to important implications on the global convergence of optimization algorithms. One example is low-rank matrix sensing under RIP, which is as a quadratic minimization problem constrained to low-rank matrices, with the Hessian acting like a perturbation of identity on low-rank matrices. We show strict saddle point properties and absence of spurious local minima for such problems under improved RIP conditions.

18:00-18:30

Hermite interpolation on matrix manifolds and applications in model reduction

Ralf Zimmermann — University of Southern Denmark

Abstract: Reduced-order models may be parameterized and adapted by interpolating between orthogonal bases. As a rule, these stem from a low-rank approximation of a large data matrix. Mathematically, this corresponds to interpolation problems with sampled data from the compact Stiefel manifold, which includes, e.g., the structured interpolation of the matrix factors of a truncated SVD. In this talk, we discuss different interpolation approaches on the Stiefel manifold and assess their performance via numerical experiments.

18:30-19:00

The geometric interpretation of dynamical model order reduction: some recent developpements for continuous time matrix algorithms

FEPPON Florian — Ecole polytechnique - CMAP

LERMUSIAUX P.F.J. — MIT

Abstract: The Dynamically Orthogonal approximation is an optimal geometric Reduced Order Method for time-dependent PDEs. A curvature analysis of the fixed rank manifold allowed us to (i) determine a formula for the derivative of the truncated SVD, (ii) perform an error analysis of the DO approximation error and (iii) to derive an ODE computing the truncated SVD. Numerical applications will be discussed for ROM of convection dominated problems, and extensions to other matrix manifolds.

MS A6-1-2 4 **17:00-19:00**

Optimization methods and applications - Part 4

For Part 1 see: MS A6-1-2 1

For Part 2 see: MS A6-1-2 2

For Part 3 see: MS A6-1-2 3

For Part 5 see: MS A6-1-2 5

Organizer: Cong Sun — Beijing Univ. Posts and Telecommunications

Organizer: Xin Liu — Academy of Mathematics and Systems Science

Abstract: This multiple minisymposium is to address the recent progress in nonlinear optimization field. The topics include but not limit to: first-order methods, Newton-like methods, derivative free methods, stochastic optimization methods, methods for problems with orthogonality constraints and applications with optimization methods.

17:00-17:30

Convergence Analysis of Some Efficient Splitting Methods for Separable Problems

Deren Han — Beihang University

Abstract: For large scale optimization problems with separable structure, the splitting methods, exhibited high efficiency, both for convex and for nonconvex objective functions. While the research for the nonconvex case is in its infancy. In this talk, we consider some classes of optimization problems involving nonconvex functions. By using different analysis techniques, we prove the global convergence of some splitting algorithms, and under some further conditions on the problem's data, we also analyze the convergence rate.

17:30-18:00

A 2-block Alternating Direction Method of Multipliers for k-means Clustering Problem

Yuan Shen — Nanjing University of Finance & Economics

Xin Liu — Institute of Computational Mathematics and Scientific/Engineering Computing, CAS

Abstract: The k-means clustering problem is widely used in various fields such as machine learning. For its importance, it has been studied extensively in the past few decades, and there have been a bunch of efficient algorithms for solving it. However, most algorithms are based on heuristic methods which are lack of theory. We propose a 2-block model and use ADMM to solve it. It outperforms the classical k-means algorithm according to our limited numerical experiments.

18:00-18:30

Generalized ADMM with optimal indefinite proximal term for linearly constrained convex optimization

Xingju Cai — Nanjing Normal University

Abstract: We consider the GADMM for linearly constrained convex optimization. To make the GADMM easy to solve as well as to enploy a large stepsize, an indefinite proximal term is added. The global convergence and the convergence rate are given.

18:30-19:00

A Nonmonotone Smoothing Newton Algorithm for Weighted Complementarity Problems

Hongchao Zhang — Louisiana State University

Hongchao Zhang — Louisiana State University

Abstract: The weighted complementarity problem (WCP) significantly extends the general complementarity problems in optimization. By introducing a one-parametric class of smoothing functions with weight vector, we propose a smoothing Newton algorithm with nonmonotone line search to solve WCP. Any accumulation point generated by the algorithm is a solution. Moreoever, the local convergence speed can be superlinear/quadratical under weaker assumptions than the Jacobian nonsingularity assumption. Promising numerical results compared with interior point methods will be also reported.

MS ME-0-6 4 17:00-19:00

Novel Concepts in Model-driven Optimization and Control of Agent-based Systems - Part 4

For Part 1 see: MS ME-0-6 2
For Part 2 see: MS ME-0-6 1
For Part 3 see: MS ME-0-6 3
Organizer: Dante Kalise University of Nottingham
Organizer: Giuseppe Visconti RWTH Aachen University
Organizer: Herty Michael RWTH Aachen University
Organizer: Giacomo Albi University of Verona

Abstract: This minisymposium features recent developments in optimization and control of agent-based dynamics arising in collective behaviour phenomena across different spatio-temporal scales, with particular emphasis on the interplay between multiscale modelling and optimal control. The talks will focus on different techniques stemming from multiscale modelling, nonlinear optimal control, Hamilton-Jacobi Equations and uncertainty quantification, and will incorporate recent breakthroughs in model-driven optimization, high-dimensional approximation and learning. This minisymposium will also address different applications in learning and control of animal and human crowd motion, social dynamics, and the control of autonomous vehicles.

17:00-17:30

KINETIC MODELS FOR DIFFERENTIAL GAMES

Christian Ringhofer Arizona State University

Abstract: Kinetic models for the time evolution of multi agent systems generally drive the system towards a global minimum energy state. We present an alternative kinetic framework for the time evolution of multi agent systems where individual agents make decisions based on concepts of behavioral and evolutionary game theory and the system is driven towards a Pareto optimum or Nash equilibrium.

17:30-18:00

A singular Cucker-Smale model with decentralized formation control

Young-Pil Choi Inha University

Abstract: In this talk, we address the design of decentralized feedback control laws inducing consensus and prescribed spatial patterns over a singular Cucker-Smale type model. The control design consists of a feedback term regulating the distance between each agent and pre-assigned neighbors. For the proposed model, we study consensus formation, collision-avoidance, and formation control features.

18:00-18:30

Energy-Decaying & Positivity-Preserving Schemes for Kinetic Gradient Flows

Rafael Bailo Imperial College London
José Antonio Carrillo De La Plata Imperial College London
Jingwei Hu Purdue University

Abstract: We propose fully-discrete, implicit-in-time finite-volume schemes for general non-linear non-local Fokker-Planck equations with a gradient flow structure. The schemes verify the positivity-preserving and energy-decaying properties, done conditionally by the second order scheme and unconditionally by the first order counterpart. Dimensional splitting allow for the construction of these schemes with the same properties and a reduced computational cost in any dimension. We will showcase the handling of complicated phenomena: free boundaries, meta-stability, merging, and phase transitions.

18:30-19:00

Emergence of alignment and nematic alignment for a generalized Justh-Krishnaprasad model

Hui Yu Tsinghua University

Abstract: We proposed a generalized Justh-Krishnaprasad model for the alignment and nematic alignment. The deterministic and the stochastic models with a multiplicative noise have been studied to derive the initial configurations for the emergence of alignment and nematic alignment. The Fokker-Planck equation is developed in the kinetic level. Numerical simulations are provided to demonstrated the pattern formation of the models.

MS ME-1-5 4 17:00-19:00

Emerging trends in liquid crystals encompassing modelling, simulation and analysis - Part 4

For Part 1 see: MS ME-1-5 1
For Part 2 see: MS ME-1-5 2
For Part 3 see: MS ME-1-5 3
Organizer: Arghir Dani Zarnescu Basque Center for Applied Mathematics
Organizer: Pingwen Zhang Peking University

Abstract: Liquid crystals are modelled mathematically by functions taking values into a certain space of order parameters. Various spaces of order parameters correspond to different theories of liquid crystals. Initial mathematical explorations started in the 80s in connection with harmonic maps. The last decade has brought a surge in the mathematical study of liquid crystals, to the extent that the mathematical literature in the area has nearly doubled. The proposed minisymposium aims to explore the recent advances, and generate new directions, by bringing together major contributors from the modelling, simulation and analysis of liquid crystals.

17:00-17:30

A forward and inverse problem on the excluded volume of convex bodies

Jamie Taylor Basque Center for Applied Mathematics

Abstract: Interactions between hard particles are geometric in nature, with the pairwise excluded volume determining leading order behaviour. We will consider two dual problems on calculating the pairwise excluded volume of 2D convex bodies. The first, forward, problem is to obtain the pairwise excluded volume as a function of angle, which admits a series solution. The second, ill-posed inverse problem to reconstruct a body from its excluded volume function, tackled through a numerical optimisation scheme.

17:30-18:00

Existence and partial regularity of suitable weak solutions of Beris-Edwards system in dimension three

Changyou Wang Purdue University

Abstract: In this talk, I will discuss the corational case of Beris-Edwards system that models the hydrodynamics of nematic liquid crystals based on Landau-De Gennes Q-tensor theory. I will present the existence and partial regularity of suitable weak solutions in dimension three, which is smooth away from a closed set of zero 1-dimensional Hausdorff measure. This is a joint work with Hengrong Du (Purdue University) and Xianpeng Hu (City University of HongKong).

18:00-18:30

Topological defects in two-dimensional liquid crystals confined in some domains

Hui Zhang Beijing Normal University,

Abstract: When a spatially uniform system that displays a liquid-crystal ordering on a two-dimensional surface is confined inside a rectangular box, the liquid crystal direction field develops inhomogeneous textures accompanied by topological defects because of the geometric frustrations. We show that the rich variety of nematic textures and defect patterns found in recent experimental and theoretical studies can be classified by the solutions of the rather fundamental, extended Onsager model.

MS FE-1-G 4 17:00-19:00

Numerical analysis for PDE constrained optimization - Part 2

For Part 1 see: MS FE-1-G 3
Organizer: Johannes Pfefferer Technical University of Munich
Organizer: Arnd Rösch Universität Duisburg-Essen

MS Organized by the GAMM activity group "Optimization with Partial Differential Equations" (OPDE)

Abstract: Optimal control problems with PDE constraints are of huge interest both from a theoretical point of view but also in practical applications. In order to solve such problems computationally, different approximation methods are under active research. This minisymposium will bring together young and experienced researchers working on different aspects in this field. For instance, this includes a priori and a posteriori analysis for optimal control problems subject to partial differential equations and inclusions, the numerical treatment of nonlinear terms in the PDE setting, or the coupling of partial differential equations and ordinary differential equations as additional constraint.

17:00-17:30

A posteriori error analysis for H(curl)-elliptic variational inequalities of the second kind

Malte Winckler University of Duisburg-Essen
Irwin Yousept University of Duisburg-Essen

Jun Zou The Chinese University of Hong Kong

Abstract: In this talk we discuss an AFEM algorithm for elliptic curl-curl VIs of the second kind. Based on the Moreau-Yosida regularization and a local regularity property of the dual variable, we present reliable and efficient a posteriori error estimators as well as an AFEM algorithm. The main result is the strong convergence of the sequence of solutions generated by the algorithm. Last, the algorithm is applied to a problem stemming from type-II (high-temperature) superconductivity.

17:30-18:00

Error estimates for the numerical approximation of semilinear control problems in the absence of Tikhonov regularization.

Mariano Mateos Universidad de Oviedo
Eduardo Casas Universidad de Cantabria
Arnd Rösch Universität Duisburg-Essen

Abstract: In this talk, we provide new second order sufficient conditions for strong optimality, which are the key to obtain error estimates for the state variable, even in the case of having an optimal control with singular arcs. When the optimal control is bang-bang, we are also able to deduce error estimates for the control. Both the elliptic and parabolic cases are investigated, different discretization concepts are considered. The case of sparse controls is also discussed.

18:00-18:30

Discretization error estimates for coupled parabolic PDE-ODE systems

Marita Holtmannspötter University of Duisburg-Essen

Abstract: We investigate a priori error estimates for the space-time finite element discretization for the optimal control of a simplified damage model which is given by a coupled parabolic PDE-ODE system. One difficulty arises from low regularity properties of solutions provided by this system. We provide error estimates for a dG(0)cG(1)-discretization of the state equation as well as for the optimal control. Numerical experiments are added to illustrate the proven rates of convergence.

18:30-19:00

Numerical Approximation of Bilinear Boundary Control Problems

Max Winkler Technische Universität Chemnitz

Abstract: Bilinear boundary control problems usually arise when the solution of a boundary value problem shall be optimized by controlling the coefficient in the Robin boundary condition. A further and closely related application is the identification of a possibly unknown Robin coefficient from a given measurement of the state variable. In this talk we discuss optimality conditions for these control problems and study several discretization methods based on finite elements.

MS FT-0-2 4 17:00-19:00

Mean Field Games: New Trends and Applications - Part 4

For Part 1 see: MS FT-0-2 2
For Part 2 see: MS FT-0-2 3
For Part 3 see: MS FT-0-2 9
For Part 5 see: MS FT-0-2 5
For Part 6 see: MS FT-0-2 1
Organizer: Francisco José Silva Alvarez Techniques Université de Limoges
Organizer: Adriano Festa L'Aquila university
Organizer: Daniela Tonon Paris Dauphine University

Abstract: Mean Field Games (MFGs) problems have been introduced by Lasry-Lions and Huang-Caines-Malhamé in 2006. This theory describes Nash equilibria of some differential games with infinitely many players. In light of the numerous applications of MFGs, which include Economics, Finance and Social Sciences, several mathematical techniques are currently employed for its development. The scope of this minisymposium is to bring together several specialists in MFGs in order to present recent progress on the area and open problems. Among the topics covered in the minisymposium sessions are: analytic, probabilistic and numerical aspects of MFGs, and the applications mentioned in the paragraph above.

17:00-17:30

Ground states for Mean Field Games with aggregation.

Annalisa Cesaroni UNIVERSITY OF PADOVA

Abstract: I will discuss some recent results and some open problems related to a class of viscous ergodic Mean Field Games where agents prefer clustering in highly populated areas.

17:30-18:00

Variational inequalities in Mean Field Games

Charles Bertucci Université Paris-Dauphine and PSL Research University

Abstract: In this talk we present how we can model mean field games involving optimal stopping or impulse control. We explain the good notion of solution (mixed solutions), which is expressed in terms of variational inequalities. We then give results of existence and uniqueness of such solutions. We also present numerical methods to approach the equilibria of such games.

18:00-18:30

Regularity of viscous Hamilton-Jacobi equation with rough data and applications to MFG

Marco Cirant Università di Padova

Abstract: Lipschitz regularity of solutions to Hamilton-Jacobi equations is a crucial aspect in the analysis of Mean-Field Games systems, and it is in particular the lynchpin of classical regularity in the viscous case. In this talk I will present some results in this direction obtained in collaboration with A. Goffi (GSSI-Padova), based on duality methods. Finally, I will discuss further perspectives regarding the so-called problem of "maximal regularity" for viscous HJ equations.

MS A1-1-1 4 17:00-19:00

Geometry and Topology in Data Analysis - Part 4

For Part 1 see: MS A1-1-1 1
For Part 2 see: MS A1-1-1 2
For Part 3 see: MS A1-1-1 3
Organizer: Facundo Memoli The Ohio State University
Organizer: Yasuaki Hiraoka Kyoto University
Organizer: Washington Mio Florida State University

Abstract: Understanding the organization of data across spatial and temporal scales, extracting information and knowledge from data and making inferences are fundamental problems in data analysis that pose many challenges, particularly if the data objects are complex entities such as shapes, networks, or images. This mini-symposium will provide a forum for discussion and dissemination of recent advances based on topological and geometric methods. The presentations will address foundational questions, mathematical modeling and computation, as well as applications to the analysis of data arising in various domains of science and engineering.

17:00-17:30

Stable and Discriminative Invariants for Persistence

Martina Scolamiero KTH

Abstract: I will present new stable invariants for multi-parameter persistence. The key element of our approach is defining metrics induced by so called ‘noise systems’. Such metrics generalize interleaving distance. At the same time, in the one parameter case, they allow to overcome the usual dichotomy interpreting short bars in a barcode as noise and long bars as relevant information. I will then focus statistical properties of the proposed invariants. Joint with TDA group at KTH.

17:30-18:00

Using topological signatures and machine learning to predict breast cancer subtypes

Javier Arsuaga UCDAVIS

Abstract: Copy Number Aberrations can be detected using microarray comparative genomic hybridization (aCGH). We combined Topological Analysis of aCGH with machine learning to build classifiers on the ERBB2 and Estrogen Receptor (ER) binary phenotypes. We found 17q11-q22 correctly classified 78% of the ERBB2 positive individuals and a combination of 4p, 6p and 16q classified 76% of ER positives. We suggest that topological and machine learning methods on genetic data can be combined for phenotype prediction.

18:00-18:30

The magnitude of a metric space

Nina Otter UCLA

Abstract: The magnitude is an isometric invariant of metric spaces that was introduced by Tom Leinster in 2010, and is currently the object of intense research. Magnitude encodes many invariants of a metric space such as volume, dimension, capacity, and so on. I will give an overview of existing results and current research in this area, and explain how magnitude is related to persistent homology. This talk is partly based on the preprint https://arxiv.org/abs/1807.01540.

18:30-19:00

The representation theory of filtered hierarchical clustering

Ulrich Bauer	TUM
Magnus Botnan	VU Amsterdam
Steffen Oppermann	NTNU Trondheim
Johan Steen	UC San Diego

Abstract: Many data clustering methods require a choice of two parameters (geometric scale and density). Applying 0th homology yields a diagram of vector spaces reflecting the connected components, with surjections in the scale parameter direction. This motivates the study of the parameter space by means of representation theory. We give a full classification of representation types of the subcategories of representations of an m × n rectangular grid with epimorphisms in one or both directions.

MS A1-1-2 4 17:00-19:00

In control of interfacial flows - Part 2

For Part 1 see: MS A1-1-2 3

Organizer: Radu Cimpeanu	University of Oxford
Organizer: Susana Gomes	University of Warwick

Abstract: Multi-fluid flow control underpins many fundamental and applied physical phenomena, from nano- to geophysical scales, and is required in state-of-the-art processes such as the manufacturing of microelectromechanical devices or the optimisation of heat exchangers. At the heart of these systems lies the understanding and subsequent manipulation of interfacial dynamics, which can be achieved through diverse means in both passive (stability analysis, geometry) and active (external fields) ways. This mini-symposium brings together specialists with expertise in analytical and computational techniques behind such manipulations, promoting cross-fertilisation of ideas to a wide range of related areas and extending further into applied mathematical contexts.

17:00-17:30

Controlling falling liquid films using variable wall heating

Susana Gomes	University of Warwick
Alice Thompson	The University of Manchester
Fabian Denner	Otto-von-Guericke-Universität Magdeburg
Michael Dallaston	Coventry University
Serafim Kalliadasis	Imperial College London

Abstract: Falling liquid films can be controlled by the application of spatially and temporally non-uniform inputs such as substrate heating, mass injection or moving topography. In this talk, we analyse the problem of controlling falling liquid films using substrate heating, when assuming that the imposed heating affects the film dynamics only through temperature-dependent surface tension. We present a new model for the evolution of the interface, and explore the applicability of substrate heating as a control.

17:30-18:00

Electrostatic control of instabilities in thick liquid layers

Alexander Wray	University of Strathclyde

Abstract: We apply a recently developed method for modelling thick flows (Wray et al., 2017) to the Moffatt problem for flow on the outside of a rotating cylinder, and the control thereof using electric fields. Via comparison with Direct Numerical Simulations, we show that good accuracy can be maintained even for thick films at moderate levels of inertia. The nonlocal effect of the electric field solution in particular is examined in detail.

18:00-18:30

Controlling the complex dynamics of multilayer shear flows using surfactants

Anna Kalogirou	University of Nottingham
Mark Blyth	University of East Anglia

Abstract: The stability of two-layer shear flow in a channel is considered, in the case when one of the fluids is contaminated with surfactants. The surfactant molecules can get adsorbed at the interface or form micellar aggregates when their concentration is beyond a critical value. The effect of surfactants and their sorption kinetics on the flow stability is investigated via a linear stability analysis and by carrying out numerical simulations of a highly nonlinear longwave model.

18:30-19:00

Morphogenesis on a bubble: Capillary waves on surfactant-laden interfaces

Li Shen	Imperial College London

Abstract: On a surface-tension-driven liquid interface, the behaviour of the capillary wave is often a bellweather of the overall motion of the system. Consequently, understanding how capillary waves behave over time is crucial in various interfacial flows at the edge of instability, such as capillary-driven breakup, liquid bridges and pattern forming, or Turing-esq morphogenic phenomena often found in biological and engineering contexts.

IM FT-4-2 4 17:00-19:00

Mathematics for Industry in the Asia Pacific Area - Part 2

For Part 1 see: IM FT-4-2 2

Organizer: Kenji Kajiwara	Kyushu University
Organizer: Masato Wakayama	Kyushu University/ IMI
Organizer: Osamu Saeki	Kyushu University
Organizer: Yasuhide Fukumoto	Institute of Mathematics for Industry, Kyushu

Abstract: This minisymposium is aimed at exposing various activities of "Mathematics for Industry" (MfI) in the Asia Pacific area, in particular, those which have been carried out by the members of the Asia Pacific Consortium of Mathematics for Industry (APCMfI), and at sharing the experiences with the worldwide communities. The topics will cover the comprehensive introduction of APCMfI, overview and historical remarks, the efforts to develop the relationship with industries such as the study groups, and the programs for young researchers and students. The current status of the preparation of ICIAM2023 will also be reported.

17:00-17:30

Main activities and achievements of industrial mathematics in KOREA

Joon Heo	National Institute for Mathematical Sciences

Abstract: The Korean government announced plans to foster industrial mathematics in 2016 and is now supporting universities and research institutes. National Institute for Mathematical Sciences (NIMS) moderators have been at the forefront of hunting and resolving mathematical problems that are encountered by industry in practice, and enhances the public understanding of industrial mathematics. Furthermore, NIMS is conducting various activities to train mathematicians to solve practical problems. This way, we are promoting industrial mathematics in Korea.

17:30-18:00

Mathematics-in-Industry Study Groups in Australia and New Zealand (and Japan)

Winston Sweatman	Massey University

Abstract: The annual Mathematics in Industry Study Groups (MISG) in Australia began in 1984. My first experience was in 2004 when this meeting moved to New Zealand for three years. I have been fortunate to attend nearly every year subsequently. Since 2015, study groups have been regularly held in both countries (MISG in Australia and MINZ in New Zealand). I will describe some projects and the 2016 exchange between New Zealand and Japanese MISGs.

18:00-18:30

PhD Program in Mathematics for Key Technologies - Attempt of Kyushu University

Osamu Saeki	Kyushu University

Abstract: Graduate School of Mathematics, Kyushu University, has been running a PhD program in Mathematics for Key Technologies since 2014. This is designed to nurture doctors in mathematics, referred to as "Mathematics Navigators", who lead the development of future key technologies in the globalized world. The main feature is participatoin in internships in overseas companies. In the talk, the program performance will be presented together with its development to future education platform of Mathematics for Industry.

18:30-19:00

Scope of Institute for Mathematical Science, Waseda University and State of the Art of Preparation of ICIAM 2023

Shin'ichi Oishi	Waseda University

Abstract: Institute of Mathematical Science, Waseda University has launched in 2017 and has three divisions devoted to scientific computing, mathematical fluid dynamics and mathematical statistics. The division of scientific computing mainly treated verified numerical computations and completely integrable systems, which is mainly introduced in my talk. Furthermore, I will report the state of the art of preparation of ICIAM 2023 which will be held at Waseda University, Tokyo.

MS FT-S-5 4 17:00-19:00

Recent advances in matrix equations with applications - Part 3

For Part 1 see: MS FT-S-5 2

For Part 2 see: MS FT-S-5 3

Organizer: Davide Palitta Max Planck Institute

Organizer: Patrick Kürschner KU Leuven

Abstract: Matrix equations like Lyapunov, Sylvester, and Riccati equations, are an important tool in systems and control theory as they are related to, e.g., stability analysis, controller design, and model order reduction (MOR). In particular, with the advent of MOR the demand for efficient algorithms for large-scale matrix equations increased tremendously over the last decades. The goal of this minisymposium is to present new developments w.r.t. theory and numerical methods for matrix equations, together with emerging applications where such equations play an important role like image reconstruction, signal processing, and discretization of certain PDEs.

17:00-17:30

A Schur algorithm for functional matrix equations with an application to the matrix logarithm

Bruno Iannazzo Università di Perugia

Abstract: We consider the equation f(X)=A, with f analytic and X and A square matrices. We approximate the solution by choosing a rational approximation r to f and computing the solution of r(X)=A, by a substitution algorithm based on the Schur form, having the same cost as the evaluation of r. For the matrix logarithm (defined by exp(X)=A), a strucured rational approximation to the exponential provides an algorithm requiring fewer matrix multiplications than the inverse-scaling-and-squaring algorithm.

17:30-18:00

On the solution of systems of matrix integral equations in paramet- ric model order reduction

Jens Saak Max Planck Institute Magdeburg

Manuela Hund Max Planck Institute Magdeburg

Tim Mitchell Max Planck Institute Magdeburg

Petar Mlinarić Max Planck Institute Magdeburg

Abstract: First-order necessary conditions (FONC) given as a set of coupled matrix integral equations arise in optimal model order reduction of parametric linear time-invariant dynamical systems, with respect to the Hardy H_2-norm in the system component and the L_2-norm in the parameter domain. We motivate the FONC and present an optimization-based approach to satisfying them.

18:00-18:30

Dynamics of SPDEs via Lyapunov equations

Christian Kuehn Technical University of Munich

Abstract: In this talk, I am going to outline, how numerical continuation methods can be combined with matrix Lyapunov equations to study stochastic differential equations. We start with the case of SODEs and illustrate the method on a low-dimensional example to demonstrate its use for stochastic bifurcation analysis. Then we proceed to SPDEs and utilize it for the Allen-Cahn equation and indicate, how it can be used for a fluid dynamics problem in geoscience.

18:30-19:00

Characterisations and computation of H_2-norms for time-delay systems

Wim Michiels KU Leuven

Abstract: We present a general approach for computing delay Lyapunov matrices and H2 norms for systems with discrete delays, whose applicability extends towards problems where the matrices are large and sparse, and the associated positive semidefinite matrix has a low rank. In contrast to existing methods that are based on solving the associated boundary value problem directly, our method is grounded in solving standard Lyapunov equations of increased dimensions by a dynamic structure exploiting Krylov algorithm.

MS FT-S-6 4 17:00-19:00

Eigenvalue Problems: Analysis, Algorithms and Applications - Part 4

For Part 1 see: MS FT-S-6 1

For Part 2 see: MS FT-S-6 2

For Part 3 see: MS FT-S-6 3

Organizer: Xiaoying Dai Academy of Mathematics and Systems Science

Organizer: Xin Liu Academy of Mathematics and Systems Science

Organizer: Huajie Chen Beijing Normal University

Abstract: Eigenvalue problems are widely used in many fields such as physics, materials sciences, chemistry, biology and image sciences. The research on eigenvalue problems, including its mathematical theory analysis, efficient algorithm design, practical applications, and many unresolved issues, is a challenging topic. This minisymposium aims to provide a platform for experts in this field to exchange the latest developments and explore the topic of further research and cooperations.

17:00-17:30

Plane wave methods for quantum eigenvalue problems of incommensurate systems

Huajie Chen Beijing Normal University

Abstract: In this talk, we propose a novel numerical algorithm for computing the electronic structure related eigenvalue problems of incommensurate systems. Unlike the conventional practice that approximates the system by a large commensurate supercell, our algorithm directly discretizes the eigenvalue problems under the framework of a plane wave method. The numerical results of 1D and 2D quantum eigenvalue problems are presented to show the reliability and efficiency of our algorithm.

17:30-18:00

Guaranteed a posteriori bounds for eigenvalues and eigenvectors: multiplicities and clusters

Genevieve Dusson University of Warwick

Eric Cances ENPC/INRIA

Yvon Maday Sorbonne Université

Benjamin Stamm RWTH Aachen University

Martin Vohralik INRIA/ENPC

Abstract: I will present a posteriori error estimates for clusters of eigenvalues of self-adjoint elliptic operators. The bounds on the eigenvalues and eigenvectors (through the orthogonal projector on the eigenspace) are guaranteed and valid under checkable conditions. We show that they can be turned into fully computable bounds in two particular cases: the Laplace eigenvalue problem discretized with conforming finite elements, and a Schrödinger operator with periodic boundary conditions of the form $-\Delta+V$ discretized with planewaves.

18:00-18:30

Coordinate-wise descent methods for leading eigenvalue problem from full CI

Yingzhou Li Duke University

Jianfeng Lu Duke University

Zhe Wang Duke University

Abstract: We develop an efficient algorithm, coordinate descent FCI (CDFCI), for the electronic structure ground state calculation in the configuration interaction framework. CDFCI captures and updates appreciative determinants with different frequencies proportional to their importance. We show that CDFCI produces accurate variational energy for both static and dynamic correlation by benchmarking the binding curve of nitrogen dimer. We also demonstrate the efficiency and accuracy of CDFCI for chromium dimer and produces state-of-the-art variational energy.

18:30-19:00

Fast Algorithms for Calculating Excited States in PP-RPA

Haizhao Yang National University of Singapore

Jianfeng Lu Duke University

Abstract: Partical-partical random phase approximation (PP-RPA) has been shown to be capable of describing double, Rydberg, and charge transfer excitations, for which the conventional time-dependent density functional theory might not be suitable. This talk introduces interpolative separable density fitting for developing cubic scaling algorithms for computing O(N) eigenpairs in PP-RPA, making it practical for large-scale systems. If low accuracy is permitted, we can further reduce the cost to approximate eigenpairs in PP-RPA.

MS FE-1-4 4 17:00-19:00

Numerical methods for balance laws and non-conservative hyperbolic systems - Part 4

For Part 1 see: MS FE-1-4 1

For Part 2 see: MS FE-1-4 2
For Part 3 see: MS FE-1-4 3
Organizer: Carlos Parés Madroñal Universidad de Málaga
Organizer: Manuel J. Castro Universidad de Málaga

Abstract: Balance laws and non-conservative hyperbolic systems naturally appear in many real world applications and, in particular, in many fluid models in different contexts: shallow water models, multiphase flow models, gas dynamic, etc. The main goal of the mini-symposium will be the discussion and presentation of state-of-the-art computational and numerical methods for balance laws and non-conservative hyperbolic systems and their applications.

17:00-17:30

Well-balanced finite volume schemes for hydrodynamic systems with general free energy

Sergio Pérez	Imperial College London
José A. Carrillo	Imperial College London
Serafim Kalliadasis	Imperial College London
Chi-Wang Shu	Brown University

Abstract: We outline a well-balanced finite volume scheme for a general choice of free energy, which contains dependencies with respect to the density and potentials. This scheme is sufficiently flexible and is applied to a variety of applications involving cell chemotaxis and dynamic-density functional theory, to name but two. We show that the scheme preserves the steady states and the nonnegativity of the density, is consistent with the original system and satisfies a cell entropy inequality.

17:30-18:00

A first order lagrange-projection scheme for Ripa model

María De La Luz Muñoz-Ruiz	Universidad de Málaga
Manuel J. Castro Díaz	Universidad de Málaga
Tomás Morales De Luna	Universidad de Córdoba

Abstract: This work concerns the numerical approximation of the one-dimensional system of shallow-water equations that takes into account the water temperature fluctuations, also known as Ripa system, using a Lagrange-Projection type approach. Appropriate reconstruction operators are used to design the proposed numerical scheme and its properties of (fully) well-balancing and positivity are studied.

18:00-18:30

Semi-implicit approaches for multilayer systems

José Garrés Díaz	Universidad de Córdoba
Luca Bonaventura	Politecnico di Milano
Enrique D. Fernández-Nieto	Universidad de Sevilla
Gladys Narbona-Reina	Universidad de Sevilla

Abstract: In this talk we present an IMEX-ARK2 second order scheme for multilayer shallow systems. It is based on the semi-implicit method introduced by Casulli & Cheng (1992) for shallow systems. The main novelties are the fact that the vertical mesh is not fixed, and that the number of vertical layers can vary along the horizontal direction providing a better approximation where needed. We also show some numerical applications.

18:30-19:00

A well-balanced finite volume method for a two-layer/two-axes model for submarine avalanches

Juan Manuel Delgado-Sánchez	Univesity of Seville
Enrique Domingo Fernández-Nieto	Departamento de Matemática Aplicada I/Universidad de Sevilla
Francois Bouchut	Laboratoire d'Analyse et de Mathématiques Appliquées/Université Paris-Est
Anne Mangeney	Institut de Physique du Globe de Paris/Université Paris-Diderot
Gladys Narbona-Reina	Departamento de Matemática Aplicada I/Universidad de Sevilla

Abstract: A coupled two-layer shallow water model for submarine avalanches is presented. Local coordinates are used for the granular layer to simulate the tangential velocity to the bottom, while the equations for the fluid layer are written in cartesian coordinates to prescribe properly the perturbation at the surface. The main difference with similar previous models is that any interpolation of the granular surface is required. A finite volume method is presented to discretize the model.

MS GH-3-5 4 17:00-19:00

Modelling and Simulation in Additive Manufacturing

Organizer: Maryam Khaksar Ghalati CDRSP, Polytechnic Institute of Leiria
Organizer: Nuno Alves CDRSP, Polytechnic Institute of Leiria
Organizer: Paula Pascoal-Faria CDRSP, Polytechnic Institute of Leiria
Organizer: Adérito Araújo UNIVERSITY OF COIMBRA

Abstract: Additive manufacturing is an important rapidly growing technology for the fabrication of a wide variety of components and structures. AM enables for rapid production of complex 3D micro and macrostructure parts, from medical implants to aerospace components directly from CAD data, with minimum need of post-processing and applicable to a wide variety of materials. This mini-symposium will address the mathematical modelling and simulation required to define and optimize the complexity of AM processes. A comprehensive mathematical modelling of AM processes offers a root to the control and opimization of the process and can lead to major advances and new design.

17:00-17:30

Modelling and simulation of thermal evolution in selective laser melting

Maryam Khaksar Ghalati	CDRSP, Polytechnic Institute of Leiria
Nuno Alves	CDRSP, Polytechnic Institute of Leiria
Aderito Araujo	CMUC, Department of Mathematic, University of Coimbra
Paula Pascoal-Faria	CDRSP, Polytechnic Institute of Leiria

Abstract: Selective Laser Melting (SLM) is an additive manufacturing process for production of metallic structural components. The thermal history during the SLM process can determine the resulting micro-structure and material properties. Thermal modelling of SLM will help to achieve process and product optimization. We will present a comprehensive model to study transient temperature evolution using heat transfer equation coupled with the phase function considering temperature dependent material properties, which solved with finite difference method.

17:30-18:00

On the winding number of a complex-link and its applications to morphological operations

Nelson Martins-Ferreira	Polytechnic Institute of Leiria

Abstract: We provide an efficient high level procedure to compute morphological operations for regions on the complex plane. Based on the notion of a link structure we describe a procedure that can be used for resolving ambiguous regions on the plane. This procedure relies on a generalization for the winding number of a link and has particular cases that may be used in computing offsets and other morphological operations, namely, unions, intersections and symmetric differences.

18:00-18:30

Modelling, simulation, and parameter identification for laser additive manufacturing of tool steels with phase transitions

Alfred Schmidt	Center for Technomathematics at the University of Bremen
Luttmann Andreas	University of Bremen, Center for Industrial Mathematics

Abstract: During the laser additive manufacturing of steel components, the repeated temperature cycles by heating/melting and cooling have an important effect on the microstructure of the generated material. A full prediction of the final material properties is not yet available. We model the generation of components from tool steel by laser beam build-up welding, considering autenite-martensite phase transitions and tempering of martensite. Identification of model parameters is done by comparison with experimental data.

MS FT-4-3 4 17:00-19:00

Optimisation and Inverse Problems in Imaging Science - Part 1

For Part 2 see: MS FT-4-3 5
For Part 3 see: MS FT-4-3 6
For Part 4 see: MS FT-4-3 7
Organizer: Fiorella Sgallari University of Bologna
Organizer: Raymond Chan The City University of Hong Kong

Abstract: Next-generation imaging and diagnostics provide an unprecedented step forward in our knowledge in imaging science. Defining new approaches to handle images is both fundamental and challenging due to the huge amount of data and the need for a precise and self-consistent analysis. By combining experiences from different fields, this mini-symposium aims at creating an interdisciplinary bridge that can enrich all research areas. This mini-symposium is dedicated to Prof. Mila Nikolova whose contributions on inverse problems and models such as non-smooth and nonconvex ones were substantial and lasting.

17:00-17:30

Learning to benchmark: a meta-learning inverse problem

Alfred Hero University of Michigan

Abstract: A framework is introduced for learning the intrinsic difficulty of classifying a labeled training sample, based on empirical estimation of the minimal achievable classification error, i.e., the Bayes error rate. We call this meta-learning problem "learning to benchmark" with the objective of finding low complexity and statistically consistent estimates of the Bayes mis-classification error rate that bypasses the problem of approximating the Bayes-optimal classifier using convex optimization over an ensemble of learners. .

17:30-18:00

A Three-Stage Approach for Segmenting Degraded Color Images: Smoothing, Lifting and Thresholding (SLaT)

Tieyong Zeng The Chinese University of Hong Kong

Abstract: In this talk, we propose a Smoothing, Lifting and Thresholding (SLaT) method with three stages for multiphase segmentation. At the first stage, a convex variant of the Mumford–Shah model is applied to each channel to obtain a smooth image. The second stage is dimension lifting. In the last stage, we apply multichannel thresholding to the combined vector-valued image to find the segmentation. Experiments demonstrate that our SLaT method gives excellent results.

18:00-18:30

Properties of the landscape of the objective function for deep-learning problems

Francois Malgouryres Universite Paul Sabatier Toulouse

Abstract: When applied to deep learning problems, descent optimization algorithms manage to reach low cost limit points. This is due to fine properties of the objective function in the vicinity of its first order critical points. We describe some configurations of the network for which these properies hold and the algorithm converges to a good solution.

18:30-19:00

Well-Behaved Landscape of Phase Retrieval with Optimal Sampling Complexity

Jianfeng Cai Hong Kong University of Science and Technology

Zhenzhen Li Hong Kong University of Science and Technology

Ke Wei Fudan University

Abstract: We consider the phase retrieval problem, which is to solve a system of phaseless equations. A new loss function is constructed for this problem. Under the Gaussian measurement model, we establish that with high probability our new loss function has no spurious local minima. Therefore, any algorithm finding a local minimum will converge to the target signal x.

MS GH-1-A 4 **17:00-19:00**

Recent trends in the mathematics of images - Part 3

For Part 1 see: MS GH-1-A 2

For Part 2 see: MS GH-1-A 3

Organizer: Chambolle Antonin CMAP, Ecole Polytechnique, CNRS

Organizer: Jalal Fadili CNRS and ENSICAEN

Organizer: Kristian Bredies University of Graz

MS Organized by: SIAG/IS

Abstract: Mathematical imaging relies on many different mathematical disciplines including linear algebra, differential geometry, harmonic analysis, functional analysis, mathematical physics, numerical analysis, optimisation, PDEs, stochastic and statistical methods, machine learning. The fields of application encompass medical and astronomical imaging, radar, optics, etc. The goal of this 3-part mini-symposium is to present recent theoretical, numerical and applicative trends by young researchers in these fields, with a stress put on modeling, optimisation and theoretical recovery results.

17:00-17:30

Forward Jacobian estimation: applications to risk estimation and re-fitting

Samuel Vaiter Univ. Bourgogne and CNRS

Abstract: In this talk, I will present some heuristics based on automatic differentiation, especially its forward mode, which allow efficient algorithms in two applications: re-fitting (or debiasing) and risk estimation for image processing. I will discuss several cases where these heuristics are in fact provable. Joint works with C.Deledalle, J. Fadili, N. Papadakis, G. Peyré, J. Salmon

17:30-18:00

Particle trajectories from dynamic PET via optimal transport regularization

Bernhard Schmitzer TU Munich

Klaus Schäfers Uni Münster

Benedikt Wirth Uni Münster

Abstract: Positron emission tomography (PET) can measure the distribution of radiolabelled biomarkers in the body. For research and therapy it is desirable to trace small amounts of markers as they flow through the patient. Unfortunately conventional PET image reconstruction techniques break down in this regime due to particle motion and low signal intensity. We propose a functional which explicitly models the flow of the biomarker and enforces temporal consistency by regularization with optimal transport.

18:00-18:30

Multi-scale Decomposition of Transformations (MUSCADET)

Paul Escande Aix Marseille Univ. and CNRS

Maggioni Mauro Johns Hopkins University

Abstract: Transformations between two domains are usually defined through point-wise mappings. They can become costly to store and compute, but also hard to interpret in a geometric fashion. We propose to decompose them through a multi-scale cascade of elementary transformations allowing to: Efficiently approximate transformations using understandable blocks ; Measure similarities between objects ; Perform statistical tasks on sets of transformations. We will give both theoretical and numerical insights to show the relevance of the method.

18:30-19:00

Solving Sparse Problems over Measures with Over-parameterized Gradient-based Algorithms

Lénaïc Chizat CNRS and University of Paris-Sud

Abstract: Some image processing tasks such as sparse spikes deconvolution can be formulated as a convex minimization problem over the space of measures with a sparsity-inducing penalty. We show that such problems can be solved globally and accurately by discretizing the measure and running non-convex gradient descent on the position and weights of the particles. The proof relies on a local convergence analysis in Wasserstein space.

MS A1-3-1 4 **17:00-19:00**

Mathematical models and methods in phenomenological thermodynamics of continuous media - Part 3

For Part 1 see: MS A1-3-1 2

For Part 2 see: MS A1-3-1 3

Organizer: Josef Malek Charles University, Faculty of Mathematics and Physics

Organizer: Sergey Gavrilyuk CNRS - IUSTI - AMU

Organizer: Vít Průša Charles University, Faculty of Mathematics and Physics

Organizer: Boyaval Sébastien Ecole des Ponts / Inria

Abstract: Biological fluids, all kinds of foams, granular materials, suspensions and emulsions, polymeric materials etc. are complex fluid-like materials that are of interest in many areas of science and engineering. Understanding the physical background of the models as well as the analysis of the corresponding initial and boundary value problems is crucial in the development of tools for efficient and robust numerical simulations of flows of these materials. The minisymposium aims to bring together physicists, PDE and numerical analysts and code developers working in the field of thermodynamics and mathematics for complex fluid flows and help them share different perspectives.

17:00-17:30

GENERIC-derived viscoelastic models and their application to the flow of complex suspensions

Marco Ellero	Basque Center for Applied Mathematics
Adolfo Vazquez-Quesada	Universidad Autonoma Madrid
Pep Español	UNED Madrid
Roger Tanner	Sydney University

Abstract: Smoothed Dissipative Particle Dynamics will be presented: a mesoscopic method for the simulation of thermal viscoelastic flows with Brownian fluctuations. Application of the GENERIC formalism allows to derive stochastic viscoelastic models which maintains thermodynamic consistency, i.e. they satisfy 1st/2nd Thermodynamics Laws and Fluctuation-Dissipation Theorem. As an application, simulations of a complex suspension of particles in a viscoelastic liquid will be presented. The phenomenon of elastic shear-thickening is reproduced in excellent agreement with experimentalal data.

17:30-18:00

Multi-scale simulations of complex fluids - kinetic-hydrodynamic coupling for polymer models

Piotr Minakowski	Otto von Guericke University Magdeburg

Abstract: We propose a mixed finite element – finite volume discretization scheme for a viscosity model for concentrated polymers. The numerical method is based on the splitting of the Navier-Stokes and polymer part. We employ alternating direction method to separate physical and the one-dimensional configuration space of the polymer length. The result is equipped with numerical benchmarking.

18:00-18:30

Conservation laws in viscoelastic flows

Sébastien Boyaval	École des Ponts ParisTech

Abstract: Many viscoelastic fluids have been proposed to capture a wealth of rheological phenomenas and model real flows. But standard viscoelastic fluids inspired by Maxwell's 1867 seminal proposition have not yet delivered their promise. Standard viscoelastic equations do nor allow for useful numerical results in practical flow situations, neither define good mathematical models. We generalize Maxwell's one-dimensional proposition to multi-dimensional flows using conservation laws, quite differently from standard viscoelastic equations.

MS A1-1-3 4 17:00-19:00

Mining and modeling evolving and higher-order complex data and networks - Part 4

For Part 1 see: MS A1-1-3 1
For Part 2 see: MS A1-1-3 2
For Part 3 see: MS A1-1-3 3

Organizer: Francesco Tudisco	University of Strathclyde
Organizer: Austin Benson	Cornell University
Organizer: Christine Klymko	Lawrence Livermore National Laboratory
Organizer: Eisha Nathan	Lawrence Livermore National Laboratory

Abstract: The analysis of complex networks is a rapidly growing field with applications in many diverse areas. A typical computational paradigm is to reduce the system to a set of pairwise relationships modeled by a graph (matrix) and employ tools within this framework. However, many real-world networks feature temporally evolving structures and higher-order interactions. Such components are often missed when using static and lower-order methods. This minisymposium explores recent advances in models, theory, and algorithms for dynamic and higher-order interactions and data, spanning a broad range of topics including persistent homology, tensor analysis, random walks with memory, and higher-order network analysis.

17:00-17:30

Nonbacktracking Walks in Dynamic Graphs

Eisha Nathan	Lawrence Livermore National Laboratory

Abstract: We study a centrality metric based on non-backtracking walks in which the pattern 'i-j-i' is forbidden and derive efficient algorithms for approximating these scores in static and dynamic graphs. Experiments on graphs with several million vertices/edges show (1) our static algorithm produces scores of high accuracy within theoretically guaranteed bounds of exact scores and (2) compared to the static algorithm, our dynamic algorithm has several orders of magnitude speedup and significant reductions in space.

17:30-18:00

Monte Carlo Simulation of Higher-Order PageRank

Jordan Katz	Lawrence Livermore National Laboratory
Geoff Sanders	Lawrence Livermore National Laboratory

Abstract: Random walks are used to determine PageRank centrality rankings; however, such walks cannot incorporate higher-order structure. We consider flexible higher-order walks that allow transitions to be biased: they may depend on previous nodes and graph metadata. Given the massive state spaces involved, simulating random walks is preferred over linear algebraic approaches. We give theoretical convergence bounds for biased random walk simulation algorithms and demonstrate their utility with high-fidelity dynamic ranking in real-world temporal networks.

18:00-18:30

Higher-order ergodicity coefficients

Francesco Tudisco	University of Strathclyde
Dario Fasino	University of Udine

Abstract: Coefficients of ergodicity for stochastic matrices provide easily computable conditions to ensure the uniqueness of a positive eigenvector and the convergence of the power method. We extend a class of ergodicity coefficients to stochastic tensors of order three. Similarly to the matrix case, the higher-order ergodicity coefficients provide novel conditions that guarantee the existence and uniqueness of a positive Z-eigenvector and the global convergence of so-called higher-order and alternate higher-order power methods to such eigenvector.

MS ME-0-2 4 17:00-19:00

A broad view on the least gradient problems - Part 1

For Part 2 see: MS ME-0-2 5

Organizer: Ahmad Sabra	American university of beirut
Organizer: Wojciech Górny	The University of Warsaw
Organizer: Piotr Rybka	The University of Warsaw

Abstract: Various versions of the least gradient problem (LGP) have been studied, because of its applications to medical imaging or free material design. We would like to present progress related to our understanding of the boundary condition, the role of anisotropy, uniqueness, relaxing the strict convexity assumptions on the 2D-domains. More recently we witness the importance of the LGP connection to the optimal transportation and the role in the studies of e.g. regularity of solutions. We would like to expose this link too.

17:00-17:30

Least gradient solution on polygonal convex sets

Ahmad Sabra	American university of beirut
Piotr Rybka	University of Warsaw

Abstract: We present recent results on least gradient problems on non strictly convex set. As opposed to the strictly convex case, a BV function with minimal potential and predetermined continuous trace might not exist in general. Assuming our domain is a convex polygon, we give sufficient conditions on the boundary data for existence of least gradient functions. We use the geometry of the level sets of least gradient functions to construct explicitly the solutions.

17:30-18:00

The total variation flow in metric random walk spaces

Jose Mazon	Universitat de Valencia
Marcos Solera	Universitat de Valencia
Julian Toledo	Universitat de Valencia

Abstract: We study the Total Variation Flow (TVF) in metric random walk spaces (MRWS), which includes the TVF on locally finite weighted connected graphs. We introduce the concepts of perimeter and mean curvature for subsets of a MRWS. After proving the existence and uniqueness of solutions of the TVF, we study the asymptotic behaviour. We introduce the concepts of Cheeger and calibrable sets. In connection with the Cheeger cut problem we study the eigenvalue problem.

18:00-18:30

Minimizers of relaxed functional in BV space:uniqueness and regularity via comparison principles

Giulia Treu	Dipartimento di Matematica

Abstract: We consider a wide class of integrals functionals defined in the BV space and we prove that, under mild assumptions on the boundary datum, there exists one minimizer that is locally Lipschitz continuous. Suitable and weak assumption on the boundary datum are then proved to be sufficient for the uniqueness of the minimizer. The main tool to obtain the results is the comparison principle that we proved to be true for BV functions.

18:30-19:00

The least gradient problem with respect to a non-smooth or non-strictly convex norm

Wojciech Górny	The University of Warsaw

Abstract: The least gradient problem arises (for instance) as a dimensional reduction in the free material design problem in mechanics. From the point of view of applications we are mainly interested in norms with low regularity, such as crystalline or stadium-shaped norms, so that the unit balls in these norms may have corners or flat parts. We discuss which properties of the norm influence the existence, uniqueness, and regularity of minimizers for fairly general boundary data.

MS A6-2-2 4 **17:00-19:00**

Generalized Inverses and its Applications - Part 2

For Part 1 see: MS A6-2-2 3

Organizer: Dragana Cvetkovic Ilic	University of Nis
Organizer: Néstor Thome	Universitat Politècnica de València
Organizer: Yimin Wei	Fudan University

Abstract: Generalized inverses was firsrt introduced on operators (Fredholm 1903, Hilbert 1904) and later on matrices (Moore 1920, Penrose 1955). The most important fact was its conection with least-squares method. Theory, applications, and computational methods have been lastly developed in important monographs by Rao-Mitra, Ben-Israel and Greville, Campbell-Meyer, Wang, Wei and Qiao. Generalized inverses cover a wide range of mathematical areas: matrix theory, operator theory, or rings. Recent studies focus on: numerical computation, reverse order law, perturbation theory, partial orders, etc. Numerous applications include areas such as: differential equations, Markov chains, cryptography, control and coding theories, incomplete data recovery and robotics.

17:00-17:30

Matrix properties related to powers and involutions linked to the group inverse

Leila Lebtahi	Universitat de València
Néstor Thome	
Catral Minerva	
Jeffrey Stuart	

Abstract: A matrix is called -potent (respectively, -potent) if satisfies (respectively,) for some nonnegative integer s and some -involutory matrix (that is,), where denotes the conjugate transpose of the matrix . In this talk, the group inverse of a matrix will be used to study some spectral properties of and -potent matrices. Some applications and relationships with other classes of matrices is studied.

17:30-18:00

GENERALIZED INVERSES FOR SCHRÖDINGER OPERATORS ON PRODUCT NETWORKS

Andrés M. Encinas Encinas	Universitat Politecnica de Catalunya
Ángeles Carmona	Universitat Politecnica de Catalunya
Margarida Mitjana	Universitat Politecnica de Catalunya

Abstract: Green's functions on a connected network are related with self-adjoint boundary value problems for Schrödinger operators. Since the matrices associated with these operators are symmetric M-matrices, each Green function can be interpreted as the group inverse of such matrices. Our aim is to describe a general methodology for the computation of the Green function for some BVP on cartesian product of networks, that represent the discrete version of the Separation of Variables Method for PDE.

18:00-18:30

Group Inverse of Circulant Matrices with few parameters

María José Jiménez	Universitat Politècnica de Catalunya
Andrés M. Encinas	Universitat Politècnica de Catalunya

Abstract: In this work we complete the analysis of some circulant matrices that depend on three parameters, namely circulant matrices of type Circ(a, b, c, . . . , c) and Circ(a, b, c, . . . , c, b), by considering the singular case. Specifically, we compute their group inverse using the same techniques the authors developed for the non singular case; that is, solving boundary value problems associated to second order linear difference equations.

IM FT-2-2 4 **17:00-19:00**

Molecular and Mesoscopic Modelling in Chemical Engineering Data Science - Part 2

For Part 1 see: IM FT-2-2 3

Organizer: Martin Thomas Horsch	UKRI Science and Technology Facilities Council
Organizer: Gianluca Boccardo	Politecnico di Torino

Abstract: Reaching quantitative agreement with available experimental data, and predicting properties where data are absent, molecular and mesoscopic modelling transforms chemical engineering data science. This minisymposium discusses virtual marketplaces and platforms by which the knowledge from multiscale modelling and simulation can be transferred to engineering practice. This requires an institutionalized collaboration between academic and industrial engineering, scientific computing, and applied mathematics, and jointly governed semantic assets to ensure the interoperability of models, numerical solvers, and databases. Initiatives working toward this (VIMMP, MARKETPLACE, MULTIMAT, COMPOSELECTOR, and FORCE) are represented at the minisymposium jointly with "translators" who connect method development with engineering practice.

17:00-17:30

Reliable and interoperable computational molecular engineering

Martin Thomas Horsch	UKRI Science and Technology Facilities Council
Silvia Chiacchiera	STFC Daresbury Laboratory
Michael Seaton	STFC Daresbury Laboratory
Ilian Todorov	STFC Daresbury Laboratory

Abstract: To facilitate the advance of computational molecular engineering in process engineering data technology, community-governed standards need to be established to ensure the interoperability of models, numerical solvers, and databases. The present contribution reviews ongoing work on repositories, such as the MolMod database, semantic assets based on EMMO and MODA, and the potential of multicriteria optimization to allow industrial engineers to compute material properties reliably, with a characterized uncertainty, using bespoke molecular models.

17:30-18:00

Multiscale simulations of industrial problems in an open simulation platform: The compounding of rubber materials as a case study

Graziano Frungieri	Politecnico di Torino

Abstract: The development of Open Simulation Platforms (OSP) is a fundamental step towards further integration between model developers and end-users, facilitating the translation of real problems in multi-scale simulation workflows. In the VIMMP project (https://vimmp.eu/) the open-source code SALOME is used as an OSP. In this contribution, a real-world industrial case is studied coupling a CFD code integrated in SALOME (Code_Saturne) with an in-house Discrete Element Method to investigate the compounding step of a rubber composite.

18:00-18:30

Multiscale modelling of polymer materials: Recent advances and challenges

Patrice Malfreyt	Université Clermont Auvergne

Abstract: The modelling of the matter at a higher scale than the atomic scale raises many issues about how to develop Coarse Grain (CG) models at this scale. Many generic CG models has been successfully applied to reproduce universal properties of polymer materials but they are unable to account for the chemical nature of monomers. We propose to show how to develop realistic CG models that are capable of reproducing properties of interest for the industry.

MS A3-2-2 4 **17:00-19:00**

Prognostic MR Thermometry for Thermal Ablation of Liver Tumours

Organizer: René Pinnau	TU Kaiserslautern

Organizer: Axel Klar TU Kaiserslautern

Abstract: We present modern mathematical and numerical approaches for the thermal ablation of liver tumours which is guided by prognostic MR thermometry. The goal is to „burn“ the tumour with a laser, but without damaging the surrounding healthy tissue. This poses several challenging questions in the fields of thermal conduction and radiation in tissue, parameter-identification, model reduction and optimal therapy planning, which will be addressed in this minisymposium.

17:00-17:30

Modeling and Simulation for Laser-Induced Interstitial Thermotherapy

Norbert Siedow Fraunhofer ITWM
Leithaeser Christian Fraunhofer ITWN
Huebner Frank IDIR, University Hospital Frankfurt
Bazrafshan Bagak IDIR,University Hospital Frankfurt

Abstract: Laser-induced thermotherapy (LITT) is an alternative, minimally invasive method in oncology to destruct liver tumors due to heat ablation and coagulative effects of the tissue. The treatment takes place under MRI. Using MR thermometry it is feasible to monitor tissue temperature during cancer treatment. Combining MR thermometry with mathematical simulation is a promising procedure to identify tissue parameters and to optimize the cancer treatment. The paper describes the mathematical modeling, simulation, and optimization of LITT.

17:30-18:00

The Cattaneo model in the context of thermal ablation of liver tumors

Matthias Andres TU Kaiserslautern
René Pinnau TU Kaiserslautern

Abstract: The heat transfer inside the liver during laser-induced thermotherapy is classically described by a nonlinear coupling of the so-called bio-heat equation and a radiative transfer model. In order to control the modeled speed of heat propagation we consider an additional term for the second-order time derivative of the solution in the equation and obtain a Cattaneo-like model. For this we investigate the problem of parameter identification in terms of PDE-constrained optimization.

18:00-18:30

Multi-Fidelity Optimization for LITT using Reduced Order Models

Kevin Tolle University of Trier
Nicole Marheineke Trier University

Abstract: Laser-induced thermotherapy offers a minimally invasive alternative to surgery as a treatment for tumors. It is important to have a prognosis of the temperature distribution during the treatment in order to ensure the complete ablation of the tumor. We combine space-mapping and model order reduction techniques in order to efficiently solve optimal control problems, which describe different aspects of the treatment process. Our approach is evaluated via a comprehensive performance study.

18:30-19:00

Robust Optimization using Surrogate Models

Emre Özkaya TU Kaiserslautern

Abstract: Robust design optimization can be computationally very expensive since the underlying function evaluations may require high computational effort. One way of reducing the computational cost is by constructing surrogate models, which mimic the behavior the true objective function. In this way, evaluating statistical quantities becomes possible. In this talk, we present a novel surrogate model, called as the primal-dual aggreation model, which uses gradients as well as the functional values to achieve better model accuracy.

MS A6-5-4 4 17:00-19:00

Numerical Approaches Addressing Multiscale Computational Challenges in Cell Population Dynamics - Part 1

For Part 2 see: MS A6-5-4 5

Organizer: Dumitru Trucu University of Dundee

Abstract: The past few decades have witnessed exciting modelling developments for multiscale cell population dynamic phenomena arising both in normal and pathological processes within the human tissue (such as embryogenesis, would healing, or cancer invasion), leading to very challenging computational questions. To address these challenges, innovative numerical approaches at the cross-interface between heterogeneous multiscale moving-boundary methods, multigrid and front-checking techniques are needed to facilitate efficient computational implementations. This mini-symposium aims to identify suitable numerical approaches able to address these computational challenges through a cross-fertilization of ideas from leading experts and young researchers in both numerical analysis and cell population dynamics modelling.

17:00-17:30

Multiscale Dynamics of Bulk and Leading Edge in Cancer Invasion

Dumitru Trucu University of Dundee

Abstract: We introduce a novel multiscale moving boundary approach for cancer invasion that accounts for cell-adhesion in the context of the natural multiphase ECM dynamics. Distinguishing between the fibres component and the rest of the ECM components and incorporating their multiscale dynamics within the new modelling approach, this framework connects the tissue-scale macro-dynamics with both the proteolytic cell-scale dynamics occurring at the tumour interface and the micro-scale ECM fibres dynamic rearrangement occurring inside the tumour domain.

17:30-18:00

A robust and efficient multigrid method for geometric surface PDEs will applications to cell migration

Anotida Madzvamuse University of Sussex
Feng Wei Yang University of Surrey
Chandrasekhar Venkataraman University of Sussex
Vanessa Styles University of Sussex

Abstract: In this talk, I will present a novel solution strategy to efficiently and accurately compute approximate solutions to semilinear optimal control problems, focusing on phase field formulations of geometric evolution laws with applications to cell migration. The solver for the discretised partial differential equations is based upon geometric multigrid methods. A number of computational results that demonstrate the accuracy and efficiency of our algorithms and applications to single and population cell migration will be exhibited.

18:00-18:30

Cellular automata modelling for skin cancer

Fred Vermolen TU Delft

Abstract: We consider a cellular automata model for simulating skin cancer. We show various theorems in which we prove how the transfer probabilities should be calculated in a cellular automata grid. Furthermore, we present the results of uncertainty quantification, as well as possible alternative applications.

18:30-19:00

CompuCell3D, an Open-Source Software Tool for Multiscale Virtual-Tissue Modeling

James Glazier Indiana University Bloomington

Abstract: Virtual-tissue models are multiscale computer simulations of tissues and organs which find applications in developmental biology, biomedicine, tissue engineering and toxicology. Over the past 20 years we have developed CompuCell3D (www.compucell3d.org) as an open-source platform to support the rapid development of sophisticated virtual-tissue models by researchers with limited computer experience using Python and CC3DML scripts based on biologically meaningful concepts like cell division, adhesion and motility. Challenges include cluster deployment, parallelization and interoperability.

MS A1-2-3 4 17:00-19:00

Cryptography, from industry applications to the post-quantum era - Part 1

For Part 2 see: MS A1-2-3 5

Organizer: Irene Márquez Corbella Universidad de La Laguna
Organizer: Javier Fernandez De Bobadilla BCAM

Abstract: Cryptography is one of the key ingredients in any successful secure communication in the digital world: consider e-commerce, e-government and increasingly embedded applications ranging from handheld devices to medical implants. However, it has become a hard task to provide efficient primitives that survive cryptanalytic attacks. For example the security of popular crypto-systems such as RSA, discrete logarithm schemes and Elliptic Curve Cryptography will be devastatingly affected by the success of the construction of quantum Computers. This mini-symposium will be devoted to so-called Post Quantum Cryptographic primitives which can be grouped in three families: Code-based cryptography, Lattice cryptography and Multivariate cryptography.

17:00-17:30

LegoSNARK: Modular Design and Composition of Succinct Zero-Knowledge Proofs

Dario Fiore IMDEA Software Institute

Abstract: Zero-knowledge proofs let a prover convince a verifier of a statement without revealing more information than its validity. zkSNARKs are zero-knowledge proofs that are short and easy to verify -- an ideal tool to achieve privacy and anonimity in distributed applications like blockchains. In this talk, I will present LegoSNARK, a framework for commit-and-prove zkSNARKs that can be modularly composed in a lightweight manner -- a new design that improves flexibility, reusability and efficiency.

17:30-18:00

Ring learning with errors: a crossroads between postquantum cryptography, machine learning and number theory

Ivan Blanco Changing employment

Abstract: In the present talk we give an overview of the cryptosystem derived from the RLWE problem in its two different formulations: primal and polynomial and mention the conditions which, up to date, make them equivalent. Likewise, we report on current research by the author in this direction and mention one of the most interesting applications of the cryposystem: homomorphic encryption. Time permitting, we will also discuss key-exchange protocols and a signature schemes derived from RLWE.

18:00-18:30

Codigos inseparables y la conjetura de Avi Silverberg

Jorge Urroz UPC Universitat Politècnica de Catalunya

Abstract: Abstract. En el estudio de la identificacion de traidores en esquemas de proteccion de copyright aparece la necesidad de distinguir grupos de palabras del codigo entre sí. En el caso de codigos Reed Solomon se conjetura que si la distancia es pequeña, la distinccion es imposible. En esta charla mostramos una prueba de dicha conjetura y alguna de sus aplicaciones.

18:30

Threshold Cryptography – commercial state-of-the-art and a look to the future

Jakob Illeborg Pagter Pagter Sepior

Abstract: Threshold Cryptography (TC) is an application of techniques from Multiparty Computation and Secret Sharing to achieve key management systems, where the secret keys are never present at any one place. Several start-ups are working on commercialising this technology for application (e.g. blockchain and cloud security). In this presentation I will introduce the core mathematical primitives for TC, how TC is being used commercially, and what developments can be foreseen.

IM FT-4-1 4 **17:00-19:00**

EU-MATHS-IN: Success Stories of Mathematics in Societal Challenges and Industry - Part 4

For Part 1 see: IM FT-4-1 1
For Part 2 see: IM FT-4-1 2
For Part 3 see: IM FT-4-1 3
Organizer: Carlos Parés Madroñal Universidad de Málaga
Organizer: Manuel Cruz PT-MATHS-IN | LEMA-ISEP/IPP

Abstract: The European Service Network of Mathematics for Industry and Innovation (EU-MATHS-IN) is an organization promoted by several European research networks following the recommendations of the European Science Foundation. Its main purpose is to increase the impact of mathematics on innovations in key technologies and to foster the development of new modeling, simulation and optimization tools. The goal of this mini-symposium is to present to the attendees some success stories of application of mathematical technologies in industry developed by researchers belonging to the national networks that are members of EU-MATHS-IN. The sessions are organized according to the addressed societal challenges.

17:00-17:30

A Mathematical Approach to Support Diagnostics and Therapy Planning of Cerebral Palsy Children

Hans Georg Bock University of Heidelberg
Ekaterina Kostina University of Heidelberg
Marta Sauter University of Heidelberg
Johannes Schlöder University of Heidelberg
Matthias Schlöder University of Heidelberg

Abstract: We report on a collaboration project with the Orthopedic University Hospital Heidelberg. Goal is the development a of a biomechanical optimal control problem (OCP) with path and control constraints as predictive model for the gait of handicapped children with cerebral palsy to support diagnosis and therapy. Identifying the individual patient's kinematic and dynamic parameters and joint forces for diagnosis by gait data from the motion lab, leads to bi-level inverse OCP with complementarity constraints.

17:30-18:00

Tsunami-HySEA: A numerical model developed for tsunami early warning systems.

José Manuel González Vida Universidad de Málaga
Manuel J. Castro University of Málaga
Jorge Macías University of Málaga
Marc De La Asunción University of Málaga
Sergio Ortega University of Málaga
Carlois Parés University of Málaga

Abstract: We present the collaboration between the EDANYA research group of the University of Málaga and several international institutions in the framework of the Tsunami Early Warning Systems. This collaboration resulted in the development of the first GPU-based finite volumes numerical model, Tsunami-HySEA, able to accelerate tsunami numerical simulations to become a real operational tool in Tsunami Warning Centers. Tsunami-HySEA has improved the operational treatment of tsunami alerts and it's making substantial improvements to citizens security.

18:00-18:30

Optimization models in resource logistics for fighting forest fires

Balbina V. Casas Méndez University of Santiago de Compostela, IMAT & ITMATI
Jorge Rodríguez Veiga ITMATI, Technological Institute of Industrial Mathematics
María José Ginzo Villamayor MODESTYA, Group of Optimization Models, Decision, Statistics and Applications, University of San

Abstract: This work presents several models of mathematical programming that are aimed at the allocation and resource planning problems. These problems have been studied as a part of the research project called Enjambre, which involves both the public and the private sector. The objective of Enjambre is the development of advanced technologies for the fight against forest fires, which is why it also deals with other tasks such as the design of algorithms for the anti-collision.

18:30-19:00

Optimum Experimental Design for DE Processes. A Success Story in the Chemical Industry

Ekaterina Kostina Heidelberg University

Abstract: Motivation for validated models is new concept of "digital twins". The idea is that every new product is accompanied by an ensemble of models and algorithms, used to analyze data and perform optimal operation. However, application of mathematical models requires their thorough validation based on process data, which should preferably be obtained by optimized experiments. For the latter, efficient numerical methods were developed, which proved to be a powerful mathematical instrument of high economic impact.

MS FT-1-1 4 **17:00-19:00**

Nonlinear and multiparameter eigenvalue problems - Part 4

For Part 1 see: MS FT-1-3 1
For Part 2 see: MS FT-1-1 2
For Part 3 see: MS FT-1-1 3
For Part 5 see: MS FT-1-1 5
For Part 6 see: MS FT-1-1 6
For Part 7 see: MS FT-1-1 7
Organizer: Fernando De Terán Universidad Carlos III de Madrid
Organizer: Froilán M. Dopico Universidad Carlos III de Madrid

MS Organized by: SIAG/LA

Abstract: A nonlinear eigenvalue problem (NLEVP) is to find scalars x (eigenvalues) and nonzero vectors v,w (eigenvectors) satisfying F(x)v=0, w*F(x)=0, where F:C→Cnxn is a matrix-valued function.

NLEVPs can be extended to multiparameter eigenvalue problems (MPEPs) F(x1,...,xd)v=0, w*F(x1,...,xd)=0, with F:Cd→Cnxn. Important cases of NLEVPs are the polynomial and rational eigenvalue problems, where the entries of F(x) are polynomial or rational functions. NLEVPs and MPEPs arise in many applications, and much research on these problems has been performed in the last years from computational and theoretical perspectives. This minisymposium presents the most recent advances in NLEVPs and MPEPs, and on their applications.

17:00-17:30

Recent progress in eigenvector-dependent nonlinear eigenvalue problems

Zhaojun Bai	University of California, Davis
Yunfeng Cai	Peking University
Ren-Cang Li	University of Texas at Arlington
Lei-Hong Zhang	Shanghai University of Finance and Economics

Abstract: Eigenvector-dependent Nonlinear Eigenvalue Problems (NEPv) arise in electronic structure calculations among others. NEPv is a much less explored topic compared to eigenvalue-dependent nonlinear eigenvalue problems. I will start this talk with recent work on the existence and uniqueness of NEPv, and then present local and global convergence analysis of the self-consistent field iteration for solving NEPv. A number of practical issues for solving NEPv will also be discussed.

17:30-18:00

A Note on an Eigenvector-Dependent Nonlinear Eigenvalue Problem from the perspective of relative perturbation theory

Ninoslav Truhar	Josip Juraj Strossmayer University of Osijek

Abstract: We consider the eigenvector-dependent nonlinear eigenvalue problem (NEPv) $H(V)V = V\Lambda$, where $H(V) \in C^{n\times n}$ is an Hermitian matrix-valued function of $V \in C^{n\times k}$ with orthonormal columns, i.e., $V^H V = I_k$, $k \le n$ (usually $k \ll n$). We present the conditions on existence and uniqueness for the solvability of NEPv using the well known results of the relative perturbation theory.

18:00-18:30

On filters for isospectral matrix polynomials

Silvia Marcaida	Universidad del País Vasco UPV/EHU
Agurtzane Amparan	Universidad del País Vasco UPV/EHU
Ion Zaballa	Universidad del País Vasco UPV/EHU

Abstract: Matrix polynomials of possibly different sizes, ranks or degrees that share the same spectral structure, i.e., the same finite and infinite elementary divisors, are called isospectral. An equivalence relation is defined characterizing the matrix polynomials with the same spectral structure using the notion of coprime filters, extending an original idea by Fuhrmann. Several criteria are given to check when two matrices are isospectral, and a constructive procedure is presented to obtain filters connecting isospectral matrices.

18:30-19:00

Wilkinson's bus: That eigenvalue has condition ∞, but QZ doesn't know and computes it accurately

Vanni Noferini	University of Essex
Martin Lotz	University of Warwick

Abstract: Simple eigenvalues of singular matrix polynomials have infinite condition number. However, vanilla eigensolvers (blind to the singular structure) are often able to compute these eigenvalues to machine precision. We propose and analyse a more sophisticated theory of condition, with higher predicting power than the existing ones. Don't miss this talk if you would like to hear the solution of the mystery of the ill posed eigenvalue problems that are in practice solved with remarkable accuracy!

MS ME-1-G 4 17:00-19:00

Women in Applied Mathematics: Recent Advances in Modeling and Applications - Part 4

For Part 1 see: MS ME-1-G 1
For Part 2 see: MS ME-1-G 2
For Part 3 see: MS ME-1-G 3

Organizer: Baasansuren Jadamba	Rochester Institute of Technology
Organizer: Natasha S Sharma	University of Texas at El Paso

Abstract: This minisymposium aims at bringing women mathematicians to share their recent progress and to inspire new ideas in applied mathematics. Talks may address modeling, theoretical and computational aspects of numerical methods for partial differential equations, as well as various applications arising from engineering, biology, medicine and material science etc. The fourth part of the minisymposium includes a career panel session, whose goal is to create a network platform for women mathematicians at different stages of career and career paths, to exchange experiences and advice in career advancement, and to discuss challenges and strategies for a successful career.

17:00-17:30

Mentoring and Promotion

Baasansuren Jadamba	Rochester Institute of Technology

Abstract: In this talk, I will share my experience regarding mentoring, collaboration, building networks, and strategies for promotion and advancing an academic career.

17:30-18:00

Advancing equity and inclusion in mathematics

Vrushali Bokil	Oregon State University

Abstract: I will describe the creation of graduate seminars at Oregon State University that address systemic inequities that lead to underrepresentation of women and minorities in the mathematical sciences. The seminars help students engage in personal reflection about their own location in relation to power and privilege, and challenge students to examine how the mathematical sciences discipline has evolved in ways that reproduces hierarchy and dominance. Students are mentored in writing their own diversity statement.

18:00-18:30

Building collaboration and network

Fengyan Li	Rensselaer Polytechnic Institute

Abstract: I will take this opportunity to share some experiences in building research collaborations and support networks.

18:30-19:00

Stereotypes, implicit bias and impostor syndrome

Yuliya Gorb	University of Houston

Abstract: In this talk, I want to touch on a few factors that affect women's representation in math and science.

MS ME-1-3 4 17:00-19:00

Computational approaches for multiscale, possibly random problems - Part 2

For Part 1 see: MS ME-1-3 3
For Part 3 see: MS ME-1-3 5
For Part 4 see: MS ME-1-3 6

Organizer: Legoll Frederic	Ecole des Ponts and Inria
Organizer: Claude Le Bris	Ecole des Ponts & Inria

Abstract: This mini-symposium is motivated by the following observations. First, computational approaches dedicated to multiscale problems have recently witnessed very significant developments. Second, an increasing amount of probabilistic features is currently introduced in PDEs for the modelization of complex phenomena. The purpose of this mini-symposium is to review the recent advances in these two directions, and at the intersection of those.

17:00-17:30

Multi-scale finite element methods with generalized Crouzeix-Raviart boundary conditions

Alexei Lozinski	Université de Franche-Comté

Abstract: We present a multiscale finite element Method (MsFEM) type method in the vein of classical Crouzeix-Raviart finite elements suited for problems on a complex perforated domain. We consider the diffusion equation and the Stokes system paying special attention to higher order variants of the method. This is achieved by enriching the multiscale finite element space with bubble functions and by adding appropriate weighting functions to the terms enforcing continuity across the edges.

17:30-18:00

Goal-oriented adaptivity in the Generalized Multiscale Finite Element Method

Sai Mang Pun	Chinese University of Hong Kong
Eric Chung	The Chinese University of Hong Kong
Sara Pollock	University of Florida

Abstract: In this talk, we consider the goal-oriented adaptivity for flow problem in heterogeneous media within the framework of generalized multiscale finite element method (GMsFEM). The idea is to include more degrees of freedoms based on a class of well-designed error indicators, depending on the information of residuals, during the adaptive iteration. We will present two different adaptive approaches (namely, offline and online) for Darcy's flow model and the mixed formulation.

18:00-18:30

A Multiscale Finite Element approach using high order polynomials

Pierre-Loïk ROTHE ENPC and INRIA

Abstract: Many multiscale numerical approaches have been proposed to address problems posed for heterogeneous media, among which the Multi-scale Finite Element Method (MsFEM). MsFEM is a two step approach: create a relevant coarse space and solve the associated Galerkin problem. We present here an enriched MsFEM variant, where solutions to local problems with high degree polynomials as boundary conditions complement the standard MsFEM basis set. We illustrate our theoretical convergence results by some numerical experiments.

18:30-19:00

Homogenization of elliptic equations in perforated media: the periodic and defect cases

Sylvain Wolf Université Paris 7

Abstract: We present the homogenization of the Poisson problem in some perforated domain with homogeneous Dirichlet boundary conditions. The size of the perforations is proportional to the distance between neighbouring periodic cells. The periodic case is well understood ; we propose in this talk geometric assumptions that extends the results to a non-periodic case and study the homogenization theory: existence of a corrector, convergence to the homogenized problem and two-scale expansion.

MS A3-3-L1 4 17:00-19:00

Recent advances on numerical methods and analysis of complex fluids - Part 4

For Part 1 see: MS A3-3-L1 1
For Part 2 see: MS A3-3-L1 2
For Part 3 see: MS A3-3-L1 3
For Part 5 see: MS A3-3-L1 5

Organizer: Zhonghua Qiao The Hong Kong Polytechnic University
Organizer: Hui Zhang Beijing Normal University

Abstract: The goal is to integrate advances in mathematics (theory, modeling, algorithms, simulations, high performance computing techniques) with new experimental data from complex fluids and biological systems, and targeted applications. The specific systems represented include liquid crystal flow, polymeric flow and magnetic fluids, phase-field and beyond these area.

17:00-17:30

EXtended HDG methods for second order elliptic interface problems

Xiaoping Xie Sichuan University
Yihui Han
Huangxin Chen
Xiao-Ping Wang

Abstract: In this talk, we discuss two arbitrary order eXtended hybridizable discontinuous Galerkin (X-HDG) methods for second order elliptic interface problems in two and three dimensions. Optimal error estimates are derived, and several numerical examples are provided to verify the theoretical results.

17:30-18:00

Phase Field Models: Benchmarks and a Second Look at Time Stepping

Brian R. Wetton University of British Columbia
Xinyu Cheng UBC Mathematics
Dong Li HKUST Mathematics
Keith Promislow Michigan State Mathematics

Abstract: Adaptive time stepping methods for meta-stable dynamics of the Allen Cahn and Cahn Hilliard equations are investigated in the spatially continuous setting. Predicted behaviour of the number of time steps with specified local error tolerance and its dependence on the order parameter is computationally verified. Some methods require asymptotically more time steps. Backward (Implicit) Euler has a particularly desirable property. This last result is obtained with a formal asymptotic argument backed by computational evidence.

18:00-18:30

Application of Onsager Principle in solving coating dynamic problems

Yana Di

Abstract: In 1931, Onsager proposed a variational principle which has become the base of many kinetic equations for non-equilibrium systems. We have been showing that this principle is useful in obtaining approximate solutions for the kinetic equation. And we also use it to determine the steady state in non-equilibrium system by a variational calculus.

CP A6-4-3 4 17:00-19:00

Numerical Analysis VIII

Chair Person: Azahar Monge DeustoTech

CP A6-4-3 4 1 17:00-17:20

A time adaptive multirate Dirichlet-Neumann waveform relaxation method for heterogeneous coupled heat equations

Azahar Monge DeustoTech
Philipp Birken Lund University

Abstract: We present a high order, time adaptive, multirate numerical method for two heterogeneous coupled heat equations. We use the Dirichlet-Neumann waveform relaxation (DNWR) method which is a variant of WR methods based on the classical Dirichlet-Neumann iteration. When choosing the relaxation parameter right, DNWR becomes a direct solver. We compute the optimal relaxation parameter for variable material coefficients. To get an adaptive multirate scheme, we use possibly different adaptive temporal discretization methods on each subdomains.

CP A6-4-3 4 2 17:20-17:40

An Expanded Mixed FEM for Kirchoff Type Parabolic Equation

Nisha Sharma Panjab University
Morrakot Khebchareon Chiang Mai University
Amiya Pani IIT Bombay

Abstract: In this article, an expanded mixed finite element method with lowest order Raviart Thomas elements is discussed. New regularity results are derived avoiding compatibility conditions on the initial data. A priori estimates for the semidiscrete problem are established. Based on backward Euler method, a completely discrete scheme is derived and existence is proved by using a variant of Brower's fixed point theorem. Finally, numerical experiments are conducted for confirming our theoretical analysis.

CP A6-4-3 4 3 17:40-18:00

A study on sloshing frequencies in presence of damping device

Neelam Choudhary Bennett University
Swaroop Nandan Bora Indian Institute Of Technology Guwahati

Abstract: A circular cylindrical container, partially filled with liquid is considered to discuss sloshing. A ring shaped rigid baffle is placed in the liquid domain, attached to outer wall of the cylinder. This partly covered interface effects the sloshing frequency and shifts away from the control frequency of the vehicle, which helps in the reducing the sloshing mass effecting the dynamic motion of the vehicle.

CP A6-4-3 4 4 18:00-18:20

Discontinuous finite volume methods for optimal control problems governed by Brinkman equations

Sarvesh Kumar Indian Institute of Space Science and Technology
Ricardo Ruiz-Baier Mathematical Institute, Oxford University
Ruchi Sandilya Weierstrass Institute for Applied Analysis and Stochastics

Abstract: We introduce lowest order discontinuous finite volume method for the approximation of distributed Brinkman optimal control problem where a force field is sought such that it produces desired velocity profile. Three different approaches are used for the control representation: a variational discretisation and approximation through piecewise constant or piecewise linear elements. A priori error estimates in suitable norms are derived, and a set of numerical examples is presented to illustrate the performance of the method.

CP A6-4-3 4 5 18:20-18:40

Artificial Viscosity Joint Spacetime Multigrid Method for Hamilton-Jacobi-Bellman and Kolmogorov-Fokker-Planck System Arising from Mean Field Games

Justin Wan	University of Waterloo
Yangang Chen	University of Waterloo

Abstract: Mean field games have recently been used in applications such as economics, finance, sociology, and engineering. In this talk, we will present numerical methods for solving the underlying system of HJB-KFP equations. We will propose a fast multigrid approach that employs the joint spacetime framework together with new techniques of hybrid full-semi coarsening and artificial viscosity coarse grid correction. Numerical results show mesh-independent convergence rate and is faster than the existing method in the literature.

CP A6-4-2 4 **17:00-19:00**

Fluids Physics and Statistical Mechanics I

Chair Person: Andre Sonnet University of Strathclyde

CP A6-4-2 4 1 **17:00-17:20**

Nematic Shells: From Planar Domains to Curved Surfaces

Andre Sonnet	University of Strathclyde

Abstract: The director field of a nematic liquid crystal on a curved surface can be obtained by lifting it from a planar domain using a suitable height function. The free energy can then be minimised on the plane rather than on the surface. Supplementing the height function by two further scalar functions on the plane allows one to predict the spontaneous deformation of nematic glasses and elastomers induced by the nematic field imprinted on the plane.

CP A6-4-2 4 2 **17:20-17:40**

Higher order compact numerical simulation of forced convection from an isothermal square cylinder in shear flow

Rajendra K. Ray	Indian Institute of Technology Mandi
Atendra Kumar	Indian Institute of Technology Mandi

Abstract: Forced convection from a heated square cylinder in an incompressible, two-dimensional shear flow is investigated. Higher order compact (HOC) formulation of streamfunction-vorticity formulation of Navier-Stokes equations is used for computation in Cartesian coordinates. Reynolds number(Re) =100, Prandtl number(Pr) = 0.7 and shear parameter(K) values ranging from 0.0 to 0.2 are considered. Nusselt number variation on the surface, isotherm patterns, and many other phenomena are studied. This study reveals many interesting findings for the first time.

CP A6-4-2 4 3 **17:40-18:00**

AMG-based preconditioners for fully-coupled Newton-Krylov methods for implicit continuum plasma simulations

Paul Lin	Sandia National Laboratories
John Shadid	Sandia National Laboratories
Edward Phillips	Sandia National Laboratories
Roger Pawlowski	Sandia National Laboratories

Abstract: The computational simulation of continuum models for highly nonlinear multiple-time-scale plasma physics systems can be extremely challenging. A promising solution approach for these systems employs implicit, or implicit/explicit, time-integration and preconditioned Newton-Krylov methods. In this context the scalable and efficient solution of large-scale sparse linear systems is critical. This talk considers the scaling and performance of algebraic multigrid-based preconditioners based on both fully-coupled, and block/Schur complement techniques for large-scale, transient plasma simulations.

CP A6-4-2 4 4 **18:00-18:20**

Vortex shedding modes and their competition in shear flow past a rotationally oscillating circular cylinder

Atendra Kumar	Indian Institute of Technology Mandi
Rajendra K. Ray	Indian Institute of Technology Mandi

Abstract: Vortex shedding modes of rotationally oscillating circular cylinder in an incompressible, two-dimensional shear flow is investigated. Higher order compact (HOC) formulation of streamfunction-vorticity form of Navier-Stokes equations is used for computation in polar coordinates. Shear rate, K=0.05-0.1, maximum angular velocity, αm=0.5-1.0, and frequency ratio, f/f0=1.0 at Reynolds number, Re=100 are considered. The resulting vortex modes behind cylinder as well as fluid forces are analyzed. Many interesting findings reveal from this study for first time.

CP A6-4-2 4 5 **18:20-18:40**

Controlling viscous fingering patterns in a Hele-Shaw cell

Scott McCue	Queensland University of Technology
Liam Morrow	Queensland University of Technology
Timothy Moroney	Queensland University of Technology

Abstract: When a less viscous fluid displaces a more viscous fluid in a Hele-Shaw cell, the interface is known to be unstable (Saffman-Taylor instability) in a way that promotes viscous fingering patterns and branching structures. We discuss here a number of ways to alter the standard Hele-Shaw configuration in order to attempt to control the instability. The methodology used includes linear stability analysis and fully-nonlinear simulations computed via a level set method.

CP ME-1-9 4 **17:00-19:00**

Numerical Analysis X

Chair Person: Ron Estrin Stanford University

CP ME-1-9 4 1 **17:00-17:20**

SPMR: a Family of Saddle-Point Minimum-Residual Solvers

Ron Estrin	Stanford University
Chen Greif	The University of British Columbia

Abstract: SPMR is a new family of methods for iteratively solving saddle-point systems using a minimum or quasi-minimum residual approach. No symmetry assumptions are made. The basic mechanism underlying the method is a novel simultaneous bidiagonalization procedure that yields a simplified saddle-point matrix on a projected Krylov-like subspace, and allows for a monotonic short-recurrence iterative scheme. We develop a few variants, demonstrate the advantages of our approach, derive optimality conditions, and discuss connections to existing methods.

CP ME-1-9 4 3 **17:20-17:40**

Modeling and simulation of leachate flow in an anaerobic biodegradation of waste in a landfill.

Zoubida Mghazli	Ibn Tofail University
Zakaria Belhachmi	University of Haute Alsace
Salih Ouchtout	Ibn Tofail University

Abstract: In this talk, we present a coupled PDE model that describes the bacterial dynamics of biodegradation of waste in a landfill. The model is fully a PDE system governing both the biological reactions and the porous medium flow. We present the analysis of the problem and a discretization based on mixed finite element and BDF schemes in time. We also give some numerical results.

CP ME-1-9 4 4 **17:40-18:00**

Numerical approach to the repeated appearance and disappearance phenomena of non-infiltrated area with fluid through porous media

Kenji Tomoeda	Kyoto University

Abstract: From numerical and analytical points of view, we consider the " repeated appearance and disappearance phenomena of the non-infiltrated area with fluid" which are caused by the outflow and inflow of the fluid from the boundary. In this talk we show several numerical examples and prove such phenomena by using the model equation which is written in the form of the initial-boundary value problem for a porous media equation with absorption

CP ME-1-9 4 5 **18:00-18:20**

Multiscale coefficient reconstruction of time harmonic viscoelastic equations with nonconforming finite element methods for MR Elastography

Suguru Maekawa	Graduate School of Informatics, Kyoto University

Abstract: We shall discuss on coefficients reconstruction of time harmonic viscoelastic equation for MR Elastography. MR Elastography is one of noninvasive modalities to identify the stiffness of human tissue, and is expected to support diagnosis of several kinds of disease such as cancer. Although few numerical methods have been proposed, they are not appropriate for nearly incompressible materials with complicated structure. In this presentation, we propose a novel algorithm with nonconforming FEM for efficient reconstructions.

CP ME-1-9 4 6 **18:20-18:40**

Numerical Simulation of Van der Pol Equation Using Multiple Scales Modified Lindstedt Poincare Method

Manoj Kumar	Motilal Nehru National Institute of Technology Allahabad
Parul Varshney	Motilal Nehru National Institute of Technology Allahabad

Abstract: In this paper, an efficient perturbation algorithm combining the method of Multiple Scales and Modified Lindstedt-Poincare Techniques is proposed to solve the equation of Van der Pol oscillator with very strong nonlinearity. This algorithm combines the advantages of both methods. Solution of Van der Pol equation by the Multiple Scales Modified Lindstedt Poincare (MSMLP) method is compared with the Multiple Scales method and numerical solution using MATLA

CP A1-3-5 4 **17:00-19:00**

Partial Differential Equations II

Chair Person: Shruti Dubey	Indian Institute of Technology Madras

CP A1-3-5 4 1 **17:00-17:20**

Solution to Fractional Navier-Stokes equations with delay term

Shruti Dubey	Indian Institute of Technology Madras
Mansur Alam	Indian Institute of Technology Madras

Abstract: Navier-Stokes equation is a heart of fluid flow modelling. On the other hand, fractional derivatives play a significant role in modelling, fluid flow, control theory etc. In this work, we aim to establish mild solution and the regularity result to fractional Navier-Stokes equations with delay term. To this end, suitable integral formulation to the problem and a definition of mild solution are introduced. Then results are established using theory of analysis, semigroup operator, fractional calculus.

CP A1-3-5 4 2 **17:20-17:40**

Slender body theory for plasmonics resonances

Matias Ruiz	Imperial College
Ory Schnitzer	Imperial College

Abstract: We propose a slender-body theory for calculating the surface-plasmon eigenvalues and eigenmodes of smooth high-aspect-ratio metallic nanoparticles (of otherwise arbitrary shape) and their resonant excitation by incident electromagnetic radiation. Analytical solutions to this problem are restricted to simple shapes, whereas slender bodies are commonly used in nanophotonics. Using matched asymptotic expansions, we develop an equivalent one-dimensional model which is straightforward to solve numerically and in special cases furnishes closed form solutions.

CP A1-3-5 4 3 **17:40-18:00**

Symmetry reductions and conservation laws for a generalized Benney–Lin equation

Maria Bruzón	University of Cádiz
Almudena Del Pilar Márquez	University of Cádiz
Elena Recio	University of Cádiz
Rafael De La Rosa	University of Cádiz

Abstract: We apply the Lie-group formalism to deduce symmetries of a generalized Benney-Lin equation. By using the symmetries, we derive all the group-invariant reductions. We construct some exact solutions with physical interest, in particular, we determine travelling wave solutions. By using the multipliers method, we show that the generalized Benney-Lin equation only admits conservation laws when the equation is reduced to the Kawahara equation (or the fifth-order Korteweg–de Vries equation). We construct all conservation laws.

CP A1-3-5 4 4 **18:00-18:20**

Existence of weak solutions for a $p(x)$ –Kirchhoff-type equation with Navier boundary conditions

Zakaria El Allali	Polydisciplinary Faculty of Nador
Said Taarabti	Polydisciplinary Faculty of Nador
Khalil Ben Haddouch	National School of Applied Sciences

Abstract: In this paper, we prove the existence of solutions for $p(x)$ –Kirchhoff-type problem with Navier boundary condition . Using variational approach and the Mountain Pass theorem, we establish some conditions for the existence of nontrivial weak solutions for $p(x)$ –Kirchhoff equation.

CP A1-3-5 4 5 **18:20-18:40**

Lie Symmetries, One Dimensional Optimal System and Group Invariant Solutions for Generalized Chaplygin Gas Equations

Manoj Pandey	BITS Pilani
Pabitra Kumar Pradhan	BITS Pilani

Abstract: A complete symmetry group classification for the Chaplygin gas equations is presented. A rigorous and systematic procedure based on the general invariants of the adjoint representation is used to construct the one-dimensional optimal system of the Lie algebra. The complete inequivalence class of the group invariant solutions are obtained by using the one-dimensional optimal system. One such solution of the governing system is used to study the evolutionary behaviour of a discontinuity wave.

CP A1-3-5 4 6 **18:40-19:00**

Investigation of weak solvability and attractors for one viscoelastic fluid model with memory.

Victor Zvyagin	Voronezh

Abstract: In the report, the existence of weak solutions to the initial-boundary value problem for one viscoelastic model of Oldroyd's type fluid with memory along trajectories of the velocity field on finite and infinite time interval is obtained. This problem is solved on based of approximations, a priori estimates and passing to the limit. The existence theorems for trajectory and global attractors for this system in the autonomous and non-autonomous cases are obtained.

CP A1-3-3 4 **17:00-19:00**

Dynamical Systems and Nonlinear Analysis I

Chair Person: Abhishek Choudhary	Rensselaer Polytechnic Institute

CP A1-3-3 4 1 **17:00-17:20**

Stochastic Modeling of Neuronal Transport in Various Cellular Geometries

Abhishek Choudhary	Rensselaer Polytechnic Institute
Peter Kramer	Rensselaer Polytechnic Institute
Joe Klobusicky	Rensselaer Polytechnic Institute

Abstract: We present a mathematical framework to analyze the transport processes inside a neuron. Our model captures spatial dynamics and interactions of a motor and cargo particles through a system of coupled stochastic differential equations. We study the transport on a parallel arrangement of microtubules inside axon (axonal transport), as well as various tangled networks of microtubules inside soma (somatic transport). In all cases, we derive the effective velocity and diffusion coefficient at the macroscopic scale.

CP A1-3-3 4 2 **17:20-17:40**

Stochastic differential inclusions and set-valued stochastic equations

Mariusz Michta	University of Zielona Góra

Abstract: In the talk properties of solutions to stochastic differential inclusions and set-valued stochastic differential equations with respect to semimartingale integrators are presented. It is shown that attainable sets of solutions to inclusions are subsets of values of solutions of certain set-valued stochastic equations. Solutions to inclusion are continuous selections of multivalued solutions of associated set-valued stochastic equation. The results in the presentation generalize those known in this topic both in deterministic and stochastic cases.

CP A1-3-3 4 3 **17:40-18:00**

Mathematical Modeling of Spatial Action of a Medium on a Body of Conical Form

Maxim V. Shamolin	Lomonosov Moscow State University

Abstract: We consider a mathematical model of spatial action of a medium on a rigid body whose external surface has a part that is a circular cone. We present a complete system of motion equations under the quasistationary conditions. The dynamical part forms an independent system of the sixth order are distinguished. We study the stability problem with respect to the part of variables of key regime. We obtain new family of nontrivial phase portraits.

CP A1-3-3 4 4 **18:00-18:20**

Stability conditions of 2D and nD discrete time models

Djillali Bouagada	Abdelhamid Ibn Badis University
Aïssa Omar El Osmani	Abdelhamid Ibn Badis University
Paul Van Dooren	Université catholique de Louvain, Belgium

Abstract: Two dimensional and n dimensional systems have received in recent decades considerable research interest. Several methods and approaches can be found to determine whether a 2D system is stable or not. In this study, using the concept of the LMI, new and sufficient conditions are derived to insure the asymptotic stability of general 2D discrete time models. Furthermore, the extension of the obtained conditions to nD discrete time models is also considered.

CP A1-3-3 4 5 **18:20-18:40**

Dynamical analysis of fractional-order predator-prey system with Holling type II functional response

Bongsoo Jang	Ulsan National Institute of Science and Technology
H. A. A. El-Saka	Damietta University
Seyeon Lee	Ulsan National Institute of Science and Technology

Abstract: Local stability and Hopf bifurcation of fractional-order predator-prey systems biological economic system with Holling type II functional response have been investigated. We explore how the economic profit and fractional orders influence the local stability and Hopf bifurcation for the fractional order predator-prey system. For an incommensurate system, we propose a new theory for the existence of Hopf bifurcation. Several experiments are demonstrated to validate the theoretical results.

CP A1-3-3 4 6 **18:40-19:00**

On Existence of Locally Attractive Solution for Fractional order Nonlinear Volterra Random Integral Equation

SIDDHARTH SHETE	S. R. T. M. University Nanded
R G METKAR	INDIRA GANDHI COLLGE NANDED

Abstract: In this research paper we prove the existence and locally attractivity results for a fractional order nonlinear Volterra type random integral equation in separable Banach space under mixed generalized compactness, contraction and caratheodory conditions, and also the existence of the locally attractive solutions is proved under some certain monotonicity conditions.

CP FT-1-8 4 17:00-19:00

Numerical Analysis IX

Chair Person: NAVEEN KUMAR GARG Southern University of Science and Technology, SUSTech

CP FT-1-8 4 1 **17:00-17:20**

Use of Jordan forms for convection-pressure split Euler solvers

NAVEEN KUMAR GARG	Southern University of Science and Technology, SUSTech

Abstract: In this study, we analyze convection-pressure split Euler flux functions which contain weakly hyperbolic convection subsystems. To construct an upwind solver, we require to generate a full set of LI eigenvectors. This can be done through the addition of generalized eigenvectors using the theory of Jordan canonical forms. The concept of generalized eigenvectors is found to be useful in dealing with the weakly hyperbolic parts of the considered Euler systems.

CP FT-1-8 4 2 **17:20-17:40**

Identifying the lights position in Photometric Stereo under unknown lighting.

Anna Concas	University of Cagliari
Riccardo Dessì	University of Cagliari
Caterina Fenu	University of Cagliari
Giuseppe Rodriguez	University of Cagliari
Massimo Vanzi	University of Cagliari

Abstract: A classical problem in Computer Vision consists in reconstructing the 3D shape of an object, starting from a set of pictures. Photometric Stereo technique extracts shape and color information from an object which is observed from a fixed point of view but under different lighting conditions. We will describe an algorithm to approximate the framed object, treating, in particular, the case when the position of the light sources is unknown. Numerical experiments will be illustrated.

CP FT-1-8 4 3 **17:40-18:00**

Weak Antithetic MLMC Estimation with the Milstein Scheme for Diffusion and Jump-Diffusion SDEs

Kristian Debrabant	University of Southern Denmark
Azadeh Ghasemifard	Isfahan University of Technology
Nicky Cordua Mattsson	University of Southern Denmark

Abstract: We show that combining the antithetic MLMC with the weak MLMC, we can achieve a quadratic computational complexity when estimating expected values of smooth functionals of SDEs, without requiring strong convergence of the underlying one-step-method. By using appropriate discrete variables this allows us to reduce the variance of the scheme and, for low-dimensional problems, calculate the expectation on the coarsest level of resolution by enumeration, which results in a reduced computational effort.

CP FT-1-8 4 4 **18:00-18:20**

Structure-preserving numerical scheme for the area-preserving curve shortening flow

Tomoya Kemmochi	Nagoya University

Abstract: A novel numerical scheme for the area-preserving curve shortening flow for planar closed curves will be presented. Our scheme preserves both the energy dissipation and area-preservation property. Namely, the length of numerical solution never increase at each time step and the area of the domain enclosed by the curve never change. We will present some numerical examples in the last part of the talk.

CP FT-1-8 4 5 **18:20-18:40**

Condition and convergence of a barycentric rational interpolant

Jean-Paul Berrut	University of Fribourg, Switzerland

Abstract: We study two properties of a linear rational interpolant. First, we show that it is remarkably well-conditioned, as its Lebesgue constant grows about as slowly as that of polynomial interpolation between Chebyshev nodes. Second, we prove that the convergence as the square of the maximal mesh distance conjectured earlier is indeed valid, but merely under some conditions about the location of the nodes. We illustrate our findings with numerical calculations.

CP FT-1-8 4 6 **18:40-19:00**

A periodic map for linear barycentric rational trigonometric interpolation

Giacomo Elefante	University of Fribourg
Jean-Paul Berrut	University of Fribourg

Abstract: The trigonometric barycentric interpolant of an arbitrary 2π-periodic function between equidistant points in [0,2π) converges exponentially, when the nodes are images of equidistant points under a periodic conformal map. In this work, we present a simple periodic conformal map which accumulates nodes in the neighborhood of an arbitrarily located front, as well as its extension to several fronts. Despite its simplicity, it yields a very accurate approximation of functions with steep gradients.

CP FT-4-5 4 17:00-19:00

Simulation and Modelling II

Chair Person: Oleg Kudryavtsev Russian Customs Academy - Rostov branch

CP FT-4-5 4 1 **17:00-17:20**

Advanced Monte Carlo method for pricing seasoned lookback options under Levy models

Oleg Kudryavtsev	Russian Customs Academy - Rostov branch

Abstract: At present in finance, more and more attention is attracted to Levy models which admit jumps and heavy tails. We suggest a new Monte Carlo technique for pricing lookback options with the prefixed extremum of the underlying asset price observed prior to the current time. The method uses Laplace transform and Wiener-Hopf factorization for direct simulating the extremum of the Levy process. The reported study was funded by RFBR according to the research project No.18-01-00910.

CP FT-4-5 4 3 **17:20-17:40**

Quantitative Simulation of Garment Fitting

Sebastian Götschel	Zuse Institute Berlin
Martin Weiser	Zuse Institute Berlin

Abstract: In this talk we investigate methods to accurately simulate the fitting of clothes. We derive a 2D formulation from the 3D model of nonlinear elasticity with anisotropic materials. Seams joining individual cloth panels are handled by equality constraints, self-contact and contact of the 2D cloth with a 3D body are treated as inequality constraints. The constrained energy minimization problem is solved using an Augmented Lagrangian method combined with Morley finite elements.

CP FT-4-5 4 4 **17:40-18:00**

FEMPAR-AM: Leveraging unfitted finite elements, hierarchical octree meshes and balancing domain decomposition by constraints for digital design and certification in 3D printing with metals.

Eric Neiva	Universitat Politècnica de Catalunya
Santiago Badia	Universitat Politècnica de Catalunya
Alberto F. Martín	Universitat Politècnica de Catalunya
Francesc Verdugo	Universitat Politècnica de Catalunya
Michele Chiumenti	Universitat Politècnica de Catalunya

Abstract: Digital design and certification in metal 3D printing requires solving very computationally demanding multiscale and multiphysics problems governed by partial differential equations. To handle such complexity in time frames compatible with time-to-market, the authors propose a novel parallel, fully-distributed finite-element framework. It is grounded on: (1) Octree-based hierarchical adaptive mesh refinement, (2) the aggregated unfitted finite-element method and (3) the balancing domain decomposition by constraints method, enhanced with a coarse subgraph extraction algorithm.

CP FT-4-5 4 5 **18:00-18:20**

A Finite Element Study of Cardiac Electrical Activity in a Human Cardiac Tissue with Multiple Myocardial Ischemia

Meena Pargaei	Indian Institute of Technology Kanpur
B. V. R. Kumar	Indian Institute of Technology Kanpur

Abstract: A modified Human ventricular TT06 ionic model coupled with the Monodomain model is solved using FE and BEFD methods to analyze the cardiac electrical activity in Human Cardiac Tissue with Multiple Myocardial Ischemia. 61% decrease in the vicinity of two ischemic regions leads to 13% drop in action potential duration(APD) in the neighboring healthy region. Increasing the number of ischemic regions from 1 to 4 leads to a 39% drop in APD.

CP FT-4-5 4 6 **18:20-18:40**

A 3D Solution-Adaptive Framework for Hyperbolic PDEs with Application to Explosive Dispersal of Radioactive Material

Andrée-Anne Dion-Dallaire	University of Ottawa
James Gerald McDonald	University of Ottawa
Lucian Ivan	Canadian Nuclear Laboratories

Abstract: This talk presents a three-dimensional (3D) framework for solving hyperbolic balance laws on block-based solution-adaptive grids. A massively-parallel and flexible implementation is presented for the solution of a new set of PDEs governing the evolution of polydisperse particles resulting from the detonation of a radiological dispersal device (RDD). The first-order hyperbolic nature of the model combined with the optimal locality of the discontinuous Galerkin method is well suited for large-scale parallel solution on supercomputers.

CP FT-S-3 4 17:00-19:00

Partial Differential Equations III

Chair Person: Artur Stephan Weierstraß-Institut Berlin

CP FT-S-3 4 1 **17:00-17:20**

Evolutionary Γ-convergence for a linear reaction-diffusion system with different time scales

Artur Stephan	Weierstraß-Institut Berlin
Alexander Mielke	Weierstraß-Institut Berlin

Abstract: We study a linear reaction-diffusion system involving slow and fast reactions and investigate its bahavior if some reaction rates tend to infinity. Assuming detailed balance, the problem can be understood as a gradient flow in Wasserstein space. We show how an effective limiting system can be rigorously derived preserving the underlying gradient structure. The limiting process is a reaction-diffusion system with mixed diffusion coefficients coarse-grained with respect to the local equilibria of the fast reactions.

CP FT-S-3 4 2 **17:20-17:40**

Complex dynamics of a diffusive modified Holling-Tanner predator-prey model with strong Allee effect

Claudio Arancibia-Ibarra	Faculty of Science and Engineering, Queensland University of Technology (QUT), Brisbane, Australia. Faculty of Education, Universidad de las Americas (UDLA), Santiago, Chile..

Abstract: In this work, we consider temporal and spatio-temporal modified Holling-Tanner predator-prey models with an alternative food for the predator and strong Allee effect in the prey. From our result of the temporal model, we identify regions in parameter space in which Turing instability in the spatio-temporal model are expected. Subsequently, we analyse these instabilities. We use simulations to illustrate the behaviour of both the temporal and spatio-temporal model.

CP FT-S-3 4 3 **17:40-18:00**

Regularity and wellposedness of the KdV- Kuramoto-Sivashinski equation to two parameters on periodic Sobolev spaces and its behavior at the limit

Yolanda Santiago Ayala	Universidad Nacional Mayor de San Marcos

Abstract: We study the Cauchy problem associated to model ut+δuxxx+β(uxxxx+uxx)=0 in Hs-4, u(0)=φ in Hs proposed in R. Iorio (2002), and prove it is globally well posed. We do this in an intuitive way using Fourier Theory and in a fine version using Semigroups theory. Also, we analyze its behavior at the limit for the cases (δ>0 , β → 0+),(β>0 and δ→0+). Finally, we prove that the corresponding nonhomogeneous problem is locally well posed.

CP FT-S-3 4 4 **18:00-18:20**

An inhomogeneous minimization problem with free boundary for the $p(x)$-Laplacian

Claudia Lederman	Universidad de Buenos Aires
Noemi Wolanski	Universidad de Buenos Aires

Abstract: We study an inhomogeneous minimization problem associated to the $p(x)$-Laplacian. This operator has been used in the modelling of electrorheological fluids and in image processing. We analyze essential properties of minimizers and we show that they are solutions to a one phase free boundary problem for the $p(x)$-Laplacian with non-zero right hand-side, and that the free boundary is a smooth surface. We overcome deep technical difficulties not present in previous literature.

CP FT-S-3 4 5 **18:20-18:40**

Liouville theorems in the regularity theory of the Navier-Stokes equations

Dallas Albritton	University of Minnesota
Tobias Barker	Ecole Normale Superieure, CNRS, PSL Research University

Abstract: Liouville theorems are classification theorems for special solutions of partial differential equations, often obtained by ``zooming in'' on singular solutions. Historically, such theorems have been highly successful in the regularity theory of minimal surfaces, harmonic maps, etc. We investigate potential singularities of Navier-Stokes solutions from the perspective of Liouville theorems. In particular, we prove that Type I singularities occur if and only if there exist non-zero bounded ancient solutions satisfying a critical decay condition.

CP FT-S-3 4 6 **18:40-19:00**

Recovery of Membrane's temperature for a parabolic Membrane Distillation System from partial boundary measurements

Mohamed GHATTASSI	KAUST

Abstract: In this work we consider the reconstruction problem of the temperature profile on the surface of a membrane used in a direct contact membrane distillation process. Its model is described by a parabolic system. First, we introduce a change of variables to decouple the problem at the boundary and make the membrane temperature as a source term to recover. Then, we construct the temperature at the membrane by reading at the boundary.

CP FT-4-7 4 17:00-19:00

Mathematical Topics and their Applications VII

Chair Person: Rabah Khaldi Badji Mokhtar Annaba University

CP FT-4-7 4 1 **17:00-17:20**

New Lyapunov inequality type for a boundary value problem

Rabah Khaldi	Badji Mokhtar Annaba University
Assia Guezane Lakoud	Badji Mokhtar Annaba University

Abstract: Lyapunov inequality and its generalizations have many applications in various fields such in oscillation theory, asymptotic theory, disconjugacy, eigenvalue problems…. The aim of this talk is to establish a new Lyapunov-type inequality for a differential equation of a noninteger order and subject to Dirichlet-type boundary conditions. Moreover an application to the corresponding eigenvalue problem is discussed.

CP FT-4-7 4 2 **17:20-17:40**

Bifurcation diagrams of positive solutions for one-dimensional Minkowski-curvature problem and its applications

Shao-Yuan Huang National Formosa University

Abstract: In this paper, we study the classification and evolution of bifurcation curves of positive solutions for one-dimensional Minkowski-curvature problem where the nonlinearity term f(u) satisfies (b-u)f(u)>0. In particular, we find that the bifurcation cruve is monotone increasing for L>0 when f(u)/u is of Logistic type, and is either C-shaped or S-shaped for large L>0 when f(u)/u is of weak Allee effect type.

CP FT-4-7 4 4 **17:40-18:00**

A size structured cell growth model with stochastic growth rate

Ali Ashher Zaidi Lahore University of Management Sciences

Bruce Van Brunt Massey University

Messoud Efendiev Helmholtz Centre

Graeme Wake Massey University

Abstract: A cell growth model for a size-structured cell population with a stochastic growth rate for size is considered. The model entails an initial boundary value problem that involves a second-order parabolic partial differential equation with nonlocal terms. The solution techniques for such problems are rare due to the nonlocal terms. We obtain a separable solution and the general solution to the problem, and show that the solutions converge to the separable solution for large time.

CP FT-4-7 4 5 **18:00-18:20**

Evolution of Weakly Nonlinear Waves in Regions Exhibiting Mixed Nonlinearity

Triveni Prasad Shukla Indian Institute of Technology Kanpur

Vishnu D. Sharma Indian Institute of Technology Bombay

Abstract: We consider quasilinear hyperbolic system of PDEs to study the evolution of weakly nonlinear waves in the region of mixed nonlinearity. The evolution equation involves quadratic, cubic, and quartic nonlinear terms. It is shown that (i) the presence of quartic term leads to the formation of a double sonic shock, (ii) during the interaction of expansion and compression waves, a single compression shock disintegrates into a pair of sonic shocks, separated by a compression fan.

CP FT-4-7 4 6 **18:20-18:40**

Comparative analysis of the histogram-based and projection-based Monte Carlo algorithms in the problem of the bidirectional characteristics of polarized radiation evaluation

Natalya Tracheva Novosibirsk State University, Institute of Computational Mathematics and Mathematical Geophysics SB RAS

Sergey Ukhinov Novosibirsk State University, Institute of Computational Mathematics and Mathematical Geophysics SB RAS

Abstract: For the problem of the evaluation of the bidirectional angular characteristics of the polarized radiation, transmitted and back-scattered by the absorbing and scattering layered substance, a two-dimensional statistical weighted kernel density estimate is formulated. This approach is numerically compared with the alternative one, based on the orthonormal series expansion with some particular for this problem weight function. The reported study was partially funded by RFBR according to the research projects 17-01-00823, 18-01-00356, 18-31-00213.

CP A1-3-4 4 **17:00-19:00**

Industrial Applications in Economy and Finances

Chair Person: Anatoliy Swishchuk University of Calgary

CP A1-3-4 4 1 **17:00-17:20**

Applications of Hawkes Processes in Finance and Insurance

Anatoliy Swishchuk University of Calgary

Abstract: The talk is devoted to the Hawkes processes and their applications in finance and insurance, and consists of three parts. The first part introduces the Hawkes processes and describes their properties. The second part is devoted to modelling of limit order books with Hawkes processes. The third part focuses on application of Hawkes processes in insurance. Numerical examples will be presented using real data.

CP A1-3-4 4 2 **17:20-17:40**

What could be digital twins for the insurance industry? Example of the global sensibility analysis for the Solvency Capital Requirement.

Maume-Deschamps Véronique Université Claude Bernard Lyon 1

Elie Die Cosaque Kevin SCOR

Abstract: The Solvency Capital Requirement (SCR) is fundamental for insurance businesses and regulators. It depends on several parameters subject to some uncertainty. Sensitivity analysis may help in the quantification of the uncertainty of parameters on the variability of the SCR. Global Sensitivity analysis is well adapted when the inputs are independent and for central variability. We shall focus on estimation and computational aspects. This is a joined work with Kevin Elie di Cosaque and SCOR.

CP A1-3-4 4 3 **17:40-18:00**

Coupled transform method for time-space fractional Black-Scholes Option Pricing model

Sunday Edeki Covenant University,

Abstract: This paper presents analytical solutions of a time-space-fractional Black-Scholes model (TSFBSM) using a coupled technique referred to as Fractional-Complex-Transform with the aid of modified differential transform. The derivatives are in Jumarie's sense. The considered applications show more consistency of the TSFBSM with actual financial market data compared to the classical BSM. The method is noted to be very effective even with little knowledge of fractional calculus. Hence, it is recommended for multi-factor stochastic models.

CP A1-3-4 4 4 **18:00-18:20**

Examining equal weighted portfolio construction

Eben Mare University of Pretoria

Byran Taljaard University of Pretoria

Abstract: In this contribution we consider portfolios of risky financial securities (typically equities) with equal weighting - we examine risk characteristics as well as performance characteristics of such portfolios compared to so-called market-capitalisation methodologies and examine regimes of under/over performance on a relative basis.

CP A1-3-4 4 5 **18:20-18:40**

A comparison of expected utility between DP and PFPP under the binomial model

Daichi Sato Hosei University Graduate School of Science and Engineering

Kazuhiro Yasuda Hosei University

Abstract: A Predictable Forward Performance Processes (PFPP) was proposed in Angoshtari, et al. [2018] and they consider multi-period portfolio optimization using PFPP in finance. The classical DP method does not allow change of the market situation from the initial supposition for parameters. However it is not realistic in financial markets. On the other hand PFPP can adapt to such cases. Here we work out relations between market changes and expected utilities in these two methods.

CP FT-S-7 4 **17:00-19:00**

Simulation and Modelling III

Chair Person: Jana Fuchsberger University of Graz

CP FT-S-7 4 1 **17:00-17:20**

Simulating a Heart Valve using a Varying Permeability Approach

Jana Fuchsberger University of Graz

Gundolf Haase University of Graz

Elias Karabelas University of Graz

Gernot Plank Medical University of Graz

Abstract: Models of total heart function include computational fluid dynamics models of blood flow. The effect of heart valves upon flow patterns can be taken into account by a fictitious domain approach in combination with the Navier-Stokes-Brinkman equations. The motion of the valve is represented by means of a spatio-temporal varying permeability function while the underlying mesh remains unchanged.

We present first proof-of-concept simulations of blood flow in the left ventricle and aorta to demonstrate feasibility.

CP FT-S-7 4 2 **17:20-17:40**

A finite volume method for a predator-prey model with double chemotaxis

Rafael Ordoñez	Universidad de Concepción

Abstract: W propose a convergent finite volume method for a reaction diffusion predator prey model with double chemotaxis. Furthermore, we our numerical scheme, an a priori estimate and proof of existence of a solution to the finite volume scheme. The convergence proof uses the discrete Sobolev Embedding inequalities and space-time L^1 compactness argument. Finally, we report some numerical test illustrating the behavior of the solution of the finite volume scheme.

CP FT-S-7 4 3 **17:40-18:00**

A High-Level Software Approach to Parallel Reservoir Simulation

Sungwoo Jeong	Massachusetts Institute of Technology
Alan Edelman	Massachusetts Institute of Technology
Xiangdong Liang	Aramco Service Company
Ali Dogru	Saudi Aramco

Abstract: We introduce a new high-level software approach to develop parallel multi-phase reservoir simulators using the Julia programming language. Our interactive and extensible simulator demonstrates ease of coding, ease of use, and high performance. This simulator runs on both CPU and GPU architectures through minor code adjustments, without MPI or CUDA. It also includes features like customized data formats for stencil computation and in-place visualization. Our work is validated with the petroleum industry benchmark problem SPE10.

CP FT-S-7 4 4 **18:00-18:20**

Application of the Finite Element Method and the Wavelet Transform to Early Fault Detection in aeroderivative gas turbines.

Alejandro Silva	ETS. de Ingenieros Industriales, Universidad Politécnica de Madrid
Alejandro Zarzo	ETS. de Ingenieros Industriales, Universidad Politécnica de Madrid
Juan Manuel Muñoz-Guijosa	ETS. de Ingenieros Industriales, Universidad Politécnica de Madrid

Abstract: Rotor-stator rub in aeroderivative gas turbines is difficult to diagnose because of limitations in the positioning of probes but may cause machine breakdown when undetected. This talk focuses on the application of the Early Fault Detection paradigm to develop rub detection tools based on the Wavelet Transform. Before their implementation in real machinery, the performance of these tools is tested on a model simulated with the help of the Finite Element Method.

CP FT-S-7 4 5 **18:20-18:40**

Comparison of methods for determining the effective permittivity of composite materials

H. Thomas Banks	North Carolina State University
Marcela Morvidone	Universidad Nacional de San Martin
Diana Rubio	Universidad Nacional de San Martin
Nicolas Saintier	Universidad de Buenos Aires

Abstract: We are concerned with the estimation of electromagnetic properties of composite materials modelled in first approximation as layered materials. We propose to estimate the permittivity as a function of the wavenumber using non-invasive and non-destructive interrogation techniques based on the reflectance coefficient. We use different mathematical models for the permittivity (Efimov, Prokhorov based, homogenization) and compare their performances in the estimation process by numerically simulating noisy reflectance coefficients for a wide range of frequencies.

CP FT-S-7 4 6 **18:40-19:00**

Neuro-computational modeling of basal ganglia for understanding Parkinson’s disease, Attention Deficit Hyperactivity Disorder and their medication

Véronneau-Veilleux Florence	Université de Montréal
Nekka Fahima	Université de Montréal
Robaey Philippe	University of Ottawa

Abstract: Parkinson's disease and Attention Deficit Hyperactivity Disorder both affect the dopaminergic system of basal ganglia by decreasing the dopaminergic concentration in the synaptic cleft and in the extrasynaptic space. A neuro-computational model was used to study the impact of this decrease. It contains the three main neurotransmission pathways. The symptoms for Parkinsonian patients and for patients with ADHD were simulated in order to improve the use of Levodopa and psychostimulants.

CP A1-3-2 4 17:00-19:00

Numerical Analysis of PDE

Chair Person: Vusala Ambethkar	University of Delhi

CP A1-3-2 4 1 **17:00-17:20**

A new smoothness indicator for third order ESWENO scheme to improve the convergence order of accuracy

Vusala Ambethkar	University of Delhi
Anurag Kumar	University of Delhi

Abstract: A new global smoothness indicator is proposed for FDWENO3 scheme to recover desired order of accuracy. We choose a simple global indicator which switches to novel weight functions . A TVDRK3 method is used in this numerical scheme . We apply our modified scheme in several benchmark problems for linear, 1D and 2D Euler system of equations. Numerical results indicate that FDWENO-MES scheme provides more efficiency and better performance than FDWENO-JS3, FDWENO-Z3 and FDWENO-ES schemes.

CP A1-3-2 4 2 **17:20-17:40**

Using an automatic meshing algorithm to rationalize the use of computational resources in numerical simulations: an application to a Lean Direct Injection gas turbine

Raúl Payri	Universitat Politècnica de València
Ricardo Novella	Universitat Politècnica de València
Marcos Carreres	Universitat Politècnica de València
Pedro Quintero	Universitat Politècnica de València
Mario Belmar-Gil	Universitat Politècnica de València

Abstract: LDI combustors emerged as an alternative to comply with strict polluting emissions limits. Numerical CFD simulations of these devices are usually computationally unaffordable since they imply a multi-scale problem. In this work, non-reactive flow is modelled both through a conventional mesh and an Adaptive Mesh Refinement algorithm, aiming at reducing computational costs. Different turbulence models, discretization schemes and numerical algorithms are tested to determine the optimal meshing strategy by comparing turbulent statistics with experimental data.

CP A1-3-2 4 3 **17:40-18:00**

Numerical approximations to nonlocal problems in wavelets spaces

Alfredo Calvo	University of Salamanca

Abstract: Integrals of convolution of the form $\int K(x|y) * u(y)$ appear in a wide variety of nonlocal diffusion problems like physical models to simulate forest fires, equations modelling biological processes or treatment of images. Numerical approximations using the classical methods yield dense matrices for this nonlocal operator with a cost in time computation and storage. The Galerkin discretization using wavelets spaces gives rise to sparse matrices under certain conditions of the operator $K(x|y)$

CP A1-3-2 4 5 **18:00-18:20**

A NOVEL HIGH ORDER ACCURATE WENO SCHEME FOR SOLUTION OF HYPERBOLIC CONSERVATION LAWS

AMBETHKAR VUSALA	UNIVERSITY OF DELHI

Abstract: In this work a novel high order (≥3) accurate weighted essentially non-oscillatory (WENO) scheme is presented in the finite difference structure for computing solutions of hyperbolic conservation laws. The present scheme is established to be of high performance as it is constructed by devising a novel reference smoothness indicator that satisfies a sufficient condition on weights to get high accuracy (≥3). Benchmark Numerical results obtained with this scheme reveal the capability of this novel scheme.

CP A1-3-2 4 6 **18:20-18:40**

Black Box multigrid algorithms on partially structured grids for magnetohydrodynamics problems

Luc Berger-Vergiat	Sandia National Laboratories
Ray Tuminaro	Sandia National Laboratories
Ari Rappaport	University of New Mexico

Abstract: Black Box multigrid algorithms have be shown to provide fast convergence rate for specific class of problems such as diffusion problems and underground flow (Darcy). We aim at extending this approach to a specific formulation of magnetohydrodynamics, which is a currently challenging problem for multigrid. Emphasis will be place on the implementation aspects of the method for structured and partially structured meshes.

CP FT-1-7 4 17:00-19:00

Mathematical Topics and their Applications VI

Chair Person: Jagdish Prasad Maurya	Jorhat Engineering College

CP FT-1-7 4 1 17:00-17:20

Mathematical modelling of intensification of cyclonic wind

Jagdish Prasad Maurya	Jorhat Engineering College

Abstract: In this paper, we consider the general viscous model and present the analytical model of cyclonic winds and investigating how cyclonic winds intensify rapidly. Existence of double exponential terms are expected as the reason for the general form of viscosity. The azimuthal velocity rises fast with time close to the ground, but the rise is slower at a height little above the ground. We observe that pressure ascends with the vertical and radial distances.

CP FT-1-7 4 2 17:20-17:40

Spatial and Temporal Averaging Windows and Their Impact on Forecasting: Exactly Solvable Examples

YING LI	University of Wisconsin Madison
Samuel Stechmann	University of Wisconsin-Madison

Abstract: In making weather and climate predictions, the goal is often to predict quantities of temperature, wind speed, or rainfall after averaging in time and/or space instead of instantaneous, local value. What is the impact of spatial and/or temporal averaging on forecasting skill? Here this question is investigated using simple stochastic models that can be solved exactly analytically. Space averaging and time averaging are shown to have distinctly different impacts on prediction skill.

CP FT-1-7 4 3 17:40-18:00

Numerical Stability of s-step Enlarged Conjugate Gradient Methods

Sophie Moufawad	American University of Beirut

Abstract: In the aim of speeding-up the convergence of Krylov subspace methods on modern architectures, we present s-step enlarged Krylov subspace methods, whereby s iterations of enlarged Krylov subspace methods are merged; leading to faster convergence than Krylov methods in terms of iterations. Moreover, computing st basis vectors of enlarged Krylov subspace $K_{ks,t}(A|r_0)$ at each s-step iteration further reduces communication in parallel. We present several s-step enlarged CG versions (SRE-CG, MSDO-CG) and discuss their numerical stability.

CP FT-1-7 4 4 18:00-18:20

On time-optimal control in multibody dynamics

Philipp Eichmeir	Josef Ressel Center for Advanced Multibody Dynamics
Stefan Oberpeilsteiner	Josef Ressel Center for Advanced Multibody Dynamics
Thomas Lauß	Josef Ressel Center for Advanced Multibody Dynamics
Wolfgang Steiner	Josef Ressel Center for Advanced Multibody Dynamics

Abstract: Time-optimal control of multibody systems deals with the problem of finding control inputs minimizing the time. This task leads to a two-point boundary value problem, which is hard to solve and requires an initial guess close to the optimal solution. Instead of solving the underlying boundary value problem, we propose the adjoint-gradient method. Using the gradient information, a minimum of a cost function is found by applying the method of steepest descent or the BFGS-algorithm.

CP FT-1-7 4 5 18:20-18:40

Optimal design of piezoelectric transducers

David Ruiz	University of Castilla-La Mancha
José Carlos Bellido	University of Castilla-La Mancha
Alberto Donoso	University of Castilla-La Mancha

Abstract: The number of publications of the topic “Topology optimization” increases every year covering a wide range of applications such as: structural design, fluid-structure interaction, design of metamaterials, etc. This work presents chronologically the advances made by the research group OMEVA, from the beginning ten years ago, to the current lines. During this last decade, the works focused on piezoelectric microtransducers, working under the assumption of small deformation (static and modal analysis) and large deformation.

CP FT-1-7 4 6 18:40-19:00

Multiscale modelling of environmentally-friendly, high-performance 3D printable piezoelectric materials: challenges and applications

Andres Saez	University of Seville
Federico C. Buroni	University of Seville
Felipe Garcia Sanchez	University of Malaga
Anakkavoor K. Jagdish	Wilfrid Laurier University
Luis Rodriguez-Tembleque	University of Seville
Roderick Melnik	Wilfrid Laurier University

Abstract: We focus on the modelling of piezoelectric nanocomposites consisting of lead-free piezoelectric nanomaterials embedded in flexible matrices. The application of such materials is ranging from wearable piezoelectric energy harvesters to larger structures in civil infrastructures, replacing lead-based piezoelectrics. We develop and apply a new coupled electro-elastic model to bring together the effects of nanoscale and microstructural considerations in design of such 3D printable composites. We computationally investigate important aspects of piezoelectric composite design and performance.

SL03 19:15-20:00

The John von Neumann Prize Lecture

Chair Person: Lisa Fauci	Tulane University

19:15-20:00

A Hungarian Feast of Applied Mathematics

Margaret H. Wright	Courant Institute of Mathematical Sciences, New York University.

Abstract: If asked to name one Hungarian dish, almost everyone would say ``goulash’’, even though there is no shortage of other traditional Hungarian foods. This relationship is reversed when mathematicians are asked to name John von Neumann’s most important contributions. People tend to believe that his special interest was in their field, and they are often correct. The speaker will highlight a selection of areas in which von Neumann took a non-trivial interest, illustrating modern ramifications.

Wednesday sessions July, 17

IL07 08:30-09:15

Alfredo Bermúdez de Castro

Chair Person: Wil Schilders	TU Eindhoven

08:30-09:15

Some case studies in environmental and industrial mathematics

Alfredo Bermudez De Castro	Univ. Of Santiago de Compostela, Spain
Alfredo Bermúdez	Universidade de Santiago de Compstela and ITMATI

Abstract: Four case studies in environmental and industrial mathematics developed by the Mathematical Engineering research group in the University of Santiago de Compostela and ITMATI are shown. Two of them are related with fluid mechanics (submarine outfalls on the coast and gas transport in networks) and are modelled by nonlinear hyperbolic equations with source terms. The other two concern electromagnetism: magnetic hysteresis in simulation of nondestructive testing procedures and fast computing methods for electric machines.

IL08 08:30-09:15

Wolfgang Dahmen

Chair Person: Gitta Kutyniok	Technische Universität Berlin

08:30-09:15

High-Dimensional Operator Equations - Error Control and Complexity

Wolfgang Dahmen	University of South Carolina, USA
Cohen Albert	Sorbonne Universite

DeVore Ronald	Texas A & M University
Mula Olga	Universite Paris Dauphine
Nichols James	Sorbonne Universite

Abstract: Conventional numerical concepts, applied to problems posed in high spatial dimensions, suffer from the "curse of dimensionality" paraphrasing an often prohibitive exponential dependence of computational cost on the number of variables. Partial differential equations (PDEs) in high dimensional phase space, such as Fokker-Planck and Schrödinger equations, or Uncertainty Quantification for families of PDEs, depending on a large (even infinite) number of parameters, are important examples of such problems. For both scenarios we discuss intrinsic obstructions, characteristic approximability properties and adaptive solution strategies that realize a given target accuracy while avoiding the curse of dimensionality. Conceptual ingredients are low-rank and tensor methods or reduced basis techniques.

IL09 **08:30-09:15**

Hans De Sterck

Chair Person: Mejdi Azaiez Bordeaux INP, France

08:30-09:15

Scalable Solvers for Computational Science and Data Science: Multilevel, Nonlinearly Preconditioned, and Parallel-in-Time

Hans De Sterck University of Waterloo, Canada

Abstract: In the current era of big data and big computational models, numerical methods of iterative type are crucial algorithmic building blocks for tackling large-scale problems from scientific computing and data analysis. Bridging the two worlds of computational science and data science, this talk will discuss recent advances in scalable iterative solvers for such problems, highlighting synergies in ideas and approaches between the two worlds. We will first extend well-known ideas of linear preconditioning for systems of algebraic equations to the setting of nonlinear preconditioning for optimization methods (e.g., LBFGS and Nesterov's method), dramatically speeding up convergence for data analysis applications such as tensor decomposition and recommendation. Next we will discuss how recursive preconditioning on multiple levels may lead to efficient parallel-in-time integration for PDEs from computational science. Spatial parallelism alone quickly saturates on contemporary fast computers that may have up to millions of cores due to stagnating processor clock speeds, and parallelism in time can help overcome this bottleneck. Challenges for applying these techniques to hyperbolic PDEs that model wave propagation will be discussed. We will conclude with some natural and some surprising combinations of these ideas across the two worlds. For example, parallel-in-time ideas can be applied to data analysis problems, and acceleration ideas can be combined with stochastic optimization methods and randomization.

IL11 **09:30-10:15**

Marsha J. Berger

Chair Person: Leslie Greengard Flatiron Institute/Courant Institute

09:30-10:15

Progress in Modeling of Asteroid-Generated Tsunamis

MARSHA BERGER Courant Institute, NYU

Abstract: Could an asteroid that explodes over the ocean generate a tsunami threatening coastal populations far away? We show simulations of tsunami propagation from asteroid-generated airbursts. We then present a 1D model with an explicit solution to understand the unexpected results. The model is then extended to explore the effects of dispersion and compressibility. We end with a discussion of appropriate tools to study the more serious case of an asteroid that impacts the water.

IL10 **09:30-10:15**

Peter Bühlmann

Chair Person: Carlos Vázquez Cendón Universidade da Coruña

09:30-10:15

Statistical Robustness, Stability and Interpretability of Algorithms

Peter Bühlmann ETH Zurich, Switzerland

Abstract: Interpretable machine learning and artificial intelligence is a big emerging theme, complementing the development of pure black box prediction tools. Looking through the lens of statistical causality opens up new paths and opportunities for enhanced interpretability and predictive robustness of algorithms, with wide-ranging prospects for various applications; and we will highlight some of them from molecular biology. The key technical idea relies on a notion of probabilistic invariance, exhibiting novel connections to robust optimization.

IL12 **09:30-10:15**

Kazue Sako

Chair Person: Yasumasa Nishiura Tohoku University

09:30-10:15

Cryptography and Digital Transformation

Kazue Sako NEC Corporation

Abstract: We are all aware that the discrete mathematics is a foundation of cryptography. It is beautifully exemplified in RSA cryptosystem which uses Fermat's little theorem and difficulty of factorization. However, cryptography is not only for encryption and signing messages. By combining cryptographic primitives, we can design and digitally implement various services with desired features in security, privacy and fairness. In the talk, we will discuss some examples such as electronic voting, sealed-bid auction and cryptocurrencies.

MS ME-1-0 5 **11:00-13:00**

Recent Advances in Optimal Control Theory - Part 5

For Part 1 see: MS ME-1-0 1
For Part 2 see: MS ME-1-0 2
For Part 3 see: MS ME-1-0 3
For Part 4 see: MS ME-1-0 4

Organizer: Alexander Zaslavski	The Technion - Israel Institute of Technology
Organizer: Monica Motta	University of Padua
Organizer: Boris Mordukhovich	Wayne State University
Organizer: Nobusumi Sagara	Hosei University

Abstract: This minisimposium on new developments in optimal control theory and its applications will bring together a selected group of experts in this area. The growing importance of control and optimization has been realized in recent years. This is due not only to theoretical developments, but also because of numerous applications to engineering, economics and life sciences. The topics which will be discussed include optimal control of PDE, turnpike phenomenon, infinite horizon optimal control, necessary and sufficient optimality conditions, qualitative and quantitative aspects of optimal control and applications.

11:00-11:30

Optimal strategies of a treatment in control models of allergy

Ellina Grigorieva	Texas Woman's University
Evgenii Khailov	Lomonosov Moscow State University

Abstract: An accute allergic reaction is immune disorder that changes the code in action of T-helper cells. The objective of this study is to create realistic control models of different types of allergy and using optimal control theory find possible way to prevent its symptoms by optimal treatment.

11:30-12:00

On the convergence problem for first order mean field games

Francisco José Silva Alvarez Techniques Université de Limoges

Abstract: In this talk, based on a joint work with M. Fischer (University of Padua), we provide a simple justification of the first order MFG system, first introduced by Lasry and Lions in 2007, as a PDE characterization of Nash equilibria for symmetric deterministic differential games with a continuum of players. Our main result shows that such equilibria can be found as the limit of Nash equilibria of suitable differential games with finite number of players.

MS A1-1-1 5 **11:00-13:00**

Advances in reduced order methods for parameter-dependent problems

Organizer: Francisco Pla Martos Martos Universidad de Castilla-La Mancha

Abstract: The main objective of this minisymposium is to present some recent advances in reduced order methods for parameter-dependent problems. These types of problems may be expensive due to the calculations of partial differential equations systems together with a large number of values of the parameters. Hence, the reduced order methods is necessary to reduce the computational cost. Different reduced order modelling will be presented, such as POD or reduced bases. This minisymposium will bring together scientists to present their recent advances on reduced order methods applied to parameter-dependet problems, provide a forum for discussion and interaction in these methods.

11:00-11:30

Efficient adaptive ROMs using LUPOD on the fly

María Luisa Rapún Universidad Politécnica de Madrid, UPM
Filippo Terragni Universidad Carlos III de Madrid
José Manuel Vega Universidad Politécnica de Madrid

Abstract: We accelerate time-dependent solvers for PDEs by improving the performance of adaptive low-dimensional models through a recent collocation strategy called LUPOD. The method combines on-the-fly (on demand) short runs of a numerical solver with a POD-based Galerkin integration. LUPOD is performed to identify small sets of snapshots and collocation points. The latter are used for both POD and Galerkin projection. Numerical experiments will be shown.

11:30-12:00

Reduced order modelling in bifurcating parametrised non-linear equations

Federico Pichi SISSA, International School for Advances Studies.
Gianluigi Rozza SISSA, International School for Advanced Studies

Abstract: We present the applicability of the reduced basis method in non-linear systems undergoing bifurcations. Bifurcation analysis is a complex computational task and the Reduced Order Models (ROM) can potentially reduce the computational burden by several orders of magnitude. Models describing bifurcating phenomena arising in several fields with interesting applications, from computational to quantum mechanics. Some of these studies are carried out in collaboration with A.T. Patera at MIT and A. Quaini at University of Houston.

12:00-12:30

A method for the problem of identification of surface sources in non-homogeneous media and their computational cost

Jose Julio Conde Mones Benemérita Universidad Autónoma de Puebla
José Jacobo Oliveros Oliveros Facultad de Ciencias Físico Matemáticas de la BUAP.
Lorenzo Héctor Juárez Valencia Universidad Autónoma Metropolitana, Unidad Iztapalapa.
María Monserrat Morín Castillo Facultad de Ciencias de la Electrónica de la BUAP.

Abstract: This work presents a method for the identification of defined surface sources on the separation interface of two homogeneous media. The method consists in recovering in stable form a source from the normal derivative of the solution of the Cauchy problem and the Laplace equation with Dirichlet boundary conditions using the Tikhonov regularization method and the method of recursive smoothing method. Some numerical examples are presented to validate the proposed method and their computational cost.

12:30-13:00

An Adaptive Method for Interpolating Reduced-Order Models Based on Matching and Continuation of Poles

Yao Yue Max Planck Institute for Dynamics of Complex Technical Systems

Abstract: This work presents an adaptive parametric model order reduction method based on interpolating poles of reduced-order models. To match the poles correctly, a combinatorial optimization problem is introduced. A branch and bound optimization algorithm is proposed to avoid combinatorial explosion. Furthermore, a continuation technique is employed not only to further ease pole-matching, but also to guide the generation of a small set of reduce-order models that represent the parameter space.

MS ME-0-5 5 11:00-13:00

Integrable systems and beyond - Part 2

For Part 1 see: MS ME-0-5 1
For Part 3 see: MS ME-0-5 6

Organizer: Baofeng Feng University of Texas Rio Grande Valley
Organizer: Sara Lombardo Mathematical Sciences, School of Science, Loughborough University
Organizer: Peter Miller University of Michigan

Abstract: Integrable systems arise in various branches of applied mathematics, notably in the study of nonlinear wave propagation and in integrable probability or mathematical physics. These applications have benefited from the use of functional analysis, asymptotic analysis, as well as algebraic and geometric reasoning to study the underlying integrable systems. This session aims to bring together researchers applying a wide range of tools to integrable models in order to solve important and interesting applied problems.

11:00-11:30

A deformation for the Kadomtsev–Petviashvili equation (KP) hierarchy

Baofeng Feng University of Texas Rio Grande Valley

Abstract: It is observed that some bilinear equations to soliton equations such as the CH equation cannot be obtained within the framework of the KP theory. By introducing nonzero constant in pseudo-differential operators including the dressing operator, we attempt to give a modification of the KP theory. We will give the Sato equation and the corresponding tau functions. In addition, we will develop a family of bilinear equations which include the ones for the CH equation

11:30-12:00

The hyperbolic Ernst equation in a triangular domain

Julian Mauersberger KTH Royal Institute of Technology
Jonatan Lenells KTH Royal Institute of Technology

Abstract: In Einstein's theory of relativity, the interaction of two plane gravitational waves can be described mathematically by a Goursat problem for the hyperbolic Ernst equation in a triangular domain. In this talk, I will show how to use the integrable structure of the hyperbolic Ernst equation to present the solution of the Goursat problem in terms of a corresponding Riemann--Hilbert problem. Our results treat uniqueness, existence and regularity, and a representation formula of the solution.

12:00-12:30

From integrability of nonlinear differential-difference equations to integrability of nonlinear PDEs

Zuonong Zhu Shanghai Jiao Tong University

Abstract: In this talk, we will address the topic that from integrability of nonlinear differential-difference equations to integrability of nonlinear PDEs. We will take the Hirota equation as an example. We will show how to get the integrability of the Hirota equation from the integrability of our space discrete Hirota equation. This is a joint work with A. Pickering, and H.Q. Zhao.

12:30-13:00

Rigorous Asymptotic of a KdV Soliton Gas

Robert Jenkins Colorado State University
Manuela Girotti John Abbott College
Tamara Grava University of Bristol / SISSA
Ken McLaughlin Colorado State University

Abstract: We analytically study the long-time/large-space asymptotics of a broad class of solutions of KdV introduced by Dyachenko, Zakharov, and Zakharov. These solutions are characterized by a Riemann-Hilbert problem which we show arises as the limit of a gas of -solitons. We establish an asymptotic description for large times that is valid over the entire spatial domain, in terms of Jacobi elliptic functions.

MS FE-1-4 5 11:00-13:00

Multiscale analysis and numerical methods for oscillatory PDEs - Part 1

For Part 2 see: MS FE-1-4 6
For Part 3 see: MS FE-1-4 7
For Part 4 see: MS FE-1-4 8

Organizer: Yongyong Cai Beijing Computational Science Research Center
Organizer: Carles Remi CNRS & Univ Rennes
Organizer: Hanquan Wang Yunnan University of Finance and Economics

Abstract: Oscillatory behaviors are ubiquitous in nature and arise in different disciplines, such as semiclassical limits of Schroedinger equations in computational chemistry, nonrelativistic limit of Klein-Gordon equation in particle physics, subsonic limits of Zakharov system in plasma physics, Vlasov-Poisson equation with strong magnetic field, Boltzmann equation in the diffusion limit, etc. These oscillatory PDEs typically involve two or more different temporal/spatial scales, where multiscale analysis has been playing an important role. This mini-symposium aims to bring experts together to exchange and discuss recent progresses on analysis and numerical methods in this area, and to identify future research directions with possible collabrations.

11:00-11:30

Efficient pseudospectral methods for Vlasov-Poisson system

Hanquan Wang	Yunnan University of Finance and Economics
Hanquan Wang Wang	Yunnan University of Finance and Economics

Abstract: Vlasov-Poisson (VP) system is one of most important models in physics. In this talk we propose two efficient methods for solving VP system: a splitting Fourier pseudospectral method and a semi-Lagrangian based pseudospectral method. Both method have spectral accuracy in both space and phase directions and can be implemented efficiently with the fast Fourier transform. High order time stepping method can be constructed by spectral deferred correction. Preliminary results show good agreement with previous studies.

11:30-12:00

Multiscale methods and analysis for nonlinear Klein-Gordon equation in the nonrelativistic limit regime

Weizhu Bao	Beijing Computational Science Research Center

Abstract: I will review and compare different numerical methods and their error bounds for solving the nonlinear Klein-Gordon (KG) equation in the nonrelativistic limit regime, which is a highly oscillatory dispersive partial differential equations. Those numerical methods include fintie different time domain methods, exponential wave integrator Fourier pseudospectral methods, multiscale time integrator Fourier pseudospectral methods, etc. The spatial/temporal resolution of those numerical methods with respect to the small parameter are analyzed and compared.

12:00-12:30

A uniformly and optimally accurate method for the Klein-Gordon-Zakharov system in simultaneous high-plasma-frequency and subsonic limit regime

Chunmei Su	Technical University of Munich
Zhao Xiaofei	Wuhan University

Abstract: We consider the KGZ system with two dimensionless parameters $0 < \epsilon \leq 1$ and $0 < \gamma \leq 1$, which are inversely proportional to the plasma frequency and acoustic speed, respectively. When $\epsilon < \gamma 0^+$, the solution propagates waves with $O(\epsilon^2)$-wavelength in time and meanwhile contains outgoing initial layers with speed $O(1/\gamma)$ in space. Via a multiscale decomposition, we propose a multiscale time integrator Fourier pseduospectral method which is uniformly and optimally accurate at the first order for all $0 < \epsilon < \gamma \leq 1$.

12:30-13:00

Computing ground states of spin 2 Bose-Einstein condensates by the normalized gradient flow

Qinling Tang	Sichuan University
Yongjun Yuan	Hunan Normal University
Weizhu Bao	National University of Singapore

Abstract: In this talk, we will propose an efficient and accurate numerical method to compute the ground state of spin-2 Bose-Einstein condensates via the normalized gradient flow (NGF). The key idea is to find proper additonal conditions to uniquely solve out the five projection constants in the corresponding projection step of NGF.Numerical results will be reported to show the efficiency of our method and to demonstrate some interesting physical phenomena.

MS A6-1-1 5 11:00-13:00

Mathematical Optimization for Industrial and Scientific Applications

Organizer: Sven Leyffer Argonne National Laboratory

MS Organized by: SIAG/CSE

Abstract: Optimal design and operational planning problems arise in a wide range of scientific and industrial applications. The goal of this mini-symposium is to present a broad range of optimization applications as well as industrial strength solvers for mathematical optimization problems.

11:00-11:30

A Scalable Global Optimization Algorithm for Stochastic Nonlinear Programs

Yankai Cao	University of British Columbia

Abstract: This Presentation introduces a new global optimization algorithm for two-stage stochastic nonlinear programs that uses a specialized branch and bound strategy. Lower bounds are constructed by relaxing the non-anticipativity constraints and upper bounds are constructed by fixing the first-stage variables. Both lower and upper bounds can be computed by solving individual scenario subproblems. Convergence can be guaranteed by branching only on the first-stage variables. Numerical experiments are performed for a number of test problems.

11:30-12:00

Bayesian Optimization and Dimension Reduction with Active Subspaces

Mickael Binois	Inria Sophia Antipolis - Méditerranée
Wycoff Nathan	Virginia Tech
Wild Stefan	Argonne National Laboratory

Abstract: To handle expensive black-box optimization problems in high-dimension, we present a Gaussian process (GP) based methodology that incorporates active subspace estimation. In particular, we show that the active subspace of a GP as well as updates with new designs can be expressed directly, enabling its use within sequential uncertainty reduction techniques for optimization. We discuss relations with existing methods from the literature and present results on several examples.

12:00-12:30

Distributed optimization with quantization of gradient differences

Peter Richtarik	KAUST

Abstract: We consider distributed optimization problems where the data describing the objective function is spread among several workers. To alleviate the communication bottleneck, recent papers propose various update compression (e.g., quantization or sparsification) heuristics. However, compression introduces additional variance, which slows down convergence, and often even prevents the quantized version of the method from converging. Our work is the first to show how quantization should be applied to prevent such issues from happening.

12:30-13:00

Mixed-Integer PDE Constrained Optimization

Sven Leyffer	Argonne National Laboratory

Abstract: Many complex science and engineering applications can be formulated as optimization problems, constrained by partial differential equations (PDEs), that involve both continuous and integer variables, and must overcome the combinatorial challenge of integer decision variables combined with the numerical and the computational complexity of PDE-constrained optimization. We present a new class of trust-region methods that have successfully solved a number fo challengibng applications of such problems.

MS FT-4-7 5 11:00-13:00

Iterative processes for solving nonlinear problems: Convergence and Stability - Part 4

For Part 1 see: MS FT-4-7 1
For Part 2 see: MS FT-4-7 2
For Part 3 see: MS FT-4-7 3
Organizer: Juan Torregrosa Universitat Politècnica de València

Abstract: Solving nonlinear equations and systems is a non-trivial task that involves many areas of Science and Technology. Usually it is not affordable in a direct way and iterative algorithms play a fundamental role in their approach. The main theme of this Special Issue, but not the unique, is the design, analysis of convergence and stability and application to practical problems of new iterative schemes for solving nonlinear problems. This includes methods with and without memory, with derivatives of derivative-free, the real or complex dynamics associated to them and an analysis of their convergence that can be local, semilocal or global.

11:00-11:30

Improving the efficiency orbit determination processes

Miguel Camarasa	Universitat Politecnica de Valencia
Alicia Cordero	Instituto de Matemática Multidisciplinar, Universitat Politècnica de València
Juan Ramon Torregrosa	Instituto de Matemática Multidisciplinar, Universitat Politècnica de València

Abstract: In Classical Mechanics, the solution of the two body problem with known initial values is well established and finds many applications. For instance, it can be applied to approximate the position of an Earth satellite. However, as the Earth-satellite system is in practice affected by numerous other bodies a correction is often necessary. We aim to reach an increased precision using high order methods and measuring solely the angle data.

11:30-12:00

Efficient iterative methods for nonlinear systems

R. Rafael Capdevila	Universitat Politecnica de Valencia
Alicia Cordero	
Juan Ramón Torregrosa	

Abstract: In this work, a new class of iterative methods for solving nonlinear equations is presented and also its extension for nonlinear systems of equations. This family is developed by using a weight function procedure, getting 6th-order of convergence in both cases. Several numerical examples are given to illustrate the efficiency and performance for the proposed methods.

12:00-12:30

Generating classes of iterative mthods with memory

Neus Garrido	Universitat Politecnica de Valencia
Francisco I. Chicharro	Escuela Superior de Ingeniería y Tecnología, Universidad Internacional de La Rioja
Alicia Cordero	Instituto de Matemáticas Multidisciplinar, Universitat Politècnica de València
Juan R. Torregrosa	Instituto de Matemáticas Multidisciplinar, Universitat Politècnica de València

Abstract: Iterative methods are commonly used to find the solution of nonlinear problems in many scientific fields. Moreover, the design of iterative schemes and their analysis in terms of the order of convergence allows to solve these nonlinear problems more efficiently. This analysis has shown that methods with memory are usually a good choice in order to improve the order of convergence from an original method. The theoretical results are verified by showing some numerical results.

12:30-13:00

Stability of iterative methods for approximating multiple roots of nonlinear equations.

María Mora Jiménez	Universitat Politècnica de València
Alicia Cordero	Universitat Politècnica de València
Juan R. Torregrosa	Universitat Politècnica de València

Abstract: A new parametric family of iterative methods for finding multiple roots of nonlinear equations is presented. We analyze the convergence of this family for both simple and multiple roots. By using complex dynamic tools, we study the stability of this family to find the elements of it with better stability properties. Some numerical tests are shown to confirm the theoretical results and to compare the new methods with other known ones.

MS ME-1-5 5 11:00-13:30

Recent developments in the analysis of nonlocal operators - Part 1

For Part 2 see: MS ME-1-5 7

Organizer: Donatella Danielli	Purdue University
Organizer: Nicola Garofalo	University of Padova

Abstract: In recent years there has been a resurgence of interest for non-local operators, largely motivated by applications. For instance, fully nonlinear integro-differential equations naturally arise in the study of problems in stochastic control. In turn, the study of non-local operators has led to the development of a wide range of new mathematical tools and methods. Our session's aim is to bring together mathematicians at different stages of their career to present the state of the art on the subject. We also hope to stimulate interaction on the latest developments of analytic, geometric, and probabilistic properties of problems involving nonlocal operators.

11:00-11:30

Generic regularity of free boundaries for the obstacle problem in R^3

Xavier Ros-Oton	Universitat Zurich
Alessio Figalli	ETH
Joaquim Serra	ETH

Abstract: The obstacle problem is the most classical and motivating example in the study of free boundary problems. By the work of Caffarelli (1977), free boundaries are smooth outside a certain set of singular points. A long-standing open question in the field asks to establish generic regularity results in this setting. We will present some new results in this context, proving in particular generic regularity of free boundaries for the obstacle problem in 3D.

11:30-12:00

Unique continuation principles for higher order fractional equations

Veronica Felli	Università di Milano - Bicocca

Abstract: In this talk I discuss unique continuation principles for solutions to higher order fractional equations in open domains. By the Caffarelli-Silvestre extension method the problem is formulated as a system of two second order equations with singular or degenerate weights in a half-space, for which asymptotic estimates are derived by a blow-up analysis and energy estimates obtained by studying an Almgren type frequency function.

12:00-12:30

Sobolev and isoperimetric inequalities for non-symmetric and non-doubling semigroups

Nicola Garofalo	University of Padova
Giulio Tralli	University of Padova

Abstract: In 1934 Kolmogorov introduced a second order hypoellipitc evolution equation which displays many challenging features. In the opening of his famous 1967 hypoellipticity paper Hormander discussed a general class of degenerate Ornstein-Uhlenbeck operators that includes Kolmogorov's as a special case. I present a fractional calculus adapted to these operators, and using such calculus, discuss some Sobolev and Isoperimetric inequalities.

12:30-13:00

Fractional powers of Kolmogorov-type operators

Giulio Tralli	University of Padova

Abstract: In this talk we present a class of nonlocal equations driven by the fractional powers of hypoelliptic operators of Kolmogorov-type. We will introduce an extension problem related to such operators and provide an explicit construction for its solution. As a main application, we will discuss how to exploit these fractional powers to obtain new Sobolev-type inequalities. This is a joint work with N. Garofalo.

13:00-13:30

Nodal sets and free boundaries of segregated critical configurations involving fractional laplacians

Susanna Terracini	Università di Torino
Giorgio Tortone	Università di Torino
Stefano Vita	Università di Torino
Yannick Sire	Johns Hopkins University

Abstract: We consider equations in divergence form involving a singular/degenerate weight which is not in the Muckenhoupt class. Under suitable regularity assumptions for the matrix A and the r.h.s. we prove Hxlder continuity of even solutions and possibly of their derivatives up to order two or more (Schauder estimates). In addition, we show stability of these a priori bounds for when the weight is suitably regularised. Our method is based upon blow-up and Liouville type theorems.

MS A6-1-2 5 11:00-13:00

Optimization methods and applications - Part 5

For Part 1 see: MS A6-1-2 1
For Part 2 see: MS A6-1-2 2
For Part 3 see: MS A6-1-2 3
For Part 4 see: MS A6-1-2 4

Organizer: Cong Sun	Beijing Univ. Posts and Telecommunications
Organizer: Xin Liu	Academy of Mathematics and Systems Science

Abstract: This multiple minisymposium is to address the recent progress in nonlinear optimization field. The topics include but not limit to: first-order methods, Newton-like methods, derivative free methods, stochastic optimization methods, methods for problems with orthogonality constraints and applications with optimization methods.

11:00-11:30

Completely positive binary tensors

Jinyan Fan	Shanghai Jiongtong University
Jiawang Nie	University of California San Diego
Anwa Zhou	Shanghai University

Abstract: In this talk, we characterize completely positive binary tensors. We show that a binary tensor is completely positive if and only if it satisfies two linear matrix inequalities. For a completely positive binary tensor, we give an algorithm for computing its cp-rank and the decomposition. When the order is odd, we show that the cp-rank decomposition is unique. When the order is even, we completely characterize when the cp-rank decomposition is unique.

11:30-12:00

An improved hyperplane method for generalized Nash equlibrium with inertial step

Lingling Xu — Nanjing Normal University

Abstract: In the paper, we improved a kind of half-space projection method for solving GNEP. By the projection method, we got the prediction point first. Then using this point we constructed a hyperplane. A extra-gradient method was used to get the projection on the hyperplane. The next iterate was obtained by an inertial technology. Some numerical examples show that our algorithm is efficient.

12:00-12:30

Inexact stochastic proximal quasi-Newton method for nonconvex optimization

Xiao Wang — University of Chinese Academy of Sciences

Abstract: We study an inexact stochastic proximal quasi-Newton (ISPQN) algorithmic framework for nonconvex optimization. At each iteration, we inexactly solve a proximal subproblem dependent on some positive definite matrix. Then we analyze the computational complexity of the whole algorithm under mild conditions. In addition, we explore the theoretical properties under PL inequality. Finally, we establish the computational complexity for nonconvex optimization with non-Lipschitz continuous gradient.

12:30-13:00

Tight semidefinite programming relaxations for polynomial optimization

Jiawang Nie — University of California

Abstract: This talk presents tight semidefinite programming relaxations for solving polynomial optimization. Optimality conditions are investigated. For general polynomials, we show that Lagrange multipliers can be expressed as polynomial functions in decision variables over the set of critical points. Based on these expressions, we construct tight semidefinite programming relaxations.

MS FT-4-2 5 — 11:00-13:00

Recent advances on computational wave propagation - Part 1

For Part 2 see: MS FT-4-2 6

For Part 3 see: MS FT-4-2 7

Organizer: Jichun Li	University of Nevada Las Vegas
Organizer: Yunqing Huang	Xiangtan University, China
Organizer: Lise-Marie Imbert-Gérard	University of Maryland

Abstract: This mini-symposium will include investigations of recent achievements on numerical analysis and mathematical modeling of wave propagation problems. 12 leading experts from 8 countries are temporary agreed to speak in our mini-symposium. Topics include development and analysis of numerical methods for electromagnetic wave propagation or scattering in photonics, complex dispersive media and plasmonics etc.

11:00-11:30

Optimal control for time-harmonic and non-stationary eddy current problems

Alberto Valli	Università degli Studi di Trento
Fredi Troeltzsch	Institut für Mathematik, Technische Universität, Berlin (Germany)

Abstract: We analyze two optimal control problems related to the time-harmonic and the time-dependent eddy current equations. The control is the current density and the voltage, respectively. The well-posedness is proved and the optimal control problem is investigated. First-order necessary optimality conditions are determined by means of a solution of the adjoint problem. Attention is devoted to devise a formulation for which the computational complexity of the finite element approximation method is substantially reduced.

11:30-12:00

Divergence-free DG discretization of Maxwell's equations

Sjoerd Hack	University of Twente
Lars Corbijn Van Willenswaard	University of Twente

Abstract: We present a mixed discontinuous Galerkin finite element method for the second-order Maxwell equations. The approach allows accurate discretization of complex structures while explicitly enforcing a divergence free electric field. We combine the discretization with the Hagstrom-Warburton nonreflecting boundary condition, which has an a-priori error estimate. We present eigenvalue as well as scattering calculations for several problems of physical interest, such as a Bragg stack and a photonic crystal.

12:00-12:30

Sharp stability analysis for high-order finite element discretizations of general wave propagation problems

Théophile Chaumont-Frelet	Inria
Serge Nicaise	University of Valenciennes

Abstract: We analyze the convergence of high-order finite element discretizations of time-harmonic wave propagation problems. We propose a general methodology to derive stability conditions and error estimates that are explicit with respect to the wavenumber. The method is developed in its full generality and is illustrated on particular cases including acoustic and elastic wave propagation in heterogeneous media. We present numerical experiments which confirm that the stability conditions and error estimates are sharp.

MS FT-1-SG 5 — 11:00-13:00

New trends in the developpment of Gaussian process for representing and learning data

Organizer: Baccou Jean	IRSN
Organizer: Jacques Liandrat	Centrale Marseille

Abstract: Gaussian process appears in various domains including data modelling, de- sign of experiment, regression and reconstruction. The goal of the minisympo- sium is to gather mathematicians covering the different domains to point out new trends and ongoing works.

11:00-11:30

Gaussian process optimization with simulation failures

Francois Bachoc — Institut de Mathématiques de Toulouse

Abstract: We address the optimization of a computer model, where each simulation either fails or returns a valid output performance. We suggest a joint Gaussian process model for classification of the inputs and for regression of the performance function. We extend the celebrated expected improvement criterion to our setting of joint classification and regression. We prove the convergence of the algorithm. We also study its practical performances, on simulated data, and on a real computer model.

11:30-12:00

Non-stationary Gaussian Process modeling for the prediction of data with heterogeneous variation

Jean Baccou	IRSN
Marmin Sébastien	EURECOM
Ginsbourger David	UNIBE/IDIAP
Liandrat Jacques	ECM

Abstract: Gaussian Process approaches have become very popular in the last decades for data analysis. One of their advantages stands in the flexibility for the choice of the so-called covariance kernel. We propose to focus on recent developments related to the construction of non-stationary kernels and their efficiency for the prediction of data with heterogeneous variations. Applications to nuclear safety problems will be given and perspectives in the framework of signal processing will be emphasized.

12:00-12:30

Gaussian process meet subdivision schemes

Jacques Liandrat — Centrale Marseille

Abstract: Gaussian process regression (Kriging) share various properties with subdi- vision schemes, even if these two reconstruction approaches come from different fields. They have also different degrees of freedom. Bringing closer these two approaches lead to new developments with potential applications. The talk will develop some of them.

12:30-13:00

Doubly Sparse Variational Gaussian Process

Vincent Adam Prowler.io

Abstract: The use of GP models is limited to data sets with thousands of observations. The two most commonly used methods to overcome this limitation are 1) the variational sparse approximation which relies on inducing points and, 2) the state-space (SS) equivalent formulation of Gaussian processes which exploits some sparsity in the precision matrix. We show that the inducing point framework is valid for SS models and that it can bring further computation and memory savings.

MS FE-1-2 5 11:00-13:00

Divergence-free and pressure-robust discretizations for the Navier-Stokes equations - Part 1

For Part 2 see: MS FE-1-2 6
For Part 3 see: MS FE-1-2 7
Organizer: Christian Merdon Weierstrass Institute Berlin
Organizer: Michael Neilan University of Pittsburgh

Abstract: Recently, pressure-robustness was identified as an important property in the discretisation of the Navier-Stokes equations. Opposite to classical finite element methods (like Taylor-Hood) that relax the divergence constraint, pressure-robust schemes compute discrete flow fields that are independent of the exact pressure and so are much more robust against small viscosity parameters. In this mini-symposium we want to gather active researchers in this field to discuss recent novel discretisation schemes, applications and related developments.

11:00-11:30

Pressure-robustness in the discretisation of the Navier-Stokes equations - An overview

Christian Merdon Weierstrass Institute Berlin

Abstract: Pressure-robustness was identified as an important discretisation property for the incompressible Navier-Stokes equations as it ensures that the discrete velocity solution is independent of the resolution of the pressure and avoids a possible locking behavior for small viscosity parameters. This talk explains the importance of pressure-robustness with the help of some convincing examples and gives a brief overview over different approaches how it can be achieved.

11:30-12:00

Pressure robust a posteriori error estimates for pressure robust methods

Joachim Schöberl Vienna University of Technology

Abstract: Pressure robust finite element methods for incompressible flows provide errors in velocity independent of the pressure error. In this talk we present a pressure robust a posteriori error estimator, which estimates the velocity error independent of the quality of pressure approximation.

12:00-12:30

On high Reynolds number flows, pressure-robustness and high-order methods

Alexander Linke Weierstrass Institute
Philipp W. Schroeder University of Göttingen
Nicolas Gauger Technical University of Kaiserslautern

Abstract: An improved understanding of the divergence-free constraint for the incompressible Navier-Stokes equations leads to the observation that a semi-norm and corresponding equivalence classes of forces are fundamental for their nonlinear dynamics. The recent concept of pressure-robustness allows to distinguish between space discretisations that discretise these equivalence classes appropriately or not. This contribution compares the accuracy of pressure-robust and non-pressure-robust space discretisations for transient high Reynolds number flows.

12:30-13:00

The mass conserving mixed stress method (MCS) for the Stokes equations: Recent developments

Philip Lederer Vienna University of Technology
Joachim Schöberl Technical University of Vienna
Jay Gopalakrishnan Portland State University

Abstract: Recent developments show that H(div)-conforming finite elements for the approximation of the velocity (of the Stokes equations) provide major benefits. By introducing a new variable which approximates the gradient of such an H(div)-conforming (discrete) velocity we derive the mass conserving mixed stress method of the Stokes equations. For the analysis a new function space, the H(curldiv), is defined and used to motivate the definition of tensor valued Finite elements which are normal-tangential continuous.

MS GH-1-1 5 11:00-13:00

Stochastic dynamics of biological cells and fluids - Part 1

For Part 2 see: MS GH-1-1 6
Organizer: Peter Kramer Rensselaer Polytechnic Inst
Organizer: Scott McKinley Tulane University

Abstract: Many physical processes involving biological cells and particle dynamics in complex microfluids involve inherent irregularities due to thermal fluctuations or other noisy aspects of protein function. The quantitative study of such systems generally relies on stochastic models which integrate the uncertain noisy aspect in a physically, or sometimes phenomenologically, motivated manner. The speakers in this minisymposium will illustrate how stochastic models can be deployed and analyzed to obtain insights on a broad variety of processes involving biological cells, their interior dynamics, and/or the complex fluid environment.

11:00-11:30

An emerging paradigm in biology: the power of weak binding

Greg Forest University of North Carolina at Chapel Hill

Abstract: Understanding Nature’s biological design rules is essential for regenerative medicine, therapies for disease pathologies, and vaccines. Working with diverse biologists, medical and clinical scientists, we have data to guide and validate underlying biological mechanisms. One is now clear: the use of transient, short-lived, binding interactions for diverse functionalities. I will focus on dynamic organization of the genome in live cells and mucus barriers that protect all organs. Collaborators will be acknowledged in the lecture.

11:30-12:00

"Convolutional neural networks automate detection for tracking of submicron-scale particles

Jay Newby University of Alberta

Abstract: Particle tracking of microscopic species is widely employed to infer biophysical transport properties and to validate prospective species transport models. “Particles” include viruses, bacteria, bacteriophages, passive or active microbead probes, and drug carrier nanoparticles. The current major bottleneck for particle tracking is low data throughput (manual conversion of videos to ensemble position time series). I will present a machine learning algorithm that automates the conversion of 2D and 3D raw videos.

12:00-12:30

A stochastic model that explains axonal organelle pileups induced by a reduction of motors

Chuan Xue Ohio State University
Chuan Xue Ohio State University
Xiulan Lai Renmin University
Anthony Brown Ohio State University

Abstract: Nerve cells are critically dependent on the transport of intracellular cargoes by motor proteins along microtubule tracks. Impairments in this movement are thought to explain the focal accumulations of axonal cargoes observed in many neurodegenerative diseases. In some cases, these diseases are caused by mutations that impair motor protein function. In this talk I present a stochastic model that explains this behavior.

12:30-13:00

A network of transition pathways in a soft-sphere model

Katherine Newhall University of North Carolina at Chapel Hill

Abstract: Many intriguing dynamical properties of complex systems, such as metastability or resistance to applied forces, emerge from the underlying energy landscape. We propose a systematic approach to mapping this landscape, forming a network of transition pathways between energy minimizers. For a soft-sphere model of a granular material, our goal is to relate observable phenomena to dynamics on the network representation of the system.

MS A3-2-2 5 11:00-13:00

Phase-Field Models in Simulation and Optimization - Part 1

For Part 2 see: MS A3-2-2 6
For Part 3 see: MS A3-2-2 7

Organizer: Wollner Winnifried	TU Darmstadt
Organizer: Alessi Roberto	Sapienza - Università di Roma
Organizer: Wick Thomas	Leibniz Universität Hannover

Organized by the GAMM activity group "Optimization with Partial Differential Equations" (OPDE)

Abstract: Phase-field models are of recent interest for the simulation of fracture and damage phenomena as well as in topology optimization. This minisymposium will provide a forum for discussions of modeling, discretization techniques, algorithms, and optimization based on phase-field models.

11:00-11:30

Optimization of Phase-Field Fracture

Wollner Winnifried	TU Darmstadt
Robert Haller-Dintelmann	TU Darmstadt
Hannes Meinlschmidt	RICAM
Masoumeh Mohammadi	TU Darmstadt
Ira Neitzel	Universität Bonn
Thomas Wick	Universität Hannover

Abstract: Within this talk, we will discuss the finite element approximation of optimization problems subject to phase-field damage processes as constraints. To utilize standard optimization algorithms, the irreversibility of the damage is relaxed by a penalty. We will discuss regularity of solutions to these regularized damage-models, and show that the regularity carries over to the limit in the regularization. Based on these new regularity results, we will discuss the approximability of the problem by finite elements.

11:30-12:00

Optimal control of a rate-independent system constrained to balanced viscosity solutions

Stephanie Thomas	Kassel University
Dorothee Knees	Kassel University

Abstract: We analyze an optimal control problem which is constrained to balanced viscosity (BV) solutions of a rate-independent system. This system is given in terms of a state variable , a time-dependent external load , a non-convex stored energy functional , and a dissipation potential . The evolution of is given by: We first show existence of BV solutions, and then of solutions of an optimal control problem which is governed by the rate-independent system.

12:00-12:30

A level-set based mesh evolution algorithm for shape and topology optimization

Dapogny Charles	CNRS & Laboratoire Jean Kuntzmann
Allaire Grégoire	Centre de Mathématiques Appliquées (CMAP) Ecole Polytechnique
Feppon Florian	Centre de Mathématiques Appliquées (CMAP) Ecole Polytechnique & SafranTech
Frey Pascal	Institut des Sciences du Calcul et des Données (ISCD) et Laboratoire Jacques-Louis Lions

Abstract: In this presentation, we introduce a robust front-tracking method for dealing with arbitrary motions of shapes, even dramatic ones (e.g. featuring topological changes); this method is illustrated in the context of shape optimization. It combines an explicit mesh of shapes, which allows for efficient mechanical calculations by means of any standard Finite Element solver, and a description of them by the level set method, a format under which it is easy to track their evolution.

12:30-13:00

Shape and topology optimization with phase field models

Michael Hinze	University of Koblenz-Landau
Garcke Harald	University of Regensburg, Germany
Kahle Christian	Technical University Munich, Germany

Abstract: We consider a phase field approach to shape and topology optimization in fluid flow. The mathematical modeling leads to a PDE constrained optimization problem with control in the coefficients where the control enters as phase field in the Darcy term of the Navier-Stokes model. We prove existence of solutions and present a numerical realization based on the finite element method. We illustrate the performance of our approach with some numerical examples.

MS FE-1-3 5 11:00-13:00

Network based model reduction in large-scale simulations, imaging and data-science - Part 1

For Part 2 see: MS FE-1-3 6
For Part 3 see: MS FE-1-3 7

Organizer: Mikhail Zaslavskiy	Schlumberger
Organizer: Vladimir Druskin	Worcester Polytechnic Institute

Abstract: Model-driven and data-driven reduced-order models (ROMs) have been proven to be a useful tool for robust simulations of the response of large-scale dynamical systems as well as for reducing the complexity of inverse problems. Rather recently the list of applications has been extended by data science. ROM representation by sparsely-connected networks is crucial for both the approach efficiency and proper interpretation of ROM parameters. We will discuss various model reduction techniques and sparse network-based approximations with applications to both forward and inverse PDE problems as well as to machine learning and data science.

11:00-11:30

Rational graph filtering using RKFIT

Stefan Guettel	The University of Manchester

Abstract: We give an overview of the RKFIT algorithm for nonlinear rational least-squares approximation and show how it can be applied to compute and evaluate filters on graphs. We further discuss an extension of the RKFIT method to block rational functions.

11:30-12:00

Local and global network model analysis via spectral densities

David Bindel	Cornell University

Abstract: In this talk, we describe an approach to understanding networks via local and global densities of eigenvalues. We describe how these densities play a common role in such seemingly disparate topics as spectral geometry, condensed matter physics, and the study of centrality measures in graphs. We discuss how structural motifs manifest in the spectrum, give fast algorithms to estimate spectral densities, and show how to use these tools to analyze large-scale graphs.

12:00-12:30

Reduced order model approach for inverse scattering

Liliana Borcea	University of Michigan
Vladimir Druskin	WPI
Alexander Mamonov	University of Houston
Mikhail Zaslavsky	Schlumberger

Abstract: We study an inverse scattering problem, which seeks to estimate a reflecting medium from waves measured at an arry of sensors. Most imaging methods assume a linear mapping between the unknown reflectivity and the array data. The linearization i.e., the Born approximation is not accurate in strongly scattering media. We show that it is possible to remove the multiple scattering (nonlinear) effects from the data using a data driven reduced order model (ROM).

12:30-13:00

Properties of Order Reduction Approaches for the Algebraic Riccati Equation

Valeria Simoncini	University of Bologna

Abstract: The Algebraic Riccati equation (ARE) plays a fundamental role in the stability analysis and computations of linear dynamical systems and of linear-quadratic regulator problems. Recent low rank methods have shown great potential in the approximation of the ARE numerical solution, with strong motivation stemming from the order reduction of the underlying dynamical system. We present new computational and theoretical advances in the ARE numerical treatment, associated with reduction techniques based on rational Krylov subspace projections.

MS A6-3-4 5 11:00-13:00

Mathematical models of epidemics and awareness

Organizer: Konstantin Blyuss University of Sussex

Abstract: Changes in human behaviour in response to ongoing epidemics can have a huge impact on epidemic dynamics. Importantly, awareness can both reduce disease burden through people taking some protective measures, and sometimes it can also have a detrimental effect of increasing the level of epidemic. Thus, to develop successful tools for disease control, it is extremely important to correctly account for behavioural changes in mathematical models for the spread of infectious diseases. This mini-symposium will present latest developments in mathematical modelling of epidemics with awareness, including the effects of seasonality, delayed response, analysis of vaccination, and control of plant diseases.

11:00-11:30

Mathematical models of awareness-based control of plant diseases

Konstantin Blyuss University of Sussex

Abstract: Plant diseases cause significant economic and societal damage, thus it is essential to develop efficient strategies for mitigating their impact. In this talk I will present a model for control of mosaic disease of plants using fertilizers and insecticides, whose application depends on the level of awareness resulting from global awareness campaigns and observation of infected plants. I will also discuss modelling results for the case where natural biostimulants are used to control this disease.

11:30-12:00

Effects of seasonality in models of behaviour-dependent vaccination

Bruno Buonomo University of Naples Federico II
Alberto D'Onofrio IPRI-Lyon
Piero Manfredi University of Pisa
Rossella Della Marca University of Parma

Abstract: When children vaccination is not mandatory, the propensity to vaccinate may reduce when the prevalence of disease is low. However, the Public Health System (PHS) may enact public campaigns to favor vaccine uptake. In this talk we present some recent results concerning the interplay between private vaccination choices and actions of PHS to improve vaccine propensity. Special emphasis will be given to the effects of seasonality on the optimal time scheduling of PHS campaigns.

12:00-12:30

Effects of population awareness and delayed response on the spread of epidemics

Yuliya Kyrychko University of Sussex

Abstract: In models of infectious diseases, behavioural changes of individuals in response to their disease status and available information play a major role. In this talk I will discuss how interactions between awareness due to contacts with aware individuals, and global awareness due to reported cases of infection and awareness campaigns, affect the spread of infectious diseases. I will also discuss the effects of time delay in individuals' response, and the effects of a vaccination program.

12:30-13:00

Sustainability of vaccination programs: the conflict between private and public rationalities

Piero Manfredi University of Pisa
Alberto D'Onofrio IPRI-Lyon, France

Abstract: We study a general behaviour-infection model for voluntary vaccination systems where the information communicated by public health institutions (PHS) competes with the information exchanged by private individuals during their daily (real or virtual) encounters. The mathematical analysis allows to identify the critical communication parameters, and resulting actions, that wise PHS should undertake to influence individuals' perceptions about vaccination and infection payoffs, in order to mitigate resistance to vaccination and enhance the resilience of vaccination programmes.

MS ME-1-1 5 11:00-13:00

Advances in NonSmooth Dynamical Systems within Spanish Network DANCE - Part 1

For Part 2 see: MS ME-1-1 6
Organizer: Victoriano Carmona Universidad de Sevilla
Organizer: Antonio E. Teruel Universidad de las Islas Baleares
Organizer: Soledad Fernandez Garcia Universidad de Sevilla

Abstract: The network DANCE (Dynamics, Atractors and Non Linearities. Chaos and Stability) aims at being the meeting point of the Spanish researchers in Dynamical Systems. Some nodes focus on their research in the analysis of the nonsmooth systems. This analysis is based in the applications because these systmes are able to model several mechanical and electronic elements. The goal of this minisymposium is to show some advances in nonsmooth dynamics done in the network. The minisymposium is divided into parts. The first part is devoted to the piecewise linear systems. The second part focuses on the singularly perturbed nonsmooth systems.

11:00-11:30

Inverse Integrating Factor and Planar Piecewise Linear Systems

Fernando Fernández-Sánchez Universidad de Sevilla

Abstract: In this talk we will explain how to use inverse integrating factors to easily obtain some relevant properties of Poincaré half maps and periodic orbits in planar piecewise linear systems.

11:30-12:00

Periodic Orbits and Global Connections in Three Dimensional Piecewise Linear Systems

Elisabeth García-Medina Universidad de Sevilla
Victoriano Carmona Dpto. Matemática Aplicada II (Universidad de Sevilla)
Fernando Fernández-Sánchez Dpto. Matemática Aplicada II (Universidad de Sevilla)

Abstract: In this work we analyze the existence of periodic orbits and global connections (homoclinic orbits and T-point heteroclinic cycles) in a one-parameter family of piecewise linear systems. Concretely, we have verified that the existence of both global connections are similar. We also obtain bifurcations diagram of families of reversible and non-reversible periodic orbits. Let us remark the presence of fold, symmetry breaking and period doubling bifurcations and a configuration called a noose bifurcation.

12:00-12:30

Limit cycles in piecewise linear ystems with nonregular separation line

Joan Torregrosa Universitat Autònoma de Barcelona

Abstract: Piecewise linear differential systems have been used for modelling different real problems. One important problems is the study of the number of isolated periodic orbits (limit cycles). Usually the differential systems are defined in two zones separeted by a straight line. We will present a review of new results about the lower bounds for the maximum number of limit cycles when the separation curve is defined by two straight lines having a nonregular intersection point.

12:30-13:00

Lum-Chua's conjecture through inverse integrating factor theory

Douglas Novaes IMECC - UNICAMP
Victoriano Carmona
Fernando Fernandez-Sánchez

Abstract: In this talk, using the theory of inverse integrating factor, we provide a new simple proof for the Lum-Chua's conjecture, which says that a continuous planar piecewise linear differential system with two zones separated by a straight line has at most one limit cycle. In addition, we prove that if this limit cycle exists, then it is hyperbolic and its stability is characterized in terms of the parameters.

MS A1-2-6 5 11:00-13:00

Modeling and simulation of interface problems in biology - Part 1

For Part 2 see: MS A1-2-6 6
For Part 3 see: MS A1-2-6 7
Organizer: Sebastian Aland HTW Dresden
Organizer: Wanda Strychalski Case Western Reserve University

Abstract: Problems with moving interfaces are ubiquitous in the modelling of biological phenomena. Examples include cell motility, transport of biological compartments by flow, as well as every process that involves growth or pattern formation. Given the complexity of the biology and mathematical models of these processes, analytical solutions are often intractable; simulating such models requites state-of-the-art numerical methods. The goal of this mini-symposium is to foster the exchange of ideas by bringing together modelers, numerical analysts and experts in scientific computing who share a common interest in understanding complex biological systems.

11:00-11:30

Physical modeling of collective cell motility: from cell to tissue

Axel Voigt	TU Dresden
Wenzel Denis	TU Dresden
Praetorius Simon	TU Dresden

Abstract: We consider a multi phase field model for collective cell motility. Each cell is thereby described by a phase field variable with an active polar gel model inside. Numerically each phase field is discretized on its own adaptively refined mesh and its own processor. This allows parallel scaling with the number of cells. We study emerging phenomena, such as statistical properties of the cellular structure, resulting liquid crystal order and flow phenomena of the tissue.

11:30-12:00

Efficient 3D surface FSI Simulations

Marcel Mokbel — HTW Dresden

Abstract: Fluid structure interaction (FSI), especially the case of elastic membranes in flow, is of high interest in biolocal, physical and mechanical research. An efficient ALE model for 3D axisymmetric surface FSI simulations is presented capturing surface tension, surface elasticity and bending stiffness as the driving forces on the membrane in a monolithically coupled system.

12:00-12:30

Energy-stable approximations for vesicle membranes in fluids

Francisco Guillen Gonzalez	Universidad de Sevilla
Tierra Giordano	Temple university

Abstract: In this talk, we consider a vesicle membrane model, which is disipative with respect to the bending energy, satisfies exactly the conservation of volume and penalizes the surface area. We present an unconditionally energy stable splitting scheme decoupling the interaction of the vesicle with a surrounding fluid. Finally, the well behavior of the proposed schemes are illustrated through several computational experiments, comparing with other schemes proposed in the literature.

12:30-13:00

Dynamics of multicomponent vesicles in channel flows

Kai Liu	
John Lowengrub	UC Irvine

Abstract: We study the dynamics of multicomponent, two-dimensional vesicle in a narrow pipe driven by pressure gradient. We study the influence of elastic inhomogeneity, relative ratio of surface lipid phase concentrations, and excess surface length on the dynamics. Unlike uniform vesicles, whose steady state in pipe is symmetric bullet shape, compositional heterogeneity can drive symmetry-breaking and depending on excess surface area, phase concentration, initial position, and bending stiffnesses, the vesicle can exhibit various kinds of shapes.

MS GH-3-3 5 — 11:00-13:00

Model Reduction and Coupled Problems in Industry Applications - Part 1

For Part 2 see: MS GH-3-3 6

Organizer: Andrés Prieto — ITMATI - Universidade da Coruña

Organizer: Peter Maass — Universität Bremen

MS Organized by: SIAG/CSE

Abstract: The future competitiveness of the European economy crucially depends on the development of new and the improvement of current products and processes in all key technology areas. Product development is increasingly based on simulation and optimization of virtual products and processes that are described via mathematical models. Such common mathematical representation of real physical products or processes via partial differential and algebraic equations is the basis for simulation and optimization. This minisymposium aims at mathematically proven algorithms in particular utilizing adaptive and tuneable model order reduction techniques. A particular emphasis is on techniques combining analytical approaches with data driven concepts.

11:00-11:30

Deep image priors for magnetic particle imaging

Tobias Kluth	University of Bremen
Sören Dittmer	University of Bremen
Daniel Otero Baguer	University of Bremen
Peter Maass	University of Bremen

Abstract: Magnetic particle imaging (MPI) is a tracer-based imaging modality developed to detect the concentration of superparamagnetic iron oxide nanoparticles by solving an inverse problem. Deep image priors (DIP) have been recently introduced as a machine learning approach for tasks in image processing and potential applications to inverse problems. In this talk we discuss DIP in the context of MPI and show reconstructions from real data when compared with classical Tikhonov or sparsity regularization.

11:30-12:00

Model Reduction for Pressure Gain Combustion

Schulze Philipp	TU Berlin
Reiss Julius	TU Berlin
Mehrmann Volker	TU Berlin

Abstract: In this talk we discuss the application of model reduction techniques in pressure gain combustion engines. These systems provide several challenges for the application of standard model reduction techniques, especially, due to multiple propagating shock waves. We present the shifted proper orthogonal decomposition (shifted POD) which extends the classical POD via introducing coordinate transformations for describing the propagation of shock waves with just a few modes. Numerical experiments demonstrate the potential of this new method.

12:00-12:30

Performance Needs in Financial Risk Analysis and Regulation

Andreas Binder — MathConsult GmbH

Abstract: With the European Regulation 1286/2014 and the Commission Delegated Regulation 2017/653, manufacturers of packaged retail and insurance-based investment products (PRIIPs) are required to equip their PRIIPs with key information documents describing the risk and the possible returns of these products. The (daily) calculation of the risk indicator and the performance scenario values may require up to 70.000 valuations of a single financial instrument. Computational performance is crucial.

12:30-13:00

Efficient solvers for atmospheric tomography

Bernadett Stadler	Johannes Kepler Universität Linz
Ronny Ramlau	Industrial Mathematics Institute, JKU Linz
Roberto Biasi	Microgate, Bolzano

Abstract: The new generation of ground-based extremely large telescopes require highly efficient algorithms to achieve an excellent image quality in a large field of view. These systems rely on adaptive optics, where one aims to compensate in real-time the rapidly changing optical distortions in the atmosphere. In this talk, we compare a novel method called Finite Element Wavelet Hybrid Algorithm to the frequently used reconstruction method MVM within the framework of the Extremely Large Telescope.

MS FT-S-7 5 — 11:00-13:00

Recent advances in high order methods for time dependent PDEs - Part 1

For Part 2 see: MS FT-S-7 6

Organizer: Yan Jiang — University of Science and Technology of China

Organizer: Yuan Liu — Mississippi State University

Organizer: Wei Guo — Texas Tech University

Abstract: The main objective of this mini-symposium is to present the recent advances in development in construction, analysis and applications of cutting-edge high order computational methods for solving hyperbolic and other time dependent PDEs. The methods include but not limited to discontinuous Galerkin method and weighted essentially Non-oscillatory methods, which have experienced significant growth and development in recent years. The aim of this minisymposium is to bring together researchers in academia who are working on the theoretical or practical development of these methods and provide a forum for discussion and interaction.

11:00-11:30

HIGH-ORDER BOUND-PRESERVING DISCONTINUOUS GALERKIN METHODS FOR STIFF MULTISPECIES DETONATION

Jie Du — Tsinghua University

Abstract: We develop high-order bound-preserving DG methods for multispecies and multi-reaction chemical reactive flows. The new high-order time integration does not depend on the Strang splitting.

Moreover, the time discretization is explicit and can handle the stiff source with a large time step. Most importantly, in addition to the positivity-preserving property, the algorithm can preserve the upper bound 1 for each species. Numerical experiments will be given to demonstrate the good performance of the bound-preserving technique.

11:30-12:00

Third order maximum-principle-satisfying DG schemes for convection-diffusion problems with anisotropic diffusivity

Hui Yu	Tsinghua University
Hailiang Liu	Iowa State University

Abstract: For a class of diffusion equations with variable diffusivity, we construct third order accurate DG schemes on one and two dimensional rectangular meshes. With an explicit time stepping, it is shown that under suitable time step restrictions, the scaling limiter proposed in [Liu and Yu, 2014] when coupled with the present DG schemes preserves the solution bounds indicated by the initial data, while maintaining uniform third order accuracy.

12:00-12:30

Numerical methods for nonlinear Maxwell's equations in optics

Yingda Cheng	Michigan State University

Abstract: In this talk, we present several high order numerical scheme for Maxwell's equation in nonlinear optics. The considered methods include finite difference/discontinuous Galerkin methods in space, and energy stable time integrators. We study the property of the scheme by investigating the dispersion relations in linear Lorentz media.

12:30-13:00

High-resolution central-upwind scheme on unstructured meshes for shallow water models

Yekaterina Epshteyn	The University of Utah

Abstract: We will present central-upwind scheme on triangular grids for the Saint-Venant system of shallow water equations. The Saint-Venant system is widely used in many scientific and engineering applications related to modeling of water flows in rivers, lakes and coastal areas. We will show that the designed central-upwind scheme delivers high-resolution, handles complicated geometry, and satisfies necessary stability conditions. Current and future research will be discussed as well.

MS FT-0-2 5 11:00-13:00

Mean Field Games: New Trends and Applications - Part 5

For Part 1 see: MS FT-0-2 2
For Part 2 see: MS FT-0-2 3
For Part 3 see: MS FT-0-2 9
For Part 4 see: MS FT-0-2 4
For Part 6 see: MS FT-0-2 1

Organizer: Francisco José Silva Alvarez	Techniques Université de Limoges
Organizer: Adriano Festa	L'Aquila university
Organizer: Daniela Tonon	Paris Dauphine University

Abstract: Mean Field Games (MFGs) problems have been introduced by Lasry-Lions and Huang-Caines-Malhamé in 2006. This theory describes Nash equilibria of some differential games with infinitely many players. In light of the numerous applications of MFGs, which include Economics, Finance and Social Sciences, several mathematical techniques are currently employed for its development. The scope of this minisymposium is to bring together several specialists in MFGs in order to present recent progress on the area and open problems. Among the topics covered in the minisymposium sessions are: analytic, probabilistic and numerical aspects of MFGs, and the applications mentioned in the paragraph above.

11:00-11:30

Forward Forward Mean Field Games and learning dynamics of a crowd of agents

Adriano Festa	L'Aquila university
Simone Goettlich	Mannheim University
Stephan Knapp	Mannheim University

Abstract: While the general theory for the terminal-initial value problem for mean-field games (MFG) is largely used in many models of applied mathematics, the features of the corresponding forward-forward version is still under-considered. Here, we explain how the framework is appropriated to model a systems of players that are learning about their environment starting from an initial guess and adapting it to new information possibly transmitted by other players.

11:30-12:00

Spatially Inhomogeneous Leader/Follower Dynamics

Marco Morandotti	Politecnico di Torino
Francesco Solombrino	University of Naples "Federico II"

Abstract: We study an interaction model of a population of players with labels based on a two-player game, which describes how the distribution of labels changes in time, in the spirit of a leader/follower-type dynamics. We assume that the population of players is distributed over a state space and that they are each endowed with probability distributions over the labels. We establish existence, uniqueness, and stability of the solutions. This is joint work with Francesco Solombrino.

12:00-12:30

Some one-dimensional switching mean field games for pedestrian flow and thermostatic control

Fabio Bagagiolo	University of Trento, Italy
Raffaele Pesenti	University Ca' Foscari, Venice, Italy
Silvia Faggian	University Ca' Foscari, Venice, Italy
Rosario Maggistro	University Ca' Foscari, Venice, Italy

Abstract: I present a one-dimensional mean field game model where both continuous and switching variables are introduced to respectively describe the position and some modal states of an agent. The existence of a mean field equilibrium will be discussed. The switching modal states may represent the already visited attractions by a pedestrian tourist in an art heritage city, as well as some internal switching variables of a physical/mechanical/biological system, such as thermostats.

12:30-13:00

Mean Field Models for Interacting Particle Systems

Helene Ranetbauer	Universität Wien

Abstract: In this talk we derive and analyse mean-field models for the dynamics of particles undergoing a random walk. The random motion is only influenced by the perceived densities of the different groups present as well as the available space. Simple interaction rules lead to the formation of aggregates as well as segregation. We discuss existence and stability properties of solutions and illustrate the rich dynamics with numerical simulations.

MS GH-0-2 5 11:00-13:00

Stability of inverse problems and parameters identification

Organizer: Mahjoub Moncef	ECOLE NATIONALE D'INGENIEURS DE TUNIS

Abstract: This mini-symposium is particularly interested to 1) present some lipshitz stability results for a set of parameters to solve inverse problems in cardiac electrophysiology. 2) present a uniqueness and stability issues for the inverse spectral problem of recovering the magnetic field and the electric potential in a Riemannian manifold from the eigenvalues of the magnetic Laplacian. 3) identify a set of parameters un ensemble de paramètres using a variational method based on the conjugate gradient method and the Tikhonov's regularization method to replace the original ill-posed problem with a well-posed problem.

11:00-11:30

Stability analysis of the POD reduced order method for solving the bidomain model in cardiac electrophysiology

Mahjoub Moncef	Ecole Nationale d'Ingénieurs de Tunis
Corrado Cesare	INRIA, Bordeaux - Sud-Ouest
Jamila Lassoued	University of Tunis El Manar, LAMSIN − ENIT
Néjib Zemzemi	INRIA, Bordeaux - Sud-Ouest

Abstract: We show the numerical stability of the Proper Orthogonal Decomposition (POD) reduced order method used in cardiac electrophysiology applications. The proof of the stability of this method is based on a priori estimates controlling the gap between the reduced order solution and the Galerkin finite element one. We present some numerical simulations confirming the theoretical results.

11:30-12:00

Stable determination of a first order coefficient in a wave equation from DN map

Ben Aicha Ibtissem	Beijing Computational Science Research Center

Mourad Bellassoued	LAMSIN-ENIT

Abstract: In this work we study an inverse problem for an hyperbolic equation. More precisely, we stably recover a first order coefficient appearing in a wave equation from the knowledge of Neumann boundary data. We show in dimension n greater than two, a stability estimate of Hölder type for the inverse problem under consideration. The proof involves a Carleman estimate and a reduction to an auxiliary inverse problem for an electro-magnetic wave equation.

12:00-12:30

Ionic Parameters identification via optimal control for a bidomain system in cardiac electrophysiology

Yassine ABIDI	National Engineering School of Tunis

Abstract: In this work, we present an optimal control formulation for the bidomain model to estimate maximal conductance parameters associated with the current of the ionic model. The optimal control approach is based on minimizing a properly chosen cost functional depending on the maximal conducance parameter as control variable and on the potential as the state variable. The optimality system and the numerical results are established with the physiological ionic Luo-Rudy phase I model.

MS A6-2-3 5 11:00-13:00

Tensor methods for model reduction of dynamical systems - Part 2

For Part 1 see: MS A6-5-2 4

Organizer: Billaud Friess Marie	Centrale Nantes
Organizer: Antonio Falcó Montesinos	Universidad CEU Cardenal Herrera
Organizer: Anthony Nouy	Centrale Nantes

Abstract: High-dimensional dynamical systems arise in various applications as quantum chemistry, physics, and uncertainty quantification. Solving such problems with traditional numerical methods is usually untractable, especially when depending on parameters. Tensor-based model reduction methods aim at reducing the complexity by projecting the solution onto low-dimensional tensor manifolds, using either a global variational approach or a dynamical approach, possibly exploiting the geometrical structures of these manifolds. The symposium aims at gathering experts to present their recent work in this field, including: -Variational and geometrical approaches for model reduction -Integration schemes for reduced dynamical systems -Low-rank tensor format approximation

11:00-11:30

Model reduction in Wasserstein spaces for transport problems

Virginie Ehrlacher	Ecole des Ponts Paristech & INRIA

Abstract: In this talk, we present a new model-order reduction methods for parameter-dependent transport problems using concepts from optimal transport theory, in particular Wasserstein spaces, which provides interesting approximation properties. Some theoretical error bounds will be shown on particular examples, together with preliminary numerical results.

11:30-12:00

A low-rank projector-splitting integrator for problems from plasma physics

Lukas Einkemmer	University of Innsbruck

Abstract: Many problems encountered in plasma physics require a kinetic description. Such problems are posed in an up to six-dimensional phase space. This makes their numerical treatment extremely expensive. Here we propose a dynamical low-rank approximation for the Vlasov equation. This approximation is derived by constraining the dynamics to a manifold of low-rank functions. This reduces a time step for the six-dimensional Vlasov equation to solving lower-dimensional advection equations.

12:00-12:30

DLR approximation and a posteriori error estimation for a random heat equation

Eva Vidlickova	EPFL
Fabio Nobile	EPFL

Abstract: Reduced Order Models (ROMs) express the solution of a PDE as a combination of few basis functions. For random time dependent problems, if the structure of the solution considerably changes over time, Dynamical Low Rank (DLR) methods are very appealing ROMs as the basis functions are free to evolve in time. In this talk we present the DLR method and discuss possible approaches for a posteriori error estimation to a random heat equation.

12:30-13:00

Charts based algorithms for dynamical low-rank approximation in matrix manifold

BILLAUD FRIESS Marie	Centrale Nantes

Abstract: Model order reduction (MOR) allows to solve high-dimensional dynamical systems by projecting them onto low-dimensional manifolds. Here, we focus on dynamical low-rank method exploiting the geometrical structure of the set of fixed rank matrices. We present a geometric description of this set relying on a natural parametrization of matrices. It is endowed with the structure of analytic principal bundle, with an explicit description of local charts. Algorithms working in local coordinates are proposed for MOR.

MS FT-S-3 5 11:00-13:00

Efficient time-stepping methods for differential problems with special features - Part 1

For Part 2 see: MS FT-S-3 6

Organizer: DOMINGO HERNANDEZ ABREU	UNIVERSITY OF LA LAGUNA
Organizer: Dajana Conte	Dipartimento di Matematica, Univ. di Salerno

Abstract: This minisymposium deals with recent advances in the numerical treatment of differential equations with applications to some relevant PDE and stochastic models. These include reaction-diffusion problems, stochastic oscillators or models from financial option pricing, among others. Special emphasis is placed on the design and analysis of accurate and optimized numerical methods, as well as their efficient implementations. The minisymposium also aims at promoting and enhancing collaborations between researchers with interest in the above-mentioned topics.

11:00-11:30

Long-term analysis of time discretizations for stochastic Hamiltonian problems

Raffaele D'ambrosio	University of L'Aquila
Chuchu Chen	Chinese Academy of Sciences
David Cohen	University of Umea
Annika Lang	Chalmers University of Technology & University of Gothenburg
Beatrice Paternoster	University of Salerno

Abstract: The talk is focused on the analysis of numerical methods solving stochastic Hamiltonian problems of Ito type, for which a linear drift of the expected energy is visible along the exact dynamics. We study the behaviour of stochastic Runge-Kutta methods through epsilon-expansions of the solutions, where epsilon is the amplitude of the stochastic fluctuation. A drift-preserving scheme is also provided and analyzed, whose effectiveness is also checked through a selection of test problems.

11:30-12:00

Micro-macro acceleration schemes for linear slow-fast stochastic DEs with additive noise

Kristian Debrabant	University of Southern Denmark
Giovanni Samaey	KU Leuven
Przemyslaw Zielinski	KU Leuven

Abstract: We discuss convergence and stability results for a micro-macro acceleration method for the simulation of SDEs with a separation between the (fast) time scale of individual trajectories and the (slow) time scale of the macroscopic function of interest. The method couples the microscopic model to a macroscopic level described by a finite set of macroscopic state variables, alternating between short bursts of microscopic path simulation and extrapolation of macroscopic states forward in time.

12:00-12:30

An application of AMFR-W-methods on multidimensional SABR/LIBOR market models

MARIA SOLEDAD PEREZ RODRIGUEZ	UNIVERSIDAD DE LA LAGUNA
Carlos Vázquez	Universidade da Coruña
José Germán López-Salas	Univesidade da Coruña

Abstract: Recently, a new high dimensional PDE formulation for the pricing of interest rate derivatives with SABR/LIBOR market models has been proposed and solved with a finite differences space-time discretization on sparse grids with recombination technique. Here we propose an alternative method of lines, with an unconditionally stable (in any spatial dimension) AMFR-W-method for the time-integration of the resulting initial value problem. In order to tackle high dimensional problems a sparse grid recombination technique is considered.

12:30-13:00

Adapted discretization of reaction-diffusion problems generating periodic wavefronts

Beatrice Paternoster Dipartimento di Matematica, Univ. Salerno

Raffaele D'Ambrosio University of L'Aquila

Abstract: The talk is focused on adapted discretizations of advection-reaction-diffusion partial differential equations which are a-priori known to provide periodic wavefronts as fundamental solutions. A spatial discretization based on trigonometrically fitted finite differences, as well as an adapted IMEX time integration are presented and analyzed. The estimation of time and space frequencies is also addressed, by means of an approach free from step-by-step optimization procedures. A selection of numerical experiments confirms the effectiveness of the approach.

MS A3-3-2 5 **11:00-13:00**

Efficient Numerical Methods for Multiphysics Problems - Part 1

For Part 2 see: MS A3-3-2 6

For Part 3 see: MS A3-3-2 7

Organizer: Chensong Zhang Academy of Mathematics and Systems Science

Organizer: Xiaowen Xu IAPCM

Abstract: With the recent development of numerical algorithms and increase of computational power, more and more groups are conducting high-resolution and high-fidelity multiphysics simulations. The proposed minisymposium will bring together international scientists, including early-career researchers, who are at the forefront of multiphysics simulation. The proposed workshop provides a forum for experts from different backgrounds to exchange recent progress and ideas, and to create new collaboration. An important goal of our minisymposium is to foster collaboration between computational mathematicians and domain scientists in various real-world application areas with special focus on high-performance numerical methods for multiphysics problems.

11:00-11:30

Fast algorithms for large-scale radiation hydrodynamics computation

Xiaowen Xu IAPCM

Abstract: Radiation-Hydrodynamics (RHD) computation plays an important role in simulation of high energy density physics area. Designing high efficient numerical algorithms for RHD is a great challenge task due to multi-physics coupling in the governing equations. In this talk, we will introduce the recent progress for designing fast algorithms for RHD coupled systems arising from laser fusion applications. Especially, we will discuss the multigrid type algorithms and show the performance of large-scale computing on $O(10^4)$ cores.

11:30-12:00

Reliability Analysis of 3D ICs with Adaptive Finite Element Method

Tao Cui AMSS, the Chinese Academy of Sciences

Abstract: Thermo-mechanical stress is one of the most important issues in performance and reliability analysis of through silicon via (TSV) based three-dimensional integrated circuits (3D ICs). In this talk, we propose a knowledge oriented non-uniform (KONU) refinement strategy for 3D IC stress simulation under the framework of parallel adaptive finite element method (FEM), and apply it in 3D IC stress and reliability analysis.

12:00-12:30

Temporal multiscale methods for multihphysics problems

Thomas Richter University of Magdeburg

Abstract: We consider PDE systems with a temporal multiscale character, where a slowly evolving variable interacts with a fast oscillating component. Based on the introduction of local periodic solutions we describe and analyze temporal multiscale schemes for the efficient simulation of such problems. Simplified numerical analysis and computational tests considering a difficult problem in hemodynamics show enormous speedups ranging to 1:10000 as compared to a direct simulations.

12:30-13:00

A multiscale asymptotic approach for the ablative materials

Jizu Huang Academy of Mathematics and Systems Science

Abstract: In this talk, we discuss the multi-scale asymptotic approach for the ablative materials with a periodic microstructure. The system satisfies a nonlinear parabolic equation with rapidly oscillating discontinuous coefficients. To save the computational cost, we present the homogenization method and first/second order multi-scale asymptotic. An explicit rate of convergence is derived for the first/second order multi-scale asymptotic. Several numerical tests are carried out to confirm the efficiency and accuracy of the approaches.

MS ME-1-4 5 **11:00-13:00**

Stabilization of distributed parameter systems: design methods and applications - Part 1

For Part 2 see: MS ME-1-4 6

For Part 3 see: MS ME-1-4 7

Organizer: Alexander Zuyev Max Planck Institute Magdeburg

Organizer: Grigorij Sklyar University of Szczecin

Organizer: Alexander Zuyev Max Planck Institute Magdeburg

Abstract: The stabilization problem for infinite-dimensional control system has close connections with methods of functional analysis and important applications in different branches of science and engineering. This Minisymposium aims at bringing together presentations dealing with stabilizing control design for different classes of dynamical systems described by partial differential equations, functional-differential equations, delay equations, and dynamical systems in abstract spaces. This includes new results in the theory of nonlinear semigroups, port-Hamiltonian systems, and further developments of Lyapunov's direct method. The scope of the Minisymposium also covers applications of these methods to mathematical models in continuum mechanics, chemical engineering, and transportation networks.

11:00-11:30

On complete stabilizability and exact null controllability of a class of time delay systems

Sklyar Grigory University of Szczecin

Pavel Barkhaev Institute for Low Temperature Physics and Engineering of the National Academy of Sciences

Rabah Rabah IMT Atlantique

Abstract: The conditions of complete stabilizability are given for several classes of retarded and mixed time delay systems and it is shown that exact null controllability implies complete stabilizability. We prove that the inverse implication holds under some additional conditions on system's coefficients. To investigate the problem we use trigonometric moment problem approach.

11:30-12:00

Stabilization of quasilinear hyperbolic systems with application to crystallization processes

Alexander Zuyev Max Planck Institute for Dynamics of Complex Technical Systems

Peter Benner Max Planck Institute for Dynamics of Complex Technical Systems

Abstract: A class of hyperbolic control systems governed by quasilinear partial differential equations with one spatial variable is considered in the talk. We present an approach for constructing control Lyapunov functionals for such systems as sums of squares of weighted seminorms in Sobolev spaces. The case of Lyapunov functionals with negative semi-definite derivatives is analyzed by exploiting the invariance principle. These results are applied to the stabilization of mathematical models of continuous preferential crystallization.

12:00-12:30

Limitations of stabilizability for networks of strings

Martin Gugat Friedrich-Alexander Universität Erlangen-Nürn

Abstract: Bastin and Coron pointed out that boundary-feedback stabilization of certain 1-d hyperbolic systems is impossible if the space interval is too long. We show that similar phenomena also occur for stars of strings that are governed by the wave equation with a certain source term. If one of the strings is sufficiently long or the number of strings is sufficiently large, boundary-feedback stabilization is not possible. The source term influences the system dramatically.

MS GH-1-A 5 **11:00-13:00**

Theoretical Foundations of Deep Learning - Part 1

For Part 2 see: MS GH-1-A 6
For Part 3 see: MS GH-1-A 7
Organizer: Gitta Kutyniok Technische Universität Berlin
Organizer: Philipp Petersen University of Oxford

MS Organized by: SIAG/IS

Abstract: Deep learning is the key technology in the latest advances in self-driving cars, natural language processing, and medical diagnosis. Despite its overwhelming success, several empirically observed phenomena of this technique are not entirely understood, including the remarkable generalisation properties of the resulting classifiers, their tendency to exhibit adversarial examples, and the success of the underlying optimisation procedure despite a highly non-convex energy landscape. Several of these issues were addressed individually using various techniques from approximation theory, statistical learning theory, or optimisation. To achieve more profound insights, an exchange between the individual contributors is essential and the focus of this mini-symposium.

11:00-11:30

Expressive Power of Deep Neural Networks: Beating The Curse of Dimensionality

Gitta Kutyniok Technische Universität Berlin

Abstract: The task of estimating the generalization error of deep neural networks decomposes into a statistical problem and an approximation theoretical problem typically coined expressivity. Focussing on the question of expressivity, we will first discuss the design of deep neural networks to achieve certain approximation rates while minimizing the complexity of the network itself. Then we will analyze the application to parametric PDEs showing how deep neural networks are able to overcome the curse of dimensionality.

11:30-12:00

Learning data-driven algorithms with graph neural networks

Soledad Villar New York University

Abstract: Graph neural networks are a natural architecture to approach optimization problems in graphs that generalize regularized spectral methods. In this talk we discuss the expressive power of GNNs, in particular in comparison with sum of squares, and we show their performance at solving specific problems.

12:00-12:30

Deep learning from a sparse coding perspective

Avaid Aberdam Technion

Abstract: Models play a central role in practically every task in signal and image processing and machine learning. Recently, the Multi-Layer Sparse Coding (ML-SC) model has introduced as a model-based explanation of deep learning. While early research analyzed the ML-SC merely as a cascade of simple single-layer models resulting in sub-optimal pursuit algorithms, we offer an integrated view revealing a unique symbiosis between synthesis and analysis sparse models and leading to experimental and theoretical improvements.

12:30-13:00

On multi-layer Basis Pursuit and convolutional neural networks

Jeremias Sulam Johns Hopkins University
Aviad Aberdam Technion
Amir Beck Tel Aviv University
Michael Elad Technion

Abstract: Motivated by a recent multilayer sparse model, we generalize the Basis Pursuit problem to a multilayer setting introducing similar sparse enforcing penalties at different representation layers in a symbiotic relation between synthesis and analysis sparse priors. We propose a multilayer extension of iterative shrinkage algorithms with weak convergence guarantees. These algorithms generalize feed-forward neural networks without introducing any parameters. We demonstrate these architectures in a supervised learning setting, improving the performance of classical convolutional networks.

MS FT-S-8 5 **11:00-13:00**

Challenges in theory and numerics for kinetic models with applications - Part 1

For Part 2 see: MS FT-S-8 6
For Part 3 see: MS FT-S-8 7
Organizer: Liu Liu University of Texas at Austin
Organizer: Marlies Pirner University of Vienna

Abstract: Modern applications of kinetic equations of collisional type, such as the Boltzmann equation, have brought researches in mesoscopic modeling, from rarefied gas or plasma dynamics, to quantum mechanics, gas mixtures, chemical reactions and uncertainty quantification for the models. Moreover, they had led to new challenges both in analysis and numerical methods for kinetic models such as spectral-gap estimates, hypocoercivity for studying exponential convergence towards global equilibrium, and multiscale scientific computings to avoid numerically resolve small scales in the models that can be prohibitively expensive. This minisymposium aims to bring together applied mathematicians to explore the recent progress in this field.

11:00-11:30

BGK models for gas mixtures

Marlies Pirner Vienna University
Christian Klingenberg University of Wuerzburg
Liu Liu University of Texas
Gabriella Puppo University of Rome

Abstract: A kinetic description for evolving gases with a simplifications of the collision operator is given by the BGK model. I shall present various of such models for gas mixtures. One is a multi-species model, for we can show conservation properties, H-Theorem, Existence and Uniqueness of solutions and results on the large time behaviour. The other is its extension to polyatomic multi-species gases.

11:30-12:00

Gauss Wave Packet Transform methods for the Schödinger equation with random inputs

Zhennan Zhou Peking University

Abstract: We study the semiclassical limit of the Schrödinger equation with random inputs, and show that the semiclassical Schrödinger equation produces O(epsilon) oscillations in the z variable in general. With the Gaussian wave packet transform (GWPT), the original Schrödinger equation is mapped to an ODE system for the wave packet parameters coupled with a PDE for the quantity w in rescaled variables. We propose multi-level sampling strategy in implementing the Gaussian wave packet transform.

12:00-12:30

Hydrodynamic equations from inert and reactive BGK models

Marzia Bisi University of Parma

Abstract: Chapman-Enskog method allows to deduce from consistent BGK models an explicit closure of macroscopic equations at Euler or Navier-Stokes level, with transport coefficients in agreement with physical expectations. In this talk we derive hydrodynamic Navier-Stokes equations from a BGK model for inert mixtures, which preserves the structure of the original Boltzmann equations and is well-posed for general intermolecular potentials. Analogous macroscopic equations may be obtained also from kinetic models involving bimolecular chemical reactions.

12:30-13:00

Sensitivity analysis and stochastic Galerkin approximation to collisional kinetic equations with uncertainty

Liu Liu University of Texas at Austin
Shi Jin Shanghai Jiao Tong University
Esther S. Daus Vienna University of Technology

Abstract: We first show that the general framework by Mouhot, Neumann and Briant et al. based on hypocoercivity for the collisional kinetic equations can be adopted to the sensitivity analysis for multiscale kinetic equations with uncertainty, giving an exponential convergence of the solution toward the global equilibrium. Then we study the stochastic Galerkin approximation and obtain a spectral convergence of the numerical solution, assuming that the random perturbation of the collision kernel can be O(1).

MS ME-0-7 5 **11:00-13:00**

Recent advances in understanding suspensions and granular media flow - Part 1

For Part 2 see: MS ME-0-7 6
Organizer: Dirk Peschka Weierstrass Institute for Applied Analysis and Stochastics

Organizer: Andreas Münch University of Oxford

Abstract: Particulate flows are ubiquitous in nature, e.g., geophysical processes and biological systems, but also relevant in industrial applications. While the up-scaling of microscopic particle dynamics can be made mathematically rigorous, modern applications often employ effective models for mesoscales. In this minisymposium, we bring together scientists that provide different point-of-views to flows of disperse media, i.e., suspensions and granular flows. In particular, we focus on practically relevant aspects such as modeling/simulation/analysis of shear-induced migration, normal pressures, discontinuous shear thickening, jamming, aspects of universality, nonlocality, and general well-posedness in the view of recent experiments and industrial applications.

11:00-11:30

Mechanics of wet particulate materials

Martin Brinkmann Experimentalphysik, Universtiät des Saarlands

Somanth Karmakar

Marc Schaber

Ralf Seemann

Abstract: The resistance of wet granular beds to shear is commonly explained by an enhanced friction at the grain contacts in presence of attractive capillary forces. Here, I discuss additional mechanisms of dissipation during shear including the hysteretic formation and rupture of capillary bridges and rolling friction of bridges with moving liquid/air/solid contact lines. The former mechanism may contribute to the shear stress during slow deformations and could explain the shear rate dependence seen in experiments.

11:30-12:00

Gradient structures for flows of concentrated suspensions

Marita Thomas Weierstrass Institute for Applied Analysis and Stochastics

Dirk Peschka WIAS Berlin

Tobias Ahnert Deloitte Consulting

Andreas Münch Oxford University

Barbara Wagner WIAS Berlin

M. Hassan Farshbaf-Shaker WIAS Berlin

Andrea Zafferi WIAS Berlin

Abstract: We discuss a two-phase model for concentrated suspensions with yield-stress behaviour. We establish a PDE formulation using a gradient flow structure featuring dissipative coupling terms between fluid and solid phase as well as different driving forces. Our construction is based on flow maps, accounts for flows in moving domains with free boundaries, and features a non-smooth two-homogeneous term in the dissipation potential, that creates a normal pressure even for pure shear flows.

12:00-12:30

Interparticle friction leads to non-monotonic flow curves and hysteresis in viscous suspensions

Hugo Perrin EPFL - IUSTI

Clavaud Cécile IUSTI

Matthieu Wyart EPFL

Bloen Metzger IUSTI

Yoël Forterre IUSTI

Abstract: Hysteresis is a major feature of the solid-liquid transition in granular materials. This property, by allowing metastable states, can yield catastrophic phenomena such as earthquakes. By using micro-silica particles whose interparticle friction coefficient can be turned off, we show that microscopic friction, conversely to inertia, is key to triggering hysteresis in granular suspensions. Our measurements reveal monotonous rheological law for frictionless particles and a velocity-weakening behavior for frictional particles, thereby explaining the emergence of hysteresis.

12:30-13:00

Constitutive Laws for Well-Posed Continuum Equations for Granular Flow

Michael Shearer North Carolina State University

Abstract: Recent developments in the continuum modeling of granular materials address the long-standing problem of ill-posedness in the evolution equations. Compressibility, a physically relevant property captured by a variable packing fraction, is introduced to the mu(I) rheology, using ideas from Critical State Soil Mechanics. The result is a set of conditions on the constitutive laws under which granular flow is well posed. The theory is tested with numerical simulations in a shear cell.

MS GH-0-1 5 11:00-13:00

Modeling and simulation of materials defects and inhomogeneities - Part 5

For Part 1 see: MS GH-0-1 1

For Part 2 see: MS GH-0-1 2

For Part 3 see: MS GH-0-1 3

For Part 4 see: MS GH-0-1 4

For Part 6 see: MS GH-0-1 6

Organizer: Luchan Zhang National University of Singapore

Organizer: Shuyang Dai Wuhan University

Abstract: Materials defects and inhomogeneities, such as dislocations and grain boundaries in solids, fluid-solid and fluid-fluid interfaces, and fine microstructures within advanced materials, play essential roles in the mechanical and dynamical behaviors of the materials. The complexity of modeling microstructures of these defects and inhomogeneities, and their evolution at various length and time scales present new challenges for mathematical modeling and analysis. Multiscale and multiphysics models are required to accurately describe the complicated phenomenon associated with defects and inhomogeneities. Speakers in this minisymposium will discuss recent advances in modeling approaches and simulation methods, and new findings obtained in analysis and simulations.

11:00-11:30

Modelling and Simulation for a sliding gel film on a moving substrate

Xianmin Xu State Key Laboratory of Scientific and Engineering Computing

Abstract: The sliding frinction of soft materials like rubber is important in many applications. We develop an elastic model for a sliding gel film on a moving substrate. The model is based on a reduced elastic energy functional. The Onsager Principle is used to derive the dynamics of the film. Numerical methods are developed for the model. Numerical results show that the model captures the essential phenomena of the sliding friction of soft materials.

11:30-12:00

Drops on soft substrates: Equilibrium states and quasi-static dynamics

Luchan Zhang National University of Singapore

Weiqing Ren National University of Singapore

Abstract: Interactions between liquid drops and soft materials are omnipresent and play an essential role in biological activities. A liquid droplet can deform the elastic solid substrate due to the capillary forces. We consider a two-dimensional system of a liquid drop on a semi-infinite incompressible isotropic soft substrates, and propose a continuum model to study the spreading behaviors and equilibrium properties of this system. Based on this model, numerical simulations are operated and compared to experiments.

12:00-12:30

On an Allen-Cahn-type equation for matrix-valued fields

Dong Wang The University of Utah

Braxton Osting University of Utah

Xiao-Ping Wang Hong Kong University of Science and Technology

Abstract: In this talk, we develop a numerical approach to the Allen-Cahn-type equation for matrix-valued fields. We show that the method is unconditionally stable. We perform several numerical experiments on at tori and closed surfaces, which, unsurprisingly, exhibit classical behavior from the Allen-Cahn and Ginzburg-Landau equations, but also new phenomena. These new phenomena are further investigated using asymptotic methods.

12:30-13:00

Variational modeling of moving contact line problems with elastic membrane

Zhen Zhang Southern University of Science and Technology

Weiqing Ren National University of Singapore

Jin Yao National University of Singapore

Abstract: We introduce a sharp interface models for moving contact lines with elastic membrane. A continuous model with the boundary conditions is derived for the dynamics of two immiscible fluids with moving contact lines based on thermodynamic principles. Both static configuration and dynamic models are developed. Perturbation analysis is conducted for the 2D static configuration to reveal the multiscale structure. We also discuss related models on surfactants and polymers.

MS GH-1-3 5 11:00-13:00

Novel Computational Methods for Electromagnetic Problems in Complex Nonlinear Materials - Part 1

For Part 2 see: MS GH-1-3 6
For Part 3 see: MS GH-1-3 7

Organizer: Vrushali Bokil	Oregon State University
Organizer: Fengyan Li	Rensselaer Polytechnic Institute
Organizer: Yingda Cheng Cheng	Michigan State University
Organizer: Camille Carvalho	University of California, Merced

MS Organized by: SIAG/CSE

Abstract: Advances in the fabrication of novel artificial materials, described under the umbrella name of "metamaterials", has led to significant research in modeling, analysis of models and their computational simulation to aid in engineering design. This minisymposium will feature recent results on novel computational methods for electromagnetic problems with applications in photonics, optics, micromagnetics, magnetohydrodynamics and other areas. Computational methods will include finite difference, discontinuous Galerkin and other finite element, as well as mimetic methods. Additionally, important issues such as new models and new formulations for different applications, dispersion errors, PMLs for unbounded domains, and efficient solvers will be discussed.

11:00-11:30

Frequency-domain wave propagation in hyperbolic metamaterials

Maryna Kachanovska	INRIA

Abstract: We consider wave propagation in hyperbolic metamaterials, described by 2D anisotropic Maxwell's equations with a tensor of dielectric permittivity that depends on the frequency. For a range of frequencies, the respective model becomes hyperbolic (Klein-Gordon equation). We demonstrate the well-posedness (in particular, the radiation condition), limiting absorption and limiting amplitude principles for the respective problem in the free space. Additionally, we discuss the reduced (compared to the elliptic case) regularity of the solutions.

11:30-12:00

Simulation of optical fiber amplifiers

Jay Gopalakrishnan	Portland State University
Jay Gopalakrishnan	Portland State University

Abstract: A full vectorial simulation of a realistic fiber using Maxwell equations is infeasible today. Simplified models using CMT (Coupled Mode Theory) form the state of the art. Building on CMT, we present a novel scale model, referred to as an equivalent short fiber, which captures some of the essential characteristics of a longer fiber much more efficiently. Computations using models of commercially available (ytterbium and thulium doped) fibers show the practical utility of the concept.

12:00-12:30

New formulations of resonant models for propagative media with sign-changing coefficients

Anouk Nicolopoulos	Sorbonne Universite
Martin Campos Pinto	CNRS & LJLL Sorbonne Universite
Bruno Després	LJLL Sorbonne Universite

Abstract: We are interested in hybrid resonances in a plasma with the objective of developing stable FE methods for their numerical simulations. The equation at stake is -div(alpha grad u)-u=0 in 2D, with alpha that vanishes along a curve and is positive on one side of it, negative on the other side. The solution to this equation is not unique, and is singular. We will propose a well-posed formulation for this PDE, and present numerical illustrations.

12:30-13:00

Parallel frequency domain electromagnetic solvers without agonizing pain

Daniel Appelo	University of Colorado, Boulder
Olof Runborg	Royal Institute of Technology, Sweden
Fortino Garcia	University of Colorado, Boulder

Abstract: In this talk we show how construct high order accurate and scalable Helmholtz solvers by a novel fixed point iteration for the time-dependent wave equation. Unlike direct discretization of Helmholtz equation, which leads to indefinite linear systems of equations, our method results in symmetric and positive definite systems of equations that can be solved efficiently using iterative methods.

MS FT-4-3 5 11:00-13:00

Optimisation and Inverse Problems in Imaging Science - Part 2

For Part 1 see: MS FT-4-3 4
For Part 3 see: MS FT-4-3 6
For Part 4 see: MS FT-4-3 7

Organizer: Fiorella Sgallari	University of Bologna
Organizer: Raymond Chan	The City University of Hong Kong

Abstract: Next-generation imaging and diagnostics provide an unprecedented step forward in our knowledge in imaging science. Defining new approaches to handle images is both fundamental and challenging due to the huge amount of data and the need for a precise and self-consistent analysis. By combining experiences from different fields, this mini-symposium aims at creating an interdisciplinary bridge that can enrich all research areas. This mini-symposium is dedicated to Prof. Mila Nikolova whose contributions on inverse problems and models such as non-smooth and nonconvex ones were substantial and lasting.

11:00-11:30

Multivariate Myriad Filters by Estimating Parameters of Student-t Distributions

Gabriele Steidl	University of Kaiserslautern
Laus Friederike	TU Kaiserslautern

Abstract: We propose an efficient algorithm, called generalized multivariate myriad filter, for computing the ML estimator of the multivariate t-distribution. Then we use it in a nonlocal framework for the denoising of images corrupted by different kinds of noise. The resulting method is very flexible and can handle heavy-tailed as well as Gaussian noise. The special case of the projected normal distribution in 2D can be used for the robust denoising of circle data.

11:30-12:00

Isotonic regressions and image quality measures

Pierre Weiss	CNRS
Paul Escande	CNRS
Gabriel Bathie	ENS Lyon
Yiqiu Dong	DTU (Denmark Technical University)

Abstract: We design image quality measures independent of contrast changes, defined as a set of transformations preserving an order between the level lines of an image. This problem can be cast as a large scale isotonic regression problem on either chains, polytrees or directed acyclic graphs. We design original algorithms that improve the best known complexities.

12:00-12:30

Fast and Accurate Multiplicative Decomposition for Fringe Removal in Interferometric Images

Andres Almansa	Université Paris Descartes
Daniel-Chen Soncco	CMLA - ENS Paris Saclay
Clara Barbanson	LTCI - Telecom ParisTech
Mila Nikolova	CMLA - ENS Paris Saclay
Yann Ferrec	ONERA - The French Aerospace Lab

Abstract: Airborne Hyperspectral images can be efficiently obtained with static interferometric spectrometers. This technology requires to register hundreds of images with subpixel precision, which is only reachable if images have firts been decomposed into panchromatic and interferometric components. In this talk we present a cartoon+texture-like image decomposition algorithm, where the decomposition model is multiplicative and thus bi-convex. We show how an appropriate choice of initialization and regularization are key to obtaining fast and accurate decompositions.

12:30-13:00

Identifying Differential Equations with Numerical Time evolution

Sung Ha Kang	Georgia Institute of Technology

Abstract: Identifying unknown differential equations from given discrete time dependent data is a challenging problem. A small amount of noise can make the recovery unstable, and nonlinearity varying coefficients add complexity to the problem. We propose a new direction based on numerical partial differential equation, which is explored for data with non-periodic boundary conditions, noisy data and PDE with varying coefficient for nonlinear PDE identification. Joint work with Wenjing Liao and Yingjie Liu.

MS ME-0-1 5 11:00-13:00

Recent developments in nonlocal geometric variational problems - Part 1

For Part 2 see: MS ME-0-1 6

Organizer: Cyrill Muratov Department of Mathematical Sciences, NJIT

Organizer: Matteo Novaga University of Pisa

Abstract: In recent years, there has been a growing interest in variational problems involving different kinds of nonlocal interactions. Such problems arise naturally in a variety of application contexts and present new mathematical challenges in the calculus of variations and nonlinear partial differential equations. To study these problems, new analysis tools are currently being developed, bringing this area of calculus of variations to the forefront of applied mathematics research. This two-part minisymposium brings together a group of researchers that have contributed to different aspects of this class of problems and will give an opportunity to share their ideas and recent results.

11:00-11:30

A nonlocal isoperimetric problem with dipolar repulsion

Thilo Simon New Jersey Institute of Technology

Cyrill Muratov New Jersey Institute of Technology

Abstract: We discuss a model for perpendicularly oriented dipoles in the plane in which perimeter and regularized 3D dipolar repulsion compete under a volume constraint. The nonlocal term contributes to the perimeter term to leading order for small regularization cutoffs. For subcritical dipolar strengths and for small cutoff lengths all minimizers are disks. For critical dipolar strength, we identify the next-order Γ-limit and prove symmetry breaking for a slight modification of the dipolar kernel.

11:30-12:00

An isoperimetric problem for charged liquid drops

Berardo Ruffini University of Montpellier

Abstract: We review the state of the art of a project carried on with M. Goldman, C. Muratov and M. Novaga, in which we investigate a variational model for charged liquid drops. We show that the model, originally formulated by Lord Rayleigh in 1882, is ill-posed unless some regularity on drops is imposed, as convexity of flatness of the drops.

12:00-12:25

Optimal shape of isolated ferromagnetic domains

Hans Knuepfer University of Heidelberg

Abstract: We investigate the optimal shape and the scaling of the minimal energy of an isolated magnetic domain with prescribed volume. The energy of the magnetic domain consists of the interfacial and the magnetostatic energy which appears in the nucleation theory for magnetization reversal in uniaxial materials. We show existence of minimizers and a scaling law for the minimal energy. We also derive a reduced model in the framework of Gamma-convergence.

12:30-13:00

Nonlocal isoperimetric problems in anisotropic settings

Ihsan Topaloglu Virginia Commonwealth University

Rustum Choksi McGill University

Robin Neumayer Institute of Advanced Study

Abstract: In this talk I will introduce a variant Gamow's liquid drop model with an anisotropic surface energy. Under suitable regularity and ellipticity assumptions on the surface tension, Wulff shapes are minimizers in this problem if and only if the surface energy is isotropic. In sharp contrast, Wulff shapes are the unique minimizers for certain crystalline surface tensions. I will also introduce related models with anisotropic repulsion for which the Wulff shape is the minimizer.

MS FE-1-G 5 11:00-13:00

Large-Scale Structured Matrix and Eigenvalue Computations - Part 1

For Part 2 see: MS FE-1-G 6

Organizer: Tiexiang Li Southeast University

Organizer: Eric Chu Monash University

Abstract: We are interested in the numerical solution of large-scale problems with structures. The problems arise from diverse real-life applications range from 3D Maxwell equations, big data, photonics crystals, the Procrustes problem, Markovian jump systems, structure-preserving flows and facial recognition. We are linked by our attempts to benefit from some structures in the problems. In the associated numerical computations, techniques in large-scale matrix and eigenvalue problems are applied and analyzed. The speakers (seven male and one female) come from China, Taiwan and Australia, in various stages of their careers.

11:00-11:30

Electromagnetic field behaviour of 3D Maxwell equations for chiral media

Tiexiang Li Southeast University

Tsung-Ming Huang National Taiwan Normal University

Ruey-Lin Chern National Taiwan University

Wen-Wei Lin National Chiao Tung University

Abstract: This work focuses on numerically studying the eigenstructure behavior of generalized eigenvalue problems (GEPs) arising in 3D source-free Maxwell equations in reciprocal chiral media. It is challenging to solve such a large-scale GEP with dimension 5,308,416 efficiently. We show that the eigenstructure is heavily determined by the chirality parameter, and the electric and magnetic fields of the resonance modes are localized inside the structure with little field leaking into the background material.

11:30-12:00

Solving the unbalanced Procrustes problem via a nonlinear eigenvalue problem

Leihong Zhang Shanghai University of Finance and Economics

Chungen Shen

Weihong Yang

Abstract: In this talk, we will first show that the classical unbalanced Procrustes problem can equivalently be translated into a nonlinear eigenvalue problem, whose nonlinearity of the coefficient matrix is dependent on the targeted eigenvectors. For solving such a specific nonlinear eigenvalue problem, we propose an Self-Consistent Field Iterations (SCF). Theoretical analysis and numerical behaviors of the SCF iteration will be presented.

12:00-12:30

High-performance computing for three dimensional photonic crystals

Tsung-Ming Huang National Taiwan Normal University

Wen-Wei Lin National Chiao Tung University

Tiexiang Li Southeast University

Abstract: We propose a nullspace-free method with FFT-based matrix-vector multiplications to simulate the band structure of 3D photonic crystals. Using the Lanczos method and the conjugate gradient method without using a preconditioner, numerical results illustrate that our proposed method successfully solves each of a set of 5.184 million dimension eigenvalue problems within 18 to 50 seconds on a workstation with NVIDIA Tesla P100 GPUs.

MS GH-3-2 5 11:00-13:00

Sedimentation, flotation, and related processes: modeling, numerics, applications, and calibration - Part 1

For Part 2 see: MS GH-3-2 6

For Part 3 see: MS GH-3-2 7

Organizer: Raimund Bürger Universidad de Concepción

Organizer: Stefan Diehl Lund University

Abstract: Mathematical models for sedimentation, flotation, and related processes such as fluidization, creaming, and centrifugal separation are important in industrial applications such as mineral processing, wastewater treatment, chemical engineering, and medicine. They are frequently formulated in terms of nonlinear convection-diffusion-reaction PDEs with non-standard properties (such as discontinuous coefficients, type degeneracy, and large system size) are as coupled flow-transport problems. It is the purpose of this minisymposium to review recent advances in the formulation of such models, their well-posedness analysis, the determination of exact and numerical solutions to direct and inverse problems, and their applications.

11:00-11:30

Flux identification of scalar conservation laws from sedimentation in a cone

Raimund Bürger Universidad de Concepción

Julio Careaga	Lund University, Sweden
Stefan Diehl	Lund University, Sweden

Abstract: A method is presented for the identification of non-convex fluxes of scalar conservation laws that model solid-liquid sedimentation in a vessel with downward-decreasing cross-sectional area. The data given is the location of the descending supernatant-suspension interface as a function of time. The inverse problem is solved by utilizing the construction of solutions of the direct problem by the method of characteristics. The method is tested on synthetic and experimental data.

11:30-12:00

On diffusively corrected multispecies kinematic flow models

Luis Miguel Villada Osorio	Universidad del Bío Bío

Abstract: In this talk we focus on the efficiently implementation of nonlinear Implicit-Explicit Runge-Kutta (IMEX-RK) and Linearly Implicit Explicit Runge-Kutta (LI-IMEX-RK) methods for solving a coupled system of quasilinear strongly degenerate convection-diffusion equations. Applications of this models include the settling of polydisperse suspensions, multiclass vehicular traffic, the settling of dipersions and emulsions, and chromatography.

12:00-12:30

Qualitative validation of a compression settling model to simulate secondary clarifiers in wastewater resource recovery facilities

Maria Elena Valle	Université de Strasbourg
Isabelle Charpentier	ICUBE / Université de Strasbourg / CNRS
Julien Laurent	ICUBE / Université de Strasbourg / CNRS / ENGEES

Abstract: Sludge parameters identified for a batch settling column are used to simulate a full size secondary clarifier. The Nash-Sutcliffe efficiency is a normalized statistic introduced to evaluate the quality of an estimation process. Here, it compares the calculated sludge height to experimental data in the clarifier, and shows that the proposed method is acceptable.

12:30-13:00

A dynamic multilayer shallow water model for polydisperse sedimentation, Part I

Enrique Domingo Fernández Nieto	Universidad de Sevilla
Raimund Bürger	Universidad de Concepción
Víctor Osores	Universidad de Concepción

Abstract: A multilayer shallow water approach for polydisperse sedimentation in a viscous fluid is presented. The fluid is assumed to carry finely dispersed solid particles that belong to a finite number of species that differ in density and size. The global mass conservation and linear momentum balance laws of the mixture are recovered. The final model can be written as a multilayer model with variable density. Numerical simulations in various scenarios are presented.

MS FT-S-5 5 11:00-13:00

Distance Metrics and Mass Transfer Between High Dimensional Point Clouds - Part 1

For Part 2 see: MS FT-S-5 6

For Part 3 see: MS FT-S-5 7

Organizer: Naoki Saito	University of California, Davis
Organizer: Alexander Cloninger	University of California San Diego

Abstract: Measuring distance between probability distributions plays a fundamental role in statistics, imaging, PDEs, and machine learning, and has inspired a variety of algorithmic approaches, including Kullback-Leibler divergence, maximum mean discrepancy, and Wasserstein distance, along with various approximations. In practice, however, efficiently computing such distances leads to a series of important mathematical questions, especially when the distributions are in high-dimensional space, or can only be accessed through finite samples taken from each distribution. In this minisymposium, we shall showcase a variety of approaches to developing theory, computation, and applications of such metrics, as well as promote closer interactions among different communities.

11:00-11:30

Graph wavelets via natural organization of Laplacian eigenvectors

Naoki Saito	University of California, Davis
Haotian Li	University of California, Davis
Alexander Cloninger	University of California, San Diego

Abstract: Some existing methods to construct graph wavelets view graph Laplacian eigenvalues and eigenvectors as frequencies and complex exponentials. For graphs more complicated than a path or a cycle, however, this viewpoint becomes problematic. The first step toward building natural graph wavelets is to organize Laplacian eigenvectors in a "dual" domain. I will discuss our effort using Wasserstein distance to measure distances between eigenvectors and how to combine such eigenvectors to generate natural graph wavelets.

11:30-12:00

Optimal transport on manifolds for domain adaptation and metric learning

Ronen Talmon	Technion
Almog Lahav	Technion - IIT

Abstract: We present an approach combining geometry and manifold learning with Optimal Transport (OT). OT searches for the most effective way to transport one mass distribution to another, and in turn induces a metric between the two distributions. We introduce a new OT approach for high-dimensional data that lie on hidden low- dimensional manifolds. Simulations and application to real data illustrate the advantage of our approach.

12:00-12:30

Kernel distances between distributions for generative models

Dougal Sutherland	University College London

Abstract: Kernel-based distances between distributions both satisfiy nice properties (e.g. they metrize weak convergence) and are statistically and computationally easy to estimate. The main challenge is in choosing a kernel, i.e. a "similarity" on data points, appropriate for a particular application. After overviewing the basics of kernel distances, we define a new distance that allows for flexible kernels given by deep neural networks, while maintaining nice properties, and use them for state-of-the-art generative models of images.

12:30-13:00

Anisotropic diffusion kernels to compare distributions

Xiuyuan Cheng	Duke University
Alexander Cloninger	University of California, San Diego
Ronald R Coifman	Yale University

Abstract: A Maximum Mean Discrepancy statistic for comparing multivariate distributions from data is introduced based on anisotropic kernels which compute the affinity between data points and a set of reference points. When the unknown distributions are locally low-dimensional, the proposed test can be more powerful to distinguish certain distributions, which is theoretically characterized by the spectral decomposition of the kernel. Applications to flow cytometry and diffusion MRI datasets will be shown.

MS ME-1-2 5 11:00-13:00

Nonlinear acoustics: analytical and numerical aspects

Organizer: Marta Pellicer	Universitat de Girona
Organizer: Mechthild Thalhammer	University of Innsbruck
Organizer: Barbara Kaltenbacher	University of Klagenfurt

Abstract: A variety of industrial and medical applications of high intensity ultrasound reinforces current research interest in the field of nonlinear acoustics. Even though classical models have been devised in the 1960's, the physically correct and mathematically sound modelling of nonlinear wave propagation remains a highly active field of research. A profound mathematical analysis of the underlying models based on partial differential equations is an important prerequisite for reliable and well-founded numerical simulation and optimisation of high intensity ultrasound devices. The intension of this minisymposium is to provide a platform to present recent results and discuss open questions.

11:00-11:30

Optimal control of a linearized dynamics in ultrasonic wave propagation

Francesca Bucci	Universita' degli Studi di Firenze

Abstract: The talk will deal with the optimal (boundary) control of the Stokes-Moore-Gibson-Thompson equation, linearization of an established PDE model for ultrasonic wave propagation. A solution to an optimization problem is proposed, aimed at ensuring the feedback synthesis of optimal controls via well-posed operator Riccati equations, and that overcomes intrinsic challenges such as the hyperbolic character of the dynamics. (The talk is based on past and ongoing joint work with Irena Lasiecka (University of Memphis, USA).)

11:30-12:00

Self-adaptive absorbing boundary conditions for quasilinear acoustic wave propagation

Vanja Nikolic	Technical University of Munich
Markus Muhr	Technical University of Munich
Barbara Wohlmuth	Technical University of Munich

Abstract: In this talk, we will present a self-adaptive absorbing technique for quasilinear ultrasound waves modeled by the Westervelt equation. Within the method, the angle of incidence of the wave is computed based on the information provided by the wave-field gradient which is readily available in the finite element framework. The absorbing boundary conditions are then updated with the angle values in real time. Numerical experiments illustrate the accuracy and efficiency of the proposed method.

12:00-12:30

The Moore–Gibson–Thompson equation arising in high intensity ultrasound

Marta Pellicer	University of Girona
J. Solà-Morales	Universitat Politècnica de Catalunya

Abstract: The MGT equation is the linearization of the Jordan-MGT equation, an important model in Acoustics that avoids the paradox of infinite propagation speed waves. Although linear, it exhibits very different behaviours depending on the parameters. When dissipative, we show a new and explicit scalar product in which, for most parameters, the operator becomes normal (the best we can expect) and use it to proof the optimal exponential decay rate of the solutions (see EECT 2019).

12:30-13:00

Models of nonlinear acoustics viewed as an approximation of the Navier-Stokes and Euler compressible isentropic systems

Anna Rozanova Pierrat	CentraleSupélec
Adrien Dekkers	CentraleSupélec
Vladimir Khodygo	CentraleSupélec

Abstract: The derivation of different models of non linear acoustic in thermo-ellastic media as the Kuznetsov equation, the KZK equation and the Nonlinear Progressive wave Equation (NPE) from an isentropic Navier-Stokes/Euler system is systematized using the Hilbert type expansion in the corresponding perturbative and (for the KZK and NPE equations) paraxial ansatz. We estimate the time during which the solutions of these models keep closed in the L^2 norm, establishing different well-poseness results.

MS FT-S-6 5 — 11:00-13:00

Recent advances on numerical methods and applications of phase-field models - Part 1

For Part 2 see: MS FT-S-6 6
For Part 3 see: MS FT-S-6 7
For Part 4 see: MS FT-S-6 8

Organizer: Chuanju Xu	Xiamen University

Abstract: Interfacial dynamics in complex fluids presents tremendous challenges to science. From a fluid mechanical viewpoint, the essential physics is the coupling between interfacial movement and the flow of the bulk fluids. Phase field methods start from a multi-scale point of view and treat the interface as a microscopic transition zone of small but finite width. Then a set of governing equations can be derived that are thermodynamically consistent and mathematically well-posed. This mini-symposium will bring together numerical analysts and computational scientists working on phase field methods to present their recent advances in algorithm designs and applications of phase field methods.

11:00-11:30

Fractional phase-field models: algorithm and simulations

Chuanju Xu	Xiamen University

Abstract: We propose a fractional mass-conserving Allen-Cahn phase-field model derived from an energy variational formulation. The model allows controlling the sharpness of the interface, which is typically diffusive in integer-order phase-field models. The spatial discretization is based on a spectral method whereas the temporal discretization is based on a stabilized ADI scheme or SAV approach. In particular, an efficient method for computing fractional Laplacians on complex-geometry domains will be discussed.

11:30-12:00

A variant of scalar auxiliary variable approaches for gradient flows

Mejdi Azaiez	Bordeaux INP, France
Xu Chuanju	Xiamen University
Hou Dianming	Xiamen University

Abstract: In this talk, we propose and analyze a class of schemes based on a variant of the scalar auxiliary variable (SAV) approaches for gradient flows see, e.g., [Shen et al., J. Comput. Phys. 2018]. Like for SAV, the method consists in splitting the gradient flow into decoupled linear systems with constant coefficientsoach and requires that the total free energy is bounded from below. The unconditional stability is established and series of numerical experiments are given

12:00-12:30

Phase-Field method for Thermal Characterization of composite materials

Maimouna Mint Brahim	I2M Bordeaux
Mejdi Azaiez	I2M - Bordeaux
Elena Palomo	CICenergiGUNE

Abstract: A phase-field method combined with Karhunen–Loève decomposition technique is used to estimate thermal parameters using infra-red images of the studied materials. This method allowed to accurately estimate thermal parameters for homogeneous with all types of geometries and has proven to be highly accurate and its robustness to noise is tested on different quality data. This new method has allowed to estimate thermal parameters in the case of some heterogeneous materials with very complex layouts.

12:30-13:00

A stable scheme for a 2D dynamic Q-tensor model of nematic liquid crystals

Yongyong Cai	Beijing Computational Science Research Center

Abstract: We propose a stable numerical scheme for a $2D$ dynamic Q-tensor model of nematic liquid crystals. This dynamic Q-tensor model is a L^2 gradient flow generated by the liquid crystal free energy that contains a cubic term. Our convergence analysis also leads to, as a byproduct, the well-posedness of the original PDE system for the 2D Q-tensor model. Several numerical examples are presented to validate and demonstrate the effectiveness of the scheme.

MS ME-1-I1 5 — 11:00-13:00

Variational Analysis for Optimal Control and Inverse Problems - Part 1

For Part 2 see: MS ME-1-I1 6
For Part 3 see: MS ME-1-I1 7

Organizer: Akhtar A. Khan	Rochester Institute of Technology Rochester, New York
Organizer: Christian Clason	University of Duisburg-Essen
Organizer: Miguel Sama	UNED

Abstract: The study of inverse and optimal control problems is a vibrant and expanding branch of applied mathematics with wide-ranging applications to numerous related disciplines. In recent years, new directions of research emerged. For example, identification of stochastic parameters in stochastic PDEs and multi-objective control problems have been the focus of new research. Moreover, the ongoing investigations into inverse and control problems enormously benefited from the tools from fields such as variational and nonsmooth analysis. This minisymposia aims to gather experienced and young researchers actively engaged in the cross-fertilization of ideas among variational analysis, inverse problems and optimal control problems.

11:00-11:30

Iterative regularization of nonsmooth inverse problems

Christian Clason	University of Duisburg-Essen

Abstract: We consider inverse problems for nonlinear forward models that are directionally but not Fréchet differentiable; examples include solution mappings for nonsmooth partial differential equations or variational inequalities. In this setting, standard derivative-based regularization methods such as Landweber or Levenberg--Marquardt iteration are inapplicable. We show that using elements of the Bouligand subdifferential for the linearization still leads to a convergent regularization scheme.

11:30-12:00

Conical Regularization for Multi-objective Optimal Control Problems

Miguel Sama — Universidad Nacional de Educación a Distancia

Abstract: By conical regularization of an abstract constrained optimization problem, we understand those methods which construct a family of approximate problems by replacing the constraint cone by an approximating family of cones. We present new results on the conical regularization for the multiobjective case with linear infinite-dimensional constraints. To be specific, we perform a detailed stability analysis of the set-valued map such as each regularization assigns the Pareto efficient map of the corresponding regularized problem.

12:00-12:30

Vector-Valued Control Problems and Necessary Optimality Conditions

Niklas Hebestreit — Martin-Luther-Universität Halle-Wittenberg, Institut für Mathematik

Tammer Christiane — Martin-Luther-Universität Halle-Wittenberg

Abstract: We consider a vector-valued optimal control problem with PDI-constraints and apply a nonlinear scalarization technique for deriving characterizations of solutions to this vector-valued optimal control problem that are useful for corresponding algorithms.

12:30-13:00

Stable Identification by Regularizing Saddle Point Problems

Akhtar A. Khan — Rochester Institute of Technology Rochester, New York

Abstract: This talk will investigate the inverse problem of identifying material parameters in general saddle point problems. Using an optimization framework, we will devise a stable approximation scheme by regularizing the saddle point problem. Convergence analysis, optimality conditions, numerical results, and applications will be presented.

MS A1-2-3 5 — 11:00-13:00

Cryptography, from industry applications to the post-quantum era - Part 2

For Part 1 see: MS A1-2-3 4

Organizer: Irene Márquez Corbella — Universidad de La Laguna

Organizer: Javier Fernandez De Bobadilla — BCAM

Abstract: Cryptography is one of the key ingredients in any successful secure communication in the digital world: consider e-commerce, e-government and increasingly embedded applications ranging from handheld devices to medical implants. This is the second part on a coordinated mini-symposium in cryptography. While in the first part we focused on post-quantum cryptography systems, in this part we will concentrate on industry applications of cryptography,. We will pay a special attention to homomorphic encryption because of the power of its applications.

11:00-11:30

Homomorphic Encryption: the Past, the Present, and the Future

NICOLAS GAMA — Inpher

Abstract: In this talk, we recall the state of the science and the current trends in the domain of homomorphic encryption. We give a brief overview of the theory behind homomorphic encryption, the security assumptions with respect to privacy preserving techniques, and the current efficient schemes that achieve fully homomorphic encryption. Finally, we discuss the current capabilities and the current challenges in order to tackle real world applications.

11:30-12:00

Applications of error-correcting codes in secure computation.

Ignacio Cascudo — Department of Mathematical Sciences, Aalborg University

Abstract: The theory of error correcting codes has found several applications in cryptography throughout the years. Coding theory is in particular useful in the area of secure computation, that deals with how a number of mutually distrustful parties can collaborate in doing computations on private data. I will discuss some problems in secure computation that motivate the study of certain algebraic properties of error-correcting codes, captured by the notion of square of a code.

12:00-12:30

Entanglement-Assisted Quantum AG Codes

Francisco Fernandes — Eindhoven University of Technology

Ruud Pellikaan — Eindhoven University of Technology

Abstract: Quantum error correcting codes play the role of suppressing noise and decoherence in quantum systems by introducing redundancy. Some strategies can be used to improve the parameters of these codes, such as the use of entanglement. Such codes are called entanglement-assisted quantum (QUENTA) codes. In this talk, I will show how to use algebraic geometry (AG) codes to construct new families of QUENTA codes with interesting properties.

12:30-13:00

On varieties and codes defined by quadratic equations

Irene Márquez Corbella — Universidad de La Laguna

Ruud Pellikaan — Eindhoven University of Technology

Abstract: We will work with AG codes CL(X,P, E) that have a unique representation (X,P,E), where X is an algebraic curve, P is an n-tuple of mutually distinct points and E is a divisor. As a consequence AG codes with certain parameters are not secure for the code based McEliece crypto system. One of the key ingredients of these results is the classical fact that certain curves embedded in projective space are defined by quadratic equations.

MS A3-S-C1 5 — 11:00-13:00

Tensor Methods - Part 2

For Part 1 see: MS A3-S-C1 4
For Part 3 see: MS A3-S-C1 6
For Part 4 see: MS A3-S-C1 7
For Part 5 see: MS A3-S-C1 8
For Part 6 see: MS A3-S-C1 9

Organizer: Lieven De Lathauwer — KULeuven

Organizer: Konstantin Usevich — CRAN - CNRS - Université de Lorraine

Organizer: André Uschmajew — MPI MiS

Abstract: A significant research effort is currently dedicated to the extension of linear to multilinear algebra. This work involves a rethinking of both theoretical concepts and numerical computation. The developments gradually allow a transition from classical vector and matrix based methods in applied mathematics and mathematical engineering to methods that involve tensors of arbitrary order. Tensor decompositions open up various new avenues beyond the realm of matrix methods. Important applications include efficient computation in high dimensions, the unique recovery of latent variables in data analysis, and large-scale system identification and machine learning.

11:00-11:30

Tensor Numerical Methods for PDE Based Applications

Boris Khoromskij — Max-Planck-Institute for Mathematics in the Sciences

Abstract: Tensor numerical methods for PDE related applications are based on the canonical, Tucker, tensor train (TT) and quantized-TT (QTT) rank-structured data formats. The novel range-separated (RS) tensor format allows to extend tensor approximation techniques to various applications including highly non-regular and unstructured data. I focus on the RS tensor calculation of electrostatics in large bio-molecules described by the Poisson-Boltzmann equation. The second example considers solving the optimal control problems constrained by fractional Laplacain.

11:30-12:00

Equivalent polyadic decompositions of matrix multiplication tensors

Pierre-Antoine Absil — UCLouvain

Berger Guillaume — UCLouvain

De Lathauwer Lieven — KU Leuven

Raphaël Jungers — UCLouvain

Marc Van Barel — KU Leuven

Abstract: As matrix multiplication is a bilinear map, it can be represented by a third-order tensor. Finding fast matrix multiplication schemes can be approached by decomposing the associated tensor as a sum of rank-1 terms (polyadic decomposition). We present an algorithm to efficiently decide whether two such polyadic decompositions are related by an invariance transformation. This analysis relates to the question of how many essentially different fast matrix multiplication algorithms there exist.

12:00-12:30

Symmetry of the Eigenvalues of a Uniform Hypergraph

Shenglong Hu — Hangzhou Dianzi University

Abstract: In this talk, the index of imprimitivity of an irreducible nonnegative matrix in the famous Perron-Frobenius theorem is studied within a more general framework, both in a more general tensor setting and in a more natural spectral symmetry perspective. The spectral symmetry of an irreducible nonnegative Sylvester matrix is completely resolved via characterizations with the indices of its positive entries. A generalization of the bipartition-spectral symmetry theory for graphs is given for 3-graphs.

12:30-13:00

Dealing with Degeneracy in CPD and Efficient method for Decomposition of Convolutional tensors

Anh-Huy Phan — Skolkovo Institute of Science and Technology

Petr Tichavsky — The Czech Academy of Sciences, Institute of Information Theory and Automation

Andrzej Cichocki — Skolkovo Institute of Science and Technology (Skoltech), Russia

Abstract: The Canonical Polyadic decomposition (CPD) is a convenient and intuitive tool for tensor factorization. In CPD, degeneracy often occurs and makes algorithms getting stuck in local minima. Our method is to correct rank-1 tensors so that their norms are minimal. Continuing the decomposition with a new tensor will prevent the CP algorithms from degeneracy and thereby improve their convergence. We illustrate the method for decomposition of tensors in the convolutional layers in deep neural networks.

MS FT-1-10 5 **11:00-13:00**

Recent development of verification methods for numerical linear algebra - Part 1

For Part 2 see: MS FT-1-10 6

Organizer: Takeshi Ogita — Tokyo Woman's Christian University

Organizer: Siegfried Rump — Hamburg University of Technology

Abstract: This minisymposium is devoted to verified numerical computations, in particular, verification methods for numerical linear algebra. Since verified numerical computations enable us to rigorously solve problems in numerical linear algebra, such as linear systems, eigenvalue problems, singular value problems, and so forth, by numerical methods in floating-point arithmetic, they have become increasingly important in a wide range of science and engineering. The main objective of the minisymposium is to discuss several recent topics on verification methods for numerical linear algebra and related numerical methods.

11:00-11:30

Verified inclusion of a matrix of specified rank deficiency

Siegfried Rump — Hamburg University of Technology

Abstract: The proof that a matrix is rank-deficient is an NP-hard problem and therefore outside the scope of verification methods. Given a matrix and integer k, we present algorithms to compute error bounds for a nearby matrix which is proved to have a rank-deficiency of at least k.

11:30-12:00

Reproducible and Accurate Parallel Triangular Solver

Chemseddine Chohra — University 8 Mai 1945 Guelma, Algeria

Philippe Langlois — University of Perpignan Via Domitia, DALI, LIRMM

David Parello — University of Perpignan Via Domitia, DALI, LIRMM

Abstract: Non-reproducibility occurs mainly due to the non-associativity of floating-point addition. We focus here on reproducibility of parallel triangular solver. Two parallel algorithms that provide reproducible solution are presented. The first algorithm minimizes the residual, and our experiments show a ~5X extra cost for reproducibility compared to Intel MKL implementation. The second algorithm provides a solution that is as accurate as XBLAS' one, it shows ~8X extra cost on CPU, and ~3X on Xeon Phi accelerator.

12:00-12:30

Optimal Signed Relative Error for Floating-Point Arithmetic

Katsuhisa Ozaki — Shibaura Institute of Technology

Abstract: Floating-point number and its arithmetic are widely used in numerical computations. Because information of the floating-point numbers is finite, a rounding error may occur in floating-point arithmetic. The optimal relative error bound for floating-point arithmetic is given by Jeannerod and Rump. In this paper, we extend the discussion to signed relative error and derive the optimal range of the signed relative error.

MS FT-2-2 5 **11:00-13:00**

Orthogonal polynomials and quadrature: Theory, computation, and applications - Part 1

For Part 2 see: MS FT-2-2 6

For Part 3 see: MS FT-2-2 7

Organizer: Miroslav Pranic — University of Banja Luka

Organizer: Lothar Reichel — Kent State University

Abstract: Quadrature rules find many applications in science and engineering. Their analysis is a classical area of applied mathematics and continues to attract considerable attention. This seminar brings together speakers with expertise in a large variety of quadrature rules. It is the aim of the seminar to provide an overview of recent developments in the analysis of quadrature rules. The computation of error estimates and novel applications also are described.

11:00-11:30

Anti-Gauss-Type Quadrature Rules

Lothar Reichel — Kent State University

Hessah Alqahtani — King Abdulaziz University

Caterina Fenu — University of Cagliari

David Martin — Progressive

Miroslav Pranic' — University of Banja Luka

Giuseppe Rodriguez — University of Cagliari

Abstract: Pairs of Gauss and anti-Gauss quadrature rules can be used to estimate the error in Gauss rules. Anti-Gauss rules were proposed by Laurie for nonnegative real measures on the real line. This talk reviews generalizations and simplifications of these rules, as well as extensions to matrix-valued measures. Also anti-Gauss-type quadrature rules associated with multiple orthogonal polynomials are described. Applications to network analysis will be discussed.

11:30-12:00

Corrected Fejer quadrature formulae

Sotirios Notaris — National and Kapodistrian University of Athens

Abstract: We consider an interpolatory quadrature formula having as nodes the zeros of the nth degree Chebyshev polynomial of the second kind and two additional points. We study the positivity of weights and explicit formulae for them, the precise degree of exactness, error bounds by Peano kernel methods or for analytic functions, and the convergence for Riemann integrable functions or with monotonic singularities of the new formula, which is an alternative to the well-known Clenshaw-Curtis formula.

12:00-12:30

On cubature formulae and their application to the Filter algorithm

Ramon Orive — Universidad de La Laguna

Daniel Acosta — Universidad de La Laguna

Leopoldo Acosta — Universidad de La Laguna

Juan Carlos Santos-León — Universidad de La Laguna

Abstract: In this talk we discuss the so--called Cubature Kalman Filter, introduced in 2009 as a new nonlinear filter for high--dimensional state estimation, based on some spherical--radial cubature rule. In this sense, we place that cubature rule within the framework of general cubature rules for the Gaussian weight, providing also several alternative rules with higher degree of precision. Some numerical experiments related with practical applications to a car--like robot and a ``quadcopter'' are displayed.

MS A3-3-1 5 **11:00-13:00**

Theory and Practice of meshless Fluid-Simulations - Part 3

For Part 1 see: MS A3-3-1 3

For Part 2 see: MS A3-3-1 4

Organizer: Christian Rieger — RWTH Aachen

Organizer: Matthias Kirchhart — MathCCES, RWTH Aachen University

Abstract: The aim of this minisyposium is to bring together researchers in both theoretical and applied aspects of meshless methods. We would especially like to focus on meshless simulations in fluid dynamical applications. This topic includes vortex methods, divergence free radial basis functions and SPH. From a theoretical perspective we would like to focus on the error analysis of such methods and on the analysis of new efficient methods. This includes localizing Lagrange functions, multilevel techniques, PUM and reduced basis methods. A common focus is on boundary effects of meshless methods which is a current challenge in many modern meshless methods.

11:00-11:30

Discontinuous kernel-based ROMs for modeling heat transfer

Emma Perracchione	Università degli Studi di Padova

Abstract: This talk focuses on the scattered data approximation problem of multivariate functions. Such topic naturally entails a large number of intimately related computational and theoretical issues, such as (partially) overcome the curse of dimensionality. To such aim, we study the Proper Orthogonal Decomposition (POD) combined via RBF interpolation in a varying scale setting which possibly leads to discontinuous bases. As application, we give an example about the estimation of the thermal resistance coefficients in buildings.

11:30-12:00

SPH: Kernels and Convergence

Franz Tino	University of Bayreuth
Holger Wendland	University of Bayreuth

Abstract: Smoothed particle hydrodynamics (SPH) is a popular particle- and kernel-based method for numerically computing solutions to fluid-flow problems. Assuming new conditions on the kernel function, we show convergence of SPH for the Euler equations of a specific barotropic fluid. We distinguish carefully between the smoothing and the discretisation parameter and give explicit relations between both of them to guarantee convergence. Moreover, we construct compactly supported, radial kernels which possess the required properties.

12:00-12:30

Error Bounds for a Least Squares Meshless Finite Difference Method on Closed Manifolds

Oleg Davydov	University of Giessen

Abstract: Meshless finite difference methods discretize a differential equation on a finite set with the help of local numerical differentiation formulas, and seek a discrete solution obtained by solving a sparse linear system of equations, such that . The presentation will be devoted to the convergence analysis of a least squares version of this method, giving for the first time sufficient conditions that guarantee convergence as in meshless setting.

12:30-13:00

A high-order meshfree Galerkin method for semi linear parabolic equations on spheres

Joseph Ward	Texas A & M University

Abstract: This talk will describe a novel meshless Galerkin method for numerically solving semilinear parabolic equations on spheres. We will establish convergence of this meshless method by adapting, to the sphere, a convergence result due to Thomee and Wahlbin. The new approximation method is based upon a discretization in space using spherical basis functions which can be of arbirary order and no construction of an underlying mesh is required.

MS A3-2-3 5 11:00-13:00

Kinetic modelling and multiscale simulation of nonequilibrium flow dynamics - Part 5

For Part 1 see: MS A3-2-3 1
For Part 2 see: MS A3-2-3 2
For Part 3 see: MS A3-2-3 3
For Part 4 see: MS A3-2-3 4
For Part 6 see: MS A3-2-3 6

Organizer: Lei Wu	UK/University of Strathclyde
Organizer: Kun Xu	Hong Kong University of Science and Technology
Organizer: Song Jiang	Institute of Applied Physics and Comput. Math

Abstract: The Boltzmann equation underpins a board range of applications ranging from high-altitude aerothermodynamics of space vehicles, gas dynamics in micro-electro-mechanical systems, and shale gas extractions. It has also been extended to different fields, such as granular gases, radiative transfer, phonon/electron transport, plasmas, and quantum/relativistic dynamics. However, the high-dimensional integro-differential equations pose great challenges to the numerical simulation of kinetic equations and their applications. The goal of this minisymposium is to explore recent trends and developments in the kinetic theory (simplification of Boltzmann equations, reactions) and multiscale numerical simulation of non-equilibrium dynamics from the continuum to free-molecular flow regimes.

11:00-11:30

Regularized 13-moment equations for inverse-power-law models

Yanli Wang	Peking University
Zhenning Cai	National University of Singapore

Abstract: We derive the regularized 13-moment equations based on Boltzmann equation with linearized collision operators for inverse-power-law models. First, we write down Grad's moment equations to 20th order, and examine magnitude of every moment. By asymptotic analysis, we express all terms with first 13 moments and their derivatives. The resulting model involves all information of the Chapman-Enskog expansion up to third order. Numerical verification shows the model has better accuracy than Navier-Stokes and Grad's 13-moment equations.

11:30-12:00

A collocated finite volume algorithm for rarefied gas flows at all speeds with moment method

Xiaojun Gu	STFC Daresbury Laboratory
David Emerson	Scientific Computing Department, STFC Daresbury Laboratory, Warrington, WA4 4AD, UK

Abstract: A finite volume algorithm is presented for solving the regularized moment equations, which describe the rarefied gas flows in the early transition regime. The equations are solved in the curvilinear coordinate system in a collocated structured grid. A pressure based method is used to couple the velocity, pressure and density fields. The algorithm is applied to subsonic and supersonic flows.

12:00-12:30

Lattice Boltzmann approach to flows in curved geometries using the vielbein formalism

Sergiu Busuioc	University of Edinburgh
Victor E. Ambrus	West University of Timisoara

Abstract: We present the Boltzmann equation with respect to orthonormal vielbein fields. This formalism allows the use of arbitrary coordinate systems to describe the space geometry and an adapted coordinate system in the momentum space, which is linked to the physical space through the use of vielbeins. Aligning the momentum space according to the boundary geometry allows kinetic boundary conditions to be implemented exactly using half range quadratures. The capabilities are illustrated by considering various applications.

12:30-13:00

Kinetic modeling of gas mixtures in MEMS applications

Silvia Lorenzani	Politecnico di Milano

Abstract: Over the last decades, Micro-Electro-Mechanical Systems (MEMS) devices have gained a growing diffusion in several industrial fields. Microdevices are often operated in gaseous environments and thus their performances are affected by the gas around them. In particular, the evaluation of damping forces exerted by gaseous mixtures assumes a basic relevance in all MEMS fabrication processes. Therefore, in the present work, the flow of binary gaseous mixtures in microchannels is investigated using the linearized Boltzmann equation.

MS FT-2-3 5 11:00-13:00

Recent Advances in Methods and Software for Ordinary Differential Equations - Part 1

For Part 2 see: MS FT-2-3 6

Organizer: Paul Muir	Saint Mary's University
Organizer: Raymond Spiteri	University of Saskatchewan
Organizer: Philip Sharp	University of Auckland
Organizer: Wayne Enright	University of Toronto

Abstract: The accurate, reliable, and efficient numerical solution of systems of ordinary differential equations (ODEs) and related systems involving differential-algebraic equations or delay equations has been a central task within scientific computing for many decades. In addition to arising explicitly in many application domains, the numerical solution of ODEs also arises as the central task within software for solving systems of partial differential equations (PDEs). This mini-symposium features researchers who will discuss a wide range of state-of-the-art numerical methods and software for ODEs and for PDEs that rely upon the numerical solution of ODEs. [Sponsored by IFIP Working Group 2.5, https://wg25.taa.univie.ac.at/.]

11:00-11:30

Can a method for stiff IVPs be as reliable as one for non-stiff IVPs

Wayne Enright University of Toronto

Abstract: In practice a system of interest is often simulated by a model that involves a system of ODEs. The ODEs can be IVPs, BVPs, ADEs or DDEs. Approximating these models requires that the ODE be accurately approximated at any point x. We have introduced a class of methods that can be effective for problems, when the underlying ODE is non-stiff. We will consider whether a similar claim can ever be made when it is stiff.

11:30-12:00

Optimizing an N-body integrator

Philip Sharp University of Auckland

Abstract: N-body models provide considerable insight about the dynamics of the Solar System. The larger N-body models have hundreds of thousands of bodies and are integrated over many millions of years. If these integrations are to be completed in a reasonable elapse time, the integrator must be efficient. I will present recent work on optimizing the performance of a high order non-symplectic integrator intended for accurate integrations of N-body models.

12:00-12:30

Efficient IMEX time stepping methods for ODEs and DAEs

Inmaculada Higueras Universidad Pública de Navarra

Abstract: Space discretization of some PDEs gives rise to systems of ODEs/DAEs whose terms have different stiffness properties. Strong Stability Preserving (SSP) Runge-Kutta and Implicit-Explicit methods preserve qualitative properties (e.g., monotonicity, positivity, etc.) under some given time step size restrictions. However, in applications, some other relevant properties must be incorporated to the numerical solution. In this talk we will show how the efficiency of SSP schemes can be increased. Some numerical examples will be given.

12:30-13:00

Some results on regularized discontinuous ODEs and numerical approaches

Nicola Guglielmi Gran Sasso Science Institute

Abstract: ODEs with discontinuous right-hand side, where the discontinuity of the vector field arises on smooth surfaces of the phase space, are considered together with a regularization. We study the solutions close either to a single discontinuity surface or to the intersection of two discontinuity surfaces. Numerical aspects will be also discussed both for a direct integration and the integration of the regularized system.

MS A3-3-3 5 11:00-13:00

Genomics to Populations: Mathematical Views of Modelling Biological Scales - Part 1

For Part 2 see: MS A3-3-3 6

Organizer: Candice Price University of San Diego
Organizer: Amy Buchmann University of San Diego
Organizer: Candice Price University of San Diego
Organizer: Ami Radunskaya Pomona College

Abstract: In this session, we highlight interdisciplinary efforts of scientists whose work integrates biological processes and mathematical tools across scales. The aims of the work showcased in this symposium are to develop and use efficient algorithms, data structures, visualization, and communication tools with the goal of computer modeling of biological systems. Often researchers focus on modeling or simulating with a particular biological scale in mind while neglecting the dynamical connections across scales. This mini-symposia features topics from the cellular to the population scale.

11:00-11:30

DNA Topology: Viewing Biological Mysteries Through the Lens of Mathematics

Candice Price University of San Diego

Abstract: Mathematical modeling is an effective resource for biologists since it provides ways to simplify, study and understand the complex systems common in biology and biochemistry. Many mathematical tools can be applied to biological problems, some traditional and some more novel, all innovative. This presentation will review the mathematical tools that I use to model and study the biological issues of DNA-protein interactions.

11:30-12:00

What's next in biomathematics? Dynamics on biological networks.

Ami Radunskaya Pomona College
Johanna Hardin Pomona College
Christina Duron Claremont Graduate University

Abstract: In trying to understand the evolution of a disease at the cellular level, we often lack time-series data. How can we reconstruct the dynamics of the disease from a small number of time points, typically with small sample of high-dimensional data? In this talk I will describe an approach to this problem that uses network complexity metrics and transcription data, identifying key players in the development of the disease.

12:00-12:30

Mixing and pumping at the microscale: Lessons from bacteria

Amy Buchmann University of San Diego

Abstract: Mixing and pumping in microfluidics devices is difficult because the traditional methods of mixing and pumping at large length scales don't work at small length scales. Experimental work has suggested that rotating helical flagella may be used to effectively mix and pump fluid in microfluidics devices. To further explore this idea and to characterize the flow features around rotating helices, we study the hydrodynamic interactions between two rigid helices rotating at a constant velocity.

12:30-13:00

How host variation affects the evolution of pathogen virulence

Arietta Fleming-Davies University of San Diego

Abstract: While population-level models of infectious disease often assume that all hosts are the same, in nature, both hosts and pathogens exhibit tremendous variation. We asked how variation in hosts affects the evolution of virulence, the harm that pathogens cause their hosts. We used a combination of ordinary differential equation models and empirical data from two different biological study systems to investigate different sources of host variation and their effects on virulence evolution.

MS FT-0-3 5 11:00-13:00

Numerical Approximations of Geometric Partial Differential Equations - Part 3

For Part 1 see: MS FT-0-3 3
For Part 2 see: MS FT-0-3 4
For Part 4 see: MS FT-0-3 6
For Part 5 see: MS FT-0-3 8

Organizer: Alan Demlow Texas A&M University
Organizer: Andrea Bonito Texas A&M University
Organizer: Ricardo Nochetto University of Maryland

Abstract: Geometric partial differential equations have received much attention recently due to their appearance in models for a wide range of physical processes. This mini-symposium focuses on their numerical approximation, which must overcome highly nonlinear interactions inherent to the approximation of partial differential equations defined on approximate geometries. Experts in modeling, numerical analysis, and scientific computation will discuss recent advances ranging from fundamental considerations concerning the design and analysis of numerical methods to applications in biology, materials science, and fluid dynamics.

11:00-11:30

Narrow-stencil discontinuous Galerkin methods for fully nonlinear second order PDEs in high dimensions

Xiaobing Feng The University of Tennesee
Thomas Lewis The University of North Carolina at Greensboro,

Abstract: This talk will present a newly developed narrow-stencil DG framework for approximating viscosity solutions of fully nonlinear second order PDEs. The focus of the talk will be on discussing how to compensate the loss of monotonicity of the schemes to ensure convergence and to explain some key new concepts such as generalized monotonicity, consistency and numerical moment in the DG setting. Numerical experiments will be presented to show the efficiency of the proposed DG methods.

11:30-12:00

Numerical Methods with Convergence Rates for the Monge-Ampere Equation

Ricardo Nochetto	Department of Mathematics
Wujun Zhang	Rutgers University
Dimitris Ntogkas	Wells Fargo
Wenbo Li	University of Maryland

Abstract: We analyze the Oliker-Prussner method and a two-scale method for the Monge-Ampere equation with Dirichlet boundary condition, and explore connections with a Bellman formulation. We also study a two-scale method for a fully nonlinear obstacle problem associated with convex envelopes. We derive pointwise error estimates that rely on the discrete Alexandroff maximum principle and the geometric structure of these PDEs for both classical and non-classical solutions.

12:00-12:30

Rates of convergence in W_p^2-norm for the Monge-Ampère equation

Michael Neilan	University of Pittsburgh

Abstract: We develop discrete W^2_p-norm error estimates for the Oliker-Prussner method applied to the Monge-Ampere equation. This is obtained by extending Alexandroff estimates and showing that the contact set of a function contains information on its second order differences. We also show that the size of the complement of the contact set is controlled by the method's consistency. Combined with pointwise estimates, we derive W^1_p estimates as well. This is joint work with Wujun Zhang (Rutgers)

12:30-13:00

Semi-Lagrangian methods for Monge-Ampère equations

Max Jensen	Sussex University
Xiaobing Feng	University of Tennessee

Abstract: We present semi-Lagrangian methods to discretize the simple Monge-Ampère equation and also the optimal transport problem, using a Bellman reformulation. Establishing ellipticity on the whole function space by incorporating convexity constraints into the PDE, we can show uniform convergence to viscosity solutions even in the degenerate setting. Moreover, through global convergence of semi-smooth Newton methods a highly efficient solver for very fine meshes is available.

MS A1-1-3 5 — 11:00-13:00

Computationally efficient methods for large-scale inverse problems in imaging applications

Organizer: Jiahua Jiang	1990
Organizer: Julianne Chung	Virginia Tech

Abstract: In recent years, there have been tremendous advances in both theory and computational methods for solving large inverse problems, such as those that arise in image processing applications. The main challenges include ill-conditioning of the problem, increasing model complexity, and ever-increasing data sizes. There is a great need for fast algorithms and new technologies to tackle these challenges. The aim of this mini-symposium is to highlight state-of-the-art techniques that can address these and other forthcoming challenges.

11:00-11:30

A deep learning approach for aquifer prospectivity mapping

Luz Angelica Caudillo Mata Mata	University Of British Columbia
Eldad Haber	University of British Columbia
Justin Granek	Computational Geosciences, Inc
Jenn Fohring	Computational Geosciences, Inc
Bass Peters	University of British Columbia

Abstract: Aquifer exploration requires the effective integration of diverse and large-scale geoscience datasets (e.g., geophysical, hydrological, geological, geochemical) in order to locate, delineate, and/or characterize water resources. We propose a deep learning approach to demonstrate how this technology can enrich the prospectivity mapping process. The backbone of our approach is a VNet, a deep convolutional neural network that we designed to learn multi-scale features. We exemplify our approach using data from the Northern Territory in Australia.

11:30-12:00

Image denoising with fractional operators

Akil Narayan	University of Utah

Abstract: Fractional differential operators have shown great potential in recent years for successful modeling of nonlocal phyiscal phenomena. More recently, fractional operators have been used to in an image denoising optimization framework. However, numerical algorithms involving fractional operators are typically very expensive precisely because of the nonlocal behavior. We present somre recent work in acceleration of numerical schemes for fractional operators, and discuss their applications to image denoising.

12:00-12:30

An imaging problem from microscopy using sparsity constraints

Fabian Hinterer	Johannes Kepler University Linz

Abstract: We consider a localization problem in microscopy, where we are given a sequence of images of a cell that are obtained by using a super-resolution imaging technique called STORM. Proteins on the surface of this cell are selectively illuminated and the goal is to reconstruct the position of these proteins with subpixel accuracy from the noisy images. We discuss an approach involving Tikhonov functionals with sparsity constraints.

12:30-13:00

A physically oriented method for quantitative magnetic resonance imaging

Michael Hintermueller	Weierstrass Institute Berlin
Guozhi Dong	HU Berlin
Kostas Papafitsoros	WIAS

Abstract: Magnetic Resonance Fingerprinting is put into the context of optimization and inverse problems. As the associated Bloch manifold is non-convex, and the accuracy of MRF algorithms is limited by the discretization size of the dictionary, a physically-oriented method for qMRI is proposed. Differently to conventional two-step models, our model is dictionary-free and described by a single nonlinear equation. This non-linear equation is efficiently solved via robust Newton type methods. Numerical tests end the talk.

MS A6-4-3 5 — 11:00-13:00

Recent advances in interest rate modeling - Part 1

For Part 2 see: MS A6-4-3 6

Organizer: Claudio Fontana	University of Padova
Organizer: Zorana Grbac	University Paris Diderot

MS Organized by: SIAG/FME

Abstract: In recent years, the modeling of interest rates has been revitalized by a number of important developments, motivated by the specific features of post-crisis markets. In particular, such features include the persistence of low/negative interest rates, the emergence of multiple yield curves, the relevance of liquidity and refinancing risk, as well as the adoption of new reference rates. From a mathematical standpoint, new techniques are being developed in order to deal with these modeling challenges. In this mini-symposium, we present the latest advances in interest rate theory and discuss ongoing directions of research. This minisymposium is sponsored by SIAG/FME

11:00-11:30

A consistent stochastic model of the term structure of interest rates for multiple tenors

Martino Grasselli	University of Padova and Devinci Research Center
Erik Schlogl	UTS Sydney
Mesias Alfeus	UTS Sydney

Abstract: We construct a stochastic model in which a frequency basis (i.e. a spread applied to one leg of a swap to exchange one floating interest rate for another of a different tenor) arises endogenously. This roll-over risk consists of two components, a credit risk component, and a component reflecting the (systemic) possibility of being unable to roll over short-term borrowing at the reference rate due to an absence of liquidity in the market.

11:30-12:00

Multiple curve Lévy forward price model allowing for negative interest rates

Zorana Grbac	University Paris Diderot
Ernst Eberlein	University of Freiburg
Christoph Gerhart	University of Freiburg

Abstract: In this work we develop a framework for discretely compounding interest rates which is based on the forward price process approach and driven by time-inhomogeneous Lévy processes. The forward price approach has a number of advantages, in particular in the current market environment with multiple yield curves and persistently low/negative interest rates, that can be accommodated in a natural way.

It also possesses superb calibration properties, which we illustrate by calibration to market cap data.

12:00-12:30

Term structure modeling for multiple curves with stochastic discontinuities

Claudio Fontana	University of Padova
Zorana Grbac	Paris Diderot University
Sandrine Gümbel	University of Freiburg
Thorsten Schmidt	University of Freiburg

Abstract: Stochastic discontinuities are a key feature in interest rate markets, as for example jumps in correspondence to monetary policy meetings of the ECB show. We provide a general analysis based on NAFLVR for multiple curve markets under minimal assumptions in an extended HJM framework. This approach permits to embed market models directly, thus unifying seemingly different modeling philosophies. We also develop a new class of models based on affine semimartingales beyond stochastic continuity.

12:30-13:00

Impact of multiple curve dynamics in credit valuation adjustments under collateralization

Andrea Pallavicini	Banca IMI
Giacomo Bormetti	University of Bologna
Damiano Brigo	Imperial College London
Marco Francischello	Imperial College London

Abstract: We present a detailed analysis of interest rate derivatives valuation under credit risk and collateral modeling. We formulate a consistent realistic dynamics for the different rates emerging from our analysis and compare the resulting model performances to simpler models used in the industry. We point out limitations of multiple curve models with deterministic basis considering valuation of particularly sensitive products such as basis swaps.

MS A1-2-1 5 — 11:00-13:00

Networks, walks and matrix functions: new trends, results, potential issues - Part 1

For Part 2 see: MS A1-2-1 6

Organizer: Francesca Arrigo — University of Strathclyde

Abstract: Complex networks are a reliable and versatile tool used to describe various types of interactions. Their most popular linear algebraic representation, namely, their (rescaled) adjacency matrix, translates them into more easily tractable objects. Appropriately chosen functions of such matrices are a well-established tool to define sensible centrality and communicability measures. The talks in this minisymposium sample recent advances and contributions from (numerical) linear algebra and network theory, discussing, among the others, issues related to walk-based measures, sensitivity of these, edge centralities and the exploitation of alternative network representations.

11:00-11:30

Ranking edges in weighted digraphs using line graphs and the matrix exponential with application

Mona Matar	Kent State University
Reichel Lothar	Kent State University
De La Cruz Cabrera Omar	Kent State University

Abstract: This presentation is concerned with the identification of important edges in a network, in both their roles as transmitters and receivers of information. We propose a method based on computing the matrix exponential of a matrix associated with a line graph of the given network. Both undirected and directed networks are considered. Edges may be given positive weights. Computed examples illustrate the performance of the proposed method.

11:30-12:00

Stability of network indexes defined by means of matrix functions

Stefano Pozza	Charles University
Francesco Tudisco	Strathclyde University

Abstract: Given a network G with adjacency matrix A, the kth diagonal entry of a matrix function f(A) can be used to measure the centrality of the node k. We estimate the changes in f(A) with respect to edge perturbations in G. We propose several bounds showing that the variation of the (k,k) element in f(A) decays exponentially with the distance in G that separates k from the set of nodes touched by the perturbed edges.

12:00-12:30

Applications of Centrality Measures to Simplicial Complexes

Grant Ross — University of Strathclyde

Abstract: This presentation will describe the advantages of treating Networks as Simplicial Complexes. By considering interactions between the edges and triangles of these Simplicial Complexes it is possible to gain further insight into the mechanics of a Complex System. These methods will then be demonstrated by applications to Random Geometric Graphs.

12:30-13:00

Centrality collisions, walk classes, and spider donuts

Kyle Kloster — North Carolina State University

Abstract: When one node surpasses another in centrality rankings as the underlying parameter varies, the nodes' scores must cross at some parameter. Between such "collisions" the rankings remain stable, so the number of possible node-orderings for a centrality measure depends on the number of collisions. Analyzing the walk-classes of a graph reveals how often nodes can collide, ranking behavior at the parameter's limits, and which nodes behave identically for a host of popular centralities.

MS FT-2-6 5 — 11:00-13:00

Fast iterative methods for large-scale inverse problems in imaging - Part 1

For Part 2 see: MS FT-2-6 6

Organizer: James Herring — University of Houston

Organizer: Andreas Mang — University of Houston, Dept. of Mathematics

MS Organized by: SIAG/CSE

Abstract: We discuss recent advances in the design and analysis of iterative methods for solving large-scale inverse problems with applications in imaging sciences. These types of problems are inherently ill-posed, have a large number of unknowns, and are typically plagued with data and model uncertainties. This makes solving them efficiently a challenge. We will discuss recent advances in applied and computational mathematics to address these challenges.

11:00-11:30

Multigrid solvers for problems in medical imaging

Jan Modersitzki — MIC, University of Luebeck

Abstract: An introduction to image registration is presented. Image registration is phrased as an optimization process. Here we discuss a multi-level solution approach, which is both, a regularization strategy and an acceleration. Starting with a coarse representation, numerical solutions are determined which then serves as a starting guess on finer representations until a desired accuracy is reached. The working horse is a quasi-Newton type optimizer with a multigrid solver for the underlying linear systems.

11:30-12:00

Fast diffeomorphic image registration in 3D

Andreas Mang	University of Houston, Dept. of Mathematics
George Biros	University of Texas at Austin
Malte Brunn	University of Stuttgart
Naveen Himthani	University of Texas at Austin
Felix Huber	University of Stuttgart
Miriam Mehl	University of Stuttgart

Abstract: We present a fast implementation of a solver for diffeomorphic image registration problems termed CLAIRE. We consider an optimal control formulation. Our contributions are new algorithms and dedicated computational kernels to significantly reduce the runtime. We study the performance of our solver and compare it to the state-of-the-art. As a highlight, we demonstrate that we can solve problems for clinically relevant data sizes with high accuracy in less than 10 seconds using moderate compute resources.

12:00-12:30

An iterative regularization method for dynamic inverse problems

Bernadette Hahn	University of Wuerzburg
Stephanie Blanke	University of Würzburg
Anne Wald	Saarland University

Abstract: For most tomographic imaging modalities, deformations of the investigated specimen cause inconsistent measurements. Consequently, suitable models and algorithms have to be developed in order to provide artefact free images. In this talk, we present an iterative strategy to solve such dynamic inverse problems which treats the dynamic behavior as uncertainty in the forward model. The approach is validated for data sets from computerized tomography with different dynamic behavior.

12:30-13:00

Adaptive Regularization Parameter Choice Rules for Large-Scale Problems

Malena Sabate Landman — University of Bath
Silvia Gazzola — Mathematical Sciences, University of Bath (United Kingdom)

Abstract: This talk introduces a new class of adaptive regularization parameter choice strategies that can be efficiently applied when regularizing large-scale linear inverse problems using a combination of projection onto Krylov subspaces and Tikhonov regularization, and that can be regarded as special instances of bilevel optimization methods. The links between Gauss quadrature and Golub-Kahan bidiagonalization are exploited to prove convergence results for some of the considered approaches, and numerical tests are shown to give insight.

MS A3-2-1 5 — 11:00-13:00

Lagrangian and Eulerian methods for compressible multi-material flows - Part 1

For Part 2 see: MS A3-2-1 6
For Part 3 see: MS A3-2-1 7
Organizer: Michael Dumbser — University of Trento
Organizer: Mikhail Shashkov — Los Alamos National Laboratory
Organizer: Raphael Loubère — University of Bordeaux

Abstract: This minisymposium brings together researchers from universities and governmental research laboratories to discuss recent advances in the mathematical modeling and the numerical simulation of complex compressible multi-material hydrodynamics as well as nonlinear, irreversible large deformation solid mechanics. Multi-material problems are relevant in many industrial applications (e.g. fuel injection), in geophysics (debris flow) and nuclear physics (inertial confinement fusion), to mention a few. Topics include Lagrangian hydrodynamics, large-strain nonlinear elasto-plasticity, Arbitrary Lagrangian Eulerian (ALE) methods, Eulerian diffuse interface methods, mesh generation methods and mesh adaptation, interface reconstruction methods, data transfer between meshes and conservative remapping, structure preserving schemes and high-order methods.

11:00-11:30

A framework for non conservative formulation of conservation laws: multifluids and entropy

Remi Abgrall — University of Zurich

Abstract: We are interested in the approximation of hyperbolic problems where an additional conservation relation needs to be dealt with: entropy, kinetic momentum, etc. In some cases, the more natural form of the system is a non conservative version, though the system is conservative. We show, starting from the discretisation of the original PDE, how to construct a scheme that is consistent with the original PDE and the additional conservation relation.

11:30-12:00

Algebraic limiting techniques and their use in partition-of-unity FEM

Dimitri Kuzmin — TU Dortmund University
Manuel Quezada De Luna — KAUST
Christopher Kees — ERDC-CHL

Abstract: In this talk, we present a partition of unity finite element method (PUFEM) in which we use continuous blending functions to combine high-order Lagrange or Bernstein polynomial basis functions with basis functions of a piecewise (multi-)linear submesh approximation. The proposed approach preserves the continuity of traces at common boundaries of adjacent mesh cells. Discrete maximum principles are enforced by using limiter-based hp-adaptation and modifying the element matrices of the submesh Galerkin discretization.

12:00-12:30

A high order residual distribution scheme: applications to compressible multi-material flows

Svetlana Tokareva — Los Alamos National Laboratory
Remi Abgrall — University of Zurich
Nathaniel Morgan — Los Alamos National Laboratory
Konstantin Lipnikov — Los Alamos National Laboratory

Abstract: We present high-order matrix-free Staggered Grid Residual Distribution (SGH RD) scheme for Lagrangian hydrodynamics and discuss stabilization techniques allowing to improve the robustness of the method at high orders and at the same time minimize the dissipation of the numerical solution, in particular MARS artificial viscosity. We shall demonstrate computational results obtained with the proposed SGH RD scheme for several challenging test problems involving strong shocks and vortical flows.

12:30-13:00

High order ADER schemes for compressible multi-phase flows

Michael Dumbser — University of Trento

Abstract: In this talk we discuss high order ADER finite volume and discontinuous Galerkin finite element schemes with a posteriori subcell limiting for compressible multi-phase flow problems. A very simple diffuse interface approach for the description of complex non-hydrostatic free surface flows and for the simulation of linear and nonlinear elasto-plastic solids with complex geometry is presented. We show a large set of numerical results and compare with analytical, numerical or experimental reference solutions.

MS ME-0-6 5 — 11:00-13:00

Stochastic dynamics and applications: non-Gaussian noises - Part 1

For Part 2 see: MS ME-0-6 6
Organizer: Yayun Zheng — Huazhong University of Science and Technology, China
Organizer: Jinqiao Duan — Illinois Institute of Technology
Organizer: Yongge Li — Center for Mathematical Sciences

Abstract: Non-Gaussian noise induced stochastic dynamics and fundamental theories are mainly considered in this minisymposium, which can be found applications in biology, physics and engineering science. For a better understanding the influences of non-Gaussian noises, the topics of stochastic bifurcation, first passage time and splitting probability are presented. Some data-driven problems will be discussed to illustrate the existence and sources of non-Gaussian noises in different systems. Theoretical issues related to averaging principle under alpha-stable process will also be shown. This minisymposium provides an opportunity to bring together researchers with diverse but related background to communicate and cooperate.

11:00-11:30

Existence, uniqueness and averaging principles for non-autonomous slow-fast systems of stochasti

Yong Xu — Department of Applied Mathematics
Ruifang Wang — Department of Applied Mathematics, Northwestern Polytechnical University

Abstract: In this paper, we develop the averaging principle for a slow-fast system of stochastic reaction-diffusion equations. We assume that all coefficients have polynomial growth, and the drift term is non-Lipschitz. The existence and uniqueness of the mild solution is first proved. Then, the existence of time-dependent evolution family of measures associated with the fast equation is studied, and the averaged coefficient is obtained. Finally, the validity of the averaging principle is verified.

11:30-12:00

First exit times of dynamical systems perturbed by heavy-tail noise

Ilya Pavlyukevich — Institut für Mathematik Stochastik

Abstract: We consider dynamical systems perturbed by small heavy-tail Lévy noise and discuss the asymptotics of their first passage times in the small noise limit (Kramers' problem). The dynamical systems under consideration naturally appear in various physical problems and will include perturbed gradient and non-gradient finite-dimensional dynamical systems, partial differential equations and differential equations with delay. We show that the heavy tail dynamics differs strongly from the well known case of Gaussian perturbations.

12:00-12:30

Lévy-noise-induced transport in classical rough potentials

Yongge Li — Center for Mathematical Sciences

Abstract: Rough energy landscape is a remarkable feature in protein folding. We construct rough potentials by superimposing a fast oscillating function on the background potentials. The mean velocity, splitting probability and mean first passage time are calculated. We find that the roughness functions like ladders to help particles to climb up but hinder them to slide down. As a whole effect, roughness is able to enhance the transport and accelerate the transitions under Lévy noise.

12:30-13:00

Strong Convergence Rate in Averaging Principle for Stochastic Partial Differential Equations

Bin Pei — Graduate School of Mathematics

Abstract: This talk considers stochastic averaging for stochastic partial differential equation. We establish an averaging principle in which the fast-varying diffusion process acts as a “noise” and is averaged out in the limit. This averaging principle paves a way for reduction of computational complexity. The implication is that one can ignore the complex original systems and concentrate on the average systems instead.

MS ME-1-6 5 — 11:00-13:00

Control and Estimation Problems in Fluid Mechanics and Related Fields - Part 1

For Part 2 see: MS ME-1-6 6

Organizer: Bartosz Protas — McMaster University

Organizer: Takashi Sakajo — Kyoto University

Abstract: The minisymposium has for its objective to survey recent progress related to both theoretical and practical aspects of control and estimation problems. Given the significance of their applications, the focus will be on fluid-dynamics and other transport models described by differential equations. The minisymposium will offer a unifying perspective on both control and estimation problems which share many important mathematical and computational ingredients. In addition to discussing new developments in the classical areas of feedback control and data assimilation applied to fluid systems, we will also aim to highlights emerging topics such as Bayesian inference and machine learning.

11:00-11:30

Harnessing the Kelvin-Helmholtz Instability: Feedback Stabilization of an Inviscid Vortex Sheet

Bartosz Protas — McMaster University

Takashi Sakajo — Kyoto University

Abstract: We investigate stabilization of inviscid vortex sheets via feedback control. Such models, expressed in terms of the Birkhoff-Rott equation, are often used to describe the Kevin-Helmholtz instability. First, we prove that the equilibrium (straight vortex sheet) can be stabilized provided a sufficient number of point-source actuators is used. Then, we synthesize a linear feedback control strategy which stabilizes the sheet in the linear regime and, for sufficiently small perturbations, also in the nonlinear regime.

11:30-12:00

Computation and demonstration of nonlinear feedback control laws in fluids

Jeff Borggaard — Virginia Tech

Abstract: An approach for computing nonlinear feedback control laws that combines model reduction with approximations to the HJB equations is reviewed. The latter follows an algorithm from the Nonlinear Systems Toolbox that is based on Al'Brekht's method. Numerical tests for flows described by Navier-Stokes equations compare the effectiveness of the nonlinear state feedback to the effectiveness of linear feedback.

12:00-12:30

Linear feedback stabilization of point vortex equilibria near a Kasper Wing

Takashi Sakajo — Kyoto University

Rhodri Nelson — Imperial College London

Bartosz Protas — McMaster University

Abstract: I will present a linear feedback model stabilizing a point vortex entrapped around an aerofoil with multiple wings. Since the entrapped point vortex generates an additional lift acting on the wing, its stabilization gives rise to an efficient wing design. The stabilization model is constructed through the potential flow theory with point vortices on a multiply connected domain, in which the dynamics of the point vortex is stabilized by a blow/suction placed on the wing.

MS A6-2-1 5 — 11:00-13:00

Mathematical and Computational Modeling in Ecology and Epidemiology

Organizer: Lihong Zhao — University of Idaho

Organizer: Rocio Marilyn Caja Rivera — University of Notre Dame

Abstract: This mini-symposium will bring together established and up-and-coming researchers to explore how mathematical and computational models can be applied to address public and veterinary health challenges in ecology and epidemiology. Infectious diseases, including vector borne diseases and influenza, present different and controversial behavior patterns between multiple hosts and pathogen interactions. The presentations will range from theoretical perspective, such as developing mathematical and computational models to better understand the transmission dynamics and spatiotemporal patterns, to more applied aspects, such as fitting models to evaluate the impact of control strategies. Current mathematical and computational modeling challenges will also be discussed.

11:00-11:30

How Do Host’s Competence and The Feeding Preference by Vectors are Related in a Multi-Host Model

Rocio Marilyn Caja Rivera — University of Notre Dame

Abstract: Vector-borne diseases that occur in humans, domestic and wild reservoir hosts cause a significant concern for public health. Different hosts have their own ability to transmit pathogens and to attract vectors.These combined transmission mechanisms are often called "host competencies" and "vector feeding preferences." The results of this research shows the relationship between the host's ability to transmit the pathogen to vectors and the different feeding preferences for a specific host using a multi-host mathematical model.

11:30-12:00

Inverse Problem in Infection Diseases: Malaria

Alfredo Villanueva — University of Saint Francis

Abstract: Malaria is a disease caused by a parasite of the Plasmodium group, with a high mortality and morbidity rate. There has been progress in the treatment of this disease, and currently there are several models describing the evolution of spreading, nevertheless it is still causing hundreds of thousands of deaths per year worldwide. Here we present Malaria as an inverse problem with over-posed data; we work with numerical methods to find the unknown parameters.

12:00-12:30

Resource Mediated Interactions and Species Dynamics in Microbial Communities

Lihong Zhao — University of Idaho

Abstract: Microbial communities are complex and essential in maintaining ecological balance and hosts’ health. The generalized Lotka-Volterra (gLV) model has been widely used to understand species interactions and community assembly, but it has a few limitations. Here, we hypothesize that interactions are indirect and mediated by molecules in the environment (e.g., resources, toxins), rather than direct as assumed in gLV. Our model allow us to track the evolutionary dynamics of the system along with ecological dynamics.

12:30-13:00

Parallel algorithm to solve differential equations and its possible applications to models.

Maria Trinidad Pimentel Villegas — Instituto Tecnológico Superior del Sur the Guanajuato (Higher Technological Institute of Southern Guanajuato)

Miguel Angel Moreles — Researcher Center of Mathematics

Joaquin Peña

Abstract: This talk aim is to show the advantages of a parallel algorithm to solve differential equations based in the high order parallel time integrator employed belongs to the family of revisionist integral deferred correction. We will analyze the behavior and advantages of the algorithm to find solutions differential equations with discretization over time and space. Finally, we will describe how to applied this type of algorithms to solve mathematical models focus in infectious diseases problems.

MS ME-0-8 5 — 11:00-13:00

Singular Limits in Fluid Dynamics, Related Equations, and Numerical Analysis - Part 2

For Part 1 see: MS ME-0-8 4

For Part 3 see: MS ME-0-8 6

For Part 4 see: MS ME-0-8 7

Organizer: Steve Schochet	Tel Aviv University
Organizer: Bin Cheng	University of Surrey
Organizer: Qiangchang Ju	IAPCM

Abstract: Many areas of physics are described by two models, one derived from basic laws and the second simplified using additional assumptions. Prominent pairs include compressible and incompressible fluid or magneto-hydrodynamic models, kinetic and fluid models, and many-body systems and mean-field theories. Clarifying relationships between models increases understanding of corresponding physical systems and guides development of improved numerical methods. This minisymposium examines current techniques for justifying simplified models via singular limits, quantifying the difference between solutions to related models, and simulating them numerically. Techniques to be discussed include classical, relative, and discrete energy and entropy estimates, and averaging methods.

11:00-11:30

Singular limits in thin domains

Sarka Necasova	Czech Academy of Sciences
Bernard Ducomet	University of Creteil, France
Milan Pokorny	Charles University
Matteo Caggio	University of Aquila
Donatella Donatelli	University of Aquila
Yongzhong Sun	Nanjing University
Maria Ángeles Rodríguez Bellido	University of Sevilla

Abstract: We study the 3D compressible barotropic fluid dynamics system describing the motion of the compressible rotating/nonrotationg viscous fluid with or without gravitation and with radiation confined to a straight layer with or without low Mach number limit. We show that weak solutions in the 3D domain converge to the 2D compressible Navier-Stokes / Navier- Stokes- Poisson (strong solution) / 2D incompressible (weak or strong).

11:30-12:00

Zero entropic relaxation time for a ferromagnetic fluid system

Stefano Scrobogna	Basque Center for Applied Mathematics

Abstract: In the physical sciences, relaxation means the return of a perturbed system to equilibrium, and it is categorized by a relaxation time τ. For a generic commercial grade ferrofluid the relaxation time is 10^{-9}. In this talk I will construct solutions for the Shliomis model of ferrofluids in a critical space of infinite L^2 energy uniformly for $\tau \in (0|\tau_0)$, and study the convergence $\tau 0$.

12:00-12:30

Multi-scale Singular Limits of Rotating Boussinesq Equations

Qiangchang Ju	Institute of Applied Physics and Computational Mathematics

Abstract: We investigate the multi-scale small parameters singular limits of rotating Boussinesq equations. The singular limits are rigorously proved for the equations when Foude number and Rossby number tend to zero at different rates. The dynamic behavior of the system at low Foude and Rossby number is established, and the classical filtering method is developed.

12:30-13:00

Fast singular limit of MHD system

Xin Xu	Tel Aviv University
Steven Schochet	School of Mathematical Sciences, Tel Aviv University, Israel

Abstract: We study the behavior of the solutions of the compressible MHD system when the Mach number and the Alfven number tend to zero simultaneously.

MS A6-5-3 5 11:00-13:00

Mathematical Models in the Systems Biology of Cancer - Part 2

For Part 1 see: MS A6-5-3 4

For Part 3 see: MS A6-5-3 6

Organizer: Juan Belmonte Beitia	UCLM
Organizer: Alicia Martínez González	Universidad de Castilla-La Mancha

Abstract: Recently, a new generation of mathematical and computational models of cancer has emerged that have been built in close collaboration with experimentalists and are primarily aimed at understanding aspects of cancer progression and treatment. For this minisymposium, we strongly encourage authors to submit their original studies in modeling, control and mathematical analysis of tumor growth

11:00-11:30

Mathematical model describing low grade gliomas and its reaction to chemotherapy

Marek Bodnar	University of Warsaw

Abstract: We discuss simple mathematical model of low grade gliomas growth and its response to chemotherapy. The model agrees with a clinical data, and predicts that the speed of response to chemotherapy is related to tumour aggressiveness. We study mathematical properties of the model in the case of constant, finite or periodic treatment administration. We investigate stability of tumour-free equilibrium. We also investigate the stability of the fitting procedure and perform sensitivity analysis of the model.

11:30-12:00

An optimal control problem for chemotherapy based on selection-mutation PDE models for resistance

Camille Pouchol	KTH

Abstract: One of the pitfalls in cancer chemotherapy lies in resistance to treatment. Going beyond ODEs with binary representation (resistant vs sensitive) leads to PDEs coming from adaptive dynamics, where resistance is modelled by a continuous trait. I will talk about the optimal (chemotherapy) control of such a PDE selection-mutation model. The optimal strategies are reminiscent of "drug-holiday and rechallenge", advocating for low infusion of drugs to resensitise the tumour, before using the maximum tolerated doses.

12:00-12:30

The emergence of drug resistance in cancer. An analysis with a system of integro-differential equations

Arturo Alvarez Arenas	UCLM
Juan Belmonte-Beitia	UCLM
Gabriel Fernández-Calvo	UCLM
Ana Podoloski-Renic	nstitute for Biological Research ”Sinisˇa Stankovic´”,
Milica Pesic	nstitute for Biological Research ”Sinisˇa Stankovic´”,

Abstract: Drug resistance is one of the major problems in cancer treatment. Beside Darwinian selection, Lamarckian Induction and transfer of resistant characteristics have attracted the attention of cancer researchers. In this talk, a system of hyperbolic partial differential equations is presented, and these three processes involved in the emergence of drug resistance in cancer are quantified. Moreover, the response of cancer cells to different drug protocols are simulated with the model, and their differences are analyzed.

MS A1-2-4 5 11:00-13:00

Recent Advances in Applications Performance on Supercomputers

Organizer: Tulin Kaman	University of Arkansas

Abstract: Performance analysis and optimization of scientific applications are essential to develop highly scalable, parallel applications that take advantage of the computing power of supercomputers. The goal of this minisymposium is gathering researchers to present and discuss the tools that are available for high performance computing users for performance analysis, optimization and tuning of the scientific applications to perform efficient numerical simulations on petascale supercomputers.

11:00-11:30

Performance Improvements for Compressible Turbulent Mixing Simulations

Tulin Kaman	University of Arkansas

Abstract: High quality simulations help us investigate the dynamics of chaotic mixing and predict the growth rate of the fluid interface instabilities. The performance measurements and analysis allow us to observe the performance of the application code on Blue Waters petascale supercomputer and identify the most computationally expensive parts. In this talk, we present the performance enhancement of collective operations and improvement of the computational performance of the high order accurate weighted essentially non-oscillatory numerical scheme.

11:30-12:00

Advances in Measurement using the TAU Performance System

Sameer Shende	University of Oregon
Allen Malony	University of Oregon

Abstract: The TAU performance system equips application developers with tools to observe application performance at different levels of the runtime systems. TAU supports the OpenACC, Kokkos, and HIP runtime systems to map performance from higher-level source constructs to lower level kernel executions and data transfers between host and accelerator devices. This talk describes the recent advances in measurement technology to expose performance artifacts in the context of extreme heterogeneity in HPC systems and software.

12:00-12:30

Global cloud-resolving climate simulations: fantasy or reality?

William Sawyer — Swiss National Supercomputing Centre

Abstract: As High Performance Computing moves to Exascale previously unimaginable simulations become possible. Global climate simulations now run at 20-50km resolution, can soon be run down to kilometer scale with new technologies like Graphics Processing Units. This in turn make it possible to resolve individual clouds, which demonstrably improves the quality of the prediction. We illustrate the latest results from the ICON, IFS and COSMO models at kilometer scale and answer the question "fantasy or reality?".

12:30-13:00

More With Less: Memory & Computate Limited N-Body Simulations for Euclid Precision Cosmology

Doug Potter — University of Zurich

Abstract: The ESA Euclid mission preparation requires unprecedented precision in the theory of structure formation of the Universe. I will discuss the numerical and computational methods employed in PKDGRAV3 to reduce memory usage, and to increase the numerical performance. These improvements have made it possible to run the Euclid Flagship simulations with the 4 trillion particles necessary to meet the physical resolution requirements for Euclid.

MS ME-0-2 5 11:00-13:00

A broad view on the least gradient problems - Part 2

For Part 1 see: MS ME-0-2 4

Organizer: Ahmad Sabra — American university of beirut
Organizer: Wojciech Górny — The University of Warsaw
Organizer: Piotr Rybka — The University of Warsaw

Abstract: Various versions of the least gradient problem (LGP) have been studied, because of its applications to medical imaging or free material design. We would like to present progress related to our understanding of the boundary condition, the role of anisotropy, uniqueness, relaxing the strict convexity assumptions on the 2D-domains. More recently we witness the importance of the LGP connection to the optimal transportation and the role in the studies of e.g. regularity of solutions. We would like to expose this link too.

11:00-11:30

A variational Approach to the Crystalline Mean Curvature Flow

Massimiliano Morini — University of Parma
Antonin Chambolle — Ecole Polytechnique de Paris
Matteo Novaga — Università di Pisa
Marcello Ponsiglione — Università di Roma "la Sapienza"

Abstract: We study the mathematical well-posedness of the Crystalline Mean Curvature flow in all dimensions and for arbitrary anisotropies and (convex) mobilities by means of a variational approach recently developped in collaboration with A. Chambolle, M. Novaga and M. Ponsiglione.

11:30-12:00

An elliptic 1-Laplacian equation with dynamical boundary conditions

Marta Latorre Balado — Universidad Rey Juan Carlos
Sergio Segura De León — Universitat de València

Abstract: In this talk we present an elliptic equation leaded by the 1-Laplacian operator with dynamical boundary conditions. Applying nonlinear semigroup theory, we show the existence of a unique solution. We also have proved a comparison principle and that this solution is, indeed, a strong solution. This is a joint work with S. Segura de León.

12:00-12:30

Continuity of minimizers to weighted least gradient problems

Andres Zuniga — Universite Paris-Dauphine

Abstract: We construct, in arbitrary dimensions, a continuous solution of where , and is a uniformly-positive weight function. Under suitable geometric conditions on the domain, we extend the Sternberg-Williams-Ziemer procedure to this inhomogeneous setting. The level sets of the minimizer are minimal surfaces in the conformal metric . This approach complements the one of Jerrard-Nachman-Moradifam since it provides a continuous solution even in high dimensions, where the level sets may develop singularities.

MS A6-4-2 5 11:00-13:00

ECMI Education Programs

Organizer: Cláudia Nunes — IST, VAT 8025188

Abstract: Since the beginning of ECMI that special attention has been paid to the education of applied mathematicians. The network of universities joining the ECMI Master Program is growing, and with this growth comes new challenges. The industry is also more aware of the importance of industrial mathematicians. In this minisymposium we will present and discuss the present activities lead by the ECMI Educational Committee, and we will reflect about the new challenges and how can we deal with them, specially in terms of virtual education.

11:00-11:30

ECMI Programs: Past and Future

Claudia Nunes — Instituto Superior Tecnico

Abstract: ECMI Educational programs dates from the 80's. The majority have been updated, reflecting the evolution of the needs and challenges for mathematics in industry. They are a successful story, in the students perspective, exchange programs and activities. They are a way to facilitate collaborations between research centers, providing the natural network for projects. The past is known. But in view of new technologies and platforms of teaching, we need to plan the future.

11:30-12:00

ECMI Master Programs

Ewald Lindner — Johannes Kepler University Linz

Abstract: We will present the framework of the ECMI Master Program and then discuss various master programs from ECMI members, which were approved as an ECMI Master Program. By this we want to demonstrate the flexibility of the framework and how to interprete the framework.

12:00-12:30

ECMI Modelling Weeks

Christophe Picard — Grenoble Institute of Technology

Abstract: The main aims of the Modelling Weeks are to train students in Mathematical Modelling and stimulate their collaboration and communication skills, in a multinational environment. The time constraints of the week make this experience unique. This presentation will give an overview of some of the work perform by two group of students, as well as the pedagogical challenges in preparing modeling problems for students.

MS FT-1-1 5 11:00-13:00

Nonlinear and multiparameter eigenvalue problems - Part 5

For Part 1 see: MS FT-1-3 1
For Part 2 see: MS FT-1-1 2
For Part 3 see: MS FT-1-1 3
For Part 4 see: MS FT-1-1 4
For Part 6 see: MS FT-1-1 6
For Part 7 see: MS FT-1-1 7

Organizer: Fernando De Terán — Universidad Carlos III de Madrid
Organizer: Froilán M. Dopico — Universidad Carlos III de Madrid

MS Organized by: SIAG/LA

Abstract: A nonlinear eigenvalue problem (NLEVP) is to find scalars x (eigenvalues) and nonzero vectors v,w (eigenvectors) satisfying F(x)v=0, w*F(x)=0, where F:C→Cnxn is a matrix-valued function. NLEVPs can be extended to multiparameter eigenvalue problems (MPEPs) F(x1,...,xd)v=0, w*F(x1,...,xd)=0, with F:Cd→Cnxn. Important cases of NLEVPs are the polynomial and rational eigenvalue problems, where the entries of F(x) are polynomial or rational functions. NLEVPs and MPEPs arise in many applications, and much research on these problems has been performed in the last years from computational and theoretical perspectives. This minisymposium presents the most recent advances in NLEVPs and MPEPs, and on their applications.

11:00-11:30

Quasi-Newton algorithms for the eigenvector dependent nonlinear eigenproblem

Parikshit Upadhyaya — KTH Royal Institute of Technology
Elias Jarlebring — KTH Royal Institute of Technology, Stockholm

Abstract: We consider the problem of computing to the problem: , where maps Hermitian matrices to Hermitian matrices . These eigenvalue problems arise in quantum mechanics and machine learning. In this work, we take a Quasi-Newton approach to the problem by viewing it as a structured nonlinear system of equations. We characterize several Quasi-Newton methods, of which one is equivalent to state-of-the-art methods in quantum chemistry, and others lead to new algorithms with favorable convergence properties.

11:30-12:00

Perturbations of matrix polynomial linearizations

Andrii Dmytryshyn — Örebro University and Umeå University

Abstract: A number of computational problems for matrix polynomials are solved by passing to linearizations, in particular Fiedler linearizations. We present an algorithm that finds which perturbations of the matrix coefficients of a polynomial correspond to a given perturbation of the entire linearization pencil. These results should help us to solve various distance problems for matrix polynomials. For example, finding a singular matrix polynomial, or a polynomial with a particular structure, nearby a given matrix polynomial.

12:00-12:30

Structured companion quadratifications of matrix polynomials

Carla Hernando — Universidad Carlos III de Madrid
Fernando De Terán Vergara — University Carlos III of Madrid

Abstract: In this talk we present new families of structured companion quadratifications for structured polynomials of degree 2d, with d an odd number. The motivation for considering quadratifications comes from the fact that there cannot be structured companion linearizations for structured polynomials of even degree. Moreover, we will prove that there are no companion quadratifications for structured polynomials of degree 4, so these constructions cannot be extended to polynomials with degree 2d and d even.

12:30-13:00

Some Remarks on Eigenvalue Computations with Block Kronecker Linearizations

Philip Saltenberger — TU Braunschweig
Heike Fassbender — TU Braunschweig

Abstract: We discuss the solution of polynomial eigenvalue problems by linearization via block Kronecker pencils. We show that the special form of block Kronecker pencils is particularly valuable for Krylov subspace methods as linear systems involving block Kronecker linearizations can be implicitly and efficiently solved. This efficiency increase is demonstrated for the Even-IRA algorithm (which is designed for the solution of T-even generalized eigenvalue problems) incorporating a special T-even linearization of block Kronecker form.

MS GH-1-G 5 **11:00-13:00**

Models involving fractional differential equations and their analysis - Part 1

For Part 2 see: MS GH-1-G 6
Organizer: Adam Kubica — Warsaw University of Technology
Organizer: Piotr Rybka — The University of Warsaw

Abstract: We are interested in fractional diffusion equations arising e.g. in problems of the sub-surface movement of water and the surface transport of sediment. We focus on the time or space fractional Caputo derivative. Our purpose is to bring together specialist working in the areas of modeling and analysis related to these topics. We want to report on the progress of modeling and analysis. In particular we mean development of existence and uniqueness theory in the Sobolev space framework or viscosity theory. We will present the development of regularity theory and analysis of asymptotic behavior including decay of solutions.

11:00-11:30

Weak solutions of fractional diffusion equation

Adam Kubica — Warsaw University of Technology

Abstract: We discuss an initial-boundary value problem for a time-fractional diffusion equation with Caputo derivative. We prove the existence of properly defined weak solutions by means of the Galerkin approximation. We also show the uniqueness of solution and under additional assumptions on the data we obtained the existence of regular solutions.

11:30-12:00

Numerical method for a nonlinear time-fractional diffusion

Lukasz Plociniczak — Wroclaw University of Science and Technology

Abstract: We will discuss a nonlinear time-fractional diffusion equation modelling transport in porous media (e.g. building materials). A standard approach to numerical approximation of its solution is usually very expensive due to the interplay of nonlinearity and nonlocality. To remedy this, we will construct a fast algorithm based on self-similar solutions and nonlinear Volterra equations, prove its convergence, and provide several numerical illustrations.

12:00-12:30

Computational solutions of fractional Stefan problems: pragmatic approaches and issues

Vaughan Voller — The University of Minnesota

Abstract: The Stefan problem, describing the melting of a solid can be posed in terms of an enthalpy formulation, relating the change of heat with time to the divergence of the temperature gradient. Here we investigate numerical solutions of this problem in cases where the time derivative and temperature gradient are expressed as fractional derivatives. We discuss some of the possible physical consequences and issues related to the numerical solution of the fractional enthalpy formulation.

MS GH-3-4 5 **11:00-13:00**

Nonlocal Modeling, Analysis, and Computation - Part 5

For Part 1 see: MS GH-3-4 1
For Part 2 see: MS GH-3-4 2
For Part 3 see: MS GH-3-4 3
For Part 4 see: MS GH-3-4 4
Organizer: Robert Lipton — Louisiana State University
Organizer: Qiang Du — Columbia University
Organizer: Pablo Seleson — Oak Ridge National Laboratory

Abstract: The past decade has seen a rapid growth in the development of nonlocal mathematical models. Nonlocal modeling is now being used in applications including continuum mechanics and fracture mechanics, anomalous diffusion and advection diffusion, and probability models. This minisymposium seeks to bring together mathematicians and domain scientists from different disciplines working on nonlocal modeling and is intended to serve as international forum for the state of the art in the modeling, analysis, and numerical aspects of nonlocal models.

11:00-11:30

Local Boundary Conditions in Nonlocal Problems

Burak Aksoylu — U.S. Army Research Laboratory and Wayne State University
George Gazonas — U.S. Army Research Laboratory

Abstract: We provide a treatment on how to enforce inhomogeneous local boundary conditions (BC) in nonlocal problems. The construction of the operators is inspired by Peridynamics. The operators agree with the original Peridynamic operator in the bulk of the domain and simultaneously enforce local Dirichlet or Neumann BC. The main tool used in the construction of the novel operators is functional calculus, in which the classical governing operator is replaced by a suitable function of it.

11:30-12:00

Convergence results for finite element and finite difference approximation of nonlocal fracture

Prashant Jha — Louisisna State University
Robert Lipton — Louisiana State University

Abstract: We show apriori convergence of the nonlinear Peridynamic models. The model is shown to be well-posed in Hölder space and Sobolev space. Finite element approximation using linear conforming elements is shown to converge at the rate where is the mesh size. Piecewise constant approximation (finite difference) on a uniform grid is shown to converge at the rate . We numerically demonstrate the convergence for the Mode-I crack propagation problem. We conclude by discussing future works.

12:00-12:30

A Review of coupling approaches for peridynamics with finite elements

Patrick Diehl — Louisisna State University
Serge Prudhomme — PoltyMTL

Abstract: Local-nonlocal coupling approaches provide a means to combine the computational efficiency of local models and the accuracy of non-local models. This talk will focus on the coupling of models from peridynamics and classical continuum mechanics. We will consider a 1D benchmark problem to review and compare the different approaches. The main objective will be to provide a general overview of the state-of-the-art and to emphasize the differences between existing coupling approaches using the numerical results.

MS FT-4-1 5 11:00-13:00

Advances in Numerical Methods for Hamilton-Jacobi-type equations - Part 1

For Part 2 see: MS FT-4-1 6
For Part 3 see: MS FT-4-1 7

Organizer: Alexander Vladimirsky Cornell University
Organizer: Maria Cameron University of Maryland

Abstract: Hamilton-Jacobi (HJ) equations are nonlinear hyperbolic PDEs that arise in a broad spectrum of applications such as geosciences, optimal control, and stochastic systems. In some cases, e.g., in seismic wave propagation and stochastic systems, HJ equations result from approximations rendering the considered problem mathematically tractable. Nevertheless, their fast and accurate numerical solution poses significant challenges due to the need to tackle singularities, reconcile the discrepancy between the gradient of the solution and its characteristics, and adapt meshes for the solution. In this mini-symposium, we are bringing together researchers advancing state-of-art HJ solvers and applying them to real-life problems.

11:00-11:30

Application of eikonal solvers in geophysical image analysis

Sergey Fomel The University of Texas at Austin

Abstract: Geophysical image analysis, including such applications as image registration and image segmentation, often involves a procedure of picking curves or surfaces from attribute panels. This task can be reduced to solving the eikonal equation. I discuss computational strategies for implementing an efficient eikonal-based picking algorithm and present example applications from seismic image analysis: velocity analysis, time-lapse image registration, fault identification.

11:30-12:00

Rarefaction fans and dynamic factoring in Eikonal equation

Dongping Qi Cornell University

Abstract: In Eikonal equations, rarefaction fans are common phenomena known to degrade the rate of convergence of numerical methods. The factored Eikonal equation was developed to address rarefaction fans caused by point sources. In this talk, I will present the "just-in-time factoring" technique, which uses similar ideas to factor the 2D rarefactions arising from either non-smoothness of the boundary or discontinuities in PDE coefficients. Joint work with Alex Vladimirsky.

12:00-12:30

Ordered line integral methods for solving the eikonal equation

Samuel Potter University of Maryland

Abstract: Ordered line integral methods for solving the eikonal equation in 3D is presented. Some of these solvers are significantly more accurate than the standard fast marching method due to the use of improved directional coverage and midpoint quadrature rules. In 3D, to maintain speed parity, we develop two update strategies, top-down and bottom-up, which use constrained optimization theory and a fast local characteristic search to prune unnecessary updates. Supporting theoretical and numerical results are presented.

MS ME-1-3 5 11:00-13:00

Computational approaches for multiscale, possibly random problems - Part 3

For Part 1 see: MS ME-1-3 3
For Part 2 see: MS ME-1-3 4
For Part 4 see: MS ME-1-3 6

Organizer: Legoll Frederic Ecole des Ponts and Inria
Organizer: Claude Le Bris Ecole des Ponts & Inria

Abstract: This mini-symposium is motivated by the following observations. First, computational approaches dedicated to multiscale problems have recently witnessed very significant developments. Second, an increasing amount of probabilistic features is currently introduced in PDEs for the modelization of complex phenomena. The purpose of this mini-symposium is to review the recent advances in these two directions, and at the intersection of those.

11:00-11:30

Efficient Domain Decomposition Methods and Solvers for Stochastic Elliptic PDEs

Olivier Le Maitre LIMSI CNRS

Abstract: We present a domain-decomposition approach for Monte-Carlo resolution of Stochastic Elliptic PDEs. The method involves local Karhunen-Loeve expansions of the random coefficient over the subdomains. These local variables are used to build, off-line, Polynomial Chaos approximations of the condensed problem for the subdomain boundary conditions, which is sampled in the online stage to directly approximate the solution samples, or precondition their exact resolution. The method is suited for parallel implementation, and we provide scalability results.

11:30-12:00

Adaptive Identification of Significant Polynomial Chaos Bases in Stochastic Galerkin Method

Srikara Pranesh University of Manchester

Abstract: A computationally efficient method for uncertainty quantification using spectral stochastic finite element is the stochastic Galerkin (SG) method. In this talk I will discuss two strategies to enhance the performance of SG (i) Reformulating system of equations as a generalised Sylvester equation, and (ii) On the fly strategy to select a subspace which captures the important features of the final solution. Performance of these strategies is demonstrated for problems with large stochastic dimensionality.

12:00-12:30

Numerical homogenization and the Arlequin method

Olga Gorinyna Ecole des Ponts
Claude Le Bris Ecole des Ponts
Frederic Legoll Ecole des Ponts

Abstract: Our aim is to approximate a problem with highly oscillatory coefficients by a problem with coarse coefficients, when the oscillatory coefficients are not explicitly known. Given the oscillatory solutions, we look for the best constant matrix that is consistent with the observed behavior. In this talk, we formalize the approach of [Cottereau, IJNME 2013], based on the Arlequin type method, in which the original oscillatory model is coupled with a homogeneous model.

12:30-13:00

The choice of representative volumes for random materials

Julian Fischer Institute of Science and Technology Austria

Abstract: In the homogenization of random materials, the effective material coefficients are typically determined by the method of representative volumes: A finite sample of the random material is chosen and the cell formula is evaluated numerically. The resulting approximation for the effective coefficient is a random quantity itself, and the leading-order contribution to the error consists of random fluctuations. We provide a rigorous analysis of a variance reduction method introduced by Le Bris, Legoll, and Minvielle.

MS FT-S-1 5 11:00-13:00

Multivariate Orthogonal Polynomials: Theory and Applications - Part 1

For Part 2 see: MS FT-S-1 6

Organizer: Francisco Marcellan Universidad Carlos III de Madrid
Organizer: Teresa E. Pérez Universidad de Granada
Organizer: Yuan Xu University of Oregon

Abstract: Multivariate orthogonal polynomials have received significant attention in recent years, both in theoretic front in the framework of Approximation Theory, Group Theory, Numerical Analysis (cubature formulas, spectral methods for Boundry Problems in PDE, among others), Operator Theory, Coding Theory as well in some applications as Optics, Mathematical Physics, or Information Theory. The aim of these two minisymposium is to provide a platform for researchers working on multivariate orthogonal polynomials and related fields to report recent progress and exchange ideas. Talks will touch applications in approximation, computation, numerical integration, and various other topics related to applications that use multivariable orthogonal polynomials.

11:00-11:30

Discrepancy and Hyperuniformity of point set sequences: practical aspects

Johann Brauchart Graz University of Technology

Abstract: Given is a sequence of point sets on a compact set, say unit sphere or a flat torus, arising from certain optimization procedures, deterministic constructions, or random point processes. How uniformly are those sets distributed as the sets get larger? Discrepancy measures the deviation from uniformity and hyperuniformity gives a qualitative scale for fluctuations in uniformity as the number of points tends to infinity. We apply multivariate orthogonal polynomials to estimate discrepancy and characterize hyperuniformity.

11:30-12:00

Riesz transforms and fractional integration for weighted orthogonal polynomial expansions on spheres, balls and simplices

Feng Dai	University of Alberta
Han Feng	Hongkong City University

Abstract: We study the Hardy-Littlewood-Sobolev (HLS) inequality and the Riesz transforms for fractional integration associated to weighted orthogonal polynomial expansions on spheres, balls and simplexes with weights being invariant under a general finite reflection group on R^d. The sharp index for the HLS inequality is determined and the L^p-boundedness of the Riesz transforms is established. Our idea is based on a new decomposition of the Dunkl-Laplace-Beltrami operator on the sphere .

12:00-12:30

Orthogonal polynomials on quadratic curves and surfaces

Sheehan Olver	Imperial College

Abstract: We consider multivariate orthogonal polynomials on algebraic curves/surfaces, that is, the zero set of a polynomial. What are the properties of orthogonal polynomials on other algebraic curves? Can they be used for numerically solving surface PDEs? We will investigate this question on simple quadratic curves and surfaces and their use in solving PDEs.

12:30-13:00

Weighted approximation on the ball

Miguel Pinar	Universidad de Granada

Abstract: In this talk we explore the best approximation on the ball by means of orthogonal polynomials associated with weight functions that are invariant under reflection groups. A theory of orthogonal polynomials in this context can be developed in analogy to that for the orthogonal polynomials associated to standard spherical harmonics. Here, the standard first order partial differential operators are replaced by a family of commuting first order difference-differential operators: the so called Dunkl operators.

MS FT-2-1 5 — 11:00-13:00

Advances in models and numerical methods for environmental flows - Part 1

For Part 2 see: MS FT-2-1 6

Organizer: Luca Bonaventura	POLITECNICO DI MILANO - LABORATORIO MOX
Organizer: Enrique Domingo Fernández Nieto	Universidad de Sevilla
Organizer: Gladys Narbona Reina	University of Sevilla

Abstract: The minisymposium will present an overview of advanced numerical methods and modeling for environmental flows and geophysical fluid dynamics. Developments in the formulation, implementation, and application of numerical techniques will be reviewed, including high order finite elements, multilevel discretizations, dynamical adaptation and High-Performance Computing aspects. The participants are active in major research centers and university departments with a significant record of research activity in this field. The minisymposium can be of great interest to all ICIAM participants by presenting recent research results of major relevance and potential also in other areas of computational fluid dynamics and applied mathematics.

11:00-11:30

Design of semi-implicit atmospheric models for exascale computing

Luca Bonaventura	Politecnico di Milano
Tommaso Benacchio	Politecnico di Milano
Luca Bonaventura	Politecnico di Milano

Abstract: A summary of the current and future activities in the H2020 ESCAPE-2 project will be presented, concerning possible approaches for the development of efficient models for numerical weather prediction which can take advantage of future exascale machines. Their features include robust and accurate time discretization methods as well as resilient and fault tolerant options for the linear solvers required for their practical implementation.

11:30-12:00

A Multilayer Shallow-Water Model with Variable Density

Ernesto Guerrero Fernandez	Universidad de Malaga
Manuel J. Castro Díaz	University of Malaga
Tomás Morales De Luna	University of Cordoba
Enrique Fernández Nieto	Universidad de Sevilla

Abstract: We present a multilayer shallow-water model with variable density. This model should be suited to simulate highly stratified ocean currents. It consists on a system of hyperbolic equations with non-conservative products that takes into account the pressure variations due to the density fluctuations in a stratified fluid. The system is approximated by a path-conservative scheme. The numerical scheme is second order accurate and well-balanced for a family of stationary solutions. Numerical results will be presented.

12:00-12:30

DG schemes for the simulation of natural convection problems

Saray Busto Ulloa	University of Trento
Maurizio Tavelli	Department of Civil, Mechanical and Environmental engineering, University of Trento
Walter Boscheri	Department of Mathematics and Computer Science, University of Ferrara
Michael Dumbser	Department of Civil, Mechanical and Environmental engineering, University of Trento

Abstract: In this talk, we present a new high order semi-implicit discontinuous Galerkin method for natural convection problems on unstructured staggered grids. Small temperature disturbances are solved considering the incompressible Navier-Stokes equations under Boussinesq assumption. In addition, compressible Navier-Stokes equations are discretized and comparison of both approaches is presented. Regarding the treatment of convective terms, we analyse two diverse methodologies: an explicit upwind scheme and a semi-Lagrangian approach. The resulting algorithms are assessed using several benchmarks.

12:30-13:00

Numerical methods for geophysical yield stress fluid flows

Paul Vigneaux	Ecole Normale Superieure Lyon

Abstract: We consider a prototype of a 2D Shallow Water Bingham model. We present a 2D well-balanced FV scheme coupled to duality methods which is able to compute accurately the arrested states of avalanches. To illustrate the ability of these schemes to handle the numerical difficulties encountered in geophysical applications (complex DEM topographies, long space domains and long time scales), we present in particular a simulation of an avalanche in the Taconnaz path (Chamonix, Mont-Blanc).

MS ME-1-9 5 — 11:00-13:00

Existence and stability of nonlinear waves - Part 1

For Part 2 see: MS ME-1-9 6

Organizer: Anna Ghazaryan	Miami University
Organizer: Vahagn Manukian	Miami University
Organizer: Stephane Lafortune	College of Charleston

Abstract: This mini-symposium will focus on recent results in the area of of traveling waves and related structures, obtained by either numerical or analytic techniques. Existence, stability, dynamic properties, and bifurcations of these special solutions will be addressed.

11:00-11:30

Transition Fronts between a Singular State and Steady State Solutions in Diffusive Holling-Tanner Model

Vahagn Manukian	Miami University
Stephen Schecter	North Carolina State University

Abstract: We show existence of front solutions that are asymptotic to a singular point and a constant state and also fronts that are asymptotic to a singular point and a periodic solution in the diffusive Holling-Tanner model. We use a coordinate transformation to remove the singularity, then blow-up transformation along with multi-scale analysis to establish the existence results in the vanishing diffusive limit.

11:30-12:00

Simple model for spontaneous re-ignition of fuel droplets in microgravity

Peter Gordon	Kent State Univeristy

Abstract: In this talk I will describe simple, still experimentally feasible, model of re-ignition phenomena of fuel droplets in microgravity. It will be shown that the model predictions are quite in line with available experimental observations. Results of both formal and rigorous analysis of the model will be presented. This is a joint work with D. Deitrich, M. Hicks and F. Nazarov.

12:00-12:30

Some stability and instability results for the two dimensional alpha-Euler equations.

Yuri Latushkin	University of Missouri
Shibi Vasudevan	

Abstract: We discuss several recent results on stability and instability of the steady state solutions of the regularized Euler equations of incompressible ideal fluid, the so-called alpha-Euler model. Instability of the generalized Kolmogorov flows (the unidirectional flows) is established using continuous fractions techniques. Perturbation determinants for the operator obtained by linearizing alpha-Euler equations about steady states are studied, and the version of the Birman-Schwinger operator is introduced.

MS A6-5-4 5 11:00-13:00

Numerical Approaches Addressing Multiscale Computational Challenges in Cell Population Dynamics - Part 2

For Part 1 see: MS A6-5-4 4

Organizer: Dumitru Trucu University of Dundee

Abstract: The past few decades have witnessed exciting modelling developments for multiscale cell population dynamic phenomena arising both in normal and pathological processes within the human tissue (such as embryogenesis, would healing, or cancer invasion), leading to very challenging computational questions. To address these challenges, innovative numerical approaches at the cross-interface between heterogeneous multiscale moving-boundary methods, multigrid and front-checking techniques are needed to facilitate efficient computational implementations. This mini-symposium aims to identify suitable numerical approaches able to address these computational challenges through a cross-fertilization of ideas from leading experts and young researchers in both numerical analysis and cell population dynamics modelling.

11:00-11:30

Multi-scale model of glioblastoma invasion

Yangjin Kim	Konkuk University
Mark Chaplain	University of St. Andrews
Dumitru Trucu	University of Dundee
Sean Lawler	Harvard University and BWH
Gibin Powathil	Swansea University

Abstract: In this talk, I will present some recent multi-scale mathematical models of cancer growth (glioblastoma) and development which focus on designing anti-cancer strategies. Many different kinds of stromal components in tumor microenvironment play a significant role in regulation of tumor growth and critical invasion. The results of the models will be compared with experimental data and some new directions of how to develop a unified multi-scale mathematical model will be discussed.

11:30-12:00

Spatio-structuro-temporal Modelling and Computational approaches in human health

Arran Hodgkinson	University of Montpellier

Abstract: Biological cell distributions in oncology covary through several dimensions, whilst available numerical techniques place an arbitrary upper bound on the number of dimensions in which we are capable of calculating solutions to problems accounting for this complexity. To overcome this, we apply pseudo-spectral orthogonal polynomial methods to the calculation of solutions to higher dimensional problems in drug resistance and compare them to those computed using low-error finite difference methods.

12:00-12:30

Age structure as key to delayed logistic proliferation in scratch assays

Ana Victoria Bobadilla	Heidelberg University
Thomas Carraro	Institute for Applied Mathematics, IWR, Heidelberg University
Tomás Alarcón	Centre de Recerca Matematica, Barcelona, Spain
Helen Byrne	Wolfson Centre for Mathematical Biology, Mathematical Institute, University of Oxford
Philip Maini	Wolfson Centre for Mathematical Biology, Mathematical Institute, University of Oxford

Abstract: Scratch assays are standard in vitro experimental methods for studying cell migration. In a recent work it was observed that on a short time, there is a disturbance phase where proliferation is not logistic, and this is followed by a growth phase where proliferation appears to be logistic. In this talk, I will introduce an age-structured population model that aims to explain the two phases of proliferation in scratch assays.

12:30-13:00

Modelling the evolutionary dynamics of cancer through nonlocal parabolic equations

Tommaso Lorenzi	University of St Andrews

Abstract: A growing body of literature supports the idea that mathematical modelling can complement experimental cancer research by offering alternative means of interpreting extant data and by enabling extrapolation beyond empirical observation. In this talk, I will present a number of results illustrating how analysis and numerical simulation of mathematical models formulated in terms of nonlocal parabolic equations can uncover fresh insights into the underpinnings of the evolutionary dynamics of cancer.

MS FE-1-1 5 11:00-13:00

Recent advances in kinetic computation: forward and inverse problems - Part 1

For Part 2 see: MS FE-1-1 6

For Part 3 see: MS FE-1-1 7

Organizer: Qin Li UW-Madison

Organizer: Jingwei Hu Purdue University

Abstract: Kinetic theory describes the nonequilibrium dynamics of a large number of particles and connects microscopic Newtonian mechanics and macroscopic continuum mechanics in multiscale modeling hierarchy. It is widely used in a variety of science and engineering problems. Numerically solving kinetic equations in both forward and inverse setting present many challenges, such as high-dimensional collision operators, multiscales, uncertainties in scattering coefficients, etc. This minisymposium aims to bring together applied mathematicians to discuss recent progress in this field and exchange ideas.

11:00-11:30

Random Batch Methods for Interacting Particle Systems

Shi Jin	Shanghai Jiao Tong University

Abstract: We develop random batch methods for interacting particle systems with large number of particles. These methods use small but random batches for particle interactions, thus the computational cost is reduced from O(N^2) per time step to O(N), for a system with N particles with binary interactions. For one of the methods, we give a particle number independent error estimate under some special interactions.

11:30-12:00

Meanfield Limit of Gradient Computations For Inverse Problems

Herty Michael	RWTH Aachen University

Abstract: The Ensemble Kalman Filter method can be used as an iterative numerical scheme for inverse problems. We study the limit of infinitely large ensemble size and derive the corresponding mean-field limit. The kinetic equation allows to analyze stability of the solution to inverse problems. We illustrate the properties and the ability of the kinetic model to provide solution to inverse problems by using examples from the literature.

12:00-12:30

Stability analysis for inverse multiscale kinetic equations

Li Wang	University of Minnesota

Abstract: In the inverse setting of kinetic theory, we consider recovering model coefficients from noisy boundary measurements. Then it raises the question of how the errors in the measurement affects the recovery.

In this talk, we will discuss this issue and also explore its dependence on different scales.

12:30-13:00

Inverse transport problems with internal data

Kui Ren — Columbia University

Abstract: Inverse transport problems appear in many imaging applications. We present here some recent mathematical and computational results on inverse transport problems in hybrid imaging where the interest is to reconstruct physical coefficients system of transport equations from internal data on the transport solutions.

MS A3-3-L1 5 — 11:00-13:00

Recent advances on numerical methods and analysis of complex fluids - Part 5

For Part 1 see: MS A3-3-L1 1
For Part 2 see: MS A3-3-L1 2
For Part 3 see: MS A3-3-L1 3
For Part 4 see: MS A3-3-L1 4

Organizer: Zhonghua Qiao — The Hong Kong Polytechnic University
Organizer: Hui Zhang — Beijing Normal University

Abstract: The goal is to integrate advances in mathematics (theory, modeling, algorithms, simulations, high performance computing techniques) with new experimental data from complex fluids and biological systems, and targeted applications. The specific systems represented include liquid crystal flow, polymeric flow and magnetic fluids, phase-field and beyond these area.

11:00-11:30

The Nonlocal Cahn-Hilliard-Hele-Shaw system with regular and singular potentials

Francesco Della Porta — Max-Planck-Insitute for Mathematics in the Sciences

Abstract: The Cahn-Hilliard-Hele-Shaw system (also called the Cahn-Hilliard-Darcy) can be used to describe the evolution of a binary immiscible fluid in a Hele-Shaw cell or in porous media, and has been recently used as a building block for some tumor-growth models. In my talk, I will introduce a physically motivated nonlocal variant of the Cahn-Hilliard-Hele-Shaw system, and present some related analytical results. These include the well-posedness of the system and the convergence to a global attractor.

11:30-12:00

A positivity-preserving second-order BDF scheme for the Cahn-Hilliard equation with variable interfacial parameters

Lixiu Dong — Beijing Normal University
Hui Zhang — Beijing Normal University, Beijing 100875, P.R. China
Zhengru Zhang — Beijing Normal University, Beijing 100875, P.R. China

Abstract: Here we present and analyze a second-order BDF scheme for the Macromolecular Microsphere Composite hydrogel, Time-Dependent Ginzburg-Landau (MMC-TDGL) equation, a Cahn-Hilliard equation with Flory-Huggins-deGennes energy potential. We present a point-wise bound of the numerical solution for the proposed scheme and convergent analysis in the theoretical level. Moreover, we present the detailed convergent analysis. At last, various numerical results are presented.

12:00-12:30

Efficient and linear schemes for anisotropic Cahn-Hilliard model with the stabilized-IEQ approach

Zhen Xu — Beijing Normal University
Xiaofeng Yang — University of South Carolina
Hui Zhang — Beijing Normal Univeristy
Ziqing Xie — Hunan Normal University

Abstract: In this talk, we consider numerical approximations for anisotropic Cahn–Hilliard equation. We develop two linear and second-order schemes that combine the IEQ approach with the stabilization technique, which can be shown to be crucial to suppress the non-physical spatial oscillations caused by the strong anisotropy. We show the wellposedness and unconditional energy stabilities of our systems rigorously. Various numerical simulations are presented to demonstrate the stability, accuracy, and efficiency of the proposed schemes.

12:30-13:00

SAV schemes for the binary fluid-surfactant system

Yuzhe Qin — Beijing Normal University

Abstract: We develop a first and a second order unconditionally energy stable schemes for a binary fluid-surfactant system by using SAV approach. The free energy contains a double-well potential, a nonlinear coupling entropy and a Flory-Huggins potential. The resulting coupled system consists of a Cahn-Hilliard type equation and a Wasserstein type equation. By introducing a scalar auxiliary variable, the system is transformed into an equivalent form. Both schemes are linear and decoupled.

MS FT-4-4 5 — 11:00-13:00

Advances in Monte Carlo Methods and Applications - Part 1

For Part 2 see: MS FT-4-4 6
For Part 3 see: MS FT-4-4 7
For Part 4 see: MS FT-4-4 8
For Part 5 see: MS FT-4-4 9

Organizer: David Aristoff — Colorado State University
Organizer: Gideon Simpson — Drexel University

Abstract: Monte Carlo methods continue to be the primary tool for a host of problems posed in high dimensional spaces in fields as diverse as materials science, data science, and uncertainty quantification. These applications demand both novel algorithms and mathematical analysis to ensure accuracy and optimal performance. This minisymposium will bring together researchers and practitioners to discuss the latest results on Monte Carlo algorithms and their application. Key topics will include Gibbs-Boltzmann sampling, free energy calculations, rare event simulation, uncertainty quantification, optimization, and ensemble and particle methods.

11:00-11:30

Steady state importance sampling

David Aristoff — Colorado State University
Gideon Simpson — Drexel University
Brian Van Koten — University of Massachusetts at Amherst

Abstract: We consider various bilevel schemes for accelerating the convergence to steady state of irreversible Markov processes. The schemes, which are related to techniques in Exact Milestoning, Non-Equilibrium Umbrella Sampling, and Weighted Ensemble, are based on coupling a coarse direct solve with a fine-scale sampling step. We present conditions under which the bilevel schemes are guaranteed to beat direct numerical simulation. We also investigate examples where the bilevel schemes are degenerate.

11:30-12:00

Sampling of probability measures supported on submanifolds

Tony Lelièvre — Ecole des Ponts ParisTech and Inria Paris

Abstract: We will show how to generalize to Generalized Hybrid Monte Carlo a procedure suggested by Goodman, Holmes-Cerfon and Zappa for Metropolis random walks on submanifolds, where a reverse projection check is performed to enforce the reversibility of the algorithm for large timesteps and hence avoid biases in the invariant measure. Référence: Lelièvre, Rousset, Stoltz, Hybrid Monte Carlo methods for sampling probability measures on submanifolds, https://hal.archives-ouvertes.fr/hal-01832820v1

12:00-12:30

Approximation of quantum observables by ab initio molecular dynamics

Petr Plechac — University of Delaware

Abstract: Standard ab initio molecular dynamics on the electron ground state approximates quantum observables in the canonical ensemble when the temperature is low compared to the first electron eigenvalue gap. We discuss connection between ab initio molecular dynamics and quantum observables using Weyl quantization. We pderive a certain weighted average of different dynamics that approximates quantum observables at any temperature provided the electron eigenvalue surfaces do not cross. (joint with A. Kammonen, M. Sandberg, A. Szepessy)

12:30-13:00

Simulation of rare events in molecular dynamics with the adaptive multilevel splitting

Laura LOPES — Ecole des Ponts ParisTech
Jérôme Hénin — Institut de biologie physico-chimique

Tony Lelièvre École des Ponts ParisTech

Abstract: The Adaptive Multilevel Splitting is a powerful and versatile method to estimate rare events probabilities. The idea of the algorithm is to split the phase space into cells and calculate the probability to pass from one cell to another, a process that is done on the fly in order to reduce the variance of the estimation of the probability. In this study we apply the AMS method to two distinguished unbinding cases.

MS A6-3-3 5 11:00-13:00

Multiscale and Asymptotic Analysis, Modeling, and Simulation for Materials Science - Part 5

For Part 1 see: MS A6-3-3 1
For Part 2 see: MS A6-3-3 2
For Part 3 see: MS A6-3-3 3
For Part 4 see: MS A6-3-3 4
Organizer: Silvia Jimenez Bolanos Colgate University
Organizer: Lyudmyla Barannyk University of Idaho
Organizer: Miao-Jung Yvonne Ou University of Delaware

Abstract: Multiscale in space and time continues to be an active and challenging area of research in mathematical materials science. The aim of this minisymposium is to focus on multiscale modeling, analysis and simulation of the problems arising in fluids, composites and other heterogeneous media. In particular, topics that will be discussed include but are not limited to asymptotic analysis, homogenization, inverse problems, and computational tools for complex fluid and inhomogeneous media. The purpose of this minisimposium is to enable contact between researchers working on fluid modeling and multiscale methods with an update on recent progress in this field.

11:00-11:30

Scattering by obstacles with periodic material properties and the effect of boundary correctors.

Shari Moskow Drexel University

Abstract: We study the homogenization of a transmission problem arising in the scattering theory for bounded inhomogeneities with periodic coefficients in the lower order term of the Helmholtz equation. The squared index of refraction is assumed to be a periodic function of the fast variable. We obtain improved convergence results than previous estimates (when the periodicity was also in the second order part of the operator), and find the limiting boundary correctors at all orders.

11:30-12:00

Opening band gaps in photonic and acoustic crystals.

Robert Viator Southern Methodist University

Abstract: Band gap materials have a variety of applications in optics and acoustics, ranging from acoustic filtering to the design and optimization of solar panels. We explore a criterion for opening band gaps in high-contrast 2D photonic and 3D acoustic crystals, given entirely in terms of the crystal geometry and the contrast between the material parameters of the components. We'll also see estimates on the location and size of these gaps using the same material information.

12:00-12:30

Dispersion of waves in periodic media

Yuri Godin University of North Carolina at Charlotte

Boris Vainberg University of North Carolina at Charlotte

Abstract: Propagation of waves governed by the Helmholtz equation in a medium containing periodic lattice of spherical or cylindrical inclusions of radius is considered. Assuming that is small relative to the period of the lattice and transmission boundary conditions on inclusions interface, we suggest a novel method for determining the dispersion relations of the Floquet-Bloch waves consisting in the reduction of the singularly perturbed problem to the regular one, and derive explicit dispersion relations.

12:30-13:00

On spectral singularities of exterior elliptic problems

Boris Vainberg University of North Carolina at Charlotte

Konotop V
Lakshtanov E
Puri R

Abstract: Tunable complex valued potentials for Schrodinger operators will be constructed with a spectral singularity at a given wavelength, splitting of double singularities will be studied. We will study the critical value of the coefficient βcr at the potential term that separates boundary value problems with negative eigenvalues and those without them. The dependence of βcr on the boundary condition and on the distance from the support of the potential to the boundary will be discussed.

MS FT-2-4 5 11:00-13:00

Stochastic Computation and Complexity - Part 3

For Part 1 see: MS FT-2-4 3
For Part 2 see: MS FT-2-4 4
For Part 4 see: MS FT-2-4 6
Organizer: Raphael Kruse Technische Universität Berlin
Organizer: Stefan Heinrich University of Kaiserslautern

Abstract: The minisymposium is devoted to recent developments in stochastic numerics. This includes the numerical solution of stochastic differential equations, stochastic partial differential equations, stochastic integration and stochastic quadrature problems, as well as applications to the solution of partial differential equations. Deterministic, Monte Carlo, Multilevel Monte Carlo, quasi-Monte Carlo, and deep learning methods will be presented. Emphasis is laid on efficiency of algorithms, their convergence analysis, optimality, and the complexity of the underlying problems.

11:00-11:30

Algorithms and complexity for stochastic integration in function classes

Stefan Heinrich University of Kaiserslautern

Abstract: Extending results from [1] and [2] we study the complexity of stochastic integration with respect to the Wiener sheet measure of stochastic functions f with fractional Sobolev regularity in t. We determine the complexity in the deterministic and randomized setting, which includes finding and analyzing algorithms of optimal order and proving matching lower bounds. [1] Eisenmann,Kruse, Two quadrature rules for stochastic Ito-integrals with fractional Sobolev regularity [2] Heinrich, Complexity of stochastic integration in Sobolev classes

11:30-12:00

Application of Randomized Quadrature Formulas to the Finite Element Method for Elliptic Equations

Yue Wu University of Oxford
Raphael Kruse Technical University Berlin
Nick Polydorides University of Edinburgh

Abstract: We investigate the application of several randomized quadrature formulas to the finite element method for elliptic boundary value problems with irregular coefficient functions. To be more precise, we consider a standard Monte Carlo estimator under uniform distribution for general Elliptic equations, and an importance sampling estimator for Laplace equations.

12:00-12:30

Random Bits vs. Random Numbers for an Infinite-Dimensional Quadrature Problem

Mario Hefter Technische Universität Kaiserslautern

Mike Giles University of Oxford
Lukas Mayer Technische Universität Kaiserslautern

Klaus Ritter Technische Universität Kaiserslautern

Abstract: We study the approximation of expectations of functionals applied to solutions of stochastic differential equations (SDEs). We consider randomized (Monte Carlo) algorithms that may use either random numbers or merely random bits. To compare the power of random numbers and random bits we present upper and lower bounds on the complexity for the corresponding classes of randomized algorithms. The upper bounds are achieved by suitable multilevel methods.

12:30-13:00

MLMC using approximate RNGs and reduced precision

Oliver Sheridan-Methven Oxford University
Michael Giles University of Oxford

Abstract: Motivated by computational bottlenecks, we introduce inverse cumulative distribution function proxies for quickly producing approximate random numbers. We show the convergence of modified numerical schemes which use these proxies, and the coupling to the discretisation error. We also bound the cumulative roundoff error introduced by floating-point calculations. We combine approximate distributions and reduced-precisions into a nested multilevel Monte Carlo framework, demonstrating the associated performance improvements achieved without losing accuracy.

MS A6-2-2 5 11:00-13:00

The Mathematics of Malaria - Part 1

For Part 2 see: MS A6-2-2 6

Organizer: Maeve Mccarthy Murray State University

Organizer: Dorothy Wallace Dartmouth College

Abstract: The modeling of malaria transmission and vector dynamics has a long history dating to the original Ross model of 1911, modified by MacDonald in 1957. A google scholar search on "mathematical model malaria" yields over 66,000 results, indicated the substantial quantity of work in this field. No mechanical model reliably predicts malaria outbreaks in any region in sufficient detail to guide policy. Malaria transmission is a complex system depending on temperature, rainfall, topography, land use, and human and insect behavior. In this session we will gather an international group of eight malaria researchers whose combined expertise will inform future research.

11:00-11:30

Modelling surveillance-response systems for malaria

Nakul Chitnis Swiss Tropical and Public Health Institute

Theresa Reiker Swiss Tropical and Public Health Institute

Thomas Smith Swiss Tropical and Public Health Institute

Abstract: As countries and regions move towards malaria elimination, and incidence decreases, reactive strategies around index clinical cases could provide effective and potentially cost-effective means of identifying both remaining asymptomatic cases and new infections. We use mathematical models, ranging from deterministic population-based models to stochastic individual-based simulation models, to investigate the potential impact of these reactive strategies in reducing elimination and potentially achieving elimination.

11:30-12:00

Optimal control of sterile insect techniques for mosquito populations

Maeve McCarthy Murray State University

K. Renee Fister Murray State University

Seth Oppenheimer Mississippi State University

Abstract: We develop an optimal control framework to investigate the introduction of sterile type mosquitoes to reduce the overall mosquito population. Mosquitoes are vectors of disease. The goal is to establish the existence of a solution given an optimal sterilization protocol as well as to develop the corresponding optimal control representation to minimize the infiltrating mosquito population while minimizing fecundity and the number of sterile type mosquitoes introduced into the environment per unit time.

12:00-12:30

Optimal Control and Temperature Variations of Malaria Transmission Dynamics

Folashade Agusto University of Kansas

Abstract: This seminar presents the results from the optimal control strategies for malaria with insecticide sensitive and resistance mosquitoes using a temperature dependent malaria models. The control strategies in four different geographical regions of Sub-Saharan Africa with temperatures suitable for mosquitoes suggest on average a high usage of larviciding and adulticiding followed by a moderate usage of insecticide treated bednet. The bednet usage mimics the trajectory of the mosquitoes as the mosquitoes respond to temperature variations.

12:30-13:00

Reduction of Mosquito Abundance Via Indoor Wall Treatments: A Mathematical Model

Dorothy Wallace Dartmouth College

Vardayani Ratti Dartmouth

Evan Rheingold Dartmouth

Abstract: A lifecycle model for Anopheles gambiae is used to predict vector reduction due to four types of indoor wall treatments. The model predicts that treatment has 1) little effect on vector abundance if the percent coverage or the duration of mortality effect, 2) a substantial effect at higher coverage rates and/or higher persistence, and 3) a coverage threshold above which extra treatment has little effect. Treatments of short persistence are further affected by seasonal timing.

MS A3-S-C2 5 11:00-13:00

Geometric shape generation: integrability, variational analysis and applications - Part 2

For Part 1 see: MS A3-S-C2 4

For Part 3 see: MS A3-S-C2 6

For Part 4 see: MS A3-S-C2 7

For Part 5 see: MS A3-S-C2 8

For Part 6 see: MS A3-S-C2 9

Organizer: Kenji Kajiwara Kyushu University

Organizer: Schief Wolfgang The University of New South Wales

Organizer: Miyuki Koiso Kyushu University

Organizer: Udo Hertrich-Jeromin TU Wien

Abstract: This minisymposium is aimed at the discovery of state of the art geometric shape generation, based on methods from smooth and discrete differential geometry. In response to needs and problems raised by industrial applications, various geometric methods to generate desirable or "good" shapes have been developed, that emphasize the underlying structure of an integrable systems or variational approach. The topics addressed will range from problems raised in architecture and industrial design to the mathematical framework used to tackle them, and the modeling and analysis of smooth or discrete curves and surfaces to be used in shape design.

11:00-11:30

Gestaltung

Florian Rist Technical University of Vienna

Abstract: Understanding design as a process not only striving for the development of aesthetics shapes but in a much broader sense, as the Bauhaus or the Hochschule für Gestaltung Ulm did, this talk explores the interaction between geometry and three-dimensional design. Practical approaches to utilize the close interrelation between mathematics and the development of complex designs through computational or complementary physical approaches are illustrated, examining the integration of science and art pioneered at HfG Ulm.

11:30-12:00

Form-finding of Cable-reinforced Membrane Structures formalized by Discrete Differential Form

Yohei Yokosuka Kagoshima University

Toshio Honma Japan/Kagoshima University

Abstract: We present a numerical procedure to solve minimal surface problem based on discrete differential form. Furthermore, in order to apply the presented computation to the cable-reinforced membrain structure, we show formulation of coupling discrete triangle and line elements, and compare the presented computation and the conventinal method of form-finding in architecture. Finally, we confirm that obtained solutions posses uniform principal stress distribution on discrete surface by using geometrically nonlinear analysis by finite element method.

12:00-12:30

On the relationship between Jumonji-Urakawa's formulation on FEM and discrete exterior calculus

Sampei Hirose Shibaura Institute of Technology

Abstract: The finite element method (FEM) is one of the effective numerical methods for solving differential equations. Jumonji and Urakawa proposed FEM on a triangulated manifold embedded in the Euclidean space. On the other hand, discrete exterior calculus has been developed as a numerical method on triangulated manifold. In this talk, I will discuss the relationship between Jumonji-Urakawa's FEM and discrete exterior calculus.

12:30-13:00

Geometric modeling with Möbius geometry

Christian Müller Technical University of Vienna

Abstract: We present a framework for designing shapes from diverse combinatorial patterns, where the vertex 1-rings and the faces are as rotationally symmetric as possible. We will then discuss an algorithm which computes the geometry that brings out the symmetries encoded in the combinatorics. Further, we introduce a novel framework for creating Moebius-invariant subdivision operators with a simple conversion of existing linear subdivision operators.

MS GH-3-5 5 11:00-13:00

Mathematical solutions to real world problems involving real data - Part 1

For Part 2 see: MS GH-3-5 6
Organizer: Mili Shah — The Cooper Union
Organizer: Leila Issa — Lebanese american university (LAU)
Organizer: Mili Shah — The Cooper Union

Abstract: Most real life problems can benefit from the collection of data. Mathematical analysis of this data leads to insight on the problem at hand and helps with finding appropriate solutions. This mini-symposium presents a variety of real life problems — ranging from health and finance to politics and robotics — whose solutions has risen from a mathematical analysis of collected data. Each talk will give an overview of the problem at hand, the mathematical techniques used to collect and/or analyze the data, and the real life results and consequences of using the mathematical techniques.

11:00-11:30

Using Mathematics to Aid in the Evaluation of Robotic Systems

Mili Shah — The Cooper Union

Abstract: Robotic systems use a variety of sensors to perform tasks that are assigned to them. In order to use data collected from these sensors, they must be registered with respect to a common coordinate frame. This talk will begin with an overview of the mathematical tools needed to tackle a registration problem and will conclude with current research and open problems related to the mathematics of evaluating robotic systems.

11:30-12:00

Protecting investors with applied mathematics and natural language processing

Marco Enriquez — U.S. Securities and Exchange Commission

Abstract: To facilitate its mission of protecting investors, the U.S. Securities and Exchange Commission (SEC) collects regulatory filings from its registrants (e.g., investment advisors, corporate issuers). However, due to the large number of filings the SEC receives, manual review is not feasible. To address this challenge, we couple Applied Mathematics and Natural Language Processing (NLP) algorithms with recent advances in “big data” technologies to enable the SEC to screen terabytes of textual data.

12:00-12:30

Structural and practical identifiability analysis of Zika epidemiological models

Necibe Tuncer — Florida Atlantic University

Abstract: We introduce six models of ZIKV, beginning with a general vector-borne model and gradually including different transmission routes of ZIKV. These epidemiological models use various combinations of disease transmission (vector and direct) and infectious classes (asymptomatic and pregnant), with addition to loss of immunity being included. The disease induced death rate is omitted from the models. We perform identifiability analysis of the models to find whether unknown model parameters can uniquely be determined.

12:30-13:00

Analysis of partisan gerrymandering tools in advance of the US 2020 census

Marion Campisi — San Jose State University
Ellen Veomett — Saint Mary's College of California
Tommy Ratliff — Wheaton College
Andrea Padilla — Saint Mary's College of California

Abstract: Over the last decade, mapmakers have gerrymandered political districts for the benefit of their party. In response, political scientists and mathematicians have investigated tools to quantify and understand the mathematical structure of redistricting. Two tools for determining whether a redistricting plan is fair are gerrymandering metrics and stochastic sampling algorithms. We explore the Declination, a metric intended to detect gerrymandering. Within our analyses, we show that Declination cannot detect all forms of packing and cracking.

MS ME-0-3 5 11:00-13:00

Nonlinear waves, singularities, and turbulence in physical and biological systems - Part 5

For Part 1 see: MS ME-0-3 1
For Part 2 see: MS ME-0-3 2
For Part 3 see: MS ME-0-3 3
For Part 4 see: MS ME-0-3 4
Organizer: Pavel Lushnikov — University of New Mexico
Organizer: Alexander Korotkevich — University of New Mexico

Abstract: Appearance of waves and formation of singularities are important problems in many physical, hydrodynamical and biological systems as well as for the applied mathematics in general. Waves of finite amplitude require solutions beyond linear approximation by taking into account nonlinear effects. Solutions of nonlinear equations usually result in the formation of singularities, coherent structures or solitary waves. Examples of the corresponding phenomena can be observed in filamentation of laser beams in nonlinear media, wave breaking in hydrodynamics and aggregation of bacterial colonies. The minisymposium is devoted to new advances in the theory of nonlinear waves.

11:00-11:30

Chiral skyrmion solutions of 2D Landau-Lifshitz equations

Stephen Gustafson — University of British Columbia

Abstract: Landau-Lifshitz equations are the basic dynamical equations in a micromagnetic description of a ferromagnet. They are naturally viewed as geometric evolution PDE of dispersive (``Schrodinger map") or mixed dispersive-diffusive type, which scale critically with respect to the physical energy in two dimensions. We describe recent results on existence and stability of important topological soliton solutions known as ``chiral magnetic skyrmions". Joint work with Li Wang.

11:30-12:00

Stability and Noise in Frequency Combs: Harnessing the Music of the Spheres

Curtis Menyuk — University of Maryland Baltimore County
Zhen Qi — University of Maryland Baltimore County
Shaokang Wang — University of Maryland Baltimore County

Abstract: Frequency combs have revolutionized the measurement of time and frequency and have impacted many applications. Frequency combs are modeled mathematically at lowest order by the nonlinear Schrödinger equation (NLSE). The key theoretical issues in designing frequency combs are finding parameter regimes where they operate stably and optimizing their performance. We describe computational approaches that we have developed, based on dynamical systems theory that make it possible to solve these problems accurately and efficiently.

12:00-12:30

Dark Solitons: From 1D to 2D and 3D with Some Quantum Touches

Panayotis Kevrekidis — University of Massachusetts

Abstract: We revisit dark and dark-bright solitons in atomic BECs. We explain their existence/stability in 1d, before extending them as stripes and rings in 2d, presenting an adiabatic-invariant-based formulation of their stability. We explore their filamentary dynamics, and the states that emerge from their transverse instability. We consider planar and spherical shell solitons also in 3d. Extensions to the cases of vortex rings as well as vortex knots and the quantum setting are also considered.

CP A6-5-2 5 11:00-13:00

Partial Differential Equations IV

Chair Person: Ying-Chieh Lin — National University of Kaohsiung

CP A6-5-2 5 1 11:00-11:20

Global existence and strong trace property of entropy solutions by the source-concentration Glimm scheme for nonlinear hyperbolic balance laws

Ying-Chieh Lin — National University of Kaohsiung
Shih-Wei Chou — Soochow University
John M. Hong — National Central University

Abstract: We consider the initial-boundary value problem for nonlinear balance laws with source terms $a_x g$ and $a_t h$. The boundary data is assumed to satisfy a linear or smooth nonlinear relation. By introducing a generalized Glimm scheme, the global existence of entropy solutions is established. Under some sampling condition, we find that the entropy solutions have strong traces which match the boundary condition almost everywhere in t.

CP A6-5-2 5 2 **11:20-11:40**

Godunov Type Solvers for Hyperbolic Systems based on Discontinuous Flux for Conservation Laws

Aekta Aggarwal	Indian Institute of Management, Indor
Ganesh Vaidya	TIFR Center for Applicable Mathematics
G. D. Veerappa Gowda	TIFR Center for Applicable Mathematics

Abstract:
Godunov-type Solvers based on discontinuous flux are proposed for linear transport equations and applied on hyperbolic systems, in particular, for system of Chaplygin gas dynamics $v_t + (uv)_x=0,(vu)_t + (vu^2$-1\v)_x=0, which is seen as mathematical approximation for calculating the lifting force on a wing of airplane and as a possible model for dark energy. The novelty of the paper is to capture the delta shock wave type solutions, without exploiting the eigenstructure of the system.

CP A6-5-2 5 3 **11:40-12:00**

High-Order Adaptive Extended Stencil Finite Element Method (AES-FEM) with Applications in Elasticity Problems

Rebecca Conley	Saint Peter's University
Tristan J Delaney	Synopsys, Inc.
Xiangmin Jiao	Stony Brook University

Abstract: We present high-order Adaptive Extended Stencil FEM (AES-FEM), which is a hybrid of generalized finite differences and finite element methods. For imposing boundary conditions, our method requires only a high-order representation of the boundary, which can be reconstructed automatically from the boundary of a piecewise linear volume mesh. In this presentation, we focus on applications of AES-FEM to systems of PDEs in structural mechanics, such as linear and nonlinear elasticity problems in 2D and 3D.

CP A6-5-2 5 4 **12:00-12:20**

Higher Order Globally Constraint-Preserving FVTD and DGTD Schemes for Time-Dependent Computational Electrodynamics

Dinshaw Balsara	University of Notre Dame

Abstract: Computational Electrodynamics (CED) deals with the solution of Maxwell's equations in material media. In this talk we present FVTD and DGTD methods for solving Maxwell's equations. First, we develop constraint-preserving reconstruction which preserves all the vectorial constraints. Second, we develop a fast ADER predictor step within each zone. Third, we develop a multidimensional Riemann solver for CED which gives us the multidimensional upwinding that is truly essential for the solution of Maxwell's equations.

CP A6-5-2 5 5 **12:20-12:40**

Implicit-explicit time stepping based on recent exponential integrators called sEPIRK for viscous flow simulations

Veronika Straub	University of Kassel
Sigrun Ortleb	University of Kassel
Andreas Meister	University of Kassel

Abstract: Reliable simulations of viscous flows in real applications involve the task of discretizing both space and time in an accurate and efficient way. To cope with the large semidiscrete systems resulting from a space discretization on appropriate grids, which often include comparatively few very small cells near solid walls for boundary layer resolution, an implicit-explicit time stepping scheme can be the most efficient variant. We present such a scheme utilizing recent exponential integrators called sEPIRK.

CP A6-5-2 5 6 **12:40-13:00**

Thermodynamics and kinetics - based nonlinear electrochemistry transport problems

Maxim Zyskin	University of Oxford

Abstract: In my talk I will describe thermodynamics-based method of deriving nonlinear equations of electochemical transport, some analytical and numerical approaches to solving such equations, and molecular dynamics based methods of parameter estimation. This work has applications to multi-physics modeling of electric batteries and other electrochemistry transport problems.

CP FT-1-8 5 **11:00-13:00**

Optimization and Operations Research III

Chair Person: Renan Brito Butkeraites	Federal University of São Paulo / Technological Institute of Aeronautics

CP FT-1-8 5 1 **11:00-11:20**

A new feasibility quality measure for optimization under uncertainty

Renan Brito Butkeraites	Federal University of São Paulo / Technological Institute of Aeronautics
Luiz Leduíno Salles Neto	Federal University of São Paulo
Weldon A. Lodwick	University of Colorado Denver

Abstract: This research introduces a new metric that measures the feasibility of a given solution found for an uncertain set of parameters. It was validated by comparing solutions found using six different approaches for the farmer optimization problem. The Hardiness measure performed better than the other metric presented on the literature, showing that a relative feasibility comparison is a better choice to identify which solution was more protected given the uncertainty. The first author acknowledges the financial support from the Coordination of Improvement of Higher Level Personnel - Brazil (CAPES). 0 and 2016 / 01860-1.

CP FT-1-8 5 2 **11:20-11:40**

A note on "An improved score function for ranking neutrosophic sets and its application to decision-making process"

Akanksha Singh	Thapar Institute of Engineering & Technology
Amit Kumar	Thapar Institute of Engineering & Technology
S S Appadoo	University of Manitoba

Abstract: The aim of this note is to make the researchers aware that the shortcomings, pointed out by Nancy and Garg (Int. J. Uncertainty Quantification; 6(5):377-385(2016)) in the existing methods (http://arxiv.org/abs/1412.5202, Dec17, 2014), is also occurring in the methods proposed by Nancy and Garg. Therefore, to propose the valid methods for the same is still an open challenging research problem.

CP FT-1-8 5 3 **11:40-12:00**

Reasons for not using entropy and knowledge measure in decision making problems under intuitionistic fuzzy environment and interval-valued intuitionistic fuzzy environment

Amit Kumar	Thapar Institute of Engineering & Technology
Arshdeep Kaur	Thapar Institute of Engineering & Technology

Abstract: The aim of this paper is to make the researchers aware that it is mathematically incorrect to use the existing knowledge measure (Soft Comput (2016) 20:3421-3442) for transforming the elements of the decision matrix, represented by an intuitionistic fuzzy set/ interval-valued intuitionistic fuzzy set (IVIFS) into real numbers. Furthermore, to make the researchers aware that the knowledge measure of an IVIFS, proposed by Das et al., is not valid.

CP FT-1-8 5 4 **12:00-12:20**

Vaishnavi method to find the optimal weight vector for the criteria of MCDM problems under picture fuzzy environment

Arshdeep Kaur	Thapar Institute of Engineering & Technology
Amit Kumar	Thapar Institute of Engineering & Technology

Abstract: It is pointed out that Wang et. al's method (J. Clean. Prod. 191 (2018) 105-118) can be used only for such multi-criteria decision making problems under picture fuzzy environment in which sum of the upper bounds of the weights is greater than or equal to 1. Also, to overcome the limitation of Wang et. al's method, a new method (named as Vaishnavi method) is proposed to determine the weights.

CP FT-1-8 5 5 **12:20-12:40**

Vaishnavi approach to find unique optimal fuzzy transportation cost of fuzzy transportation problems with generalized trapezoidal fuzzy numbers

Akansha Mishra	Thapar Institute of Engineering & Technology
Amit Kumar	Thapar Institute of Engineering & Technology

Abstract: In this paper , a fuzzy transportation problem is solved by Ebrahimnejad's approach (Applied Soft Computing 19 (2014) 171–176) and shown that more than one fuzzy numbers, representing the optimal

fuzzy transportation cost are obtained, which is inappropriate as the physical meaning of these fuzzy numbers are different. To resolve this flaw of Ebrahimnejad's approach, a new approach (named as Vaishnavi approach) is proposed for solving fuzzy transportation problmes.

CP A1-3-3 5 — 11:00-13:00

Industrial Applications in Agriculture, Fishing and Food

Chair Person: Steven Psaltis — Queensland University of Technology

CP A1-3-3 5 1 — **11:00-11:20**

Characterisation of southeast Queensland's southern pine timber resource: a mathematical approach

Steven Psaltis	Queensland University of Technology
Ian Turner	Queensland University of Technology
Troy Farrell	Queensland University of Technology
Elliot Carr	Queensland University of Technology
Chandan Kumar	Queensland Government
Henri Bailleres	Queensland Government
David Lee	University of the Sunshine Coast

Abstract: In this talk I'll discuss a recent large-scale collaborative project between the timber and forestry industry, government departments and academia, to understand the variability of wood properties from southeast Queensland's (Australia) southern pine resource. This resource is stiffness-limited, characterised by the modulus of elasticity (MOE). I will focus on prediction of MOE of sawn timber boards, based on data collected from diametrical cores of sample trees, and its importance to the timber and forestry industry.

CP A1-3-3 5 2 — **11:20-11:40**

Separation of potato crisps from a conveyor belt

Laura Hattam	Institute for Mathematical Innovation
Stacie Tibos	PepsiCo Inc.
Chris Budd	Institute for Mathematical Innovation

Abstract: As part of the manufacturing process for potato crisps, potato dough is lowered into a hot oil bath whilst attached to a conveyor belt. Next, due to a variety of factors, the crisp peels off the belt and rises towards the top. It is integral that this detachment process is well-understood in order to improve manufacturing efficiency. Consequently, in collaboration with PepsiCo, we have outlined a mathematical framework to closely examine the crisp detachment dynamics.

CP A1-3-3 5 3 — **11:40-12:00**

Mathematical modeling in support of marine resources conservation

Imane AGMOUR	Hassan II University, Morocco
Meriem BENTOUNSI	Hassan II University, Morocco
Naceur ACHTAICH	Hassan II University, Morocco
Youssef EL FOUTAYENI	Hassan II University, Morocco

Abstract: In this article, we seek to highlight that the increase of the carrying capacity of marine species does not always lead to an increase on the catch levels and on the incomes. To effectively support the theoretical outcomes, we take a bioeconomic model of several seiners exploiting Sardina pilchardus, Engraulis encrasicolus and Xiphias gladius marine species in the Atlantic coast of Morocco based on the parameters given by 'Institut National de Recherche Halieutique' INRH.

CP A1-3-3 5 4 — **12:00-12:20**

Mathematical modelling of milk powder properties during shipment through elevated temperatures and humidities

Steve Taylor	University of Auckland
Luke Fullard	Massey University
Richard Clarke	University of Auckland
Andrew Fowler	Oxford University
Valerie Chopovda	Massey University

Abstract: Milk powder can undergo a complexity of chemical reactions, all influenced by oxygen, moisture and temperature. Yet, even small changes in milk powder lead to noticeable changes in its flavour. When milk powder is shipped around the world, it is subjected to diverse environmental conditions for prolonged periods of time. We discuss how mathematical modelling sheds light on what can be done to preserve its flavour under these conditions.

CP A1-3-4 5 — 11:00-13:00

Numerical Analysis XI

Chair Person: Gowrisankar Subramaniam — National Institute of Technology Patna

CP A1-3-4 5 1 — **11:00-11:20**

Uniformly Convergent Discontinuous Galerkin Method for Singularly Pertubed Convection-Diffusion Problems on Adaptive Mesh

Gowrisankar Subramaniam	National Institute of Technology Patna

Abstract: In this talk we present a numerical scheme for singularly perturbed convection-diffusion partial differential equation. The proposed numerical scheme consists of discontinuous Galerkin finite element method with adaptive mesh. The numerical method is shown to be uniform convergent with respect to the perturbation parameter. The theoretical results are justified by numerical experiments.

CP A1-3-4 5 3 — **11:20-11:40**

Finite Element Analysis of the Constrained Dirichlet Boundary Control Problem Governed by Diffusion Equation.

Thirupathi Gudi	Indian Institute of Science
Ramesh Chandra Sau	Indian Institute of Science, Bangalore, India

Abstract: We will study an energy space based approach for the Dirichlet boundary optimal control problem governed by the Laplace equation with control constraints. I will present a finite element based numerical method using the linear Lagrange finite element spaces. A priori error estimates of optimal order in the energy norm will be derived up to the regularity of the solution. Some numerical experiments will be presented to ensure the theoretical results.

CP A1-3-4 5 4 — **11:40-12:00**

On a numerical method for estimating blow-up rates

Koichi Anada	Waseda University Senior High School
Tetsuya Ishiwata	Shibaura Institute of Technology
Takeo Ushijima	Tokyo University of Science

Abstract: We propose a simple but effective numerical method which estimates blow-up rates for nonlinear evolution equations. We assume the equations satisfy a scaling invariance. Thanks to this assumption, we adopt the rescaling algorithm and construct a sequence whose behavior leads to the blow-up rate. Applying the method to several nonlinear equations, we examine the effectiveness of the method. Our method is applicable to not only simple power type blow-up rates but also more complex ones.

CP A1-3-4 5 5 — **12:00-12:20**

New a posteriori error estimator for an stabilized mixed method in incompressible fluid flows

Tomas P. Barrios	Universidad Católica de la Santísima Concepción
Edwin M. Behrens	Universidad Católica de la Santísima Concepción
María González Taboada	Universidade da Coruña

Abstract: In this talk, we consider an augmented mixed finite element method introduced in Comput. Methods Appl. Mech. Engrg. 198, 280–291 (2008) for incompressible flows with symmetric stress tensor. We develop a simple a posteriori error analysis and obtain a new a posteriori error estimator that is reliable, locally efficient and much cheaper than the existing one. We will show numerical experiments that will illustrate the performance of the corresponding adaptive algorithm.

CP FT-4-5 5 — 11:00-13:00

Simulation and Modelling IV

Chair Person: Zhicheng HU — Nanjing University of Aeronautics and Astronautics

CP FT-4-5 5 1 — **11:00-11:20**

An efficient multigrid solver for steady-state Boltzmann equation

Zhicheng HU	Nanjing University of Aeronautics and Astronautics

Abstract: The simulation of the Boltzmann equation has attracted a great deal of attention in a variety of high-tech fields such as the rarefied

gas dynamics in astronautics and the fluid mechanics in micro-electro-mechanical systems, where the mean free path of fluid molecules becomes comparable to the characteristic length of the problem. In this talk, we concentrate on efficient solution strategies for the steady-state Boltzmann equation, based on multigrid method and hyperbolic moment method.

CP FT-4-5 5 2 11:20-11:40

A new LES model with nonlinear viscosity: derivation and numerical behavior

José Manuel Rodríguez Seijo	Universidade da Coruña
Raquel Taboada-Vázquez	Universidade da Coruña

Abstract: In this paper we present a new Large Eddy Simulation (LES) model obtained by filtering a generalized version of the Navier-Stokes equations with nonlinear viscosity. We compare the numerical resolution of this new model with analytical solutions of the Navier-Stokes equations finding that the new model improves convergence when compared with direct numerical simulation of the Navier-Stokes equations. The model is also validated by simulating the unsteady flow over a backward-facing step.

CP FT-4-5 5 3 11:40-12:00

Spectral element method for 3D elliptic equations in perforated domains

Akhlaq Husain	BML Munjal University Gurgaon
Arbaz Khan	University of Manchester

Abstract: In this paper we present a least-squares spectral element method for three dimensional elliptic partial differential equations in perforated domains. The formulation is based on the minimization of a functional by the least squares method. We develop numerical scheme, estimates for the error and the computational complexity and present numerical results for validation of the proposed method.

CP FT-4-5 5 4 12:00-12:20

Solitary wave solutions to convolution-type unidirectional wave equations

Husnu Ata Erbay	Ozyegin University
Saadet Erbay	Ozyegin University
Albert Erkip	Sabanci University

Abstract: We consider a convolution-type unidirectional wave equation involving the Rosenau equation as a particular case. When the nonlinear term is a certain quintic polynomial, a sech-type solution of the Rosenau equation was given by Park. For the Rosenau equation with a power nonlinearity, sech-type solutions have not been reported in the literature. This motivates us to study solitary wave solutions of the Rosenau equation with power-type nonlinearities. We compute numerically profiles of solitary waves.

CP FT-4-5 5 5 12:20-12:40

Modeling dilatancy effects for fluidized debris flows

Gladys Narbona-Reina	Universidad de Sevilla
François Bouchut	Université Paris-Est
Enrique D. Fernández-Nieto	Universidad de Sevilla
Anne Mangeney	Institute Physique Globe Paris
El Hadji Koné	Institute Physique Globe Paris

Abstract: Debris flows represent one of the major natural hazards in mountainous or coastal areas. In particular, the effect of dilation/compression plays a key role in the evolution of a landslide. In order to modelize this phenomenon for a more accurate prediction, we propose a two-phase system that includes dilatancy effects. It is achieved thanks to the friction force between the phases that is the responsible of the interstitial pressure allowing the dilation/contraction of the mixture.

CP A1-3-5 5 11:00-13:00

Optimization and Operations Research II

Chair Person: Aurelio Oliveira	University of Campinas

CP A1-3-5 5 1 11:00-11:20

A constructive convergence of Mixed Barrier-Penalty Method Applied to Interior Point Methds for Linear Programming

Aurelio Oliveira	University of Campinas
Porfirio Suñagua	Universidad Mayor de San Andrés

Abstract: In this work we present a new, constructive, global convergence proof of the sequence generated by a mixed bi-parametric barrier-penalty method. The proof uses main known results concerning barrier and penalty methods global convergence, however, it is done in a constructive way. The optimality conditions for some classical programming problems are provided allowing to design the corresponding interior point methods. To illustrate the approach, large-scale linear programming problems are solved with the developed algorithm.

CP A1-3-5 5 2 11:20-11:40

Dynamic VRPPDTW for urgent door to door express deliveries

EL RAOUI Hanane	international university of Rabat/ Granada university/Sidi Mohamed Ben Abdellah University
Oudani Mustapha	international university of Rabat
EL HILALI ALAOUI Ahmed	Sidi Mohamed Ben Abdellah University

Abstract: Due to the strong competitiveness in the market of express deliveries, companies are struggling with remaining a high price quality ratio. We suggest an approach to solve the vehicle routing problem with pickup and delivery and time windows in a dynamic environment where customers can request service on call, to help express companies offering a reliable and cost-effective door to door delivery for time sensitive parcels and documents.

CP A1-3-5 5 3 11:40-12:00

A nonlinear conjugate gradient method with sufficient descent property and global convergence

Olabode Matthias Bamigbola	University of Ilorin
Montaz M. Ali	University of the Witwatersrand
Emmanuel Nwaeze	Alex Ekwueme University

Abstract: As a result of its very low memory requirement, the conjugate gradient method, CGM, has been efficiently utilized in solving large-scale optimization problems. A new nonlinear CGM with such desirable features as conjugacy, descent property and global convergence, is proposed. The computational efficiency of the new method is demonstrated by comparing it with some existing methods on a variety of standard large-scale test problems. The numerical comparison establish the superior performance of the new method.

CP A1-3-5 5 4 12:00-12:20

On a shape derivative formula for a volume cost functional on a family of star-shaped domains

Azeddine SADIK	University Sultan Moulay Slimane
Abdelkrim CHAKIB	University Sultan Moulay Slimane
Abdesslam BOULKHEMAIR	University of Nantes

Abstract: This work is devoted to extend a shape derivative formula for volume cost functional with respect to a class of star-shaped domains, introduced already for convex domains, by using what is called gauge and support functions in convex analysis. Finally, we shall illustrate the formula by applying it to the computation of the shape derivative for an optimal shape design problem subject to a PDE and propose an algorithm of gradient type for solving it.

CP A1-3-5 5 5 12:20-12:40

Rank-adaptive methods for low-rank optimization

Guillaume Olikier	UCLouvain
P.-A. Absil	UCLouvain

Abstract: Various problems in machine learning or control can be formulated as optimization problems on a matrix manifold with an additional rank inequality constraint. To solve such optimization problems, a Riemannian rank-adaptive method has been proposed recently. This method requires to compute tangent cones to the feasible set. We will present ongoing work that aims to compute tangent cones to some feasible sets of interest and generalize the method to third-order tensors.

CP A1-3-5 5 6 12:40-13:00

Optimal feedback control for mathematical models of viscoelactic fluids motion

Andrey Zvyagin	Voronezh State University

Abstract: The existens problem of optimal feedback control for a number mathematical motion models of viscoelactic fluids will be studied. The existence of an optimal solution yielding the minimum of a specified bounded lower semicontinuous quality function will be proved. To establish the existence of an optimal solution, the topological approximation method for hydrodynamic problems will be used.

CP A1-3-2 5 11:00-13:00

General I

Chair Person: Cristinca FULGA	The Bucharest University of Economic Studies

CP A1-3-2 5 1 **11:00-11:20**

Value at Risk estimation models based on higher order moments

Cristinca FULGA The Bucharest University of Economic Studies

Abstract: Value at Risk (VaR) has a crucial role in the practice of risk, its accurate and fast determination being essential. Approximations of the VaR value can be obtained by using the models derived from the Cornish-Fisher expansion. Motivated by the drawbacks of these approximating formulas, we propose a new methodology for calculating the VaR of a portfolio based on statistical information that can be retrieved from the population of available feasible portfolios loss distributions.

CP A1-3-2 5 2 **11:20-11:40**

Optimal Construction of Loss function without Spurious Local Minima for Solving Quadratic Equation System

Zhenzhen Li Hong Kong University of Science and Technology

Jianfeng Cai Hong Kong University of Science and Technology

Ke Wei Fudan University

Abstract: The problem of solving quadratic equation system palys an important role in various applications. Considering real-valued case, a new loss function is constructed for this problem, which combines the smooth quadratic loss function with an activation function. Under gaussian measurements, we establish with high probability the target solution up to global sign is the unique local minimizaer, and negative curvature around its saddle, under optimal sampling complexity of m=O(n).

CP A1-3-2 5 3 **11:40-12:00**

TWO-DIMENSIONAL FLOW IN A DEFORMABLE CHANNEL WITH POROUS MEDIUM AND VARIABLE MAGNETIC FIELD

Abdullahi Adem North-West University

Abstract: This talk is concerned with the analytic solution for a nonlinear flow problem of an incompressible viscous fluid. The fluid is magnetohydrodynamic in the presence of a time-dependent magnetic field. Lie group method is applied in the derivation of analytic solution. The effects of the magnetic field, porous medium, permeation Reynolds number and wall dilation rate on the axial velocity are shown and discussed.

CP A1-3-2 5 4 **12:00-12:20**

On the bounds for the energy of a graph

Shariefuddin Pirzada University of Kashmir

Abstract: The energy E(G) of a graph G is defined as the sum of the absolute values of the eigenvalues of the adjacency matrix.. This concept is intensively studied in chemistry as it approximates the total pi-electron energy of a molecule. We obtain the stronger upper bounds for E(G) in terms of vertex covering number, clique number, number of edges, maximum vertex degree and second maximum vertex degree of the connected graph G.

CP A1-3-2 5 5 **12:20-12:40**

New heuristic solutions for the Capacitated Networks Design problems

Maiza Mohamed Ecole Militaire Polytechnique
Moussaoui Tarik Ecole Militaire Polytechnique
Dafeur Malek Ecole Militaire Polytechnique

Abstract: A variant of the capacitated-networks-design problem (CND) is studied where the flow of each commodity cannot be split even between two non-additives facilities on the same link. The objective is to find an optimal facility installation to rout a set of commodities. Thus, efficient heuristics based on the resolution of the shortest path of each commodity within an aggregate formulation is proposed. Several series of tests were done to prove the efficient of these heuristics.

CP A1-3-2 5 6 **12:40-13:00**

Discrete p-laplacian with weight depending on time and Applications

Soo-Oh Yang Yonsei University
Jae-Myoung Kim Yonsei University
Kyungkeun Kang Yonsei University

Abstract: Recently, the study of discrete p-laplcian on graph is gathering a lot of attentions due to ther applications, for example, machine learing and images processing, etc. In this talk, we consider an evolution type discrete p-laplacian equations on graph and discuss about long-time behavior of solutions.

CP A6-3-2 5 **11:00-13:00**

Control and Systems Theory I

Chair Person: Nitin Kumar Indian Institute of Technology, Delhi

CP A6-3-2 5 1 **11:00-11:20**

Solving Fractional Optimal Control Problems by Hermite Wavelet Collocation method

Nitin Kumar Indian Institute of Technology, Delhi

Mani Mehra Indian Institute of Technology, Delhi

Abstract: In this paper, we study a numerical method for solving fractional optimal control problems (FOCPs) by using Hermite wavelet operational matrix of fractional order integration (fractional derivatives are in the Caputo sense). The proposed technique is applied to transform the state and control variables into nonlinear programming (NLP) parameters at collocation points. An NLP solver can then be used to solve FOCPs. Illustrative examples are included to demonstrate the applicability of the proposed method.

CP A6-3-2 5 2 **11:20-11:40**

Model reduction techniques for port-Hamiltonian differential-algebraic systems

Sarah-Alexa Hauschild Universität Trier
Nicole Marheineke Universität Trier

Abstract: Port-based network modeling of multi-physics problems leads naturally to their formulation as port-Hamiltonian differential-algebraic systems. Thereby, the physical properties are directly encoded in the structure of the model equations. Since the state space dimension of such systems can easily become very large, there is an immediate need for model reduction methods that preserve the port-Hamiltonian structure while keeping the algebraic constraints unchanged. This talk will demonstrate such methods via the example of district heating networks.

CP A6-3-2 5 3 **11:40-12:00**

Robust tracking for linear system via UDE-Based Truncated Predictive Control

SELVARAJ PALANISAMY Chungbuk National University
OH-MIN KWON Chungbuk National University

Abstract: This paper investigated the robust tracking control problem for a class of linear system with unknown disturbance and input delay. More precisely, uncertainty and disturbance estimator (UDE)-based truncated predictive control design is presented to compensate for the effects of unknown bounded disturbance and known input delay, simultaneously. The proposed approach relies on state prediction model to estimate the current state for the feedback. Numerical simulations are provided to show the effectiveness of the proposed approach.

CP A6-3-2 5 4 **12:00-12:20**

Disturbance observer-based non-fragile control for synchronization of complex dynamical networks with time-varying coupling delay

KAVIARASAN BOOMIPALAGAN Chungbuk National University
OH-MIN KWON Chungbuk National University

Abstract: This paper presents a non-fragile control scheme for complex dynamical networks with multiple disturbances and time-varying coupling delay. A disturbance observer is designed to estimate exogenous disturbance, which is integrated with the proposed controller such that the required synchronization is achieved. Sufficient conditions for the existence of the desired observer and the non-fragile controller are established in terms of linear matrix inequalities. Simulations are provided to show the effectiveness of the proposed control strategy.

CP ME-1-G 5 **11:00-13:00**

Mathematics and Computer Science I

Chair Person: Walid Gomaa Egypt Japan University of Science and Technology

CP ME-1-G 5 1 **11:00-11:20**

Analysis of Video Surveillance Cameras of Highly Crowded Scenes

Walid Gomaa Egypt Japan University of Science and Technology

Allam Shehata	Egypt Japan University of Science and Technology
Mohamed Hussein	Egypt Japan University of Science and Technology

Abstract: Analysis of crowded scenes from video surveillance cameras is currently a very hot topic. Applications involve crowd planning and management in critical places such as metro and train stations, crowd simulation, as well as for automatic anomaly and event detection/prediction. In this paper, we introduce a robust approach to analysis of crowded scenes based on probabilistic modeling techniques and the use of machine learning approaches for estimation of the model parameters.

CP ME-1-G 5 2 **11:20-11:40**

Deep Learning for Human Activity Recognition Using Inertial Data

Walid Gomaa	Egypt Japan University of Science and Technology
Sara Ashry	Egypt Japan University of Science and Technology

Abstract: We collected and publicly released human activity dataset that consists of four types of 3D sensory signals: acceleration, angular velocity, rotation displacement, and gravity for 31 activities of daily living ADL measured by a wearable smart watch. We introduced a framework of ADL recognition based on LSTM recurrent network. This framework has achieved an accuracy of 95.3% for all activities. It was also evaluated on other four public datasets: CMU-MMAC, USC-HAD, REALDISP, and Gomaa datasets.

CP ME-1-G 5 3 **11:40-12:00**

An introduction to the “Group of High Performance Scientific Computing” (HiPerSC)

Emilio Defez	Universitat Politècnica de València
Javier Ibañez	Universitat Politècnica de València
Jesús Peinado	Universitat Politècnica de València
Jorge Sastre	Universitat Politècnica de València
Michael M. Tung	Universitat Politècnica de València

Abstract: The Group of High Performance Scientific Computing is a research group dedicated to scientific and high performance computing and its applications. We present here their main contributions to the calculation of matrix functions: mixed rational/polynomial approximations, a general family of methods for the computation of matrix polynomials which is more efficient than the Paterson-Stockmeyer method, and new series expansions of Hermite matrix polynomials, both polynomial and rational, for some of the most important matrix functions.

CP ME-1-G 5 4 **12:00-12:20**

Convergence analysis on the best low rank orthogonal CP approximation

Yu Guan	UCLouvain
Delin Chu	National University of Singapore

Abstract: In this paper, we study the low rank CP approximation of tensors. To ensure the global optimum of this problem existence in real space, an orthogonality constraint should be added. In our general setting, more than one matrix factor is required to be mutually orthonormal. Our proposed SVD-based algorithm improve two factors simultaneously and maintains the required orthogonality conditions by polar decomposition. Convergence analysis both for objective function and iterates themselves is also studied.

CP ME-1-G 5 5 **12:20-12:40**

On uniqueness and computation of block term tensor decompositions

Ignat Domanov	KU Leuven
Nico Vervliet	KU Leuven
Lieven De Lathauwer	KU Leuven

Abstract: We consider a minimal decomposition of a tensor into a sum of low multilinear rank-(M_r, N_r, L_r) terms. We find conditions on the terms which guarantee that the decomposition is unique and can be computed by means of the eigenvalue decomposition of a matrix. We show that the number of terms and the parameters Mr, Nr, Lr can be estimated. We consider both the case where the decomposition is exact and the case where the decomposition holds only approximately.

CP FT-1-7 5 11:00-13:00

Linear Algebra and Geometry I

Chair Person: Ching-Sung Liu	National University of Kaohsiung

CP FT-1-7 5 1 **11:00-11:20**

The numerical methods for nonlinear eigenvalue problems

Ching-Sung Liu	National University of Kaohsiung
Chun-Hua Guo	University of Regina
Wen-Wei Lin	National Chiao Tung University

Abstract: In this talk, we will introduce nonlinear eigenvalue problems, including tensor eigenvalue problems and nonlinear Schrödinger equations. We will discuss its numerical methods and some numerical results. A great advantage of this method is that it converges quadratically and is positivity preserving in the sense that the vectors approximating the Perron vector (or the ground state vector) are strictly positive in each iteration.

CP FT-1-7 5 2 **11:20-11:40**

Toeplitz Matrices with Symmetric Eigenvalues

N. Brad Willms	Bishop's University
Trevor H. Jones	Bishop's University

Abstract: In 1994 H. J. Landau proved that for any set of n distinct, real values there exists a real symmetric Toeplitz matrix, within the class of what he defined as “regular” Toeplitz matrices, possessing these as its eigenvalues. The proof was not constructive. Thus the Toeplitz inverse eigenvalue problem (TIEP) is known to have a regular solution for distinct eigenvalues. We characterize regular, real symmetric Toeplitz matrices with symmetric spectra as odd checkerboard matrices.

CP FT-1-7 5 3 **11:40-12:00**

On a generalization of the Silvester-Kac matrix.

Mikhail Tyaglov	Shanghai Jiao Tong University

Abstract: Recently C. da Fonseca et al considered a model for deposition and evaporation on discrete cells of a finite array of any dimension that led to a matrix equation involving a Sylvester–Kac type matrix. They found the eigenvalues and eigenvectors of that matrix and generalized some results of R. Askey and O. Holtz. In this talk, we discuss a somewhat novel approach that allows to generalize the results of all previous authors.

CP FT-1-7 5 4 **12:00-12:20**

Exceptional paths in the geometry of eigenvector matrices

Brian Sutton	Randolph-Macon College

Abstract: Because the phase of an eigenvector is arbitrary, what we call an "eigenvector matrix" may really be an equivalence class of unitary matrices. The quotient space U(n)/(U(1)*...*U(1)) of these objects is called a flag manifold. We are generally concerned with computations on flag manifolds, such as computing distances between eigenvector matrices. This talk will consider some exceptional points that reveal aspects of the global geometry and that admit closed-form expressions for geodesics.

CP FT-1-7 5 5 **12:20-12:40**

Efficient Factorizations of Large-Scale Oblique Projection Matrices

Johannes Brust	Argonne National Laboratory
Roummel Marcia	University of California Merced
Cosmin Petra	Lawrence Livermore National Laboratory

Abstract: Oblique projections are non-symmetric projection matrices, used in weighted least-squares, signal processing, and constrained optimization. We develop the eigendecomposition and an efficient Singular Value Decomposition of oblique projections. When the dimension of the range space is low in relation to the matrix size, we propose algorithms for accurate SVDs, which are several times faster than popular alternatives. We demonstrate how to apply the factorizations to optimization problems, by eigendecomposing large-scale Hessian matrix approximations.

CP FT-1-7 5 6 **12:40-13:00**

A highly parallel algorithm for computing the action of a matrix exponential on a vector based on a multilevel Monte Carlo method

Juan Acebron	ISCTE-University Institute of Lisbon
Jose Ramon Herrero	Universitat Politecnica de Catalunya
Jose Monteiro	Instituto Superior Tecnico

Abstract: A novel algorithm for computing the action of a matrix exponential over a vector is proposed. The algorithm is based on a multilevel Monte Carlo method, and the vector solution is computed probabilistically generating suitable random paths which evolve through the indices of the matrix according to a suitable probability law. This new algorithm allows in practice the computation of much more accurate solutions and to develop a highly scalable implementation.

MS FT-4-4 6 **14:30-16:30**

Advances in Monte Carlo Methods and Applications - Part 2

For Part 1 see: MS FT-4-4 5
For Part 3 see: MS FT-4-4 7
For Part 4 see: MS FT-4-4 8
For Part 5 see: MS FT-4-4 9

Organizer: David Aristoff — Colorado State University
Organizer: Gideon Simpson — Drexel University

Abstract: Monte Carlo methods continue to be the primary tool for a host of problems posed in high dimensional spaces in fields as diverse as materials science, data science, and uncertainty quantification. These applications demand both novel algorithms and mathematical analysis to ensure accuracy and optimal performance. This minisymposium will bring together researchers and practitioners to discuss the latest results on Monte Carlo algorithms and their application. Key topics will include Gibbs-Boltzmann sampling, free energy calculations, rare event simulation, uncertainty quantification, optimization, and ensemble and particle methods.

14:30-15:00

Stratification as a Variance Reduction Method for Markov Chain Monte Carlo

Brian Van Koten — UMass Amherst

Abstract: In stratified surveys, one divides a population into homogeneous subgroups and then samples each subgroup independently. Stratification often permits accurate computation of statistics from a sample much smaller than required otherwise. One can stratify MCMC simulations as well as surveys. I will explain how to use stratified MCMC for a broad class of problems, including both the computation of averages with respect to an arbitrary target distribution and the computation of dynamical quantities like rates.

15:00-15:30

Tensorized Adaptive Biasing Force Method for Molecular Dynamics

Virginie Ehrlacher — Ecole des Ponts Paristech & INRIA
Tony Lelièvre — Ecole des Ponts Paristech & INRIA
Pierre Monmarché — Université Paris Sorbonne

Abstract: The Adaptive Biasing Force (ABF) Method is an importance sampling method which aims at accelerating the rates of convergence of macroscopic averages in molecular dynamics simulations. This talk will present a numerical method which reads as a combination of tensor approximations and ABF, which can be used in situations where the number of reaction coordinates of the system is large, theoretical convergence and preliminary numerical results.

15:30-16:00

Expanding our statistical mechanical toolbox with modern molecular dynamics simulations

Cameron Abrams — Drexel University

Abstract: Our group is devoted to overcoming finite sampling problems in molecular dynamics simulations with novel methods. I will highlight the development and application of several modern MD techniques, including (i) temperature-acceleration for enhanced sampling, (ii) climbing string method for identifying saddle points on free-energy surfaces, and Markovian milestoning for computing transition rates. Applications to be discussed include ligand entry and exit kinetics in enzymes and transmembrane ion transport.

MS FT-4-2 6 **14:30-16:30**

Recent advances on computational wave propagation - Part 2

For Part 1 see: MS FT-4-2 5
For Part 3 see: MS FT-4-2 7

Organizer: Jichun Li — University of Nevada Las Vegas
Organizer: Lise-Marie Imbert-Gérard — University of Maryland
Organizer: Yunqing Huang — Xiangtan University, China

Abstract: This mini-symposium will include investigations of recent achievements on numerical analysis and mathematical modeling of wave propagation problems. 12 leading experts from 8 countries are temporary agreed to speak in our mini-symposium. Topics include development and analysis of numerical methods for electromagnetic wave propagation or scattering in photonics, complex dispersive media and plasmonics etc.

14:30-15:00

Multi-resolution vertical mode expansion method for modeling photonic crystal devices

Ya Yan Lu — City University of Hong Kong

Abstract: A typical photonic crystal device (PCD) is a non-periodic structure on a dielectric slab with sub-wavelength air-holes. To simulate a PCD numerically, one has to truncate waveguides and solve the 3D Maxwell's equations in a domain much larger than the wavelength. We present a mutli-resolution vertical mode expansion method for PCDs. It takes advantage of the slab structure by using 1D eigenmode expansions and the partial periodicity by computing DtN maps for unit cells.

15:00-15:30

An efficient formulation and algorithm for simulation of a class of wave propagation models

Victor Dominguez — Universidad Publica de Navarra
Mahadevan Ganesh — Colorado School of Mines
Francisco-Javier Sayas — University of Delaware

Abstract: We present a new method for modelling the acoustic scattering from a non-homogeneous obstacle by combining Finite Elements in a neighborhood of the inhomogeneity an integral representation of the solution (BEM) valid in the exterior. Both representations are determined by making them coincide in an artificial domain containing the obstacle. We then enjoy: fast convergence from the BEM, capturing properly the behavior at infinity and the flexibility of the FEs to work with the inhomogeneities.

15:30-16:00

Optical Phenomena on Layered Heterostructures

Matthias Maier — Texas A&M University

Abstract: Plasmonic crystals, a class of particularly interesting metamaterials, consist of stacked metallic layers arranged periodically with subwavelength distance, and embedded in a dielectric host. These structures have made it possible to observe aberrant behavior such as the epsilon-near-zero effect. This level of control of the path and dispersion of light is of fundamental interest. In this talk we present analytical and computational results for the simulation of optical phenomena on layered structures.

16:00-16:30

Finite element analysis and simulation of surface plasmon polaritons in graphene

Jichun Li — University of Nevada Las Vegas
Yunqing Huang — Xiangtan University
Wei Yang — Xiangtan University

Abstract: Graphene was invented in 2004. Due to its outstanding electrical, mechanical, magnetic, and thermal properties, graphene has gained significant interest among scientists as evidenced by the award of Nobel Prize in Physics 2010 to two graphene experts. In this talk, I will focus on the development and analysis of a mathematical model for simulating the surface plasmon polaritons. Finite element method for solving this model will be presented. Finally, I will show some numerical simulations.

MS GH-1-A 6 **14:30-16:30**

Theoretical Foundations of Deep Learning - Part 2

For Part 1 see: MS GH-1-A 5
For Part 3 see: MS GH-1-A 7

Organizer: Gitta Kutyniok — Technische Universität Berlin
Organizer: Philipp Petersen — University of Oxford

MS Organized by: SIAG/IS

Abstract: Deep learning is the key technology in the latest advances in self-driving cars, natural language processing, and medical diagnosis. Despite its overwhelming success, several empirically observed phenomena of this technique are not entirely understood, including the remarkable generalisation properties of the resulting classifiers, their tendency to exhibit adversarial examples, and the success of the underlying optimisation procedure despite a highly non-convex energy landscape. Several of these issues were addressed individually using various techniques from approximation theory, statistical learning theory, or optimisation. To achieve more profound insights, an exchange between the individual contributors is essential and the focus of this mini-symposium.

14:30-15:00

A theoretical analysis of machine learning and partial differential equations

Philipp Petersen	University of Oxford

Abstract: We analyse to what extent deep neural networks can be used as ansatz systems for the solution of PDEs. In this regard, we analyse approximation and optimisation theoretical aspects of sets of neural networks. We observe that neural networks are very efficient approximators for classes of functions relevant in PDE applications and can even overcome the curse of dimension. However, the set of neural networks is very complicated which potentially hinders provably efficient optimisation.

15:00-15:30

On the Global Convergence of Gradient Descent for Over-parameterized Models using Optimal Transport

Francis Bach	INRIA - Ecole Normale Supérieure

Abstract: Many tasks in machine learning and signal processing can be solved by minimizing a convex function of a measure (sparse spikes deconvolution or training a neural network with a single hidden layer). In our algorithm, the unknown measure is discretized into a mixture of particles and a continuous-time gradient descent is performed on their weights and positions. We show that, when initialized correctly and in the many-particle limit, this gradient flow converges to global minimizers.

15:30-16:00

On Optimization Landscape in Deep Learning

Kenji Kawaguchi	Massachusetts Institute of Technology

Abstract: As the amount of available data is increasing, there is a rise in the demand of methods to make predictions based more on data, such as deep learning. However, deep learning typically requires us to deal with non-convex optimization. In this talk, I will present recent theoretical analyses of non-convex optimization problems in deep learning.

16:00-16:30

On the Implicit Bias of Dropout

Jeremias Sulam	Johns Hopkins University
Poorya Mianjy	Johns Hopkins University
Raman Arora	Johns Hopkins University
Rene Vidal	Johns Hopkins University
Ben Haeffele	Johns Hopkins University
Jacopo Cavazza	Johns Hopkins University

Abstract: While dropout is an effective regularization technique in deep learning, its theoretical properties remain elusive. This talk presents a complete characterization of the optimization and regularization properties of dropout for single-hidden-layer-linear-neural networks. We show that dropout applies stochastic gradient descent to a certain regularized loss, and that the regularizer induces solutions that are low-rank (smallest number of neurons) and balanced (product of norms of incoming and outgoing weight vectors is the same for all neurons).

MS A6-4-2 6 14:30-16:30

State estimation, prediction, and uncertainty quantification in geophysics - Part 1

For Part 2 see: MS A6-4-2 7

Organizer: Mustafa Mohamad	Courant Institute, New York University
Organizer: Di Qi	New York University

MS Organized by: SIAG/CSE

Abstract: The uncertainty quantification of complex nonlinear systems in geophysics and climate is amongst the most challenging problems in applied math. This minisymposium will highlight recent work aimed at understanding various aspects of turbulent complex system including their control, state estimation, prediction, and model error to applications related to problems in geophysics and meteorology. Various methods and techniques have been applied to understand such systems, including statistical approaches, stochastic modelling, information theory, and dynamical systems theory. We highlight various important approaches, by bringing together experts with diverse backgrounds to highlight recent advances.

14:30-15:00

Reduced-Order Statistical Models for Predicting Statistical Responses and Extreme Events in Geophysics

Di Qi	New York University
Andrew Majda	Courant institute, NYU

Abstract: The capability of using imperfect reduced-order models to capture crucial statistics in turbulent flow and passive tracers is investigated. Simpler and more tractable models are proposed to approximate the high-dimensional turbulent flow equations. A systematic framework with empirical information theory is introduced, and optimal model parameters can be achieved. It is demonstrated that crucial principal statistical quantities can be captured efficiently with accuracy using the reduced-order model in various dynamical regimes.

15:00-15:30

Stochastic superparameterization through local data generation.

Yoonsang Lee	Dartmouth College

Abstract: Stochastic superparameterization is a class of multiscale methods that approximate large-scale dynamics of complex dynamical systems such as turbulent flows. Unresolved sub-grid scales are modeled by a cheap but robust stochastic system that mimics the true dynamics of the sub-grid scales, which is crucial to model non-trivial and non-equilibrium dynamics. In this talk, we propose a numerical procedure to estimate the modeling parameters, which avoids the use of climatological data.

15:30-16:00

Accelerating data assimilation through reduced precision arithmetic

Sam Hatfield	University of Oxford
Tim Palmer	University of Oxford
Peter Dueben	European Centre for Medium-Range Weather Forecasts

Abstract: We present a new approach for improving the efficiency of data assimilation, by trading numerical precision for computational speed. We will present results on how lowering numerical precision affects the performance of two data assimilation systems: the ensemble Kalman filter and 4D-Var. The lowest usable level of precision is related to the level of uncertainty present: with greater uncertainty, precision is less important.

MS FT-2-1 6 14:30-16:30

Advances in models and numerical methods for environmental flows - Part 2

For Part 1 see: MS FT-2-1 5

Organizer: Luca Bonaventura	POLITECNICO DI MILANO - LABORATORIO MOX
Organizer: Gladys Narbona Reina	University of Sevilla
Organizer: Enrique Domingo Fernández Nieto	Universidad de Sevilla

Abstract: The minisymposium will present an overview of advanced numerical methods and modeling for environmental flows and geophysical fluid dynamics. Developments in the formulation, implementation, and application of numerical techniques will be reviewed, including high order finite elements, multilevel discretizations, dynamical adaptation and High-Performance Computing aspects. The participants are active in major research centers and university departments with a significant record of research activity in this field. The minisymposium can be of great interest to all ICIAM participants by presenting recent research results of major relevance and potential also in other areas of computational fluid dynamics and applied mathematics.

14:30-15:00

LES for variable density flows with high order DG methods

Caterina Bassi	Istituto Nazionale di Alta Matematica
Antonella Abbà	Dipartimento di Scienze e Tecnologie Aerospaziali, Politecnico di Milano
Luca Bonaventura	MOX - Modelling and Scientific Computing, Dipartimento di Matematica, Politecnico di Milano
Lorenzo Valdettaro	MOX - Modelling and Scientific Computing, Dipartimento di Matematica, Politecnico di Milano

Abstract: We perform 3D DNS and LES of turbulent gravity currents with a Discontinuous Galerkin Finite Elements method. The DNS allows to capture the loss of coherence of turbulent structures, providing an accurate description of the phenomenon. The DNS is employed to assess different LES models (Smagorinsky, isotropic and anisotropic dynamic models).The LES highlight the excessively dissipative nature of the Smagorinsky model with respect to the dynamic models, with better results provided by the anisotropic model.

15:00-15:30

Numerical analysis and simulation of the free surface Navier-Stokes-Fourier system (flows with varying densities)

Jacques Sainte-Marie	Inria & Sorbonne Univeristy
Bristeau Marie-Odile	Inria & Sorbonne University
Boittin Léa	Inria & Sorbonne University
Souillé Fabien	Inria & Sorbonne University
Mangeney Anne	IPGP
Bouchut François	University Paris-Est

Abstract: We are interested in free surface flows where density variations coming e.g. from temperature or salinity differences play a significant role. Based on a layer-averaged discretization of the 3d Navier-Stokes-Fourier system, we present a numerical scheme endows with the following stability properties : domain invariant, well-balanced, maximum principle, fully discrete entropy. Analytical and experimental validations are presented.

15:30-16:00

Efficient non-hydrostatic pressure systems with enhanced dispersive properties

ECCOMAS Prize for the Best Ph.D. Thesis of 2018

Cipriano Escalante Sánchez	Universidad de Málaga
Enrique D. Fernández-Nieto	Universidad de Sevilla
Tomás Morales De Luna	Universidad de Córdoba
Manuel J. Castro Díaz	Universidad de Málaga

Abstract: In this talk, we present a shallow-water non-hydrostatic pressure system for two levels. The equations are obtained by a process of depth-averaging on the vertical direction. The total pressure is decomposed into a sum of hydrostatic and non-hydrostatic pressures. A slight correction in the non-hydrostatic pressure is proposed enhancing the dispersive properties of the system. The efficiency and accuracy of the resulting method for the simulation of dispersive water waves will be highlighted.

16:00-16:30

A non-hydrostatic model for free-surface flows

Yohan Penel	INRIA
Fernandez-Nieto Enrique D.	University of Sevilla, Spain
Sainte-Marie Jacques	Inria Paris, France
Parisot Martin	Inria Paris, France
Morales-de Luna Tomas	University of Cordoba, Spain
Escalante-Sanchez Cipriano	University of Malaga, Spain

Abstract: To model free surface shallow water flows, we consider a non-hydrostatic model, i.e. a system of 4 prognostic equations and 2 diagnostic equations corresponding to an approximation of the free divergence constraint. This is highly more complicated than the classic Shallow Water equations. To avoid prohibitive computational costs, we consider a splitting strategy combined with the Uzawa algorithm. Numerical analysis is carried out to ensure properties still hold at the discrete level.

MS FT-S-3 6 14:30-16:30

Efficient time-stepping methods for differential problems with special features - Part 2

For Part 1 see: MS FT-S-3 5

Organizer: DOMINGO HERNANDEZ ABREU	UNIVERSITY OF LA LAGUNA
Organizer: Dajana Conte	Dipartimento di Matematica, Univ. di Salerno

Abstract: This minisymposium deals with recent advances in the numerical treatment of differential equations with applications to some relevant PDE and stochastic models. These include reaction-diffusion problems, stochastic oscillators or models from financial option pricing, among others. Special emphasis is placed on the design and analysis of accurate and optimized numerical methods, as well as their efficient implementations. The minisymposium also aims at promoting and enhancing collaborations between researchers with interest in the above-mentioned topics.

14:30-15:00

Implicit and Explicit Parallel Across Method Error Inhibiting Schemes

ZACHARY GRANT	Oak Ridge National Laboratory
Sigal Gottlieb	University of Massachusetts Dartmouth
Adi Ditkowski	Tel Aviv University

Abstract: In the work of Gottlieb and Ditkowski it was shown one can inhibit the accumulation of local truncation errors of Type III DIMSIMs with certain coefficients. Additionally the individual stages can be computed in parallel, allowing a reduction of the overall runtime. We extend the Error Inhibiting Scheme formulation to explicit and implicit methods with a global error two orders higher than the LTE, and construct new methods of varying orders with desirable stability properties.

15:00-15:30

Scalable High-Order Time-Stepping via Krylov Subspace Spectral Methods

JAMES LAMBERS	UNIVERSITY OF SOUTHERN MISSISSIPPI

Abstract: For time-dependent PDEs, both linear and nonlinear, Krylov Subspace Spectral (KSS) methods offer a balance between the efficiency of explicit methods and the stability of implicit methods, by computing each Fourier coefficient using techniques of Golub and Meurant for approximating bilinear forms. It is shown how asymptotic analysis of block Krylov projection can dramatically improve efficiency while preserving accuracy. New theoretical results pertaining to stability will also be presented.

15:30-16:00

Adaptive Linear Multistep Methods

Fekete Imre	Eötvös Loránd University

Abstract: In a k-step adaptive linear multistep methods the classical error model is based on the asymptotic model. This doesn't reflect actual computations with multistep methods, where the step-size control selects the next step-size, based on information from previous accepted steps. We derive dynamic asymptotic models of the local error and its estimator, and show how to use dynamically compensated step-size controllers that keep the asymptotic local error near a prescribed tolerance TOL.

16:00-16:30

Low Storage Strong Stability Preserving Runge-Kutta Implementations

TEODORO ROLDAN MARRODAN	UNIVERSIDAD PUBLICA DE NAVARRA

Abstract: Strong Stability Preserving (SSP) Runge-Kutta methods have been studied in the literature and stepsize restrictions that ensure numerical monotonicity have been found. We study the family of third order 5-stage optimal SSP schemes, and analyze different properties such as the low storage pattern, the leading term of the local error and the observed SSP coefficient. In this way, we obtain the *best* optimal SSP(5,3) methods. These schemes achieve the highest possible value for the SSP coefficient, however they cannot be implemented in *2N* memory registers. It is possible to find *2N* low-storage SSP(5,3) methods. They are no optimal, but achieve an SSP coefficient good enough and they have other relevant properties.

MS ME-1-0 6 14:30-16:30

Anisotropic variational models and partial differential equations - Part 1

For Part 2 see: MS ME-1-0 7

Organizer: Bertram Düring	University of Sussex
Organizer: Carola-Bibiane Schönlieb	University of Cambridge

Abstract: Anisotropic structures frequently arise in nature, biology, socio-economic modelling, mathematical imaging and data analysis. This minisymposium brings together research that ranges from the modelling and analysis to the numerical solution of anisotropic partial differential equations and anisotropic variational regularisation models. The anisotropic nature of these problems requires bespoke analytical and numerical techniques that will be discussed in talks featured in this minisymposium.

14:30-15:00

Proper regularizers for semi-supervised learning

Dejan Slepcev	Carnegie Mellon University
Matthew Thorpe	Cambridge University

Jeff Calder University of Minnesota

Abstract: Given a data set with a few labeled points the task is to extrapolate the label values to the whole data set. To utilize the geometry of the dataset one creates a graph by connecting nearby points. We consider functionals, which reward the agreement with the labels and the regularity of the estimator. Our models overcome the issues observed in Laplacian learning. We show that properly weighted models converge to solutions of elliptic PDE.

15:00-15:30

Second order methods for the solution of anisotropic total variation denoising models

Juan Carlos De Los Reyes Centro de Modernización Matemática/Escuela Politécnica Nacional de Quito

Abstract: We present a second order method for solving composite sparse optimization problems given by 1–norm of a matrix times the coefficient vector. Our proposed method generalizes the previous second order algorithms designed for sparse problems. We extend its three main ingredients to the case of the generalized composite optimization: orthant directions, projection step and, in particular, the full second–order information associated to the nondifferentiable terms.

15:30-16:00

An Anisotropic Interaction Model for Simulating Fingerprints

Lisa Maria Kreusser University of Cambridge

Abstract: Motivated by the formation of fingerprints we consider a class of interaction models with short-range repulsive, long-range attractive forces whose orientations depend on an underlying stress field. This stress field introduces an anisotropy leading to complex patterns which do not occur in the associated isotropic models. We analyze the steady states and their stability by considering the microscopic and the macroscopic formulations. Besides, we propose a bio-inspired model to simulate fingerprint patterns as stationary solutions.

16:00-16:30

Equilibrium measures for nonlocal interaction energies: The role of anisotropy

Maria-Giovanna Mora Università di Pavia

Abstract: Particle systems subject to long-range interactions can be described, for large numbers of particles, in terms of continuum models involving nonlocal energies. For radially symmetric interaction kernels, several authors have established qualitative properties of minimizers for this kind of energies. But what can be said for anisotropic kernels? Starting from an example that describes dislocation interactions in metals, I will discuss how the anisotropy may affect the equilibrium measure and, in particular, its dimensionality.

MS FT-S-6 6 14:30-16:30

Recent advances on numerical methods and applications of phase-field models - Part 2

For Part 1 see: MS FT-S-6 5
For Part 3 see: MS FT-S-6 7
For Part 4 see: MS FT-S-6 8

Organizer: Chuanju Xu Xiamen University

Abstract: Interfacial dynamics in complex fluids presents tremendous challenges to science. From a fluid mechanical viewpoint, the essential physics is the coupling between interfacial movement and the flow of the bulk fluids. Phase field methods start from a multi-scale point of view and treat the interface as a microscopic transition zone of small but finite width. Then a set of governing equations can be derived that are thermodynamically consistent and mathematically well-posed. This mini-symposium will bring together numerical analysts and computational scientists working on phase field methods to present their recent advances in algorithm designs and applications of phase field methods.

14:30-15:00

A decoupled finite element method for the coupled two-phase porous media flow and free flow

Xiaoming He Missouri University of Science and Technology
Yali Gao Northwestern Polytechnical University
Liquan Mei Xi'an Jiaotong University
Xiaofeng Yang University of South Carolina

Abstract: We present an efficient numerical method for the Cahn-Hilliard-Navier-Stokes-Darcy interface model. The coupled system is decoupled based on seven interface conditions which couple the Cahn-Hilliard-Navier-Stokes for the free flow with the Cahn-Hilliard-Darcy equation for the porous media flow. The scheme is linearized and energy stable. A modified discrete energy is introduced with an interface component. Numerical experiments are presented to illustrate the features of the proposed numerical method and verify the theoretical conclusions.

15:00-15:30

Spectral methods to describe transition to chaos in incompressible Navier-Stokes with heat

Henar Herrero Sanz Universidad de Castilla-La Mancha
Damián Castaño Universidad de Castilla-La Mancha
María Cruz Navarro Universidad de Castilla-La Mancha

Abstract: The studied scheme is a second-order time-splitting method combined with a pseudo-spectral Fourier Chebyshev in space to solve incompressible Boussinesq Navier-Stokes equations in a cylinder with a primitive variable formulation. The chaotic flow regime is reached after a sequence of successive supercritical Hopf bifurcations to periodic, quasiperiodic, and chaotic flow regimes.

15:30-16:00

Numerical schemes for the viscous Cahn-Hilliard / Navier-Stokes equations with dynamic boundary conditions

Laurence Cherfils La Rochelle University
Madalina Petcu University of Poitiers, France

Abstract: We consider the coupling between the viscous Cahn-Hilliard and the incompressible Navier-Stokes equations, which models the motion of isothermal mixture of two confined immiscible fluids with comparable densities and viscosities. We endow these equations with dynamic boundary conditions, which allow us to take into account the interaction between the fluids interface and the walls of the physical domain. We will present two numerical schemes corresponding to two kinds of dynamic boundary conditions.

16:00-16:30

A Highly-Accurate Numerical Method for the Solution of the Two-Dimensional Allen-Cahn Equation

Emine Celiker University of Lincoln
Ping Lin University of Dundee

Abstract: In this study, the O(ε) formal asymptotic expansion of the solution to the Allen-Cahn equation is obtained in a polygon, where ε is the width of the interface. From this it is seen that the intersection of the interface with the re-entrant corners of the domain causes strong singularities in the solution. To overcome the effect of the singularities, we develop an efficient finite-element method with exponential mesh refinement in the vicinity of singular corners.

MS ME-1-1 6 14:30-16:30

Advances in NonSmooth Dynamical Systems within Spanish Network DANCE - Part 2

For Part 1 see: MS ME-1-1 5

Organizer: Victoriano Carmona Universidad de Sevilla
Organizer: Soledad Fernandez Garcia Universidad de Sevilla
Organizer: Antonio E. Teruel Universidad de las Islas Baleares

Abstract: The network DANCE (Dynamics, Atractors and Non Linearities. Chaos and Stability) aims at being the meeting point of the Spanish researchers in Dynamical Systems. Some nodes focus on their research in the analysis of the nonsmooth systems. This analysis is based in the applications because these systmes are able to model several mechanical and electronic elements. The goal of this minisymposium is to show some advances in nonsmooth dynamics done in the network. The minisymposium is divided into parts. The first part is devoted to the piecewise linear systems. The second part focuses on the singularly perturbed nonsmooth systems.

14:30-15:00

Saddle-Node Canards in a piecewise linear version of the FitzHuhg-Nagumo system. II. Supercritical case: Three canard cycles.

Antonio E. Teruel Universidad de las Islas Baleares
Victoriano Carmona Centeno Universidad de Sevilla
Mathieu Desroches Inria, Sophia Antipoli - Méditerranée Center

Soledad Fernández-García Universidad de Sevilla

Abstract: We study canard cycles in a PWL version of the FitzHugh-Nagumo system by using singular perturbation theory tools. We focus on the supercritical case. Novel slow-fast behavior is obtained: we prove the existence of canard cycles growing at double speed than usual ones. Here, we find situations with two saddle-node bifurcations which take place exponentially close in parameter space; one of headless canards and another of canards with head. There, three canard cycles can coexist.

15:00-15:30

Saddle-Node Canards in a PWL version of the FitzHuhg-Nagumo system. I. Subcritical case: Transitory canards.

Soledad Fernández-García Universidad de Sevilla
Victoriano Carmona Universidad de Sevilla
Mathieu Desroches Inria Sophia Antipolis - Méditerranée Centre
Antonio E. Teruel Universidad de las Islas Baleares

Abstract: We study canard cycles in a PWL version of the FitzHugh-Nagumo system by using singular perturbation theory tools. In this talk, we focus on the subcritical configuration. We find saddle-node bifurcations of canard cycles with head for some values of the parameters and without head for other values of the parameters and we detect a transition between both type of saddle-node canard orbits. These saddle-node canard cycles are referred to as transitory canards.

15:30-16:00

A Pitchfork bifurcation of periodic orbits in hysteretic systems

Marina Esteban Universidad de Sevilla
Enrique Ponce Universidad de Sevilla
Francisco Torres Universidad de Sevilla

Abstract: Planar piecewise linear systems with hysteresis coming from a dimensional reduction of symmetric 3D systems with slow-fast dynamics are considered. We concentrate our attention on the cases of saddle and node dynamics, determining the existence and stability of periodic orbits as well as possible bifurcations. Our analysis rigorously shows, apart from standard bifurcations, a pitchfork bifurcation of periodic orbits being responsible for the coexistence of up to four different periodic orbits.

MS FE-1-G 6 14:30-16:30

Large-Scale Structured Matrix and Eigenvalue Computations - Part 2

For Part 1 see: MS FE-1-G 5

Organizer: Tiexiang Li Southeast University
Organizer: Eric Chu Monash University

Abstract: We are interested in the numerical solution of large-scale problems with structures. The problems arise from diverse real-life applications range from 3D Maxwell equations, big data, photonics crystals, the Procrustes problem, Markovian jump systems, structure-preserving flows and facial recognition. We are linked by our attempts to benefit from some structures in the problems. In the associated numerical computations, techniques in large-scale matrix and eigenvalue problems are applied and analyzed. The speakers (seven male and one female) come from China, Taiwan and Australia, in various stages of their careers.

14:30-15:00

Coupled Lyapunov and algebraic Riccati equations arising in Markovian jump systems

Eric King-Wah Chu Monash University

Abstract: We consider the solution of the coupled algebraic Riccati equation, arising in the optimal control of linear systems driven by a Markov chain. Newton's method is applied to construct the solutions, leading to some coupled Lyapunov and Stein equations. The linear equations are analyzed, leading to the solvability condition in terms of stabilizability. Several iterative methods of $O(n^3)$ computational complexity have been proposed for the coupled Lyapunov and Stein equations. Illustrative examples will be presented.

15:00-15:30

Structure-preserving flows of symplectic matrix pairs

Shih-Feng Shieh National Taiwan Normal University

Abstract: We construct a nonlinear differential equation of matrix pairs (M(t),L(t)) that is invariant in the class of symplectic matrix pairs. Its solution also preserves invariant subspaces on the whole orbit. Such a flow is called a structure-preserving flow and is governed by a Riccati differential equation (RDE). Radon's lemma leads to the explicit form of the solution. We then utilize the Grassmann manifolds to extend the domain of the structure-preserving flow to the whole R.

15:30-16:00

A structure preserving flow for computing Hamiltonian matrix exponential

Yueh-Cheng Kuo National University of Kaohsiung

Abstract: This article focuses on computing Hamiltonian matrix exponential. Given a Hamiltonian matrix H, it is well-known that the matrix exponential e^H is a symplectic matrix and its eigenvalues form reciprocal $\left(\lambda\middle| 1/\bar{\lambda}\right)$. It is important to take care of the symplectic structure for computing e^H. Based on the structure-preserving flow preposed by Kuo, we develop a numerical method for computing the symplectic matrix pair $(M|L)$ which represents e^H.

16:00-16:30

A new real structure-preserving method for large-scale discriminant analysis and color face recognition

Zhigang Jia Jiangsu Normal University

Abstract: In the supervised feature abstraction of color face images, the core work of linear discriminant analysis (LDA) is to solve a generalized eigenvalue problem with multi-symplectic structure. In this talk, we characterize the multi-symplectic structure, and propose a new algorithm for computing the dominant generalized eigenpairs with preserving the multi-symplectic structure. Applied to color face recognition, the proposed algorithm is indicated to be very efficient and its recognition rate is higher than state-of-the-art methods.

MS ME-1-2 6 14:30-16:30

Mathematical modeling in epidemiology of infectious diseases

Organizer: Mondal Hasan Zahid University of Texas at Arlington

Abstract: In this minisymposium, researchers are going to present their recent works on infectious diseases, vector borne and non-vector borne, using mathematical models. These works focus on ongoing health concerns, like Chikungunya and Chagas disease. Also, the dynamics of nosocomial infections and potentiality of antiviral drugs during Influenza pandemic are also addressed. Researchers used deterministic and stochastic approaches in these analyses. These studies provide novel findings regarding the effect of seasonality and biodiversity on disease transmissions, policies for public health,and spread and control of nosocomial infections. This minisymposium is well suited for disease modelers, epidemiologists, ecologists and for public health officials.

14:30-15:00

Decoys and dilution: the impact of incompetent hosts on prevalence of Chagas disease

Mondal Hasan Zahid University of Texas at Arlington
Christopher Kribs

Abstract: Biodiversity is commonly believed to reduce risk of vector-borne zoonoses. This study focuses on the effect of biodiversity, specifically on the effect of decoy process on reducing Chagas disease infections. We use mathematical population models to observe the impact of the proximity of chickens. We consider three cases as distance varies between two hosts populations: short, intermediate, and far. Our finding shows the presence of chickens reduces parasite prevalence in humans only at intermediate distance.

15:00-15:30

Identifying the Dominant transmission pathway in a multi-stage infection model of the Emerging Fungal Pathogen Batrachochytrium Salamandrivorans on the Eastern Newt

Md Rafiul Islam Texas Tech University
Mattew Gray Center for Wildlife Health, University of Tennessee Institute of Agriculture, Knoxville, TN, USA
Angela Peace Department of Mathematics and Statistics, Texas Tech University, Lubbock, TX, USA

Abstract: We developed compartmental host-pathogen models to examine the transmission dynamics of an emerging fungal pathogen on an amphibian population. Multiple stages of infection are incorporated into the model, allowing disease-induced mortality and zoospore shedding rates to vary as the disease progresses. Parameter sensitivity analysis is used to identify the important model parameters. Calculation of the basic reproductive number highlights the virulence of this pathogen and is used to determine the dominant transmission pathways.

MS A1-3-1 6 14:30-16:30

PDE-based models and their computational simulation - Part 1

For Part 2 see: MS A1-3-1 7

Organizer: Gerardo Hernandez-Duenas	National Autonomous University of Mexico
Organizer: Pedro Gonzalez Casanova H	UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO
Organizer: Miguel Angel Moreles	Centro de Investigación en Matemáticas
Organizer: Lorenzo Héctor Juárez Valencia	Universidad Autónoma Metropolitana - Iztapalapa

Abstract: The evolution of a great variety of natural or physical phenomena can be described by physical laws expressed in terms of rates of change or gradients of appropriate variables, resulting in Partial Differential Equations. Exact solutions of PDE-based models are not always available and correctly computing numerical approximations could involve several theoretical and computational challenges. The aim of this proposed mini-symposium is to provide a platform for participants to present novel PDE-based models in areas such as shallow water flows, microscale materials, and biological systems. The talks will discuss theoretical aspects of the models or show associated robust numerical schemes.

14:30-15:00

The Discontinuous Galerkin method for the heat equation. Application to dMRI

Miguel Angel Moreles	Centro de Investigación en Matemáticas
Daniel Cervantes	INFOTEC
Joaquin Peña	CIMAT
Alonso Ramirez	CIMAT

Abstract: Our focus is on the simulation of water diffusion inside the brain tissue. The problem is to characterize the hydrogen molecular displacement due to brownian motion. The numerical solvers to compute the propagator of the hydrogen displacement are based on Monte Carlo diffusion simulators and partial differential equation (PDE) solvers. We follow the PDE approach and develop a GPU implementation of the Discontinuous Galerkin Method for solution of the PDE.

15:00-15:30

Meshfree methods for the solution of convection diffusion optimal control problems

Jorge Zavaleta	National Autonomous University of Mexico

Abstract: We aim at solving optimal control problems for the convection-diffusion equation by RBFs meshfree methods. An important matter on using these methods is that as the convergence order increases, the condition number grows. By using modified FD-RBF techniques, we prove that the condition number of the algebraic systems remains within an acceptable value in standard precision. Also, through several benchmark problems, we show that these methods have an excellent performance in both stability and error.

15:30-16:00

Two-layer blood flows through axi-symmetric vessels

Gerardo Hernandez-Duenas	National Autonomous University of Mexico
Cesar Rosales-Alcantar	National Autonomous University of Mexico

Abstract: A model for two-layer blood flows through axi-symmetric vessels will be presented. The model consists of a hyperbolic system of balance laws and its main properties will be discussed. A well-balanced, positivity-preserving central-upwind scheme will be constructed. The merits of the scheme will be tested in a variety of scenarios. This is joint work with Cesar Rosales-Alcantar.

16:00-16:30

Identification of dipolar sources located on the cerebral cortex from EEG

José Jacobo Oliveros Oliveros	Benemérita Universidad Autónoma de Puebla
Claudia Netzahuacoyotl-Bautista	Benemérita Universidad Autónoma de Puebla
María Monserrat Morín-Castillo	Benemérita Universidad Autónoma de Puebla
José Julio Conde-Mones	Benemérita Universidad Autónoma de Puebla
Alina Santillán-Guzmán	Instituto Tecnológico Superior de Eldorado-Benemérita Universidad Autónoma de Puebla

Abstract: In this talk, it is presented a stable algorithm for determining, from electroencephalographic measurements on the scalp, the parameters of a dipolar source located on the cerebral cortex. The dipolar source represents the activity of epileptic focus which is represented using the Dirac delta. As the first step, the algorithm determines the center of the delta. In the second step, the algorithm determines the dipolar moment. The algorithm is illustrated by synthetic examples.

MS ME-1-6 6 14:30-16:30

Control and Estimation Problems in Fluid Mechanics and Related Fields - Part 2

For Part 1 see: MS ME-1-6 5

Organizer: Bartosz Protas	McMaster University
Organizer: Takashi Sakajo	Kyoto University

Abstract: The minisymposium has for its objective to survey recent progress related to both theoretical and practical aspects of control and estimation problems. Given the significance of their applications, the focus will be on fluid-dynamics and other transport models described by differential equations. The minisymposium will offer a unifying perspective on both control and estimation problems which share many important mathematical and computational ingredients. In addition to discussing new developments in the classical areas of feedback control and data assimilation applied to fluid systems, we will also aim to highlights emerging topics such as Bayesian inference and machine learning.

14:30-15:00

Greedy sensor placement for state estimation and control with cost constraints

Emily E Clark	University of Washington
Travis Askham	New Jersey Institute of Technology
Steven L. Brunton	University of Washington
J. Nathan Kutz	University of Washington

Abstract: We consider the problem of optimally placing sensors under a cost constraint. We extend a well-established greedy algorithm for the optimal sensor placement problem without cost constraints, producing an often near-optimal solution to a relaxed version of the full optimization formulation. With slight modifications, the greedy algorithm can be applied to sensor and actuator placement in balanced control system design. We demonstrate this algorithm's effectiveness on systems and data sets from multiple fields.

15:00-15:30

Advancing data assimilation as a science hub: from weather forecasting and beyond

Takemasa Miyoshi	RIKEN

Abstract: Data Assimilation was introduced in numerical weather prediction to combine computer model forecasts with real-world observations, using dynamical systems theory and statistical mathematics. Computing, sensing, and information/communication technologies are all advancing rapidly, and Data Assimilation is becoming more popular as a means to perform cyber-physical fusion in other sciences and technology fields. I will talk about our exciting research in numerical weather prediction and give a perspective towards Data Assimilation becoming a new science hub.

15:30-16:00

Computational Advances in Calibrating Relative Permeability for Petroleum Reservoirs Using Data of Multiple Types

Vladislav Bukshtynov	Florida Institute of Technology
Oleg Volkov	Stanford University
Louis J. Durlofsky	Stanford University
Khalid Aziz	Stanford University

Abstract: Comprehensive models for subsurface flow typically include many parameters inferred from observed data. Additional complexity arises when these parameters are state-dependent functions, e.g., phase relative permeability krp, which depend on phase saturation Sp. Our novel approach for constructing krp(Sp) curves uses a data assimilation procedure formulated as a regularized optimization problem, which is solved using adjoint-gradients from automatic differentiation techniques. Results include cases where both relative and absolute permeability are uncertain.

16:00-16:30

Flow Control by Shape Optimization Problem based on Snapshot Proper Orthogonal Decomposition

Takashi Nakazawa Osaka university
Hirofumi NOTSU Kanazawa univ

Abstract: In this talk, the shape optimziation method for suppressing the time dependent flow on Non-Newtonian fluid is talked.

MS FT-2-4 6 14:30-16:30

Stochastic Computation and Complexity - Part 4

For Part 1 see: MS FT-2-4 3
For Part 2 see: MS FT-2-4 4
For Part 3 see: MS FT-2-4 5
Organizer: Raphael Kruse Technische Universität Berlin
Organizer: Stefan Heinrich University of Kaiserslautern

Abstract: The minisymposium is devoted to recent developments in stochastic numerics. This includes the numerical solution of stochastic differential equations, stochastic partial differential equations, stochastic integration and stochastic quadrature problems, as well as applications to the solution of partial differential equations. Deterministic, Monte Carlo, Multilevel Monte Carlo, quasi-Monte Carlo, and deep learning methods will be presented. Emphasis is laid on efficiency of algorithms, their convergence analysis, optimality, and the complexity of the underlying problems.

14:30-15:00

Random sections of ellipsoids and the power of random information

Aicke Hinrichs Johannes Kepler Universität Linz
David Krieg JKU Linz
Erich Novak FSU Jena
Joscha Prochno KFU Graz
Mario Ullrich JKU Linz

Abstract: We study the circumradius of the intersection of an ellipsoid with random subspaces of codimension n. This random circumradius corresponds to the worst-case error of random information for L_2-approximation of functions from a Hilbert space. Random information behaves very differently depending on whether $\sigma \in \ell_2$ or not. For $\sigma \notin \ell_2$ random information is completely useless, for $\sigma \in \ell_2$ the expected radius of random information tends to zero at least at rate $o(1/\sqrt{n})$.

15:00-15:30

How good are random sampling points?

David Krieg Johannes Kepler University Linz
Aicke Hinrichs
Erich Novak
Joscha Prochno
Mario Ullrich

Abstract: We study problems like recovering a function from a finite number of function values. Usually, it is assumed that these function values can be computed at arbitrary points. In this talk, we assume that we do not get to choose the points. We compare the quality of random sampling points with the quality of optimal sampling points. How much do we loose?

15:30-16:00

Algorithms and Complexity for Functions on General Domains

Erich Novak Friedrich-Schiller-Universität Jena

Abstract: Error bounds are often proved for functions on very simple domains: cubes, tori, or spheres. We study functions that are defined on general domains and study three different concepts: order of convergence, asymptotic constant, and explicit uniform lower bounds.

MS GH-0-2 6 14:30-16:30

Multifidelity methods for uncertainty quantification and optimization in complex systems - Part 1

For Part 2 see: MS GH-0-2 7
For Part 3 see: MS GH-0-2 8
Organizer: Alex Gorodetsky University of Michigan
Organizer: John Jakeman Sandia National Laboratories
Organizer: Gianluca Geraci Sandia National Laboratories
Organizer: Michael Eldred Sandia National Laboratories

Abstract: Algorithms that leverage multiple simulation fidelities can significantly reduce the cost of UQ, optimization, and control problems. These so-called multi-fidelity methods exploit different discretizations, scales, and descriptions of the underlying physics to gain marked improvement in overall computational efficiency. This mini-symposium aims to bring together researchers who develop and apply these algorithms. Algorithms and applications of interest include, but are not limited to: analyzing non-hierarchical models whose relationships are not know a-priori; handling dynamical systems that provide streaming data; using multiscale hierarchies; sampling methods for variance reduction; and surrogate-based approaches that exploit special types of structure.

14:30-15:00

Multifidelity machine learning by the combination technique

Peter Zaspel University of Basel
Helmut Harbrecht University of Basel, Switzerland
Bing Huang University of Basel, Switzerland
Anatole Von Lilienfeld University of Basel, Switzerland

Abstract: We introduce multifidelity machine learning for kernel ridge regression (KRR). Our aim is to solve expensive parametric problems in scientific computing. Machine learning by KRR allows to approximate the involved parametric mapping at high convergence rates. To further optimize this approach, we have combined the sparse grid combination technique with KRR. By combining machine learning models at different fidelities, we strongly reduce the computational effort. We showcase this approach for an application in quantum chemistry.

15:00-15:30

Adaptive multi-index collocation and sensitivity analysis

John Jakeman Sandia National Laboratories
Michael Eldred Sandia National Laboratories
Gianluca Geraci Sandia National Laboratories
Alex Gorodetsky University of Michigan

Abstract: This talk will present an adaptive multi-index approach which leverages a convergent hierarchy of models to build approximations of the parameter-output map of high-fidelity predictions. The adaptive algorithm we present automatically balances stochastic approximation and physical discretization errors, whilst minimizing cost and identifying parameter combinations that significantly influence uncertainty. We demonstrate the efficacy of our algorithm on a state-of-the art aerospace model with multiple hyper-parameters controlling the model discretization.

15:30-16:00

Low-rank multifidelity approaches for quantifying uncertainty in topology optimization

Akil Narayan University of Utah

Abstract: We consider topology optimization under uncertainty with multiresolution finite element models. In our bifidelity setting, a coarse and fine mesh corresponding to low- and high-resolution models are available. The inexpensive low-resolution model is used to explore the parameter space and approximate the parameterized high-resolution model and its sensitivity, where parameters are considered in both structural load and stiffness. Error bounds on approximation errors and sensitivity errors are presented, along with numerical examples on benchmark problems.

16:00-16:30

Performance of Multifidelity Estimators for Uncertainty Quantification in Numerical Hemodynamics

Daniele Schiavazzi University of Notre Dame
Casey M. Fleeter Stanford University
Gianluca Geraci Sandia National Labs
Daniele E. Schiavazzi University of Notre Dame
Alison L. Marsden Stanford University

Abstract: Numerical predictions are increasingly trusted in the diagnosis/treatment of cardiovascular disease. While deterministic numerical models provide limited insight as they do not account for uncertainties, stochastic approaches are penalized by large computational costs. We discuss multilevel/multifidelity Monte Carlo estimators of reduced variance and reasonable computational cost. Our framework leverages three cardiovascular model fidelities and is integrated with the Sandia's Dakota toolkit. We demonstrate the performance of these estimators on pulsatile simulations in health and disease.

MS GH-1-G 6 14:30-16:30

Models involving fractional differential equations and their analysis - Part 2

For Part 1 see: MS GH-1-G 5

Organizer: Adam Kubica Warsaw University of Technology
Organizer: Piotr Rybka The University of Warsaw

Abstract: We are interested in fractional diffusion equations arising e.g. in problems of the sub-surface movement of water and the surface transport of sediment. We focus on the time or space fractional Caputo derivative. Our purpose is to bring together specialist working in the areas of modeling and analysis related to these topics. We want to report on the progress of modeling and analysis. In particular we mean development of existence and uniqueness theory in the Sobolev space framework or viscosity theory. We will present the development of regularity theory and analysis of asymptotic behavior including decay of solutions.

14:30-15:00

Time-fractional derivatives in inverse transport problems

Manabu Machida Hamamatsu University School of Medicine
Atsushi Kawamoto The University of Tokyo

Abstract: We consider inverse problems determining coefficients of the time-fractional diffusion equation with the half-order Caputo fractional derivative. These inverse problems are related to slow transport phenomena in the diffusion regime. We will show that under some conditions the inverse problems have the Lipschitz stability.

15:00-15:30

On viscosity solutions of space-fractional diffusion equation

Tokinaga Namba Research & Development
Piotr Rybka University of Warsaw

Abstract: We introduce the notion of viscosity solutions to the initial boundary value problem of the one-dimensional heat equation including the Caputo space fractional derivative of the local heat flux. The existence and uniqueness results are proved by Perron's method and comparison principle. We also show the continuity property of the solution when the order of the fractional derivative is continuously changed. This talk is based on the work with Professor Piotr Rybka (University of Warsaw).

15:30-16:00

Carleman estimate for a time-fractional advection-diffusion equation and application to a lateral Cauchy problem

Xinchi Huang The University of Tokyo

Abstract: We consider the Carleman estimate for a time-fractional diffusion equation (TFDE) in this talk. Carleman estimate is not well established for general TFDE due to the absence of the Newton-Leibniz formula for the fractional derivative. In this talk, we investigate a TFDE with first-order time derivative. We first apply an argument of iterations to prove the Carleman estimate. After that we follow the well-known strategy to prove the stability result for a lateral Cauchy problem.

16:00-16:30

Decay of weak solutions of fractional diffusion equations

Katarzyna Ryszewska Warsaw University of Technology
Adam Kubica Warsaw University of Technology

Abstract: In the talk I will present results concerning the decay of weak solutions to fractional diffusion equation with the distributed order Caputo derivative. We will consider the case where the elliptic operator is time-dependent and the weight function, contained in the definition of the distributed order Caputo derivative, is just integrable. We will establish the relation between behavior of weight function near zero and the decay rate of the solution.

MS A6-3-3 6 14:30-16:30

Quantitative methods for insurance markets modeling

Organizer: Sebastian Jaimungal University of Toronto
Organizer: Francesca Biagini University of Munich
Organizer: Agostino Capponi Columbia University

MS Organized by: SIAG/FME

Abstract: This symposia presents recent developments in the mathematical modeling of insurance and credit risk markets. In particular, new results on neural networks for solvency capital requirement will be shown. An overview of the mathematical challenges arising in Cyber Insurance risk will be given with focus on the modeling of claim frequency. Optimal investment and consumption problem for an agent in a market with longevity bond and regime-switching as well as optimal reinsurance under partial information will be investigated. This minisymposium is sponsored by the SIAG/FME.

14:30-15:00

Optimal investment and consumption in a Markov-modulated market with a longevity bond

Alessandra Cretarola University of Perugia
Katia Colaneri University of Leeds

Abstract: We investigate the optimal investment and consumption problem for an agent in a market with a money market account, a bond and a longevity bond. We define a model where the residual lifetime of the agent is stochastic, and assets price dynamics are affected by an exogenous economic/environmental factor. The optimization problem is solved via a dynamic programming approach, that allows to characterize the value function and the optimal investment and consumption strategy.

15:00-15:30

About mathematical issues arising on cyber-risk insurance

Caroline Hillairet Ensae

Abstract: With the rise of digital economy, cyber risk has become a major concern for all customer segments, and insurers are intended to play a crucial role in providing financial protection. In the frame of building insurance solutions to the customers, this talk proposes an overview of the mathematical challenges arising in Cyber Insurance. A special focus on the modeling of claim frequency, using models of contagion and Hawkes processes, is addressed. "

15:30-16:00

Neural networks for solvency capital requirement

Thorsten Rheinländer Vienna University of Technology
Maria-Theresa Baumgartner

Abstract: We study solvency capital requirements for select products, where the policyholder has a choice of receiving a risk-free interest rate or the payoff of some option on the EUROSTOXX index. We proceed by implementing a deep learning convolutional feed forward neural network, using the ADAM algorithm with mini batch sizes, and study robustness to various network parameters.

16:00-16:30

Optimal reinsurance and investment problems under partial information

Claudia Ceci Università degli Studi G. d'Annunzio Chieti e Pescara
Matteo Brachetta University of Chieti-Pescara

Abstract: We study the optimal proportional reinsurance and investment problem for an insurer that has only partial information on intensity and claim sizes of the losses process. The insurer subscribes a reinsurance contract to reduce her/his risk exposure and, in addition, invests the surplus in a financial market. Using filtering techniques we reduce the partially observable control problem to an equivalent one with complete information, whose solution is discussed in terms of BSDEs.

MS ME-1-9 6 14:30-16:30

Existence and stability of nonlinear waves - Part 2

For Part 1 see: MS ME-1-9 5

Organizer: Anna Ghazaryan Miami University
Organizer: Vahagn Manukian Miami University
Organizer: Stephane Lafortune College of Charleston

Abstract: This mini-symposium will focus on recent results in the area of of traveling waves and related structures, obtained by either numerical or analytic techniques. Existence, stability, dynamic properties, and bifurcations of these special solutions will be addressed.

14:30-15:00

Asymptotic behavior of semigroups generated by Hamiltonian linearizations

Milena Stanislova Kansas University

Abstract: This talk showcases the advantages of using uniform resolvent estimates close to the imaginary axis to investigate asymptotic behavior of the solution semigroups in the case of spectrally stable generators. We apply this to the Lugiato-Lefever model of optical fibers and to the linearization about standing waves of the NLS, both on periodic domains.

15:00-15:30

On the ground states for the generalized Ostrovskyi equation and their stability

Atanas Stefanov	University of Kansas

Abstract: The Ostrovskyi equations are ubiquitous modelsin physics. They describe water waves under the action of a Coriolis force or the amplitude of "short" pulse in an optical fiber. We construct traveling waves as minimizers of the Hamiltonian for any fixed L^2 norm. The existence is via compensated compactness, but it requires detailed Fourier analytic arguments to rule out the non-triviality of the minimizing sequences. We show that all of these waves are stable.

15:30-16:00

Phase singularities and defects in pattern forming systems

Joceline Lega	University of Arizona

Abstract: I will summarize recent work on stable grain boundary solutions of the Swift-Hohenberg equation, which in the strong bending limit, display dislocations at their core. I will then discuss novel applications of complex function theory in this setting, by relating the phase singularities at the core of the dislocations to the complex zeroes for the Poisson extension built from the real field and its Hilbert transform. This work is joint with Nick Ercolani.

16:00-16:30

On the stability of planar fronts with marginally unstable essential spectra

Anna Ghazaryan	Miami University
Yuri Latushkin	University of Missouri-Columbia, USA
Xinyao Yang	Xi'an Jiaotong-Liverpool University, China

Abstract: We consider planar fronts in a class of reaction-diffusion systems with the following property: the linearization about the front has no unstable discrete eigenvalues, but its essential spectrum touches the imaginary axis. We use a bootstrapping argument to show that perturbations to the front that are initially small in an exponentially weighted norm and the original norm without the weight remain bounded in the original norm and decay algebraically in time in the weighted norm.

MS GH-3-2 6 **14:30-16:30**

Sedimentation, flotation, and related processes: modeling, numerics, applications, and calibration - Part 2

For Part 1 see: MS GH-3-2 5

For Part 3 see: MS GH-3-2 7

Organizer: Raimund Bürger	Universidad de Concepción
Organizer: Stefan Diehl	Lund University

Abstract: Mathematical models for sedimentation, flotation, and related processes such as fluidization, creaming, and centrifugal separation are important in industrial applications such as mineral processing, wastewater treatment, chemical engineering, and medicine. They are frequently formulated in terms of nonlinear convection-diffusion-reaction PDEs with non-standard properties (such as discontinuous coefficients, type degeneracy, and large system size) are as coupled flow-transport problems. It is the purpose of this minisymposium to review recent advances in the formulation of such models, their well-posedness analysis, the determination of exact and numerical solutions to direct and inverse problems, and their applications.

14:30-15:00

Flotation with sedimentation I: Models with systems of conservation laws with discontinuous flux

Stefan Diehl	Lund University
Raimund Bürger	Universidad de Concepción
María Carmen Martí	Universitat de València

Abstract: Flotation is a separation process used in mineral processing to separate out valuable minerals or coal from unwanted decay products, and in wastewater treatment to remove unwanted organic solids, dissolved oils and algae. Hydrophobic particles attach to injected gas bubbles which float while hydrophilic particles sediment. The three-phase flow is modelled in 1D with a system of 2 PDEs having spatial flux discontinuities at the inlets and outlets. Industrially relevant stationary solutions are presented.

15:00-15:30

Flotation with sedimentation II: Numerical solution and characterization of stationary solutions

Maria Carmen Martí	Universitat de València
Stefan Diehl	Lund University
Raimund Bürger	Universidad de Concepción

Abstract: Flotation is a separation process used in the recovery of minerals in mineral processing and in related applications. The governing PDEs for the 1D three-phase model, including gas bubbles, solid particles and fluid, can be written as a triangular system of balance laws. Exploiting this fact, we propose a numerical method that treats the equations consecutively, use a pair of staggered grids and prove that it produces approximate concentration values between zero and one.

15:30-16:00

Design optimisation of a dissolved air flotation process in drinking water treatment using CFD

Ingmar Nopens	Ghent University
Kamal Satpahty	UGent
Usman Rehman	AM-Team

Abstract: A 3-phase CFD model (air, liquid and particles) was implemented to compare different geometries for dissolved air flotation. A discrete particle method (DPM) was used to predict the removal of particles in the froth layer. The mixing zone proves to be crucial for good system performance as particles need to be connected to bubbles. Mixing pattern and residence time are crucial for maximising particle-bubble interactions.

MS A6-5-4 6 **14:30-16:30**

Recent Advances in Tomographic Imaging - Part 2

For Part 1 see: MS A6-3-4 8

For Part 3 see: MS A6-3-4 10

Organizer: Haltmeier Markus	Universitat Innsbruck
Organizer: Richard Kowar	University of Innsbruck

Abstract: Tomographic imaging is a central diagnostic tool in clinical practice. Examples include x-ray CT, photoacoustic tomography, emission tomography and MRI. One of the central mathematical aspects in tomography is the development efficient and accurate image reconstruction algorithms. Besides traditional reconstruction methods using analytical or iterative estimation techniques, recently, a new class of image reconstruction methods appeared which is based on techniques from deep learning. This can be used, for example, for improving image quality, reducing computation time or reducing radiation exposure. In this Minisymposium, leading experts will report on recent developments in image reconstruction and various tomographic modalities.

14:30-15:00

Deep null space learning for tomographic image reconstruction

Johannes Schwab	University Innsbruck
Markus Haltmeier	University Innsbruck
Stephan Antholzer	University Innsbruck

Abstract: Recently, methods based on deep learning appeared as a new paradigm for solving inverse problems. These methods empirically show outstanding performance but still lack of theoretical justification. In our work we analyze trained deep neural networks called null space networks combined with a classical regularization as a reconstruction method. This proposed deep null space learning approach is shown to be a convergent regularization method and additionally convergence rates are derived.

15:00-15:30

Deep Larning-based Methods for Regularization in Cardiac CT an MRI

Andreas Kofler	Charité - Universitätsmedizin Berlin
Markus Haltmeier	Universität Innsbruck
Christian Wald	Charité- Universitätsmedizin Berlin
Christoph Kolbitsch	Physikalisch-Technische Bundesanstalt Berlin and Braunschweig
Tobias Schaeffter	Physikalisch-Technische Bundesanstalt Berlin and Braunschweig
Marc Dewey	Charité - Universitätsmedizin Berlin
Marc Kachelrieß	Deutsches Krebsforschungszentrum

Abstract: Recently, Neural Networks have been widely applied for solving inverse problems arising in different medical imaging modalities. In cardiac CT, for example, low-dose scan protocols can be used to reduce the patient’s radiation exposure. In cardiac cine MRI, undersampling acquisition schemes are applied to shorten the data-acquisition process. In this talk, we discuss different Deep Learning-based methods for regularization of the ill-posed inverse problems in low dose cardiac CT and accelerated cardiac MRI.

15:30-16:00

New applications and challenges in X-ray CT

Felix Lucka — CWI & UCL

Abstract: In this talk, we will introduce and discuss several exciting extensions of traditional X-ray computed tomography applications or work-flows such as real-time image reconstruction, scan adaptation, dynamic tomography, spectrally resolved photon detection, or X-ray light field imaging. We highlight some of the corresponding image reconstruction challenges and showcase how deep learning can be used to approach them.

16:00-16:30

Learned iterative schemes for solving inverse problems

Ozan Öktem — KTH - Royal Institute of Technology

Jonas Adler — KTH - Royal Institute of Technology

Abstract: The talk will survey various approaches from deep learning to solve ill-posed large scale inverse problems. A key element is the usage of learned iterative schemes that yield deep neural network architectures for the reconstruction operator that encodes the forward operator and the adjoint of its derivative. The performance is demonstrated for low-dose computed tomography.

MS A1-1-2 6 — 14:30-16:30

Geometry and topology in mass and fluid dynamics - Part 1

For Part 2 see: MS A1-1-2 7

Organizer: Takashi Sakajo — Kyoto University

Organizer: Stefanella Boatto — Universidade Federal De Rio De Janeiro

Abstract: Topological and geometric methods has been successfully applied to predicting and interpreting the dynamics of interacting points such as masses and point vortices in fluid mechanics qualitatively. We organize the mini-symposium to offer an opportunities to share the recent developments on this topic among experts and we thereby explore new research collaborations among participants who are interested in applying these methodologies for modeling interaction dynamics on surfaces, and characterizing structure and transport in complex flows, with applications to fluids, biological and physical sciences.

14:30-15:00

A vortex ring on a sphere. The case of total vorticity equal to zero

Stefanella Boatto — Universidade Federal De Rio De Janeiro

Carles Simó

Abstract: The stability of a ring of vortices has attracted the interest of researchers for over a century. Recent beautiful observations show polygonal configurations of vortices in the atmosphere of Jupiter and Saturn. We present analytical and numerical results about the linear, spectral and Lyapunov stability of a ring in the presence of polar vortices. Motivated by both atmospheric observations we considered the special case of total vorticity equal to zero.

15:00-15:30

The role of connections in point vortex motion

Björn Gustavsson — KTH Royal Institute of Technology

Abstract: We discuss point vortex dynamics on a closed two-dimensional Riemann manifolds from the point of view of affine connections. The speed of a vortex then comes out as the difference between two affine connections, one derived from the coordinate Robin function and the other being the Levi-Civita connection associated to the Riemannian metric . In a Hamiltonian formulation, the Hamiltonian function consists of two main terms which interact with each other in a nontrivial manner.

15:30-16:00

Models of vortex reconnection under Biot-Savart evolution

Yoshifumi Kimura — Nagoya University

Keith Moffatt — University of Cambridge

Abstract: Reconnection of vortex filaments under the Biot-Savart law is investigated numerically using a tent model, two vortex filaments in the configuration of tilted hyperbolae initially. It is shown that this model exhibits the self-similar scaling by J. Leray. Extending this model, a dynamical system is introduced which describes the development of two tilted vortex rings as a model for a finite time singularity of the Navier-Stokes equations.

16:00-16:30

The evolving geometry of a vortex triangle

Vikas Krishnamurthy — University of Vienna

Mark Stremler — Virginia Tech, USA

Abstract: We reformulate the planar three vortex problem in terms of three geometrical points endowed with a dynamics. A number of known results in the three-vortex problem follow readily from the equations of motion, giving an alternate geometrical perspective on the problem. Symmetries in the governing equations are used to apply the theory to investigate the finite-time collapse of three point vortices and derive new formulas relating the time of collapse and the Hamiltonian energy.

MS A3-3-1 6 — 14:30-16:30

Collaborative Mathematics - Part 1

For Part 2 see: MS A3-3-1 7

Organizer: Timothy Gerard Myers — CRM- Centre de Recerca Matematica

Abstract: In recent years the Centre de Recerca Matemàtica (CRM) has received PhD and Post-doctoral funding from La Caixa bank to carry out research in collaboration with other disciplines. The projects have been supervised jointly by members of CRM and researchers from biology, physics, nanoscience and also local research centres. This has led to a broad range of research lines where, due to the influence of the non-mathematical partners, the focus has been firmly on practical problems. In this mini-symposium we present a selection of this topics, with the unifying theme being the collaboration between researchers from mathematics and another discipline.

14:30-15:00

Finding nanoparticles with visible light

Tim Myers — Centre de Recerca Matematica

Wolfgang Bacsa — Centre d'Elaboration de Materiaux et d'Etudes Structurales

Helena Ribera — U. Chicago

Abstract: The wavelength of visible light is too large to observe nanoparticles. Observation therefore requires the use of electron microscopy. Recently an experimental method has been developed, using a laser and optical fibre, to produce a diffraction pattern from nanoparticles. A mathematical model to reproduce this pattern will be described. Using two measurements the particle position can be identified. The solution also predicts the phase shift of the scattered wave however this is sensitive to errors.

15:00-15:30

Modelling diffusion at nanoscale

Claudia Fanelli — Centre de Recerca Matematica

Abstract: Starting from a mathematical description of the nanoparticle growth process and guidelines for efficient growth strategies, I will show a specific practical application of nanoparticles, namely targeted drug delivery. The physical situation modelled involves the motion of a non-Newtonian nanofluid subject to an external magnetic field and an advection-diffusion equation for the concentration of the nanoparticles in the fluid. The ultimate goal is to determine strategies to maximise drug delivery to a specific site.

15:30-16:00

Surface temperature profiles induced by ultra-high-frequency laser heating and non-Fourier heat conduction

Matthew Hennessy — Mathematical Institute, University of Oxford

Abstract: Irradiating the surface of a semiconducting material with a high-frequency laser induces modes of thermal transport that cannot be described by Fourier's law. Solving an extended model of heat conduction that replaces Fourier's law with the Guyer-Krumhansl equation reveals two new modes of non-Fourier transport which are analogous to the pressure and shear waves observed in viscoelastic wave propagation. The extended model is found to accurately describe experimental data without any fitting parameters.

16:00-16:30

Mathematical modelling of carbon capture by adsorption

Francesc Font — Centre de Recerca Matemàtica

Tim Myers

Abstract: Global atmospheric concentration of CO2 has risen by more than 30% over the last fifty years. Of the greenhouse gases, CO2 contributes by far the largest share to global warming. Technologies based on carbon capture by adsorption offer a promising route for large scale CO2 removal from the atmosphere. In this talk we present a mathematical model describing carbon capture by adsorption in a typical experimental set up and discuss solutions in several limiting scenarios.

MS FT-4-1 6 14:30-16:30

Advances in Numerical Methods for Hamilton-Jacobi-type equations - Part 2

For Part 1 see: MS FT-4-1 5
For Part 3 see: MS FT-4-1 7
Organizer: Alexander Vladimirsky Cornell University
Organizer: Maria Cameron University of Maryland

Abstract: Hamilton-Jacobi (HJ) equations are nonlinear hyperbolic PDEs that arise in a broad spectrum of applications such as geosciences, optimal control, and stochastic systems. In some cases, e.g., in seismic wave propagation and stochastic systems, HJ equations result from approximations rendering the considered problem mathematically tractable. Nevertheless, their fast and accurate numerical solution poses significant challenges due to the need to tackle singularities, reconcile the discrepancy between the gradient of the solution and its characteristics, and adapt meshes for the solution. In this mini-symposium, we are bringing together researchers advancing state-of-art HJ solvers and applying them to real-life problems.

14:30-15:00

Adaptive Filtered Schemes for first order Hamilton-Jacobi equations

Maurizio Falcone University of Rome "La Sapienza"
Giulio Paolucci Università di Roma "La Sapienza"
Silvia Tozza INDAM & Università di Roma "La Sapienza"

Abstract: Filtered schemes are high-order accurate methods based on a simple coupling between two schemes: one is monotone (and convergent) and the other is high-order accurate. The filtered scheme switches from one scheme to the other according to a filter function and a switching parameter. Based on a smoothness indicator, we introduce a space/time adaptive choice of the switching parameter proving a general convergence result in 1D and some 2D applications to image processing.

15:00-15:30

Fast marching methods for globally optimal curvature penalized shortest paths

Jean-Marie Mirebeau University Paris-Sud, CNRS, Univ Paris-Saclay

Abstract: Motivated by applications to motion planning and image segmentation, we consider paths models with a data-driven cost and a curvature penalization, such as the Euler/Mumford elasticas or the Reeds-Shepp car. Our strategy for computing paths of minimal energy involves a dimension lifting in $R^d x S^{d-1}$, d=2,3, and a strongly anisotropic approximation of the singular metric underlying the model. The relevant eikonal equation is then numerically solved by a variant of the Fast-Marching algorithm.

15:30-16:00

Computing control Lyapunov functions numerically via supersolutions of Hamilton-Jacobi equations

Lars Gruene University of Bayreuth
Philipp Braun University of Newcastle, Australia
Robert Baier Universität Bayreuth, Germany
Christopher M. Kellett University of Newcastle, Australia

Abstract: In this talk we present a novel method for representing and computing control Lyapunov functions using piecewise linear finite elements on a simplicid grid. The novelty of the approach is that the computed function is indeed a control Lyapunov function, i.e., a supersolution of the corresponding Hamilton-Jacobi equation, in any point on the computational domain. The essential difficulty to overcome is the nonsmoothness of the control Lyapunov function which requires a sophisticated approximation tecnnique.

16:00-16:30

Surveillance-Evasion Mean Field Games

Elliot Cartee Cornell University
Alexander Vladimirsky Cornell University

Abstract: We consider a class of Surveillance-Evasion games where a large crowd of selfish Evaders try to exit the domain while minimizing their cumulative exposure to an enemy Observer. The movement of the Evaders is modeled using the framework of Mean Field Games. The Observer aims to maximize crowdwide exposure by choosing a probability distribution over its predefined patrol trajectories. We develop algorithms for finding the Nash Equilibrium policies, and illustrate our method on several examples.

MS FE-1-1 6 14:30-16:30

Recent advances in kinetic computation: forward and inverse problems - Part 2

For Part 1 see: MS FE-1-1 5
For Part 3 see: MS FE-1-1 7
Organizer: Qin Li UW-Madison
Organizer: Jingwei Hu Purdue University

Abstract: Kinetic theory describes the nonequilibrium dynamics of a large number of particles and connects microscopic Newtonian mechanics and macroscopic continuum mechanics in multiscale modeling hierarchy. It is widely used in a variety of science and engineering problems. Numerically solving kinetic equations in both forward and inverse setting present many challenges, such as high-dimensional collision operators, multiscales, uncertainties in scattering coefficients, etc. This minisymposium aims to bring together applied mathematicians to discuss recent progress in this field and exchange ideas.

14:30-15:00

Multiscale control variate strategies for uncertainty quantification in kinetic equations

Giacomo Dimarco University of Ferrara

Abstract: Kinetic equations play a major rule in modeling large systems of interacting particles. Uncertainties may be due to various reasons, like lack of knowledge on the microscopic interaction details or incomplete informations at the boundaries. In this talk, we consider the construction of novel multi-scale methods for such problems which, thanks to a control variate approach, are capable to reduce the variance of standard Monte Carlo techniques.

15:00-15:30

Reconstructing parameters in nonlinear kinetic equations using averaging lemma

Qin Li UW-Madison

Abstract: A typical approach in reconstructing parameters in linear kinetic equation is to perform Neumann series expansion, and identify different levels of singularities in the solution. Different components with various of singularities are then utilized to reconstruct corresponding parameters. The approach is usually accompanied by careful but tedious calculation. We follow the same strategy, but argue that the use of celebrated averaging lemma can significantly reduce the complexity in analysis, and permit nonlinear extension.

15:30-16:00

Highly oscillatory evolution problems with vanishing frequency: asymptotics and numerical approximation

Mohammed Lemou CNRS & University of Rennes

Abstract: Highly oscillatory evolution problems with vanishing frequency: asymptotics and numerical approximation

MS ME-1-I1 6 14:30-16:30

Variational Analysis for Optimal Control and Inverse Problems - Part 2

For Part 1 see: MS ME-1-I1 5
For Part 3 see: MS ME-1-I1 7
Organizer: Akhtar A. Khan Rochester Institute of Technology Rochester, New York
Organizer: Miguel Sama UNED
Organizer: Christian Clason University of Duisburg-Essen

Abstract: The study of inverse and optimal control problems is a vibrant and expanding branch of applied mathematics with wide-ranging applications to numerous related disciplines. In recent years, new directions of research emerged. For example, identification of stochastic parameters in stochastic PDEs and multi-objective control problems have been the focus of new research. Moreover, the ongoing investigations into inverse and control problems enormously benefited from the tools from fields such as variational and nonsmooth analysis. This minisymposia aims to gather experienced and young researchers actively engaged in the cross-fertilization of ideas among variational analysis, inverse problems and optimal control problems.

14:30-15:00

A variational approach to second order optimality conditions.

Helene Frankowska — CNRS, IMJ-PRG and Sorbonne Université

Abstract: This talk concerns a direct variational approach to derive the second order necessary optimality conditions in optimal control problems. The approach is fairly general and can be exploited in both deterministic and stochastic settings of finite and infinite dimensional problems. It relies on a second order variational inequality derived for the twice linearized data (dynamics, cost and constraints). Then the usual techniques of convex analysis lead to a dual formulation of the necessary optimality conditions.

15:00-15:30

Preconditioning Inverse Problems for Hyperbolic Equations with Applications to Photoacoustic Tomography

Alexander Beigl	University of Vienna
Otmar Scherzer	University of Vienna
Jarle Sogn	Johannes Kepler University Linz
Walter Zulehner	Johannes Kepler University Linz

Abstract: This work is concerned with an analysis for stable preconditioning of wave equation constrained linear inverse problems from boundary observation data. Taking the hyperbolic equation as the state constraint, the optimality conditions for the regularized inverse problem are reduced to a mixed variational formulation involving both the state to reconstruct and a Lagrange multiplier. We discuss well-posedness and propose a preconditioner which is robust with respect to the regularization parameter and choice of conforming discretization.

15:30-16:00

Gradient-Based Solution Algorithms for a Class of Bilevel Optimization and Optimal Control Problems with a Non-Smooth Lower Level

Constantin Christof — Technical University of Munich

Abstract: We explore a peculiar regularization effect that occurs in the sensitivity analysis of certain elliptic variational inequalities of the second kind. The effect causes the solution operator of the inequality at hand to be continuously differentiable although the problem itself contains non-differentiable terms. Our analysis shows in particular that gradient-based algorithms can be used to solve bilevel optimization problems that are governed by inequalities of the considered type - all without regularizing the lower-level problem.

16:00-16:30

Parameter Identification in Ill-posed Systems

Baasansuren Jadamba — Rochester Institute of Technology

Abstract: We will discuss optimization formulations of an inverse problem of parameter identification in a linear elasticity system. A stable identification process using regularization as well as optimality conditions will be presented. Numerical simulations with synthetic data are discussed.

MS A3-3-2 6

Efficient Numerical Methods for Multiphysics Problems - Part 2

For Part 1 see: MS A3-3-2 5
For Part 3 see: MS A3-3-2 7

Organizer: Chensong Zhang — Academy of Mathematics & Systems Science
Organizer: Xiaowen Xu — IAPCM

Abstract: With the recent development of numerical algorithms and increase of computational power, more and more groups are conducting high-resolution and high-fidelity multiphysics simulations. The proposed minisymposium will bring together international scientists, including early-career researchers, who are at the forefront of multiphysics simulation. The proposed workshop provides a forum for experts from different backgrounds to exchange recent progress and ideas, and to create new collaboration. An important goal of our minisymposium is to foster collaboration between computational mathematicians and domain scientists in various real-world application areas with special focus on high-performance numerical methods for multiphysics problems.

Solvers for Coupled PDE problems in Porous Media Science

Arne Naegel — Goethe-Universität Frankfurt

Abstract: Many problems in porous media science and geophysics are formulated as a system of transient, non-linear coupled PDEs. Developing efficient solvers is a delicate task, since one must to combine suitable schemes for (i) time integration, (ii) linearization, and (iii) multilevel solvers, suitable for (iv) a parallel computing environment. In this presentation, we address problems from poroelasticity and density-driven-flow and present numerical results in an application-oriented approach using a unified framework.

A Cartesian grid nonconforming immersed finite element method for planar elasticity interface problems

Fangfang Qin	Nanjing University, China
Jinru Chen	Nanjing University, China
Zhilin Li	North Carolina State University, USA
Mingchao Cai	Morgan State University, USA

Abstract: A nonconforming IFEM is developed for solving planar elasticity interface problems. The method possesses optimal approximation property. Its degree of freedom is much less than those of existing finite element methods for the same problem. Moreover, the method is robust with respect to the shape of the interface and its location relative to the domain and the underlying mesh. Both theory and numerical experiments are presented to demonstrate the effectiveness of the method.

Some fast solvers for poroelastic models

Mingchao Cai — Morgan State University, USA

Abstract: Poroelastic models have been widely used in Biomechanics. We aim at solving poroelastic models under a stabilized finite element discretization and the MAC Finite Difference discretization.Some preconditioners and iterative methods are proposed and tested.

A solution of 3D benchmark problems of Discrete Fracture Networks with Hybrid Mixed Finite Elements

Chensong Zhang — Academy of Mathematics & Systems Science

Abstract: This work attends for the calling of participation for four 3D benchmark tests. The tests are proposed to compare numerical schemes for a linear tracer flow through a naturally fractured porous media. Every experiment is devised to account several challenging issues associated with the modeling of a Discrete Fracture Network. The approximated solution adopted in this research is a hybrid mixed Lagrange multiplier method with multidimensional high-order approximation characteristics in complex DFN discretizations.

MS GH-3-4 6 — 14:30-16:30

The CJK-SIAMs joint mini-symposium on Mathematical Cryptography

Organizer: Katsuyuki Takashima — Mitsubishi Electric

Abstract: Recent advances in cryptography pose several interesting research directions in mathematical cryptography. Among them, elliptic curves and lattices give a variety of interesting and challenging problems to be solved. In this session, we present four state-of-the-art topics in the area: new authenticated group key exchange from elliptic curve isogenies, highly-secure identity-based encryption scheme from pairing on an elliptic curve, improvement of fundamental cryptanalytic algorithm against lattice cryptosystems, and cryptanalysis of BP obfuscation which is built on lattices.

14:30-16:30

14:30-15:00

One-Round Authenticated Group Key Exchange from Isogenies

Katsuyuki Takashima	Mitsubishi Electric
Atsushi Fujioka	Kanagawa University
Kazuki Yoneyama	Ibaraki University

Abstract: We propose two one-round authenticated group-key exchange protocols from newly employed cryptographic invariant maps (CIMs): one is secure under the quantum random oracle model and the other resists against maximum exposure of secret keys. We instantiate the proposed protocols on the hard homogeneous spaces with limitation where the number of the user group is two. The protocols instantiated by using the CSIDH key exchange are currently more realistic than the general n-party CIM-based ones.

15:00-15:30

Tightly Secure Identity-Based Encryption

Junqing Gong CNRS, ENS, INRIA

Abstract: Once we have obtained a provably secure construction for a cryptographic primitive, one of the crucial theoretical questions we can ask is how tight the reduction can be. A tighter reduction means the security of this target construction has a stronger connection to the hardness of underlying computational problems. This talk will focus on tightly secure identity-based encryptions (IBE). We will review several recent progresses and discuss some interesting open problems.

15:30-16:00

Improvement of BKZ by deep insertions for finding short lattice vectors

Masaya Yasuda Kyushu University

Abstract: The security of lattice-based cryptography is based on the hardness of lattice problems such as the shortest vector problem (SVP). The block Korkine-Zolotarev (BKZ) algorithm and its variants are essential to solve lattice problems. In this talk, I present a new mathematical variant of BKZ, called DeepBKZ, in which LLL with deep insertions is called as a main subroutine. I also show a demonstration how DeepBKZ finds short lattice vectors.

16:00-16:30

Statistical Zeroizing Attack: Cryptanalysis of Candidates of BP Obfuscation over GGH15 Multilinear Map

Changmin Lee ENS de Lyon
Jung Hee Cheon Seoul National University
Wonhee Cho Seoul National University
Minki Hhan Seoul National University
Jiseung Kim Seoul National University

Abstract: We present a new cryptanalytic algorithm on obfuscations based on GGH15 multilinear map. Our algorithm directly distinguishes distributions from two obfuscated programs. Our attack breaks the recent indistinguishability obfuscation candidate suggested by Chen et al. (CRYPTO'18) for the optimal parameter settings. In addition, we show that the obfuscation scheme suggested by Bartusek et al. (TCC'18) does not achieve the desired security in a certain parameter regime, in which their algebraic security proof still holds.

MS A6-5-3 6 14:30-16:30

Mathematical Models in the Systems Biology of Cancer - Part 3

For Part 1 see: MS A6-5-3 4
For Part 2 see: MS A6-5-3 5
Organizer: Juan Belmonte Beitia UCLM
Organizer: Alicia Martínez González Universidad de Castilla-La Mancha

Abstract: Recently, a new generation of mathematical and computational models of cancer has emerged that have been built in close collaboration with experimentalists and are primarily aimed at understanding aspects of cancer progression and treatment. For this minisymposium, we strongly encourage authors to submit their original studies in modeling, control and mathematical analysis of tumor growth.

14:30-15:00

Plastic behaviour of genes with bivalent epigenetic regulation

Tomás Alarcón ICREA-Centre de Recerca Matematica

Abstract: Plastic behaviour of genes with bivalent epigenetic regulation is a major driver in cancer. Unbalanced activity of key epigenetic-regulatory enzymes have been shown to upset cell regulatory processes producing repressive or permissive states. We explore a stochastic model of a selfactivating gene under bivalent epigenetic regulation. Multiplescale reduction and singular perturbation analysis allows us to derive an analytical expression of an effective potential and analyse the robustness of pathological gene expression states.

15:00-15:30

Mathematical models of brain metastasis: Growth and response to stereotactic radiosurgery

Odelaisy Leon Triana UCLM
Victor M. Pérez García Mathematical Oncology Laboratory, University of Castilla-La Mancha, Spain
Julián Pérez Beteta Mathematical Oncology Laboratory, University of Castilla-La Mancha, Spain
Estanislao Arana Valencian Institute of Oncology, Spain
Ana Ortiz Department of Radiology, Hospital de San Chinarro, Madrid, Spain
José David Albillo MD Anderson Cancer Center (Madrid)

Abstract: Brain metastases (BMs) are cancer cells that spread to the brain from primary tumors in other organs. We have developed an in-depth study of the dynamics and response to stereotactic radiosurgery (SRS) using diagnosis and follow-up imaging data from BM patients treated with SRS obtained from different institutions participating in the METMATH retrospective study. Here we will describe how simple few-compartment mathematical models are able to describe the response to SRS.

15:30-16:00

Mathematical Models and Data Analysis on Lymphoblastic Leukemia

Salvador Chulian García Universidad de Cádiz

Abstract: Lymphoblastic leukaemia is the most common cancer type among children. The survival rate has increased in the last decades, but there is a 15% of the patients with relapse. In this work, we will show several mathematical models which describe the dynamics of lymphoblastic leukaemia and we will apply discriminant analysis to find new biomarkers, which may classify accurately whether a patient may be at risk of relapse, by using experimental data.

MS ME-0-6 6 14:30-16:30

Stochastic dynamics and applications: non-Gaussian noises - Part 2

For Part 1 see: MS ME-0-6 5
Organizer: Yayun Zheng Huazhong University of Science and Technology, China
Organizer: Yongge Li Center for Mathematical Sciences
Organizer: Jinqiao Duan Illinois Institute of Technology

Abstract: Non-Gaussian noise induced stochastic dynamics and fundamental theories are mainly considered in this minisymposium, which can be found applications in biology, physics and engineering science. For a better understanding the influences of non-Gaussian noises, the topics of stochastic bifurcation, first passage time and splitting probability are presented. Some data-driven problems will be discussed to illustrate the existence and sources of non-Gaussian noises in different systems. Theoretical issues related to averaging principle under alpha-stable process will also be shown. This minisymposium provides an opportunity to bring together researchers with diverse but related background to communicate and cooperate.

14:30-15:00

Stochastic resonance and bifurcation of mean-field coupled models of underdamped Duffing oscillators

Yanmei Kang School of mathematics
Ruonan Liu Xi'an Jiaotong University
Yuxuan Fu Xi'an Jiaotong University
Guanrong Chen City University of Hong Kong

Abstract: Boltzmann-type H-theorem is proved for the associated nonlinear Fokker-Planck equation to ensure that the system can asymptotically relax to one of the stationary states. And then, the linear dynamic susceptibility of the order parameter is deduced and calculated with a semi-analytic method. It is shown that, for small driving frequency, the mean-field coupled system can greatly improve the effect of stochastic resonance, with the optimal parameter nearly the same as the critical bifurcation parameter.

15:00-15:30

Dynamical Inference for Transitions in Stochastic Systems with α−stable L´evy Noise

Ting Gao Illinois Institute of Technology

Abstract: A goal of data assimilation is to infer stochastic dynamical behaviors with available observations. We consider transition phenomena between metastable states for a stochastic system with (non-Gaussian) α−stable L´evy noise. With either discrete time or continuous time observations, we infer such transitions between metastable states by computing the corresponding nonlocal Zakai equation (and its discrete time counterpart) and examining the most probable orbits for the state system. Examples are presented to demonstrate this approach.

15:30-16:00

The stochastic dynamics of a quasi-linear system with time-delayed feedback controls under Poisson white noises.

Wantao Jia Northwestern Polytechnical University

Abstract: In the present paper, we studied the stochastic dynamics of quasi-linear system with time-delayed feedback controls and Poisson white noises. The stochastic averaging method is first applied to derive the averaged equations, including the averaged stochastic differential equations and averaged generalized Fokker-Planck-Kolmogorov equation. Based on the averaged equations, stochastic response and stochastic stability of the system are obtained. Then, the influences of the time delay and Poisson white noises on the stochastic dynamics are discussed.

16:00-16:30

The maximum likelihood transition path for controlling greenhouse under Levy noise

Yayun Zheng Huazhong University of Science and Technology, China

Abstract: The abrupt transition of paleoclimatic trigged by random perturbation is reflected in its transition paths. We use a Markov property relating the Fokker Planck equation to identify the maximum likelihood transition path. The theory is illustrated with application to energy balance model influenced greenhouse factor under non-Gaussian fluctuation.

MS FT-4-7 6 14:30-16:30

Numerical methods for PDE-based multi-physics models in biomechanics - Part 1

For Part 2 see: MS FT-4-7 7

For Part 3 see: MS FT-4-7 8

For Part 4 see: MS FT-4-7 9

For Part 5 see: MS FT-4-7 10

Organizer: Ricardo Ruiz Baier University of Oxford

Organizer: Kent-Andre Mardal University of Oslo

Abstract: The scope of the proposed minisymposium deals with the numerical approximation of multiphysics models in biomechanics. First, a particular emphasis will be placed on rigorous convergence analysis, tailored domain decomposition techniques, recent mixed finite element and hybrid discretizations, boundary element methods, design and analysis of preconditioners. Secondly, the session will focus on the application of these new methodologies in the solution of PDE-based coupled models arising in biomechanics and related systems. For instance, we especially welcome submissions involving brain multiphysics, cardiac electromechanics, or respiratory system modelling; as well as more general fluid-structure interaction, and multiscale and/or multiphysics problems.

14:30-15:00

Mathematical modeling of the glymphatic system

Kent-Andre Mardal University of Oslo

Abstract: In this talk we will review the basic concept of the glymphatic system relevant for Alzheimer´s disease and discuss how this leads us to coupled problems consisting of viscous and poro-elastic flow problems. We will then discuss in particular how the associated interface problems can be solved with solution algorithms built from fractional Laplacians.

15:00-15:30

Calcium signalling in embryogenesis and in cancer

Katerina Kaouri Cardiff University, UK

Abstract: Calcium (Ca2+) is a versatile second messenger and plays a crucial role in embryogenesis and in cancer. We present PDE models for Ca2+ signalling in embryogenesis and in cancer and outline similarities and differences. In the cancer model we couple a reaction-diffusion system for Ca2+ with a cell density PDE. For embryogenesis. we present a mechanochemical model where the Ca2+ reaction-diffusion system is coupled to the mechanics of the embryonic cells through a two-way feedback.

15:30-16:00

Finite element discretization of FSI with a fictitious domain approach

Lucia Gastaldi University of Brescia

Abstract: We recall a finite element version of the Immersed Boundary Method (FE-IBM) which, thanks the introduction of a Lagrange multiplier, can be considered as a Fictitious Domain formulation for FSI. We are going to present some results on the analysis of the scheme including error estimates both in time and space and the stability of a time splitting approach. We shall show how our technique can handle the case of compressible solids as well.

16:00-16:30

A Bidomain simulation study on the onset of ventricular tachycardia in presence of infarct scars

Simone Scacchi University of Milano

Piero Colli Franzone University of Pavia

Luca F. Pavarino University of Pavia

Vincenzo Gionti Istituto di Cura Citta' di Pavia

Cesare Storti Istituto di Cura Citta' di Pavia

Abstract: Sudden cardiac death (SCD) is the first cause of death in the industrialized countries. The majority of SCDs is due to ventricular arrhythmias, especially in patients affected from infarct scars, due to prior myocardial infarction events. In this study, we investigate by means of three-dimensional Bidomain numerical simulations the role played by scar dimension and border zone thickness on the onset of re-entrant ventricular tachycardia.

MS ME-0-1 6 14:30-16:30

Recent developments in nonlocal geometric variational problems - Part 2

For Part 1 see: MS ME-0-1 5

Organizer: Cyrill Muratov Department of Mathematical Sciences, NJIT

Organizer: Matteo Novaga University of Pisa

Abstract: In recent years, there has been a growing interest in variational problems involving different kinds of nonlocal interactions. Such problems arise naturally in a variety of application contexts and present new mathematical challenges in the calculus of variations and nonlinear partial differential equations. To study these problems, new analysis tools are currently being developed, bringing this area of calculus of variations to the forefront of applied mathematics research. This two-part minisymposium brings together a group of researchers that have contributed to different aspects of this class of problems and will give an opportunity to share their ideas and recent results.

14:30-15:00

Pattern formation for colloidal systems

Sara Daneri Gran Sasso Science Institute

Eris Runa Deutsche Bank AG

Abstract: In this talk we consider the double Yukawa model, used by physicists and chemists to model pattern formation in colloidal suspensions and protein solutions. We prove that, in certain regimes, global minimizers of the interaction functional governing the material are periodic stripes, thus showing for the first time breaking of symmetry in a model where both the short-range and the long-range competing potentials are nonlocal. This work is in collaboration with Eris Runa.

15:00-15:30

Heteroclinic connections for a nonlocal functional

Annalisa Cesaroni UNIVERSITY OF PADOVA

Abstract: We discuss existence and basic properties of heteroclinic connections in a nonlocal setting, that is transition layers connecting two (variationally stable) pure phases of a phase coexistence model with a nonlocal interaction term, which is not scale invariant. The methods used are mainly variational, and due to the lack of scale invariance, the problem presents some issues, mainly related to the regularity and uniqueness of such heteroclinic minimizers.

15:30-16:00

Nonlocality in variational problems of micromagnetics

Valeriy Slastikov University of Bristol

Abstract: We review the nonlocal variational problems arising in the context of micromagnetics. In particular, we concentrate on the influence of nonlocal effects on the structure of charged domain walls. As an example we provide an explanation of the symmetry breaking of the charged domain wall profile in thin ferromagnetic strips due to the magnetostatic interaction.

16:00-16:30

The surface diffusion flow with elasticity in two and three dimensions

Massimiliano Morini University of Parma

Nicola Fusco University of Naples

Vesa Julin University of Jyvaskyla

Abstract: We prove short-time existence and uniqueness for the surface diffusion flow with a non-local forcing of elastic type. We also establish long-time existence and asymptotic behavior for a suitable class of stable initial data.

MS FT-2-6 6 **14:30-16:30**

Fast iterative methods for large-scale inverse problems in imaging - Part 2

For Part 1 see: MS FT-2-6 5

Organizer: James Herring University of Houston

Organizer: Andreas Mang University of Houston, Dept. of Mathematics

MS Organized by: SIAG/CSE

Abstract: We discuss recent advances in the design and analysis of iterative methods for solving large-scale inverse problems with applications in imaging sciences. These types of problems are inherently ill-posed, have a large number of unknowns, and are typically plagued with data and model uncertainties. This makes solving them efficiently a challenge. We will discuss recent advances in applied and computational mathematics to address these challenges.

14:30-15:00

Stochastic primal-dual hybrid gradient using acoustic Hamilton-Green solver for large-scale PAT

Marta Betcke University College London

Abstract: In this talk we discuss stochastic methods for tomographic image reconstruction in photoacoustic tomography building upon a Hamilton-Green (HG) ray based solver for the forward and adjoint problem. In contrast to full wave solvers usually deployed for heterogenous sounds speeds, the HG solver scales proportionally with the number of detectors which allows for efficient partial operator evaluations required by the stochastic solvers.

15:00-15:30

Improving FISTA: Faster, Smarter and Greedier

Jingwei Liang University of Cambridge

Carola-Bibiane Schönlieb University of Cambridge

Abstract: In this talk, we discuss a simple yet effective approach to improve the practical performance of FISTA, such modification has mainly two advantages: 1) it enables us to prove the convergence of the generated sequence; 2) it allows to design a so-called ``lazy-start'' strategy which can be significantly faster than the original scheme. Moreover, adaptive and greeedy strategies are proposed, the performance of the resulted methods outperforms the state-of-the-art schemes in the literature.

15:30-16:00

Analysis and Quantification of Biophysical Parameters in Clinical MRI Data by means of Brain Tumor Inversion Methods.

Klaudius Scheufele University of Texas

Shashank Subramanian ICES, University of Texas at Austin

George Biros ICES, University of Texas at Austin

Abstract: We target quantification in computational oncology (high-grade gliomas pathologies) by means of inverse methods. We use tumor-growth inversion to localize tumor emergence, and quantify infiltration and proliferation of malignant cells. This enables patient specific calibration of biophysical models. To regularize this highly ill-conditioned problem, the tumor inversion solver is enhanced to favour sparse initial tumor sites. We apply the methodology to 200 clinical cases, and perform basic statistics to correlate biophysical features with patient survival.

16:00-16:30

Fast ADMM-type algorithms for diffeomorphic shape matching

James Herring University of Houston

Andreas Mang University of Houston

Robert Azencot University of Houston

Jiwen He University of Houston

Peng Zhang University of Houston

Abstract: We present efficient algorithms for finding a diffeomorphism that matches 3D point clouds (shapes). We use an optimal control formulation. The optimization problem consists of a functional for the data misfit, a regularization functional to control the smoothness of the velocity field that parameterizes the diffeomorphism, and an ODE-constraint for the flow of the diffeomorphism. We apply the ADMM method to solve this optimization problem. We showcase results for cross-patient matching of cardiac imaging data.

MS A6-1-2 6 **14:30-16:30**

Recent advances in large scale and distributed stochastic optimization - Part 1

For Part 2 see: MS A6-1-2 7

Organizer: Natasa Krejic Faculty of Sciences, University of Novi Sad

Organizer: Dusan Jakovetic University of Novi Sad

Abstract: In the Big Data era, huge scale, data-intensive applications call for the development of novel methods for numerical optimization. The sheer volume of the data necessitates parallel and distributed processing, where the samples and/or features are partitioned across a number of computational units (nodes in a computer cluster, virtual machines, smart devices, etc.). In addition, it is often expensive to utilize exact first or second order search directions, and hence stochastic, sub-sampled, or block-coordinate-type directions are often used. This session reviews recent advances in this fast-progressing research field of parallel and distributed stochastic optimization.

14:30-15:00

Subsampled Trust Region Methods for finite-sum minimization

Stefania Bellavia University of Florence

Benedetta Morini Universita' di Firenze

Natasa Krejic University of Novi Sad

Abstract: Finite-sum minimization problems arise in many scientific computing and machine learning applications. Recently, second-order methods for this class of problems have received great attention due to their resilience to problem ill-conditioning and their low sensitivity to parameter tuning. We propose a new trust-region method that employees suitable approximations of the objective function, gradient and Hessian matrix built via random subsampling techniques. We discuss its convergence properties and show some numerical results.

15:00-15:30

Subspace acceleration in split Bregman methods with application to machine learning on fMRI data

Daniela Di Serafino Università della Campania "L. Vanvitelli"

Abstract: We propose an acceleration technique for split Bregman methods, based on second-order subspace minimization steps, for the solution of optimization problems where the objective function consists of a smooth data fitting term plus anisotropic total variation and l1 regularization. These problems arise, e.g., in learning of predictive models from functional Magnetic Resonance Imaging (fMRI), where the use of the previous regularizers seem to encourage structured sparsity. Numerical experiments on fMRI data are discussed.

15:30-16:00

Problem-driven scenario trees in multistage stochastic optimization

Fabian Bastin Universite de Montreal

Keutchayan Julien Polytechnique Montréal

Gendreau Michel Polytechnique Montréal

Abstract: Multistage stochastic programming problems are typically characterized by a stochastic process capturing the uncertainty, but require an approximation step through scenario generation, often focusing exclusively on approximating the stochastic process. Problem-driven methods consider the problem as a whole, by capturing relevant features of the objective function and the constraints as well. We develop a new problem-driven approach base on the "figure of demerit", which can be used to generate scenario approximations better suited to problems.

16:00-16:30

On an Inexact Restoration Subgradient Method

Tijana Stojancevic Faculty of Technical Sciences, Novi Sad

Natasa Krejic Department of Mathematics and Informatics, Faculty of Sciences, University of Novi Sad

Natasa Krklec Jerinkic Department of Mathematics and Informatics, Faculty of Sciences, University of Novi Sad

Abstract: We consider unconstrained minimization of a finite sum of nondifferentiable convex functions. A new subgradient method, which employs suitable approximations of the objective function and subgradient, is proposed. The parameter which determines the expected number of average sample size for the function and subgradient approximation is obtained by means of Inexact Restoration method. The convergence of the method is proved and numerical results that illustrate the benefits of the proposed method are presented.

MS FT-S-5 6 **14:30-16:30**

Distance Metrics and Mass Transfer Between High Dimensional Point Clouds - Part 2

For Part 1 see: MS FT-S-5 5
For Part 3 see: MS FT-S-5 7

Organizer: Naoki Saito	University of California, Davis
Organizer: Alexander Cloninger	University of California San Diego

Abstract: Measuring distance between probability distributions plays a fundamental role in statistics, imaging, PDEs, and machine learning, and has inspired a variety of algorithmic approaches, including Kullback-Leibler divergence, maximum mean discrepancy, and Wasserstein distance, along with various approximations. In practice, however, efficiently computing such distances leads to a series of important mathematical questions, especially when the distributions are in high-dimensional space, or can only be accessed through finite samples taken from each distribution. In this minisymposium, we shall showcase a variety of approaches to developing theory, computation, and applications of such metrics, as well as promote closer interactions among different communities.

14:30-15:00

Dual Norms on Product Spaces

William Leeb	University of Minnesota, Twin Cities

Abstract: I will present a theory of harmonic analysis for a class of metric spaces and their products. This will include measures of mixed smoothness for functions on product spaces (matrices and tensors) and the corresponding dual distances between distributions. I will focus on fast approximations, as well as applications to denoising and compression.

15:00-15:30

Information geometry of entropy-regularized optimal transport

Ryo Karakida	National Institute of AIST
Shun-ichi Amari	RIKEN CBS
Masafumi Oizumi	University of Tokyo
Marco Cuturi	Google Brain, ENSAE

Abstract: The optimal transport problem with an entropic term is known to bring several computational benefits and useful in many applications. However, because of that regularization, the resulting approximation of the optimal transport cost does not define a proper distance or divergence between probability distributions. We propose a novel divergence for the entropy-regularized optimal transport by introducing the information geometry of the manifold of transportation plans.

15:30-16:00

Morphing of Manifold-Valued Images inspired by Discrete Geodesics in Image Spaces

Sebastian Neumayer	Technische Universität Kaiserslautern
Persch Johannes	
Steidl Gabriele	

Abstract: Image Metamorphosis is a framework for computing an interpolation path between two images which is split into a deformation part and an additional intensity modulation. We generalize a time discrete variant of the model to manifold-valued images, which can consist of phase data, tensor-valued information or probability distributions.

16:00-16:30

Non-rigid manifolds matching via geometric modeling methods

Rongjie Lai	Rensselaer Polytechnic Institute

Abstract: Non-rigid manifold-structured data registration is an important problem for data comparisons. I will discuss our work on mapping nearly isometric manifolds and non-isometric manifolds based on spectral geometry and quadratic assignment methods.

MS ME-1-4 6 **14:30-16:30**

Stabilization of distributed parameter systems: design methods and applications - Part 2

For Part 1 see: MS ME-1-4 5
For Part 3 see: MS ME-1-4 7

Organizer: Alexander Zuyev	Max Planck Institute Magdeburg
Organizer: Grigorij Sklyar	University of Szczecin

Abstract: The stabilization problem for infinite-dimensional control system has close connections with methods of functional analysis and important applications in different branches of science and engineering. This Minisymposium aims at bringing together presentations dealing with stabilizing control design for different classes of dynamical systems described by partial differential equations, functional-differential equations, delay equations, and dynamical systems in abstract spaces. This includes new results in the theory of nonlinear semigroups, port-Hamiltonian systems, and further developments of Lyapunov's direct method. The scope of the Minisymposium also covers applications of these methods to mathematical models in continuum mechanics, chemical engineering, and transportation networks.

14:30-15:00

Boundary control of linear distributed port-Hamiltonian systems

Alessandro Macchelli	University of Bologna
Yann Le Gorrec	FEMTO-ST Institute, France
Federico Califano	University of Twente, The Netherlands

Abstract: The contribution of this talk is an overview of control synthesis methodologies for linear boundary control systems in port-Hamiltonian form. It is shown how to design a state-feedback control action able to shape the energy function, and achieve asymptotic stability via damping injection. Then, since such systems are dissipative with respect to a quadratic supply rate, conditions that a linear regulator has to satisfy to have a well-posed and exponentially stable closed-loop system are presented.

15:00-15:30

Stability analysis for optimal control problems and its use for model predictive control

Manuel Schaller	University of Bayreuth
Lars Gruene	University of Bayreuth
Anton Schiela	University of Bayreuth

Abstract: Model predictive control is a feedback control technique for the optimal control of dynamic systems on indefinite or infinite time horizons. In this talk, we present a stability property for a wide class of optimal control problems which allows for an efficient computation of the feedback using goal-oriented error estimation. Furthermore, we show how this stability also leads to a turnpike result for general evolution equations.

15:30-16:00

Existence of optimal stability margin for weakly damped beams

Jarosław Woźniak	Institute of Mathematics, University of Szczecin
Mateusz Firkowski	University of Szczecin // The West Pomeranian University of Technology, Szczecin

Abstract: We analyze stability of a particular model of vibrations of Timoshenko beams with a weak (distributed) damping connected to rotations of cross-sections of the beam. For some values of physical parameters of the beam the optimal stablity margin phenomenon may be observed, which means that under some conditions there exists an optimal value of a damping coefficient, that is a coefficient that guarantees the fastest possible decay of norms of solutions of the system.

16:00-16:30

Discrepancy based control of continuous fluidized bed agglomeration

Stefan Palis	Otto von Guericke University Magdeburg

Abstract: Fluidized bed spray agglomeration is an important particulate process, which is often used to improve particle properties like flowability or solubility. Modeling the process using a population balance for the particle size distribution results in a partial integro-differential equation. In order to control the distributed state of the derived infinite dimensional system a generalized stability notion, stability with respect to two discrepancies, is used. The performance of the proposed control is shown using simulations.

MS FT-2-2 6 **14:30-16:30**

Orthogonal polynomials and quadrature: Theory, computation, and applications - Part 2

For Part 1 see: MS FT-2-2 5
For Part 3 see: MS FT-2-2 7

Organizer: Miroslav Pranic	University of Banja Luka
Organizer: Lothar Reichel	Kent State University

Abstract: Quadrature rules find many applications in science and engineering. Their analysis is a classical area of applied mathematics and continues to attract considerable attention. This seminar brings together speakers with expertise in a large variety of quadrature rules. It is the aim of the seminar to provide an overview of recent developments in the analysis of quadrature rules. The computation of error estimates and novel applications also are described.

14:30-15:00

Paraorthogonal polynomials on the unit circle. Electrostatic interpretation of zeros

Francisco Marcellan	Universidad Carlos III de Madrid

Abstract: We analyze analytic properties of paraorthogonal polynomials with respect to non trivial probability measures supported on the unit circle. In particular, we study the behavior of their zeros. A review about Gaussian quadratures based on such zeros will be given. An electrostatic interpretation of them will be discussed when the measure is semiclassical.

15:00-15:30

Quasi-paraorthogonal polynomials and positive quadrature formulas on the unit circle

Ruyman Cruz-Barroso	Department of Mathematical Analysis, La Laguna University
Carlos Javier Díaz-Mendoza	Department of Mathematical Analysis, La Laguna University.
Adhemar Bultheel	Department of Computer Science, KU Leuven

Abstract: For a given positive Borel measure supported on the unit circle, we introduce the concept of quasi-paraorthogonality, which extends the concept of paraorthogonality. Our main result links the number of orthogonality conditions satisfied by a quasi-paraorthogonal polynomial and the number of zeros on the unit circle. We present a complete characterization of quasi-paraorthogonal polynomials, by using properties of Toeplitz matrices, and an application to the construction of positive quadrature formulas on the unit circle.

15:30-16:00

Simultaneous quadrature and multiple orthogonal polynomials

Walter Van Assche	KU Leuven
Doron Lubinsky	Georgia Institute of Technology, Atlanta GA
Anton Vuerinckx	KU Leuven, Belgium

Abstract: We approximate r integrals $\int f(x) d\mu_j(x)$ by sums of the form $\sum_{k=1}^{N} f(x_k)\lambda_k^{(j)}$ using the same quadrature nodes but with quadrature weights depending on the measure μ_j. Similar to Gaussian quadrature, there is an optimal choice for the quadrature nodes that maximizes the degree of accuracy: one needs to take the zeros of a multiple orthogonal polynomial for the measures $(\mu_1| \dots |\mu_r)$. We will give properties of the quadrature nodes and the quadrature weights.

MS A1-1-1 6 — 14:30-16:30

Mathematical Theory and Applications of Deep Learning - Part 1

For Part 2 see: MS A1-1-1 7
For Part 3 see: MS A1-1-1 8

Organizer: Haizhao Yang	National University of Singapore
Organizer: Tingran Gao	University of Chicago

Abstract: The “unreasonable effectiveness” of deep learning for massive datasets posed numerous mathematical and algorithmic challenges along the path towards gaining deeper understandings of new phenomena in machine learning. This minisymposium aims at bringing together applied mathematicians interested in the mathematical aspects of deep learning, with diverse background and expertise ranging from approximation theory, optimization methods, and generalization performance to modeling high-dimensional scientific computing problems and nonlinear physical systems; the talks reflect the collaborative, multifaceted nature of the mathematical theory and applications of deep neural networks. The first part of this minisymposium concerns the approximation capacity and optimization of deep learning.

14:30-15:00

Approximation Rate of Deep ReLU Networks

Shijun Zhang	National University of Singapore
Zuowei Shen	National University of Singapore
Haizhao Yang	National University of Singapore

Abstract: This talk introduces a quantitative and optimal approximation rate of ReLU neural networks in terms of both width and depth simultaneously to approximate continuous functions on a compact domain. The analysis provides a general guide for selecting the width and depth of ReLU networks to approximate continuous functions, especially when the computation is conducted with parallel computing in large-scale applications.

15:00-15:30

Tropical Geometry of Deep Neural Networks

Gregory Naitzat	University of Chicago
Gregory Naisat (Naitzat)	The University of Chicago

Abstract: Abstract: We establish connections between feedforward neural networks with ReLU activation and tropical geometry — we show that the family of such neural networks is equivalent to tropical rational maps. Among other things, we show that linear regions of such neural networks correspond to vertices of polytopes associated with tropical rational functions. We characterize those polytopes and deduce from our tropical formulation that a deeper network is exponentially more expressive than a shallow network.

15:30-16:00

Uniform-in-Time Weak Error Analysis for Stochastic Gradient Descent Algorithms via Diffusion Approximation

Tingran Gao	University of Chicago

Abstract: Diffusion approximation provides weak approximation for stochastic gradient descent algorithms in a finite time horizon. In this talk, we introduce new tools motivated by the backward error analysis of numerical stochastic differential equations into diffusion approximation, extending the validity of the weak approximation from finite to infinite time horizon. The new techniques enable us to characterize the asymptotic behavior of constant-step-size SGD algorithms for strongly convex objective functions within the diffusion approximation framework.

MS ME-0-7 6 — 14:30-16:30

Recent advances in understanding suspensions and granular media flow - Part 2

For Part 1 see: MS ME-0-7 5

Organizer: Dirk Peschka	Weierstrass Institute for Applied Analysis and Stochastics
Organizer: Andreas Münch	University of Oxford

Abstract: Particulate flows are ubiquitous in nature, e.g., geophysical processes and biological systems, but also relevant in industrial applications. While the up-scaling of microscopic particle dynamics can be made mathematically rigorous, modern applications often employ effective models for mesoscales. In this minisymposium, we bring together scientists that provide different point-of-views to flows of disperse media, i.e., suspensions and granular flows. In particular, we focus on practically relevant aspects such as modeling/simulation/analysis of shear-induced migration, normal pressures, discontinuous shear thickening, jamming, aspects of universality, nonlocality, and general well-posedness in the view of recent experiments and industrial applications.

14:30-15:00

Ill-posedness of two-phase flow models of concentrated suspensions

Barbara Wagner	Weierstrass Institute Berlin
Ahnert Tobias	Deloitte
Muench Andreas	University of Oxford
Niethammer Barbara	University of Bonn

Abstract: The stability of two-dimensional Poiseuille flow and plane Couette flow for concentrated suspensions is investigated. Linear stability analysis of the two-phase flow model shows the existence of a convectively driven instability with increasing growth rates of the unstable modes as the particle volume fraction increases. Moreover, we show that there exists a bound for the particle phase viscosity below which the model may become ill-posed as the particle phase approaches its maximum packing fraction.

15:00-15:30

Pattern formation in suspension flows

Sungyon Lee	University of Minnesota

Abstract: We examine the spontaneous emergence of particle clusters inside the suspension that is radially displacing air inside a Hele-Shaw cell. This pattern formation is driven by the interfacial instability that follows the particle accumulation at the suspension-air interface. We observe that the key characteristics of the pattern are directly affected by the nature of particle accumulation. We incorporate the stabilizing and destabilizing effects that govern the suspension to rationalize the observed wavelength of instability.

15:30-16:00

Self-channelisation and levee formation in monodisperse granular flows

Chico Rocha	University of Manchester
Chris Johnson	University of Manchester
Nico Gray	University of Manchester

Abstract: Geophysical mass flows have the ability to spontaneously self-channelise by forming static levees. Modelling this process is still a significant challenge, because it requires an understanding of the underlying granular rheology as well as the frictional hysteresis that leads to coexisting static and moving regions. We describe a simple depth-averaged model, based on the μ(I)-rheology, that is able to quantitatively predict the height width and velocity profile across the channel observed in experiments.

16:00-16:30

Distributed Lagrange multiplier methods for the simulation of elastic granular media flow

Luca Heltai	Luca Heltai
Daniele Boffi	University of Pavia
Lucia Gastaldi	University of Brescia

Abstract: The fictitious domain method is one of the preferred tools for the simulation of individual particles suspended in fluids. FDM is very effective when the particles are modeled as rigid bodies (spheres), but fails to capture correctly the effect of deformation. We present a new distributed Lagrange multiplier method that is effective when the granular media is deformable and/or compressible, capable of capturing the full fluid-structure interaction behavior of elastic particulate flows.

MS FT-1-1 6 14:30-16:30

Nonlinear and multiparameter eigenvalue problems - Part 6

For Part 1 see: MS FT-1-3 1
For Part 2 see: MS FT-1-1 2
For Part 3 see: MS FT-1-1 3
For Part 4 see: MS FT-1-1 4
For Part 5 see: MS FT-1-1 5
For Part 7 see: MS FT-1-1 7

Organizer: Fernando De Terán	Universidad Carlos III de Madrid
Organizer: Froilán M. Dopico	Universidad Carlos III de Madrid

MS Organized by: SIAG/LA

Abstract: A nonlinear eigenvalue problem (NLEVP) is to find scalars x (eigenvalues) and nonzero vectors v,w (eigenvectors) satisfying F(x)v=0, w*F(x)=0, where F:C→Cnxn is a matrix-valued function. NLEVPs can be extended to multiparameter eigenvalue problems (MPEPs) F(x1,...,xd)v=0, w*F(x1,...,xd)=0, with F:Cd→Cnxn. Important cases of NLEVPs are the polynomial and rational eigenvalue problems, where the entries of F(x) are polynomial or rational functions. NLEVPs and MPEPs arise in many applications, and much research on these problems has been performed in the last years from computational and theoretical perspectives. This minisymposium presents the most recent advances in NLEVPs and MPEPs, and on their applications.

14:30-15:00

Rational Interpolation for NLEVPs, Part I: Overview of Three Interpolation Algorithms

Mark Embree	Virginia Tech
Jonathan Baker	Virginia Tech
Michael Brennan	MIT
Serkan Gugercin	Virginia Tech

Abstract: Rational interpolation technology enables several distinct approaches for solving nonlinear eigenvalue problems. We shall give an overview of three such algorithms: an interpolation-based projection method that reduces the dimension of a large-scale nonlinear eigenvalue problem but maintains its nonlinear structure; a method that reduces the nonlinear problem to an interpolating Loewner matrix pencil; and a contour-based algorithm that amounts to a data-driven system realization problem.

15:00-15:30

Rational Interpolation for NLEVPs, Part II: Contour Integral Methods as System Realization

Serkan Gugercin	Virginia Tech
Michael Brennan	Massachusetts Institute of Technology, USA
Mark Embree	Virginia Tech, USA

Abstract: Realization theory aims to recover a state-space representation of a (rational) transfer function corresponding to an underlying dynamical system, using its samples at selected points in the complex plane. This work revisits this systems theoretical concept in the setting of nonlinear eigenvalue problems (NLEVP) and reformulates contour integral methods for NLEVP through systems theory. This analysis, then, allows the use of tools such as tangential interpolation for matrix valued transfer functions to tackle NLEVP.

15:30-16:00

On nonlinear eigenvalue problems arising in convex minimization in Rayleigh quotients

Ding Lu	UC Davis

Abstract: We consider optimization problems in which a continuous convex function is to be minimized over the joint numerical range of two Hermitian matrices. We show that the global minimizer is corresponding to a solution of a nonlinear eigenvalue problem with eigenvector nonlinearity. A sequential subspace method is proposed to find the eigenvector. Numerical examples, with applications in computing coercivity constants of boundary integral operators and solving multicast beamforming problems, show the effectiveness of our approach.

16:00-16:30

Nonlinear eigenvalue problems in Computer Aided Geometric Design: Sylvester Matrices by Values

Laureano González Vega	Universidad de Cantabria

Abstract: Computing the intersection of parametric curves and surfaces can be reduced to compute the generalized eigenvalues of several matrix pencils coming from the linearization of polynomial matrices provided by Elimination Theory (Manocha and Demmel). We will present how resultants can be described in terms of the evaluation at any set of points and how to use these tools to deal with the intersection problems before mentioned when the geometric objects considered are presented by values.

MS A1-2-3 6 14:30-16:30

Algebraic Coding Theory and Information Theory

Organizer: Diego Ruano	University of Valladolid
Organizer: Carlos Galindo	Universitat Jaume I

Abstract: Topics: 1- Long stabilizer quantum codes over a small finite field, desirable for practical implementations of quantum computes, will be presented. 2-Locally recoverable codes are useful for distribute storage systems. The locality, the number of nodes necessary to reconstruct, will be addressed. 3-The sum-rank metric naturally extends both the Hamming and rank metrics. It measures the error-correcting capability of codes in multishot matrix-multiplicative channels (e.g. linear network coding). 4-Usually one considers the Shannon entropy in information theory. In this talk one considers generalized entropies (that include the Shannon entropy as a particular case) and its applications in machine learning.

14:30-15:00

Quantum Codes using Algebraic Geometric Codes

Fernando Hernando	Universidad Jaume I
Gary McGuire	UCD
Francisco Monserrat Del Palillo	UPV
Julio Jose Moyano Fernández	UJI

Abstract: We consider a family of smooth projective and absolutely irreducible plane curves over F_q. We compute the number of rational points and a canonical divisor for it. Thanks to it we can deduce when the associated algebraic geometric code is self-orthogonal and construct stabilizer quantum codes.

15:00-15:30

On the construction of high dimensional affine codes whose square code has designed minimum distance

Irene Márquez Corbella	Universidad de La Laguna
Ignacio García Marco	Universidad de La Laguna

Diego Ruano Universidad de Valladolid

Abstract: Given a linear code , we define its square code as the span of all component-wise products of two elements of . Our purpose with this work is to answer the following question: which families of affine codes have simultaneously high dimension and high minimum distance of ? Our method receives as input a positive integer and builds a code such that and for any code from the family of weighted Reed-Muller satisfying that .

15:30-16:00

Sum-Rank Codes and Linearized Reed-Solomon Codes

Umberto Martínez-Peñas University of Toronto

Frank Kschischang University of Toronto

Abstract: The sum-rank metric extends the Hamming and rank metrics in Coding Theory. In this talk, we present linearized Reed-Solomon codes, the first family of maximum sum-rank distance (MSRD) codes whose field sizes are subexponential in the code length. We will show how these codes are natural hybrids between Reed-Solomon codes and Gabidulin codes. We will then present their applications in multishot network coding and local repair, and a more recent application in private information retrieval.

16:00-16:30

Generalized entropies and divergences for machine learning

Santiago Mazuelas BCAM-Basque center of applied mathematics

Abstract: Shannon entropy and Kullback-Leibler divergence play a fundamental role in information theory. Such metrics can be described as the minimum loss and regret in the coding decision problem, while other decision problems lead to different notions of entropy and divergence. This talk will present supervised learning as a decision problem and describe the corresponding notions of entropy and divergence showing their role in determining the performance bounds of learning algorithms.

MS ME-0-8 6 14:30-16:30

Singular Limits in Fluid Dynamics, Related Equations, and Numerical Analysis - Part 3

For Part 1 see: MS ME-0-8 4

For Part 2 see: MS ME-0-8 5

For Part 4 see: MS ME-0-8 7

Organizer: Steve Schochet Tel Aviv University

Organizer: Bin Cheng University of Surrey

Organizer: Qiangchang Ju IAPCM

Abstract: Many areas of physics are described by two models, one derived from basic laws and the second simplified using additional assumptions. Prominent pairs include compressible and incompressible fluid or magneto-hydrodynamic models, kinetic and fluid models, and many-body systems and mean-field theories. Clarifying relationships between models increases understanding of corresponding physical systems and guides development of improved numerical methods. This minisymposium examines current techniques for justifying simplified models via singular limits, quantifying the difference between solutions to related models, and simulating them numerically. Techniques to be discussed include classical, relative, and discrete energy and entropy estimates, and averaging methods.

14:30-15:00

The limits of solutions for the Boltzmann equation

Feimin Huang AMSS, Chinese Academy of Sciences

Yi Wang Chinese Academy of Sciences

Yong Wang Chinese Academy of Sciences

Tong Yang City University of Hong Kong

Abstract: In this lecture, I will present two kind of limits of solutions to the Boltzmann equation, that is, the hydrodynamic limit to the compressible Euler equations in the setting of Riemann solution that contains the generic superposition of shock, rarefaction wave and contact discontinuity, and the diffusive limit, which is related to the so-called ghost effect phenomenon. This lecture is based on two joint works with Yi Wang, Yong Wang and Tong Yang.

15:00-15:30

Models of collective behavior with singular couplings and their mean-field limits

Juan Soler Universidad de Granada

David Poyato Universidad de Granada

Abstract: This talk deals with the derivation and analysis of a compressible Euler--type equation with singular commutator, which is derived from a hyperbolic limit of the kinetic description to the Cucker--Smale model of interacting individuals. Some extensions of these ideas to other collective dynamic descriptions, such as those of Kuramoto-type models, are discussed.

15:30-16:00

Rigorous derivation of a cross diffusion system via mean field limit

Li Chen University of Mannheim

Abstract: This paper investigates the rigorous derivation of a multi-species crossdiffusion system from an underlying particle model. Starting from a stochastic particle system with scaled interaction potential, the rigorous mean- field limit to the cross diffusion system is performed.

16:00-16:30

On two geophysical problems with vanishing parameter limit

Edriss Titi Texas A&M University

Jinkai Li South China Normal University

Abstract: In this talk we will provide rigorous justification for the derivation of the Primitive Equations of planetary scale oceanic dynamics from the 3D incompressible Navier-Stokes equations, for small values of the aspect ratio of the depth to horizontal width. Furthermore, we will also consider the singular limit behavior of a tropical atmospheric model with moisture, as the moisture phase transition convective adjustment relaxation time parameter tends to zero. Rate of convergence will also be provided.

MS A6-3-2 6 14:30-16:30

Multiscale Modeling and Methods for Defects in Solid - Part 1

For Part 2 see: MS A6-3-2 7

Organizer: Pingbing Ming Chinese Academy of Sciences

Organizer: Zhijian Yang Wuhan University

Abstract: Real materials are never perfect, they always contain considerable defects, which are manipulated to control and determine the electronic and mechanical properties of real materials. The behavior of defects usually involves several temporal scales and spatial scales. Multiscale modeling and multiscale simulation methods are hereby important tools to understanding defects. The purpose of this workshop is for participants from different disciplinary to discuss the latest developments in the area of multiscale modeling and simulation techniques of defects in solids.

14:30-15:00

Peierl-Nabarro models and its atomic origin

Pingbing Ming Chinese Academy of Sciences

Abstract: We shall discuss the properties of Peierl-Nabarro model and how it may be derived from the atomic model, the relation between two models will be addressed.

15:00-15:30

Domain reduction in Density-functional Theory and Time-dependent Density Function theory calcula

Xiantao Li Penn State University

Abstract: Density-functional theory (DFT) - based computations have been standard routine in material science. Due to the overwhelming number of degrees of freedom, such calculations have been limited to rather simple systems. In this talk, we present some methods to extend DFT calculations to much large domains and much more complex systems. This is accomplished by formulating the problem as a domain reduction problem. The electronic degrees of freedom are reduced via an appropriate projection procedure.

15:30-16:00

Deep learning for multi-scale molecular modeling

Han Wang IAPCM

Abstract: We introduce deep learning based methods for molecular modeling at different scales. We discuss this topic in two aspects: model construction and data generation. As applications, we consider the coarse-graining of liquid water and the configuration exploration of dissolved poly-peptides. We demonstrate the power of our method in terms of enhanced sampling and constructing the free energy landscape in a high-dimensional collective variable space.

16:00-16:30

Estimation of exciton diffusion lengths of organic semiconductors in random domains

Jingrun Chen Soochow University
Lin Ling Sun Yat-Sen University
Zhiwen Zhang The University of Hong Kong, China
Xiang Zhou City University of Hong Kong, China

Abstract: Exciton diffusion length plays a vital role in the function of opto-electronic devices. Oftentimes, the domain occupied by a organic semiconductor is subject to surface measurement error. The experimental result is sometimes found to be sensitive to the surface geometry of the domain. From numerical results we find that the correlation length of randomness is important to determine whether a 1D reduced model is a good surrogate.

MS A3-2-3 6 14:30-16:30

Kinetic modelling and multiscale simulation of nonequilibrium flow dynamics - Part 6

For Part 1 see: MS A3-2-3 1
For Part 2 see: MS A3-2-3 2
For Part 3 see: MS A3-2-3 3
For Part 4 see: MS A3-2-3 4
For Part 5 see: MS A3-2-3 5
Organizer: Lei Wu UK/University of Strathclyde
Organizer: Kun Xu Hong Kong University of Science and Technology
Organizer: Song Jiang Institute of Applied Physics and Comput. Math

Abstract: The Boltzmann equation underpins a board range of applications ranging from high-altitude aerothermodynamics of space vehicles, gas dynamics in micro-electro-mechanical systems, and shale gas extractions. It has also been extended to different fields, such as granular gases, radiative transfer, phonon/electron transport, plasmas, and quantum/relativistic dynamics. However, the high-dimensional integro-differential equations pose great challenges to the numerical simulation of kinetic equations and their applications. The goal of this minisymposium is to explore recent trends and developments in the kinetic theory (simplification of Boltzmann equations, reactions) and multiscale numerical simulation of non-equilibrium dynamics from the continuum to free-molecular flow regimes.

14:30-15:00

The method of fundamental solutions for simulating low-speed non-equilibrium gas flows

Duncan Lockerby Warwick University

Abstract: Fundamental solutions to linearised moment equations are used to predict the external creeping flow around a variety of 3D geometries (spheres, ellipsoids, tori, and others) at moderate Knudsen number. The scope for extending the Method of Fundamental Solutions to deal with multiple interacting bodies is explored.

15:00-15:30

Unified gas kinetic scheme for disperse multiphase flow

Chang Liu Hong Kong University of Science and Technolog
Chang LIU Hong Kong University of Science and Technology

Abstract: We propose a unified gas kinetic scheme for multiphase dilute gas-particle system, which captures flow physics in the regimes from collisionless multispecies transport to the two-fluid hydrodynamic Navier-Stokes (NS) solution with the variation of Knudsen number, and from granular flow regime to dusty gas dynamics with the variation of Stokes number. The UGKS-M shows a good multiscale property in capturing the particle trajectory crossing (PTC), article wall reflecting phenomena, etc.

15:30-16:00

Quadrature-based lattice Boltzmann models for relativistic hydrodynamics and applications in quark-gluon plasma

Victor Ambrus West University of Timisoara
Calin G. Guga-Rosian West University of Timisoara

Abstract: Both theoretical and experimental evidence indicate that the quark-gluon plasma (QGP) behaves as a nearly perfect relativisic fluid. Due to the extremely short lifetime of the QGP in accelerator experiments, a kinetic description is more appropriate than the macroscopic hydrodynamic approach. In this talk, we present a quadrature-based finite-difference lattice Boltzmann (FDLB) algorithm for obtaining numerical solutions of the relativistic Boltzmann equation with the Anderson-Witting single relaxation time approximation for the collision term.

16:00-16:30

Assessment of kinetic boundary conditions in rarefied gas dynamics

Lei Wu University of Strathclyde

Abstract: The gas kinetic boundary condition that describes how the gas molecules are reflected at the solid surface is complicated and important in rarefied gas flow simulations. By developing an efficient method to solve the Boltzmann equation efficiently and accurately, we assessed the accuracy of various boundary conditions in low-speed rarefied gas flows. We then found that significant drag reduction can be achieved when using certain types of boundary conditions.

MS ME-0-5 6 14:30-16:30

Integrable systems and beyond - Part 3

For Part 1 see: MS ME-0-5 1
For Part 2 see: MS ME-0-5 5
Organizer: Baofeng Feng University of Texas Rio Grande Valley
Organizer: Sara Lombardo Mathematical Sciences, School of Science, Loughborough University
Organizer: Peter Miller University of Michigan

Abstract: Integrable systems arise in various branches of applied mathematics, notably in the study of nonlinear wave propagation and in integrable probability or mathematical physics. These applications have benefited from the use of functional analysis, asymptotic analysis, as well as algebraic and geometric reasoning to study the underlying integrable systems. This session aims to bring together researchers applying a wide range of tools to integrable models in order to solve important and interesting applied problems.

14:30-15:00

On Boussinesq-Klein-Gordon and Ostrovsky equations and apparent zero-mass contradiction

Karima Khusnutdinova Loughborough University

Abstract: I will discuss a weakly-nonlinear solution of the Cauchy problem for the Boussinesq-Klein-Gordon (BKG) equation in the class of periodic functions on a finite interval. We consider the deviation from the oscillating mean and construct an explicit d'Alembert-type solution in terms of solutions of two Ostrovsky equations. Importantly, initial conditions for the Ostrovsky equations by construction have zero mean, while initial conditions for the BKG equation may have non-zero means. Joint work with Matthew Tranter.

15:00-15:30

Rational solutions to higher order Painlevé equations. Part II: complete classification

David Gomez-Ullate Oteiza Universidad Complutense de Madrid

Abstract: We introduce a new representation for rational solutions of the A2k - Painlevé system (a.k.a. Noumi-Yamada system). These solutions are indexed by cyclic Maya diagrams and expressed as Wronskian determinants of suitably chosen sequences of Hermite polynomials. We show that all known rational solutions “with a name” (e.g. Okamoto, Umemura, generalized Hermite, etc.) are just particular cases that fit into this larger scheme.

15:30-16:00

Multi-component Curie-Weiss model

Oleg Senkevich Northumbria University, Newcastle
Antonio Moro Northumbria University, Newcastle
Adriano Barra Salento University

Abstract: Multi-component Curie-Weiss model is a binary spin model on a complete graph which consists of several distinct CW-models connected to each other with the couplings that can be different from the internal couplings within the components. In this work the thermodynamic equations of state for this model are derived using the PDE-based approach, and the detailed analysis of the 2-component case is done using the elements of singularity theory.

MS A1-2-1 6 14:30-16:30

Networks, walks and matrix functions: new trends, results, potential issues - Part 2

For Part 1 see: MS A1-2-1 5

Organizer: Francesca Arrigo University of Strathclyde

Abstract: Complex networks are a reliable and versatile tool used to describe various types of interactions. Their most popular linear algebraic representation, namely, their (rescaled) adjacency matrix, translates them into more easily tractable objects. Appropriately chosen functions of such matrices are a well-established tool to define sensible centrality and communicability measures. The talks in this minisymposium sample recent advances and contributions from (numerical) linear algebra and network theory, discussing, among the others, issues related to walk-based measures, sensitivity of these, edge centralities and the exploitation of alternative network representations.

14:30-15:00

Walk and don't look back

Francesca Arrigo	University of Strathclyde

Abstract: The combinatorics of walks is at the basis of centrality and communicability indices defined in terms of matrix functions. The only property that matters in defining these is the walk length; however, not all walks are created equal. Two walks with the same length may visit the network very differently. In this talk, we describe how to reduce the walk count to only consider walks that do not backtrack, but just keep moving forward.

15:00-15:30

α-nonbacktracking centrality for complex networks. Existence and limit cases.

Julio Flores	UNIVERSIDAD REY JUAN CARLOS
Regino Criado	URJC
Esther García	URJC
Alejandro García Del Amo	URJC
Angel Pérez	URJC
Miguel Romance	URJC

Abstract: Nonbactracking centrality was introduced by Newman et. al to correct some deficiencies of eigenvector centrality. Recently α-nonbacktracking centrality was introduced by the authors as an interpolation measure between the nonbacktracking centrality of the edges of a directed network and the eigenvector centrality of the corresponding directed line graph. It provides a sound extension of the the original definition that avoids some inconsistencies. Our methods can be applied to other centrality measures such as the PageRank.

15:30-16:00

Dynamics-based approach to communicability

Michael Grinfeld	Univesity of Strathclyde
Phil Knight	University of Strathckyde

Abstract: All approaches to network communicability in the literature are based on the adjacency matrix of the underlying graph. Following the ideas of Borgatti on vertex centrality and using very elementary examples, we discuss notions of communicability based on the specific dynamics imposed on the network. Such ideas typically result in non-symmetric communicability functions.

MS GH-1-1 6 14:30-16:30

Stochastic dynamics of biological cells and fluids - Part 2

For Part 1 see: MS GH-1-1 5

Organizer: Peter Kramer Rensselaer Polytechnic Inst

Organizer: Scott McKinley Tulane University

Abstract: Many physical processes involving biological cells and particle dynamics in complex microfluids involve inherent irregularities due to thermal fluctuations or other noisy aspects of protein function. The quantitative study of such systems generally relies on stochastic models which integrate the uncertain noisy aspect in a physically, or sometimes phenomenologically, motivated manner. The speakers in this minisymposium will illustrate how stochastic models can be deployed and analyzed to obtain insights on a broad variety of processes involving biological cells, their interior dynamics, and/or the complex fluid environment.

14:30-15:00

Modeling particle tracking experiments that reveal passive and active transport mechanisms

Scott McKinley	Tulane University

Abstract: There are numerous models for the biophysical mechanisms that drive microparticle movement in biological fluids. The key challenge is to determine which of these models is appropriate for a given particle, and whether or not a given experiment is sufficiently rich enough in information to accomplish this task. In this talk, I will outline some results from our (mostly) Bayesian approach to questions concerning uncertainty quantification, model selection, and experimental design for microparticle tracking experiments.

15:00-15:30

Cell protrusions initiated by fluctuations

Christopher Miles	Courant Institute (NYU)
Alex Mogilner	New York University
Gaudenz Danuser	UT Southwestern
Erik Welf	UT Southwestern

Abstract: The role of stochasticity in cytoskeletal filaments force generation has a rich history, but largely investigates the magnitude of the forces, rather than the dynamics. In this talk, we use a system of SDEs to explore how small amounts of stochasticity can dictate the stop-and-go nature of cell protrusion as a metastable switch. We also propose a spatial system of SPDEs to explore the inherent link between the spatial extent and duration of protrusion events.

15:30-16:00

Stochastic Spatial Modeling of Attachment and Detachment Processes in Molecular Motor-Cargo Systems

Peter Kramer	Rensselaer Polytechnic Inst
Joseph Klobusicky	Rensselaer Polytechnic Institute
Abhishek Choudhary	Rensselaer Polytechnic Institute
John Fricks	Arizona State University

Abstract: Intracellular transport is conducted largely by molecular motor proteins which walk along cytoskeletal filaments, from which they can attach or detach. We apply asymptotic techniques to compute effective transport properties within a framework of switched stochastic differential equations, with the switching rates influenced by the spatial configuration of the motors and cargo. A "small target" asymptotic calculation describes how attachment rates depend on the geometry of the cargo and microtubule network.

16:00-16:30

The evolution of a buffering protein from random interactions.

Swati Patel	Tulane University
Scott McKinley	Tulane University

Abstract: HSP90, a chaperone protein critical to other proteins' folding, has gained attention as a putative buffer of the effects of genetic mutations. Indeed, when HSP90 is reduced in model organisms, a wide variety of phenotypes are exhibited. Here, we test a hypothesis that this buffering property resulted from random interactions of this protein with mutations and subsequent selection. In particular, we study how strength and timing of selection pressures relative to mutation influence protein buffering.

MS A3-2-2 6 14:30-16:30

Phase-Field Models in Simulation and Optimization - Part 2

For Part 1 see: MS A3-2-2 5

For Part 3 see: MS A3-2-2 7

Organizer: Wollner Winnifried TU Darmstadt

Organizer: Wick Thomas Leibniz Universität Hannover

Organizer: Alessi Roberto Sapienza - Università di Roma

Organized by the GAMM activity group "Optimization with Partial Differential Equations" (OPDE)

Abstract: Phase-field models are of recent interest for the simulation of fracture and damage phenomena as well as in topology optimization. This minisymposium will provide a forum for discussions of modeling, discretization techniques, algorithms, and optimization based on phase-field models.

14:30-15:00

Analytical and numerical aspects for the approximation of gradient-regularized damage models

Marita Thomas	WIAS Berlin

Abstract: This presentation deals with techniques for the spatial and temporal discretization of models for rate-independent damage featuring a gradient-regularization and a non-smooth constraint due to the unidirectionality of the damage process. Results and challenges on the convergence of the discrete problems in the sense of evolutionary Gamma-convergence in dependence of the choice of the gradient term and the mesh properties are discussed. This is ongoing research within SPP 1748.

15:00-15:30

Adaptive method for a phase-field fracture model in incompressible solids

Mang Katrin Leibniz Universität Hannover

Abstract: We consider adaptive mesh refinement for a monolithic phase-field description for fractures in incompressible materials. Our approach for adaptive refinement is based on an a posteriori error estimator for the phase-field variational inequality realizing the irreversibility constraint. Within a mixed formulation, the resulting saddle-point system has four unknowns: displacements, pressure, phase-field, and Lagrange multiplier for the crack irreversibility. Several numerical experiments demonstrate our theoretical findings with the newly developed estimators and the corresponding refinement strategy.

15:30-16:00

A Phase-field model for cell blebbing

Werner Philipp Friedrich-Alexander Universität Erlangen-Nürnberg

Burger Martin Friedrich-Alexander-Universität Erlangen-Nürnberg

Abstract: Blebbing is a process during which the membrane of an eucaryotic cell is disconnected from the cortex. Besides the biological motivation, there are challenges in modelling and analysing the resulting PDEs. We present a phase field model which includes membrane bending, volume and area conservation as well as membrane-cortex interaction through proteins. It turns out that the resulting system is a gradient flow on an infinite dimensional Riemannian manifold coupled with a reaction-diffusion system.

MS FT-1-SG 6 14:30-16:30

Approximation Theory and its Applications - Part 1

For Part 2 see: MS FT-1-SG 7

Organizer: Juan Ruiz Álvarez Universidad Politécnica de Cartagena

Organizer: Ángel Alberto Magreñán Ruiz Universidad de la Rioja

Organizer: Dionisio Félix Yáñez Avendaño Universidad de Valencia

Organizer: Juan Carlos Trillo Universidad Politécnica de Cartagena

Abstract: The Approximation theory covers the theoretical and practical study of methods that use numerical approximation to solve problems of different areas. Numerical algorithms in approximation theory have been a major thrust for the research activities in this field during the past years. This session is devoted to provide new trends in the field of approximation theory and related applications in mathematics. Studies about the construction of new algorithms, the study of their properties, such as convergence or stability, and their applications using computer simulations will be welcomed.

14:30-15:00

Nonlinear PPH type reconstructions with triangles

Juan Carlos Trillo Moya Universidad Politécnica de Cartagena

Abstract: We present and prove analytically some interesting properties of the arithmetic and the harmonic mean of three values. Using a kind of second order divided differences, we build a third order interpolation with triangular meshes. Then a nonlinear modification is implemented. Adaption to discontinuities is thus attained and third order of accuracy is maintained in smooth areas.

15:00-15:30

Strong stability of explicit Runge-Kutta time discretizations for semi-negative linear systems

Chi-Wang Shu Brown University

Zheng Sun Ohio State University

Abstract: We study the strong stability property of explicit Runge-Kutta time discretizations of linear semi-discrete semi-negatively stable schemes. We show by a counter example that the classical four stage, fourth order Runge-Kutta method is not strongly stable, and we also show that after two time steps the fourth order Runge-Kutta method is strongly stable. Furthermore, we present a general framework on analyzing the strong stability of explicit Runge-Kutta time discretizations for semi-negative autonomous linear systems.

15:30-16:00

Novel aspects of cardinal interpolation from the viewpoint of subdivision schemes

Lucia Romani Università di Bologna

Alberto Viscardi Università di Bologna

Abstract: A wide class of fundamental functions for cardinal interpolation is provided by the basic limit functions of interpolatory subdivision schemes. The goal of this work is to fill a theoretical gap in the literature by showing the existence of dual interpolatory subdivision schemes of arbitrary arity m, and providing the polynomial equation that their m sub-symbols satisfy. Examples of new interpolatory subdivision schemes that fall within the new category are provided.

16:00-16:30

Multiregularization methods for the approximation of lengths of curves

Vicente F. Candela Universitat de València

Abstract: Overregularization is often a problem opposed to multidimensionality when smoothing methods (discretization among them) are used to deal with singular problems. In this talk, adaptive techniques based on the required regularity, are introduced in order to deal with these problems.

MS A6-3-4 6 14:30-16:30

Electrodiffusion, fluid flow and ion channels: modeling, analysis and numerics - Part 1

For Part 2 see: MS A6-3-4 7

Organizer: Nir Gavish Technion

Abstract: Concentrated aqueous electrolyte solutions play a crucial role in ionic transport in biological and electrochemical systems. Specifically, controlled ion permeation through ion channels governs an enormous range of biological function in health and disease. Electrolyte solutions are complex fluids driven by gradients of concentration, chemical and electrical potential, and hydrostatic pressure. This mini-symposium will provide an opportunity for researchers with various backgrounds to share ideas, methods, approaches and findings on modeling, analysis, numerics, and their applications to electrodiffusion and charged nano-fluidic phenomena in general and ion channel properties in particular.

14:30-15:00

Do Bi-Stable Steric Poisson-Nernst-Planck Models Describe Single Channel Gating?

Nir Gavish Technion

Chun Liu Illinois Institute of Technology, Chicago

Bob Eisenberg Rush Medical Center, Chicago

Abstract: Experiments measuring currents through single protein channels show unstable currents, a phenomena called the gating of a single channel. One hypothesis is that gating corresponds to noise-induced fast transitions between multiple steady (equilibrium) states of the underlying system. In this work, we use the (high-order) steric Poisson−Nernst−Planck (PNP) model to test this hypothesis. Our results strongly suggest that one has to go beyond gradient flow dynamics to explain the spontaneous gating of single channels.

15:00-15:30

Rate Constants and Maxwell's Electrodynamics

Robert Eisenberg Rush University

Abstract: Chemistry uses Mass Action to describe reactions of charged species. Maxwell's equations imply conservation of total current, for all chemical species, under all conditions. Unfortunately, a sequence of chemical reactions A ==> B ==> C does not conserve current if described by mass action. Auxiliary conditions are needed to ensure that the current A to B equals the current from B to C.

15:30-16:00

Accounting for excluded-volume effects in narrow channels

Maria Bruna University of Cambridge

Jon Chapman University of Oxford

Abstract: We consider a system of hard-core-interacting Brownian particles and use the method of matched-asymptotic expansions to obtain a systematic model reduction. We focus on the application of this method to confined geometries, such as narrow channels in ion transport. The result is a nonlinear Fokker-Planck equation, with the nonlinear term that depends on both the excluded-volume and the confinement. By including both effects, the equation can interpolate between severe confinement (single-file diffusion) and unconfined diffusion.

16:00-16:30

Water evaporation in hydrophobic nanopores: what can we learn from atomistic simulations and continuum models?

Alberto Giacomello Sapienza Università di Roma

Abstract: Rare-event simulations of hydrophobic nanopores immersed in water are presented, focusing on the mechanism and kinetics of formation of nanoscale vapor cavities in simple pore models. The effect of extreme confinement on the phase behavior of water is assessed, revealing that nanoscale effects, such as line tension, play a major role in accelerating the formation of bubbles. The relevance of these preliminary results for hydrophobic gating in biological ion channels is discussed.

MS GH-1-3 6 14:30-16:30

Novel Computational Methods for Electromagnetic Problems in Complex Nonlinear Materials - Part 2

For Part 1 see: MS GH-1-3 5
For Part 3 see: MS GH-1-3 7

Organizer: Vrushali Bokil Oregon State University
Organizer: Yingda Cheng Cheng Michigan State University
Organizer: Fengyan Li Rensselaer Polytechnic Institute
Organizer: Camille Carvalho University of California, Merced

MS Organized by: SIAG/CSE

Abstract: Advances in the fabrication of novel artificial materials, described under the umbrella name of "metamaterials", has led to significant research in modeling, analysis of models and their computational simulation to aid in engineering design. This minisymposium will feature recent results on novel computational methods for electromagnetic problems with applications in photonics, optics, micromagnetics, magnetohydrodynamics and other areas. Computational methods will include finite difference, discontinuous Galerkin and other finite element, as well as mimetic methods. Additionally, important issues such as new models and new formulations for different applications, dispersion errors, PMLs for unbounded domains, and efficient solvers will be discussed.

14:30-15:00

Energy Stable Compatible Discretizations for Kerr-Type Nonlinearities in Nonlinear Optics

Vrushali Bokil Oregon State University
Yingda Cheng Michigan State University
Daniel Appelo University of Colorado, Boulder
Fengyan Li Rensselaer Polytechnic Institute

Abstract: We consider a variety of different constitutive models for modeling the Kerr effect in nonlinear optics. These include the instantaneous cubic Kerr model and the cubic dispersive Duffing model for the time evolution of the electric polarization. Appending these constitutive laws to Maxwell's equations we construct fully discrete energy stable Yee discretizations of the resulting nonlinear Maxwell models. Numerical simulations illustrate discrete energy stability and provide a comparison between the performance of the different models.

15:00-15:30

Generalized plane waves for electromagnetics

Lise-Marie Imbert-Gérard University of Maryland
Jean-Francois Fritsch ENSTA ParisTech, France

Abstract: Modeling for wave propagation in magnetically confined plasma motivates the development of numerical methods for smooth variable coefficient time-harmonic Maxwell's equations. Generalized Plane Waves (GPWs) were introduced in the 2D variable refractive index Helmholtz framework. These functions are constructed to satisfy approximately the PDE, as exponential of polynomials and using Taylor expansions.The extension of the GPW construction to the 3D vector-valued Maxwell's equation is introduced, including a discussion on possible ansatz.

15:30-16:00

Modal analysis of frequency in dispersive media

Guillaume Demésy Institut Fresnel
Frédéric Zolla Institut Fresnel
André Nicolet Institut Fresnel
Boris Gralak Institut Fresnel

Abstract: Modal analysis using Quasi-Normal Modes (QNM) allows to interpret the behavior of open systems based on their complex resonances. When dealing with frequency dispersive media, the eigenvalue problem becomes non-linear. Starting from a general causal rational function as a material model, we will present various linearization schemes to tackle the non-linear eigenvalue problem using finite elements, to finally show a general frame based on the Keldysh theorem to expand the solution of direct problems.

MS A3-S-C2 6 14:30-16:30

Geometric shape generation: integrability, variational analysis and applications - Part 3

For Part 1 see: MS A3-S-C2 4
For Part 2 see: MS A3-S-C2 5
For Part 4 see: MS A3-S-C2 7
For Part 5 see: MS A3-S-C2 8
For Part 6 see: MS A3-S-C2 9

Organizer: Kenji Kajiwara Kyushu University
Organizer: Schief Wolfgang The University of New South Wales
Organizer: Miyuki Koiso Kyushu University
Organizer: Udo Hertrich-Jeromin TU Wien

Abstract: This minisymposium is aimed at the discovery of state of the art geometric shape generation, based on methods from smooth and discrete differential geometry. In response to needs and problems raised by industrial applications, various geometric methods to generate desirable or "good” shapes have been developed, that emphasize the underlying structure of an integrable systems or variational approach. The topics addressed will range from problems raised in architecture and industrial design to the mathematical framework used to tackle them, and the modeling and analysis of smooth or discrete curves and surfaces to be used in shape design.

14:30-15:00

Curve and surface modeling for aesthetic design

Kenjiro T. Miura Shizuoka University
R.U. Gobithaasan University of Malaysia, Terengganu

Abstract: Aesthetic shapes are usually actualized as 3D objects represented by free-form surfaces. The main component to achieve aesthetic surfaces is 2D/3D curves. However Bezier, B-Spline and NURBS produce complex curvature function undermining the formulation of shape aesthetics. A viable solution will be formulating aesthetic curves and surfaces from well defined curvature. This presentation advocates on formalizing the theories of aesthetic curve and surface to fill the gap mentioned above which existed since 1970s.

15:00-15:30

Generation of aesthetic shapes by integrable geometry

Kenji Kajiwara Kyushu University

Abstract: We give a formulation of the log-aesthetic curves(LAC) in the industrial design by using the framework of the similarity geometry. LAC is characterized as the rigid motion of an integrable deformation of the plane curves in the similarity geometry, which implies that LAC can be regarded as the analogue of the Euler's elastica in the Euclidean geometry. Based on this formulation, we present an integrable discretization and a space curve extension of LAC .

15:30-16:00

Recent progress on working with elastic curves

David Brander Technical University of Denmark

Abstract: Euler's elastica are natural curves that appeared in pre-digital design as spline curves. Recently, in the development of hot-blade cutting, it has become desirable to work with elastica in a digital environment. Here one encounters problems of non-uniqueness and instability. These practical issues can be solved by introducing a suitable proxy curve to represent the elastica. In this talk, I will describe this work, and some remaining issues.

16:00-16:30

Discrete curve shortening flow

Nozomu Matsuura Kurume Institute of Technology

Abstract: The curve shortening flow was proposed by Mullins in 1956, and is now understood as the one-dimensional case of the mean curvature flow. I will discuss some discrete models of the curve shortening flow, and introduce a simple mechanism to avoid numerical instabilities which are frequently caused by the concentration of vertices of discrete curves.

MS FT-1-10 6 14:30-16:30

Recent development of verification methods for numerical linear algebra - Part 2

For Part 1 see: MS FT-1-10 5

Organizer: Takeshi Ogita Tokyo Woman's Christian University

Organizer: Siegfried Rump Hamburg University of Technology

Abstract: This minisymposium is devoted to verified numerical computations, in particular, verification methods for numerical linear algebra. Since verified numerical computations enable us to rigorously solve problems in numerical linear algebra, such as linear systems, eigenvalue problems, singular value problems, and so forth, by numerical methods in floating-point arithmetic, they have become increasingly important in a wide range of science and engineering. The main objective of the minisymposium is to discuss several recent topics on verification methods for numerical linear algebra and related numerical methods.

14:30-15:00

Verification methods for numerical linear algebra and applications

Takeshi Ogita Tokyo Woman's Christian University

Abstract: We discuss verification methods for numerical linear algebra, such as linear systems and eigenvalue problems. Since these problems play an important role in scientific computing, reliable solutions of the problems are desired. In this talk, we introduce fast verification algorithms for the problems. We also present some numerical examples for practical applications.

15:00-15:30

Compensated algorithms with stochastic arithmetic and interval arithmetic

Stef Graillat Sorbonne University

Abstract: Compensated algorithms consist in computing the rounding errors of individual operations and then adding them later to the computed result. This makes it possible to increase the accuracy of the computed result efficiently. In this talk, we will show how we can use them with stochastic arithmetic and interval arithmetic.

15:30-16:00

Verified bounds for conic programming problems with bounded variables

Marko Lange Hamburg University of Technology

Abstract: In 2007, Jansson introduced a novel concept to obtain verified bounds for conic programming problems in vector lattices. This talk is concerned with a simple generalization of this concept. We compare different bounding techniques for the central inner product term of our estimate. Moreover, we show how some of these techniques can be combined to improve the accuracy of the verified bounds for the objective value of the respective programming problems.

16:00-16:30

Numerical verification of a basis of the null space of a rectangular matrix

Ryo Kobayashi Waseda University

Abstract: We propose methods to compute a verified inclusion of a basis of the null space of a rectangular matrix. Those methods can be obtained a inclusion of an almost orthogonal basis or a well-conditioned basis. To improve the accuracy of methods, we propose methods with preconditioning are not almost dependent on the size and the condition number of the matrix.

MS FT-S-8 6 14:30-16:30

Challenges in theory and numerics for kinetic models with applications - Part 2

For Part 1 see: MS FT-S-8 5

For Part 3 see: MS FT-S-8 7

Organizer: Liu Liu University of Texas at Austin

Organizer: Marlies Pirner University of Vienna

Abstract: Modern applications of kinetic equations of collisional type, such as the Boltzmann equation, have brought researches in mesoscopic modeling, from rarefied gas or plasma dynamics, to quantum mechanics, gas mixtures, chemical reactions and uncertainty quantification for the models. Moreover, they had led to new challenges both in analysis and numerical methods for kinetic models such as spectral-gap estimates, hypocoercivity for studying exponential convergence towards global equilibrium, and multiscale scientific computings to avoid numerically resolve small scales in the models that can be prohibitively expensive. This minisymposium aims to bring together applied mathematicians to explore the recent progress in this field.

14:30-15:00

Numerics of multi-species BGK models taking ions and electrons into account

Christian Klingenberg Wuerzburg University

Abstract: This project is inspired by an attempt to compute plasma in a regime found in inertial confinement fusion. To this end we developed a multi-species kinetic model, an extension of the model Klingenberg, Pirner, Puppo, Kinetic and Related Models Vol. 10, No. 2, (2017), where now the collison frequency depends on the microscopic velocity. We peresent a a robust numerical approach. This is joint work with Jeff Haack, Cory Hauck, Marlies Pirner and Sandra Warnecke.

15:00-15:30

An asymptotic preserving scheme for kinetic chemotaxis models in two space dimensions

Alina Chertock North Carolina State University

Abstract: We study 2-D multiscale chemotaxis models based on a combination of the macroscopic evolution equation for chemoattractant and microscopic models for cell evolution. We propose a new asymptotic preserving numerical scheme that reflects the convergence of the studied micro-macro model to its macroscopic counterpart in the singular limit. The method is based on the operator splitting and a suitable combination of the higher-order implicit and explicit time discretizations. We conduct and present several numerical expreiments.

15:30-16:00

Convergence of a semi-Lagrangian scheme for ES-BGK model

Seok-Bae Yun Sungkyunkwan University

Abstract: The ellipsoidal BGK model is a generalized version of the original BGK model designed to reproduce the physical Prandtl number in the Navier-Stokes limit. In this talk, we consider a new implicit semi-Lagrangian scheme for the ellipsoidal BGK model and derive an L^x norm error estimate, which holds uniformly in the range of relaxation parameter 1/2¡x¡1, including x=0 that corresponds to the original BGK model.

16:00-16:30

Flux limited Keller-Segel limit of a kinetic model with biochemical pathway

Min Tang Shanghai Jiaotong University

Abstract: The run and tumble process is well established in order to describe the movement of bacteria in response to a chemical stimulus. The present study aims at deriving conclusions at the macroscopic scale from assumptions on the microscopic scales. In particular we are interested in comparisons between stiffness of the response and adaptation time. Both the standard Keller-Segel equation and the Flux Limited Keller-Segel equation can occur.

MS FE-1-3 6 14:30-16:30

Network based model reduction in large-scale simulations, imaging and data-science - Part 2

For Part 1 see: MS FE-1-3 5

For Part 3 see: MS FE-1-3 7

Organizer: Mikhail Zaslavskiy Schlumberger

Organizer: Vladimir Druskin Worcester Polytechnic Institute

Abstract: Model-driven and data-driven reduced-order models (ROMs) have been proven to be a useful tool for robust simulations of the response of large-scale dynamical systems as well as for reducing the complexity of inverse problems. Rather recently the list of applications has been extended by data science. ROM representation by sparsely-connected networks is crucial for both the approach efficiency and proper interpretation of ROM parameters. We will discuss various model reduction techniques and sparse network-based approximations with applications to both forward and inverse PDE problems as well as to machine learning and data science.

14:30-15:00

Model order reduction of non-linear dynamical system using neural networks

Aleksandr Katrutsa Skoltech

Ivan Oseledets Skoltech

Vladimir Druskin Worcester Polytechnic Institute

Abstract: We present a model order reduction approach for a class of nonlinear diffusion PDEs via a physically constrained CNN. The architecture of this network is motivated by classical approximation technique, e.g. matrix Chebyshev series, and requires the minimal number of training samples. We perform experiments to demonstrate that the dependence between the initial state of the system and the final state at a given moment of time can be well approximated by our ROM.

15:00-15:30

Data-driven identification of dissipative dynamics

Christopher Beattie	Christopher Beattie

Abstract: Computational models of physical systems should take into account the manner in which systems handle energy flux, but this can be a significant challenge when models are derived directly from response data in the absence of ancillary knowledge of internal dynamics. A data-driven modeling framework is introduced that can yield either a convex family of passive/dissipative models consistent with observed response profiles or a minimal perturbation to data that is consistent with such models.

15:30-16:00

Enhanced Magnetic Resonance Imaging Based on High-Permittivity Pad Optimization

Rob Remis	Delft University of Technology
Jeroen Van Gemert	Delft University of Technology
Wyger Brink	Leiden University Medical Center
Andrew Webb	Leiden University Medical Center

Abstract: In high-field magnetic resonance imaging (MRI), destructive and constructive interference effects may degrade the quality of an MR image to such an extent that it can no longer be used for diagnostic purposes. Properly designed high-permittivity pads offer an affordable solution to this problem and in this contribution, we describe a reduced-order modeling optimization technique for their design. The effectiveness of the pads is illustrated for brain scans acquired at seven tesla.

16:00-16:30

A discrete elasticity inverse problem

Fernando Guevara Vasquez	The University of Utah

Abstract: We consider the inverse problem of finding the Lamé parameters of an elastic medium from measurements of displacements and forces at the boundary. We report preliminary results on a numerical method for solving the problem and that consists of first finding a triangulation on which the problem for reference Lamé coefficients can be easily solved and using this triangulation for reconstructions for general Lamé parameters.

MS A6-2-3 6 14:30-16:30

Mathematics Education

Organizer: Marta Peña Carrera	Universitat Politècnica de Catalunya
Organizer: Cristina Solares	University of Castilla-La Mancha

Abstract: It is well known that in order to achieve greater motivation and engagement of students, it is convenient to contextualize the sciences, in our case, mathematics, through immediate applications to the disciplines of the career. The students must participate actively in the construction of their knowledge and the introduction of realistic applications is helpful for providing meaning to knowledge. The scope of this minisymposium is to illustrate through applications, which can be solved also using computing software, how mathematics can be explained.

14:30-15:00

Contextualization of mathematics subjects in engineering studies

Marta Peña Carrera	Universitat Politècnica de Catalunya
María Teresa López Díaz	Universitat Politècnica de Catalunya

Abstract: It is well known that in order to achieve greater motivation and use of students, it is useful to contextualize the sciences (mathematics, ...) through immediate applications to the disciplines of the career. For example, matrix modeling engineering problems and then applying matrix calculation techniques for study and resolution. The objective of this work is the improvement of the teaching of mathematics in engineering studies, illustrating teaching of these through different technological problems.

15:00-15:30

Teaching of calculus concepts under problem solving perspective

Cristina Solares Martínez	Universidad de Castilla-La Mancha
Henar Herrero Sanz	Universidad de Castilla-La Mancha
Mª Del Rocío Blanco Somolinos	Universidad de Castilla-La Mancha

Abstract: In this study we propose to introduce the concepts of derivative and integral starting from applied contexts, providing to the students problems related to their studies. The teacher presents different questions to guide the students in the construction of their knowledge. Students participate actively and the new concepts involved become meaningful for them.

15:30-16:00

Learning mathematics: the role of the mathematical modeling

Carmen Coll Aliaga	Universitat Politècnica de València
Elena Sánchez	Universitat Politècnica de Valeència

Abstract: In this talk, it is analyzed how the introduction of mathematical models increases students' interest in a specific Mathematics subject and how these models can help students understand and develop mathematical concepts. In particular, some examples of epidemic models are given and emphasis is placed on the important role of knowledge of Algebra, differential equations or equations in differences in the study of these models.

16:00-16:30

Constructing probability problems

Marlén Alonso Castaño	Campus of Llamaquique
Pedro Alonso	University of Oviedo
Laura Muñiz-Rodríguez	University of Oviedo
Luis José Rodríguez-Muñiz	University of Oviedo

Abstract: Problem-solving is a fundamental aspect in mathematical thinking development. In this study, we focus on the creation of probability problems formulated by prospective teachers. Our objective is to identify how they use their mathematical and pedagogical knowledge in the creation of these problems. We observed that students provide few explanations to justify the problem adequacy to the level requested. This leads us to think that we should emphasize these aspects to improve their training.

MS FT-0-3 6 14:30-16:30

Numerical Approximations of Geometric Partial Differential Equations - Part 4

For Part 1 see: MS FT-0-3 3
For Part 2 see: MS FT-0-3 4
For Part 3 see: MS FT-0-3 5
For Part 5 see: MS FT-0-3 8

Organizer: Alan Demlow	Texas A&M University
Organizer: Andrea Bonito	Texas A&M University
Organizer: Ricardo Nochetto	University of Maryland

Abstract: Geometric partial differential equations have received much attention recently due to their appearance in models for a wide range of physical processes. This mini-symposium focuses on their numerical approximation, which must overcome highly nonlinear interactions inherent to the approximation of partial differential equations defined on approximate geometries. Experts in modeling, numerical analysis, and scientific computation will discuss recent advances ranging from fundamental considerations concerning the design and analysis of numerical methods to applications in biology, materials science, and fluid dynamics.

14:30-15:00

Finite element approximation of an obstacle problem for a class of integro-differential operator

Abner Salgado	University of Tennessee at Knoxville

Abstract: We study the regularity of the solution to an obstacle problem for a class of integro-differential operators. The differential part is a second order elliptic operator, whereas the nonlocal part is given by the integral fractional Laplacian. The obtained smoothness is then used to design and analyze a finite element scheme.

15:00-15:30

Discontinuous skeletal methods for the elliptic obstacle problem

Thirupathi Gudi	Indian Institute of Science Bangalore

Alexandre Ern — University Paris-East CERMICS and INRIA Paris

Matteo Cicuttin — University Paris-East CERMICS and INRIA Paris

Abstract: In this talk, we discuss on discontinuous skeletal methods with linear and quadratic reconstructions for the elliptic obstacle problem. We will discuss on the optimal order a priori error estimates upto the regularity for both linear and quadratic methods in two and three space dimesnions.

15:30-16:00

The Kirchhoff Plate Equation on Curved Domains

Shawn Walker — Louisiana State University

Douglas Arnold — University of Minnesota

Abstract: We prove optimal convergence of a curved finite element Hellan-Herrmann-Johnson (HHJ) method for the Kirchhoff plate equation on curved domains. Indeed, we show that the lowest order HHJ method on a polygonal approximation of the disk does not succumb to the classic Babuska paradox (numerical examples will be given). We also discuss 4th order elliptic problems on surfaces, formulate a surface version of the Kirchhoff plate problem, and solve it with surface HHJ elements.

16:00-16:30

On Basis Constructions in Finite Element Exterior Calculus

Martin Licht — UC San Diego

Abstract: We systematically construct geometrically decomposed bases and degrees of freedom in finite element exterior calculus. We elaborate upon a previously overlooked basis. Moreover, we give details for the construction of isomorphisms and duality pairings between finite element spaces. These structural results show, for example, how to transfer linear dependencies between canonical spanning sets, or give a new derivation of the degrees of freedom.

MS GH-0-1 6 — 14:30-16:30

Modeling and simulation of materials defects and inhomogeneities - Part 6

For Part 1 see: MS GH-0-1 1
For Part 2 see: MS GH-0-1 2
For Part 3 see: MS GH-0-1 3
For Part 4 see: MS GH-0-1 4
For Part 5 see: MS GH-0-1 5

Organizer: Luchan Zhang — National University of Singapore
Organizer: Shuyang Dai — Wuhan University

Abstract: Materials defects and inhomogeneities, such as dislocations and grain boundaries in solids, fluid-solid and fluid-fluid interfaces, and fine microstructures within advanced materials, play essential roles in the mechanical and dynamical behaviors of the materials. The complexity of modeling microstructures of these defects and inhomogeneities, and their evolution at various length and time scales present new challenges for mathematical modeling and analysis. Multiscale and multiphysics models are required to accurately describe the complicated phenomenon associated with defects and inhomogeneities. Speakers in this minisymposium will discuss recent advances in modeling approaches and simulation methods, and new findings obtained in analysis and simulations.

14:30-15:00

Numerical methods for the grain boundary dynamics models with long-range elastic interaction

Yuan Lan — Hong Kong University of Science and Technology

Abstract: Grain boundary dynamics models with long-range elastic interaction of the underlying line defects (dislocations and disconnections) have been developed recently to account for the microscopic mechanisms. In this talk, we will discuss numerical methods for these grain boundary dynamics models.

15:00-15:30

Continuum Model and Numerical Scheme for Grain Boundaries in Three Dimensinons Incorporating Underlying Microstructure

Xiaoxue Qin — The Hong Kong University of Science and Techn

Abstract: We present a continuum model for curved low angle grain boundaries. Our model is an optimization problem with two constraints, the objective function is the grain boundary energy derived by the dislocation density potential function η. This problem is solved by the augmented Lagrangian multiplier algorithm and projection method. Comparisons with atomistic simulation results shows that our energy can deal with interactions and our continuum model can give excellent prediction of curved low angle boundaries.

15:30-16:00

Inclination angle between a dislocation and free surface in BCC crystal

Fengru Wang — Wuhan University

Abstract: We develope a continuous model to describe the inclination angle between a dislocation and free surface in BCC crystal. In this model, an energy variation equation is set, obtaining the force balance between effect of energy difference in lattice orientation and influence of the free surface. The results reads the relationship of inclination angle and tilt of burgers vector. We simulate our model with MD method which verifies the validity of our model.

MS A1-2-4 6 — 14:30-16:30

Asynchronous Iterative Methods - Part 1

For Part 2 see: MS A1-2-4 8

Organizer: Christian Glusa — Sandia National Laboratories
Organizer: Frederic Magoulès — CentraleSupelec

Abstract: Classical synchronous iterative methods alternate between local computation and boundary data exchange. In asynchronous iterative methods this dependency is relaxed and processing units are allowed to use whatever data is available at the beginning of a computation phase. Originally called `Chaotic Relaxation' for fixed-point iterations, asynchronous iterative methods are used in various areas of high-performance computing and numerical optimization. In this minisymposium, recent research is presented both on the theory and implementation of asynchronous iterative methods.

14:30-15:00

Asynchronous Multigrid Methods

Jordi Wolfson-Pou — Georgia Institute of Technology

Abstract: We examine how multigrid methods can be executed asynchronously. We present models of asynchronous multigrid which we use to study the convergence properties of asynchronous multigrid. We also introduce two parallel algorithms for implementing asynchronous multigrid. Our experimental results show that asynchronous multigrid can exhibit grid-size independent convergence and can be faster than classical multigrid in terms of wall-clock time. For our test cases, we show that asynchronous smoothing is the best choice of smoother.

15:00-15:30

On the appropriate choice of coarse grid correction for the Optimized Schwarz Method.

Faycal Chaouqui — Temple University

Abstract: We explore and test different options for adding a coarse grid correction to the parallel Optimized Schwarz Method seen as an iterative solver. We do both synchronous and asynchronous frameworks. (Joint work with Daniel B. Szyld)

15:30-16:00

Asynchronous Optimized Schwarz Method for the Screened Poisson equation in rectangular domains

Jose Garay — Louisiana State University

Daniel Szyld — Temple University

Frédéric Magoulès — CentraleSupélec

Mireille El Haddad

Abstract: Asynchronous iterative algorithms are parallel iterative algorithms in which communications and iterations are not synchronized among processors. These algorithms suppress most idle times of processors which usually results in a reduction of the time to achieve convergence. Optimized Schwarz methods are fast domain decomposition methods that can be implemented asynchronously. We present a convergence analysis of an asynchronous Optimized Schwarz method for the Screened Poisson equation in rectangular domains. Numerical experiments illustrate our theoretical results.

MS FT-S-7 6 — 14:30-16:30

Recent advances in high order methods for time dependent PDEs - Part 2

For Part 1 see: MS FT-S-7 5

Organizer: Yan Jiang	University of Science and Technology of China
Organizer: Yuan Liu	Mississippi State University
Organizer: Wei Guo	Texas Tech University

Abstract: The main objective of this mini-symposium is to present the recent advances in development in construction, analysis and applications of cutting-edge high order computational methods for solving hyperbolic and other time dependent PDEs. The methods include but not limited to discontinuous Galerkin method and weighted essentially Non-oscillatory methods, which have experienced significant growth and development in recent years. The aim of this minisymposium is to bring together researchers in academia who are working on the theoretical or practical development of these methods and provide a forum for discussion and interaction.

14:30-15:00

High order multi-dimensional characteristics tracing for the incompressible Euler equation and the guiding-center Vlasov equation

Tao Xiong	Xiamen University
Giovanni Russo	University of Catania
Jingmei Qiu	University of Delaware

Abstract: In this talk, we will introduce a high order characteristics tracing scheme for the two-dimensional nonlinear incompressible Euler system in vorticity stream function formulation and the guiding center Vlasov model. The scheme is incorporated into a backward semi-Lagrangian FD WENO framework without dimensional splitting. Besides, a conservation correction procedure based on a flux difference form will also be discussed.

15:00-15:30

Building Robust Solvers for FEMs for the Cahn-Hilliard Equation

Amanda Diegel	Mississippi State University
Susanne C. Brenner	Louisiana State University
Li-Yeng Sung	Louisiana State University

Abstract: The Cahn-Hilliard equation is one of the most important and widely used equations in modeling two-phase phenomena. In this talk, we will explore the development of an iterative solver for both a first and second order finite element method for the Cahn-Hilliard equation. Both solvers rely on minimal residual and multigrid methods. We will furthermore demonstrate the advantages of these new solvers to the traditional ones.

15:30-16:00

An HDG Method for Tangential Boundary Control of Stokes Equations

Weiwei Hu	Oklahoma State University
WEI GONG	Institute of Computational Mathematics, Academy of Mathematics and Systems Science, CAS, China
MARIANO MATEOS	Universidad de Oviedo, Spain
JOHN SINGLER	Missouri University of Science and Technology, USA
XIAO ZHANG	Sichuan University, China

Abstract: We propose a hybridizable discontinuous Galerkin (HDG) method to approximate the solution of a tangential Dirichlet boundary control problem for the Stokes equations with an L2 penalty on the boundary control. In the 2D case, our theoretical convergence rate for the control is superlinear and optimal with respect to the global regularity on the entire boundary. We present numerical experiments to demonstrate the performance of the HDG method.

MS FT-2-3 6 14:30-16:30

Recent Advances in Methods and Software for Ordinary Differential Equations - Part 2

For Part 1 see: MS FT-2-3 5

Organizer: Paul Muir	Saint Mary's University
Organizer: Wayne Enright	University of Toronto
Organizer: Philip Sharp	University of Auckland
Organizer: Raymond Spiteri	University of Saskatchewan

Abstract: The accurate, reliable, and efficient numerical solution of systems of ordinary differential equations (ODEs) and related systems involving differential-algebraic equations or delay equations has been a central task within scientific computing for many decades. In addition to arising explicitly in many application domains, the numerical solution of ODEs also arises as the central task within software for solving systems of partial differential equations (PDEs). This mini-symposium features researchers who will discuss a wide range of state-of-the-art numerical methods and software for ODEs and for PDEs that rely upon the numerical solution of ODEs. [Sponsored by IFIP Working Group 2.5, https://wg25.taa.univie.ac.at/.]

14:30-15:00

Hermite-Obreshkov One-Step Methods with Continuous Spline Extension

Francesca Mazzia	Università degli Studi di Bari Aldo Moro
Alessandra Sestini	Università di Firenze, Italy

Abstract: We consider the use of symmetric one step Hermite-Obrechkoff methods (BSHO) for the solution of canonical Hamiltonian problems. These integrators turn out to be conjugate symplectic up to order p+2, where p is the order of the method. Moreover, they have the peculiar property of admitting an interesting spline extension that allows us to give a dual interpretation of these schemes in the context of discrete spline quasi-interpolation requiring Hermite data.

15:00-15:30

eBACOLI: a fully adaptive 1D multi-scale PDE solver

Raymond Spiteri	University of Saskatchewan
Kevin Green	University of Saskatchewan

Abstract: BACOLI is software for solving one-dimensional parabolic partial differential equations by B-spline adaptive collocation methods. BACOLI is able to estimate and control error through the use of adaptive meshes in both space and time. We have extended BACOLI to a software package eBACOLI to solve multi-scale systems consisting of parabolic and elliptic partial differential equations describing dynamics on a global scale with ordinary differential equations describing dynamics on a local scale.

15:30-16:00

Recent advances for the numerical solution of coupled ODE/DAE systems

Caren Tischendorf	Humboldt University Berlin
Jonas Pade	Humboldt University of Berlin
Christian Strohm	Humboldt University of Berlin
Henning Sauter	Humboldt University of Berlin

Abstract: We consider the simulation of coupled systems of ODEs/DAEs that describe dynamic processes on networks. Co-simulation is known to be successful for the coupled simulation if the subsystems do not exceed DAE-index-1 and certain contractivity conditions are satisfied (Arnold, Bartel, Günther, Schöps et.al.). We present convergence criteria for a coupled simulation of ODEs/DAEs with index-2 and structural criteria of the coupling that guarantee convergence for the co-simulation independently of the states of the subsystems.

16:00-16:30

General linear methods for direction-split implicit integration

Adrian Sandu	Virginia Tech
Arash Sarshar	Virginia Tech

Abstract: Alternating Directions Implicit (ADI) integration is an operator splitting approach to solve parabolic and elliptic partial differential equations in multiple dimensions based on solving sequentially a set of related one-dimensional equations. We discuss a new ADI approach based on the partitioned General Linear Methods framework. This approach allows the construction of high order ADI methods. Due to their high stage order, the proposed methods can alleviate the order reduction phenomenon seen with other schemes.

MS FT-S-1 6 14:30-16:30

Multivariate Orthogonal Polynomials: Theory and Applications - Part 2

For Part 1 see: MS FT-S-1 5

Organizer: Francisco Marcellan	Universidad Carlos III de Madrid
Organizer: Yuan Xu	University of Oregon
Organizer: Teresa E. Pérez	Universidad de Granada

Abstract: Multivariate orthogonal polynomials have received significant attention in recent years, both in theoretic front in the framework of Approximation Theory, Group Theory, Numerical Analysis (cubature formulas, spectral methods for Boundry Problems in PDE, among others), Operator Theory, Coding Theory as well in some applications as Optics, Mathematical Physics, or Information Theory. The aim of these two minisymposium is to provide a platform for researchers working on multivariate orthogonal polynomials and related fields to report recent progress and exchange ideas. Talks will touch applications in approximation, computation, numerical integration, and various other topics related to applications that use multivariable orthogonal polynomials.

14:30-15:00

Cubature rules for unitary Jacobi ensembles

Jan Felipe Van Diejen	Universidad de Talca

Abstract: We present cubature rules for the exact integration of rational symmetric functions with poles on prescribed coordinate hyperplanes, against the densities of unitary Jacobi ensembles given by the Haar measures of the orthogonal and the compact symplectic Lie groups. For polynomial functions without singularities, this recovers known cubature rules stemming from the sixteen discrete sine-- and cosine transforms. Based on work in collaboration with Erdal Emsiz (Pontificia Universidad Católica de Chile).

15:00-15:30

Zernike-like ortogonal basis and its application in Optics

Chelo Ferreira	Universidad de Zaragoza
José Luis López	Universidad Pública de Navarra
Rafael Navarro	ICMA, CSIC & Universidad de Zaragoza
Ester Pérez Sinusía	Universidad de Zaragoza

Abstract: Zernike polynomials are commonly used to represent the wavefront phase on circular optical apertures, since they form a complete and orthonormal basis on the unit disk. We present a generalization of the Zernike basis for a variety of important optical apertures. We apply a diffeomorphism (or piece-wise) that transforms the unit circle into the new optical aperture. Some applications in optics are presented.

15:30-16:00

Shannon-like integrals of hypergeometric orthogonal polynomials with large parameters and applications to high-dimensional harmonic and hydrogenic systems

Irene Valero Toranzo	Universidad Rey Juan Carlos

Abstract: In this talk we determine the asymptotics of various logarithmic-type integral functionals of certain hypergeometric orthogonal polynomials when their parameter $\alpha \to \infty$. Then, we apply the corresponding results to find the physical Shannon entropies for all the stationary states of harmonic and hydrogenic systems with a very high dimensionality D. Briefly, it is found that these entropies have the same rate of growth for both types of quantum systems.

16:00-16:30

Heun operators and algebras

Luc Vinet	Université de Montreal
Alexei Zhedanov	Renmin University

Abstract: I shall present recent results that have been obtained in connection with the novel concept of algebraic Heun operator associated to bispectral problems.

MS FE-1-2 6 14:30-16:30

Divergence-free and pressure-robust discretizations for the Navier-Stokes equations - Part 2

For Part 1 see: MS FE-1-2 5

For Part 3 see: MS FE-1-2 7

Organizer: Christian Merdon	Weierstrass Institute Berlin
Organizer: Michael Neilan	University of Pittsburgh

Abstract: Recently, pressure-robustness was identified as an important property in the discretisation of the Navier-Stokes equations. Opposite to classical finite element methods (like Taylor-Hood) that relax the divergence constraint, pressure-robust schemes compute discrete flow fields that are independent of the exact pressure and so are much more robust against small viscosity parameters. In this mini-symposium we want to gather active researchers in this field to discuss recent novel discretisation schemes, applications and related developments.

14:30-15:00

The Stokes complex for Virtual Elements

Giuseppe Vacca	University of Milano-Bicocca
Lourenco Beirao Da Veiga	University of Milano Bicocca
David Mora	University of Bio Bio

Abstract: In the present talk we investigate the underlying Stokes complex structure of the Virtual Element Method for Stokes and NavierxStokes equations. We introduce a Virtual Element space $\Phi_h \in H^2$ and prove that the triad $\{\Phi_h|V_h|Q_h\}$ (with V_h, and Q_h denoting the discrete velocity and pressure spaces) is an exact Stokes complex. The theoretical findings are supported by numerical tests.

15:00-15:30

Pressure-robust discretisations for the generalised Stokes problem on non-affine meshes

Gunar Matthies	Technische Universität Dresden
Alexander Linke	WIAS Berlin
Lutz Tobiska	Otto-von-Guericke-Universität Magdeburg

Abstract: Based on inf-sup stable finite element pairs of arbitrary order with discontinuous pressure approximation, we present a modified discretisation of the generalised Stokes problem which provides pressure robustness and maintains optimal error estimates. The approach uses a reconstruction operator mapping discretely divergence-free functions to divergence-free ones. In particular, we consider non-affine meshes and discuss the impact of the Piola transform for defining appropriate discrete function spaces.

15:30-16:00

A non-conforming pressure-robust finite element method for the Stokes equations on anisotropic meshes

Volker Kempf	Bundeswehr University Munich
Thomas Apel	Bundeswehr University Munich
Alexander Linke	Weierstrass Institute for Applied Analysis and Stochastics

Abstract: The classical Crouzeix-Raviart element has favorable properties that allow the application on anisotropically refined meshes, however it is not pressure-robust. We examine the recently introduced approach for the Stokes equations to achieve pressure robustness by applying divergence-free interpolation operators on the velocity test functions. To this end, we prove error estimates on meshes with relaxed shape regularity.

16:00-16:30

The Basics of Theory and Implementation for Weak Galerkin FEMs in CFD

Junping Wang	National Science Foundation

Abstract: The speaker will discuss the basics of theory and implementation of weak Galerkin finite element methods (WG-FEMs) for the Navier-Stokes equation. An integration formula on polytope will be introduced and applied to element stiffness matrices. WG-FEM is a new numerical method where the differential operators in the weak form are reconstructed by using a discrete distribution framework. The regularity of the approximating functions is compensated by stabilizers. The primal-dual weak Galerkin will also be discussed.

MS GH-3-3 6 14:30-16:30

Model Reduction and Coupled Problems in Industry Applications - Part 2

For Part 1 see: MS GH-3-3 5

Organizer: Andrés Prieto	ITMATI - Universidade da Coruña
Organizer: Peter Maass	Universität Bremen

MS Organized by: SIAG/CSE

Abstract: The future competitiveness of the European economy crucially depends on the development of new and the improvement of current products and processes in all key technology areas. Product development is increasingly based on simulation and optimization of virtual products and processes that are described via mathematical models. Such common mathematical representation of real physical products or processes via partial differential and algebraic equations is the basis for simulation and optimization. This minisymposium aims at mathematically proven algorithms in particular utilizing adaptive and tuneable model order reduction techniques. A particular emphasis is on techniques combining analytical approaches with data driven concepts.

14:30-15:00

Model order reduction for boundary condition estimation in casting machinery

Umberto Emil Morelli	Instituto tecnológico de Matemática Industrial (ITMATI)
Peregrina Quintela	Instituto Tecnológico de Matemática Industrial (ITMATI)
Patricia Barral	Instituto Tecnológico de Matemática Industrial (ITMATI)

Giovanni Stabile	Scuola Internazionale Superiore di Studi Avanzati (SISSA)
Gianluigi Rozza	Scuola Internazionale Superiore di Studi Avanzati (SISSA)

Abstract: In continuous casting machinery, the molten metal solidifies in a mold. In order to control the casting process, a proper knowledge of the heat flux between the mold and the metal is crucial. This boundary condition can be estimated using thermocouples measurements inside the mold and solving an inverse problem. In this paper, we describe the application of model order reduction techniques to this problem that allow its solution in real time.

15:00-15:30

Acoustic scattering simulations in coupled fluid-porous media problems

Ashwin Sadanand Nayak	Instituto tecnológico de Matemática Industrial (ITMATI)
Andrés Prieto	University of A Coruña
Daniel Fernández-Comesaña	Microflown Technologies B.V

Abstract: Sound-intensity sensors are sensitive to flow conditions and utilize porous windscreens to mitigate induced noise. Introduction of an effective windscreen requires development of a coupled mathematical model accounting for acoustic transmission across the porous media layer around the probe. We utilize the finite element method along with perfectly matched layers to study the scattering of a plane wave by such representative configurations under no flow conditions.

15:30-16:00

Coupling Model Order Reduction and Multirate Strategies in Coupled Simulation

Marcus Bannenberg	Bergische Universität Wuppertal

Abstract: In industrial circuit and device simulation, simulation problems have to be run many times in the optimization flow. This can only be done by drastically reducing simulation costs via model order reduction (MOR). This is particularly challenging for coupled systems of different subcomponents and physical domains. For efficiency, MOR and multirate error estimates have to be linked to define overall error estimates, balanced to the accuracy requirements of the iteration level of the optimization flow.

16:00-16:30

Fluid-Structure Interaction for Membrane-Based Blood Pumps

Marco Martinolli	Politecnico di Milano
Jacopo Biasetti	CorWave SA
Stefano Zonca	MOX, Dipartimento di Matematica, Politecnico di Milano
Luc Polverelli	CorWave SA
Christian Vergara	LaBS, Dipartimento di Chimica, Materiali e Ingegneria Chimica, Politecnico di Milano

Abstract: Membrane-based blood pumps are implantable Left Ventricular Assist Devices (LVADs) which support the pumping activity of damaged hearts by means of a wave propagation transmitted along an elastic membrane. In view of the optimization of pump performance, we simulate the Fluid-Structure Interaction (FSI) between the oscillating membrane and the blood flow using the Extended Finite Element Method (X-FEM), which avoids remeshing by using fixed unfitted meshes. Funded by EU ROMSOC Project, Grant Number 765374.

MS ME-0-2 6 14:30-16:30

Non-local equations for diffusion and aggregation - Part 1

For Part 2 see: MS ME-0-2 7
For Part 3 see: MS ME-0-2 8

Organizer: Alexis Molino	University of Granada
Organizer: José A. Cañizo	Universidad de Granada

Abstract: Nonlocal Partial Differential Equations arise often in physical models, as a result of potential interactions between particles, or as a result of scattering or long-range interactions. They also arise in biological models and in population dynamics, and play a central role in kinetic theory. This session will focus on their mathematical theory, which is seeing important recent advances regarding existence and uniqueness results for solutions, and a good understanding of their asymptotic behavior. Diffusion and aggregation processes are central examples of this.

14:30-15:00

Nonlinear nonlocal operators in Orlicz spaces

Arturo De Pablo	Universidad Carlos III de Madrid
Ernesto Correa	Universidad Carlos III de Madrid

Abstract: We study integral operators of the type of the fractional p-Laplacian operator, and the properties of the corresponding Sobolev-Orlicz spaces. In particular we show a Poincaré inequality and a Sobolev inequality, depending on the singularity of the kernel J, which may be very weak. Both inequalities lead to compact inclusions. We use those properties to study the associated elliptic problem in a bounded domain , where or , including the generalized eigenvalue problem .

15:00-15:30

Blow-up for a non-local reaction-diffusion equations

Raúl Ferreira	Universidad Complutense de Madrid
Mayte Peréz-Llanos	Universidad de Buenos Aires

Abstract: This talk is concerned about the existence of solutions to the nonlocal semilinear problem

$$\begin{cases} -\int_{R^N} J(x-y)\big(u(y)-u(x)\big)dy + h\big(u(x)\big) = f(x) & x \in \Omega, \\ u = g & x \in R^N \setminus \Omega, \end{cases}$$

verifying the blow-up boundary condition $\lim_{x\to\partial\Omega, x\in\Omega} u(x) = +\infty$ known in the literature as large solutions.

15:30-16:00

On some fractional problems with Dirichlet-Neumann boundary conditions

Eduardo Colorado	Universidad Carlos III de Madrid
Alejandro Ortega	Universidad Carlos III de Madrid

Abstract: We will study existence of solutions to critical fractional elliptic problems with Dirichlet Neumann boundary value problems. To do so, we will analyze the role of the mixed boundary conditions, how they affect to the existence of solutions and we will move the boundary conditions in an appropriate way.

MS FT-4-3 6 14:30-16:30

Optimisation and Inverse Problems in Imaging Science - Part 3

For Part 1 see: MS FT-4-3 4
For Part 2 see: MS FT-4-3 5
For Part 4 see: MS FT-4-3 7

Organizer: Fiorella Sgallari	University of Bologna
Organizer: Raymond Chan	The City University of Hong Kong

Abstract: Next-generation imaging and diagnostics provide an unprecedented step forward in our knowledge in imaging science. Defining new approaches to handle images is both fundamental and challenging due to the huge amount of data and the need for a precise and self-consistent analysis. By combining experiences from different fields, this mini-symposium aims at creating an interdisciplinary bridge that can enrich all research areas. This mini-symposium is dedicated to Prof. Mila Nikolova whose contributions on inverse problems and models such as non-smooth and nonconvex ones were substantial and lasting.

14:30-15:00

On new and robust models for selective segmentation of low contrast images

Ke Chen	University of Liverpool

Abstract: This talk will present some variational models for image segmentation. My focus is on more recent works done at our Liverpool group to design robust models for segmentation of images with weak contrast. Our work can be sued to help preparation of AI training data which is a crucial step in deep learning. The talk covers joint work with several colleagues inducing M. Roberts, L. Burrows, J. Spencer (Exeter) and J. M. Duan (Birmingham).

15:00-15:30

Variational methods for Electron Paramagnetic Resonance Imaging

Sylvain Durand	Université Paris Descartes
Maud Kerebel	
Yves-Michel Frapart	LCBPT, Université de Paris

Abstract: Electron Paramagnetic Resonance Imaging is a method based on the resonance property of unpaired electrons when they are placed in a magnetic field. It permits to characterize and localize free radicals and paramagnetic centers, leading to applications in material and biomedical sciences. We propose a variational method to obtain the image of the specie concentration from a measured sinogram. The method is extended to the case when two or more species are in the cavity.

15:30-16:00

Flexible space-variant directional regularization for image restoration problems

Fiorella Sgallari University of Bologna

Abstract: In this talk we will discuss recent space-variant and directional variational regularization terms for image restoration problems based on explicit statistical assumptions on the gradients of the target image. Compared to TV, the new regularizers are much more flexible and their several space-variant parameters are automatically computed. The numerical solution of the corresponding image restoration models will be presented and discussed.

16:00-16:30

Simultaneous Tomographic Reconstruction and Segmentation with Discriminative Dictionary Learning

Yiqiu Dong Technical University of Denmark

Abstract: In this talk, I will introduce a hybrid method that simultaneously produces both CT reconstructed image and a corresponding segmentation. We use learned dictionaries from a set of training images for both reconstruction and segmentation. Through a joint sparse coding, the segmentation acts as a regularizer and brings more prior knowledge for the reconstruction. Numerical experiments are carried out with artificial and real data.

MS FT-0-2 6 14:30-16:30

Nonlinear Spectral Decompositions with Applications in Imaging and Data Science - Part 1

For Part 2 see: MS FT-0-2 8

Organizer: Martin Benning Queen Mary University of London

Organizer: Martin Burger FAU Erlangen-Nürnberg

Organizer: Guy Gilboa Technion

Abstract: In recent years, there have been many advances in the theory and application of nonlinear eigenvalue analysis. Formulations of nonlinear transforms, based on one-homogeneous functionals like the total-variation semi-norm, and their numerical counterparts have found their way into various applications including image fusion, denoising, invariant descriptors and more. In machine learning, nonlinear eigenvectors of the graph 1-Laplacian have successfully been used for classification and clustering. Despite these recent successes, major theoretical gaps and open problems remain in this area. In this two-part minisymposium researchers with different perspectives will present their latest results and discuss future trends in this emerging field.

14:30-15:00

Eigenfunctions and calibrable sets associated to absolutely one-homogeneous functionals

Nicholas Papadakis Insitut de Mathématiques de Bordeaux

Abstract: This talk concerns the minimization of generalized Rayleigh quotients of the form J(u)/H(u), where J and H are absolutely one-homogeneous functionals. To that end, a time-continuous flow is presented and a discrete scheme is analyzed. Its solution admits a nonlinear eigenvalue problem, based on subgradients of J and H. Taking J as non-local total variation, the approach shares some connections with Cheeger cuts and is applied to unsupervized and semi-supervised segmentation of images and graphs.

15:00-15:30

Nonlinear spectral decompositons and extinction behavior of gradient flows

Leon Bungert Friedrich-Alexander Universität Erlangen-Nürnberg

Burger Martin Friedrich-Alexander Universität Erlangen-Nürnberg

Chambolle Antonin CMAP, Ecole Polytechnique

Novaga Matteo Università di Pisa

Abstract: We establish a theory of decompositions into eigenvectors of a nonlinear subdifferential operator. The main object of study is the gradient flow of an absolutely one-homogeneous functional. We investigate when it yields a decomposition of the initial datum into eigenvectors and study the consequences thereof. Our results shed light onto several known results for the 1D total variation flow and related evolutions. We also prove that asymptotic profiles of homogeneous gradient flows are eigenvectors.

15:30-16:00

Nonlinear Perron-Frobenius theorem with applications to positive tensors and globally optimal training of neural networks

Antoine Gautier Saarland University

Matthias Hein University of Tuebingen

Francesco Tudisco University of Strathclyde

Quynh Nguyen Saarland University

Abstract: We discuss a class of tensors with positive entries for which the best rank one approximation can be computed with global optimal guarantees using the tensor power method. We prove a linear convergence rate and extend the result to the convergence of the tensor Sinkhorn method used in multi-marginal optimal transport. Finally, we present a class of generalized polynomial neural networks with nonnegative weights that can be trained to global optimality.

16:00-16:30

A variational approach to the total variation flow

Verena Bögelein Universität Salzburg

Abstract: In this talk we present a purely variational approach to the existence of solutions to the total variation flow. The technique is very flexible and allows to treat gradient flows arising in image denoising models as well as obstacle problems or time dependent boundary data. We also present a stability result for parabolic p-Laplacian type equations for the limit p→1.

MS A3-S-C1 6 14:30-16:30

Tensor Methods - Part 3

For Part 1 see: MS A3-S-C1 4

For Part 2 see: MS A3-S-C1 5

For Part 4 see: MS A3-S-C1 7

For Part 5 see: MS A3-S-C1 8

For Part 6 see: MS A3-S-C1 9

Organizer: Lieven De Lathauwer KULeuven

Organizer: Konstantin Usevich CRAN - CNRS - Université de Lorraine

Organizer: André Uschmajew MPI MiS

Abstract: A significant research effort is currently dedicated to the extension of linear to multilinear algebra. This work involves a rethinking of both theoretical concepts and numerical computation. The developments gradually allow a transition from classical vector and matrix based methods in applied mathematics and mathematical engineering to methods that involve tensors of arbitrary order. Tensor decompositions open up various new avenues beyond the realm of matrix methods. Important applications include efficient computation in high dimensions, the unique recovery of latent variables in data analysis, and large-scale system identification and machine learning.

14:30-15:00

Optimization methods for computing low rank eigenspaces

André Uschmajew Max Planck Institute for Mathematics in the Sciences

Pfeffer Max

Krumnow Christian

Abstract: We consider the task of approximating the eigenspace belonging to the lowest eigenvalues of a self-adjoint operator on a space of matrices, with the condition that it is spanned by low rank matrices that share a common row space of small dimension. Such a problem arises for example in the DMRG algorithm in quantum chemistry. We propose a Riemannian optimization method based on trace minimization that takes orthogonality and low rank constraints simultaneously into account.

15:00-15:30

Low Rank Symmetric Tensor Approximations

Jiawang Nie University of California

Abstract: For a symmetric tensor, we find a new one whose symmetric rank is small and that is close to the given one. There exist linear relations among the entries of low rank symmetric tensors. They can be expressed by generating polynomials, which can be used to compute low rank tensor approximations. If the given tensor is sufficiently close to a low rank one, we show that the computed low rank approximation is quasi-optimal.

15:30-16:00

Adaptive Tensor Approximation Algorithms

Martin Mohlenkamp Ohio University

Todd Young Ohio University

Abstract: The problem of approximating a given tensor by a tensor in the canonical format remains difficult, despite years of development of optimization-based algorithms. We have identified steep-sided valleys, in the forms of ill-conditioned minima and essential saddles, as causes for slow algorithm progress ('swamps'). Here we describe adaptive algorithms that attempt to detect and react to such features in order to accelerate progress.

16:00-16:30

Randomized Rank-1 Method for Tensor Recompression

Lana Perisa EPFL-SB-MATH-ANCHP

Abstract: Many basic linear algebra operations with low-rank tensors, like element-wise product, have a tendency to significantly increase the rank, even though the resulting tensors admit a good low-rank approximation. We use randomized algorithm to recompress these tensors when dealing with low-rank formats such as Tucker and Tensor Train, by employing random vectors with rank-1 structure which matches the structure of the tensors, which has shown to significantly reduce the computational effort.

MS A3-2-1 6 14:30-16:30

Lagrangian and Eulerian methods for compressible multi-material flows - Part 2

For Part 1 see: MS A3-2-1 5

For Part 3 see: MS A3-2-1 7

Organizer: Michael Dumbser University of Trento

Organizer: Raphael Loubère University of Bordeaux

Organizer: Mikhail Shashkov Los Alamos National Laboratory

Abstract: This minisymposium brings together researchers from universities and governmental research laboratories to discuss recent advances in the mathematical modeling and the numerical simulation of complex compressible multi-material hydrodynamics as well as nonlinear, irreversible large deformation solid mechanics. Multi-material problems are relevant in many industrial applications (e.g. fuel injection), in geophysics (debris flow) and nuclear physics (inertial confinement fusion), to mention a few. Topics include Lagrangian hydrodynamics, large-strain nonlinear elasto-plasticity, Arbitrary Lagrangian Eulerian (ALE) methods, Eulerian diffuse interface methods, mesh generation methods and mesh adaptation, interface reconstruction methods, data transfer between meshes and conservative remapping, structure preserving schemes and high-order methods.

14:30-15:00

Design of "VOF-Machine Learning" scheme for bi-material compressible Euler

Després Bruno Université Paris 6, UPMC

Abstract: Transport of interfaces is a critical step in fluid flow models described by bi-material compressible Euler nonlinear hyperbolic systems. I will review recent progress made with Tensor-Flow Keras for the training of a VOF numerical scheme and present preliminary good results for advection and compressible flows. It shows an interesting additivity principle for the training step.

15:00-15:30

Hyperbolic thermodynamically compatible model for solid-fluid multiphase mixtures

Evgeniy Romenskiy University of Trento

Galina Reshetova Institute of Computational Mathematics and Mathematical Geophysics SB RAS, Novosibirsk, Russia

Ilya Peshkov Institut de Mathématiques de Toulouse, Université Toulouse III, France

Michael Dumbser Laboratory of Applied Mathematics, University of Trento, Italy

Abstract: For the development of nonlinear processes in deforming porous media we apply the theory of Symmetric Hyperbolic Thermodynamically Compatible (SHTC) systems for multiphase mixture and recently developed unified SHTC model of Newtonian continuum mechanics. We extend the SHTC unified model of continuum by consideration of flow of compressible fluid in elastoplastic deforming porous medium. We derive PDEs for the small amplitude wave propagation in the fluid saturated porous medium and study the properties of wavefields.

15:30-16:00

A high order parallel Eulerian-Lagrangian algorithm for advection-diffusion problems on unstructured meshes

Maurizio Tavelli University of Trento

Walter Boscheri University of Ferrara

Abstract: We present a high order DG Eulerian-Lagrangian method for the solution of advection-diffusion problems on staggered unstructured meshes. The particle trajectories are tracked backward in time by means of a high order representation of the velocity field and a linear mapping from the physical to a reference system. Finally, a complete MPI parallelization of the code is presented, showing that our approach can reach up to 95% of scaling efficiency on 1024 CPUs.

16:00-16:30

Distribution-based remapping of nodal mass and momentum between arbitrary meshes for ALE

Mikhail Shashkov Los Alamos National Laboratory

Mack Kenamond LANL

Abstract: We present a distribution-based method for remapping nodal mass and momentum between arbitrary source and arbitrary target meshes for staggered arbitrary Lagrangian-Eulerian hydrodynamics: we define the cell-centered momentum and mass on the source mesh and conservatively remap cell-centered quantities from source to target meshes using an intersection-based remap. Next, we use a local constrained optimization approach for each cell of the target mesh to conservatively distribute cell mass and momentum between nodes of the cell.

MS A6-5-2 6 14:30-16:30

Modeling and Simulation in Medicine and Biology - Part 1

For Part 2 see: MS A6-5-2 7

Organizer: Jose Ferreira UNIVERSITY OF COIMBRA

Organizer: Giuseppe Romanazzi State University of Campinas (UNICAMP)

Abstract: It is nowadays accepted that mathematical models are powerful tools that can provide insight into life sciences. In fact, they contribute to the understanding of chemical and physical mechanisms and their interactions in Medicine and Biology. In this mini-symposium, we aim to provide a forum for presenting new results on mathematical models and numerical methods for partial differential equations in Medicine and Biology. Particular attention will be given to drug delivery, their applications to cancer and cardiovascular diseases. Applications to other biological phenomena will be also addressed.

14:30-15:00

Mathematical modeling and numerical simulation in drug delivery enhanced by physical stimuli

Jose Ferreira UNIVERSITY OF COIMBRA

Abstract: Anticancer therapeutic agents are traditionally administered systemically leading to severe side effects. Drug delivery systems (DDSs), where material, drug and stimuli properties are integrated, have been subject of intense research in the last decades. DDSs locally deliver the drug, maximizing its effectiveness and reducing side effects. In this talk, our goal is to present mathematical models, and the correspondent numerical simulation, that describe the drug release from DDSs enhanced by stimuli.

15:00-15:30

On the influence of non-Newtonian blood flow in drug diffusion from a DES

Elias Gudino Federal University of Paraná

Cassio Oishi UNESP

Adélia Sequeira CEMAT-IST

Abstract: In this talk, we investigate the influence of non-Newtonian blood flow models on drug diffusion from a coronary drug-eluting-stent (DES). We consider different viscoelastic models for the description of fluid dynamics of blood. The model for the transport problem takes into consideration non-Fickian diffusion, drug dissolution, polymer degradation and binding. We propose an Implicit-Explicit (IMEX) finite element method, we show numerical experiments confirming the effectiveness and order of convergence of the employed methodology.

15:30-16:00

An accurate scheme for iontophoretic drug delivery systems

Gonçalo Pena UNIVERSITY OF COIMBRA

Elisa Silveira CMUC/University of Coimbra

Paula Oliveira CMUC/University of Coimbra

José Ferreira CMUC/University of Coimbra
Gonçalo Pena CMUC/University of Coimbra

Abstract: Iontophoresis is an effective technique to facilitate drug transport across tissues. It’s particularly relevant to disrupt protective barriers or to increase the transport of drugs with high molecular weight. In this talk we propose a system of PDEs that model the potential generated by an iontophoteric device, the temperature evolution and the drug concentration distribution in the tissue. A numerical scheme and its analysis are presented. Numerical simulation illustrating the system's behavior will be shown.

16:00-16:30

Numerical modelling of bone poroelasticity with deformation dependent permeability

Silvia Barbeiro UNIVERSITY OF COIMBRA

Abstract: We consider the poroelasticity theory to model the mechanical behavior of fluid-saturated bone. We focus on the numerical solution of a coupled fluid flow and mechanics in Biot’s consolidation model. The permeability tensor is allowed to be deformation dependent. We deal with the nonlinear term by considering a semi-implicit in time scheme. For efficiency, we explore an operator splitting strategy where the flow problem is solved before the mechanical problem, in an iterative process.

MS A6-4-3 6 14:30-16:30

Recent advances in interest rate modeling - Part 2

For Part 1 see: MS A6-4-3 5
Organizer: Claudio Fontana University of Padova
Organizer: Zorana Grbac University Paris Diderot

MS Organized by: SIAG/FME

Abstract: In recent years, the modeling of interest rates has been revitalized by a number of important developments, motivated by the specific features of post-crisis markets. In particular, such features include the persistence of low/negative interest rates, the emergence of multiple yield curves, the relevance of liquidity and refinancing risk, as well as the adoption of new reference rates. From a mathematical standpoint, new techniques are being developed in order to deal with these modeling challenges. In this mini-symposium, we present the latest advances in interest rate theory and discuss ongoing directions of research. This minisymposium is sponsored by SIAG/FME

14:30-15:00

Replacement of LIBOR as a benchmark rate for swaps

Damir Filipovic EPFL and Swiss Finance Institute
Dorn Jochen Bank Vontobel AG
Stefan Pomberger Bank Vontobel AG
Sander Willems EPFL and Swiss Finance Institute

Abstract: We discuss some of the challenges of the transition from LIBOR to overnight rate benchmarks. We explore the scope for hedging of overnight index swap rates using overnight futures and discuss a capital based approach to the uncovered risk of backward looking rate solutions.

15:00-15:30

Macro-Finance Model of Tenor-Dependent Yield Curves

Christoph GERHART University of Freiburg
Eva Lütkebohmert University of Freiburg, Department of Quantitative Finance

Abstract: We consider an affine macro-finance short rate model for multiple yield curves to forecast tenor-dependent bond yields. As a special case we derive an arbitrage free multiple term structure version of the Nelson-Siegel model that can take into account additional macroeconomic factors. We use Kalman filtering applied to the related state space equations together with neuronal networks to fit the model.

15:30-16:00

Refinancing risk

Andrea Macrina University College London
Alex Backwell University of Cape Town
David Skovmand University of Copenhagen
Erik Schlögl University of Technology Sydney

Abstract: We develop a dynamical no-arbitrage term-structure approach that accommodates, aside from the interest rate and credit risks, chiefly roll-over risk. When refinancing a financial position over fixed periods of time, roll-over risk is a significant source of funding cost, particularly in markets with reduced liquidity. Our approach to the incorporation of roll-over risk in interest rate term-structures produces flexible models for IBOR-OIS spread and the basis-spread dynamics, anchored in a sound financial and mathematical ground.

16:00-16:30

Learning multi-curve interest models

Christa Cuchiero WU Wien

Abstract: We investigate neural network approaches in the context of multiple yield curve modeling. On the one hand we shed light on calibration of interest rate models by supervised learning of the calibration functional. On the other hand we consider scenario generation of (multiple) yield curves using neural networks to predict the yield curve evolutions over time. Both aspects are considered from a Heath-Jarrow-Morton point of view for modeling forward rates and spreads.

MS A1-2-6 6 14:30-16:30

Modeling and simulation of interface problems in biology - Part 2

For Part 1 see: MS A1-2-6 5
For Part 3 see: MS A1-2-6 7
Organizer: Sebastian Aland HTW Dresden
Organizer: Wanda Strychalski Case Western Reserve University

Abstract: Problems with moving interfaces are ubiquitous in the modelling of biological phenomena. Examples include cell motility, transport of biological compartments by flow, as well as every process that involves growth or pattern formation. Given the complexity of the biology and mathematical models of these processes, analytical solutions are often intractable; simulating such models requites state-of-the-art numerical methods. The goal of this mini-symposium is to foster the exchange of ideas by bringing together modelers, numerical analysts and experts in scientific computing who share a common interest in understanding complex biological systems.

14:30-15:00

Mathematical modelling of a cereal killer: Modeling plant cell invasion by the rice blast fungus

Vanessa Styles University of Sussex

Abstract: We present a mathematical model for plant cell invasion by the rice blast fungus. The model couples an evolution law for the growth of a tumour on the plant leaf to a reaction diffusion system that holds on the surface of the tumour. We derive a finite element approximation to the model and we show some computational results.

15:00-15:30

Design of poroelastic scaffolds for optimal tissue growth

Matteo Taffetani University of Oxford
Sarah Waters University of Oxford, Mathematical Institute

Abstract: To engineer artificial tissue, a poroelastic biomaterial scaffold seeded with cells may be cultured within a perfusion bioreactor. The local cellular mechanical environment may be tuned by controlling the geometry of the poroelastic scaffold. Here we consider poroelastic scaffolds with heterogeneous porosity, and determine the impact of the heterogeneity on the resulting mechanical load distribution. We identify the optimum pore distribution to achieve a target mechanical load distribution.

15:30-16:00

Phase-field modeling of lung branching morphogenesis

Lucas Daniel Wittwer HTW Dresden

Abstract: A Turing Pattern-based framework can predict the experimentally determined growth field and thus locations of the emerging branches in lung branching morphogenesis. We developed a phase-field model to describe the lung geometry and model the non-linear interaction of the involved proteins in the bulk and on the surface of the growing lung. In this talk, we show the modelling aspect as well as simulation results and compare to biological data.

16:00-16:30

A steady state approach to modelling of glioblastom tumor invasion

Michael Wenske Universität Münster

Abstract: Glioblastoma multiforme is a malignant brain tumor. It is possible to model the tumor progression via PDEs incorporating medical imaging data. The incorporation of diffusion tensor images allows patient specific in-silico experiments but poses problems in the numerical treatment due to steep differences in the diffusion coefficients within the brain. We employ a MPFA-O Method for numerical simulations on 13 DTI datasets and investigate further improvements in the numerical treatment.

MS FE-1-4 6 14:30-16:30

Multiscale analysis and numerical methods for oscillatory PDEs - Part 2

For Part 1 see: MS FE-1-4 5
For Part 3 see: MS FE-1-4 7
For Part 4 see: MS FE-1-4 8
Organizer: Yongyong Cai — Beijing Computational Science Research Center
Organizer: Hanquan Wang — Yunnan University of Finance and Economics
Organizer: Carles Remi — CNRS & Univ Rennes

Abstract: Oscillatory behaviors are ubiquitous in nature and arise in different disciplines, such as semiclassical limits of Schroedinger equations in computational chemistry, nonrelativistic limit of Klein-Gordon equation in particle physics, subsonic limits of Zakharov system in plasma physics, Vlasov-Poisson equation with strong magnetic field, Boltzmann equation in the diffusion limit, etc. These oscillatory PDEs typically involve two or more different temporal/spatial scales, where multiscale analysis has been playing an important role. This mini-symposium aims to bring experts together to exchange and discuss recent progresses on analysis and numerical methods in this area, and to identify future research directions with possible collabrations.

14:30-15:00

Numerical methods for the logarithmic Schrodinger equation

Remi Carles — Institut de recherche mathématique de Rennes
Weizhu Bao — National University of Singapore
Chunmei Su — Technical University of Munich
Qinglin Tang — Sichuan University

Abstract: The logarithmic Schrodinger equation was introduced at the end of the 70's, and has regained some interest recently in various fields of Physics. Due to the singularity of the logarithm at the origin, confirmed methods for the "standard" nonlinear Schrodinger equation (e.g. cubic) require some modifications. We present an efficient strategy, and provide error estimates for two families of time discretization: finite difference, and time splitting.

15:00-15:30

Nested Picard Integrators for the Dirac equation in the nonrelativistic limit

Yongyong Cai — Beijing Computational Science Research Center
Yan Wang — Central China Normal University

Abstract: We present the construction and analysis of uniformly accurate nested Picard iterative integrators (NPI) for the Dirac equation in the nonrelativistic limit involving a dimensionless parameter inversely proportional to the speed of light. The constructed NPI methods are uniformly first-, second- and third-order convergent in time. The NPI method can be extended to arbitrary higher order in time with optimal and uniform accuracy. The implementation of the second order NPI method is demonstrated and analyzed.

15:30-16:00

Quasi-Neutronal limit of semiconductor equations

Shu Wang — Beijing University of Technology

Abstract: In this talk I will discuss quasineutral limit of one-dimensional and multi-dimensional Drift-diffusion models for semiconductors and the related models such as PNP-NS equations. Quasi-neutrality assumption is one basic physical assumption,raised by W. Van Roosbroeck (Bell System Tech. J., 1950). I will talk some mathematical theory of quasi-neutrality for semiconductor and plasma and the related applied sciences. Some rigorous convergence results on structure stability are reviewed and some new results obtained recently will be given.

16:00-16:30

Space-time resonances and high-frequency instabilities in two-fluid Euler-Maxwell systems

Yong Lyu — Nanjing University
Benjamin Texier — University Paris 7
Eric Dumas — Universite Fourier

Abstract: We apply the symbolic flow method to the two-fluid Euler-Maxwell system, and show that space-time resonances induce high-frequency Raman instabilities. A conse- quence is that the Zakharov WKB approximation to Euler-Maxwell is unstable for non-zero group velocities. A key step in the proof is the reformulation of the set of resonant fre- quencies as the locus of weak hyperbolicity for the linearized equations around the WKB solution.

MS A6-2-2 6 14:30-16:30

The Mathematics of Malaria - Part 2

For Part 1 see: MS A6-2-2 5
Organizer: Maeve Mccarthy — Murray State University
Organizer: Dorothy Wallace — Dartmouth College

Abstract: The modeling of malaria transmission and vector dynamics has a long history dating to the original Ross model of 1911, modified by MacDonald in 1957. A google scholar search on “mathematical model malaria” yields over 66,000 results, indicated the substantial quantity of work in this field. No mechanical model reliably predicts malaria outbreaks in any region in sufficient detail to guide policy. Malaria transmission is a complex system depending on temperature, rainfall, topography, land use, and human and insect behavior. In this session we will gather an international group of eight malaria researchers whose combined expertise will inform future research.

14:30-15:00

The role of mosquito gonotrophic cycle in the dynamics of mosquito populations and consequently malaria transmission dynamics

Miranda Teboh-Ewungkem — Lehigh University
Gideon Ngwa — University of Buea

Abstract: We propose a model that illustrates the gonotrophic cycle contributions to the mosquito population and hence malaria transmission dynamics. Female anopheles mosquitoes require blood for the maturation of their eggs. To acquire this blood from humans or animal populations, adult females mosquitoes must seek and find hosts to draw blood from, a necessary process that can be costly to the mosquito. This process of feeding to egg laying is known as the gonotrophic cycle.

15:00-15:30

A Mathematical Study of a Within-Host Malaria Parasite Dynamics Model as it relates to Disease Morbidity

Miranda Teboh Ewungkem — Lehigh University
Gideon Ngwa — University of Buea

Abstract: In malaria, three evolutionary processes interact: parasite's, human's, mosquito's. To understand this complex disease, understanding each evolutionary dynamics and their role in disease propagation is essential. A mathematical model formulated to understand within-human-host parasite dynamics, setting the stage for future drug treatment analysis, is presented. The model incorporates key players - HRBCs, asexual forms, transmissible sexual forms, involved in the parasite's development, and integrates the role of immunity, innate and adaptive, in inhibiting parasite success.

15:30-16:00

A malaria transmission model predicts holoendemic, hyperendemic, and hypoendemic transmission patterns under varied seasonal vector dynamics

Vardayani Ratti — Dartmouth College
Dorothy Wallace — Dartmouth College

Abstract: A model is developed of malaria (Plasmodium falciparum) transmission in vector (Anopheles gambiae) and human populations that include the capacity for both clinical and antiparasitic immunity. The model is coupled with a vector population model that varies seasonally with temperature and larval habitat availability. At steady state, the model clearly distinguishes unstable hypoendemic transmission patterns from stable hyperendemic and holoendemic patterns of transmission.

16:00-16:30

Integrating land use,topography and rainfall in a model of larval habitat

Dorothy Wallace — Dartmouth College
Jonathan Chipman — Dartmouth
Vardayani Ratti — Dartmouth
Michael Shaw — CRREL

Abstract: Malaria transmission patterns depend on multiple local factors: rainfall, temperature, topography and land use. Studies linking these to malaria outbreaks illustrate their importance but do not capture the complex interactions among them. With remotely sensed images and real-time data streams now publicly available, it becomes feasible to create and test a predictive simulation based on physical processes underlying changes in mosquito abundance. A proposed approach is described, highlighting problems where further work is needed.

MS A3-3-3 6 14:30-16:30

Genomics to Populations: Mathematical Views of Modelling Biological Scales - Part 2

For Part 1 see: MS A3-3-3 5

Organizer: Candice Price	University of San Diego
Organizer: Ami Radunskaya	Pomona College
Organizer: Amy Buchmann	University of San Diego

Abstract: In this session, we highlight interdisciplinary efforts of scientists whose work integrates biological processes and mathematical tools across scales. The aims of the work showcased in this symposium are to develop and use efficient algorithms, data structures, visualization, and communication tools with the goal of computer modeling of biological systems. Often researchers focus on modeling or simulating with a particular biological scale in mind while neglecting the dynamical connections across scales. This mini-symposia features topics from the cellular to the population scale.

14:30-15:00

Modeling How Temperature Affects the Dynamics of the Human Sleep/Wake Cycle

Shelby Wilson	University of Maryland
Janet Best	The Ohio State University
Gemma Huguet	Universitat Politecnica de Catalunya
Alicia Prieto-Langarica	Youngstown State University
Selenne Banuelos	California State University Channel Islands
Pamela Pyzza	Ohio Wesleyan University

Abstract: We present a Morris-Lecar type, ODE model of human sleep-wake regulation with thermoregulation and temperature effects. Simulations of this model show features previously presented in experimental data such as elongation of duration and number of REM bouts across the night as well as the appearance of awakenings due to deviations in body temperature from thermoneutrality. The model highlights how temperature effects interact with sleep history to effect sleep regulation.

15:00-15:30

Delineating ovulatory phenotypes with a new endocrine model

Erica Graham	Bryn Mawr College
David Albers	University of Colorado Denver

Abstract: Reproductive hormone dysregulation may disrupt the ovulatory cycle, and the complex physiological feedback defining this endocrine system creates a real challenge for identifying sources of dysfunction. Given limited availability of clinical data and unidentifiability of unknown parameters in existing models, we introduce a new endocrine framework to limit model complexity, with analysis based on simulated parameter distributions. We identify a collection of parameter-based mechanisms that differentiate normal and abnormal phenotypes independently of hormone levels.

15:30-16:00

Using Multi-scale Methods and Machine Learning for Autism Detection

Karamatou Yacoubou Djima	Amherst College
Catalina Anghel	University of California, Davis, Genome Center
Jen-Mei Chang	California State University, Long Beach, CA

Abstract: Recently, variations in the placental chorionic surface vascular network (PCSVN) have been associated with developmental disorders such as autism. Studying PCSVN features in large cohorts requires a reliable, automated mechanism to extract the vascular networks. We present two methods for this purpose: one algorithm combines two multiscale methods (shearlets and Laplacian eigenmaps) and the second is a conditional generative adversarial neural network, which surpasses existing automated methods for PCSVN extraction on digital photographs of placentas.

16:00-16:30

The Dynamics of a Mathematical Model with NonREM/REM stages and REM Latency

Selenne Bañuelos	CSU Channel Islands
Janet Best	The Ohio State University
Gemma Huguet	Universitat Politecnica de Catalunya
Alicia Prieto-Langarica	Youngstown State University
Shelby Wilson	Morehouse College
Pamela Pyzza	Ohio Wesleyan University

Abstract: We propose a mathematical model for NonREM/REM dynamics with sleep/wake cycling that illustrates several features observed in humans during sleep. These include first falling asleep into the NonREM stage, oscillating between it and the REM stage during the sleep period where the first REM bout (REM latency) occurs about 90 minutes into sleep, and having four or five NonREM/REM cycles. The analysis of the model will be presented.

MS A1-1-3 6 14:30-16:30

Computational Linear Algebra in Massively Parallel contexts: Precision and Performance - Part 1

For Part 2 see: MS A1-1-3 7

Organizer: Jens Saak	Max Planck Institute Magdeburg
Organizer: Pablo Ezzatti	Universidad de la República

MS (co-)organized by the GAMM activtiy group "Applied and Numerical Linear Algebra" (ANLA)

Abstract: Numerical linear algebra (NLA) operations are frequently the demandest in scientific-computing, motivating the development of algorithms with a heavy use of HPC techniques. In the last decades the hardware-platforms have notoriously increased the number of computational-units, e.g. GPUs have experienced groundbreaking evolution. Efforts to generate new computational kernels that can efficiently run on hybrid platforms are constantly being performed. Also transitioning from petascale to exascale machines the questions of energy, communication and fail-safeness need to be rethought. In this minisymposium we revisit techniques to accelerate NLA methods, leveraging hybrid and distributed platforms, while focusing on precision and performance of implementations.

14:30-15:00

Solution of Sparse Triangular Systems in GPUs

Pablo Ezzatti	Universidad de la República
Ernesto Dufrechou	Universidad de la República

Abstract: Sparse triangular linear systems are ubiquitous in engineering applications, appearing as a critical stage in several numerical methods. Therefore their efficient solution in parallel platforms is crucial. With the rapid adoption of GPUs, a number of massively-parallel methods have been proposed to tackle this problem. Most of these can be classified into two main categories, namely, the level-set and the self-scheduling paradigms. In this work we review the state of the art in this field.

15:00-15:30

Fast Approximation of the Generalized Eigenvalue Problem and the Solution of Sylvester-like Matrix Equations

Martin Koehler	Max Planck Institute for Dynamics of Complex Technical Systems

Abstract: The solution of the generalized eigenvalue problem is still a computationally hard tasks. Although the QZ algorithm was improved during the last decades it does not utilize most parts of recent computer architectures. As an alternative, in our contribution we present a spectral divide and conquer scheme based on the Generalized Matrix Sign Function and the Matrix Disc Function with focus on mutlicore CPUs as well as multiple GPUs.

15:30-16:00

Preconditioned Conjugate Gradient on Message-Passing Platforms with Reproducible Results

Maria Barreda	Universidad Jaume I
Roman Iakymchuk	KTH Royal Institute of Technology, Fraunhofer ITWM
Jose Ignacio Aliaga Estelles	UJI
Stef Graillat	Sorbonne University
Enrique S. Quintana-Orti	UPC

Abstract: In this talk, we address the accuracy and reproducibility issue of the Preconditioned Conjugate Gradient method in a message-passing implementation. We design and employ two strategies: the

ExBLAS approach (preserves every bit of information until final rounding) and a more lightweight performance-oriented strategy (expands the intermediate precision). These algorithmic strategies are reinforced with programmability suggestions to assure deterministic executions. Finally, we verify these strategies on modern HPC systems with up-to 768 processes.

16:00-16:30

Bridging the performance gap: towards a modular precision ecosystem

Terry Cojean	Karlsruhe Institute of Technology
Goran Flegar	Universidad Jaume I (UJI)
Hartwig Anzt	Karlsruhe Institute of Technology (KIT)
Enrique Quintana-Ortí	Universidad Jaume I (UJI)

Abstract: We present a first high-performance GPU implementation of the adaptive precision block-Jacobi preconditioner, which selects the precisions used to store the preconditioner data on the fly. We explore options of using customized data storage formats not supported by hardware by decoupling the storage format from the format used for arithmetic computations. Experiments run on the state of the art accelerator hardware show that our implementation offers attractive speedups compared to the conventional full-precision block-Jacobi preconditioner.

MS ME-1-3 6 **14:30-16:30**

Computational approaches for multiscale, possibly random problems - Part 4

For Part 1 see: MS ME-1-3 3
For Part 2 see: MS ME-1-3 4
For Part 3 see: MS ME-1-3 5

Organizer: Legoll Frederic	Ecole des Ponts and Inria
Organizer: Claude Le Bris	Ecole des Ponts & Inria

Abstract: This mini-symposium is motivated by the following observations. First, computational approaches dedicated to multiscale problems have recently witnessed very significant developments. Second, an increasing amount of probabilistic features is currently introduced in PDEs for the modelization of complex phenomena. The purpose of this mini-symposium is to review the recent advances in these two directions, and at the intersection of those.

14:30-15:00

Nonconforming MsFEMs for incompressible Navier-Stokes flow problems in perforated domains

Qingqing Feng	CEA

Abstract: We extend MsFEMs to solve Oseen problems and Navier-Stokes problems. To improve the accuracy, we propose several methods to enrich the approximation space, such as adding bubble functions, using higher order polynomials for both the velocity and the pressure, and so on. SU/PG method is developped to stabilize the solution of Navier-Stokes problems. MsFEMs are applied to highly heterogeneous 2D and 3D domains to show the performance of the methods.

15:00-15:30

A tensor-based method for multiscale problems in quasi-periodic media

Quentin Ayoul Guilmard	EPFL
Anthony Nouy	Centrale Nantes
Christophe Binetruy	Centrale Nantes

Abstract: We present a method for complexity reduction in multiscale diffusion problems on quasi-periodic media. It is based on a two-scale representation of the solution with a discontinuous Galerkin method and a reformulation of the problem on a tensor product space. The solution is then efficiently approximated using low-rank tensor methods. This method is applied to stochastic homogenisation problems with randomly-perturbed periodic media. Also, we present several possibilities to exploit this method with weaker quasi-periodicity assumptions.

15:30-16:00

Multidimentional smoothness indicators and Adaptive Filtered schemes for Hamilton-Jacobi equations

Giulio Paolucci	Sapienza, University of Rome
Maurizio Falcone	Sapienza, University of Rome
Silvia Tozza	Sapienza, University of Rome

Abstract: We present multidimensional smoothness indicators for non regular functions, we are focused on Lipschitz continuous functions and the goal is to detect the cells containing a jump in the gradient. We generalize the WENO approach to structured two-dimensional grids, overcoming the limitations of other indicators based on dimensional splitting. Our indicators allow for the construction of multidimensional adaptive filtered schemes that we use to get an accurate approximation of viscosity solutions of first-order Hamilton-Jacobi equations.

16:00-16:30

Error Analysis for Enriched Multiscale Hybrid-Mixed Methods for Linear Elasticity with Weak Stress Symmetry

Sonia Gomes	Universidade Estadual de Campinas and Universidade Federal da Paraíba
Antonio J.B. Dos Santos	Universidade Estadual da Paraíba
Philippe R. B. Devloo	Universidade Estadual de Campinas
Frédéric Valentin	Laboratório Nacional de Computação Científica

Abstract: Discretizations are based on macro partitions, the global system solving normal stress (multiplier) over the mesh skeleton, and piecewise constant displacements. Using the multiplier as Neumann boundary conditions, higher resolution local solvers give details for internal stress tensors, displacement components with vanishing mean values, and rotation (to weakly enforce symmetry). The error analysis reveals multiplier, stress tensor and rotation with the same accuracy order, but super convergence for stress divergence and enhanced displacement approximations occur.

MS GH-3-5 6 **14:30-16:30**

Mathematical solutions to real world problems involving real data - Part 2

For Part 1 see: MS GH-3-5 5

Organizer: Mili Shah	The Cooper Union
Organizer: Leila Issa	Lebanese american university (LAU)

Abstract: Most real life problems can benefit from the collection of data. Mathematical analysis of this data leads to insight on the problem at hand and helps with finding appropriate solutions. This mini-symposium presents a variety of real life problems — ranging from health and finance to politics and robotics — whose solutions has risen from a mathematical analysis of collected data. Each talk will give an overview of the problem at hand, the mathematical techniques used to collect and/or analyze the data, and the real life results and consequences of using the mathematical techniques.

14:30-15:00

A 3-D VAR algorithm to model surface currents, with applications in the East-Med.

Leila Issa	Lebanese american university (LAU)
Julien Brajard	LOCEAN, Paris VI
Georges Baaklini	CNRS-L

Abstract: I will present a near real time 3D-Var assimilation algorithm that provides continuous corrections to the geostrophic velocity, known to be inaccurate near the coast, using drifter trajectories. We shall extend the application of the method presented in [1] to a larger regional scale. [1] L. Issa, J. Brajard, M. Fakhri, D. Hayes, L. Mortier, P-M. Poulain. Modelling Surface Currents in the Eastern Levantine Mediterranean Using Surface Drifters and Satellite Altimetry. Ocean Modelling, May 2016.

15:00-15:30

Machine Learning Methods Using Indefinite Hessian Approximations

Roummel Marcia	University of California, Merced
Jennifer Erway	Wake Forest University
Joshua Griffin	SAS
Riadh Omheni	SAS

Abstract: Machine learning (ML) problems are often posed as highly nonlinear and nonconvex unconstrained optimization problems. Methods for solving ML problems based on stochastic gradient descent generally require fine-tuning many hyper- parameters. In this talk we discuss alternative approaches for solving ML problems based on a quasi-Newton trust-region framework that does not require extensive parameter tuning. We will present numerical results from applications in image processing.

15:30-16:00

Data-driven generalized hybrid iterative approach with application to tomographic reconstruction

Jiahua Jiang	Virginia Tech
Julianne Chung	Virginia Tech
Taewon Cho	Virginia Tech

Abstract: In this project, we investigate data-driven generalized hybrid iterative approaches, where the covariance matrix is combination of a generic prior covariance matrix and a sample convariance matrix that was constructed from training data. Our method improves the flexibility of the conventional generalized hybrid iterative approach without losing the benefits such as automatically estimating the regularization parameter.

16:00-16:30

Learning from MRI Data to Diagnose Chiari Malformation

Malena Espanol	The University of Akron
Aintzane Urbizu	Universitat de Barcelona
Bryn Martin	University of Idaho
Dulce Moncho	Universitat Autònoma de Barcelona
Alex Rovira	Universitat Autònoma de Barcelona
Maria Poca	Universitat Autònoma de Barcelona
Juan Sahuquillo	Universitat Autònoma de Barcelona
Alfons Macaya	Universitat Autònoma de Barcelona

Abstract: In this talk, we will present the use of several machine learning classification methods to identify morphometric measures obtained from magnetic resonance images, to help diagnose Chiari malformation, a condition in which brain tissue extends into the spinal canal.

MS A6-2-1 6 14:30-16:30

Mathematical and Computational Modeling in Ecology and Epidemiology - Part 2

CP A3-3-L1 6 14:30-16:30

Mathematical Topics and their Applications VIII

Chair Person: Fatia Fatimah	Universitas Terbuka

CP A3-3-L1 6 1 14:30-14:50

The multi-fuzzy N-soft set and its operations

Fatia Fatimah	Universitas Terbuka
José Carlos R. Alcantud	University of Salamanca

Abstract: This work first combines two successful approaches to the modelization of vague knowledge about objects. The authors have proposed the concept of N-soft set as a multinary parameterized description of the universe of objects. It extends the idea of soft set, and in turn has been extended to fuzzy, resp. hesitant, N-soft sets. Yang, Tang and Meng (AMM, 2013) defined multi-fuzzy soft sets. Here we propose the hybrid model called multi-fuzzy N-soft sets.

CP A3-3-L1 6 2 14:50-15:10

Characterizing random number generation amongst undergraduate students

Samuel Ogunjo	Federal University of Technology Akure
Emmanuel Dansu	Federal University of Technology Akure
O. A. Olukanye-David	University of Manitoba, Winnipeg
Ibiyinka Fuwape	Michael and Cecilia Ibru University

Abstract: The ability of humans to generate numbers that are really random has always been a subject of debate. This paper investigated the possibility for generating random generation amongst 2344 first year undergraduate students. Using various statistical tests, we found that gender, test scre or age did not significantly influence the choice of random numbers. Numbers generated are highly random and chaotic despite number 1 being the most selected number across all predictors that was considered.

CP A3-3-L1 6 3 15:10-15:30

Ceratain fractional calculus and solutions of fractional Kinetic equations associated with the generalized multiindex Bessel function via Laplace transform

Sunil Dutt Purohit	Rajasthan Technical University
Dinesh Kumar	Agriculture University

Abstract: Recently Bessel function has been investigated by many authors who have applied in various areas. Here we introduce and investigate a generalized multiindex Bessel function associated with Riemann-Liouville fractional calculus operators. Also we express the solutions of fractional kinetic equation associated with the proposed function using Laplace transform and present numerical and graphical solutions of the main theorems. The main results here are general enough to be specialized to yield many new and known results.

CP A3-3-L1 6 4 15:30-15:50

A KERNEL-INDEPENDENT TREECODE BASED ON BARYCENTRIC LAGRANGE INTERPOLATION

Lei Wang	University of Wisconsin, Milwaukee
Svetlana Tlupova	Farmingdale State College, SUNY
Robert Krasny	University of Michigan, Ann Arbor

Abstract: A kernel-independent treecode is presented for fast summation of pairwise particle interactions. The treecodes replace the particle-particle interactions by particle-cluster interactions using barycentric Lagrange interpolation at Chebyshev points to compute well-separated particle-cluster interactions. The scheme is kernel-independent because it requires only kernel evaluations. For a given level of accuracy, the treecode reduces the operation count for pairwise interactions from $O(N^2)$ to $O(N)$, where N is the number of particles in the system.

CP A3-3-L1 6 5 15:50-16:10

Modified HHT-integration scheme for the Numerical Simulation of Rigid Body Rotations with Euler Parameters

Karim Sherif	Josef Ressel Center for Advanced Multibody Dynamics
Wolfgang Steiner	Josef Ressel Center for Advanced Multibody Dynamics
Thomas Lauss	Josef Ressel Center for Advanced Multibody Dynamics
Karin Nachbagauer	Josef Ressel Center for Advanced Multibody Dynamics

Abstract: In multibody dynamics, Euler Parameters are often used for the numerical simulation of rigid body rotations. The Hilber-Hughes-Taylor (HHT) method is widely employed for solving the resulting equations of motion of the mechanical system. However, a direct use of the classical HHT integration scheme has a very unfavorable impact on the Euler parameter description of rotational motions. To circumvent this problem without losing the advantage of Euler parameters, we present a modified HHT-method.

CP A3-3-L1 6 6 16:10-16:30

Numerical approximation of the fluctuations in random heterogeneous problems

Pierre-Loïk ROTHE	ENPC
Frédéric LEGOLL	ENPC

Abstract: Considering random heterogeneous problems, our aim is to understand how much the response fluctuates around its homogenized limit. We aim at estimating the distribution of the response, knowing the distribution of the material coefficients, without resorting to a costly Monte-Carlo approach. We show that, in a weakly-random setting, the fluctuations of the response are governed by a tensor that we identify. In a strongly random setting, we perform numerical simulations that confirm our theoretical findings.

CP FT-1-8 6 14:30-16:30

Mathematics and Computer Science II

Chair Person: Mermri El Bekkaye	Faculty of Science, University Mohammed Premier

CP FT-1-8 6 1 14:30-14:50

Implemention of the finite element method with C program to solve partial differential equations

Mermri El Bekkaye	Faculty of Science, University Mohammed Premier
Mellah Zhor	Faculty of Science, University Mohammed Premier

Abstract: The main goal of this paper is to develop the method and an efficient C program to numerically solve partial differential equations based on finite element approximation in two dimensions. We consider three models of linear PDEs. First, we describe the data structure to represent the triangulation and boundary conditions. Then we analyse and describe the implementation of FEM for linear PDEs. The proposed programs aim to be fast and easy to understand and modify.

CP FT-1-8 6 2 **14:50-15:10**

A numerical investigation on the structure of the zeros of the q-sigmoid polynomials

Jung Yoog Kang	Silla University

Abstract: Abstract: We introduce q-sigmoid polynomials and their basic properties including q-derivative and q-integral. By using Mathematica, we find approximate roots of q-sigmoid polynomials. We also investigate relations of zeros between q-sigmoid polynomials and classical sigmoid polynomials.

CP FT-1-8 6 3 **15:10-15:30**

On performance portability and library reuse: A Navier-Stokes miniapp

Valeria Barra	University of Colorado Boulder
Jed Brown	University of Colorado Boulder
Jeremy Thompson	University of Colorado Boulder
Yohann Dudouit	Lawrence Livermore National Laboratory

Abstract: We demonstrate library reuse via a Navier-Stokes miniapp, where differential operators are expressed via a pointwise representation of the weak form, and composed using libCEED to act on subdomains with various execution strategies to exploit tensor product structure and symmetries of high order/spectral elements, and to enable vectorization on diverse architectures.

CP FT-1-8 6 4 **15:30-15:50**

Efficient Parallel Numerical Schemes for Reaction-Diffusion System by Domain Decomposition

ASWIN V S	NATIONAL INSTITUTE OF TECHNOLOGY CALICUT
RAGHU H V	CENTER FOR DEVELOPMENT OF ADVANCED COMPUTING
ASHISH AWASTHI	NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

Abstract: The Reaction-Diffusion (RD) models are capable of recreating various natural patterns, and this property is the fundamental essence of many applications including cancer growth analysis. In this paper, three parallel numerical algorithms are proposed for the RD model. The domain decomposition method is applied to divide the physical domain into several subdomains. Then the schemes are formulated by employing various combinations of differential quadrature and finite difference methods for the spatial and temporal derivatives approximations.

CP FT-1-8 6 5 **15:50-16:10**

Digital topological rough set structures and their applications

Sang-Eon Han	Chonbuk National University

Abstract: Based on several kinds of locally finite covering rough sets, we introduce digital topological rough sets and their applications. By using neighborhood systems and new adhesions, we firstly develop LFC-rough set structures and develop digital topological rough sets. These approaches can facilitate the studies of the fields of objects or images classification, pattern recognition, computational topology, discrete geometry, rough set theory, and so on.

CP FT-1-8 6 6 **16:10-16:30**

An Efficient Algorithm for Computing Derivative of Mean Structural Similarity Index Measure (MSSIM) Applied to Imaging Inverse Problems

Isabel Molina Orihuela	University of Ontario Institute of Technology
Mehran Ebrahimi	University of Ontario Institute of Technology

Abstract: Many inverse problems in imaging can be addressed using energy minimization. The Euclidean distance is traditionally used in data fidelity term of energy functionals, even though it is not an optimal measure of visual quality. Recently the use of Mean Structural Similarity Index Measure (MSSIM) in data fidelity expressions has been examined. Solving such problems requires derivative of MSSIM. We propose an efficient algorithm for computing this derivative using convolutions and present preliminary numerical results.

CP ME-0-3 6 **14:30-16:30**

Applied Mathematics for Industry and Engineering V

Chair Person: Alejandro Muñoz-Diosdado	Instituto Politécnico Nacional

CP ME-0-3 6 1 **14:30-14:50**

Calculating entropy of times series with different mathematical methodologies: The case of cardiac time series from stress tests

Alejandro Muñoz-Diosdado	Instituto Politécnico Nacional

Abstract: Approximate, sample and fuzzy entropies were obtained for heartbeat intervals time series of subjects in stress tests because exercise can reveal cardiovascular alterations that are not present at rest. We have obtained statistically different entropy results for young and middle-aged adults, healthy subjects and patients with congestive heart failure and sedentary subjects and people who perform physical activity on a regular basis. We can characterize health status and physical condition with the entropy values.

CP ME-0-3 6 2 **14:50-15:10**

Parametric Models for Motion Correction of Digital Tomosynthesis

Joseph Field	University of Oxford
Raphael Hauser	University of Oxford

Abstract: We discuss a motion correction method for a flat-panel, multi-emitter X-ray source. We present a model for image acquisition of stationary bodies, before extending the model to dynamic bodies. Image reconstructions are obtained by solving a sparse linear inverse problem, with the system matrix holding all information of the body motion. We present results which show that reconstructions of a dynamic body often can be better than those obtained by measuring a static body.

CP ME-0-3 6 3 **15:10-15:30**

Interactions between delta shock wave and classical elementary waves in a non strictly hyperbolic system of conservation laws

T. Raja Sekhar	Indian Institute of Technology Kharagpur

Abstract: We solve the Riemann problem for a thin film of perfectly soluble anti-surfactant solution in the limit of large capillary and Péclet numbers in which the governing equations are non strictly hyperbolic system of conservation laws. For some initial data, delta shock wave appears in the Riemann solution and we discuss interactions between elementary waves and delta shock wave. The global structure and large time asymptotic behaviour of the perturbed Riemann solutions are constructed.

CP ME-0-3 6 4 **15:30-15:50**

Superalgebraically convergent quasi-periodic Green functions for transmission problems in periodic surfaces

Oscar P. Bruno	California Institute of Technology
Andrés Prieto Aneiros	University of A Coruña
Laura Del Río Martín	University of A Coruña

Abstract: We introduce a superalgebraically convergent integral equation method for the problem of acoustic wave scattering by a periodic penetrable medium. Use is made of a shifted quasi-periodic Green function which enables, for the first time, solution of the associated quasi-periodic transmission problem at certain "Rayleigh-Wood anomalous frequencies" at which the classical Green function ceases to exist. Numerical results will be presented to illustrate the fast convergence of the method.

CP ME-0-3 6 5 **15:50-16:10**

Wavelet Methods for Inverse Problem associated with Fractional Black-Scholes model of one and two assets

Masood Alam	Sharda University
Pragati Tripathi	Sharda University
A. H. Siddiqi	Sharda University

Abstract: Black Scholes model of option-Pricing is a well known which fetched 1997 Nobel Prize of Economics. Its several model have been studied. There is vast literature on direct Problem of this model however there are only few papers related to inverse problems of this model. In this paper we study numerical simulation of inverse problem related to Fractional Black-Scholes Model using MatlabTools. Relevance of wavelet methods is also examined.

CP ME-0-3 6 6 **16:10-16:30**

The multiply-connected periodic Schwarz-Christoffel formula

Peter Baddoo	University of Cambridge
Darren Crowdy	Imperial College

Abstract: Although the standard Schwarz-Christoffel formula has been known since the 1800s, a periodic version has eluded researchers. We present a new formula that uses the Schottky-Klein prime function to map a canonical circular domain to a periodic array of polygons. The formula is valid for all multiplicities and permits any number of objects in each period window. Amongst other uses, the formula can be applied to biological flight, electromagnetism, and aeroacoustics.

CP A1-3-4 6 **14:30-16:30**
Numerical Analysis XII
Chair Person: Chengming Huang Huazhong University of Science and Technology

CP A1-3-4 6 1 **14:30-14:50**

Linear stability of Runge-Kutta methods for Volterra integro-differential equations

Chengming Huang Huazhong University of Science and Technology
Jiao Wen Huazhong University of Science and Technology
Min Li Huazhong University of Science and Technology

Abstract: In this talk, we discuss the stability of Runge-Kutta methods for Volterra integro-differential equations. Both the basic test equation and a convolution test equation are considered. Some recurrence relations and stability matrices are derived. Based on the stability matrices and the boundary locus technique, stability regions of some one-stage and two-stage methods are given and compared. In particular, some A0-stable and V0-stable methods are obtained.

CP A1-3-4 6 2 **14:50-15:10**

Fast methods for solving quasi-Toeplitz linear systems

Belhaj Skander University of Jeddah
Hcini Fahd University of Tunis El Manar
Zhang Yulin University of Minho

Abstract: In this paper, we consider a more generalized algorithm to solve block tridiagonal quasi-Toeplitz linear systems. This method consists on using Du's method (Du et al., Applied Mathematics and Computation, 244:10-15, 2014), and based on a block decomposition for a block tridiagonal quasi-Toeplitz matrix and the Sherman-Morrison-Woodbury inversion formula. By using the same techniques, we will propose a fast algorithm for solving quasi penta-diagonal Toeplitz linear systems.

CP A1-3-4 6 3 **15:10-15:30**

Frequency optimized RBF-FD for wave equations

Pedro González Rodríguez Universidad Carlos III de Madrid
Diego Alvarez Universidad Carlos III de Madrid
Manuel Kindelan Universidad Carlos III de Madrid

Abstract: We present a method to obtain optimal RBF-FD formulas which maximize their frequency range of validity. The optimization is based on the idea of keeping an error of interest (dispersion, phase or group velocity errors) below a given threshold for a wavenumber interval as large as possible. In order to find the weights of these optimal finite difference formulas we solve a one parameter optimization problem.

CP A1-3-4 6 4 **15:30-15:50**

Numerical Inclusion Method of Exact Periodic Solutions for Nonlinear Delay Differential Equations

Shin'ichi Oishi Waseda university

Abstract: This talk demonstrates that exact periodic solutions for various nonlinear functional differential equations can be numerically included in a unified way by a modification of the method presented in S.Oishi: Numerical Verification of Existence and Inclusion of Solutions for Nonlinear Operator Equations, J. Computational and Applied Math., **60**, pp.171-185 (1995). As examples, we will treat Wright's equaiton, time dlay Duffing's equaion and so on. Moreover, branches consiting of periodic solutions are also included.

CP A1-3-4 6 5 **15:50-16:10**

Efficient Magnus-type exponential integrators for linear Schrödinger equations with time-dependent potential

Cesáreo González University of Valladolid
Sergio Blanes Universitat Politècnica de València
Fernando Casas Universitat Jaume I
Mechthild Thalhammer Leopold--Franzens--Universität Innsbruck

Abstract: This talk is devoted to the study of a convergence result for high-order commutator-free exponential integrators proposed in [1] applied to non-autonomous linear Schrödinger equations. A stability result and a local error result are provided for the relevant specially case, where the Hamilton operator comprises the Laplacian and a regular space-time-dependent potential. [1] Ph. Bader, S. Blanes, N. Kopylov, Exponential propagators for the Schrödinger equation with a timedependent potential, J. Chem. Phys. 148 (2018).

CP A1-3-4 6 6 **16:10-16:30**

Low regularity integrators for dispersive problems

Alexander Ostermann University of Innsbruck

Abstract: Dispersive equations, like nonlinear Schrödinger equations or the Boussinesq equation, are often solved by pseudo-spectral methods, where the time integration is performed by splitting schemes. Notwithstanding the benefits of this approach, its successful application requires additional regularity of the solution. In this talk, we introduce as an alternative a class of low regularity integrators that require fewer assumptions on the data. Numerical experiments underline the superiority of this class of integrators for low regularity solutions.

CP FT-4-5 6 **14:30-16:30**
Biology and Chemistry II
Chair Person: Noel Fortun De La Salle University

CP FT-4-5 6 1 **14:30-14:50**

Robustness in class of power-law kinetics

Noel Fortun De La Salle University
Eduardo Mendoza Ludwig Maximilian University
Luis Razon De La Salle University
Angelyn Lao De La Salle University

Abstract: Shinar and Feinberg's influential work established simple network-based conditions for a biological system to possess absolute concentration robustness, a situation in which a species in a mass-action system has the same concentration for any steady state the network may admit. In this contribution, we extend this result to embrace a class of power-law kinetic systems more general than mass-action. As illustration, we apply the result to a power-law approximationof a pre-industrial carbon cycle model.

CP FT-4-5 6 2 **14:50-15:10**

A compartmental model for bacterial resistance acquisition over networks

Damian Knopoff Cordoba National University/CONICET
Marina Dolfin Università degli Studi di Messina
Facundo Trucco Argentine Red Cross

Abstract: We present a model for bacterial infections over networks. Within each node, individuals interact and bacteria can be transmitted; mutations, horizontal transfer and development of antibiotic resistance are considered. Nodes are connected through weighted edges and thus the infection may spread over the network. We perform an analytical analysis and numerical experiments to test the accuracy of the model and to analyze the importance of factors such as sanitary measures and imposition of a quarantine.

CP FT-4-5 6 3 **15:10-15:30**

Mathematical Modeling of Vas Deferens Smooth Muscle Electrophysiology: Role of Ion Channels in Generating Electrical Activity

Chitaranjan Mahapatra Indian Institute of Technology Bombay
Rohit Manchanda Indian Institute of Technology Bombay

Abstract: The Vas deferens smooth muscle (VDSM) contracts to propel sperms from the epididymis to urethra. Any abnormal VDSM contraction causes sexual disorder in men. As the activation of several ion channels causes action potential (AP) generation, any mutation of these ion channels will modulate the AP and hence the contraction. To explore the quantitative contribution of individual active ionic current to the AP generation, a biophysically based mathematical model of guinea-pig VDSM cell is presented.

CP FT-4-5 6 4 **15:30-15:50**

Modelling and analysis of genome replication data

Eduard Campillo-Funollet University of Sussex

Abstract: Genome replication is a crucial process in biology. It is a stochastic process, and yet it must occur in an accurate manner in order to guarantee the genome stability. We present a mean-field model for the polymerase usage in genome replication, together with an statistical model for the measurement error, and we fit the parameters of the model–efficiency of the origins of replication and replication speed–to experimental data from S. Pombe.

CP FT-4-5 6 5 **15:50-16:10**

Geometric Analysis of Synchronization in Neuronal Networks with Global Inhibition and Coupling Delays

Hwayeon Ryu	University of Hartford
Sue Ann Campbell	University of Waterloo

Abstract: We study synaptically coupled neuronal networks to identify the role of coupling delays in network synchronized behavior. We consider a network of excitable, relaxation oscillator neurons where two distinct populations, one excitatory and one inhibitory, are coupled and interact with each other. A geometric singular perturbation analysis yields existence and stability conditions for periodic solutions. Our results demonstrate that the presence of coupling delays in the network promotes synchronization of the excitatory population.

CP FT-4-5 6 6 **16:10-16:30**

Time delays in stochastic models of gene regulation

Jacek Miękisz	University of Warsaw

Abstract: Simple stochastic models of gene regulation based on Markov jump processes will be presented. We take into account that protein production takes some time - we introduce time delays in our models. For small time delays, we derive approximate formulas for the expected value and the variance of the number of protein molecules in the stationary state. We discuss adiabatic limit of fast switching gene states as a simple example of a singular perturbation.

CP ME-1-5 6 14:30-16:30

Simulation and Modelling V

Chair Person: Antonio Rafael Selva Castañeda — Universidad de oriente

CP ME-1-5 6 1 **14:30-14:50**

Simulation of the tumor anisotropic growth under electrochemical therapy

Antonio Rafael Selva Castañeda	Universidad de oriente
Maria Schonbek	University of California
Juan Ignacio Montijano Torcal	Universidad de Zaragoza
Luis Enrique Bergues Cabrales	Universidad de oriente

Abstract: This work performs different simulations of the anisotropic tumor growth for different responses after direct current action. The Method of Line and diffusion tensors are used. The temporal behaviors of the density, mass and volume of a tumor depend on its response post-treatment. The tumor growth is faster for the shorter therapy duration, the higher diffusion values and the anisotropy degree. Additionally, exists a close relationship between tumor biological and therapy parameters.

CP ME-1-5 6 2 **14:50-15:10**

Mathematical Modeling of humoral and cell mediated immune responses to cancer.

Sandip Banerjee	Indian Institute of Technology Roorkee
Sumana Ghosh	Indian Institute of Technology Roorkee

Abstract: In this study, a mathematical model considering interaction between cancer cells and both humoral (antibodies) and cell mediated (Cytotoxic T lymphocytes) immune responses was analysed. Least square method is used to estimate the system parameters using experimental data. Bifurcation analysis with respect to selected system parameters are also done. Through numerical simulation, it has been illustrated that both humoral as well as cell mediated immune responses play an important role in eradicating cancer cells.

CP ME-1-5 6 3 **15:10-15:30**

Development of a parallelized open-source python library for synthetic diagnostics and inversions for fusion devices

Laura S. Mendoza	Inria Nancy Grand-Est,
Didier Vezinet	CEA Cadarache

Abstract: Virtually all magnetic fusion devices resort to tomography diagnostics for a variety of plasma emissions. Reconstructing the signal from a simulated emissivity requires modeling the geometry and is used for code validation or diagnostic design. Solving the inverse problem is useful for data interpretation and requires geometry modeling and inversion-regularization routines. An open-source parallelized python library was developed to provide a common and reliable tool for solving the direct and inverse problems for synthetic diagnostics.

CP ME-1-5 6 4 **15:30-15:50**

Modelling and simulation of the aeration process in a eutrophicated lake using a meshless method: Bouregreg lake case study

Zineb Tabbakh	Mohammadia school of engineers
Rachid Ellaia	Mohammadia school of engineers
Driss Ouazar	Mohammed VI Polytechnic University

Abstract: We present a model for simulation of the aeration process in a eutrophicated lake. The governing equations consist of the incompressible Navier-Stokes equations for the flow variables coupled with a transport equation for the mass fraction. A state equation for the mixture density is used to close the system and the Boussinesq approximation is accounted for in the flow equations. For the numerical simulation, we propose a local meshless radial basis function projection method.

CP ME-1-5 6 5 **15:50-16:10**

Modeling, identification, and optimization of violin bridges

Sandra Marschke	Institute of Mathematics and Scientific Computing, University of Graz
Wolfgang Ring	Institute of Mathematics and Scientific Computing, University of Graz

Abstract: We present a mathematical model to describe the dynamical behaviour of a violin bridge. To attain appropriate results we have to incorporate the orthotropic elastic structure of the wooden bridge into the model and to apply a sophisticated numerical concept. For this purpose isogeometric mortar methods build our numerical framework. Based on this, we determine material parameters by an inverse problem and identify sensitivities of the solution with respect to shape and material parameters.

CP ME-1-5 6 6 **16:10-16:30**

A finite volume solver for population density neuron model based on quadratic-integrate-and-fire neuron.

Santosh Kumar	Dr. Y. S. Parmar Govt. P. G. College Nahan

Abstract: To present a high-order numerical scheme for a model of neuronal firing based on quadratic integrate-and-fire neuron. The scheme is based on lines approximation: spatial discretization is done by (WENO -FVM) and temporal discretization by SSP-RK. The proposed scheme is more efficient and produce accurate solutions with less grid cells than the existing schemes in the literature. The discontinuity is added in the application of model equation to illustrate the good performance of proposed scheme.

CP A1-3-3 6 14:30-16:30

Industrial Applications in Biomedicine and Health Care

Chair Person: Isabel N. Figueiredo — University of Coimbra

CP A1-3-3 6 1 **14:30-14:50**

Automatic Screening for Diabetic Retinopathy

Isabel N. Figueiredo	University of Coimbra

Abstract: An automatic screening method for Diabetic Retinopathy was developed under memorandum of understanding with the company Retmarker (http://www.retmarker.com/). It identifies the existence of microaneurysms, hemorrhages and bright lesions in retinal images, the first symptoms of the disease. A license agreement concerning the commercialization of this method was signed between the University of Coimbra, Portugal and the company. The method has been used in Portuguese public hospitals, since 2017, in approximately 100.000 patients.

CP A1-3-3 6 2 **14:50-15:10**

Development for Renal Glomerulus Detection Using Deep Learning-Based Digital Image Analysis

Sat Byul Seo	Kyungnam University

Abstract: This study is to develop a program to detect and classify glomeruli using deep learning. The goal of this study is to detect kidney glomeruli using deep learning based image analysis on a whole slide image (WSI) and then classify the glomeruli into nornal, abnormal(segmental or global glomerulosclerosis). We prepare data set(training set, test set) for three convolution neural network(CNN) models then analyze their accuracy the decide is the best fitted model for glomeruli detection.

CP A1-3-3 6 3 **15:10-15:30**

Reduced Basis Methods for Real-Time Patient Specific Thermal Ablation Cancer Treatment Planning

Zoi Tokoutsi	RWTH Aachen University and Philips Research
Martin Grepl	RWTH Aachen University
Karen Veroy	RWTH Aachen University
Marco Baragona	Philips Research
Ralph Maessen	Philips Research

Abstract: Patient specific treatment planning determines the placement of multiple ablation probes and the power control of the ablation device, based on a desired tissue temperature increase. We propose a multi-step planning algorithm, which involves solutions of PDE constrained optimal control problems, for patient specific parameters. We parametrize the problem with respect to uncertain parameters of interest, e.g. tissue properties, geometric parameters and employ the reduced basis method to construct a real-time efficient, reliable surrogate model.

CP A1-3-3 6 4 **15:30-15:50**

Modeling of muscle activity and its identification through shape observation

Shinjiro Ono	Nagoya University
Hideyuki Azegami	Nagoya University
Kenzen Takeuchi	TX Design
Yukihiro Michiwaki	Japanese Red Cross Hospital Musashino
Takahiro Kikuchi	Japanese Red Cross Hospital Musashino
Tetsu Kamiya	Meiji Co., Ltd.
Keigo Hanyuu	Meiji Co., Ltd.

Abstract: Motions of the body are caused by contraction of the muscles. Those configurations can be observed through medical imaging devices. However, medical doctors wish to know the inner muscle activity. In this study, we model the muscle activity as generation of a contractive anisotropic and inelastic strain, and formulate the identification problem of the strain by a minimization problem of the squared norm of the traction in finite elastic deformation to make the observed shape.

CP A1-3-3 6 5 **15:50-16:10**

Cost Optimization of Control Charts by Markov Chain Techniques with Healthcare Applications

Balázs Dobi	Eötvös Loránd University
András Zempléni	Eötvös Loránd University

Abstract: We show different uses of Markov chain-based cost-optimal control charts in healthcare. Namely, we propose a method in which not only the degradation of the patient's health can be random, but the effect of the treatment and time between control visits too. We investigate the effect of different shift-size distributions, the inclusion of the standard deviation in the optimisation algorithm and sensitising rules on the resulting expected cost. We apply the methods to real-life illnesses.

CP A1-3-3 6 6 **16:10-16:30**

An overview of the IMI at the University of Bath

Jonathan Dawes	University of Bath
Caroline Ang	University of Bath
Chris Budd	University of Bath
Laura Hattam	University of Bath
Paul Shepherd	University of Bath
Lorna Wilson	University of Bath

Abstract: In 2015 the University of Bath took the decision to establish a new Institute for Mathematical Innovation (IMI). IMI included a number of new (to Bath) features designed to (1) encourage greater linkage of the mathematical sciences with external organisations as well as (2) join up research across disciplines within the university. I will summarise what we have done since 2015 and try to assess what has worked and why, and what lies ahead.

CP A1-3-5 6 14:30-16:30

Numerical Analysis XIII

Chair Person: Kensuke Aishima Male Hosei University

CP A1-3-5 6 1 **14:30-14:50**

Convergence theorem of iterative projection methods for symmetric eigenvalue problems

Kensuke Aishima Male	Hosei University

Abstract: Eigenvalue problems are important in many scientific and engineering applications. In this talk, we discuss numerical methods for computing eigenvalues located in the interior part of the spectrum of a large symmetric matrix. For such eigenvalue problems, the Harmonic Ritz pairs are often used in projection methods. We present a global convergence theorem of particular iterative projection methods using the Harmonic Ritz pairs, where the standard restart strategy is employed.

CP A1-3-5 6 2 **14:50-15:10**

Simulation of Sound Absorption by Scattering Bodies Treated with Acoustic Liners Using a Time-Domain Boundary Element Method with Impedance Boundary Condition

Michelle Rodio (Pizzo)	Old Dominion University

Abstract: When designing next generation quiet aircraft, it is important to be able to accurately and efficiently predict acoustic scattering by an aircraft body from a given noise source. Acoustic liners are an effective tool for aircraft noise reduction, and are characterized by a complex valued frequency-dependent impedance. This work uses time-domain boundary integral equation with impedance boundary condition to simulate acoustic scattering of geometric bodies treated with liners. Stability will be demonstrated through eigenvalue analysis.

CP A1-3-5 6 3 **15:10-15:30**

Energy Stable Discontinuous Galerkin Finite Element Solutions of Two-Phase Flows

Andreas Aristotelous	West Chester University of Pennsylvania

Abstract: Second order in time Discontinuous Galerkin Finite Element methods for the solution of Cahn-Hilliard type equations coupled with fluid flow, e.g. the Brinkman flow, will be presented. Unconditional solvability and energy stability will be shown. Convergence and optimal error estimates will be established. Numerical tests verifying the theoretical results will be presented.

CP A1-3-5 6 4 **15:30-15:50**

Fast Predictor-Corrector method for solving Caputo and Atangana-Baleanu fractional differential equations

Seyeon Lee	Ulsan National Institute of Science and Technology (UNIST)
Bongsoo Jang	Ulsan National Institute of Science and Technology (UNIST)

Abstract: In this work, we propose a new effective Predictor-Corrector (PC) method to solve Caputo and A-B FDEs by using the kernel approximation of fractional operators. The proposed method only requires O(N) computational costs, while the conventional method does O(N2). Also, it achieves a uniform accuracy order regardless of the value of fractional order. Several numerical examples and applications are demonstrated to confirm the convergence rate and the computational cost reduction.

CP A1-3-5 6 5 **15:50-16:10**

Reorthogonalized Block Classical Gram-Schmidt using two Cholesky-based TSQR Algorithms

Jesse Barlow	The Pennsylvania State University

Abstract: Gram-Schmidt algorithms are important for the implemenation of Krylov space methods such as GMRES, Arnoldi, and Lanczos. Block versions of these algorithms point to the need for block Gram-Schmidt algorithms. In [Numerische Mathematik, 23(3),:395--423,2013], Barlow and Smoktunowicz propose a reorthogonalized block classical Gram-Schmidt algorithm called BCGS2. A signification weakening of the conditions for that algorithm's backward stability is proposed here.

CP A1-3-5 6 6 **16:10-16:30**

Rounding error analysis of divided-differences schemes: Newton's divided differences; Neville's algorithm; Richardson extrapolation; Romberg quadrature; etc

André De Camargo	Federal University of the ABC region

Abstract: We bound the numerical error in the computation of several divided diferences algorithms in finite precision. Our analysis explain some already observed instabilities of Newton’s formula for interpolation at the Chebyshev nodes. We also show that Neville's algorithm is backward stable for extrapolation in the real line and this consolidates a solid background for the usual representation of Richardson extrapolation and Romberg quadrature as divided differences schemes. Numerical examples are given to illustrate the theory.

CP FT-1-7 6 **14:30-16:30**

Applied Mathematics for Industry and Engineering IV

Chair Person: Deniz Kenan Kilic Institute of Applied Mathematics

CP FT-1-7 6 1 **14:30-14:50**

Multiresolution Analysis of S&P500 Time Series

Deniz Kenan Kilic Institute of Applied Mathematics

Abstract: In this study Fourier and wavelet transform methods are used to analyze the complex structure of a financial time series, particularly, S&P500 daily closing prices and return values. Multiresolution analysis is naturally handled by the help of wavelet transforms in order to pinpoint special characteristics of S&P500 data. Besides, further discussions include the modeling of S&P500 process by invoking linear and nonlinear methods with wavelets to address how multiresolution approach improves fitting and forecasting results.

CP FT-1-7 6 2 **14:50-15:10**

A Newton method in Sobolev space for solving free boundary problems

Julius Fergy Rabago Graduate School of Informatics, Nagoya University

Hideyuki Azegami Graduate School of Informatics, Nagoya University

Abstract: Our intent is to popularize the application of what we call H1-Newton method as a numerical scheme for solving shape optimization problems. The computational strategy was inspired by the second author and is modified in this study to simplify the utilization of the shape Hessian information in an iterative procedure. We showcase its applicability in solving shape optimization problems by numerically solving the well-known exterior Bernoulli free boundary problem in the framework of shape optimization.

CP FT-1-7 6 4 **15:10-15:30**

Efficient and Accurate Computations of Weak Formulation-based High-order Accurate Numerical Methods on Mixed-Curved Meshes

Hojun You Seoul National University

Chongam Kim Seoul National University

Abstract: The present work deals with a new scheme called Direct Reconstruction Method (DRM) that is targeted for significantly reducing the computing cost of weak formulation-based high-order accurate methods on mixed-curved meshes. Its framework for both volume and surface integrations and several mathematical characteristics that support the efficient working of DRM are provided. Efficiency and accuracy of DRM are extensively validated by benchmark problems governed by compressible Navier-Stokes equations based on high-order discontinuous Galerkin methods.

CP FT-1-7 6 5 **15:30-15:50**

Adaptive Discontinuous Galerkin Finite Elements Techniques for Complex Fluid Flow Problems

Birane Kane NORCE Norwegian Research Centre AS

Robert Kloefkorn NORCE Norwegian Research Centre AS

Abstract: We present an hp-adaptive discretization for the solution of complex flow problems. We implement and evaluate continuous and discontinuous Galerkin methods for problems ranging from porous media multi-phase flow to viscoelastic and non-Newtonian flow. The adaptive approaches implemented allow for refinement/coarsening in both the element size, the polynomial degree and the time step size. To our knowledge, this is the first time the concept of local hp-adaptivity is incorporated in the study of such topics.

CP FT-1-7 6 6 **15:50-16:10**

Continuum modelling and uniqueness of weak solutions of a traffic flow model for a two-lane highway

Juan Fancisco Padial Universidad Politécnica de Madrid

Abstract: We consider a two-lane highway going in one direction which allows cars to pass and that the drivers continuously adjust their speed towards what they consider to be ideal value under the local traffic conditions. From of point of view of macroscopic scale, we introduce a mathematical model in term of a stochastic doubly degenerate parabolic system. The proof of the uniqueness of weak solutions is inspired in S.N. Kruzhkov (L1-contraction property for entropy solutions).

CP A1-3-2 6 **14:30-16:30**

Dynamical Systems and Nonlinear Analysis II

Chair Person: Anguraj Annamalai PSG College of Arts & Science

CP A1-3-2 6 1 **14:30-14:50**

Existence and exponential stability of a class of Impulsive Neutral Stochastic Integro-differential equations with Poisson jumps

Anguraj Annamalai PSG College of Arts & Science

Abstract: In this paper by employing the fractional power of operators and semi group theory we obtain some new criteria ensuring the existence and exponential stability of a class of Impulsive Neutral Stochastic Integro-differential equations with Poisson jumps. We use fixed point strategy to establish some new sufficient conditions that ensure the exponential stability of mild solution in the mean square moment by utilizing an impulsive integral inequality.

CP A1-3-2 6 2 **14:50-15:10**

A population model in seasonal environment with short reproduction period

Attila Dénes Bolyai Institute, University of Szeged

Gergely Röst Bolyai Institute, University of Szeged

Abstract: We present a periodic nonlinear scalar delay differential equation model for a population with short reproduction period. We determine the basic reproduction number not merely as the spectral radius of an operator, but as an explicit formula and show that is serves as a threshold parameter for the stability of the trivial equilibrium and persistence. A real life application is also shown.

CP A1-3-2 6 3 **15:10-15:30**

ON WEAK SOLVABILITY OF ONE FRACTIONAL MODEL OF VISCOELASTIC CONTINUUM WITH MEMORY

Vladimir Orlov Voronezh State University

Abstract: We establish the existence of a weak solution of the initial-boundary value problems for a system of motion equations of viscoelastic fluids which subject constitutive laws with fractional derivatives and possess memory along trajectories of a velocity field. Theory of regular Lagrangean ?ows, approximative-topological method, fractional calculus and classical results on Navier-Stokes equations are used.

CP A1-3-2 6 4 **15:30-15:50**

Highway Traffic Dynamics: Data-Driven Analysis and Forecast.

Allan Avila University of California, Santa Barbara

Igor Mezic University of California, Santa Barbara

Abstract: The unpredictable elements involved in a vehicular traffic system, like human interaction and weather, lead to a very high-dimensional, nonlinear dynamical system. Therefore, it is difficult to develop a model that accurately describes the time evolution of traffic systems. Here we demonstrate how Koopman operator theory can offer a model-free, parameter-free, data-driven approach to accurately analyzing and forecasting traffic dynamics. We are able to accurately distinguish previously identified and never before identified, coherent spatiotemporal patterns.

CP A1-3-2 6 5 **15:50-16:10**

Analysis of impulsive effects on projective synchronization of neural networks with parameter mismatch and mixed time-varying delays

Rakesh Kumar Indian Institute of Technology (Banaras Hindu University), Varanasi-221005, India

Abstract: In this paper, we have analysed impulsive effects on projective synchronization between the parameter mismatched neural networks with mixed time-varying delays. Most of the results, in published articles, are devoted to investigating the stability or the synchronization between identical neural networks considering synchronizing impulse and desynchronizing impulse separately. But in our article, the analysis is done on the effects of the extensive range of impulses consisting of both types of impulses.

CP A1-3-2 6 6 **16:10-16:30**

Relaxation-oscillations in a conceptual climate model

Lukasz Plociniczak Wroclaw University of Science and Technology

Abstract: We will present our results concerning a generalization of the KCG (Källén, Crafoord, Ghil) model of climate dynamics. It constitutes a dynamical system of two nonlinear equations describing planetary energy and mass (ice) balances. We classify the critical points of this system and show that under some realistic assumptions it exhibits relaxation-oscillations which are also manifestly present in the real paleoclimatological data. Using the matched asymptotic technique we find its period and some useful estimates.

CP ME-1-G 6 14:30-16:30

Materials Science and Solid Mechanics

Chair Person: Tunç APATAY Gazi University

CP ME-1-G 6 1 14:30-14:50

Effects of wall thickness and material properties on the elastic limit behavior of a tube subject to periodic boundary conditions

Tunç APATAY Gazi University

Ahmet N. ERASLAN Middle East Technical University

Abstract: Thermoelastic solution of tubes subject to periodic surface temperature is obtained analytically. Tube is initially at zero temperature and for the times greater than zero, one of the surfaces is subjected to periodic boundary condition while the other surface is insulated. Time dependent temperature distribution is obtained by using Duhamel's theorem. According to von Mises yield criterion and the generalized plane strain state, effects of the thickness and the material properties on yielding are investigated.

CP ME-1-G 6 2 14:50-15:10

Distributed Parallel 3D FFTs on HPC Many-Core and Hybrid CPU-GPU Plaforms: Applications in Materials and Chemistry Codes

Andrew Canning Lawrence Berkeley National Laboratory

Abstract: First principles electronic structure calculations based on a plane wave Fourier expansion of the electron wavefunctions are the most commonly used approach for electronic structure calculations in materials and chemistry codes. The scaling of these codes on large parallel machines depends critically on having a 3D FFT that scales efficiently to large processor/node counts. We present results on modern HPC platforms for scaling using hybrid MPI/OpenMP as well as GPU implementations to improve parallel scaling.

CP ME-1-G 6 3 15:10-15:30

On dynamical two-dimensional models of thermoelastic piezoelectric plates with variable thickness

Gia Avalishvili I. Javakhishvili Tbilisi State University

Mariam Avalishvili University of Georgia

Abstract: In this paper a hierarchy of dynamical two-dimensional models for thermoelastic piezoelectric plates consisting of inhomogeneous anisotropic material with regard to magnetic field is constructed. The initial-boundary value problems corresponding to the two-dimensional models are investigated in suitable function spaces. The relationship between the two-dimensional and the original three-dimensional models is investigated, the corresponding convergence results and modeling error estimates are obtained. This work was supported by Shota Rustaveli National Science Foundation [Grant Number 217596].

CP ME-1-G 6 4 15:30-15:50

High performance of an Elastic-plastic Functionally Graded Rotating Shrink Fit

Eray Arslan Vienna University of Technology

Abstract: Analytical and Finite Element models are developed to investigate elastic-plastic behaviors for different structural combinations of a thin functionally graded rotating shrink fit. Numerical results of the both models are compared. Then the numerical model is improved by considering additively the variations of Poisson's ratio and nonlinear hardening parameters in the graded hub. Finally optimum mechanical parameters for the high performance and low weight of the structure have been established.

CP ME-1-G 6 5 15:50-16:10

A locking-free finite element scheme for thin viscoelastic structures

Jesus Adolfo Vellojin Mattos Universidad Tecnica Federico Santamaria

Erwin Hernandez Universidad Tecnica Federico Santamaria

Abstract: In this work we use a constitutive law in a hereditary form to analyze the dynamic and quasi-static behavior of isotropic linear viscoelastic structures with a thickness-dependent formulation trough a locking-free scheme by using low-order finite elements, where the hereditary integral is approximated using the trapezoidal rule and a recurrence formula. Numerical experiments for both quasi-static and dynamic cases for different kind of structures, like beam, rods, plate, are presented.

MS A1-1-2 7 17:00-19:00

Geometry and topology in mass and fluid dynamics - Part 2

For Part 1 see: MS A1-1-2 6

Organizer: Takashi Sakajo Kyoto University

Organizer: Stefanella Boatto Universidade Federal De Rio De Janeiro

Abstract: Topological and geometric methods has been successfully applied to predicting and interpreting the dynamics of interacting points such as masses and point vortices in fluid mechanics qualitatively. We organize the mini-symposium to offer an opportunities to share the recent developments on this topic among experts and we thereby explore new research collaborations among participants who are interested in applying these methodologies for modeling interaction dynamics on surfaces, and characterizing structure and transport in complex flows, with applications to fluids, biological and physical sciences.

17:00-17:30

Vortex dynamics on the surface of a torus

Takashi Sakajo Kyoto University

Yuuki Shimizu Kyoto University

Abstract: It is theoretically interesting to investigate how geometric nature of curved surfaces gives rise to different vortex interactions. We consider the dynamics of point vortices on a toroidal surface, which is a compact, orientable 2D Riemannian manifold with a non-constant curvature with a handle structure. We describe the interactions of point vortices in order to cultivate an insight into vortex interactions on the manifold. In addition, we discuss the stability of the N ring configuration.

17:30-18:00

Dynamics of the restricted $(N+1)$-body problem on S^2

Jaime Bustos Bustos Universidad del Bío-Bío

Abstract: We consider the motion of an infinitesimal mass particle on the sphere S^2 influenced by the presence of N bodies of unit mass placed at the vertices of a regular polygon and rotating uniformly in a fixed parallel. This problem depends on two parameters: the number of bodies $N \geq 3$ and the polar angle θ_0 determined by the position of the primaries. Results concerning stability, bifurcation and regularisation will be included in this talk.

18:00-18:30

The motion of point masses on closed surfaces

David Dritschel Prof.

Abstract: The motion of point masses on closed surfaces subject to Newtonian gravity (a central force) is formulated and illustrated on surfaces of revolution. Results are also presented for hyper-spheres in arbitrary (integer) dimension, where the two-body problem is generally non-integrable. There, a Cartesian coordinate formulation of the dynamics results in particularly simple forms for the governing equations for an arbitrary number of masses.

18:30-19:00

Navier-Stokes flow on evolving surfaces

Axel Voigt TU Dresden

Reuther Sebastian TU Dresden

Abstract: We consider an incompressible Navier-Stokes equation on an evolving surface, derive the equation by means of a thin film limit, introduce a numerical approach valid for general surfaces and show examples which demonstrate the interplay between topology, geometry and flow dynamics.

MS FT-S-3 7 17:00-19:00

Recent advances in fast iterative solvers for structured matrices

Organizer: Marco Donatelli University of Insubria

Organizer: Matthias Bolten Bergische Universität Wuppertal

Abstract: Structured matrices, like Toeplitz matrices or matrices from matrix algebras possibly perturbed by low-rank corrections or diagonal matrices, appear in a variety of applications. Application areas include image processing, integral and differential equations, including fractional ones. In many applications the solution of a linear system is being sought for. While for one-level matrices many classical preconditioners for Krylov solvers provide optimal or near-optimal convergence rates, for multi-level matrices different techniques are needed. Structure preserving preconditioners and multigrid methods, usually driven by an accurate spectral analysis, represent an effective option. In the minisymposium recent developments in this area will be presented.

17:00-17:30

Multigrid for structured matrices on parallel computers

Matthias Bolten	Bergische Universität Wuppertal

Abstract: While multigrid methods are fast solvers for structured matrices, large-scale problems in science and engineering still require the use of parallel computers. In this talk recent advances on parallel multigrid methods for structured matrices, especially circulant and Toeplitz matrices, are presented. This includes aggressive coarsening as well as different smoothing strategies. All these strategies can be applied in the fully structured case as well as in the case that the matrices have local structure, only.

17:30-18:00

B-spline approximation of 2D/3D MHD subproblems: spectral symbols and multigrid-type solvers

Mariarosa Mazza	University of Insubria

Abstract: In plasma physics, magnetohydrodynamics (MHD) is used to study the macroscopic behavior of the plasma. In this talk, we focus on a parameter-dependent MHD subproblem and we discretize it using isogeometric analysis based on tensor product B-splines. We conduct a detailed spectral study of the resulting coefficient matrices, highlighting the critical dependence on the different physical and approximation parameters, and we exploit such spectral information to design fast multigrid-type solvers for the corresponding linear systems.

18:00-18:30

Symbol-Based Spectral Analysis and Fast Multi-Iterative Solvers for Isogeometric Analysis

Carlo Garoni	University of Insubria
Marco Donatelli	
Carla Manni	
Stefano Serra-Capizzano	
Hendrik Speleers	

Abstract: Any discretization of a differential problem leads to a sequence of linear systems A_h * x_h = b_h, where dim(A_h) tends to 0 with the mesh-fineness parameter h. For the solution of such systems, it is important to understand the spectral properties of A_h. In this talk, we discuss the case of stiffness matrices arising from IgA: we compute their spectral distribution and we use this information to design a fast multi-iterative solver.

18:30-19:00

Two-Sided Optimal Preconditioners for Linear Systems From Time-Fractional Subdiffusion Equations

Xuelei Lin	Hong Kong Baptist University
Michael K. Ng	Hong Kong Baptist University
Yajing Zhi	Hong Kong Baptist University

Abstract: A two-sided preconditioning technique is proposed for linear systems arising from time-fractional sub-diffusion equation with variable coefficients, for which condition number of the preconditioned matrix is proven to be uniformly bounded by a constant independent of discretization step-sizes. The right preconditioner comes from the square root of negative Laplacian operator with constant coefficient. The left preconditioner comes from splitting the right preconditioner out of the discretization matrix of the equation but with constant coefficient.

MS ME-0-1 7 17:00-19:00

PDE's on mathematical Physics and Biology - Part 1

For Part 2 see: MS ME-0-1 8

Organizer: Cristina Brändle	U. Carlos III Madrid
Organizer: Eduardo Colorado	Universidad Carlos III de Madrid
Organizer: Pablo Álvarez González	HUCA

Abstract: This minisymposium will be focused on different models concernig mathematical biology and mathematical physicis, both from an analytical and apllied point of view. In particular, the first part we will give an overview on different problems in population dynamics, such as invasion and spreading of populations, living in regions or in graphs. The second part will deal with problems involving the Schrödinger opertaor, comming from mathematical Physics. Precisely, it will be discussed results such as existence of ground states and stability of solutions.

17:00-17:30

Generalist predator can control the invasion of an invasive pest

Madec Sten	University of Tours
Jérôme Casas	University of Tours
Christelle Suppo	University of Tours
Guy Barles	University of Tours

Abstract: We investigate a situation where a pest (the prey) arrives in a new environment wherein a natural local (generalist) predator already lives. We ask if this generalist predator may eradicate the prey. We study this situation though a reaction diffusion system with a logistic term in the predator dynamics. The exploration of the very rich dynamics of this system, (Turing instability, Traveling Waves...) gives conditions for the possible eradication of the prey.

17:30-18:00

Predator-prey model with competition, the emergence of territoriality

Alessandro Zilio	UNIVERSITE PARIS DIDEROT

Abstract: I will present a series of works in collaboration with Henri Berestyki. We study systems of reaction-diffusion equations modelling predators that compete with each other and interact with a single prey. We analyze the situation of predators, like wolves, that can divide up into several hostile packs. We focus on the analysis of stationary states, stability issues, and the asymptotic of the system when the competition parameter or the number of packs become unbounded.

18:00-18:30

The Fisher-KPP equation over simple graphs: Varied persistence states in river networks

Yihong Du	University of New England
Bendong Lou	Shanghai Normal University
Rui Peng	Jiangsu Normal University
Maolin Zhou	University of New England

Abstract: We consider the growth and spread of a new species in a river network with two or three branches via the Fisher-KPP advection-diffusion equation over some simple graphs. We obtain a rather complete description of the long-time dynamical behavior for every case under consideration, which can be loosely described by a trichotomy, including two different kinds of persistence states as parameters vary. The phenomenon of "persistence below carrying capacity" revealed here appears new.

18:30-19:00

Stability analysis for parabolic problems and application to population dynamics

Luca Rossi	CNRS-EHESS

Abstract: We discuss several notions of stability in the framework of elliptic and parabolic problems in unbounded domains. Necessary and sufficient conditions for them to hold will be derived using some generalizations of the principal eigenvalue for an elliptic operator, inspired by a series of works in collaboration with H. Berestycki and F. Hamel. As an application, we will derive the validity of the "hair-trigger" effect for the Fisher-KPP equation under Neumann boundary condition.

MS A3-3-3 7 17:00-19:00

Uncertainty quantification in imaging - Part 1

For Part 2 see: MS A3-3-3 8

Organizer: Tanja Tarvainen	University of Eastern Finland
Organizer: Nuutti Hyvönen	Aalto University
Organizer: Tapio Helin	LUT University

Abstract: Many problems in inverse problems and imaging are affected by uncertainties appearing in mathematical models or experimental measurements. These factors can be quantitatively characterised and analysed using methods of uncertainty quantification. This minisymposium brings together presentations which review inverse problems from the standpoint of uncertainty quantification, develop computational tools for tackling Bayesian inverse problems, and introduce new stochastic concepts suitable for the study of inverse problems in imaging. The applications include, but are not limited to, medical tomography, remote sensing and non-destructive testing.

17:00-17:30

MCMC for atmospheric remote sensing

Otto Lamminpää Finnish Meteorological Institute

Abstract: Proper monitoring and prediction of climate change and global warming requires global, satellite-based measurements of atmospheric greenhouse gas concentrations with an unprecedented accuracy. This is an ill-posed and non-linear statistical inverse problem, to which Markov Chain Monte Carlo methods offer a rigorous and reliable means of uncertainty quantification and accuracy assessment. In this work, we implement adaptive MCMC together with dimension reduction to NASA's Orbiting Carbon Observatory 2 satellite's atmospheric carbon dioxide concentration measurements.

17:30-18:00

Uncertainty Quantification for Hierarchical Bayesian EEG/MEG Source Reconstruction

Felix Lucka CWI & UCL

Abstract: We examine Hierachical Bayesian approaches to solve the under-determined and severely ill-posed inverse problem of EEG/MEG source reconstruction. For Laplacian scale mixture models, we show how a combination of Markov Chain Monte-Carlo methods and convex optimization techniques can be used to explore the different modes of the posterior distribution and thereby quantify the inherent uncertainty and ambiguity of such ill-posed inference procedures. Joint work with Yousra Bekhti, Joseph Salmon and Alexandre Gramfort.

18:00-18:30

Approximation error modeling applied to inverse acoustic medium scattering

Jari Kaipio University of Auckland
Timo Lahivaara University of Eastern Finland
Tomi Huttunen Ownsurround Ltd
Teemu Luostari University of Eastern Finland
Peter Monk University of Delaware

Abstract: Born approximation is widely used for inverse scattering problems with low contrast media. With high constrast media, the single scattering approximation is not a feasible one and respective reconstructions are often rendered useless. In this talk, we consider the inverse scattering problem in the Bayesian framework for inverse problems. We show that with approximative marginalization, one may be able to use the Born approximation and, furthermore, compute statistically meaningful error estimates for index of refraction.

18:30-19:00

Hyperparameter estimation in Bayesian MAP Estimation

Matthew Dunlop New York University
Tapio Helin Lappeenranta University of Technology
Andrew Stuart California Institute of Technology

Abstract: The posterior distribution in Bayesian inverse problems may in principle be sampled by means of MCMC/SMC methods, but often it is computationally infeasible to do so. In this situation MAP estimators may be sought. Whilst these are relatively cheap to compute, and have an attractive variational formulation, a key drawback is their lack of invariance under reparameterization. We consider the effect this can have on consistency of the MAP estimators when hierarchical priors are employed.

MS A1-1-1 7 17:00-19:00

Mathematical Theory and Applications of Deep Learning - Part 2

For Part 1 see: MS A1-1-1 6
For Part 3 see: MS A1-1-1 8

Organizer: Haizhao Yang National University of Singapore
Organizer: Tingran Gao University of Chicago

Abstract: The "unreasonable effectiveness" of deep learning for massive datasets posed numerous mathematical and algorithmic challenges along the path towards gaining deeper understandings of new phenomena in machine learning. This minisymposium aims at bringing together applied mathematicians interested in the mathematical aspects of deep learning, with diverse background and expertise ranging from approximation theory, optimization methods, and generalization performance to modeling high-dimensional scientific computing problems and nonlinear physical systems; the talks reflect the collaborative, multifaceted nature of the mathematical theory and applications of deep neural networks. The second part of this minisymposium concerns the generalization and perturbation error of deep learning.

17:00-17:30

A Dynamical Systems and Optimal Control Approach to Deep Learning

Qianxiao Li NUS, A*STAR

Abstract: In this talk, we discuss formulating, through a continuous-time approximation, deep supervised learning as a mean field optimal control problem. This allows us to derive necessary conditions for optimality in deep learning in the form of a mean-field Pontryagin's maximum principle, as well as global characterizations of optimality using Hamilton-Jacobi-Bellman equations. We also discuss interesting numerical algorithms and generalization estimates that can be derived from this viewpoint.

17:30-18:00

Geometry and robustness of deep networks

Alhussein Fawzi Google

Abstract: Deep neural networks have recently shown impressive classification performance on visual benchmarks. When deployed in real-world environments, it is equally important that these classifiers satisfy robustness guarantees. In this talk, I will first highlight the vulnerability of state-of-the-art classifiers to simple perturbation regimes, such as adversarial perturbations. Then, I will show the existence of fundamental connections between robustness and geometric properties of classifiers. I will finally conclude with important open problems in this emerging field.

18:00-18:30

Adversarial deformations for deep neural networks

Tandri Gauksson ETH Zurich

Abstract: Although deep neural networks have been employed as image classifiers with much success, their ability to generalize does not take to adversarial examples; visually meaningful images specifically designed to trick the classifier. We explore a class of adversarial examples constructed by image deformations. While indistinguishable from the original images, the deformed images lie far from the originals in the norms commonly used in the literature, exposing limitations of viewing adversarial examples as small additive perturbations.

18:30-19:00

A priori estimates for the generalization error in neural network models

Weinan E Princeton University

Abstract: Currently, most of the existing results on the estimates of the generalization error of neural network models are a posteriori in nature. Unfortunately these estimates are often vacuous in real large scale applications. In this talk, we will discuss recent results on a priori estimates. These results provide useful and in some sense optimal bounds on the generalization error.

MS FT-S-8 7 17:00-19:00

Challenges in theory and numerics for kinetic models with applications - Part 3

For Part 1 see: MS FT-S-8 5
For Part 2 see: MS FT-S-8 6

Organizer: Liu Liu University of Texas at Austin
Organizer: Marlies Pirner University of Vienna

Abstract: Modern applications of kinetic equations of collisional type, such as the Boltzmann equation, have brought researches in mesoscopic modeling, from rarefied gas or plasma dynamics, to quantum mechanics, gas mixtures, chemical reactions and uncertainty quantification for the models. Moreover, they had led to new challenges both in analysis and numerical methods for kinetic models such as spectral-gap estimates, hypocoercivity for studying exponential convergence towards global equilibrium, and multiscale scientific computings to avoid numerically resolve small scales in the models that can be prohibitively expensive. This minisymposium aims to bring together applied mathematicians to explore the recent progress in this field.

17:00-17:30

Quantitative stability inequalities for gravitational kinetic models

Mohammed Lemou CNRS & University of Rennes

Abstract: Quantitative stability inequalities for gravitational kinetic models

17:30-18:00

On the numerical resolution of anisotropic equations with high order differential operators arising in plasma physics

Chang Yang Harbin Institute of Technology

Fabrice Deluzet University of Toulouse
Jacek Narski University of Toulouse

Abstract: In this work, numerical schemes are introduced for the efficient resolution of anisotropic equations including high order differential operators. We introduce two successful methods offering the advantages of each approach: a condition number unrelated to the anisotropy strength and scaling as favorably as standard discretizations with the mesh refinement.

18:00-18:30

Local velocity grids for gas mixtures

Brull Stéphane Institut de Mathématiques de Bordeaux

Abstract: This work is devoted to an adaptative method for kinetic equations in the context of gas mixtures. The methodology is based on dynamic velocity grids that are that are different at each space step and computed at each time step. The method is implemented and tested on the BGK model introduced by Andries, Aoki and Perthame. We will present in this talk several test cases showin the efficiency of the method.

18:30-19:00

A quantum BGK model for partially degenerate plasma mixtures

Jeffrey Haack Los Alamos National Laboratory

Abstract: We have extended the multispecies BGK model to include degeneracy (Fermi-Dirac statistics) for an electron species. From this model we obtain a moment-based quantum hydrodynamics formulation closed through a Chapman-Enskog expansion to yield expressions for the electronic transport coefficients. Comparisons are made with previous kinetic models for dense plasmas and implications for modeling and designing experiments are discussed.

MS FT-4-4 7 17:00-19:00

Advances in Monte Carlo Methods and Applications - Part 3

For Part 1 see: MS FT-4-4 5
For Part 2 see: MS FT-4-4 6
For Part 4 see: MS FT-4-4 8
For Part 5 see: MS FT-4-4 9
Organizer: David Aristoff Colorado State University
Organizer: Gideon Simpson Drexel University

Abstract: Monte Carlo methods continue to be the primary tool for a host of problems posed in high dimensional spaces in fields as diverse as materials science, data science, and uncertainty quantification. These applications demand both novel algorithms and mathematical analysis to ensure accuracy and optimal performance. This minisymposium will bring together researchers and practitioners to discuss the latest results on Monte Carlo algorithms and their application. Key topics will include Gibbs-Boltzmann sampling, free energy calculations, rare event simulation, uncertainty quantification, optimization, and ensemble and particle methods.

17:00-17:30

Convergence of Adaptive Langevin dynamics

Gabriel Stoltz Ecole des Ponts ParisTech and Inria Paris
Ben Leimkuhler University of Edinburgh
Matthias Sachs Duke University

Abstract: Adaptive Langevin dynamics samples the canonical distribution at a prescribed temperature when the fluctuation magnitude is unknown, by considering the friction as a dynamical variable updated according to some Nose-Hoover feedback. We show using techniques from hypocoercivity that the law of the dynamics converges exponential fast to equilibrium, with a rate which can be quantified in terms of the key parameters of the dynamics. This allows in particular to obtain a CLT for time averages.

17:30-18:00

Computing the transport coefficients of stochastic dynamical systems

Ting Wang Army Research Laboratory
Petr Plechac University of Delaware
Gabriel Stoltz Ecole Des Ponts Paristech And Inria Paris

Abstract: In this talk, we describe the likelihood ratio (LR) approach for transport coefficient computation based on the Girsanov transformation theory. We show that a control variate type centering of the LR estimator leads to an efficient estimator whose variance is constant in system time. Furthermore, we discuss the design of a weak second order LR scheme for stochastic dynamical systems. We finally conclude with numerical demonstrations from stochastic reaction kinetics.

18:00-18:30

Conditioned random matrices and Coulomb gases: theory and practice

Grégoire Ferré Ecole des Ponts ParisTech

Abstract: The spectrum of random matrices plays important roles in various fields, from quantum physics to applied finance. Fluctuations of such a spectrum is an important problem, for instance in disordered systems. Naive sampling methods generally fail because the conditioning event is rare. The talk presents a numerical and theoretical study of such conditioned matrices and related Coulomb gases. In particular, we use a constrained HMC algorithm for sampling the spectrum of such conditioned matrices.

18:30-19:00

Using uncertainty quantification to build Markov models from accelerated atomistic sampling

Tom Swinburne Centre Interdisciplinaire de Nanoscience de Marseille
Danny Perez Los Alamos National Laboratory

Abstract: I will talk about recent work [1] that introduces Bayesian estimators of sampling completeness to autonomously optimize the construction of controlled-uncertainty Markov chains to model the long time dynamics of materials. I will also discuss how accommodation of exchange, rotation, reflection and translation symmetries can massively enhance sampling efficiency. [1] TD Swinburne and D Perez, Self-optimized construction of transition rate matrices from accelerated atomistic simulations with Bayesian uncertainty quantification, Physical Review Materials 2018

MS ME-1-1 7 17:00-19:00

Current Trends in Applications of Delay Equations - Part 1

For Part 2 see: MS ME-1-1 8
Organizer: Maria Vittoria Barbarossa Heidelberg University, Institute of Applied Mathematics
Organizer: Gergely Röst Bolyai Institute, Szeged, Hungary
Organizer: Felicia Magpantay Queen's University

Abstract: Including the effects of past actions into dynamical systems, Delay differential equations (DDEs) allow for the description of potentially high dimensional dynamical effects and are a useful tool for modeling phenomena occurring in various fields of life and mechanical sciences. From the point of view of dynamical systems, DDEs represent an important class of infinite dimensional problems which can be studied by advanced analytical and numerical methods. This mini-symposium presents current research works in application of DDEs, with examples from population dynamics, epidemiology, cell biology and physiology.

17:00-17:30

On the global asymptotic stability of a system of delayed logistic equations with patch structure

Ferenc A Bartha University of Szeged
Diana Knipl University of Szeged
Gergely Rost University of Szeged
Xingfu Zou University of Western Ontario

Abstract: The delayed logistic equation is a classical simple looking nonlinear delay differential equation whose global behavior is notoriously difficult to describe. It was proposed for modeling growth of a single species explaining observed oscillatory behavior. We explore extending existing results known for the scalar equation to systems with patch structure. In particular, we investigate conditions for global asymptotic stability analogous to those for the Nicholson blowfly dynamics in terms of local growth and migration parameters.

17:30-18:00

Lyapunov-Razumikhin techniques for state-dependent delay differential equations

Felicia Magpantay Queen's University
Antony R. Humphries McGill University

Abstract: We present theorems for the Lyapunov and asymptotic stability of the steady state solutions to general state-dependent delay differential equations (DDEs) using Lyapunov-Razumikhin methods. These theorems build upon the previous work of Hale and Verduyn Lunel (1993) and Barnea (1969) which were mainly aimed at equations with simpler delay terms (e.g. constant and time-dependent delays), and are less applicable to state-dependent DDEs.

18:00-18:30

Dynamics of go-or-grow type cell proliferation models with cell cycle delay

Gergely Röst	Bolyai Institute, Szeged, Hungary
Ruth Baker	Oxford
Péter Boldog	Szeged

Abstract: We propose a new delayed logistic equation, which has clear biological underpinning coming from cell population modelling. This nonlinear differential equation includes terms with discrete and distributed delays. We completely describe the global attractor of the system. The dynamics is not trivial as we can observe long-lasting transient oscillatory patterns of various shapes. We discuss the biological implications of these findings and their relations to other logistic type models of growth with delays.

18:30-19:00

Pulsing dynamics of a laser system with delayed feedback

Stefan Ruschel	University of Auckland
Soizic Terrien	Laboratoire de Mécanique des Contacts et des Structures
Neil Broderick	University of Auckland
Bernd Krauskopf	University of Auckland

Abstract: We consider the Yamada model for a self-pulsating or excitable laser in the presence of delayed feedback. This model describes the existence of pulse trains that are sustained in the external feedback loop. Producing such pulse trains with high repetition accuracy is essential to modern optoelectronic applications. We present some recent results regarding their stability and bifurcations.

MS FE-1-4 7 — 17:00-19:00

Multiscale analysis and numerical methods for oscillatory PDEs - Part 3

For Part 1 see: MS FE-1-4 5
For Part 2 see: MS FE-1-4 6
For Part 4 see: MS FE-1-4 8

Organizer: Yongyong Cai	Beijing Computational Science Research Center
Organizer: Hanquan Wang	Yunnan University of Finance and Economics
Organizer: Carles Remi	CNRS & Univ Rennes

Abstract: Oscillatory behaviors are ubiquitous in nature and arise in different disciplines, such as semiclassical limits of Schroedinger equations in computational chemistry, nonrelativistic limit of Klein-Gordon equation in particle physics, subsonic limits of Zakharov system in plasma physics, Vlasov-Poisson equation with strong magnetic field, Boltzmann equation in the diffusion limit, etc. These oscillatory PDEs typically involve two or more different temporal/spatial scales, where multiscale analysis has been playing an important role. This mini-symposium aims to bring experts together to exchange and discuss recent progresses on analysis and numerical methods in this area, and to identify future research directions with possible collabrations.

17:00-17:30

A hybrid WKB-based method for Schrödinger scattering problems in the semi-classical limit

Anton Arnold	Technische Universitaet Wien
Claudia Negulescu	Univ. of Toulouse
Kirian Döpfner	TU Wien
Christian Klein	Univ. Bourgogne
Bernhard Ujvari	TU Wien

Abstract: We consider 1D scattering problems related to quantum transport in diodes. We discuss the efficient numerical integration of ODEs like epsilon^2*u"+a(x)*u=0 for 0<epsilon<<1 on coarse grids, but still yielding accurate solutions; including oscillatory (for given a(x)>0) and evanescent regimes (for a(x)<0), partly including turning points. In the oscillatory case we use a marching method that is based on an analytic WKB-preprocessing of the equation. And in the evanescent case we use a FEM with WKB-ansatz functions.

17:30-18:00

A conservation law with spatially localized sublinear damping

Christophe Besse	University of Toulouse III
Carles Rémi	CNRS
Ervedoza Sylvain	CNRS

Abstract: We consider a general conservation law on the circle, in the presence of a sublinear damping acting locally in space. Depending on the flux, we show global/local extinction in finite time of the solution. We will present various numerical illustrations which will show how similar phenomena may be expected for other equations.

18:00-18:30

Numerical methods and analysis for KP equations

Christian Klein	University of Burgundy
Peter Ralf	University of Burgundy
Roidot Kristelle	University of Burgundy
Saut Jean-Claude	Universite Paris Sud
Stoilov Nikola	University of Burgundy

Abstract: We present numerical approaches for the study of dispersive schock waves and blow-ups in Korteweg-de Vries and Kadomtsev-Petvishvili equations.

18:30-19:00

Convergences of multi-resolution methods for Schroedinger equations

Yong Zhang	Tianjin University
Philippe Chartier	INRIA-Rennes
Florian Mehats	Université de Rennes 1
Mechthild Thalhammer	Leopold–Franzens Universität Innsbruck,

Abstract: The convergence behaviour of multi-revolution composition methods combined with time- splitting methods is analysed for highly oscillatory linear differential equations of Schrödinger type. Numerical experiments illustrate and complement the theoretical investigations.

MS FT-1-SG 7 — 17:00-19:00

Approximation Theory and its Applications - Part 2

For Part 1 see: MS FT-1-SG 6

Organizer: Juan Ruiz Álvarez	Universidad Politécnica de Cartagena
Organizer: Ángel Alberto Magreñán Ruiz	Universidad de la Rioja
Organizer: Juan Carlos Trillo	Universidad Politécnica de Cartagena
Organizer: Dionisio Félix Yáñez Avendaño	Universidad de Valencia

Abstract: The Approximation theory covers the theoretical and practical study of methods that use numerical approximation to solve problems of different areas. Numerical algorithms in approximation theory have been a major thrust for the research activities in this field during the past years. This session is devoted to provide new trends in the field of approximation theory and related applications in mathematics. Studies about the construction of new algorithms, the study of their properties, such as convergence or stability, and their applications using computer simulations will be welcomed.

17:00-17:30

A new strategy to rise the accuracy of WENO schemes close to discontinuities

Juan Ruiz Álvarez	Universidad Politécnica de Cartagena

Abstract: This work is devoted to the construction and analysis of new nonlinear optimal weights for WENO interpolation capable of raising the order of accuracy close to discontinuities. These weights are constructed using a strategy inspired by the WENO algorithm, and they work very well for kinks or jump singularities, leading to optimal theoretical accuracy. Our aim is twofold: to raise the order of accuracy near discontinuities and also in the interval which contains the kink.

17:30-18:00

Nonlinear splines and applications

Juan Carlos Trillo	Universidad Politécnica de Cartagena

Abstract: Interpolatory splines are widely used in the industry for modeling purposes and computer-aided design because of their differently properties. Tipically, they are useful to reconstruct data that present certain regularity. However, in last years, in order to construct adapted splines new techniques have been developed. In this work we design nonlinear splines and study its properties. Finally, some applications are showed.

18:00-18:30

Study of a new nonlinear parametric reconstruction

Ángel Alberto Magreñán Ruiz — Universidad de la Rioja
Sergio Amat — Universidad Politécnica de Cartagena
Juan Ruiz — Universidad Politécnica de Cartagena
Juan Carlos Trillo — Universidad Politécnica de Cartagena
Dionisio F. Yáñez — Universidad de Valencia

Abstract: Subdivision schemes have gained a lot of popularity in recent years due to their simplicity, easy implementation and flexibility. New applications developed in the past years have help to the popularization of these techniques in industry and academic environments. In this talk, we introduce a new family of nonlinear schemes with a tension parameter. We will analyze the theoretical properties of this family concerning the stability, convergence or elimination of the Gibbs phenomenon.

MS GH-0-2 7 17:00-19:00

Multifidelity methods for uncertainty quantification and optimization in complex systems - Part 2

For Part 1 see: MS GH-0-2 6
For Part 3 see: MS GH-0-2 8
Organizer: Alex Gorodetsky — University of Michigan
Organizer: Michael Eldred — Sandia National Laboratories
Organizer: Gianluca Geraci — Sandia National Laboratories
Organizer: John Jakeman — Sandia National Laboratories

Abstract: Algorithms that leverage multiple simulation fidelities can significantly reduce the cost of UQ, optimization, and control problems. These so-called multi-fidelity methods exploit different discretizations, scales, and descriptions of the underlying physics to gain marked improvement in overall computational efficiency. This mini-symposium aims to bring together researchers who develop and apply these algorithms. Algorithms and applications of interest include, but are not limited to: analyzing non-hierarchical models whose relationships are not know a-priori; handling dynamical systems that provide streaming data; using multiscale hierarchies; sampling methods for variance reduction; and surrogate-based approaches that exploit special types of structure.

17:00-17:30

Approximate control variates for Uncertainty Quantification in dynamical systems

Alex Gorodetsky — University of Michigan

Abstract: We consider variance reduction for Monte Carlo algorithms for propagating uncertainty through simulation models when simulators of varying fidelity are available. Our goal is to estimate QoIs from a specified high-fidelity model when only a limited number of such simulations is available. To aid in this task, lower fidelity models can be used to reduce uncertainty in predictions. In this talk, we apply our recently developed approximate control variate approach and discuss implications for control.

17:30-18:00

Solving Stochastic Inverse Problems using Approximate Push-forward Densities based on a Multi-fidelity Monte Carlo Method

Tim Wildey — Sandia National Laboratories
Lukas Bruder — Technical University of Munich
Michael Gee — Technical University of Munich

Abstract: We build upon a recently developed approach for solving stochastic inverse problems based on a combination of measure-theoretic principles and Bayes' rule. We propose a multi-fidelity method to reduce the computational burden of performing uncertainty quantification using high-fidelity models. Our goal is to generate samples from a high-fidelity push-forward density at a fraction of the costs of standard Monte Carlo methods. We demonstrate the feasibility of the framework in several numerical examples.

18:00-18:30

Derivative-free optimization under uncertainty using multifidelity sampling

Friedrich Menhorn — Technical University of Munich

Abstract: The stochastic nonlinear derivative-free constrained optimization method SNOWPAC solves robust optimization problems; it uses a regularized trust region approach and Monte Carlo estimators to evaluate measures of robustness or risk in the objectives/constraints. We present recent developments employing multilevel Monte Carlo and associated error estimators, implemented in DAKOTA, to achieve computational savings at any desired level of accuracy. Additionally, we describe a strategy for near-optimal noise control via Gaussian processes to improve convergence.

18:30-19:00

Accurate statistical estimators by continuation MLMC for engineering applications

Quentin Ayoul Guilmard — EPFL
Fabio Nobile — EPFL
Sundar Ganesh — EPFL

Abstract: We propose novel estimators based on the Multi-Level Monte Carlo (MLMC) method to accurately estimate central moments and other parametric expectations of output quantities to a PDE model with uncertainties. We present a continuation version of the MLMC method for calibrating the estimators with respect to suitable error estimates, and demonstrate its performance on fluid-flow problems inspired by civil engineering and aerodynamics applications. We also present a parallelised implementation aimed towards HPC.

MS A6-3-2 7 17:00-19:00

Multiscale Modeling and Methods for Defects in Solid - Part 2

For Part 1 see: MS A6-3-2 6
Organizer: Pingbing Ming — Chinese Academy of Sciences
Organizer: Zhijian Yang — Wuhan University

Abstract: Real materials are never perfect, they always contain considerable defects, which are manipulated to control and determine the electronic and mechanical properties of real materials. The behavior of defects usually involves several temporal scales and spatial scales. Multiscale modeling and multiscale simulation methods are hereby important tools to understanding defects. The purpose of this workshop is for participants from different disciplinary to discuss the latest developments in the area of multiscale modeling and simulation techniques of defects in solids.

17:00-17:30

The effect of randomness on the strength of high-entropy alloys

Luchan Zhang — National University of Singapore
Yang Xiang — The Hong Kong University of Science and Technology
Jian Han — University of Pennsylvania
David Srolovitz — City University of Hong Kong

Abstract: High-entropy alloys (HEAs), i.e., single-phase, (nearly) equiatomic multicomponent, metallic materials, have novel mechanical properties (high strength etc). We propose a stochastic Peierls-Nabarro model to understand how random site occupancy affects intrinsic strength. The model predicts the intrinsic strength of HEAs as a function of standard deviation and correlation length of the randomness. We find that compositional randomness induces an intrinsic strength. This approach provides a fundamental explanation to the origin of high strength of HEAs.

17:30-18:00

Modeling and Simulation of Dislocation Climb

Yang Xiang — Hong Kong University of Science and Technology

Abstract: We derive a Green's function formulation for the climb of curved dislocations and multiple dislocations in three-dimensions. The dislocation climb velocity is determined from the Peach–Koehler force on dislocations through vacancy diffusion in a non-local manner that is associated with vacancy diffusion. We also present numerical discretization methods of this formulation for discrete dislocation dynamics simulations. Based on this dislocation climb formulation, point defect sink efficiency of low angle grain boundaries is examined.

18:00-18:30

Multiscale Model for Interlayer Defects in Low dimension materials

Shuyang Dai — Wuhan University

Abstract: We develop a multiscale continuum model to describe the interlayer defects in bilayer materials. The model incorporates both the anisotropy elasticity of each mono-layer and the first-principle calculation informed interaction between two layers. We apply this approach to determine the structure and energetics of twisted bilayer material. We also investigated the dislocation structure in heterogeneous bilayer such as G/BN. Our model agrees well with the atomistic results. An analytical description is developed.

18:30-19:00

Perturbation model for optical modes in deformed disks

Tianpeng Jiang	Hong Kong University of Science & Technology
Yang Xiang	Hong Kong University of Science & Technology

Abstract: We present a perturbation approach to calculate optical modes in arbitrary weakly deformed disks. By introducing a small perturbation parameter into mode equation and interface conditions, the original problem is decomposed into orders of perturbation problems. Our linear perturbation model provides good approximations. The approximation explains mode-splitting phenomena of clockwise and counterclockwise degeneracy. We apply our perturbation method to limacon and spiral cavities, the results agree well with numerical results of the full problem.

MS ME-0-5 7 **17:00-19:00**

Simulation, Modeling and Analysis of Semiconductors - Part 1

For Part 2 see: MS ME-0-5 8

Organizer: Nella Rotundo	Weierstrass Institute for Applied Analysis
Organizer: Patricio Farrell	Weierstrass Institute, Berlin

MS Organized by: SIAG/CSE

Abstract: At its core technological change depends fundamentally on the quality and efficiency of semiconductor devices. Due to miniaturization, the need for higher efficiency and new (organic) materials, advanced theory and numerical methods are required to correctly predict the flow of charge carriers in a device --- without the costly production of prototypes. This minisymposium aims at providing a vision of recent theoretical advances as well as suitable simulation techniques. Furthermore, it provides a platform for international experts in applied analysis and numerical methods to learn from another.

17:00-17:30

Simulating semiconductor devices in a physically correct and stable way

Patricio Farrell	Weierstrass Institute for Applied Analysis and Stochastics

Abstract: We present accurate finite volume methods for semiconductor problems with nonlinear diffusion. Nonlinear diffusion is important at low temperatures, for organic materials or large doping concentrations. We develop schemes which are physically correct and stable, expanding ideas by Scharfetter and Gummel for linear diffusion.

17:30-18:00

Treatment of organic-organic interfaces in drift-diffusion models

Kirsch Christoph	Institute of Computational Physics, ZHAW
Balthasar Blülle	Fluxim AG, Winterthur
Alexandre Stous	Fluxim AG, Winterthur
Beat Ruhstaller	Fluxim AG, Winterthur, and Zurich University of Applied Sciences, Winterthur

Abstract: We present a way to treat organic material interfaces in drift-diffusion models for the charge transport in semiconductor devices. This treatment is compatible with the well-known Scharfetter-Gummel discretization for the semiconductor device equations. Device models including such organic-organic interfaces may be used to describe charge recombination/generation layers in organic photovoltaic devices or organic light-emitting diodes. Besides presenting the discretization we will also discuss some physical aspects of interface phenomena.

18:00-18:30

Scalable Adaptive Simulation of Organic Thin-Film Transistors

Carlo De Falco	Politecnico di Milano
Pasquale Africa	MOX, Politecnico di Milano
Dario Natali	DEIB, Politecnico di Milano

Abstract: The accurate knowledge of relevant physical parameters is crucial to determine the predictive accuracy of numerical models for organic semiconductor devices. We present a step-by-step procedure enabling to determine crit- ical model parameters - such as the density of states width, the carrier mobility and the injection barrier - by fitting ex- perimental data from a sequence of relatively simple mea- surements to 2D and 3D numerical simulations under different regimes.

18:30-19:00

Numerical methods for charge transport in semiconductors: FEM vs FV

Dirk Peschka	Weierstrass Institute for Applied Analysis and Stochastics

Abstract: In this talk, I will present some common strategies for the discretization of drift-diffusion equations for charge transport in semiconductors. We propose a benchmark of these numerical methods in light of three common challenges, i.e., boundary layers at contacts, singularities at corners of the domain, and possible nonsmooth data. Specialized finite volume methods perform particularly well in regions of very low carrier concentration, as they are generated at a classical Ohmic contact.

MS A3-S-C2 7 **17:00-19:00**

Geometric shape generation: integrability, variational analysis and applications - Part 4

For Part 1 see: MS A3-S-C2 4
For Part 2 see: MS A3-S-C2 5
For Part 3 see: MS A3-S-C2 6
For Part 5 see: MS A3-S-C2 8
For Part 6 see: MS A3-S-C2 9

Organizer: Kenji Kajiwara	Kyushu University
Organizer: Schief Wolfgang	The University of New South Wales
Organizer: Miyuki Koiso	Kyushu University
Organizer: Udo Hertrich-Jeromin	TU Wien

Abstract: This minisymposium is aimed at the discovery of state of the art geometric shape generation, based on methods from smooth and discrete differential geometry. In response to needs and problems raised by industrial applications, various geometric methods to generate desirable or "good" shapes have been developed, that emphasize the underlying structure of an integrable systems or variational approach. The topics addressed will range from problems raised in architecture and industrial design to the mathematical framework used to tackle them, and the modeling and analysis of smooth or discrete curves and surfaces to be used in shape design.

17:00-17:30

Anisotropic surface energy and crystalline variational problems

Miyuki Koiso	Kyushu University

Abstract: An anisotropic surface energy is the integral of an energy density that depends on the surface normal over the considered hypersurface, which was introduced to model the energy of a small crystal. The minimizer of this energy among closed hypersurfaces enclosing the same volume is unique and it is (up to rescaling) so-called the Wulff shape. We discuss geometry, stability, and uniqueness of equilibrium hypersurfaces, and give applications to anisotropic mean curvature flow.

17:30-18:00

Crystal structure and a discrete surface theory

Hisashi Naito	Nagoya University

Abstract: We consider trivalent network structures modeled by sp2 carbon structures (eg. fullerenes and carbon natotubes), which are seems to non-negative discrete surfaces. In this talk, we introduce a surface theory for trivalent network structures and constructing negatively curved sp2 carbon structures via the theory of topological crystals.

18:00-18:30

On mean curvature flow of hypersurface with right angle in domains

Takashi Kagaya	Kyushu University

Abstract: In this talk, we consider the mean curvature flow in domains and with free boundary in the boundary of the domain. For this free boundary problem, the mean curvature flow should "pop" upon tangential contact with the boundary of the domain. Therefore, we study Brakke's mean curvature flow with free boundary, which is a measure-theoretic weak solution to the mean curvature flow, in order to analyze topological changes by "popping".

18:30-19:00

Geometry of hinged linkage systems

Shizuo Kaji	Kyushu University
Kenji Kajiwara	Kyushu University
Hyeongki Park	Kyushu University

Abstract: We study a certain class of spacial linkage mechanisms consisting of hinges by identifying them as discrete space curves and discuss their motion in terms of isoperimetric and torsion preserving deformation of the curves. In particular, we construct an explicit motion corresponding to closed hinged linkages consisting of congruent tetrahedra, by the semi-discrete mKdV equations. This is joint work with K. Kajiwara and H. Park.

MS A6-2-1 7 **17:00-19:00**

Mathematical Models for Solid Mechanics and Soft Structures - Part 1

For Part 2 see: MS A6-2-1 8

For Part 3 see: MS A6-2-1 9

For Part 4 see: MS A6-2-1 10

Organizer: Marco Morandotti Politecnico di Torino

Organizer: Luca Lussardi POLITECNICO DI TORINO

Abstract: The modelling of materials has received more and more attention in the last decades due to the increasing capabilities and versatility of new material and composites. Applications ranging from solid mechanics to soft structures demand sophisticated models which today's mathematics can both provide and study. In this minisymposium we intend to gather international researchers in the field of applied mathematics to share their research on topics including continuum mechanics, soft structures, thin structures, homogenisation theory, material defects, and liquid crystals.

17:00-17:30

The Helfrich model for the elasticity of biomembranes as a limit of mesoscopic energies

Luca Lussardi Politecnico di Torino

Abstract: In a recent paper (2009) Peletier and Röger proposed a mesoscale model for the elasticity of cell membranes based on the amphiphilic behavior of the lipid molecules that form the membrane. In this seminar I will present the analysis of the model in 3D which requires tools from Geometric Measure Theory to have weak notions of surfaces suitable for Calculus of Variations.

17:30-18:00

Variational models for biological membranes

Katharina Brazda University of Vienna

Abstract: Biological membranes can be described as surfaces that minimize the Canham-Helfrich bending energy. This variational model explains the typical biconcave shape of human red blood cells. Moreover, many cellular processes are governed by the coupling between membrane composition and curvature. We study these geometric variational problems in the framework of generalized surfaces (oriented curvature varifolds with boundary) and present existence results for single-phase membranes and sharp-interface multi-phase membranes.

18:00-18:30

Modelling the dynamics of flexible bacterial flagella in viscous fluids

Henry Shum University of Waterloo

Abstract: Many species of bacteria use long filaments called flagella for motility. There is great diversity in the structure and arrangement of flagella across species. To understand these differences, we use models of elasticity for the flagellar filaments. A significant challenge in numerically simulating the dynamics is achieving accurate resolution of both elastic deformations and the viscous stresses due to the surrounding fluid over timescales long enough to observe swimming or tumbling behaviour.

18:30-19:00

Geometry and mechanics in the embryo at the 8-cell stage

Giulia Bevilacqua Politecnico di Milano

Pasquale Ciarletta Politecnico di Milano

Davide Ambrosi Politecnico di Torino

Abstract: During the mitotic process from the 8-cells to the 16-cells stage, the mitotic spindle in the peripheral cell polarizes along the radial direction of the cellular aggregate. We investigate the mechanical cues driving the three-dimensional packing by exploiting the maximization of the contact surface under the constraint of mass (volume) conservation. By enforcing the mechanical balance, we find that the radial surface tensions are higher than the circumferential ones.

MS ME-1-9 7 **17:00-19:30**

Dynamics of Stochastic Partial Differential Equations

Organizer: Wei Wang Nanjing University

Organizer: Jinqiao Duan Illinois Institute of Technology

Abstract: Stochastic dynamical systems concepts and techniques are crucial in modelling complex systems under uncertainty. There have been rapid advances in research and applications of stochastic dynamical systems for the last ten years. Theoretical progresses include invariant manifolds, invariant measures, slow manifold reduction, macroscopic descriptions of stochastic phenomena, among others. The techniques and tools of stochastic dynamical systems have been applied to biophysics, geophysics and other engineering and scientific fields. The objective of this minisymposium is to bring together a group of experts to showcase several aspects of stochastic dynamical systems and their applications.

17:00-17:30

Dynamics of Stochastic Partial Differential Equations via Effective Reduction

Jinqiao Duan Illinois Institute of Technology

Abstract: The need to take stochastic effects into account for modeling complex systems has now become widely recognized. Stochastic partial differential equations arise naturally as mathematical models for systems under random influences. The speaker will overview several topics on examining dynamical behaviors ---- transition pathways, connecting orbits, data assimilation, and parameter estimation --- of stochastic partial differential equations with help of effective reductions such as slow manifolds and homogenization.

17:30-18:00

Approximation of a generalized Langevin equations

Wei Wang Nanjing University

Abstract: In this talk we are concerned with the approximation of a generalized Langevin equations which describes a particle with small mass in a thermal fluctuating viscoelastic fluid. The fluctuation is described by a fast oscillating random force and depends on the frequency.

18:00-18:30

Blowup solutions of stochastic parabolic equations

Guangying Lv Hennan University

Jinlong Wei Zhongnan University of Economics and Law

Abstract: In this talk, we introduce a new method to study the blowup phenomenon on bounded domain. Comparing with the existing results, we delete the assumption that the solutions to stochastic heat equations are non-negative. Then the blowup phenomenon in the whole space is obtained by using the properties of heat kernel. We obtain that the solutions will blow up in finite time for nontrivial initial data.

18:30-19:00

Maximum likelihood estimation based on stochastic center manifolds

Xiaopeng Chen Shantou University

Abstract: We study the problem of parameter estimation for an Ornstein-Uhlenbeck process, where the data comes from the multiscale system. Based on the center manifold theory, we estimate the coefficients of the multiscale system by the maximum likelihood estimation. A simulation result about the estimation is also provided.

19:00-19:30

Approximation for evolutionary equation with highly random oscillating boundary and large interaction

Yan Lv Nanjing University of Science and Technology

Wei Wang Nanjing University

Abstract: This report is concerned with the approximation of a singularly perturbed hyperbolic type evolutionary equation with highly random oscillating boundary and larger interaction. A diffusion approximation is introduced to show that, if the interaction is large engough, the oscillating is fast enough and singular paramter is small enough, the approximation equation is one dimesinoal stochastic differential equation with white noise due to the random oscillation on boundary.

MS FE-1-2 7 **17:00-19:00**

Divergence-free and pressure-robust discretizations for the Navier-Stokes equations - Part 3

For Part 1 see: MS FE-1-2 5

For Part 2 see: MS FE-1-2 6

Organizer: Christian Merdon Weierstrass Institute Berlin

Organizer: Michael Neilan University of Pittsburgh

Abstract: Recently, pressure-robustness was identified as an important property in the discretisation of the Navier-Stokes equations. Opposite to classical finite element methods (like Taylor-Hood) that relax the divergence constraint, pressure-robust schemes compute discrete flow fields that are independent of the exact pressure and so are much more robust against small viscosity parameters. In this mini-symposium we want to gather active researchers in this field to discuss recent novel discretisation schemes, applications and related developments.

17:00-17:30

Quasi-optimal and pressure robust discretizations of the Stokes equations by new augmented Lagrangian formulations

Pietro Zanotti Università degli Studi di Milano

Christian Kreuzer Technische Universität Dortmund

Abstract: The discretization of the Stokes equations by conforming and divergence-free pairs is known to be quasi-optimal and pressure robust, in the sense that the velocity error is proportional to the best error to the analytical velocity. We show that the same property can be achieved by more general pairs. For this purpose, we employ a linear operator, mapping the discrete kernel into the analytical one, and an augmented Lagrangian formulation, inspired by discontinuous Galerkin methods.

17:30-18:00

Composite finite elements for the Stokes complex

Snorre H. Christiansen University of Oslo

Kaibo Hu University of Minnesota

Abstract: We present a conforming finite element pair for the Stokes equation with minimal degrees of freedom: for the velocity field, vertex values and integrals of normal components on faces. The pressure space consists of piecewise constants. We show how this example fits in a larger framework of finite element systems, designed to accomodate differential forms of arbitrary degree in arbitrary dimension, of desired regularity, for instance continuous with or without continuous exterior derivative.

18:00-18:30

Structure-preserving finite element methods for MHD systems

Kaibo Hu University of Minnesota

Abstract: The magnetic Gauss law $divB = 0$ plays an important role in the numerical simulation of magnetohydrodynamics (MHD) systems. We construct structure-preserving finite element methods which precisely preserve the magnetic Gauss law and the discrete energy law. Moreover, we discuss the discrete magnetic and cross helicity in the ideal limit. Continuous and discrete de Rham complexes are crucial in the construction and analysis of these schemes.

18:30-19:00

Preconditioning HDG, EDG and HDG/EDG discretizations of the Stokes problem

Sander Rhebergen University of Waterloo

Garth N. Wells University of Cambridge

Abstract: This talk will discuss optimal block-preconditioning methods that can be applied to linear systems arising from pressure-robust hybridizable discontinuous Galerkin (HDG) and combined hybridizable-embedded discontinuous Galerkin (HDG/EDG) discretizations of the Stokes problem. Typical of hybridized methods is the ease at which static condensation can be applied to reduce the size of the global problem. Our preconditioning methods have been developed to be optimal for these smaller statically condensed problems.

MS ME-1-0 7 **17:00-19:00**

Anisotropic variational models and partial differential equations - Part 2

For Part 1 see: MS ME-1-0 6

Organizer: Bertram Düring University of Sussex

Organizer: Carola-Bibiane Schönlieb University of Cambridge

Abstract: Anisotropic structures frequently arise in nature, biology, socio-economic modelling, mathematical imaging and data analysis. This minisymposium brings together research that ranges from the modelling and analysis to the numerical solution of anisotropic partial differential equations and anisotropic variational regularisation models. The anisotropic nature of these problems requires bespoke analytical and numerical techniques that will be discussed in talks featured in this minisymposium.

17:00-17:30

Efficient discretizations of strongly anisotropic PDEs on cartesian grids

Jean-Marie Mirebeau University Paris-Sud, CNRS, Univ Paris-Saclay

Abstract: We describe Voronoi's first reduction, a tool coming from the field of additive lattice geometry, which turns out to be particularly efficient for the discretization of anisotropic PDEs on cartesian grids. This approach is versatile and yields efficient numerical schemes for various PDEs, ranging from elliptic PDEs to the Monge-Ampere equation, and more. We illustrate its efficiency with numerical results in the context of image processing and stochastic control.

17:30-18:00

Blind image fusion using directional total variation

Leon Bungert Friedrich-Alexander Universität Erlangen-Nürnberg

Abstract: We propose a simultaneous super-resolution and blind deconvolution approach that allows to fuse a low resolution functional image (e.g. hyperspectral, PET, etc.) with a highly resolved image. Its structural information is incorporated via the directional total variation regulariser. The resulting non-convex variational problem is solved with alternating minimization. Numerical results on hyperspectral and panchromatic images show that our model can sucessively fuse two different image modalities even when the structural side information is mis-aligned.

18:00-18:30

Anisotropic osmosis filter for shadow removal in images

Simone Parisotto University of Cambridge

Abstract: We present an anisotropic extension of the isotropic osmosis model introduced by Weickert et al. (2013) for visual computing applications. Our model minimises an energy which involves a suitable quadratic form where the local directionality of the imaging structure is considered. Our anisotropic approach applied to shadow removal applications outperforms the isotropic one since it does not suffer from blurring artefacts at the shadow boundaries.

18:30-19:00

Joint reconstruction with complementary microlocal information

Marta Betcke University College London

Matthias Ehrhardt University of Bath

Abstract: In this talk we discuss two modifications of total variation based on (i) location and (ii) direction that take structural a priori knowledge into account and reduce to total variation in case when no structural information is available. We solve the resulting convex minimization problem with the alternating direction method of multipliers. We demonstrate the effectiveness of such a direction informed total variation on the multi-contrast data.

MS A3-3-2 7 **17:00-19:00**

Efficient Numerical Methods for Multiphysics Problems - Part 3

For Part 1 see: MS A3-3-2 5

For Part 2 see: MS A3-3-2 6

Organizer: Chensong Zhang Academy of Mathematics and Systems Science

Organizer: Xiaowen Xu IAPCM

Abstract: With the recent development of numerical algorithms and increase of computational power, more and more groups are conducting high-resolution and high-fidelity multiphysics simulations. The proposed minisymposium will bring together international scientists, including early-career researchers, who are at the forefront of multiphysics simulation. The proposed workshop provides a forum for experts from different backgrounds to exchange recent progress and ideas, and to create new collaboration. An important goal of our minisymposium is to foster collaboration between computational mathematicians and domain scientists in various real-world application areas with special focus on high-performance numerical methods for multiphysics problems.

17:00-17:30

A fictitious domain method for Stokes interface problem

Chensong Zhang Academy of Mathematics and Systems Science

Abstract: The distributed Lagrange multiplier/fictitious domain mixed finite element method is developed and analyzed for a transient Stokes interface problem with jump coefficients. The discrete DLM/FD-mixed finite element scheme are developed for problems with a moving interface, where the arbitrary Lagrangian-Eulerian (ALE) technique is employed to deal with the moving and immersed subdomain. Stability and optimal convergence properties are obtained. Numerical experiments are carried out and theoretical results are validated.

17:30-18:00

Multiphysics coupling at integration point level and implementation for high-performance computers

Andreas Vogel — Ruhr University Bochum

Abstract: For the multiphysics coupling of Finite Element simulations, we present a strategy for a modular implementation based on a flexible integration point evaluation idea allowing to separate concerns by means of the chain rule. We illustrate the idea for higher order finite volume methods and elaborate on the high-performance aspects and scaling behavior employing our software framework UG4.

MS GH-1-G 7 — 17:00-19:00

Control, Optimization, and Numerical Methods for Infinite Dimensional Systems - Part 1

For Part 2 see: MS GH-1-G 8

For Part 3 see: MS GH-1-G 9

Organizer: Weiwei Hu — Oklahoma State University

Organizer: Wei Gong — Chinese Academy of Sciences

Abstract: The aim of this minisymposium is to bring together scientists working on control, optimization and numerical methods for addressing the emerging problems in infinite dimensional systems and the related applications. This minisymposium will present recent developments in the topics such as control and estimation with non-smooth and sparsity structures; control of hyperbolic systems; numerical schemes for solving control systems with delays, optimal control of stochastic PDEs and fractional optimal control problems, etc. This forum will foster the international collaborations as well as provide an opportunity for young researchers to present their work and learn the state-of-the-art progress in this field.

17:00-17:30

Approximation of Distributed Parameter Control Problems with Application to Systems Governed by Partial and Delay Differential Equations

John Burns — Virginia Tech

James Cheung — Virginia Tech

Abstract: In this paper we consider higher order approximation schemes for control systems governed by partial and delay differential equations. We focus on methods that are (a) convergent and (b) dual convergent. We discuss hp - finite element type schemes and present a general framework that allows for the development of higher order methods that satisfy (a) and (b). Numerical examples are given to illustrate the method and ideas.

17:30-18:00

Optimal control in a bounded domain for wave propagating in the whole space: coupled through boundary integral equations

Wei Gong — Chinese Academy of Sciences

Buyang Li — The Hong Kong Polytechnic University,HK

Huanhuan Yang — Shantou University, China

Abstract: This talk presents an optimal control problem in a bounded-domain under the constraint of a wave equation in the whole space. We regularize and reformulate the problem as an initial-boundary value problem in a larger bounded domain coupled with boundary integral equations. The well-posedness and stability of the problem are proved. A fully discrete finite element method is proposed, the stability and convergence are proved and validated numerically.

18:00-18:30

Sparse discretization in PDE constrained optimization with measure controls

Evelyn Herberg — Universität Koblenz-Landau

Michael Hinze — Universität Koblenz-Landau

Henrik Schumacher — RWTH Aachen

Abstract: We consider optimal control problems that inherit a sparsity structure. Our goal is to achieve maximal sparsity on the discrete level. We use variational discretization of the control problems utilizing a Petrov-Galerkin approximation of the state which induces controls that are composed of Dirac measures. In the parabolic case this allows us to achieve sparsity on the discrete level in space-time. Numerical experiments show the differences of this approach to a full discretization approach.

18:30-19:00

A posteriori error estimates for optimal control problems involving Dirac measures

Enrique Otárola Pastén — Universidad Tecnica Federico Santa Maria, Chile

Alejandro Allendes — Universidad Tecnica Federico Santa Maria

Richard Rankin — University of Nottingham Ningbo China

Salgado Abner J. — University of Tennessee

Abstract: We present how the theory of Muckenhoupt weights, Muckenhoupt-weighted Sobolev spaces, and the corresponding weighted norm inequalities can be used in the analysis and discretization of PDE-constrained optimization problems that involve Dirac measures. We focus the discussion on the so-called pointwise tracking optimal control problem for the Poisson problem and present a priori and aposteriori error estimates for standard finite element approximations.

MS A1-2-6 7 — 17:00-19:00

Modeling and simulation of interface problems in biology - Part 3

For Part 1 see: MS A1-2-6 5

For Part 2 see: MS A1-2-6 6

Organizer: Sebastian Aland — HTW Dresden

Organizer: Wanda Strychalski — Case Western Reserve University

Abstract: Problems with moving interfaces are ubiquitous in the modelling of biological phenomena. Examples include cell motility, transport of biological compartments by flow, as well as every process that involves growth or pattern formation. Given the complexity of the biology and mathematical models of these processes, analytical solutions are often intractable; simulating such models requites state-of-the-art numerical methods. The goal of this mini-symposium is to foster the exchange of ideas by bringing together modelers, numerical analysts and experts in scientific computing who share a common interest in understanding complex biological systems.

17:00-17:30

A coupled bulk-surface model for cell polarisation

Anotida Madzvamuse — University of Sussex

Davidde Cusseddu — University of Sussex

Leah Edelstein-Keshet — University of British Columbia

John, A. Mackenzie — University of Strathclyde

Stephanie Portet — University of Manitoba

Abstract: In this talk, I will present a model describing the GTPase cycle between its active membrane-bound and inactive cytosolic form through a coupled bulk-surface framework. Rho GTPases are key players in cell polarisation, which is required in several cellular activities, such as migration. A simple basic interaction bulk-surface PDE model in 3D geometries will be presented. Bulk-surface finite element simulation results demonstrate the wave pinning mechanism in line with theoretical predictions.

17:30-18:00

Modelling and Simulation of Cell Blebbing with Surface Finite Elements Methods

Björn Stinner — University of Warwick

Abstract: Discrete particle and spring models have been successfully used in 2D to model cell blebbing. We derive a continuum model that underpins these approaches and generalizes to surfaces in 3D. An abstract variational formulation and a robust numerical method based on surface finite elements are presented. A high-level language allow for a convenient implementation whilst using efficient software backends. In particular, surface data from 3D images can be steered in.

18:00-18:30

Dynamics of lipid membrane and protein interactions

Caterina Tozzi — Universitat Politècnica de Catalunya

Abstract: Membrane shaping proteins play an important role in cellular biophysics including organelle morphogenesis, vesicular transport and buffering of cell area. Using Onsager's principle of irreversible thermodynamics, we study the chemo-mechanical coupling of curved proteins that bind and diffuse on cellular membranes while simultaneously shaping it. The model and numerical simulations provide the basis to understand and predict the curvature sensing and generation capabilities of protein-membrane system.

18:30-19:00

Modeling and simulating the multiphysics of fluidic membranes

Roger Sauer — RWTH Aachen
Kranthi Mandadapu — UC Berkeley

Abstract: We present a computational continuum framework for describing fluidic membranes, such as lipid bilayers. The framework is based on an explicit arbitrary Lagrangian-Eulerian surface description. It is suitable to describe the coupling of surface diffusion and phase transitions, surface flow and deformation, surface contact, adhesion and bonding reactions, and surface swelling and expansion. The coupling to external flows using conforming interface discretizations is also addressed, in particular in the framework of boundary element methods.

MS A3-S-C1 7 — 17:00-19:00

Tensor Methods - Part 4

For Part 1 see: MS A3-S-C1 4
For Part 2 see: MS A3-S-C1 5
For Part 3 see: MS A3-S-C1 6
For Part 5 see: MS A3-S-C1 8
For Part 6 see: MS A3-S-C1 9

Organizer: Lieven De Lathauwer — KULeuven
Organizer: Konstantin Usevich — CRAN - CNRS - Université de Lorraine
Organizer: André Uschmajew — MPI MiS

Abstract: A significant research effort is currently dedicated to the extension of linear to multilinear algebra. This work involves a rethinking of both theoretical concepts and numerical computation. The developments gradually allow a transition from classical vector and matrix based methods in applied mathematics and mathematical engineering to methods that involve tensors of arbitrary order. Tensor decompositions open up various new avenues beyond the realm of matrix methods. Important applications include efficient computation in high dimensions, the unique recovery of latent variables in data analysis, and large-scale system identification and machine learning.

17:00-17:30

Low-rank tensor approximation and preconditioning for multiscale problems

Vladimir Kazeev — Stanford University

Abstract: We consider boundary-value problems for a second-order diffusion equation with high-frequency oscillations in the diffusion coefficient. We show that, under certain assumptions, reparametrization using low-rank tensors in the form of matrix product states (MPS) or, equivalently, tensor trains (TT) allows to achieve exponential convergence of approximations and the adaptive, data-driven compression of the solution in the course of computation. The talk is based on joint works with Markus Bachmayr, Maxim Rakhuba, Christoph Schwab, Ivan Oseledets.

17:30-18:00

Chebyshev Polynomials and Best Rank-One Approximation Ratio

Khazhgali Kozhasov — Max Planck Institute for Mathematics in the Sciences
Andrei Agrachev — SISSA
Andre' Uschmajew — MPI MiS

Abstract: We establish a new extremal property of the classical Chebyshev polynomials in the context of the theory of rank-one approximations of tensors. We also give some necessary conditions for a tensor to be a minimizer of the ratio of spectral and Frobenius norms.

18:00-18:30

Convergence Rate Analysis for the Higher-Order Power Method in Best Rank One Approximation

Guoyin Li — University of New South Wales
Shenglong Hu — Huazhong Dianzi University, China

Abstract: A popular and classical method for finding the best rank-one approximation of a real tensor is the higher order power method (HOPM). In this talk, we first provide an explicit sublinear convergence rate for HOPM, in terms of the dimension/order of the tensor space. Then, we show that HOPM converges R-linearly for orthogonally decomposable tensors with order at least 3, and “typically” exhibits a global R-linear convergence rate for general tensors in a suitable sense.

18:30-19:00

A Geometrical Description of Feasible Singular Values in Tree Tensor Formats

Sebastian Kraemer — IGPM at RWTH Aachen

Abstract: Tree tensor networks such as the tensor train (TT) format are a common tool for high dimensional problems.The tensor feasibility problem asks which prescribed, associated tuples of singular values are realized by tensors. We show the equivalence to the quantum marginal problem and provide a decoupling into lower dimensional subproblems. Besides a large class of universal, necessary inequalities, we present a linear programming algorithm based on cones known as honeycombs to check TT-feasibility.

MS A3-2-3 7 — 17:00-19:00

Advances in Computational Poromechanics

Organizer: Markus Bause — Helmut Schmidt University Hamburg
Organizer: Radu Florin A. — University of Bergen

Abstract: The numerical simulation of coupled fluid flow and mechanical deformation in porous media is desired in several branches of technology and natural sciences for analyzing experimental data and devolping theories based on mathematical concepts. The fluid-structure interaction is subject to various complexities and spatial and temporal multiscale mechanisms. Recent progress in the development, analysis and application of robust and efficient discretization methods on all scales as well as adapted splitting and monolithic solver techniques with preconditioners is presented. Advanced models including the fully dynamic system of poroelasticity, fractured media and coupled Biot-Stokes systems are in the scope of interest.

17:00-17:30

Space-time finite element methods for dynamic poroelasticity and multirate approaches

Bause Markus — Helmut Schmidt University Hamburg
Köcher Uwe — Helmut Schmidt University Hamburg

Abstract: We study families of discontinuous and continuous space-time finite element methods for the efficient numerical simulation of Biot’s poroelasticity system. The discretizations are applied within an optimized fixed-stress iterative coupling of the subproblems of mechanical deformation and fluid flow. The schemes offer large potential for highly dynamic systems of poroelasticity and thin poroelastic layers with propagating waves. Results of their analysis and numerical investigation are presented. Their potential for multirate discretizations is outlined.

17:30-18:00

Robust preconditioners for multiphysics problems involving porous flow in physiology modeling

Miroslav Kuchta — University of Oslo
Kent Andre Mardal — University of Oslo/Simula
Karl Erik Holter — Simula

Abstract: In many applications, one wants to model physical systems consisting of two different domains governed by different laws. Modeling these systems then necessitates modeling two separate systems coupled along a lower dimensional interface. We present a framework for finding robust preconditioners for a fairly general class of such problems, and demonstrate its feasibility by finding parameter-robust preconditioners for multiphysics problems coupling any two of Stokes, Darcy or linear elasticity equations.

18:00-18:30

An efficient multigrid solver for the coupled Stokes flow and deformable porous medium system

Rodrigo Carmen — University of Zaragoza
Francisco José Gaspar — University of Zaragoza
Peiyao Luo — Delft University of Technology
Cornelis W. Oosterlee — Centrum voor Wiskunde en Informatica (CWI)

Abstract: We deal with the numerical solution of the coupled problem based on the Stokes and poroelastic equations. We propose a monolithic multigrid method for solving the linear system obtained after a finite volume discretization of the problem on staggered grids. The key in the design of the solver is based on a special discretization at or near the points in the interface, which combines the approximation of the governing equations and the considered interface conditions.

18:30-19:00

Adaptive asynchronous time-stepping, stopping criteria, and a posteriori error estimates for fixed-stress iterative schemes for coupled poromechanics problems

Elyes Ahmed	University of Bergen
Jan Martin Nordbotten	University of Bergen
Florin Adrian Radu	University of Bergen

Abstract: We develop in this paper adaptive iterative coupling schemes for the Biot-poromechanics system. Two common discretizations of the fixed-stress algorithm are introduced based on two MFE methods in-space and DG0 scheme in-time. Therefrom, adaptive algorithms are build, based on a posteriori error estimates, distinguishing the different error components. These error components are used to design adaptive asynchronous time-stepping and adaptive stopping criteria for the algorithms. Numerical experiments illustrate the performance of the adaptive algorithms.

MS A1-2-3 7 17:00-19:00

Complex Fluids at Small Scales: Fluctuating Hydrodynamics and Brownian Dynamics - Part 1

For Part 2 see: MS A1-2-3 8

Organizer: Aleksandar Donev New York University

MS Organized by: SIAG/CSE

Abstract: To model nano- and micro-fluidics devices and biological systems, we need to develop tools for hydrodynamic calculations at microscopic and mesoscopic scales. This minisymposium will focus on advances in multiscale numerical methods for simulating flows at small scales. Coarse-grained models cover a broad range of time and length scales by incrementally sacrificing physical fidelity for computational efficiency. Of particular interest will be fluctuating hydrodynamics of complex fluids such as reactive mixtures, colloidal passive and active suspensions, and multi-phase fluids. Topics include the inclusion of thermal fluctuations in computational models, as well as applications in the physical sciences, biology, and engineering.

17:00-17:30

Large Scale Brownian Dynamics of Confined Suspensions of Rigid Particles

Aleksandar Donev	New York University
Brennan Sprinkle	Courant Institute, New York University
Amneet Pal Singh Bhalla	College of Engineering, San Diego State University
Neelesh Patankar	McCormick School of Engineering, Northwestern University

Abstract: We introduce a Rigid-Body Fluctuating Immersed Boundary (RB-FIB) method to perform large-scale Brownian HydroDynamics of suspensions of arbitrarily-shaped rigid particles in fully confined domains. In this linear-scaling method, discretized fluctuating Stokes equations are solved with prescribed boundary conditions, avoiding the need to construct Green's functions or mobility operators. We model a quasi--two-dimensional colloidal crystal confined in a narrow microchannel and hydrodynamically driven across a commensurate periodic substrate potential mimicking the effect of a corrugated wall.

17:30-18:00

Fluctuating Hydrodynamics of Flow through Porous Membranes

Alejandro Garcia	San Jose State University
Daniel Ladiges	Lawrence Berkeley National Laboratory

Abstract: A fluid in a non-equilibrium steady state exhibits long-ranged correlations of its hydrodynamic fluctuations. This talk presents the effect of a transpiration interface---specifically, a dilute gas with a temperature gradient in a domain bisected by the interface. Simulations using direct simulation Monte Carlo (DSMC) and fluctuating hydrodynamics (FHD) find a suppression and distortion of the spatial correlations. For temperature fluctuations this effect is qualitatively described by a simple heat equation model.

18:00-18:30

Hydrodynamics of quartz crystal microbalance: measuring mechanical properties of DNA & liposomes

Rafael Delgado-Buscalioni	Universidad Autónoma de Madrid
Marc Schofield	Universidad Autonoma de Madrid
Adolfo Vazquez-Quesada	Universidad Autonoma de Madrid

Abstract: Quartz microbalance s a technique in experimental biophysics to sample the elastic and viscous response of analytes (proteins to cells) adsorbed to the surface of a piezo-electric resonator oscillating at dozens of megahertzs. We study the response of liposomes tethered to DNA strands using immersed boundary and coarse-grained models. Excellent agreement with experiments done within the EU project CATCH-U-DNA, whose objective is to detect atto-molar concentrations of mutant DNA in the serum of cancer patients.

18:30-19:00

Fluctuating Hydrodynamics for Electrolytes

Daniel Ladiges	
Aleksandar Donev	Courant Institute of Mathematical
Alejandro Garcia	San Jose State University
Jean-Philip Peraud	Lawrence Berkeley National Laboratory
Katherine Klymko	Lawrence Berkeley National Laboratory
Andrew Nonaka	Lawrence Berkeley National Laboratory
John Bell	Lawrence Berkeley National Lab

Abstract: Fluctuating hydrodynamics provides a mesoscale model for fluid flow that includes the effects of thermal fluctuations. Here, we present a generalization of fluctuating hydrodynamics to electrolytes. We discuss some of the properties of the resulting system and show how fluctuations naturally incorporate some of the distinguishing characteristics of electrolytes. We then introduce a numerical method for solving the fluctuating hydrodynamics equations and present numerical results illustrating the behavior of electrolytes in some canonical flows.

MS GH-3-2 7 17:00-19:00

Sedimentation, flotation, and related processes: modeling, numerics, applications, and calibration - Part 3

For Part 1 see: MS GH-3-2 5

For Part 2 see: MS GH-3-2 6

Organizer: Raimund Bürger Universidad de Concepción

Organizer: Stefan Diehl Lund University

Abstract: Mathematical models for sedimentation, flotation, and related processes such as fluidization, creaming, and centrifugal separation are important in industrial applications such as mineral processing, wastewater treatment, chemical engineering, and medicine. They are frequently formulated in terms of nonlinear convection-diffusion-reaction PDEs with non-standard properties (such as discontinuous coefficients, type degeneracy, and large system size) are as coupled flow-transport problems. It is the purpose of this minisymposium to review recent advances in the formulation of such models, their well-posedness analysis, the determination of exact and numerical solutions to direct and inverse problems, and their applications.

17:00-17:30

Kinematic-wave analysis of particle settling in tube centrifuges

Georgios Anestis	TU Wien
Markus Müllner	RWTH Aachen University

Abstract: Industries use extensively centrifuges to perform solid-liquid separation. Although several published experimental data for centrifugal settling appear to be in good agreement with predictions based on the one-dimensional flow analysis, ultimately this approximation does not account for particle settling at sidewalls. Accordingly, a theory of one-dimensional kinematic waves embedded in a two-dimensional bulk flow of the mixture is established; two limiting cases of particles behavior (gliding towards the bottom or deposited) are investigated analytically.

17:30-18:00

Numerical simulations of sedimentation in axisymmetric vessels

Julio Careaga	Lund University

Abstract: The multidimensional sedimentation of an ideal suspension in axisymmetric vessels is modeled by a coupled system of conservation equations in cylindrical coordinates. The approach presented is based on the local solids volume fraction, the volume average velocity and the excess pore pressure. The coupled system is composed by a scalar advection equation and a stationary Stokes system with non-constant viscosity. A numerical scheme based on discontinuous Galerkin method and simulations are presented.

18:00-18:30

A dynamic multilayer shallow water model for polydisperse sedimentation, Part II

Enrique D. Fernández Nieto — Universidad de Sevilla
Raimund Bürguer — Universidad de Concepción (Chile)
Victor Osores — Universidad de Concepción (Chile)

Abstract: In this work we study 3D simulations of polydisperse sedimentation with compression effects in a viscous fluid. A multilayer shallow water approach is considered with an assymptotic analysis of the model. A modification of the Masliyah-Lockett-Bassoon (MLB) settling velocities of each species is proposed. A numerical method is proposed, based on a generalization of HLL method. Finally, several numerical tests will be presented.

MS FT-2-3 7 — 17:00-19:00

Advanced numerical methods for differential equations - Part 1

For Part 2 see: MS FT-2-6 8
Organizer: Lemou Mohammed — CNRS, university of Rennes 1
Organizer: Mechthild Thalhammer — University of Innsbruck
Organizer: Chartier Philippe — Inria Rennes Bretagne Atlantique

Abstract: The intention of this minisymposium on "Advanced numerical methods for differential equations" is to bring together experts in the field, interconnected through their area of application or the numerical methods used. The scope of topics in particular includes Schrödinger equations, kinetic equations, exponential integrators, splitting methods.

17:00-17:30

Symplectic propagators for the Kepler problem with time-dependent mass

Sergio Blanes — Polytechnic University of Valencia
Philipp Bader — University Jaume I, Spain
Fernando Casas — University Jaume I, Spain
Nikita Kopylov — Norwegian University of Science and Technology (NTNU)

Abstract: We show how to obtain numerical integrators specifically designed for solving the two-body gravitational problem with a time-varying mass. These methods are obtained taking into account an appropriate time-average on the non-autonomous equation. They can be seen as a generalization of commutator-free quasi-Magnus exponential integrators and are based on the compositions of symplectic flows using the mapping that solves the autonomous problem with averaged masses at intermediate stages. Methods up to order eight are constructed.

17:30-17:57

Composition methods for the time integration of kinetic equations

Fernando Casas — Universitat Jaume I

Abstract: Splitting and composition methods have been recently used for the time integration of Vlasov equations appearing in the simulation of plasma physics problems, and in particular for the Vlasov--Maxwell equation. Taking advantage of the separation of the problem into three solvable parts, we propose new and efficient composition methods up to order four in time. In this talk we detail the construction strategy and illustrate the new schemes on some numerical examples.

18:00-18:30

New Gross-Pitaevskii type models for Bose -Einstein condensates

Norbert Mauser — WPI Vienna

Abstract: The Gross-Pitaevskii equation, a cubic Nonlinear Schrodinger equation with confinement potential, is the classical “mean field” model for (numerical simulation of) Bose Einstein Condensates (BEC). We discuss extensions of the GPE (with quartic and quintic terms), including “temperature”, quantum noise, decoherence, etc. for dipolar, rotating BEC, e.g. “stochastic GPE”, and their application to numerical modeling of recent BEC experiments. We also deal with optimal control of eGPE for self-bound dipolar droplet formation, related to “supersolids”.

MS A1-2-4 7 — 17:00-19:00

Geometric and learning-based models for 2D/3D Imaging and Applications

Organizer: Ronald Lok Ming Lui — The Chinese University of Hong Kong

Abstract: To analyze 2D/3D image data, image processing is an essential pre-processing. Conventional approaches usually rely on regularizing the image data. Recently, researches have been carried out to study how geometric information can be incorporated to enhance the mathematical models. Besides, in the era of big data, it is believed the combination of machine learning techniques to learn from data into the imaging models can further improve the results. In this minisymposium, researchers in this field will share their recent research works about geometric models and learning-based models for 2D/3D imaging and discuss their applications.

17:00-17:30

GANs, Optimal Transportation and Monge-Ampere Equation

David Xianfeng Gu — Stony Brook University

Abstract: Generative Adversarial Net is a powerful machine learning mode. The generator and the discriminator in a GAN model competes each other and reaches the Nash equilibrium. GAN generates samples, therefore reduce the requirements for large amount of training data. It also models distributions from data samples. However, GAN model lacks theoretic foundation. We give a geometric interpretation to optimal mass transportation theory, explain the relation with Monge-Ampere equation, and apply it for the GAN model.

17:30-18:00

QC Mapping and Ricci curvature

Emil Saucan — ORT Braude College

Abstract: Based on a discretization of the Bochner-Weitzenböck formula, Forman's Ricci curvature is simple and flexible in computations, thus rendering it, and its associated Ricci flow, as an adaptable tool for various applications. The most direct among such applications is to the fields of Imaging and Graphics, and we present its uses for such tasks as change detection in medical images, detection of man-made objects in aerial images and high dynamic range (HDR) imaging.

18:00-18:30

Curvature of Shape Spaces: Example of the Space of Landmarks

Sergey Kushnarev — SUTD

Abstract: In this talk I will introduce the simplest shape space, space of landmarks. I will demonstrate various examples of landmark configurations and the corresponding sectional curvatures. Numerical implementation of the curvature computation will be discussed. Then I will discuss the impact of the curvature on the statistical inference on landmark manifolds.

18:30-19:00

Conforming v.s. Non-conforming methods for solving geometric variational problems

Thomas P. Yu — Drexel University

Abstract: We compare two classes of numerical methods for geometric variational problems (e.g. Willmore, Canham-Helfrich-Evans, Hawking mass) based on piecewise linear (PL) and subdivision surfaces (SS) . We show that a non-conforming method based on any of the available curvature operators for PL surfaces (e.g. the `cotangent formula' for mean-curvature) fails to gamma-converge for the Willmore problem, whereas a conforming method based on SS succeeds. We discuss the consequences of these results.

MS ME-1-2 7 — 17:00-19:00

Recent Advances in Applied Integrable Systems: Theory and Computations - Part 1

For Part 2 see: MS ME-1-2 8
For Part 3 see: MS ME-1-2 9
For Part 4 see: MS ME-1-2 10
Organizer: Kenichi Maruno — Waseda University
Organizer: Anton Dzhamay — University of Northern Colorado

Abstract: Recent advances in the applications of integrable systems extend to a wide range of mathematics and physical sciences, such as random matrices, cluster algebra and combinatorics, probability theory, numerical computations, cellular automata, tropical geometry and ultra-discrete systems, differential geometry, computer visualizations, nonlinear physics, and many others. The purpose of this mini-symposium is to bring together active researchers from across the world to discuss recent developments in various aspects of applied integrable systems.

17:00-17:30

Discrete Painlevé Equations in Tiling Problems

Anton Dzhamay — University of Northern Colorado

Alisa Knizel Columbia University

Abstract: The role of discrete Painlevé equations for applications has recently been steadily growing. However, to effectively use the these equations often requires finding a highly non-trivial change of coordinates from the application coordinates to the Painlevé coordinates. In this talk we illustrate the techniques of doing so using Sakai's geometric theory of Painlevé equations. The application we consider is related to computing gap probabilities for lozenge tilings of a hexagon with generalized q-Racah weights.

17:30-18:00

Mutation combinatrics in Cluster algebras and q-Painleve equations

Teruhisa Tsuda Hitotsubashi University
Tetsu Masuda Aoyama gakuin university
Naoto Okubo Aoyama gakuin university

Abstract: Cluster algebra is an algebraic structure generated by operations of a quiver called the mutations and their associated simple birational mappings. We introduce a systematic derivation of tropical, i.e., subtraction-free birational, representation of Weyl groups. Our result is related with a class of tropical representation of Weyl groups acting on certain rational varieties and also (higher-order) q-Painleve equations. Key ingredients of the argument are the combinatorial aspects of reflections associated with n-cycles in the quiver.

18:00-18:30

Algebro-geometric solutions to Schlesinger and Painlevé VI equations

Vladimir Dragovic The University of Texas at Dallas

Abstract: New methods of construction of algebro-geometric solutions of Schlesinger systems and related Painleve VI equations are presented. They are based on study of differentials on elliptic, hyperelliptic and superelliptic curves. The research has been partially supported by the NSF grant 1444147. This presentation is based on joint works with Vasilisa Shramchenko and a joint work with Renat Gontsov and Vasilisa Shramchenko.

18:30-19:00

Noncommutative Painlevé equations of Calogero Type

Marco Bertola Concordia University and SISSA
Mattia Cafasso University of Angers
Volodya Rubtsov University of Angers

Abstract: The Calogero-Moser-Sutherland system is an autonomous integrable Hamiltonian system of particles on the line with inverse square potential. The non-interacting part is a classically integrable Hamiltonian (e.g. the harmonic oscillator). The goal of the talk is to explain how the integrability survives if we replace the single-particle Hamiltonian by any of the Hamiltonian for the six Painleve equation thus solving a conjecture posed by Takasaki in 2010. Joint work with M. Cafasso and V. Rubtsov.

MS ME-0-8 7 **17:00-19:00**

Singular Limits in Fluid Dynamics, Related Equations, and Numerical Analysis - Part 4

For Part 1 see: MS ME-0-8 4
For Part 2 see: MS ME-0-8 5
For Part 3 see: MS ME-0-8 6
Organizer: Steve Schochet Tel Aviv University
Organizer: Bin Cheng University of Surrey
Organizer: Qiangchang Ju IAPCM

Abstract: Many areas of physics are described by two models, one derived from basic laws and the second simplified using additional assumptions. Prominent pairs include compressible and incompressible fluid or magneto-hydrodynamic models, kinetic and fluid models, and many-body systems and mean-field theories. Clarifying relationships between models increases understanding of corresponding physical systems and guides development of improved numerical methods. This minisymposium examines current techniques for justifying simplified models via singular limits, quantifying the difference between solutions to related models, and simulating them numerically. Techniques to be discussed include classical, relative, and discrete energy and entropy estimates, and averaging methods.

17:00-17:30

On the numerical approximation of time-scale separated PDEs

Beth Wingate University of Exeter

Abstract: I will discuss the role of time-scale separation and nonlinear resonance in the numerical approximation of PDEs with oscillatory stiffness.I will introduce an integrator where we have used a strategy of rotating the PDEs into the solution space of the wave motion and how that leads to a 'modulated PDE'. I will discuss some of the issues important in proving convergence of a time-parallel (parareal) integrator for finite time scale separations.

17:30-18:00

Asymptotic preserving schemes for singular limits in compressible fluids

Maria Lukacova University of Mainz

Abstract: We present IMEX finite volume schemes for the Euler equations to approximate singular limits of weakly compressible flows. To resolve efficiently slow dynamics we split the system in a stiff linear part for the acoustic and a non-stiff nonlinear part for the nonlinear advection. We prove that the methods are asymptotically consistent and stable uniformly w.r.t. Mach number. We also report on uniform error analysis for the isentropic Navier-Stokes equations using a relative entropy functional.

18:00-18:30

Singular limits and error estimates for inviscid fluid dynamics in domains of non-trivial geometry

Bin Cheng University of Surrey

Abstract: For PDEs modelling inviscid fluid dynamics in physical domains, boundary conditions and/or non-flat geometry impose challeges that are further complicated in the singular limit problems. Recent progress has been made on not only uniform-in-parameter energy estimates and convergence to the limits, but also on convergence rates, namely error estimates between solutions to the original and to the limiting problems. All domains are compact and fast waves don't vanish when the separation of scales widens.

18:30-19:00

Singular limits of the compressible MHD system

Fucai Li Nanjing University

Abstract: In this talk we shall discuss two kinds of singular limits to the isentropic compressible viscous magnetohydrodynamic equations in a bounded domain Ω⊂R3. One is the incompressible limit, and the other is the inviscid limit. In the first case, the initial data are assumed to be ``ill-prepared``. In the other case, the initial data are assumed to be ``well-prepared. In both two cases, we obtain the convergence results. Some related results are also reviewed.

MS A6-2-2 7 **17:00-19:00**

Eigenvalue problems: perturbation and structure preservation - Part 1

For Part 2 see: MS A6-2-2 8
Organizer: Julio Moro Universidad Carlos III de Madrid
Organizer: Christian Mehl TU Berlin

Abstract: Structure-preserving eigenvalue algorithms are a common tool in numerical practice, since they often speed up computations, are potentially more accurate, and usually produce computed quantities reflecting more intrinsically the specific properties of the underlying matrix structure. Analyzing such algorithms requires a corresponding perturbation theory, describing the behavior of eigenvalues under structure-preserving perturbations. Sometimes such a theory is tricky to derive, due to classical perturbation theory clashing with the specific spectral properties of the structure under examination. The goal of this minisymposium is to report recent developments on both structure preservation and perturbation theory, either separately, or interacting with each other.

17:00-17:30

Structured perturbation of eigenvalues of symplectic and Hamiltonian matrices

Julio Moro Universidad Carlos III de Madrid
Fredy Sosa Universidad Carlos III de Madrid
Christian Mehl Technische Universität Berlin

Abstract: For certain matrix structures, perturbations which preserve that structure modify eigenvalues very differently from how arbitrary perturbations do. Two such families of matrices are symplectic and Hamiltonian ones. In this talk a detailed first-order structured perturbation analysis is presented for both classes. One of the main features of the analysis is framing symplectic perturbations in a multiplicative, instead of additive, way. Expansions for Hamiltonian perturbations are then derived from symplectic ones via the Cayley transform.

17:30-18:00

On rank one perturbations of structured matrices

André Ran | Vrije Universiteit Amsterdam

Abstract: Let be a nonnegative matrix, let and be in , and let denote the spectral radius of . Let with . For small all eigenvalues of are in the open right half plane , but this does not necessarily hold for all . It was conjectured that for large enough values of the eigenvalues are in . It will be shown that this conjecture is false.

18:00-18:30

Perturbations of DAEs and Chip Design

Carsten Trunk | Technische Universität Ilmenau

Abstract: Electrical circuits are often described via differential algebraic equations (DAEs), $(Es - A)x = b$, $s \in C$, where A and E are $n \times n$-matrices and E is singular. It is the aim to increase the bandwith, i.e. to change the behaviour of the modulus of the transfer function along the imaginary axis by adding additional capacities to the electrical circuit. Adding a capacity corresponds to a rank one perturbation of the matrix E.

18:30-19:00

Change of the spectral structure of (singular) matrix pencils under finite dimensional perturbations

Francisco Martínez Pería | Universidad Nacional de La Plata
Leslie Leben | TU Ilmenau
Friedrich Philipp | KU Eichstätt-Ingolstadt
Carsten Trunk | TU Ilmenau
Henrik Winkler | TU Ilmenau

Abstract: We elaborate on the deviation of the Jordan structures of two linear relations that are finite-dimensional perturbations of each other. Then, after representing matrix pencils via linear relations, we apply our results to one-dimensional perturbations of singular and regular matrix pencils. This technique allows for both proving known results for regular pencils as well as new results for singular ones.

MS ME-1-5 7 **17:00-19:00**

Recent developments in the analysis of nonlocal operators - Part 2

For Part 1 see: MS ME-1-5 5
Organizer: Donatella Danielli | Purdue University
Organizer: Nicola Garofalo | University of Padova

Abstract: In recent years there has been a resurgence of interest for non-local operators, largely motivated by applications. For instance, fully nonlinear integro-differential equations naturally arise in the study of problems in stochastic control. In turn, the study of non-local operators has led to the development of a wide range of new mathematical tools and methods. Our session's aim is to bring together mathematicians at different stages of their career to present the state of the art on the subject. We also hope to stimulate interaction on the latest developments of analytic, geometric, and probabilistic properties of problems involving nonlocal operators.

17:00-17:30

Almost minimizers for the thin obstacle problem

Arshak Petrosyan | Purdue University
Seongmin Jeon | Purdue University

Abstract: We consider almost minimizers for the thin obstacle problem with zero thin obstacle and establish their regularity on up to the thin manifold, the optimal growth away from the free boundary, and the regularity of the regular part of the free boundary. The analysis of the free boundary is based on a successful adaptation of energy methods such as a one-parameter family of Weiss-type monotonicity formulas, Almgren-type frequency formula, and the epiperimetric inequality.

17:30-18:00

The obstacle problem for the fractional heat equation: properties of the free boundary

Donatella Danielli | Purdue University
Agnid Banerjee | TIFR
Nicola Garofalo | University of Padova
Arshak Petrosyan | Purdue University

Abstract: In this talk we will discuss the structure of the free boundary in the obstacle problem for fractional powers of the heat operator. Our results are derived from the study of a lower-dimensional obstacle problem for a class of local, but degenerate, parabolic operators. Its analysis, in turn, hinges on the monotone character of functionals of Almgren, Weiss, and Monneau type, and the properties of the associated blow-ups.

18:00-18:30

On the logarithmic epiperimetric ineguality

Bozhidar Velichkov | Università degli Studi di Napoli Federico II

Abstract: In this talk we present some recent advances on the regularity of the free boundaries arising in variational minimization problems. We will present a new variational approach, based on the so-called logarithmic epiperimetric inequality, which is a powerful tool for the analysis of the singularities. This talk will be dedicated to the structure of the singular sets of the thin-obstacle free boundaries.

18:30-19:00

Hölder regularity of solutions to a class of nonlocal Dirichlet problems

Alessandro Audrito | Politecnico di Torino

Abstract: The study of the optimal Hölder regularity of solutions to local elliptic problems is a classical topic in PDEs. In this talk I will present some recent results concerning the regularity "up to the boundary" of solutions to a class of nonlocal Dirichlet problems with nontrivial boundary data and non-smooth domains, trying to highlight the main differences with the corresponding theory in the local framework. This is a joint work with Xavier Ros-Oton (UZH).

MS A3-2-1 7 **17:00-19:00**

Lagrangian and Eulerian methods for compressible multi-material flows - Part 3

For Part 1 see: MS A3-2-1 5
For Part 2 see: MS A3-2-1 6
Organizer: Michael Dumbser | University of Trento
Organizer: Raphael Loubère | University of Bordeaux
Organizer: Mikhail Shashkov | Los Alamos National Laboratory

Abstract: This minisymposium brings together researchers from universities and governmental research laboratories to discuss recent advances in the mathematical modeling and the numerical simulation of complex compressible multi-material hydrodynamics as well as nonlinear, irreversible large deformation solid mechanics. Multi-material problems are relevant in many industrial applications (e.g. fuel injection), in geophysics (debris flow) and nuclear physics (inertial confinement fusion), to mention a few. Topics include Lagrangian hydrodynamics, large-strain nonlinear elasto-plasticity, Arbitrary Lagrangian Eulerian (ALE) methods, Eulerian diffuse interface methods, mesh generation methods and mesh adaptation, interface reconstruction methods, data transfer between meshes and conservative remapping, structure preserving schemes and high-order methods.

17:00-17:30

New sufficient criterion of hyperbolicity in hyperelasticity

Sergey Gavrilyuk | CNRS - IUSTI - AMU
Nicolas Favrie | Aix-Marseille University, France
Serge Ndanou | LANL, USA

Abstract: We study hyperelastic isotropic solids in a special case where the specific stored energy is a sum of two functions. The first one depends only on the solid density and entropy, and the second one depends on the invariants of the Finger tensor in such a way that it is unaffected by the volume change. A new sufficient criterion of hyperbolicity for such a system is formulated.

17:30-18:00

Direct ALE Finite Volume and Discontinuous Galerkin schemes of arbitrary high order on Voronoi moving meshes

Elena Gaburro | University of Trento, ITALY
Michael Dumbser | University of Trento, Italy
Walter Boscheri | University of Ferrara, Italy
Simone Chiocchetti | University of Trento, Italy
Christian Klingenberg | University of Trento, Italy

Abstract: Moving Voronoi meshes that, at each time step, are regenerated and are even free to change their topology allow to follow the fluid flow, to reduce the errors due to advection, and at the same time, to maintain an exceptional high quality of the moving domain discretization. In this talk we present the first direct Arbitrary-Lagrangian-Eulerian (ALE) scheme able to deal with regenerating meshes with arbitrary high order of accuracy in space and in time.

18:00-18:30

A low-Mach correction for multi-dimensional finite volume shock capturing schemes with applications in Lagrangian frame

Labourasse Emmanuel | cea

Abstract: In this talk, we show why classical cell-centered Lagrangian schemes are not able to capture the low-Mach regime except by using unreasonably fine meshes. Consequently, we propose a modification of the original scheme, easy to implement in any scheme using an acoustic Godunov solver on unstructured mesh, and with a negligible cost in term of CPU time. The properties of the original semi-discrete scheme are preserved. Particular attention is paid to the entropy condition.

18:30-19:00

Towards very high-order approximation of gas dynamics in semi-Lagrangian coordinates

Stéphane Del Pino CEA,DAM,DIF
Hoch Philippe CEA,DAM,DIF
Labourasse Emmanuel CEA,DAM,DIF

Abstract: Multidimensional finite-volume schemes have led to great improvements to simulate compressible flows in semi-Lagrangian coordinates. However in dimensions 2 and 3, it remains difficult to extend their precision to higher order than 2: geometric conservation law must be discretized to higher order which means in the general case that a polygonal cell will not remain polygonal for higher order. We present a method to achieve very-high order based on a variationnal formulation to compute fluxes.

MS FT-S-1 7 17:00-19:00

New approaches in finite element method

Organizer: Eunjung Lee Yonsei University

Abstract: Finite element method has played an important role in the industrial mathematics and scientific computing for a long time. With that it has been evolved a lot. In this minisymposium, we present several novel finite element approaches which are developed last few years and has attracted attention. It includes a development of new finite elements, domain decomposition preconditioning with multiscale finite elements, a novel approach using staggered discontinuous Galerkin method and proposition of a general finite element setup for nonlinear lower order partial differential equations.

17:00-17:30

A simple treatment of nonnestedness of finite element spaces

Jun Hu Peking Universtiy

Abstract: We present a universal way to partially relax nonnested conforming methods for partial differential equations. We apply it to Argyris element of fourth order problems and mixed finite elements of elasticity equations, which results in conforming nested methods. We design adaptive and V-cycle multigrid algorithms for these extended methods and prove their convergence and optimality. Finally we provide some numerical examples to illustrate the theoretical results.

17:30-18:00

Domain decomposition preconditioners utilizing multiscale finite element functions

Hyea Hyun Kim Kyung Hee University
Junxian Wang Xiangtan University
Eric Chung CUHK

Abstract: Energy minimizing multiscale finite element functions with constraints are recently introduced and they are shown to have some good orthogonal properties and exponential decay. In this work, we will utilize them for building the coarse component in a two-level overlapping Schwarz domain decomposition method. The proposed domain decomposition method is shown to be robust to coefficient variations and the overlapping width in the subdomain partition. Numerical results are also included.

18:00-18:30

Staggered discontinuous Galerkin methods for elastic wave simulations

Eric Tsz Shun Chung The Chinese University of Hong Kong

Abstract: We present a new staggered hybridization technique for discontinuous Galerkin methods to discretize linear elastodynamic equations. The idea of hybridization is used extensively in many discontinuous Galerkin methods, but the idea of staggered hybridization is new. Our approach offers several advantages, namely energy conservation, high-order optimal convergence, preservation of symmetry for stress tensor, block diagonal mass matrices and low dispersion error. This research is partially supported by Hong Kong RGC General Research Fund (Project 14302018).

18:30-19:00

LL* for hyperbolic conservation law

Keunung Park Yonsei University

Abstract: We propose a finite element method for nonlinear hyperbolic conservation laws using LL* method previously suggested in elliptic equations. The LL* method allows the discontinuities in approximation which arise often in solutions of PDEs that follow hyperbolic conservation laws. The inexact Newton iteration is utilized to handle the nonlinearity and LL* method was used to solve the linearized system.

MS FT-S-5 7 17:00-19:00

Distance Metrics and Mass Transfer Between High Dimensional Point Clouds - Part 3

For Part 1 see: MS FT-S-5 5
For Part 2 see: MS FT-S-5 6
Organizer: Naoki Saito University of California, Davis
Organizer: Alexander Cloninger University of California San Diego

Abstract: Measuring distance between probability distributions plays a fundamental role in statistics, imaging, PDEs, and machine learning, and has inspired a variety of algorithmic approaches, including Kullback-Leibler divergence, maximum mean discrepancy, and Wasserstein distance, along with various approximations. In practice, however, efficiently computing such distances leads to a series of important mathematical questions, especially when the distributions are in high-dimensional space, or can only be accessed through finite samples taken from each distribution. In this minisymposium, we shall showcase a variety of approaches to developing theory, computation, and applications of such metrics, as well as promote closer interactions among different communities.

17:00-17:30

Local differences between distributions and distance measures

Alexander Cloninger University of California, San Diego
Hrushikesh Mhaskar Claremont Graduate University
Srinjoy Das University of California San Diego

Abstract: A common issue in determining distances between distributions is identifying the region in which the distributions deviate. A common approach is to use the witness function that arises in a maximum mean discrepancy problem. We derive statistical properties of the witness function, and an algorithm for determining when the deviation is significant. We also use the witness function to derive a distance measure between distributions that is more robust to missing values and spurious data.

17:30-18:00

Multiscale methods for Learning maps and Optimal Tranportation plans

Mauro Maggioni Johns Hopkins University
Sam Gerber
Paul Escande

Abstract: I discuss a multiscale approach to compute approximate optimal transportation plans for discrete point clouds, in the regime of large data sets, in high ambient dimension, but low intrinsic dimension. Then I introduce a novel way of approximating and learning maps as multiscale compositions of simple maps, well-suited for learning maps between sampled low-dimensional manifolds in high dimensions, and learning continuous optimal transportation plans from a finite number of correspondences.

18:00-18:30

Learning Embeddings into Entropic Wasserstein Spaces

Charlie Frogner MIT
Farzaneh Mirzazadeh IBM
Justin Solomon MIT

Abstract: We propose to learn an embedding that captures semantic information in the Wasserstein distance between embedded distributions. Wasserstein spaces can embed a wider variety of metric structures than Euclidean spaces. We show empirically that learned Wasserstein embeddings replicate a variety of metrics with smaller distortion than an equivalent Euclidean embedding. We also demonstrate a unique advantage: we can directly visualize the high-dimensional embedding, as it is a probability distribution on a low-dimensional space.

18:30-19:00

Learning to Generate Shapes with Geometric Deep Learning

Giorgos Bouritsas Imperial College London

Abstract: The success of deep learning in computer vision, speech recognition and natural language processing, has driven the recent interest in developing similar models for 3D geometric data. The purpose of this talk is to outline the current state-of-the-art learning techniques, widely known as Geometric Deep Learning, for data with irregular, non-Euclidean structure (e.g. meshes, point clouds and graphs), with a special focus on the case of Deep Generative Models for shape synthesis.

MS ME-0-7 7 17:00-19:00

Control and Inverse problems in PDE. Theory and applications - Part 1

For Part 2 see: MS ME-0-7 8
For Part 3 see: MS ME-0-7 9
For Part 4 see: MS ME-0-7 10

Organizer: Carlos Castro — UNIVERSIDAD POLITÉCNICA DE MADRID
Organizer: Cristóbal Meroño — Universidad Politécnica de Madrid
Organizer: Fabricio Macia — Universidad Politécnica de Madrid
Organizer: Juan Antonio Barceló — Universidad Politécnica de Madrid

Abstract: The aim of this minisymposium is to present new results in the areas of controllability and inverse problems for systems governed by partial differential equations. Bringing together both topics in a single minisymposium provides an opportunity to contrast the most recent results and techniques and estimulate collaborations between researchers coming from these areas.

17:00-17:30

Optimal design for nonlocal solid mechanics models

José Carlos Bellido — Universidad de Castilla-La Mancha

Abstract: We present a mathematical model of optimal design which is built upon a nonlocal description of continuum mechanics. We show well-posedness of the optimal design problem in situations in the classical local case analog is ill-posed, and show convergence to the local problem as the nonlocality horizon tends to zero.

17:30-18:00

A first step towards mathematical control in soft robotics

Francisco Periago — Universidad Politécnica de Cartagena
Jesús Martínez-Frutos — Universidad Politécnica de Cartagena
Rogelio Ortigosa — Universidad Politécnica de Cartagena
Pablo Pedregal — Universidad de Castilla-La Mancha

Abstract: Hyperelasticity is the appropriate mathematical theory to model the dynamics of soft robots. In this work, we state and solve two specific optimal control problems in hyperelasticity. We prove existence of optimal solutions both in a deterministic and in a discrete framework for uncertainty in material properties. We also report on some fine numerical simulations.

18:00-18:30

Control of Stochastic Dynamical Systems under uncertainty in the parameters

Pablo Angulo — Universidad Politécnica de Madrid
Carlos García-Gutiérrez — Universidad Politécnica de Madrid

Abstract: We consider some problems of optimal control with discrete time where some parameters are fixed but unknown. We translate the problem into one of stochastic control in the belief state, and compare some approximations to the solution. As we observe the system evolution, our uncertainty over the unknown parameters is updated. We show applications in which it is necessary to make trade-offs between risk, return and learning. We evaluate the impact of prior information.

18:30-19:00

Scattering with critically-singular and delta-shell potentials

Pedro Caro — BCAM - Basque Center for Applied Mathematics
Andoni García — BCAM - Basque Center for Applied Mathematics

Abstract: In this talk I will present some recent results on point-source scattering theory in the presence of potentials that are combinations of compactly supported functions with local singularities in the critical Lebesgue space and measures supported on compact hypersurfaces. To study the forward and inverse problems, we will introduce some new spaces adapted to the resolvent operator and show how the classical Agmon--Hörmander/Kenig--Ponce--Vega and Kenig--Ruiz--Sogge estimates fit in this framework.

MS A6-5-2 7 17:00-19:00

Modeling and Simulation in Medicine and Biology - Part 2

For Part 1 see: MS A6-5-2 6

Organizer: Jose Ferreira — UNIVERSITY OF COIMBRA
Organizer: Giuseppe Romanazzi — State University of Campinas (UNICAMP)

Abstract: It is nowadays accepted that mathematical models are powerful tools that can provide insight into life sciences. In fact, they contribute to the understanding of chemical and physical mechanisms and their interactions in Medicine and Biology. In this mini-symposium, we aim to provide a forum for presenting new results on mathematical models and numerical methods for partial differential equations in Medicine and Biology. Particular attention will be given to drug delivery, their applications to cancer and cardiovascular diseases. Applications to other biological phenomena will be also addressed.

17:00-17:30

Numerical modelling of crypt fission and viscoelastic deformation in the colon epithelium

Giuseppe Romanazzi — Universidade Estadual de Campinas
Giuseppina Settanni — University of Bari
Isabel Figueiredo — University of Coimbra
Carlos Leal — University of Coimbra

Abstract: We present a biomechanical differential model that simulates the colon crypt fission process and the crypt deformation when a disruption of healthy cell mechanism is active. The model couples the crypt cell dynamics with the mechanical viscoelastic properties of the colon epithelium. Its numerical implementation is based on a finite element method on moving meshes. Numerical simulations shows how changing the cell proliferation mechanism, lead to different colonic pit patterns and to the crypt fission.

17:30-18:00

Modelling and Numerical Analysis of Cancer Cell Dynamics in the Colon

Geovan Carlos Mendonça Campos — Universidade Estadual de Campinas
José Augusto Ferreira — University of Coimbra
Giuseppe Romanazzi — State University of Campinas

Abstract: We present a model for the firsts stages of the formation of colorectal cancer. It's a coupled PDE system formed by elliptic and parabolic equations whose unknowns are the proliferative cell density and the exerted cell pressure. We introduce a new stable and convergent finite difference method that solves this coupled PDE problem, that despite to be centered in space, it is proved theoretically and numerically to be second order in a discrete norm.

18:00-18:30

Modeling colorectal cancer

Giuseppina Giuseppina Settanni — Università degli Studi di Bari
Anotida Madzvamuse — Department of Mathematics, University of Sussex

Abstract: Cellular mechanisms and environment are responsible of cancer budding and growth. The aim of this talk is to present a mathematical model describing the evolution of colorectal cancer. The model is numerically solved by applying methods using finite difference schemes. Some numerical simulations will be shown in order to understand these mechanisms. This work was supported by the plan 'Future in Research' of Regione Puglia and Gruppo Nazionale per il Calcolo Scientico (GNCS-INdAM).

18:30-19:00

A mathematical model of circadian rhythms

Aderito Araujo — UNIVERSITY OF COIMBRA

Abstract: Chemical oscillators have characteristics transcend the properties of individual molecules or those interacting with each other through chemical reactions. These properties can only be fully understood from the perspective of quantitative mathematical modelling of chemical oscillatory processes. We will present a mathematical model to simulate the core loop of a plant circadian clock. Starting from the simple positive-negative feedback model, we aim to build a comprehensive model that encompasses the key features of system.

MS A6-4-2 7 **17:00-19:00**

State estimation, prediction, and uncertainty quantification in geophysics - Part 2

For Part 1 see: MS A6-4-2 6

Organizer: Mustafa Mohamad — Courant Institute, New York University

Organizer: Di Qi — New York University

MS Organized by: SIAG/CSE

Abstract: The uncertainty quantification of complex nonlinear systems in geophysics and climate is amongst the most challenging problems in applied math. This minisymposium will highlight recent work aimed at understanding various aspects of turbulent complex system including their control, state estimation, prediction, and model error to applications related to problems in geophysics and meteorology. Various methods and techniques have been applied to understand such systems, including statistical approaches, stochastic modelling, information theory, and dynamical systems theory. We highlight various important approaches, by bringing together experts with diverse backgrounds to highlight recent advances.

17:00-17:30

Fitness of the ensemble approach to observation impact assessment for ensemble-var filtering

Kayo Ide — University of Maryland, College Park

Abstract: In ensemble-var data assimilation, ensemble is used in the two ways. One is to provide the dynamically-estimated prior (background) error covariance information for the analysis process. The other is to propagate the posterior (analysis) uncertainty information during the model forecast. We propose a practical procedure to evaluate the fitness of the ensemble approach in place for the approximation to the tangent linear and adjoint model.

17:30-18:00

A large deviation method for the quantification of extreme surface gravity waves

Giovanni Dematteis — Università degli Studi di Torino

Abstract: We interpret the formation of rogue waves using tools from large deviation theory and optimal control. We compute the instantons of the problem, the most likely realizations leading to extreme surface elevations via the governing nonlinear dynamics. Strikingly, the larger waves follow the instanton evolution, with small extra fluctuations. Our results are validated by Montecarlo and by real data in a wave flume accross different forcing regimes, generalizing the limiting linear and highly-nonlinear theories.

MS ME-0-2 7 **17:00-19:00**

Non-local equations for diffusion and aggregation - Part 2

For Part 1 see: MS ME-0-2 6

For Part 3 see: MS ME-0-2 8

Organizer: Alexis Molino — University of Granada

Organizer: José A. Cañizo — Universidad de Granada

Abstract: Nonlocal Partial Differential Equations arise often in physical models, as a result of potential interactions between particles, or as a result of scattering or long-range interactions. They also arise in biological models and in population dynamics, and play a central role in kinetic theory. This session will focus on their mathematical theory, which is seeing important recent advances regarding existence and uniqueness results for solutions, and a good understanding of their asymptotic behavior. Diffusion and aggregation processes are central examples of this.

17:00-17:30

Coupling local and non-local diffusion problems

Julio Daniel Rossi — Universidad de Buenos Aires

Abstract: We prove existence and uniqueness for evolution equations that combine local and nonlocal diffusion operators acting in different subdomains and coupled in such a way that the equation is the gradient flow of an energy functional. We prove that the model preserves the total mass and study the asymptotic behaviour for large times. Finally, we can recover the usual heat equation in a limit procedure when eescaling the nonlocal kernel in a suitable way.

17:30-18:00

Large-time behaviour for solutions of the heat equation with fractional time derivative

Fernando Quirós — Universidad Autónoma de Madrid

Carmen Cortázar — Pontificia Universidad Católica de Chile

Noemí Wolanski — Universidad de Buenos Aires

Abstract: We study the large-time behaviour of bounded solutions to a heat equation with a fractional time derivative of Caputo type. This behaviour is given on compact sets by the newtonian potential of the initial datum, by a multiple of the fundamental solution of the equation in intermediate regions, and by the initial datum very far away. The main difficulty stems from the fact that the fundamental solution is singular in dimensions greater than one.

18:00-18:30

Some new results on minimisers of aggregation-diffusion equations

José A. Cañizo — Universidad de Granada

Abstract: We will discuss a recent proof of existence and boundedness of minimisers of the energy for aggregation-diffusion equations which generalises some of the results in the literature, always in the case of nonlinear diffusion of porous media-type.

MS A3-3-1 7 **17:00-19:00**

Collaborative Mathematics - Part 2

For Part 1 see: MS A3-3-1 6

Organizer: Timothy Gerard Myers — CRM- Centre de Recerca Matematica

Abstract: In recent years the Centre de Recerca Matemàtica (CRM) has received PhD and Post-doctoral funding from La Caixa bank to carry out research in collaboration with other disciplines. The projects have been supervised jointly by members of CRM and researchers from biology, physics, nanoscience and also local research centres. This has led to a broad range of research lines where, due to the influence of the non-mathematical partners, the focus has been firmly on practical problems. In this mini-symposium we present a selection of this topics, with the unifying theme being the collaboration between researchers from mathematics and another discipline.

17:00-17:30

Strategies to bifurcate tumours towards extinction

Josep Sardanyes — Centre de Recerca Matematica

Regina Martínez — Universitat Autònoma de Barcelona

Carles Simó — Universitat de Barcelona

Ricard Solé — Universitat Pompeu Fabra

Abstract: The dynamics of heterogeneous tumor cell populations competing with healthy cells is analysed with a mathematical model of unstable tumor progression using the quasispecies framework. We identify a novel type of bifurcation causing an abrupt transition to tumor extinction: the trans-heteroclinic bifurcation characterized by the exchange of stability between two distant fixed points (that do not collide) involving tumor persistence and tumor clearance. These results are discussed in the context of targeted cancer therapies.

17:30-18:00

Mathematical Modelling of Angiogenesis

Daria Stepanova — Centre de Recerca Matematica

Abstract: Angiogenic sprouting is a complex process in which endothelial cells migrate from a pre-existing vascular bed guided by local environment cues and interaction with other cells. In this work we intend to find necessary ingredients for creating a framework for reproducing angiogenic network formation. In particular, our multi-scale mathematical model takes into account intracellular cell signalling pathways, intercellular communication, extracellular matrix remodelling and reorganization.

18:00-18:30

Statistical analysis in complex systems

Isabel Serra Mochales — CRM - CENTRE DE RECERCA MATEMATICA

Álvaro Corral — Centre de Recerca Matemàtica

Abstract: From the statistical point of view, the analysis of the data generated by complex systems is a challenge. Most methodologies for analyzing data sets are based on describing (discovering, predicting, understanding, etc.) the habitual behavior (the most common pattern, the expected value, etc.). Specific methodologies should be applied to analyze complex systems. The lack of finite moments and the need to understand the deterministic pattern are the main causes.

18:30-19:00

Universality of power-law exponents by means of maximum likelihood estimation

Victor Navas-Portella López CENTRE DE RECERCA MATEMÀTICA

Álvaro Corral Centre de Recerca Matemàtica

Eduard Vives Universitat de Barcelona

Abstract: Power-law–type probability density functions spanning several orders of magnitude are found for different avalanche properties and represent a hallmark of scale invariance. However, experiments only report a limited range of events, making it difficult to measure the exponents accurately. We propose a methodology to try to beat this limitations by combining different datasets with rigorous statistical tools with the aim of finding a broader fitting range.

MS FT-0-3 7 **17:00-19:00**

Numerical methods for electromagnetic problems and high perfomance computing - Part 3

For Part 1 see: MS FT-0-3 1

For Part 2 see: MS FT-0-3 2

Organizer: Liwei Xu University of Electronic Science and Technology of China

Organizer: Tao Cui AMSS, the Chinese Academy of Sciences

Organizer: Xue Jiang Beijing University of Posts and Telecommunications

Organizer: Chunxiong Zheng Tsinghua University

Abstract: The proposed minisymposium, titled by "numerical methods for electromagnetic problems and high performance computing", seeks to bring together researchers from the computational mathematics, the electromagnetic engineering and computer scientist, who investigate the mathematical modeling, the numerical analysis, and the efficient computation for electromagnetic problems. The main topics of this minisymposium will include, but not exclusively, novel numerical methods, fast solvers and their applications to large-scale engineering problems. The goal of this minisymposium is to promote new ideas and exchange recent developments on mathematical modeling, numerical discretization, solvers, parallel computing and engineering practices of computational electromagnetism, and to create new collaboration.

17:00-17:30

A finite difference method with optimized dispersion correction for the Helmholtz equation

Xueshuang Xiang Qian Xuesen Laboratory of Space Technology

Pierre-Henri Cocquet Universit\'e de la R\'eunion

M. J. Gander Universit\'e de Gen\`eve

Abstract: We develop a new dispersion minimizing FDM for the 2D Helmholtz equation using as a new idea a modified wave number. Compared with the finite difference scheme which minimizes already the numerical dispersion, our new scheme using the same stencil, but a modified wave number, has substantially less dispersion error and thus much more accurate phase speed, which is important for effective coarse grid corrections in domain decomposition and for constructing efficient multigrid solvers.

17:30-18:00

An Efficient Adaptive Algorithm for High-Performance Electromagnetic and Multi-Physics Simulatio

Weijie Wang Beijing Institute of Applied Physics and Computational Mathematics

Haijing Zhou Institute of Applied Physics and Computational Mathematics

Abstract: We present a high-performance program for parallel simulation of electromagnetic and multi-physics problems. This program is intended to perform large-scale simulation of antenna array, integrated circuit and system in package using finite element method. An efficient adaptive algorithm for high-performance numerical simulations is implemented based on domain decomposition method and multilevel method. A brief introduction of the algorithm is given and several numerical examples are presented to demonstrate its capability inhigh-performance computing.

18:00-18:30

Inexact Parallel Subspace Correction Method for Several PDE Problems

Qian Dong Institute of Software, Chinese Academy of Sciences

Abstract: In this talk, we considered two points about the parallel subspace correction method (PSC) for the strongly smooth optimization problem, which are the inexact subproblem solution and the step size strategy. On one hand, we proved the the convergence for PSC with certain inexact subproblem solution. On the other hand, we proposed a two-stage step size strategy which can guarantee convergence. The numerical experiments showed the efficiency and suplinear speedup for PDE computation.

18:30-19:00

JAUMIN: A parallel Programming framework on unstructured mesh and its applications in Electromagnetic computing

Qingkai Liu Beijing Institute of Applied Physics and Computational Mathematics

Abstract: Domain-specific programming frameworks are usually effective to simplify the development of large-scale applications on supercomputers. This paper introduces a programming framework named JAUMIN for large-scale numerical applications on unstructured meshes. Based on JAUMIN, serial codes are only required to be written for large-scale parallel application suitable for modern supercomputers with tens of thousands of CPU cores. Some applications show that JAUMIN can facilitate the development greatly and support effective simulation on supercomputer.

MS A6-2-3 7 **17:00-19:00**

Applied Mathematics Education - Part 1

For Part 2 see: MS A6-2-3 8

Organizer: Jessica Libertini Virginia Military Institute

Organizer: Ron Buckmire Occidental College

Organizer: Rosalie Bélanger-Rioux Harvard University

MS Organized by: SIAG/AME

Abstract: The teaching of mathematical sciences needs to reflect the world we are in. From mathematical modeling and applied calculus to non-traditional courses and programs that engage learners in learning mathematics and applying it to the real world, many applied mathematicians are at the frontiers of teaching. Issues of diversity and inclusion are more and more pressing, and need to be addressed adequately, and humanely. This minisymposium will showcase educational innovations and engage participants in being reflective of their own teaching and course offerings, and of their impact on students of all backgrounds, the mathematical community, and the broader community.

17:00-17:30

Promoting interdisciplinary and mathematical modeling through competitions

Jessica Libertini Virginia Military Institute

Sergey Kushnarev Singapore University of Technology and Design

Abstract: In this talk, we will discuss several modeling competitions designed to promote the applicability of mathematics, problem-solving, creativity, teamwork, and communication skills. After introducing COMAP's MCM/ICM competitions, we will describe several options for smaller competitions that offer immediate feedback to participants and the chance to see multiple solutions. We will discuss how the competition can be modified for urban or rural settings, as well as options for including workshops for students and/or faculty.

17:30-18:00

Who Does The Math? On the Diversity and Demographics of the Undergraduate Mathematics Community in the United States

Ron Buckmire Occidental College

Abstract: Mathematics is a human endeavor. In other words, mathematics is done, taught, discovered and learned by people. Of course, people have various identifying characteristics and experiences that affect how they interact with other people and (vice versa). This presentation will discuss the diversity and demographics of the mathematics community in the United States and discuss the significance and implications of the underrepresentation of certain groups. The importance of broadening participation efforts will be included.

18:00-18:30

The definition of "mathematician," and what it means for our communities

Rosalie Bélanger-Rioux Harvard University

Abstract: This interactive talk will have participants reflect on what we mathematicians think it means to be a mathematician, and how that affects our mathematics learning, teaching and research communities. We will then practice how to be better active bystanders, that is, how to interact and react in ways that support all mathematicians and mathematics students.

18:30-19:00

Engaging diverse learners in applied mathematics education and research for global problem solvi

Padmanabhan Seshaiyer George Mason University

Abstract: In this talk, we describe the multidisciplinary nature of applied mathematics and how one can effectively engage students through education and research to solve global challenges. Specifically, we will focus on twenty-first century competencies and lifelong skills required to solve global problems using applied mathematics education and research and demonstrate how educators can provide transformational experiences to address the growing need to improve the performance of the undergraduate workforce in mathematics and science.

MS ME-1-I1 7 **17:00-19:00**

Variational Analysis for Optimal Control and Inverse Problems - Part 3

For Part 1 see: MS ME-1-I1 5

For Part 2 see: MS ME-1-I1 6

Organizer: Akhtar A. Khan Rochester Institute of Technology Rochester, New York

Organizer: Miguel Sama UNED

Organizer: Christian Clason University of Duisburg-Essen

Abstract: The study of inverse and optimal control problems is a vibrant and expanding branch of applied mathematics with wide-ranging applications to numerous related disciplines. In recent years, new directions of research emerged. For example, identification of stochastic parameters in stochastic PDEs and multi-objective control problems have been the focus of new research. Moreover, the ongoing investigations into inverse and control problems enormously benefited from the tools from fields such as variational and nonsmooth analysis. This minisymposia aims to gather experienced and young researchers actively engaged in the cross-fertilization of ideas among variational analysis, inverse problems and optimal control problems.

17:00-17:30

Exact Penalization and Viability in State-Constrained Optimal Control Problems

Rob Kipka Lake Superior State University

Abstract: We provide a new proof using exact penalization of the Pontryagin Maximum Principle for problems with state constraints of the form $g(t,x(t))\leq 0$. In particular, we show how to use two theorems of nonsmooth analysis, the multidirectional mean value inequality of Clarke and Ledyaev and a subgradient formula for maximum-type functions due to Ledyaev and Trieman, to derive the Pontryagin Maximum Principle for problems with state constraints and to derive viability-type results for state constrained problems.

17:30-18:00

Reconstructing the source term in elliptic systems: convergence analysis, convergence rates and a-posteriori error estimates using adaptive grid techniques

Tran Nhan Tam Quyen Georg-August-Universität Göttingen

Carmen Grassle University of Hamburg

Michael Hinze University of Hamburg

Thorsten Hohage Georg-August-Universität Göttingen

Abstract: In this presentation we discuss the problem of recovering the source term in elliptic systems from observations of the state on an acceptable part of the boundary. We formulate this identification problem as a minimization problem of the least squares function with the Tikhonov-type regularization. We show the convergence and convergence rates of regularized finite element approximations to an identified source. Moreover, adaptive grid techniques are used to show a-posteriori error estimates.

MS FT-1-10 7 **17:00-19:00**

Some modern questions in the simulation of advection dominated problems - Part 1

For Part 2 see: MS FT-1-10 8

For Part 3 see: MS FT-1-10 10

Organizer: Remi Abgrall University of Zurich

Organizer: Mario Ricchiuto INRIA

Organizer: Guglielmo Scovazzi Duke university

Abstract: We propose a mini symposium about modern trends in the simulation of advection dominated problems, in particular fluid dynamics (classical, MHD, etc) when compressibility cannot be ignored: How to produce good meshes, especially for high order simulation in complicated geometries where curved meshes are needed There is a debate about body fitted methods versus non body fitted ones: where do we stand? The control of the numerical dissipation: energy/entropy stable, adaptation vs no adaptation, What is a solution: classical weak solutions vs statistical solutions, More recent paradigms: could machine learning tools bring something to this field ?

17:00-17:30

Monotonicity preserving stabilization for convection dominated flows

Jesus Bonilla Universitat Politècnica de Catalunya

Santiago Badia Centre Internacional de Mètodes Numèrics a l'Enginyeria

Abstract: Monotonicity-preserving numerical schemes are of special interest for problems with discontinuities or strong shocks. Several methods exist for explicit time integrators. However, in the case of problems with different time scales, implicit time integrators are preferred. Recently several fist order finite element schemes have been developed. We perform an extension of this methods to higher order discretizations. In particular, we developed an unconditional arbitrary order space-time isogeometric scheme. We perform numerical analysis and experiments.

17:30-18:00

Computing statistical solutions of conservation laws

Kjetil Olsen Lye ETH Zurich

Siddhartha Mishra ETH Zurich

Ulrik S. Fjordholm University of Oslo

Abstract: We review the theory of statistical solutions for conservation laws. Afterward, we introduce a convergent numerical method for computing the statistical solution of conservation laws. In the case of systems of equations in multiple space dimensions, we prove a compactness result together with a version of the Lax-Wendroff theorem for statistical solutions. We test our theory against the compressible Euler equations in two space dimensions and three space dimensions.

18:00-18:30

Optimal energy-conserving discontinuous Galerkin methods for wave equations

Chi-Wang Shu Brown University

Guosheng Fu Brown University

Abstract: Energy conservation is an important property for time dependent PDEs, such as linear hyperbolic systems, linear and nonlinear dispersive wave equations including KdV equations, etc. It is difficult to design energy conserving discontinuous Galerkin (DG) methods for such problems with optimal convergence in the L^2-norm. In this talk we will describe our recent work in designing such DG schemes, which involves the technique of possible doubling of unknowns. This is joint work with Guosheng Fu.

18:30-19:00

Staggered grid schemes for Compressible Euler equations

Kseniya Ivanova University of Zurich

Rémi Abgrall Universität Zürich

Abstract: We are interested in the numerical solution of the Euler equations of fluid mechanics written in non-conservative form. A staggered grid formulation using piecewise linear approximations for the kinematic variables and cell-centered finite volume approximations for the thermodynamic parameters is considered. This approach is different, and simpler, that the one developepd by Latche and co-workers. It also has the potential of high order accuracy, in an easy and systematic way.

MS A6-4-3 7 **17:00-19:00**

Optimization based economic agent decisions in aggregated environments

Organizer: Gabriel Turinici — Université Paris Dauphine
Organizer: Corina Paraschiv — Université PAris Descartes

Abstract: The mini-symposium presents, from an application viewpoint, a body of techniques used today in economics and management when an agent is faced with a complex environment; this environment can constructed by the decision of some other agents, as is the case in the Mean Field Games (a la Lions - Lasry or Caines - Malhame - Huang) or from some exogeneous activity. The mathematical techniques are in the general area of control theory combined with game theory, but specifics are always present and will be discussed. A majority of participants are applied researchers in the respective fields.

17:00-17:30

Computation of equilibrium in multiple agents environments: application to vaccination

TURINICI Gabriel — CEREMADE, Univesité Paris Dauphine PSL

Francesco SALVARANI
Laetitia LAGUZET

Abstract: The computation of equilibria in Nash games with an infinity of players is seldom possible analytically. We will address in this talk a numerical method to compute such an equilibrium and apply it to the case of vaccination games.

17:30-18:00

Too Popular, Too Fast: Optimal Advertising and Entry Timing in Markets with Social Influence

Fruchter Gila — Bar-Ilan University
Prasad Ashutosh — UCR
Van Den Bulte Christophe — UPenn

Abstract: We study the optimal advertising and entry timing decisions for a new product being sold in a market where consumers are influenced by peers. The focus is on two-segment markets in which followers are positively influenced by elites, while elites are either unaffected or repulsed by product popularity among followers. We develop an optimal control model where the decision variables are the advertising in each segment and the time of entry into the follower segment.

18:00-18:30

Dynamic Pricing of New Products in Competitive Markets: A Mean-Field Game Approach

CHENAVAZ Regis — KEDGE Bussiness School
Corina Paraschiv — Paris Descartes University
Gabriel Turinici — Paris Dauphine University

Abstract: Dynamic pricing of new products has been extensively studied in monopolistic and oligopolistic markets. But, the optimal control and differential game tools used to investigate pricing behavior on markets with a finite number of firms are not well-suited to model competitive markets with an infinity of firms. Using a mean-field game approach, this article develops a setting where a continuum of firms optimize prices for a homogeneous new product.

18:30-19:00

Dynamic Pricing Competition in E-Commerce with Data-Driven Price Anticipations

SCHLOSSER Rainer — Hasso-Plattner-Institut für Digital Engineering gGmbH

Abstract: Online markets have become highly dynamic and competitive. We analyze automated repricing strategies with data-driven price anticipations under duopoly competition. We show how to derive optimized self-adaptive pricing strategies that anticipate price reactions of the competitor. We verify that the results of our adaptive learning strategy tend to optimal solutions, which can be derived for scenarios with full information. Finally, we analyze the case in which our learning strategy is played against itself.

MS A6-1-2 7 — 17:00-19:00

Recent advances in large scale and distributed stochastic optimization - Part 2

For Part 1 see: MS A6-1-2 6
Organizer: Natasa Krejic — Faculty of Sciences, University of Novi Sad
Organizer: Dusan Jakovetic — University of Novi Sad

Abstract: In the Big Data era, huge scale, data-intensive applications call for the development of novel methods for numerical optimization. The sheer volume of the data necessitates parallel and distributed processing, where the samples and/or features are partitioned across a number of computational units (nodes in a computer cluster, virtual machines, smart devices, etc.). In addition, it is often expensive to utilize exact first or second order search directions, and hence stochastic, sub-sampled, or block-coordinate-type directions are often used. This session reviews recent advances in this fast-progressing research field of parallel and distributed stochastic optimization.

17:00-17:30

Distributed methods for linear systems of equations

Natasa Krejic — Faculty of Sciences, University of Novi Sad

Abstract: Linear systems of equations are present in various fields of applied mathematics, either coming directly from real-world problems, or appearing during optimization process. We consider a class of fixed point methods for solving linear systems of equations in distributed computer environment. Each node generates a sequence of approximations that converges to the solution under conditions that resemble classical results for solving linear systems. Numerical results with respect to the computational and communication costs are presented.

17:30-18:00

Convex relaxation for the leader-follower problem

Claudia Soares — Larsys Instituto Superior Tecnico
Joao Xavier — Larsys Instituto superior técnico

Abstract: We address the combinatorial problem of classifying a set of signals into leaders and followers. The number of leader signals is imposed beforehand, and each follower signal must be a linear superposition of filtered leader signals. We propose a convex relaxation that handles seamlessly any convex constraint on the filter coefficients, by using gauge functions. Preliminary numerical experiments show that the proposed relaxation outperforms other approaches based on atomic norms.

18:00-18:30

A Variance-Reduced Zeroth Order Frank Wolfe Algorithm

Anit Kumar Sahu — Carnegie Mellon University
Manzil Zaheer — Google AI
Soummya Kar — Carnegie Mellon University
J. Zico Kolter — Carnegie Mellon University

Abstract: In this talk, we consider the problem of constrained stochastic optimization. A gradient free variance reduced Frank-Wolfe algorithm is proposed, where the algorithm has access to a stochastic zeroth order oracle and thus makes the algorithm both gradient free and projection free. We derive convergence rates of the proposed algorithm for both convex and non-convex functions under standard smoothness functions. Experiments on black box optimization setups demonstrate the efficacy of the proposed algorithm.

MS ME-1-3 7 — 17:00-19:00

Entropy methods for multi-dimensional systems in mechanics - Part 1

For Part 2 see: MS ME-1-3 8
For Part 3 see: MS ME-1-3 9
For Part 4 see: MS ME-1-3 10
Organizer: Cleopatra Christoforou — University of Cyprus
Organizer: Athanasios Tzavaras — KAUST

Abstract: Nonlinear Conservation Laws result from the balance laws of continuum physics and govern a broad spectrum of physical phenomena in compressible fluid dynamics, materials science, particle physics, semiconductors, and other applied areas. The minisymposium is focused on recent advances on conservation laws and related systems in mechanics that connect variational methods with dynamics and the general use of entropy methods in conservation laws and related systems. It aims to bring together researchers working in different aspects, highlight the role of PDEs in these applications, serve as a forum for the dissemination of new scientific ideas and discoveries and enhance communication.

17:00-17:30

Hydrodynamic models for attractive-repulsive interactions

José Antonio Carrillo De La Plata — Imperial College London

Abstract: I will discuss several recent results regarding qualitative properties of hydrodynamic models with attractive-repulsive interactions. These models appear as natural monokinetic closures or hydrodynamic solutions of kinetic models for collective behavior. We will discuss critical thresholds and long time asymptotics for 1D models with alignment with/without interaction forces. We will give sharp result distinguishing global existence and finite time blow-up with a complete understanding of the long time asymptotics.

17:30-18:00

Hilbert's sixth problem and the failure of the Boltzmann to Euler limit

Marshall Slemrod — University of Wisconsin, Madison

Abstract: Historically it is believed that the increase of physical entropy given by Boltzmann's Htheorem will drive the Boltzmann kinetic equations to the compressible Euler equations continuum limit. In this talk I will summarise work that suggests that this view proposed by Hilbert in his 1900 ICM address fails: there is a limiting PDE system but it is not the Euler equations of fluid compressible fluid mechanics but ones given by Korteweg's theory of capillarity.

18:00-18:30

On the dynamics of ferrofluids

Konstantina Trivisa — University of Maryland
Ricardo Nochetto — University of Maryland
Franziska Weber — Carnegie Mellon University

Abstract: This work establishes the global existence of weak solutions to a model proposed by Rosensweig (1985) for the dynamics of ferrouids. The system is expressed by the conservation of linear momentum, the incompressibility condition, the conservation of angular momentum, and the evolution of the magnetization. The existence proof is inspired by the DiPerna-Lions theory of renormalized solutions.

18:30-19:00

High-friction limits for multi-component Euler flows

Athanasios Tzavaras — KAUST

Abstract: The high-friction limit in Euler-Korteweg equations for fluid mixtures is analyzed. The first-order correction system is of Maxwell-Stefan type and its diffusive part is parabolic in the sense of Petrovskii. The high-friction limit towards the first-order Chapman-Enskog approximation is proved in the weak-strong solution context for general Euler-Korteweg systems, including constant capillarities and multicomponent quantum hydrodynamic models.

MS FT-2-4 7 — 17:00-19:00

Reduced Order Modeling for Parametric CFD Problems - Part 1

For Part 2 see: MS FT-2-4 8
For Part 3 see: MS FT-2-4 9
For Part 4 see: MS FT-2-4 10
Organizer: Annalisa Quaini — University of Houston
Organizer: Yanlai Chen — University of Massachusetts, Dartmouth
Organizer: Gianluigi Rozza — SISSA, International School for Advanced Studies Trieste

MS Organized by: SIAG/CSE

Abstract: Large-scale computing is recurrent in several contexts such as fluid dynamics, due to the high computational complexity in solving parametric and/or stochastic systems. This often leads to an unaffordable computational burden, especially when dealing with real-world applications, real-time or multi-query computing. In order to lessen this computational burden, reduced-order modeling (ROM) techniques play a crucial role: they aim to capture the most important features of the problem at hand without giving up accuracy. This minisymposium focuses on the development and application of ROM techniques in computational fluid dynamics for direct and inverse modeling, and for control, optimization and design purposes.

17:00-17:30

Reduced Order Methods for PDEs: state of the art and perspectives with applications in Industry,

Gianluigi Rozza — SISSA, International School for Advanced Studies Trieste

Abstract: We provide the state of the art of Reduced Order Methods (ROM) for parametric Partial Differential Equations (PDEs), and we focus on some perspectives in their current trends and developments, with a special interest in parametric problems arising in offline-online Computational Fluid Dynamics (CFD). Model flow problems will focus on few benchmark, as well as on simple fluid-structure interaction problems. Further examples of applications will be delivered concerning shape optimisation applied to industrial problems.

17:30-18:00

Transport dominated flow problems - is there a chance for model reduction?

Karsten Urban — Universität Ulm

Abstract: Standard model reduction methods rely on a projection onto a linear subspace generated a priori. The best possible approximation rate is given by the Kolmogorov N-width. We show that this rate is bounded by N^{-1/2} for the wave equation, which limits the applicability of projection-based model reduction techniques. Next, we discuss possible ingredients to overcome this principle obstacle for transport dominated and hyperbolic problems in terms of error estimates and transformation techniques.

18:00-18:30

Projection-based reduced order models for a cut finite element method in parametrized domains

Francesco Ballarin — SISSA mathLab
Efthymios N. Karatzas — SISSA mathLab
Gianluigi Rozza — SISSA mathLab

Abstract: The talk will present a reduced order modelling (ROM) technique built on embedded mesh finite element method, discussed in [E. N. Karatzas et al., arxiv:1901.03846]. ROMs based on CutFEM are attractive to handle large deformations of parametrized domains. The role of extension and transport of embedded solutions to a common background is discussed. The connection with a wider class of transport dominated problems is higlighted, together with an outline of ongoing works on this topic.

18:30-19:00

Theoretical, numerical and computational results on a local projection stabilization POD-ROM for convection-dominated flows

Samuele Rubino — University of Seville
Mejdi Azaïez — Institut Polytechnique de Bordeaux
Tomás Chacón Rebollo — University of Seville

Abstract: In this work, we address one of the main drawbacks of POD-ROM, namely their numerical instability when applied to convection-dominated flows. In particular, a Streamline Derivative projection-based closure modeling strategy for the numerical stabilization of POD-ROM (SD-ROM) is considered, which has been analyzed for advection-diffusion-reaction equations in the FE framework. This approach is further improved by introducing a stabilizing offline/online post-processing (SPP) strategy that showed to be very useful when considering very low diffusion coefficients.

MS FT-2-1 7 — 17:00-19:00

Recent developments in numerical analysis of integral and integro-differential equations - Part 1

For Part 2 see: MS FT-2-1 8
For Part 3 see: MS FT-2-1 9
For Part 4 see: MS FT-2-1 10
Organizer: Qiumei Huang — Beijing University of Technology
Organizer: Hermann Brunner — Hong Kong Baptist University

Abstract: Since integral equations, integro-differential equations and related functional equations with various types of delays play an important role as mathematical models in science, engineering and finance, recent years have seen major developments in the design and analysis of efficient numerical methods for such equations. It is the aim of this minisymposium to bring together leading experts in these fields, in order to describe recent achievements and further communication between numerical analysts and computational scientists working on these problems.

17:00-17:30

Recovery in discretisaton of explosions, finite--time stability, and superexponential asymptotic behaviour in stochastic integral equations

John Appleby — Dublin City University

Abstract: In this talk, we discuss sharp conditions on drift and diffusion coefficients for solutions of autonomous stochastic differential equations to inherit deterministic--type asymptotic behaviour. This means there is a related ODE whose asymptotic behaviour is known in terms of an appropriate nonlinear generalisation of the Liapunov exponent. We show that the growth, decay, or asymptotic behaviour can be recovered in the discretised process by making time steps in simulation which are state dependent.

17:30-18:00

On collocation and Galerkin methods for Volterra-type integral equations of the first kind

Hermann Brunner Hong Kong Baptist University

Abstract: While the convergence properties of collocation solutions in spaces of piecewise polynomials are well understood for classical first-kind Volterra integral equations (VIEs) with smooth kernels, this is not true for VIEs whose kernels contain weak singularities or whose underlying integral operators are not compact. We will show that the observation that collocation methods correspond to very particular discretized versions of Galerkin methods yields a powerful tool for successfully attacking these open problems.

18:00-18:30

Analytical and numerical results for singular Volterra integral equations

Teresa Diogo University of Lisbon

Abstract:

We are concerned with analytical and numerical studies for Volterra integral equations of the general form $a(t)u(t) = \int_0^t (t-s)^{-\alpha} K(t,s,u(s))ds + f(t), t \in I = [0,T],$ where $0 \leq \alpha < 1$ and $a(t)$ may vanish at certain points of the interval (0,T). In this talk several types of functions $a(t)$ will be considered and we will discuss the application of numerical methods for the solution of the resulting equation.

18:30-19:00

Discontinuous Galerkin Methods for Nonlinear Delay Differential Equations

Qiumei Huang Beijing University of Technology

Abstract: In this report, we investigate discontinuous Galerkin (DG) methods for nonlinear vanishing delay and state dependent delay differential equations. The optimal global convergence and local superconvergence results are established. By suitable designing partitions, the optimal nodal superconvergence of the discontinuous Galerkin solutions is obtained. Numerical examples are provided to illustrate the theoretical results.

MS ME-1-G 7 17:00-19:00

Trends in nonlocal PDEs - Part 1

For Part 2 see: MS ME-1-G 8

Organizer: Juan Luis Vazquez Univ. Autonoma de Madrid

Organizer: Diaz Jesus Ildefonso Universidad Complutense de Madrid

Abstract: Over the last decades there has been a strong research effort devoted to extend the theory of elliptic, parabolic and hyperbolic equations to models in which the Laplacian operator or its elliptic equivalents are replaced by different types of nonlocal integro-differential operators, most notably those called fractional Laplacian operators. The corresponding equations are motivated by applications in diverse fields: they reasonably account for observed anomalous diffusion, and they also appear in continuum mechanics, phase transition phenomena, population dynamics, optimal control, image processing... We gather in this minisymposium recent contributions of our collaborators that reflect different lines of current research.

17:00-17:30

Confinement of a particle for the quasirelativistic Schrödinger equation with a very singular potential

Ildefonso Díaz Univ. Complutense de Madrid

Abstract: The infinite well potential problem allows a "partial localizing effect": the probability to find the particle outside Ω, where the potential is finite, is zero. But some ambiguities arise. I will consider the quasirelativistic Schrödinger equation (-ħ2c2 Δ+m2c4)1/2u+V(x)u=λu. The partial localizing effect holds now when V(x) behaves like the distance to the boundary to the power α=-1. The case m=0 was previously studied in collaboration with D. Gómez-Castro and J.L. Vázquez.

17:30-18:00

On the regularity of the free boundary in the thin obstacle problem

Xavier Ros-Oton Universitat Zurich

Xavier Fernández-Real. ETH

Abstract: The thin obstacle problem is a classical free boundary problem arising in a variety of settings. It is known that the free boundary is smooth outside a certain set of degenerate points. In full generality, however, nothing can be said about such set of degenerate points, it could even be a fractal set with infinite perimeter. The aim of this talk is to show that, generically, the set of degenerate points is lower dimensional.

18:00-18:30

Fractional PDEs with singular data

David Gómez-Castro Universidad Complutense de Madrid

Abstract: In this talk we present results on the equation $(-\Delta)^s u = f$ in a bounded domain with homogeneous boundary (resp. exterior) condition for the common choices of fractional laplacian. We detect the optimal data f extending the regular theory. We show that u can diverge towards the boundary and the existence of a boundary data problem as a limit of the previous interior theory. This is joint work with N. Abatangelo and J.L. Vxzquez.

18:30-19:00

Carleman type estimates for fractional operators

Diana Stan Universidad de Cantabria

Luz Roncal Basque Center for Applied Mathematics

Luis Vega BCAM and UPV-EHU

Abstract: In this talk we will show how Carleman type estimates with quadratic exponential weight can be proved for fractional relativistic operators. This will be done via pseudo-differential calculus. The techniques apply also in case of the fractional Laplacian.

MS FT-4-2 7 17:00-19:00

Recent advances on computational wave propagation - Part 3

For Part 1 see: MS FT-4-2 5

For Part 2 see: MS FT-4-2 6

Organizer: Jichun Li University of Nevada Las Vegas

Organizer: Lise-Marie Imbert-Gérard University of Maryland

Organizer: Yunqing Huang Xiangtan University, China

Abstract: This mini-symposium will include investigations of recent achievements on numerical analysis and mathematical modeling of wave propagation problems. 12 leading experts from 8 countries are temporary agreed to speak in our mini-symposium. Topics include development and analysis of numerical methods for electromagnetic wave propagation or scattering in photonics, complex dispersive media and plasmonics etc.

17:00-17:30

Helmholtz equation with rapidly oscillating coefficients

Stefan Sauter University of Zurich

Torres Céline University of Zurich

Abstract: We will present new results on the stability of the Helmholtz equation with nonsmooth and rapidly oscillating coefficients. We develop a theoretical approach for radial-symmetric problems and find that for certain classes of heterogeneous coefficients, the stability constant is bounded independently of the number of discontinuities. We present examples of coefficients so that the solution has exponentially growing local energy with respect to the frequency at any predetermined location inside the domain.

17:30-18:00

For most frequencies, strong trapping has a weak effect on frequency-domain scattering

Euan Spence University of Bath

David Lafontaine University of Bath

Jared Wunsch Northwestern University

Abstract: It is well known that when the geometry and/or coefficients allow stable trapped rays, the solution operator of the Helmholtz equation grows exponentially through a sequence of real frequencies tending to infinity. We show that, even in the presence of the strongest-possible trapping, if a set of frequencies of arbitrarily small measure is excluded, the Helmholtz solution operator grows at most polynomially as the frequency tends to infinity.

18:00-18:30

Transparent Boundary Conditions for the Schrodinger Equation with a Uniform Applied Field

Jason Kaye	New York University
Leslie Greengard	Courant Institute of Mathematical Sciences, NYU / Flatiron Institute, Simons Foundation
Alex Barnett	Flatiron Institute, Simons Foundation

Abstract: We present an exact, nonlocal transparent boundary condition for the time-dependent Schrodinger equation (TDSE) with a compactly-supported scalar potential and a spatially-uniform vector potential. This condition gives an exact formulation of the restriction of the free space TDSE to an arbitrary bounded, piecewise-smooth computational domain, and may therefore be used in simulations on Cartesian grids. We introduce a fast, memory-efficient algorithm to apply the history-dependent integral operators arising in the condition.

18:30-19:00

New 2nd-order DDM methods for wave computations

Anouk Nicolopoulos	Sorbonne Universite
Bruno Després	LJLL Sorbonne Universite
Bertrand Thierry	CNRS & LJLL Sorbonne Universite

Abstract: We are interested in deriving transmission conditions (TC) for domain decomposition methods with mesh constraints such as corners and cross-points. Our framework adresses Dirichlet and Neumann conditions with general mesh features. To do so, we start by defining an absorbing boundary condition (ABC) that treats corner points, that we further adapt to define a TC. This work is illustrated by numerical simulations.

MS A6-5-4 7 17:00-19:00

Recent Advances in Infinite Dimensional Stochastic Analysis - Part 1

For Part 2 see: MS A6-5-4 8

Organizer: Nathan Glatt-Holtz	Tulane University
Organizer: Cecilia Mondaini	Drexel University

Abstract: Random effects as well as the presence of systematic uncertainties obviate the need for stochastic methods in a range of fields across the natural and social sciences and engineering. This session brings together a diverse group of researchers working on infinite dimensional stochastic systems. Our group will disseminate exciting recent advances in nonlinear stochastic partial differential equations (SPDEs) as wellas Bayesian statistical inversion problems addressed through Markov Chain Monte Carlo (MCMC) methods. (Part I)

17:00-17:30

Second order accurate adaptive transform filters for elliptic Bayesian inverse problems

Jana De Wiljes	University of Potsdam
Svetlana Dubinkina	Centrum Wiskunde & Informatica
Sangeetika Ruchi	Centrum Wiskunde & Informatica

Abstract: Ensemble based data assimilation methods are widely used to obtain estimations of uncertain model parameters by exploiting available observations of model states. The tempered ensemble transform particle filter (TETPF) is designed for highdimensional nonlinear inverse problems. Yet a poor initial guess of the prior distribution hampers its efficiency. Here we combine adaptive inflation with the TETPF and introduce informative prior to address such shortcomings. The performance is investigated for a Darcy flow model.

17:30-18:00

A Bayesian Approach to Estimating Background Flows from a Passive Scalar

Justin Krometis	Virginia Tech

Abstract: We consider the Bayesian inverse problem of estimating a background flow field from the partial and noisy observation of a passive scalar (e.g., a solute concentration) governed by advection and diffusion. We provide conditions under which the inference is consistent, i.e., the posterior converges to a Dirac on the true flow as the number of observations grows large. We also attack the problem computationally by leveraging MCMC methods adapted in recent years to infinite-dimensional settings.

18:00-18:30

Unique Ergodicity for the stochastic damped-driven KdV equation

Vincent Martinez	City University of New York - Hunter College

Abstract: In 1967, Foias and Prodi captured precisely a notion of finitely many degrees of freedom for the 2D incompressible Navier-Stokes equations. This notion has since led to several developments in the understanding of the long-time behavior of solutions to the NSE, particularly, in the context of turbulence. In this talk, we will discuss this property as it regards the issue of uniqueness of ergodic invariant measures for the stochastically forced, damped-driven Korteweg-de Vries equation.

18:30-19:00

Unique ergodicity for boundary forced Rayleigh Benard convection

Juraj Foldes	University of Virginia
Armen Shirikyan	University of Cergy-Pontoise
Mouhamadou Sy	University of Virginia

Abstract: In this talk we investigate properties of invariant measures for the Boussinesq equations in the presence of a degenerate random forcing acting only in the temperature component and only through the boundary. The main goal is to prove the existence of a unique invariant measure in essentially elliptic setting, that is, when sufficiently many directions are forced. The approach is based on a boundary controlablity of the Boussinesq system, variational methods, and improved Carleman estimates.

MS FT-2-6 7 17:00-19:00

Solving multidimensional polynomial systems numerically

Organizer: Alex Townsend	Cornell University
Organizer: Tyler Jarvis	Brigham Young University
Organizer: Alex Townsend	Cornell University

Abstract: Given a system of polynomials in multivariable variables, one often wants to compute all or some of its solutions. Without significant care, the task can be computationally prohibitive and numerically challenging. This is an exciting time for this field, with many recent algorithmic developments in homotopy continuation methods, multivariable resultants, linearizations, and techniques based on spectral methods. This minisymposium will bring together experts to discuss progress on this numerically challenging problem, and highlight the range of software that is currently available.

17:00-17:30

Parallel Polynomial Homotopy Continuation

Jan Verschelde	University of Illinois at Chicago

Abstract: The efficient computation of a numerical irreducible decomposition of a polynomial system requires the application of various different homotopies. Some homotopies run only in sequence while others may be applied concurrently. Load balancing and pipelining algorithms are implemented in PHCpack, to run on multicore shared memory computers, equipped with GPU accelerators. Recent results were published in the CASC 2018 Proceedings, volume 11077 of LNCS, pages 361-375, Springer-Verlag.

17:30-18:00

Avoiding ill-conditioning while solving polynomial systems numerically

Daniel Bates	United States Naval Academy

Abstract: Polynomial systems can be solved numerically with homotopy continuation, but these methods struggle and sometimes fail in the presence of ill-conditioning. We describe two recent heuristics developed to avoid zones of ill-conditioning on the fly. One, based on monodromy, succeeds in the presence of a singularity. The other, even more heuristic in nature, will work with or without an actual singularity. No polynomial systems expertise will be assumed.

18:00-18:30

Solving systems of polynomial equations and multidimensional realization theory

Philippe Dreesen	Vrije Universiteit Brussel
Kim Batselier	TU Delft
Bart De Moor	KU Leuven / ESAT-STADIUS

Abstract: Multidimensional systems provide tools for estimation, simulation and control, which go beyond one-dimensional systems. We relate multidimensional realization theory to solving polynomial equations. We show that linear algebra suffices to solve the problem. Multidimensional difference equations are associated with a Macaulay matrix, and its null space is a multidimensional observability matrix. The classical shift trick from realization theory reduces the task to an eigenvalue decomposition. We study multiple solutions and solutions at infinity.

MS FT-4-7 7 17:00-19:00

Numerical methods for PDE-based multi-physics models in biomechanics - Part 2

For Part 1 see: MS FT-4-7 6
For Part 3 see: MS FT-4-7 8
For Part 4 see: MS FT-4-7 9
For Part 5 see: MS FT-4-7 10

Organizer: Ricardo Ruiz Baier	University of Oxford
Organizer: Kent-Andre Mardal	University of Oslo

Abstract: The scope of the proposed minisymposium deals with the numerical approximation of multiphysics models in biomechanics. First, a particular emphasis will be placed on rigorous convergence analysis, tailored domain decomposition techniques, recent mixed finite element and hybrid discretizations, boundary element methods, design and analysis of preconditioners. Secondly, the session will focus on the application of these new methodologies in the solution of PDE-based coupled models arising in biomechanics and related systems. For instance, we especially welcome submissions involving brain multiphysics, cardiac electromechanics, or respiratory system modelling; as well as more general fluid-structure interaction, and multiscale and/or multiphysics problems.

17:00-17:30

Mixed methods for stress-assisted diffusion models in cardiac mechanics

Ricardo Ruiz Baier	Oxford University
Bryan Gomez	Universidad de Concepcion
Gabriel Gatica	Universidad de Concepcion
Alessio Gizzi	University Campus Bio-Medico, Rome

Abstract: A new mathematical model is proposed for the active contraction of cardiac tissue using stress-assisted conductivity as the main mechanism for mechanoelectrical feedback. The coupling variable is the Kirchhoff stress and the equations of hyperelasticity are written in mixed form. Next we address a simplified version of the model, focusing on solvability and stability of continuous and discrete mixed-primal formulations. The convergence of these methods will be illustrated through computational tests.

17:30-18:00

Finite Element Methods for the Von Karman Equations

Neela Nataraj	IIT Bombay
Gouranga Mallik	IISc Bangalore
Carsten Carstensen	Univerisitat Humbolt zu Berlin

Abstract: Very thin plates have a lot of industrial applications, such as in lithography or studying the stability of a submarine's walls, and cell membranes. The talk discusses finite element methods and analysis for the semilinear von Karman equations that describe deflection of very thin plates defined on polygonal domains. A discrete inf-sup condition and a priori error estimates are derived under minimal regularity assumptions on the exact solution.

18:00-18:30

Modeling adhesion forces in Lamelipodia: a delayed gradient flow approach

Vuk Milisik	University of Paris 13

Abstract: In the context of cell motility, we introduce the Filament Based Lamelipodium Model, and present various biological situations that this model allows to face. In this framework, we are mainly interested in the modeling and the mathematical analysis of adhesion forces that we introduce as well. We present a modified gradient flow scheme and show convergence of the time-and-age discretized problems towards various limits wrt some parameters. Some simulations and perspectives complete the presentation.

18:30-19:00

Numerical methods for unfitted meshes to solve the interaction between a fluid and an immersed structure

Christian Vergara	Politecnico di Milano
Paola Francesca Antonietti	Politecnico di Milano
Luca Formaggia	Politecnico di Milano
Marco Verani	Politecnico di Milano
Stefano Zonca	Politecnico di Milano

Abstract: We consider the numerical solution of the fluid-structure interaction problem arising for cardiac valves, which are modeled as thick structures immersed in the blood. We consider unfitted methods based on the Discontinuous Galerkin method which are able to manage non-conforming fluid and structure meshes and are based on a fixed fluid mesh cut by the moving structure mesh. Stability analysis is provided together with several numerical results. Funded by H2020-MSCA-ITN-2017, EU project 765374 "ROMSOC"

MS FE-1-1 7 17:00-19:00

Recent advances in kinetic computation: forward and inverse problems - Part 3

For Part 1 see: MS FE-1-1 5
For Part 2 see: MS FE-1-1 6

Organizer: Qin Li	UW-Madison
Organizer: Jingwei Hu	Purdue University

Abstract: Kinetic theory describes the nonequilibrium dynamics of a large number of particles and connects microscopic Newtonian mechanics and macroscopic continuum mechanics in multiscale modeling hierarchy. It is widely used in a variety of science and engineering problems. Numerically solving kinetic equations in both forward and inverse setting present many challenges, such as high-dimensional collision operators, multiscales, uncertainties in scattering coefficients, etc. This minisymposium aims to bring together applied mathematicians to discuss recent progress in this field and exchange ideas.

17:00-17:30

Hermite spectral method for the Boltzmann equation

Zhenning Cai	National University of Singapore

Abstract: We propose a Hermite spectral method for the Boltzmann equation. Due to the relation between the Hermite spectral method and the moment method, we model the collision term by introducing a BGK part to reduce the computational cost. The method is able to balance the computational efficiency and the model accuracy by tuning a parameter. One- and two-dimensional numerical experiments are carried out to validate the algorithm.

17:30-18:00

Stability deterioration of optical tomography in the optically thick regime

Kit Newton	University of Wisconsin-Madison
Qin Li	University of Wisconsin-Madison
Andrew Stuart	California Institute of Technology

Abstract: Diffuse optical tomography is a medical imaging technique which uses light measurements to reconstruct tissue properties. The radiative transfer equation (RTE) describes high-energy light, and we reconstruct properties from the inverse RTE. The Bayesian solution is the posterior distribution of these properties. For low-energy light, the diffusion equation (DE) governs the dynamics. The inverse DE is ill-posed, making the reconstruction difficult. We describe a link between the distributions for the inverse RTE and DE.

18:00-18:30

Dynamic low-rank approximation of the the Boltzmann equation

Lukas Einkemmer	University of Innsbruck

Abstract: We propose a dynamic low-rank approximation to the Boltzmann equation in order to numerically solve weakly compressible fluid flow. This procedure is numerically efficient as a small rank is sufficient to obtain the relevant dynamics. Advantages of the approach include the ease of using spectral methods and the straightforward extension to problems that require some kinetic effects, i.e. where the fluid description is not sufficient. We also discuss the limit of large collisionality.

MS FT-1-1 7 17:00-19:00

Nonlinear and multiparameter eigenvalue problems - Part 7

For Part 1 see: MS FT-1-3 1
For Part 2 see: MS FT-1-1 2
For Part 3 see: MS FT-1-1 3
For Part 4 see: MS FT-1-1 4
For Part 5 see: MS FT-1-1 5
For Part 6 see: MS FT-1-1 6

Organizer: Fernando De Terán	Universidad Carlos III de Madrid
Organizer: Froilán M. Dopico	Universidad Carlos III de Madrid

MS Organized by: SIAG/LA

Abstract: A nonlinear eigenvalue problem (NLEVP) is to find scalars x (eigenvalues) and nonzero vectors v,w (eigenvectors) satisfying F(x)v=0, w*F(x)=0, where F:C→Cnxn is a matrix-valued function. NLEVPs can be extended to multiparameter eigenvalue problems (MPEPs) F(x1,...,xd)v=0, w*F(x1,...,xd)=0, with F:Cd→Cnxn. Important cases of NLEVPs are the polynomial and rational eigenvalue problems, where the entries of F(x) are polynomial or rational functions. NLEVPs and MPEPs arise in many applications, and much research on these problems has been performed in the last years from computational and theoretical perspectives. This minisymposium presents the most recent advances in NLEVPs and MPEPs, and on their applications.

17:00-17:30

An algorithm for dense nonlinear eigenvalue problems

Françoise Marie Louise Tisseur	School Of Mathematics, University Of Manchester, UK
Gian Maria Negri Porzio	University of Manchester

Abstract: There have been numerous breakthroughs in the past ten years in the development of numerical methods for nonlinear eigenvalue problems mostly concentrating on algorithms and software for large sparse problems. The dense case has drawn less attention and there is lack of reliable software. In this talk we present an algorithm for the computation of all the eigenvalues of dense nonlinear eigenvalue problems in a given region of the complex plane and describe its implementation.

17:30-18:00

The Nonlinear FEAST Algorithm

Agnieszka Miedlar	University of Kansas
Mohamed El Guide	University of Minnesota
Brendan Gavin	University of Massachusetts Amherst
Eric Polizzi	University of Massachusetts Amherst
Yousef Saad	University of Minnesota

Abstract: Eigenvalue problems in which the coefficient matrices depend nonlinearly on the eigenvalues arise in a variety of applications, e.g., computational nanoelectronics. In this talk we will discuss how Cauchy integral-based approaches offer an attractive framework to develop highly efficient and flexible techniques for solving large-scale nonlinear eigenvalue problems. The nonlinear FEAST algorithm is used to determine eigenpairs corresponding to eigenvalues that lie in a user-specified region in the complex plane, thereby allowing for parallel calculations.

18:00-18:30

Nonlinear eigensolvers in SLEPc

José E. Román	Universitat Politècnica de València
Carmen Campos	Universitat Politècnica de València

Abstract: This talk gives an overview of the developments carried out in SLEPc, the Scalable Library for Eigenvalue Problem Computations, related to nonlinear eigenvalue problems (both polynomial and general). We describe the available solvers, and discuss implementation details such as parallelization. Attention will also be paid to applications that make use of our solvers.

18:30-19:00

NEP-PACK: a Julia package for nonlinear eigenproblems

Elias Jarlebring	KTH Royal Institute of Technology
Max Bennedich	KTH Royal Institiue of Technology
Giampaolo Mele	KTH Royal Institiue of Technology
Emil Ringh	KTH Royal Institiue of Technology
Parikshit Upadhyaya	KTH Royal Institiue of Technology

Abstract: We present an open-source library for nonlinear eigenvalue problems (NEPs): determine non-trivial solutions to , where is a holomorphic function. The library is designed for scientists working on algorithm development for high-performance computing, as well as scientists with specific NEP-applications. We provide efficient implementations of many state-of-the-art algorithms and also give access to recent research on applications. Transformations of the problem, such as rescaling and deflation, are supported natively by the library.

MS FE-1-3 7 17:00-19:00

Network based model reduction in large-scale simulations, imaging and data-science - Part 3

For Part 1 see: MS FE-1-3 5
For Part 2 see: MS FE-1-3 6

Organizer: Mikhail Zaslavskiy	Schlumberger
Organizer: Vladimir Druskin	Worcester Polytechnic Institute

Abstract: Model-driven and data-driven reduced-order models (ROMs) have been proven to be a useful tool for robust simulations of the response of large-scale dynamical systems as well as for reducing the complexity of inverse problems. Rather recently the list of applications has been extended by data science. ROM representation by sparsely-connected networks is crucial for both the approach efficiency and proper interpretation of ROM parameters. We will discuss various model reduction techniques and sparse network-based approximations with applications to both forward and inverse PDE problems as well as to machine learning and data science.

17:00-17:30

Ladder Network Realizations for dissipative wave equations

Jörn Zimmerling	University of Michigan
Vladimir Druskin	WPI
Murthy Guddati	NC State University
Rob Remis	TU Delft

Abstract: We extend the finite-difference Gaussian quadrature rules a.k.a. optimal grid from parabolic or lossless hyperbolic problems to dissipative wave propagation. For passive problems we show that data-driven reduced-order models of wave-impedances can be realized as a mechanical or electrical ladder networks with lumped elements or a coarse grid discretizations of the underlying PDE.

17:30-18:00

DISTANCE PRESERVING MODEL ORDER REDUCTION OF GRAPH-LAPLACIANS AND CLUSTER ANALYSIS

Mikhail Zaslavskiy	Schlumberger
Vladimir Druskin	Worcester Polytechnic Institute
Alexander Mamonov	University of Houston

Abstract: We design a reduced order proxy of the graph-Laplacian that allows to preserve the distances between nodes of priori chosen arbitrary vertex subset the full graph. Our approach is based on MIMO model-reduction of diffusive LTI systems approximating random walks on graphs. The constructed proxy can be applied on its own for accurate clustering of any graph vertices subset as well as a building block for multi-level clustering of entire graph.

18:00-18:30

REDUCED ORDER MODELS FOR SPECTRAL DOMAIN INVERSION: EMBEDDING INTO THE CONTINUOUS PROBLEM AND GENERATION OF INTERNAL DATA. TBD

Shari Moskow	Drexel University
Liliana Borcea	University of Michigan
Vladimir Druskin	WPI
Alexander Mamonov	University of Houston
Mikhail Zaslavsky	Schlumberger

Abstract: We generate reduced order Galerkin models for inversion of the Schrodinger equation given boundary data in the spectral domain for one and two dimensional problems. We show that in one dimension, after Lanczos orthogonalization, the Galerkin system is precisely the same as the three point staggered finite difference system on the corresponding spectrally matched grid. The reduced order model yields highly accurate internal solutions. We present inversion experiments based on the internal solutions.

18:30-19:00

Model reduction for modeling and simulation of viscoelastic materials

Elena Cherkaev	University of Utah

Abstract: The talk deals with model order reduction in application to modeling and simulation of the fields in viscoelastic microstructured media. The approach is based on matrix Pade approximation and network based model reduction of the spectral measure in the Stieltjes integral representation of the effective response of composite materials. We also discuss the fractional operator case.

MS A6-3-4 7 17:00-19:00

Electrodiffusion, fluid flow and ion channels: modeling, analysis and numerics - Part 2

For Part 1 see: MS A6-3-4 6

Organizer: Nir Gavish	Technion

Abstract: Concentrated aqueous electrolyte solutions play a crucial role in ionic transport in biological and electrochemical systems. Specifically, controlled ion permeation through ion channels governs an enormous range of biological function in health and disease. Electrolyte solutions are complex fluids driven by gradients of concentration, chemical and electrical potential, and hydrostatic pressure. This mini-symposium will provide an opportunity for researchers with various backgrounds to share ideas, methods, approaches and findings on modeling, analysis, numerics, and their applications to electrodiffusion and charged nano-fluidic phenomena in general and ion channel properties in particular.

17:00-17:30

Modeling and Simulation of Nanotechnological Sensors

Clemens Heitzinger	Technische Universität Wien
Amirreza Khodadadian	TU Wien
Daniel Pasterk	TU Wien
Leila Taghizadeh	TU Wien

Abstract: The modeling and simulation of nanotechnological sensors such as nanopores, nanowires, and nanoelectrodes lead to model equations such the nonlinear Poisson-Boltzmann equation, the drift-diffusion-Stokes-Poisson system, and the Boltzmann equation. Existence and uniqueness of the drift-diffusion-Stokes-Poisson system, applied to nanopores, is discussed. Furthermore, an adaptive multi-level Monte-Carlo algorithm for the drift-diffusion-Poisson system is presented, and finally Bayesian inverse problems are discussed.

17:30-18:00

On the selectivity of KcsA potassium channel: analysis and computation

Huaxiong Huang	York University
Zilong Song	York University
Xiulei Cao	York University
Tzyy-Leng Horng	Feng Chia University

Abstract: In this talk, we present both analysis and computational study of a mathematical model of the KcsA potassium channel, including effects of ion size (Bikerman model) and solvation energy (Born model). Under equilibrium conditions, we obtain analytical solution of our modified PNP system, which is used to explain selectivity of KcsA of various ions.

18:00-18:30

Asymptotic models for transport in large aspect ration nanopores

Marie-Therese Wolfram	University of Warwick

Abstract: Ion flow in charged nanopores is influenced by the ratio of the Debye length to the pore radius. We investigate the asymptotic behaviour of solutions to the Poisson–Nernst–Planck system for pores with small aspect ratio. This results in a quasi 1D PNP model, which can be further simplified to a fully 1D model. Finally we compare its solutions to the ones of the full 2D PNP model using numerical simulations.

18:30-19:00

Non-Isothermal Electrokinetic: Energetic Variational Approach

Pei Liu	Pennsylvania State University

Abstract: In order to understand how the temperature affects the electrokinetics, we develop a Poisson--Netnst--Planck--Fourier (PNPF) system through the energetic variational approach. With given form of the free energy functional and the entropy production, we achieve the mechanical equations and a temperature equation, which satisfy the laws of thermodynamics automatically. From the energy point of view, we also develop the numeric scheme which satisfy the discrete energy dissipation.

MS FE-1-G 7 17:00-19:00

Model-reduction, randomization, and other techniques for large-scale inversion and UQ

Organizer: Eric De Sturler	Virginia Tech
Organizer: Kirk Soodhalter	Trinity College Dublin
Organizer: Pranjal Pranjal	Virginia Polytechnic Institute and State Univ (Virginia Tech)

Abstract: Large scale scientific computing for design and data driven applications like inversion often requires the evaluation of numerous linear or nonlinear functionals in high dimensions, possibly coupled with other expensive computations like time integration, the repeated solution of a (stochastic) optimization problem, and uncertainty quantification. Making these computations tractable requires techniques like model reduction, randomization, special iterative solvers, as well as combinations of these. This minisymposium aims to organize and promote insightful discussions on recent trends in these techniques.

17:00-17:30

Efficient and Robust parametric model reduction for large nonlinear inverse problems

Eric De Sturler	Virginia Tech
Drayton Munster	Virginia Tech
Selin Aslan	Virginia Tech / Argonne National Lab
Misha Kilmer	Tufts University
Serkan Gugercin	Virginia Tech

Abstract: Nonlinear inverse problems involving PDEs with many measurements require many expensive solves in each optimization step, making the solution prohibitively expensive. Parametric reduced order models reduce these large systems to small ones, drastically reducing the solution cost. Two important problems remain.The reduced model error is often not available. Moreover, building accurate reduced order models itself is quite expensive. We discuss two methods to solve these problems and further reduce the costs of nonlinear inversion.

17:30-18:00

Efficient Bayesian Inversion for UQ for large inverse problems

Pranjal Pranjal	Virginia Polytechnic Institute and State Univ
Eric De Sturler	Virginia Tech

Abstract: Solving real-world partial differential equations (PDE) based inverse problems with many measurements can be computationally expensive: each evaluation of the associated (nonlinear) objective function and its derivatives requires solving many large-scale discretized PDEs. In this talk, I will discuss (with parameterized Diffuse Optical Tomography as the model problem) some sampling strategies for obtaining better UQ information and present a pseudo-marginal MCMC approach to reduce the tremendous computational cost associated with such problems.

18:00-18:30

Krylov subspace recycling for image reconstruction

Kirk Soodhalter	Trinity College Dublin

Abstract: In this talk, we discuss strategies for treating discretized ill-posed problems. We propose methods extending the Arnoldi-Tikhonov method to setting of augmented Krylov subspace methods. The Arnoldi-Tikhonov approach has multiple derivations, each leading to the same algorithm. These derivations leads to a different algorithm in the setting of augmented Krylov subspace methods. We present these new methods and demonstrate their behavior with experiments.

18:30-19:00

Techniques to counteract temporal delays in classical Adaptive Optics systems for astronomical observations

Markus Poettinger	Austia
Ronny Ramlau	Industrial mathematic Institute JKU

Abstract: In Adaptive Optics systems for ground-based telescopes, time delays poses a major challenge in the wavefront correction process. We introduce different techniques to counteract temporal delays, which reliey on a suitable shift of the reconstructed wavefronts. Required informations on the shifts are calculated based on previously reconstructed wavefronts. The performance of the temporal control algorithms are demonstrated using ESO's (European Southern Observatory) end-to-end simulation tool OCTOPUS.

MS GH-1-A 7 17:00-19:00

Theoretical Foundations of Deep Learning - Part 3

For Part 1 see: MS GH-1-A 5

For Part 2 see: MS GH-1-A 6

Organizer: Gitta Kutyniok	Technische Universität Berlin
Organizer: Philipp Petersen	University of Oxford

MS Organized by: SIAG/IS

Abstract: Deep learning is the key technology in the latest advances in self-driving cars, natural language processing, and medical diagnosis. Despite its overwhelming success, several empirically observed phenomena of this technique are not entirely understood, including the remarkable generalisation properties of the resulting classifiers, their tendency to exhibit adversarial examples, and the success of the underlying optimisation procedure despite a highly non-convex energy landscape. Several of these issues were addressed individually using various techniques from approximation theory, statistical learning theory, or optimisation. To achieve more profound insights, an exchange between the individual contributors is essential and the focus of this mini-symposium.

17:00-17:30

Interpreting Deep Neural Networks

Wojciech Samek	Fraunhofer Heinrich Hertz Institute

Abstract: Deep neural networks (DNN) are usually applied in a black box manner, i.e., no information is provided about what exactly makes them arrive at their predictions. This talk will present a general technique, Layer-wise Relevance Propagation (LRP), to explain predictions of complex DNN models. The effectivity of LRP will be demonstrated on various tasks and neural architectures, and its close relation to the theoretical concept of (deep) Taylor Decomposition will be discussed.

17:30-18:00

A Rate-Distortion Framework for Explaining Deep Neural Network Decisions

Jan Macdonald	Technische Universität Berlin
Stephan Waeldchen	Technische Universität Berlin
Sascha Hauch	Technische Universität Berlin
Gitta Kutyniok	Technische Universität Berlin

Abstract: We propose a rate-distortion framework for explaining neural network decisions. We formulate the task of determining the most relevant signal components for a classifier prediction as an optimisation problem. For the case of binary signals and Boolean classifier functions we show that it is hard to solve and to approximate. Finally, we present a heuristic solution strategy for deep ReLU neural network classifiers. We present numerical experiments and compare our method to other established methods.

18:00-18:30

Deep artificial neural networks overcome the curse of dimensionality in PDE approximation

Timo Welti	ETH Zürich
Arnulf Jentzen	ETH Zürich
Diyora Salimova	ETH Zürich

Abstract: In this talk it is revealed that deep artificial neural networks overcome the curse of dimensionality in the numerical approximation of Kolmogorov PDEs with constant diffusion and nonlinear drift coefficients. A crucial ingredient in our proof of this result is the fact that the artificial neural network used to approximate the PDE solution really is a deep network with a large number of hidden layers. See https://arxiv.org/abs/1809.07321 for more details.

18:30-19:00

Continuous Neural Networks - Theory and Numerical Methods

Lars Ruthotto	Emory University
Eldad Haber	UBC

Abstract: This talk provides a continuous formulation of deep residual neural networks as ordinary partial differential equations (ODEs). In this new mathematical paradigm, training deep neural networks can be cast as a dynamic optimal control problem. The talk outlines how this continuous interpretation can improve the effectiveness of deep neural networks. We will talk about the stability of continuous networks and their stable and accurate discretization and make the connection between stability and adversarial attacks.

MS A1-2-1 7 17:00-19:00

Numerical methods for multi-scale fluid problems - Part 1

For Part 2 see: MS A1-2-1 8

Organizer: Franck Emmanuel	INRIA
Organizer: Laurent Navoret	Université de Strasbourg / INRIA
Organizer: Jung Jonathan	LMAP, UPPA & Inria Cagire, Inria BSO

Abstract: Many hyperbolic models for fluids involve characteristic speeds with large ratio. From a numerical point, this large ratio raises several problems. Indeed, this ratio can induce accuracy problems to solve the slow scale but also time integration problem because of the restriction due to the fast waves. Such situation arises for instance in the low Mach regime of the Euler/MHD systems, for the quasi-neutral limit in Euler-Poisson system or for fluid models with singular pressure. Specific methods in time and space have to be devised to capture the flow with a good precision and a reasonable computational cost.

17:00-17:30

Semi implicit relaxation schemes for low-mach flows

Franck Emmanuel	INRIA
Bouchut François	Paris-Est University
Navoret Laurent	Strasbourg University

Abstract: We consider the implicit time discretization of compressible fluid models for weakly incompressible flows. The problems induced by the implicit scheme are nonlinear and ill-conditioned. In this work we propose an alternative method based on the relaxation schemes. This method allows to approximate the full complex nonlinear problem by a problem larger, but simpler with a stiff source term. We obtain new schemes accurate in the low mach regime with a very simple implicit part.

17:30-18:00

Second order TVD scheme for low-mach flow

Vignal Marie Hélène	University Paul Sabatier, Toulouse 3
Dimarco Giacomo	Department of Mathematics and Computer Science, University of Ferrara, Ferrara, Italy
Loubère Raphaël	CNRS and Institut de Mathématiques de Bordeaux (IMB) Université de Bordeaux, France
Michel-Dansac Victor	Institut de Mathématiques de Toulouse (IMT), INSA Toulouse, France

Abstract: I present implicit-explicit total variation diminishing methods for the compressible Euler system in the low-Mach number regime. Our scheme is asymptotically stable with a CFL condition independent from the Mach number and degenerates, in the low-Mach number regime, to a consistent discretization of the incompressible system. The TVD property is proved on a linear model equation and extended to the Euler case. Then, we show with numerical simulations that the method possesses the claimed properties.

18:00-18:30

Low Mach number compliant schemes: what one can learn from linear acoustics

Barsukow Wasilij	Universität Zürich

Abstract: Acoustic equations arise as a linearization of the compressible Euler equations. They also possess a low Mach number limit, which for acoustics is equivalent to the long time limit. By presenting an analysis of stationary states of numerical schemes I will describe a new way how low Mach number artefacts can be understood and corrected for linear acoustics. I will also show that low Mach compliance is equivalent to vorticity preservation.

18:30-19:00

Low Mach corrections and checkerboard modes

Jung Jonathan	LMAP, UPPA & Inria Cagire, Inria BSO
Perrier Vincent	Inria Cagire, BSO & LMAP, UPPA, Pau

Abstract: It is well known that finite volume schemes are not accurate at low Mach number in the sense that they do not allow to obtain the incompressible limit when the Mach number is small on Cartesian meshes. These schemes needs corrections. These corrections could induce checkerboard modes. We will present some results about these checkerboard modes.

MS GH-0-1 7 17:00-19:00

Reduced-order modeling and data-driven estimation in waves and fluids - Part 1

For Part 2 see: MS GH-0-1 8

Organizer: Christina Frederick	NJIT
Organizer: Yoonsang Lee	Dartmouth College

Abstract: The design of multiscale approaches is a top priority in many physical applications, including ocean acoustics, where costly simulations of high-frequency wave propagation pose major difficulties, and geophysical flow, where turbulence modeling must account for spatial scales ranging from a few meters to hundreds of kilometers. Low-cost reduced-order models must be designed to include important features that can then be recovered via inversion. Despite progress within specific areas, there is a lack of unified methodology. This minisymposium addresses reduced-order modeling approaches to efficiently incorporate accurate physics and data to solve challenging inverse problems in real-world settings.

17:00-17:30

A seamless homogenization method for multiscale diffusion and advection operators

Yoonsang Lee	Dartmouth College
Bjorn Engquist	The University of Texas at Austin

Abstract: We propose a methodology that homogenizes diffusion and advection tensors without scale separation. In particular, we investigate a specific decomposition method that imposes artificial scale separation and allows a small scale homogenization independent of larger scale components. A transformation technique minimizes the interaction between different scale components to enables the computational complexity to increase linearly in the number of different scale components. We present theory and provide numerical tests including a non-separable scale diffusion tensor.

17:30-18:00

Deep learning for sesimic substructure detection

Xu Yang	University of California, Santa Barbara

Abstract: We propose a deep learning algorithm for seismic interface and pocket detection with neural networks trained by synthetic high-frequency displacement data efficiently generated by the frozen Gaussian approximation (FGA). The convolutional neural network models are built by an open source API, GeoSeg, developed using Keras and Tensorflow. Results with a high accuracy are shown for both simple and complicated geometries including layered structures, and 2D-pocket models with networks trained by both clean and noisy data.

18:00-18:30

Bayesian parameter estimation targeting marginal distributions using local surrogate models with Markov chain Monte Carlo

Andrew Davis	CRREL

Abstract: Bayes' rule defines a posterior distribution over high dimensional parameters. We partition parameter space into parameters of interest, characterized with Markov chain Monte Carlo (MCMC), and parameters to be marginalized away. Pseudo-marginal MCMC requires repeated importance sampling estimates of the posterior density—this is computationally prohibitive. We construct a surrogate from marginal density estimations during MCMC. Continual refinement ensures asymptotically exact sampling. We balance the surrogate bias with MCMC variance, guiding an ideal refinement strategy.

18:30-19:00

Entropy stable reduced order modeling for nonlinear conservation laws

Jesse Chan	Rice University

Abstract: Reduced order models for nonlinear conservation laws based on Galerkin projection are often unstable in the presence of shocks and turbulence. We address this instability by combining skew-symmetric entropy stable discretizations with Galerkin projection, such that physically relevant solutions of the reduced model inherit a semi-discrete entropy inequality independently of discretization errors and under-resolved solution features. Preliminary results are presented for finite volume discretizations of the compressible Euler equations in one and two dimensions.

MS A6-1-1 7 17:00-19:00

Data-driven mathematical Models of Cell Migration

Organizer: Kevin Flores	North Carolina State University
Organizer: John Nardini	NC State University
Organizer: Erica Rutter	North Carolina State University

Abstract: Spatiotemporal models have provided a wealth of insight into the dominant mechanisms underlying cell migration during many processes, including wound healing, development, and cancer. Recent studies in this area have focused on determining how differences in cellular phenotypes influence the ultimate behavior of the population. Current challenges for researchers include deriving multiscale models that translate these individual cell mechanics to population behavior as well as methods to accurately infer individual mechanics from data. Speakers in this minisymposium will present recent approaches to these challenges with emphasis on wound healing and developmental biology.

17:00-17:30

Learning PDE models from noisy spatiotemporal data

John Nardini	NC State University
John Lagergren	N.C. State University
Gary Lavigne	N.C. State University
Erica Rutter	N.C. State University
Kevin Flores	N.C. State University

Abstract: Recent equation learning studies have only been successful in the presence of small amounts of noise. We develop a method here to denoise noisy data to aid the equation learning process. We demonstrate several instances where this method can correctly identify the PDE model that generated noisy spatiotemporal data. This work is a first step towards developing a methodology to generate data-driven models from biological data.

17:30-18:00

Using Automated Biomedical Image Segmentation to Investigate Cell Morphology

Erica Rutter	North Carolina State University

Abstract: In order to validate mathematical models, large amounts of quantitative data are often required but are expensive to obtain. Here we present a novel machine learning algorithm to automatically hyper-accurately segment cells in microscopy images. The deep convolutional neural network mimics the human task of tracing objects in an image. Using these hyper-accurate cell segmentations, we investigate how cell morphology influences, or is ifluenced by, cell migration in chemotaxis assays.

18:00-18:30

Spreading Mechanics and Differentiation of Astrocytes During Retinal Development

Tracy Stepien	University of Arizona
Timothy Secomb	University of Arizona

Abstract: In embryonic development, formation of the retinal vasculature is critically dependent on prior establishment of a mesh of astrocytes. Astrocytes emerge from the optic nerve head and then migrate over the retinal surface in a radially symmetric manner and mature through differentiation. We develop a PDE model describing the migration and differentiation of astrocytes, and numerical simulations are compared to experimental data to assist in elucidating the mechanisms responsible for the distribution of astrocytes.

18:30-19:00

Explaining the dynamic steady state of actin networks

Angelika Manhart	Imperial College London
Alex Mogilner	New York University
Laurent Blanchoin	CytomorphoLab
Aleksandra Icheva	CytomorphoLab

Abstract: Many cells use actin networks for movement. This requires "macroscopic treadmilling": assembly at the front balances disassembly at the rear. We combine a biomimetic system with mathematical modeling to investigate how cofilin, a known disassembly agent, creates dynamic networks of fixed lengths. To capture the observed macroscopic network fragmentation we combine PDE-based modelling of cofilin binding dynamics with a discrete network disassembly model. This allows to predict the equilibrium network length across various control parameters.

MS FT-2-2 7 17:00-19:00

Orthogonal polynomials and quadrature: Theory, computation, and applications - Part 3

For Part 1 see: MS FT-2-2 5
For Part 2 see: MS FT-2-2 6

Organizer: Miroslav Pranic	University of Banja Luka
Organizer: Lothar Reichel	Kent State University

Abstract: Quadrature rules find many applications in science and engineering. Their analysis is a classical area of applied mathematics and continues to attract considerable attention. This seminar brings together speakers with expertise in a large variety of quadrature rules. It is the aim of the seminar to provide an overview of recent developments in the analysis of quadrature rules. The computation of error estimates and novel applications also are described.

17:00-17:30

Sensitivity of Gauss quadrature - a problem that has been missed?

Zdenek Strakos	Charles University

Abstract: Numerical quadrature approximates Riemann-Stieltjes integrals by weighted sums of function values at the quadrature nodes. For smooth integrands and small changes of the distribution function defining the integral it seems that the difference between the quadratures must be of the same order as the difference between the approximated integrals. This reasoning is with the Gauss quadrature fundamentally wrong. A small change in the distribution function can cause a dramatic change in the quadrature result.

17:30-18:00

About quadrature rules that are used for error estimation of the Gauss quadrature

Miroslav Pranic University of Banja Luka
Tatjana Zec University of Banja Luka

Abstract: The known results about the Gauss quadrature for an arbitrary linear functional are used to explain some facts about some quadrature rules that are used for error estimation of the Gauss quadrature for a positive definite linear functional. Particular attention will be paid to the Gauss-Kronrod quadrature rule with complex nodes and weights.

18:00-18:30

Generalized averaged Gaussian quadrature and applications

Miodrag Spalevic Univesity of Belgrade

Abstract: A simple numerical method for constructing the optimal generalized averaged Gaussian quadrature formulas will be presented. These formulas exist in many cases in which real positive Gauss-Kronrod formulas do not exist, and can be used as an adequate alternative in order to estimate the error of a Gaussian rule. We also investigate the conditions under which the optimal averaged Gaussian quadrature formulas and their truncated variants are internal.

18:30-19:00

General case of Gaussian quadrature formulae with the third class of Bernstein-Szego weights

Aleksandar Pejcev University of Belgrade

Abstract: For analytic functions we study the remainder terms of Gauss quadrature with Bernstein-Szeg

o weight $w(t)=w_{\alpha,\beta,\delta}(t)=\frac{\sqrt{\frac{1+t}{1-t}}}{\beta(\beta-2\alpha)t^2+2\delta(\beta-\alpha)t+\alpha^2+\delta^2}, t\in(-1|1)$, where $0<\alpha<\beta, \beta 2\alpha, \vee \delta \vee \beta-\alpha$, and whose denominator is an arbitrary polynomial of exact degree 2 that remains positive on $[-1|1]$. The subcase $\alpha=1$, $\beta=2/(1+\gamma)$, $-1<\gamma<0$ and $\delta=0$ has been considered recently by M. M. Spalevi, Error bounds of Gaussian quadrature formulae for one class of Bernstein-Szeg
o weights, Math. Comp., 82 (2013), 1037-1056.

MS FT-4-3 7 17:00-19:00

Optimisation and Inverse Problems in Imaging Science - Part 4

For Part 1 see: MS FT-4-3 4
For Part 2 see: MS FT-4-3 5
For Part 3 see: MS FT-4-3 6
Organizer: Fiorella Sgallari University of Bologna
Organizer: Raymond Chan The City University of Hong Kong

Abstract: Next-generation imaging and diagnostics provide an unprecedented step forward in our knowledge in imaging science. Defining new approaches to handle images is both fundamental and challenging due to the huge amount of data and the need for a precise and self-consistent analysis. By combining experiences from different fields, this mini-symposium aims at creating an interdisciplinary bridge that can enrich all research areas. This mini-symposium is dedicated to Prof. Mila Nikolova whose contributions on inverse problems and models such as non-smooth and nonconvex ones were substantial and lasting.

17:00-17:30

Image Fusion via a Provably Convergent Plug-and-Play ADMM Algorithm

Mario Figueiredo Instituto de Telecomunicações, Instituto Superior Técnico, Universidade de Lisboa

Abstract: We propose a new approach to image fusion, inspired by the recent plug-and-play (PnP) framework, wherein a scene-specific denoiser (based on Gaussian mixture models) is used as a regularizer for image fusion problems. The form of the regularizer allows proving convergence of the proposed PnP-ADMM algorithm. Experiments on hyperspectral fusion show that the proposed method achieves state-of-the-art results.

17:30-18:00

Mirror stratifiable functions in optimization and inverse problems

Jalal Fadili Normandie Université-ENSICAEN

Abstract: This talk will present a set of activity identification results for a class of convex functions with a strong geometric structure, that we coin ``mirror-stratifiable". This class of functions encompasses all regularizers routinely used in signal and image processing, machine learning, and statistics. We show that this ``mirror-stratifiable" structure enjoys nice activity identification with crucial implications for inverse problems and optimization where the non-degeneracy condition is not fulfilled.

18:00-18:30

Some recent advance in nonsmooth nonconvex optimization : the ASAP algorithm

Pauline Tan Sorbonne Université and CNRS
Nikolova Mila CMLA, CNRS, ENS Cachan, 94235 Cachan, France
Pierre Fabien CNRS, Inria, LORIA, Université de Lorraine, 54000 Nancy, France

Abstract: In this talk, I will introduce a novel algorithm called ASAP which aims at solving nonsmooth nonconvex optimization. This algorithm can be seen as a mirror-algorithm of the well-known PALM method, in the sense that the forward and the backward steps are applied to different parts of the objective function. After providing some theoretical insights of the problem and convergence results of ASAP, I will present extensions and applications in imaging.

18:30-19:00

A survey of some of the work by Mila Nikolova

Raymond Chan The City University of Hong Kong
Mila Nikolova ENS, Cachan

Abstract: In this talk, I will present a brief overview of the work that Mila and I did together, from the old results on impulse noise removal and exact histogram specification to the recent results on segmentation, hyperspectral image classification, and point source localization for rotating point-spread functions.

MS A6-5-3 7 17:00-19:00

The CJK-SIAMs joint mini-symposium on Mathematical Biology - Part 1

For Part 2 see: MS A6-5-3 8
Organizer: Jae Kyoung Kim KAIST
Organizer: Lei Zhang Peking University

Abstract: Data analysis and modeling of multiscale dynamics in biology and medicine from molecules to cells Biological systems are regulated across many orders of magnitude in space and time. To investigate dynamics of each scale, various tools for data analysis and modeling have been developed. Furthermore, integrating dynamics from one scale to another is critical. In this session, we will present recent progress in multi-scale modeling and data analysis such as accurate projection of high-dimensional system to low-dimensional system, topological data analysis and network analysis.

17:00-17:30

Analyzing timeseries data of biological systems with hidden components

Jae Kyoung Kim KAIST
Kresimir Josic University of Houston
Matthew Bennet Rice University
Boseung Choi Korea University

Abstract: Despite dramatic advances in experimental techniques, many facets of intracellular dynamics remain hidden, or can be measured only indirectly. In this talk, I will describe two strategies to analyze timeseries data of biochemical reaction networks with the hidden parts. Then, I will illustrate how these strategies are used to understand the processes of protein maturation and drug metabolism.

17:30-18:00

Quantitative analysis of biological networks using mathematical models

Mariko Okada Osaka University

Abstract: Cell fate decision is made from temporal regulation of biochemical network. In particular, signaling network is unique in a way that it converts graded extracellular signals to discrete transcription factor activities in nucleus. Our laboratory aims to uncover the molecular mechanism of signal-dependent transcriptional regulation in cancer and immune systems using ODE-based mathematical model. In this session, I will talk about quantitative regulation of NF-kappaB transcription factor activity and logical strategies to control this activity.

18:00-18:30

Topological data anaysis of vascular disease for general vasculatures

Jae-Hun Jung	SUNY Buffalo/Ajou University
Christopher Bresten	Ajou University
John Nicponski	SUNY Buffalo

Abstract: Vascular disease is the leading cause of death world-wide. Accurate diagnosis and prediction are important for propoer treatment. We developed a new diagnosis approach based on topological data analysis (TDA), with which the flow complexitiy is measured using homology of vascular data. In this talk, we generalize the TDA approach for general vasculatiures with the principle component analysis and the mapping into sphere for prediction. We show several numerical results from the patient data.

18:30-19:00

Network Analysis of the scRNA-Seq data

Tiejun Li	Peking University

Abstract: Distinguishing the transition cells from the well-defined, meta-stable cell states is crucial to dissect the cell-fate decision process with high resolution. We present a novel method to reveal the cell-fate transition dynamics and discover the transition cells in single-cell transcriptomic data. Application of our method to induced pluripotent stem cells (iPSCs) differentiation and other scRNA-seq data unraveled the gene expression feature of the transition cells, and systematically uncovered the latent heterogeneity of upcoming cell-fate.

MS A3-2-2 7 17:00-19:00

Phase-Field Models in Simulation and Optimization - Part 3

For Part 1 see: MS A3-2-2 5
For Part 2 see: MS A3-2-2 6

Organizer: Wollner Winnifried	TU Darmstadt
Organizer: Wick Thomas	Leibniz Universität Hannover
Organizer: Alessi Roberto	Sapienza - Università di Roma

Organized by the GAMM activity group "Optimization with Partial Differential Equations" (OPDE)

Abstract: Phase-field models are of recent interest for the simulation of fracture and damage phenomena as well as in topology optimization. This minisymposium will provide a forum for discussions of modeling, discretization techniques, algorithms, and optimization based on phase-field models.

17:00-17:30

The ratio of torsional to flexural rigidity and the morphology of plant stem cross-sections

Wolff-Vorbeck Steve	Universität Freiburg

Abstract: Tailoring their resistance to twisting and bending under mechanical loading is a necessary evolutionary response of many plants. In particular, increasing the ”twist-to-bend ratio” is often advantageous if this can be achieved by small changes to the geometry of the plant stem cross-section. With the help of phase field models, we analyze this problem and compare numerically optimized cross-section shapes to plant specimens.

17:30-18:00

Approximation of a connected perimeter by phase-fields

Dondl Patrick	Universität Freiburg

Abstract: We develop a phase-field approximation of the relaxation of the perimeter functional in the plane under a connectedness constraint based on the classical Modica-Mortola functional and a diffuse quantitative version of path-connectedness. We prove convergence of the approximating energies and present numerical results and applications to image segmentation.

18:00-18:30

Phase field methods for tumour growth

Harald Garcke	University Regensburg

Abstract: Tumour growth models have been successful in describing many phenomena relevant for medical application. We will present phase field systems for tumour growth by coupling the Cahn-Hilliard equation to a diffusion equation for a nutrient. In addition, also a coupling to flow equations of Darcy and Stokes type are discussed. We will present existence and uniqueness results, optimal control problems as well as patient specific parameter estimation using reduced order modeling.

18:30-19:00

Optimal Control of Two-Phase Flow

Christian Kahle	Technische Universität München
Garcke Harald	Universität Regensburg
Hinze Michael	Universität Hamburg

Abstract: We present results on optimal control of two-phase flows that are modeled by the diffuse interface model proposed in [H. Abels, H. Garcke, G. Grün, M3AN, 22(3), 2012]. In [H. Garcke, M. Hinze, C. Kahle, APNUM, 99, 2016] we proposed a discretization scheme for this model that we now employ in an optimal control problem. We show existence of solutions and derive first order neccessary optimality conditions for the time discrete optimal control problem.

MS GH-3-4 7 17:00-19:00

The CJK-SIAMs joint mini-symposium on Inverse Problems: Theory and Computation - Part 1

For Part 2 see: MS GH-3-4 8

Organizer: Gang Bao	Zhejiang University
Organizer: Zhiyuan Li	Shandong University of Technology
Organizer: Jin Keun Seo	Yonsei University

Abstract: Recent advances on inverse problems that arise from various application areas will be reported. Of particular interest are inverse problems in wave propagation, fluorescence imaging, fractional diffusion, medical imaging, and computed tomography imaging. Mathematical and computational results will be discussed. The results are drawn from recent research projects funded by an ongoing international collaborative research project funded by China, Japan, and Korea.

17:00-17:30

Inverse Source Problems in Wave Propagation

Gang Bao	Zhejiang University

Abstract: Inverse source scattering arises in diverse application areas including seismic/medical imaging. Recent results on the boundary integral equation will be presented for elastic wave scattering. Unified stability analysis will be discussed for acoustic/EM/elastic waves. New Lipschitz type stability results for the multiple frequency case overcome the ill-posedness of the fixed frequency cases. Uniqueness for the time-dependent elasticity problems will be addressed. Recent studies of the inverse medium problems will he reported.

17:30-18:00

On fluorescence imaging by diffusion process: model and algorithm

Jijun Liu	School of mathematics, Southeast University

Abstract: Quantifications of fluorescence imaging can be modeled by an inverse problem for the coupled radiative transfer equations. We unify this model with two kinds of inversion input data into a coupled diffusion system with extra boundary data. This inverse problem is linearized, with error estimates on the solution to the inverse problem. The uniqueness of roconstruction is rigorously analyzed, revealing the physical essence of this imaging model. The reconstruction algorithm is also presented.

18:00-18:30

Mathematical analyses for inverse problems for fractional diffusion equations

Zhiyuan Li	Shandong University of Technology
Masahiro Yamamoto	The University of Tokyo
Yuri Luchko	Technical University of Applied Sciences in Berlin
Yavar Kian	Aix-Marseille University
Yikan Liu	The University of Tokyo

Abstract: Fractional diffusion models have received great attention in applied disciplines due to the succeeding in modeling physical processes such as anomalous diffusion. However, some important parameters in the model, e.g., orders of the fractional derivative or source term, are often unknown and difficult to be measured. In this talk, we consider several inverse problems for determining these physical quantities in order to match available data such as using the interior observation or Dirichlet-to-Neumann map.

MS A1-3-1 7 **17:00-19:00**

PDE-based models and their computational simulation - Part 2

For Part 1 see: MS A1-3-1 6

Organizer: Gerardo Hernandez-Duenas	National Autonomous University of Mexico
Organizer: Lorenzo Héctor Juárez Valencia	Universidad Autónoma Metropolitana - Iztapalapa
Organizer: Miguel Angel Moreles	Centro de Investigación en Matemáticas
Organizer: Pedro Gonzalez Casanova H	UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO

Abstract: The evolution of a great variety of natural or physical phenomena can be described by physical laws expressed in terms of rates of change or gradients of appropriate variables, resulting in Partial Differential Equations. Exact solutions of PDE-based models are not always available and correctly computing numerical approximations could involve several theoretical and computational challenges. The aim of this proposed mini-symposium is to provide a platform for participants to present novel PDE-based models in areas such as shallow water flows, microscale materials, and biological systems. The talks will discuss theoretical aspects of the models or show associated robust numerical schemes.

17:00-17:30

Parameter estimation for the shallow water equations

Lorenzo Héctor Juárez Valencia	Universidad Autónoma Metropolitana - Iztapalapa
Jessica T. Rojas Cuevas M.S.	

Abstract: We consider the numerical estimation of the Manning's roughness coefficient for the 1D shallow water equations using variational data assimilation. The quadratic cost functional may include measurements at one final time and different regularizations. The optimization problem is solved with a nonlinear Polak-Rivière conjugate gradient algorithm and the adjoint method. A finite volume scheme with a Roe's Riemann solver is employed to solve the hyperbolic problems. Numerical results are presented.

17:30-18:00

New hydrodynamic model for three-dimensional free-surface flows on irregular domains

Miguel Uh Zapata	CIMAT-Mérida
Damien Pham Van Bang	Laboratory for Hydraulics and Environment, Institut National de la Recherche Scientifique, Quebe
Kim Dan Nguyen	Saint-Venant Laboratory for Hydraulics, Université Paris-Est, ENPC-EDF-CEREMA, Chatou, France

Abstract: Although numerous low-dimensional hydrodynamic models have been developed, 3D models are more appropriate since they can provide information about different processes such as erosion, deposition, vertical and transverse diffusion in all directions. In this presentation, we show a 3D Navier-Stokes algorithm recently developed by our research group, which is now able to simulate flows in different environments. The system of equations is treated by an unstructured finite volume method, a sigma-transformation and a projection technique.

18:00-18:30

The Green matrix-function for a boundary value problem

María Monserrat Morín Castillo	Benemérita Universidad Autónoma de Puebla
José Jacobo Oliveros-Oliveros	Benemérita Universidad Autónoma de Puebla
José Julio Conde-Mones	Benemérita Universidad Autónoma de Puebla
José Moisés Gutiérrez-Arias	Benemérita Universidad Autónoma de Puebla

Abstract: The Green function is used for finding the solutions of boundary value problems by integral operators in which the Green function is the kernel. For the case of non-homogeneous media, compound by two coupling homogeneous media, the kernel of the integral operator is given by the Green matrix-function. In this talk is presented a Green matrix-function for an elliptic boundary problem associated with the inverse electroencephalographic problem.

18:30-19:00

Coupling methodologies for Joint inversion of Geophysical data

Emilia Fregoso	Universidad de Guadalajara
Miguel Ángel Moreles	CIMAT
Abel Palafox	Universidad de Guadalajara

Abstract: The cross-gradient joint inversion strategy has been successfully applied to various combinations of geophysical data in the search of models with enhanced structural similarity, that facilitate the interpretation of the subsurface characteristics. The coupling to cross-gradients of other structural methodologies as Euler deconvolution or Bayesian formulations reduces the ambiguity in depth resolution that occurs when potential-field data are jointly inverted.

MS ME-1-4 7 **17:00-19:00**

Stabilization of distributed parameter systems: design methods and applications - Part 3

For Part 1 see: MS ME-1-4 5

For Part 2 see: MS ME-1-4 6

Organizer: Alexander Zuyev	Max Planck Institute Magdeburg
Organizer: Grigorij Sklyar	University of Szczecin

Abstract: The stabilization problem for infinite-dimensional control system has close connections with methods of functional analysis and important applications in different branches of science and engineering. This Minisymposium aims at bringing together presentations dealing with stabilizing control design for different classes of dynamical systems described by partial differential equations, functional-differential equations, delay equations, and dynamical systems in abstract spaces. This includes new results in the theory of nonlinear semigroups, port-Hamiltonian systems, and further developments of Lyapunov's direct method. The scope of the Minisymposium also covers applications of these methods to mathematical models in continuum mechanics, chemical engineering, and transportation networks.

17:00-17:30

H2 analysis and controller synthesis for a class of delay differential algebraic systems

Wim Michiels	KU Leuven

Abstract: We consider a class of systems described by linear semi-explicit Delay Differential Algebraic Equations with multiple delays. We first provide necessary and sufficient conditions for the finiteness of the H2 norm, in which the rational dependency structure of the delays plays an important role. Second, we present a formula for computing the H2 norm in terms of an associated neutral equation. Finally we outline the synthesis of feedback controllers optimizing an H2 type cost function.

17:30-18:00

Robust observer-based feedback for the incompressible Navier-Stokes equation

Heiland Jan	Max Planck Institute Magdeburg
Benner Peter	Max Planck Institute for Dynamics of Complex Technical Systems

Abstract: The stabilization of laminar flows on the base of linearizations and feedback controllers has been the subject of many recent theoretical and computational studies. However, the applicability of the standard approaches is limited due to the inherent fragility of observer based controllers with respect to model uncertainties. We analyse how an uncertainty in the Oseen-linearization of the Navier-Stokes equations affects the controller design and show that H-infinity robustness can handle these perturbations.

18:00-18:10

On polynomial stability of certain class of C0 semigroups

Sklyar Grigory	University of Szczecin
Piotr Polak	Institute of Mathematics, University of Szczecin

Abstract: We consider linear differential equation where is a closed (usually unbounded) operator generating C0 semigroup on Banach space X. The talk is devoted to various aspects of stability of the semigroup T(t) and corresponding solutions T(t)x. We will focus on polynomial stability of certain class of equations (related to delay equations). We present the sufficient condition for polynomial stability, which is connected with the rate of approaching points of spectrum to the imaginary axis.

18:30-19:00

On the stabilization of a class of infinite-dimensional systems by extremum-seeking controllers

Victoria Grushkovskaya	Institute of Mathematics, Julius Maximilian University of Würzburg

Alexander Zuyev — Max Planck Institute for Dynamics of Complex Technical Systems

Abstract: The talk is devoted to the development of extremum seeking (ES) controls which aim, in a simple setup, to stabilize a system at the point of minimum (or maximum) of the cost function using only output measurements. The first part of the talk introduces our recent results on generating ES strategies for finite-dimensional control systems. In the second part, we will discuss extensions of these results to extremum seeking problems for distributed parameter systems.

MS FT-S-6 7 — 17:00-19:00

Recent advances on numerical methods and applications of phase-field models - Part 3

For Part 1 see: MS FT-S-6 5
For Part 2 see: MS FT-S-6 6
For Part 4 see: MS FT-S-6 8
Organizer: Chuanju Xu — Xiamen University

Abstract: Interfacial dynamics in complex fluids presents tremendous challenges to science. From a fluid mechanical viewpoint, the essential physics is the coupling between interfacial movement and the flow of the bulk fluids. Phase field methods start from a multi-scale point of view and treat the interface as a microscopic transition zone of small but finite width. Then a set of governing equations can be derived that are thermodynamically consistent and mathematically well-posed. This mini-symposium will bring together numerical analysts and computational scientists working on phase field methods to present their recent advances in algorithm designs and applications of phase field methods.

17:00-17:30

Linearly Stabilized Semi-Implicit Schemes for Phase-Field Equations

Haijun Yu — Academy of Mathematics and Systems Science, CAS

Abstract: Efficient and stable high order time schemes are very important but not easy to construct for nonlinear phase dynamics. We present several linear second order semi-implicit schemes for the phase-field Allen-Cahn and Cahn-Hilliard equation, where the nonlinear bulk forces are treated explicitly with second-order stabilization terms. Rigorous error analysis show that the schemes are second order accurate in time with a prefactor controlled by some lower degree polynomial of the inverse of interface thickness parameter.

17:30-18:00

Network formation in highly amphiphillic polymers

Keith Promislov — Michigan State University

Abstract: We present an overivew of the rich structure formed within the Functionalized Cahn Hilliard free energy as a model of self assymbly of network structures within amphiphillic polymers. This higher order model accomodates multiple interfacial and higher codimension structures, and supports bifurcations that trigger high frequency structure within the diverse set of morphologies. We present analytical reductions, simulations, and describe the challanges to obtaining accurate, effecient computational schemes.

18:00-18:30

Exponential time differencing methods for phase-field models

Zhonghua Qiao — The Hong Kong Polytechnic University

Abstract: Exponential time differencing (ETD) methods will be developed for solving phase field equations. ETD method is a very efficient ordinary differential equation solver, which solves the linear part of the equation exactly by using the exponential integral factors and keep exponential behavior of the system. Our numerical schemes preserve the property of energy decay in the discrete sense, which is the fundamental physical feature of the solutions to phase field models as the gradient flows.

18:30-19:00

Preconditioned Steepest Descent Methods for some Nonlinear Elliptic Equations Involving p-Lap

Abner Salgado — University of Tennessee at Knoxville

Abstract: We describe and analyze preconditioned steepest descent (PSD) solvers for fourth and sixth-order nonlinear elliptic equations that include p-Laplacian terms on periodic domains in 2 and 3 dimensions. Based on certain reasonable assumptions of the linear pre-conditioner, a geometric convergence rate is shown. We apply the general theory to the fourth and sixth-order problems of interest, making use of Sobolev embedding and regularity results.

MS ME-0-3 7 — 17:00-19:00

Delay and other dynamical systems with applications to mathematical biology - Part 1

For Part 2 see: MS ME-0-3 8
For Part 3 see: MS ME-0-3 9
Organizer: Elena Braverman — Department of Mathematics and Statistics, University of Calgary

Abstract: The purpose of this minisymposium is to bring experts in delay differential, difference and partial differential equations and and to discuss recent advancement in the area, as well as applications of dynamical systems to emerging areas of mathematical biology. In theoretical advancement, the focus is on asymptotic behaviour, in particular local and global stability, and its control. The areas of application include population dynamics, in a laboratory setting such as a chemostat, and in nature, as well as gene regulatory networks. We plan to bring together a really international team of experts from more than 6 countries.

17:00-17:30

Target oriented control of higher order difference equations and systems with applications

Daniel Franco Leis — Universidad Nacional de Educación a Distancia

Elena Braverman — University of Calgary

Abstract: In contrast with unstructured models, structured discrete population models have been able to fit and predict chaotic experimental data. However, most of the chaos control techniques in the literature have been designed and analyzed in a one-dimensional setting. In the talk, we will introduce target oriented control for discrete dynamical systems and we will show that this control is able to stabilize a chosen state for a wide range of structured population models.

17:30-18:00

Lyapunov functions for perturbed systems in epidemiology

Connell Mccluskey — Wilfrid Laurier University

Abstract: In attempting to find a Lyapunov function for a new disease model, we often consider the new system to be a modification (or perturbation) of an earlier model for which a Lyapunov function is known. We then modify the known Lyapunov function and hope it works for the new system. Can this be done in a systematic way? Can we characterize when it will work?

18:00-18:30

On controllability of gene regulatory networks

Felix Sadyrbaev — Institute of Mathematics and Computer Science

Svetlana Atslega
Eduard Brokan

Abstract: A multi-parameter system of ordinary differential equations modelling the interrelation of elements in gene regulatory networks is considered. Types of attractors are described. The possibility of driving the system from an undesired state to desired one is discussed.

18:30-19:00

Mathematical modeling of social insect colonies with delay

Yun Kang — Arizona State University
Jun Chen — Arizona State University
Brian Sweeney — Arizona State University
Komi Messan — U.S. Army Engineer Research and Development
Gloria DeGrandi-Hoffman — United States Department of Agriculture

Abstract: The life stages of social insects, such as ants, bees, wasps, include egg, larvae, pupae and adult, with distinct maturation time for each stage. We will discuss how delay due to maturation time affect the population dynamics, and how the related delay combined with parasitism may destablize the population with strong Allee effects and eventually lead to the collapsing of population. The potential effects of seasonality will aslo be discussed.

MS ME-0-6 7 — 17:00-19:00

Recent study in nonlinear filtering

Organizer: Xue Luo — BEIHANG UNIVERSITY

Organizer: Stephen S.-T. Yau Tsinghua University

Abstract: In our proposed minisymposium titled "Recent study in nonlinear filtering (NLF)", we shall discuss the most recent progress on the study of NLF problems, from the viewpoint of both theoretical and computational. It is well-known that NLF has wide range of applications in target tracking, weather forecasting etc. We are aim to gather the newest trend of the algorithms and theories in this field. In our minisymposium, there are interesting and up-to-date topics, including the optimal filtering driving by Levy process, the well-posedness of feedback particle filter, the prediction of some Gauss-Volterra Processes, etc.

17:00-17:30

The f-divergence invariance property and the well-posedness of feedback particle filter

Xue Luo Beihang Univeristy

Abstract: In this talk, we shall derive the admissible control input of the multivariate feedback particle filter (FPF) by minimizing the f-divergence of the posterior conditional density function and the empirical conditional density of the controlled particles. We show that the invariance property of this control input. Next, we show the uniqueness of the control input if it is the gradient of certain potential in some suitable functional space under certain regularity conditions.

17:30-18:00

Prediction of some Gauss-Volterra Processes and Related Processes

Tyrone E. Duncan University of Kansas

Abstract: Gauss-Volterra processes are a family of Gaussian processes that can be represented as singular integrals of Brownian motion and include fractional Brownian motions with the Hurst parameter greater than one-half, Liouville fractional Brownian motions, and multi-fractional Brownian motions. The solutions of prediction for these processes as well as predictions of solutions of linear and bilinear equations driven by these processes are given explicitly.

18:00-18:30

Large deviations for the optimal filter of nonlinear dynamical systems driven by Levy noise

Jie Xiong Southern University of Science and Technology

Abstract: We focus on the asymptotic behavior of the optimal filter where both signal and observation processes are driven by Lévy noises. Indeed, we study large deviations for the case where the signal-to-noise ratio is small by considering weak convergence arguments. This talk is based on a joint paper with Maroulas and Pan.

18:30-19:00

Real-Time Solution of Time-Varying Yau Filtering Problems via Direct Method and Gaussian Approximation

Xiuqiong Chen Tsinghua University
Ji Shi Tsinghua University
Stephen Yau Tsinghua University

Abstract: Direct method for Yau filtering system are limited in time-invariant systems. In this work, we extend the direct method to time-varying cases. The novelty of this work is that we propose several transformations on the forward Kolmogorov equation so that it can be solved by means of solving some ordinary differential equations if the initial distribution is Gaussian. The corresponding results for any non-Gaussian initial distributions can be obtained via Gaussian approximation.

MS A1-1-3 7 17:00-19:00

Computational Linear Algebra in Massively Parallel contexts: Precision and Performance - Part 2

For Part 1 see: MS A1-1-3 6

Organizer: Jens Saak Max Planck Institute Magdeburg
Organizer: Pablo Ezzatti Universidad de la República

MS (co-)organized by the GAMM activtiy group "Applied and Numerical Linear Algebra" (ANLA)

Abstract: Numerical linear algebra (NLA) operations are frequently the demandest in scientific-computing, motivating the development of algorithms with a heavy use of HPC techniques. In the last decades the hardware-platforms have notoriously increased the number of computational-units, e.g. GPUs have experienced groundbreaking evolution. Efforts to generate new computational kernels that can efficiently run on hybrid platforms are constantly being performed. Also transitioning from petascale to exascale machines the questions of energy, communication and fail-safeness need to be rethought. In this minisymposium we revisit techniques to accelerate NLA methods, leveraging hybrid and distributed platforms, while focusing on precision and performance of implementations.

17:00-17:30

GPU acceleration of splitting schemes applied to differential matrix equations

Lena-Maria Pfurtscheller University of Innsbruck
Tony Stillfjord Max Planck Institute for Dynamics of Complex Technical Systems
Hermann Mena Yachay Tech University

Abstract: We consider the numerical solution of differential Lyapunov and Riccati equations, and generalized versions thereof by splitting schemes . We investigate the use of graphical processing units (GPUs) to parallelize such schemes and thereby further increase their effectiveness. According to our numerical experiments, large speed-ups are often observed for sufficiently large matrices. We also provide a comparison between different splitting strategies, demonstrating that splitting the equations into a moderate number of subproblems is generally optimal.

17:30-18:00

Asynchronous iterative methods

Daniel B. Szyld Temple University
Mireille El Haddad Saint Joseph University, Beirut
Jos\'e Garay Lousiana State University
Fr\'ederic Magoul\'es CentraleSupelec, Paris

Abstract: Asynchronous methods are parallel iterative procedures where each process performs its task without waiting for other processes to be completed, with no synchronizations with other processes. An asynchronous optimized Schwarz method is presented for the solution of differential equations on a large parallel computational environment. Convergence is proved when optimal and approximate interface conditions are utilized. Numerical results are presented on large three-dimensional problems illustrating the efficiency of the proposed asynchronous parallel implementation.

18:00-18:30

Parallel solver for shifted systems in a hybrid CPU-GPU framework

Zvonimir Bujanovic University of Zagreb

Abstract: We present a new method for solving linear systems of the form $(A-\sigma I)x=B$ with large number of complex shifts σ and multiple right-hand sides, designed to run on a hybrid CPU-GPU platform in a highly parallel fashion. Numerical experiments demonstrate benefits of the proposed method in applications, e.g., in control theory when computing the transfer function of a system, or as a part of an algorithm performing interpolatory model reduction (IRKA).

18:30-19:00

Algorithms for Efficient Usage of Half Precision Arithmetic in the Solution of Linear System of Equations

Srikara Pranesh University of Manchester

Abstract: The landscape of scientific computing is undergoing a drastic change with the advent of computer hardwares which support low precision floating-point arithmetics like half precision (fp16), bfloat16. In this talk first I will discuss an algorithm to simulate low precision computations using high precisions such single or double. Next, an algorithm to squeeze a general matrix into the narrow range of fp16, with an application to solving a linear system will also be discussed.

MS FT-4-1 7 17:00-19:00

Advances in Numerical Methods for Hamilton-Jacobi-type equations - Part 3

For Part 1 see: MS FT-4-1 5
For Part 2 see: MS FT-4-1 6

Organizer: Alexander Vladimirsky Cornell University
Organizer: Maria Cameron University of Maryland

Abstract: Hamilton-Jacobi (HJ) equations are nonlinear hyperbolic PDEs that arise in a broad spectrum of applications such as geosciences, optimal control, and stochastic systems. In some cases, e.g., in seismic wave propagation and stochastic systems, HJ equations result from approximations rendering the considered problem mathematically tractable. Nevertheless, their fast and accurate numerical solution poses significant challenges due to the need to tackle singularities, reconcile the discrepancy between the gradient of the solution and its characteristics, and adapt meshes for the solution. In this mini-symposium, we are bringing together researchers advancing state-of-art HJ solvers and applying them to real-life problems.

17:00-17:30

Hamilton-Jacobi approach for multiobjectif control problems

Hasnaa Zidani	ENSTA IP-Paris

Abstract: In this talk, we will present some optimal control problems with two objective functions, of different nature, that need to be minimized simultaneously. Our approach is based on Hamilton-Jacobi-Bellman framework. We will focus on some situations where the Pareto solutions are not achieved and discuss some notions of approximate Pareto solutions.

17:30-18:00

Quantifying and managing uncertainty in piecewise-deterministic processes

Alexander Vladimirsky	Cornell University
Elliot Cartee	Cornell University
Antonio Farah	UT Austin
April Nellis	University of Maryland
Jacob Van Hook	Pennsylvania State University

Abstract: Many applications are best modeled using piecewise-deterministic processes (PDP), where deterministic and continuous evolutive equations may change randomly due to discrete switches. We address three challenges related to uncertainty in the cumulative cost of PDPs: (1) computing CDF when the switching rates are known; (2) bounding CDF when the switching rates are uncertain; and (3) controlling the system to optimize this CDF. We illustrate our method using a simple example of trajectory planning under uncertainty.

18:00-18:30

Taming the curse of dimensionality in Hamilton-Jacobi-Bellman equations by polynomial approximation and tensor calculus techniques.

Dante Kalise	Imperial College London
Sergey Dolgov	University of Bath, UK
Karl Kunisch	RICAM and University of Graz, Austria

Abstract: We present polynomial approximation and tensor calculus techniques for solving high-dimensional, nonlinear, stationary Hamilton-Jacobi-Bellman PDEs arising in infinite-horizon control of nonlinear dynamical systems. Our methodology effectively solves HJB PDEs with 120 dimensions, allowing us to synthesize optimal feedback controllers for semi-discretized nonlinear parabolic PDEs.

18:30-19:00

Hamilton-Jacobi equations and aircraft trajectory tracking

Nikolay Botkin	Technical University of Munich
Johannes Diepolder	Technical University of Munich
Barzin Hosseini	Technical University of Munich
Varvara Turova	Technical University of Munich
Florian Holzapfel	Technical University of Munich

Abstract: The paper presents a method for tracking aircraft trajectories under windshear conditions. It is interesting to note that reference aircraft trajectories, obtained as solutions of optimal control problems with zero wind, can very often be tracked in the presence of rather severe wind disturbances. Examples of tracking landing reference trajectories are given. The results are compared with that obtained using solutions of Hamilton-Jacobi equations. Models of aircraft dynamics are rather realistic and highly nonlinear.

MS ME-1-6 7 17:00-19:00

Computational methods and applications in optimal control

Organizer: Jean-Baptiste Caillau	Université Côte d'Azur, CNRS, Inria, LJAD
Organizer: Olivier Cots	Université de Toulouse
Organizer: Pierre Martinon	Inria

Abstract: This minisymposim aims at providing a view on some state of the art algorithms in optimal control and close topics (mean field games, eg.) There is a growing community of practitioners using direct solvers (based on full discretization into a mathematical programming problem), indirect ones (shooting method to compute extremals given by maximum principle), or both. The key to a good numerical resolution often relies on exploiting the structure of the problem (sparsity, eg.), and on using continuation methods to connect mild approximations of the problem to the real one to be solved. Applications in mechanical engineering will be reviewed.

17:00-17:30

Interoperating direct and indirect optimal control solvers

Olivier Cots	Université de Toulouse
Jean-Baptiste Caillau	
Pierre Martinon	

Abstract: Methods for solving optimal control problems fall into two main categories. Indirect methods based on Pontrjagin Principle are fast and accurate but require more work than direct transcription that offer a good tradeoff between robustness and accuracy. For challenging problems, one may start with a direct method to find a rough solution, then refine it through an indirect method. We discuss this combined approach on applications and the interfacing between two solvers: Bocop and HamPath.

17:30-18:00

Structure exploitation for fully discretized state constrained optimal control problems

Matthias Gerdts	Bundeswehr University Munich
Huber Andreas	Bundeswehr University Munich

Abstract: We discuss a direct discretization method for state constrained optimal control problems and an interior-point method, which is used to solve the resulting large-scale and sparse nonlinear optimization problems. We focus on the investigation of an efficient method to solve the occurring linear equations with saddle point structure. To this end we exploit the particular structure and use a tailored linear algebra solver in combination with a re-ordering of the saddle point matrices.

18:00-18:30

On the optimal control of a rolling ball robot actuated by internal point masses

Stuart Rogers	Institute for Mathematics and its Application
Vakhtang Putkaradze	University of Alberta

Abstract: The controlled motion of a rolling ball actuated by internal point masses is considered. Pontryagin's minimum principle yields the controlled equations of motion, a solution of which obeys the uncontrolled equations of motion, satisfies prescribed initial and final conditions, and minimizes a prescribed performance index. The controlled equations are solved numerically using a predictor-corrector continuation method, starting from an initial solution obtained via a direct method, to realize trajectory tracking and obstacle avoidance maneuvers.

18:30-19:00

A semi-Lagrangian scheme for second order degenerate Hamilton-Jacobi-Bellman equations in bounded domains

Francisco José Silva Alvarez	Techniques Université de Limoges

Abstract: We study the numerical approximation of parabolic and elliptic, possibly degenerate, Hamilton-Jacobi-Bellman (HJB) equations in bounded domains. This equations tipically arise in the framework of optimal control problems with exit-costs. In this work, we propose a truncated version of a semi-Lagrangian scheme and provide the related convegence analysis.

MS A6-3-3 7 17:00-19:00

Oscillators in living systems

Organizer: Alona Ben-Tal	Massey University

Abstract: Oscillators are ubiquitous in biological systems and are often essential for life. Many biological oscillators have frequencies and amplitudes that vary in time. Additionally, due to the ability of biological systems to adapt, oscillations can arise in multiple processes that serve the same function. These make data interpretation and theoretical understanding of the mechanisms that underlie biological oscillations challenging. Our minisymposium will highlight a few examples where oscillators appear in living systems and the different mathematical approaches that are used to study them.

17:00-17:30

Oscillations in the brainstem: modelling neural control of breathing

Alona Ben-Tal	Massey University
Yunjiao Wang	Texas Southern University
Maria C. A. Leite	University of South Florida St Petersburg

Abstract: Breathing is controlled by a neural network located in the brainstem. The network supports a wide range of activities and adapts to changing environmental conditions by utilising multiple mechanisms for generating breathing. We have developed a new framework for studying neural networks based on Boolean representation and used it to form a network architecture that mimics many features seen in the respiratory neural network. Our network provides novel insights and new testable predictions.

17:30-18:00

Neurologically motivated coupling functions in models of motor coordination

Krasimira Tsaneva-Atanasova	University of Exeter
Piotr Slowinski	University of Exeter
Sohaib Al-Ramadhani	University of Exeter

Abstract: We analyse the model of two Haken-Kelso-Bunz (HKB) oscillators coupled by a neurologically motivated function, involving the effect of time-delay and weighted self- and mutual-feedback. The periodic regimes of the model have been shown to capture well the frequency-induced drop of oscillation amplitude and loss of anti-phase stability that have been experimentally observed in many rhythmic movements and by which the development of the HKB model has been inspired.

18:00-18:30

Coupling functions for investigating cardiovascular oscillators

Aihua Lin — University of Oslo

Abstract: Our project is to explore interactions between three oscillatory regulatory systems: thermoregulatory, respiratory and cardiovascular. The aim of the project is to investigate whether thermoregulatory compensation in the thermoneutral zone interferes with respiratory and circulatory control systems.We apply dynamic Bayes inference to set up coupling functions between those system.

18:30-19:00

Modelling metabolic oscillations using nonautonomous oscillator networks

Joe Adams — Lancaster University

Abstract: A living system's metabolism is a key part of understanding the function of the wider system. Its dysfunction has further been linked to pathological states, including cancer and dementia. Metabolic processes also often vary periodically, and this variation can itself vary over time. Living systems in which this is observed, from cancer cells to neurons, therefore may be effectively and concisely modelled in the scheme of networks of nonautonomous phase oscillators, as will be presented.

MS GH-1-3 7 17:00-19:00

Novel Computational Methods for Electromagnetic Problems in Complex Nonlinear Materials - Part 3

For Part 1 see: MS GH-1-3 5

For Part 2 see: MS GH-1-3 6

Organizer: Vrushali Bokil	Oregon State University
Organizer: Yingda Cheng Cheng	Michigan State University
Organizer: Fengyan Li	Rensselaer Polytechnic Institute
Organizer: Camille Carvalho	University of California, Merced

MS Organized by: SIAG/CSE

Abstract: Advances in the fabrication of novel artificial materials, described under the umbrella name of "metamaterials", has led to significant research in modeling, analysis of models and their computational simulation to aid in engineering design. This minisymposium will feature recent results on novel computational methods for electromagnetic problems with applications in photonics, optics, micromagnetics, magnetohydrodynamics and other areas. Computational methods will include finite difference, discontinuous Galerkin and other finite element, as well as mimetic methods. Additionally, important issues such as new models and new formulations for different applications, dispersion errors, PMLs for unbounded domains, and efficient solvers will be discussed.

17:00-17:30

Finite element approximation of Maxwell's equations with unfitted meshes for borehole simulations

Théophile Chaumont-Frelet	Inria
Serge Nicaise	University of Valenciennes
David Pardo	Basque Center for Applied Mathematics

Abstract: Having in mind borehole logging applications, we consider 3D Maxwell's equations in the E- and H-formulations with a piecewise constant conductivity and a globally constant permeability. We discretize the problem with first-order Nédélec edge elements using unfitted meshes, that do not necessarily follow the physical interfaces. We show that unfitted meshes deliver the same convergence rate than fitted meshes to approximate the magnetic field. Our theoretical results are numerically illustrated via 2D experiments.

17:30-18:00

PML method for electromagnetic scattering problem in a two-layer medium

Weiying Zheng	Academy of Mathematics and Systems Science, Chinese Academy of Sciences
Zhiming Chen	Chinese Academy of Sciences / Academy of Mathematics and Systems Science

Abstract: The perfectly matched layer (PML) method is an efficient approach for solving exterior scattering problems. It provides a highly-accurate approximation to the radiation condition on the truncation boundary. This talk is focused on the stability and exponential convergence of the PML method for electromagnetic scattering problem in a two-layer medium. By numerical experiments from finite element discretization of the truncated PML problem, we demonstrate the efficiency and accuracy of the PML method.

CP FT-1-8 7 17:00-19:00

Applied Mathematics for Industry and Engineering VI

Chair Person: Swati Yadav — Indian Institute of Technology (BHU)

CP FT-1-8 7 1 17:00-17:20

Numerical Approximation of Burgers Equation with Non-Singular time-Fractional Derivative

Swati Yadav	Indian Institute of Technology (BHU)
Rajesh K. Pandey	Indian Institute of Technology (BHU)
Anil K. Shukla	Indian Institute of Technology (BHU)

Abstract: Burgers equation is a non-linear partial differential equation which occurs in many mathematical fields like in fluid mechanics, gas dynamics, traffic flow, etc. In the past years, authors used the concept of the fractional differential operator (FDO) with a power law kernel in which singularity occurs. In this paper, a numerical method using finite difference scheme is presented to solve the Burgers equation having FDO with Mittag-Leffler function as the kernel which assures no-singularity.

CP FT-1-8 7 2 17:20-17:40

Optimization in Transition Between Two Dynamic Systems Governed by a Class of Weakly Singular Integro-Differential Equations

Shihchung Chiang Huang — Chung Hua University

Abstract: This study presents methods for solving the numerical minimum energies that satisfy typical optimal requirements in transition between two dynamic systems, each system is governed by a different kind of weakly singular integro-differential equations. Main result of this study is providing numerical techniques for determining the stabilities between two dynamic systems in the minimum energy sense.

CP FT-1-8 7 3 17:40-18:00

Thermally irreversibility analysis of two layered electro-osmotic flow through peristaltically induced microchannel with Joule heating effects

NAYAN KUMAR RANJIT	TECHNO MAIN, SALTLAKE
GOPAL CHANDRA SHIT	JADAVPUR UNIVERSITY

Abstract: We investigated the flow characteristics, thermal behavior and entropy generation for two layered electroosmotic flow in an asymmetric microfluidic channel subject to velocity and thermal slip conditions. The electroosmotic flow is driven by the combined influence of pressure gradient and axially imposed electric field. Long wavelength, low Reynolds number approximation is considered. The Joule heating effects and Brinkman number both are equally essential for enhancement of thermal irreversibility measured in terms of Bejan number profile.

CP FT-1-8 7 4 18:00-18:20

Thermal stress intensity factor for an edge crack in orthotropic composite media

Anuwedita Singh	Indian Institute of Technology (BHU)

Abstract: This article determines the thermal stress intensity factor (SIF) of an edge crack situated in an orthotropic strip of finite thickness h bonded to an orthotropic half plane, under thermal and mechanical loadings. The analytical expression of the SIF at the edge crack tip is found for concentrated point loading. The numerical values of SIF are computed for different point loading for various crack lengths and different ratios of thermal conductivities for different particular cases.

CP FT-1-8 7 5 **18:20-18:40**

Use of response surfaces to determine the optimal operating conditions of the internal combustion engine when using diesel-ethanol mixtures

Alejandro Ruiz González	Instituto de Ciencia Animal

Abstract: The application of quadratic response surfaces is reported to study the behavior of the main functional parameters of the internal combustion engine when using diesel-ethanol mixtures. The relationship between the response variables and the levels of the factors considered was expressed through the multiple linear regression model for two factors including the quadratic and interaction effects. Stationary points were found in the surfaces according to differential calculus criteria.

CP FT-1-8 7 6 **18:40-19:00**

Thermal instability of a flow caused by internal heat generation

Andrei Kolyshkin	Riga Technical University
Armands Gritsans	Daugavpils University
Felix Sadyrbaev	Daugavpils University

Abstract: Efficient energy production as a result of biomass utilization depends on many factors. One of these factors is internal heat generation. In this paper we analyze conditions of instability of a convective motion caused by internal heat sources distributed in accordance with the Arrhenius' law. Properties of nonlinear system describing the base flow are investigated. Linear stability analysis shows that increase of the Prandtl number and Frank-Kamenetsky parameter leads to more intensive mixing.

CP GH-3-5 7 17:00-19:00

Fluids Physics and Statistical Mechanics III

Chair Person: Laurel Ohm	University of Minnesota

CP GH-3-5 7 1 **17:00-17:20**

Theoretical justification and error analysis for slender body theory

Laurel Ohm	University of Minnesota
Yoichiro Mori	University of Minnesota
Daniel Spirn	University of Minnesota

Abstract: Slender body theory facilitates computational simulations of thin fibers immersed in fluid by approximating each fiber as a one-dimensional curve of forces. We develop a PDE framework for analyzing the error introduced by this approximation. In particular, given a 1D force along the fiber centerline, we define a notion of 'true' solution to the full 3D slender body problem and obtain an error estimate for the slender body approximation in terms of the fiber radius.

CP GH-3-5 7 2 **17:20-17:40**

Vanishing viscosity limit for the incompressible Navier-Stokes equations with helical symmetry

MILTON LOPES FILHO	UFRJ
Quansen Jiu	Capital Normal University
Dongjuan Niu	Capital Normal University
Helena Nussenzveig Lopes	UFRJ

Abstract: We present a recent result on convergence of the vanishing viscosity limit for a class of flows satisfying the Incompressible Navier-Stokes equations with helical symmetry and rough data. Helical symmetry is invariance under the group of rigid motions generated by a rotation of 3D Euclidean space around an axis combined with a translation along the same axis. Such flows are naturally produced by rotating blades, such as an eletric fan or a helicopter.

CP GH-3-5 7 3 **17:40-18:00**

Vortex cusps

Volker Elling	Academia Sinica

Abstract: Vortex cusps are pairs of self-similar vortex sheets with opposite circulation that merge in a cusp. Such solutions are observed in engineering flows, for example vortex sheets in Mach reflection at a solid wall. We present modelling and numerics of vortex cusps, calculate the cusp exponent and discuss possible rigorous existence proofs.

CP GH-3-5 7 4 **18:00-18:20**

Flow structure beneath rotational water waves propagating over flat and variable bottom.

Roberto Ribeiro Santos Junior	Federal University of Paraná
André Nachbin	IMPA
Paul Milewski	University of Bath
Marcelo V. Flamarion	Rural Federal University of Pernambuco

Abstract: The purpose of this talk is to show how to use mathematical techniques such as conformal maps to explore underwater. We are going to discuss some results concerning the flow structure beneath rotational water waves propagating over flat and variable bottom. Our numerical formulation allows us to compute the particle trajectories and the location of stagnation points. Moreover, we present regimes in which the pressure has very different features from the usual irrotational wave case.

CP A3-3-L1 7 17:00-19:00

Fluids Physics and Statistical Mechanics II

Chair Person: Paula Vasquez	University of South Carolina

CP A3-3-L1 7 1 **17:00-17:20**

A Parallel Approach to Kinetic Viscoelastic Modelling in Oscillatory Flows

Paula Vasquez	University of South Carolina
Erik Palmer	University of South Carolina

Abstract: In this talk, we investigate the transient network behavior of stimuli-responsive polymer gels by introducing a non-linear elastic bead-spring model. This approach leverages the parallel processing power of graphical processing units (GPUs) to overcome the mathematical and computational challenges that arise in this micro-macro scale design. Finally, we demonstrate the model's ability to efficiently recreate measured data from single polymer gels in simple shear and oscillatory flows.

CP A3-3-L1 7 2 **17:20-17:40**

A Polydisperse Gaussian Moment Model for the Three-Dimensional Simulation of the Explosive Dispersal of Radioactive Material

Lucian Ivan	Canadian Nuclear Laboratories
Andree-Anne Dion-Dallaire	University of Ottawa
Francois Forgues	Canadian Nuclear Laboratories
James G. McDonald	University of Ottawa

Abstract: This talk presents a three-dimensional (3D) Gaussian moment model designed to accurately treat the modelling challenges associated with the prediction of the dispersal of polydisperse particles resulting from the detonation of a radiological dispersal device (RDD) while remaining computationally affordable for large-scale practical calculations. This Eulerian model allows for anisotropic variance of particle velocities in phase space and directly treats correlations between particle diameter and velocity. Experimental measurements are used to validate the 3D implementation.

CP A3-3-L1 7 3 **17:40-18:00**

Analytical model for sensing particles in unsteady flow

Daisuke Takagi	University of Hawaii at Manoa
J. Rudi Strickler	University of Wisconsin -- Milwaukee

Abstract: We present a theory for locating an inert particle from a distance using mechanical sensors. The process consists of generating unsteady flow and detecting particle-induced fluctuations, a principle analogous to active sonar except with flow instead of sound. A simple analytical model shows how the size and position of the particle can be uniquely determined. This suggests that a variety of organisms and devices may actively agitate their surroundings to enhance their sensory range.

CP A3-3-L1 7 4 **18:00-18:20**

Asymptotic solution of stratified shear flows with eddy coefficients of turbulent viscosity

Natanael Karjanto	Sungkyunkwan University
Andy Chan	University of Nottingham Malaysia

Abstract: We consider a vertical velocity perturbation model under Boussinesq approximation with eddy coefficients of turbulent viscosity. In the absence of vertical eddy viscosity, we obtain an extended version of the Taylor-Goldstein equation of the inviscid case; while its presence leads to a fourth-order differential equation. We propose asymptotic solutions using WKB approximation for slowly varying background horizontal velocity and Brunt-Väisälä frequency, where the method has been successfully applied in the lower troposphere and boundary layer.

CP A3-3-L1 7 5 **18:20-18:40**

Effect of fluctuating magnetic field on the barrier crossing dynamics of a charged Brownian particle.

Shrabani Mondal	Visva-Bharati
Alendu Baura	Visva-Bharati
Bidhan Chandra Bag	Visva-Bharati

Abstract: We have studied the mechanism of the barrier crossing dynamics of a charged particle in presence of a magnetic field. Starting with Hamiltonian we have proposed the Langevin equation of motion. It shows that the effective dynamics experiences a time dependent damping strength even for the Markovian thermal bath. By virtue of it a new turnover prior to the Kramers' one, resonant activation and a tri-turnover phenomenon appears.

CP A3-3-L1 7 6 **18:40-19:00**

Solitary waves in an active droplet lattice

Stuart Thomson	Massachusetts Institute of Technology
Miles Couchman	Massachusetts Institute of Technology
Ruben Rosales	Massachusetts Institute of Technology
John Bush	Massachusetts Institute of Technology

Abstract: In this talk, we present the results of a combined experimental and theoretical study in which we characterize and rationalize the behaviour of a circular chain of fluid droplets bouncing on a vertically vibrating bath, reminiscent of a one-dimensional crystal lattice. As the vibrational forcing is increased, the stationary chain first destabilizes into an oscillatory mode and then into a striking soliton-like disturbance, before``melting'' at sufficiently high acceleration of the bath.

CP A1-3-4 7 17:00-19:00

Mathematical Topics and their Applications IX

Chair Person: NEMINATH ADUVINAMANI — GULBARGA UNIVERSITY, KALABUARGI

CP A1-3-4 7 1 **17:00-17:20**

Surface Roughness Effects on Static and Dynamic Characteristics of Porous Plane Slider bearings Lubricated with MHD-Couple Stress Fluid

NEMINATH ADUVINAMANI	GULBARGA UNIVERSITY, KALABUARGI

Abstract: Porous bearings operate similar to that of conventional bearings, the pressuer generated will support load by the bearings.In this paper it theoretically analyzed the problem of effects of surface roughness on the performance of static and dynamic characeteristics of porous plane slider bearings in the presence of applied magnetic field with couple stress fluid. It is found that, the effects of couple stresses and magnetic field is to improve the performance of the bearing.

CP A1-3-4 7 2 **17:20-17:40**

The Elastoviscoplastic Navier-Stokes Equations: Mimetic Discretisation and Preconditioned Defect Correction

Timm Treskatis	The University of British Columbia
Masoud Daneshi	The University of British Columbia
Mark Martinez	The University of British Columbia

Abstract: Realistic models of complex fluids include viscous dissipation, but also an elastoplastic response to stresses. Flows of such gels or pastes can be described by the incompressible Navier-Stokes equations, complemented with a nonlinear and nonsmooth transport equation for the non-Newtonian stress contribution. To solve this system numerically, we propose a pressure robust, mass and momentum conservative discontinuous Galerkin scheme, and a fully coupled, genuinely nonsmooth yet efficient nonlinear solver. Numerical results shall complement this presentation.

CP A1-3-4 7 3 **17:40-18:00**

Parallelization Strategy for Elastic Waves' Simulation in Time-Frequency Domain with an Iterative Solver

Vladimir Cheverda	IPGG
Dmitry Neklyudov	IPGG
Victor Kostin	IPGG

Abstract:
We present a parallelization strategy for our novel iterative method to solve 3D heterogeneous elastic wave equation via MPI
. The unique features of the solver are the preconditioner developed to assure fast convergence of the Krylov-type iteration method at low time frequencies. We successfully benchmark the accuracy of our solver against the exact solution and compare it to another iterative solver. The quality of the parallelization is justified by weak and strong scaling analysis.

CP A1-3-4 7 4 **18:00-18:20**

Propagation of Lamb waves in a nonlocal elastic plate with voids

Gurwinderpal Kaur	Panjab University
Dilbag Singh	Panjab University
Sushil Kumar Tomar	Panjab University

Abstract: Propagation of Lamb waves in an infinite nonlocal elastic plate with voids has been studied. Dispersion relations for symmetric and anti-symmetric vibrations have been derived using appropriate boundary conditions. It is found that both symmetrical and anti-symmetrical vibrations are dispersive in nature and are affected by the presence of nonlocality as well as voids in the plate. Due to the presence of nonlocality, both the families face critical frequencies above which they cease to propagate.

CP A1-3-4 7 5 **18:20-18:40**

Modelling Acoustic Metamaterials

Michael M. Tung	Universitat Politècnica de València

Abstract: Metamaterials are artificial materials which exceed the properties of ordinary materials in nature. This presents researchers and engineers with unique possibilities for the design and manufacture of novel devices with extraordinary characteristics. We developed a mathematical framework which allows to straightforwardly model waves in acoustic metamaterials. These exhibit exotic features according to predefined spacetime geometries. The talk outlines this novel approach for the simulation of sophisticated acoustic phenomena with curved background spacetimes and gives applications.

CP A1-3-4 7 6 **18:40-19:00**

Reduced Basis Method applied to eco-efficient buildings design

Cristina Caravaca García	Universidad de Sevilla

Abstract: We are interested in the design of eco-efficient buildings. This involves computing models for several parameters which could be geometrical or physical. Sometimes, each computation could take a long time and this situation is not the most desirable. This reason encourages us to consider the basis reduced method that allow us to obtain a faster solution with a little error.

CP GH-3-3 7 17:00-19:00

Astronomy, Astrophysics and Geophysics

Chair Person: Xinsheng Qin — University of Washington

CP GH-3-3 7 1 **17:00-17:20**

Efficient Tsunami Modeling on Adaptive Grids with Graphics Processing Units (GPUs)

Xinsheng Qin	University of Washington
Randall LeVeque	University of Washington
Michael Motley	University of Washington

Abstract: We present an efficient CUDA implementation of GeoClaw, an open source finite volume numerical scheme on adaptive grids for SWE with varying topography. Numerical experiments on an about 20 realistic transoceanic tsunamis in the Pacific Ocean show the validity and efficiency of the code. The GPU implementation, when running on a single GPU, is 2 to 5 times faster than the original model running in parallel on a 16-core CPU.

CP GH-3-3 7 2 **17:20-17:40**

Interaction of Kaluza-Klein Liked Wet Dark Fluid in f(R,T) Gravity

Sanasam Surendra Singh	NIT Manipur

Abstract: We study the essence of f(R, T) gravitation theory in Kaluza-Klein Universe and see the role of dark energy in the form of wet dark fluid. It is interesting that some derived models behave to be either oscillatory or cyclic. Some models are observed to be ΛCDM models with initial singularity. They undergo early inflation as well as late time accelerating expansion. The derived models are observed to be in agreement with present observations.

CP GH-3-3 7 3 **17:40-18:00**

Modified Chaplygin gas cosmology in a viscous holographic Ricci dark energy framework

Surajit Chattopadhyay Amity University, Kolkata

Abstract: We report a study on modified Chaplygin gas (MCG)-based reconstruction scheme for extended holographic Ricci dark energy (EHRDE) in the presence of viscous type dissipative term. The dissipative effect has been described by using Eckart approach with time-varying form of the bulk viscosity coefficient. We have investigated the statefinder diagnostics and also the validity of the generalized second law (GSL) of thermodynamics considering event horizon as the enveloping horizon of the universe.

CP GH-3-3 7 4 **18:00-18:20**

An asymptotic explicit model for the propagation of Love wave fields in heterogeneous media

Santanu Manna Indian Institute of Technology Indore

Keele University, UK

Abstract: In this paper, we derive the asymptotic model for the propagation of surface seismic (Love) wave at the interface between two layers. The dispersion of interfacial and edge waves are established in each layer media. The analytical and graphical approaches to the effects of heterogeneity, elasticity mixed boundary conditions are taken into consideration. The benefit of the developed approach is illustrated by the steady-state problem for a moving load on an elastic medium.

CP GH-3-3 7 5 **18:20-18:40**

Impulse noise treatment in Geosounding inversion.

Hugo Hidalgo CICESE

Enrique Gomez-Trevino CICESE

Abstract: Magnetotelluric (MT) sounding method is used to estimate the electrical conductivity distribution at depth associated with subsurface geological structures. Least-squares regression is used, assuming data follow a stationary and Gaussian model. In practice, most data display gross departures, or outliers, usually appearing as a fraction of useful observations. Several algorithms able to recover models from MT data contaminated with impulse noise are proposed here. They can also be applied to other types of electromagnetic soundings.

CP A1-3-5 7 **17:00-19:00**

Numerical Analysis and Probability

Chair Person: Mark Ainsworth Brown University

CP A1-3-5 7 1 **17:00-17:20**

Two classes of composite hierarchical high order exact sequences of finite element approximations for hybrid meshes combining hexahedra, tetrahedra, prisms and pyramids

Mark Ainsworth Brown University

Philippe R. B. Devloo Universidade Estadual de Campinas

Omar Durán Universidade Estadual de Campinas

Sônia M. Gomes Universidade Estadual de Campinas

Abstract: The sequences use Nédélec spaces of first kind, or their enhanced versions with properly chosen higher order internal bubble functions. Inside a pyramid, composite polynomial approximations are based on local tetrahedral partitions, traces over their triangular faces being constrained to shape functions on the quadrilateral face shared by neighboring hexahedron or prism. Construction of projection-based interpolants commuting the de Rham diagram and space assembly use hierarchic shape functions. Applications to Poisson mixed formulations are shown.

CP A1-3-5 7 2 **17:20-17:40**

Rational minimax iterations for computing functions of matrices

Evan Gawlik University of Hawaii at Manoa

Abstract: We construct a family of iterations for computing the matrix square root using Zolotarev's rational minimax approximants of the function z1/2. We show that these rational functions obey a recursion, allowing one to iteratively generate optimal rational approximants of z1/2 of high degree using compositions and products of low-degree rational functions. The corresponding matrix iterations converge to A1/2 for any input matrix A having no nonpositive real eigenvalues. Extensions to pth roots are also presented.

CP A1-3-5 7 3 **17:40-18:00**

Globally constraint-preserving FR/DG scheme for Maxwell's equations upto fifth order of accuracy

Arijit Hazra TIFR-Centre for Applicable Mathematics

Praveen Chandrashekar TIFR-Centre for Applicable Mathematics

Dinshaw S Balsara University of Notre Dame

Abstract: We propose a globally divergence-conforming DG-like scheme for CED upto fifth order of accuracy. We achieve global constraint-preservation of involution constraints of CED by collocating the electric displacement, magnetic induction and their higher order modes in the faces of the mesh. The novel features of our schemes are: retention of higher order accuracy without any limiter, superior control of numerical diffusion, and preservation of electromagnetic energy with strongly varying material properties in absence of conductivity.

CP A1-3-5 7 4 **18:00-18:20**

monotonocity properties in [M2/G2/1→.G/1/1] with preemptive priority

Alem Lala Maghnia University of Bouira

Boualem Mohamed University of Bejaia

Aissani Djamil University of Bejaia

Abstract: This work aims use the stochastic comparison approach to investigate the monotonicity properties of an [M2/G2/1 ?.G/1/1] with preemptive priorite. we show the monotonicity of the transition operator of the embedded Markov chain relative to the strong stochastic ordering and convex ordering, as well as the comparability of two transition operators. These studies are motivated by the difficulty of obtaining explicit performance results for most queuing networks.

CP A1-3-5 7 5 **18:20-18:40**

Discrete Green-Gauss formulae based on finite volume operators using Voronoi mesh and structure-preserving methods

Daisuke Furihata Osaka University

Abstract: We have found some rigorous discrete Gauss, Green and Stokes formulae among finite volume operators based on the Voronoi meshes to design structure-preserving numerical methods for some PDE problems and run numerical computations. In this talk, we would like to indicate those operators, Green, Gauss and Stokes formulae and the obtained discrete variational derivative methods, which is one of the structure-preserving methods for PDEs, based on Voronoi cells.

CP A1-3-5 7 6 **18:40-19:00**

On Self-normalized Trimmed Means

Qi-Man SHAO The Chinese University of Hong Kong

Abstract: Trimmed mean is an alternative way of estimating the population mean. It is more robust than the sample mean. The central limit theorem is well-established. To estimate the tail probability of the trimmed mean, it is necessary to study the relative error of the normal approximation. In this talk, we will establish a Cramer type moderate deviation theorem for the self-normalized trimmed mean. Applications to statistical inference will also be discussed.

CP A1-3-3 7 **17:00-19:00**

Industrial Applications in TIC

Chair Person: Alvaro Riascos University of los Andes & Quantil

CP A1-3-3 7 1 **17:00-17:20**

Efficient allocation of law enforcement resources using predictive police patrolling

Alvaro Riascos University of los Andes & Quantil

Mateo Dulce Quantil

Simon Ramirez Bancolombia

Abstract: In a previous study (forthcoming Barreras et.al (2019)) it has been shown that a simplified version of the self-exciting point process explained in Mohler et.al (2011), performs better predicting crime in the city of Bogotá - Colombia, than many standard hotspot models. This paper fullyimplements the Mohleret.al(2011) model in the city of Bogotá and explains its technological deployment for the city as a tool for the efficient allocation of police resources.

CP A1-3-3 7 2 **17:20-17:40**

Mathematics in machine learning

Daisuke Satow	Arithmer Inc.
Yoshihiro Ohta	Arithmer Inc. / Univ. of Tokyo

Abstract: Arithmer Inc. is a startup company providing with business solutions in the field of AI/machine learning/robotics, which emerged from Univ. of Tokyo a few years ago. I will present our recent success stories and ambitious attempts in which applied mathematics is fully utilized, such as optical character recognition (OCR), automatic artificial tooth design, scoring driver's skill from movie, and image measurement of human body.

CP A1-3-3 7 3 17:40-18:00

Aggregation in Quality Models: Saying "NO!" to Fuzzy Notions.

Maria Ulan	Linnéuniversitetet

Abstract: Software Quality Models have hierarchical structure. Quality assessment with a proper aggregation approach should be mathematical sound and fulfill the industrial needs, i.e. provide answers for such type of questions: How good is a product? What should be improved? At what cost? To address this challenge we propose a probabilistic approach. The effectiveness and accuracy of proposed aggregation approach was evaluated by assessing software quality for ca. 100 real-world industry software projects.

CP A1-3-3 7 4 18:00-18:20

Translation of Industrial Challenges to Materials Modelling Solution: take advantage of EMMC Translation and training resources to promote effective Industrial –Academia collaboration

Natalia Konchakova	Helmholtz-Zentrum Geesthacht
Denka Hristova-Bogaerds	DPI
Pietro Asinari	Politecnico di Torino
Daniel Höche	Helmholtz-Zentrum Geesthacht
Luca Bergamasco	Politecnico di Torino

Abstract: European Materials Modelling Council is developing Translation concept to provide service to European industry for efficient application of modelling, simulation and optimisation for industrial innovation, novel manufacturing process and agile product marketing. Translation is considered as process, which translates an industrial challenge into computational action based on modelling solution. The EMMC Translation and training resources support implementation of infrastructure to establish effective Industrial-Academia collaboration. The approach is realized within EU-projects: EMMC-CSA, VIMMP, MARKETPLACE, FORCE, COMPOSELECTOR.

CP A1-3-3 7 5 18:20-18:40

Automation of High-Fidelity CFD Analysis for Aircraft Design and Optimization

Mengmeng Zhang	Airinnova AB
Jing Gong	KTH Royal Institute of Technology
Lilit Axner	KTH Royal Institute of Technology
Michaela Barth	KTH Royal Institute of Technology

Abstract: Airinnova AB is a start-up company that provides and develops advanced computational solutions for cutting-edge preliminary designs for aircraft, including computational aerodynamics, and multi-disciplinary optimization. High fidelity computational fluid dynamics (CFD) analysis is a vital tool in modern aircraft design and optimization. Together with KTH Royal Institute of Technology, Airinnova is developing an automated procedure to carry out Reynolds-Averaged Naiver-Stokes based CFD analysis, either using watertight aircraft geometries defined by CAD or CPACS files.

CP A1-3-3 7 6 18:40-19:00

Scattering on an electrically large launcher

Bakry Marc	Ecole Polytechnique
Alouges François	Ecole Polytechnique
Aussal Matthieu	Ecole Polytechnique

Abstract: Gypsilab is a recent prototyping environment written in Matlab, aiming at solving easily the FEM/BEM formulations of multiphysics problems. Mostly available under the GPL3.0, we use it to study the electromagnetic scattering on a PEC large launcher proposed by the CNES (60 million degrees of freedom). On a 32 cores server, we use a custom accelerated BEM featuring the Fast and Furious Method (to be published) and domain decomposition techniques.

CP FT-0-2 7 17:00-19:00

Numerical Analysis XV

Chair Person: Antigoni Kleanthous University College London (UCL)

CP FT-0-2 7 1 17:00-17:20

Preconditioning of boundary integral equations for scattering by multiple absorbing dielectric particles

Antigoni Kleanthous	University College London (UCL)
Timo Betcke	University College London (UCL)
David Hewett	University College London (UCL)
Anthony Baran	Met Office

Abstract: In this talk, we will discuss recent developments in the solution of dielectric scattering problems using the Boundary Element Method (BEM). These include preconditioning techniques such as mass-matrix and Calderòn preconditioning along with their efficient implementation in Bempp. We will demonstrate how one can use the above to efficiently solve examples of light scattering by single and multiple ice crystals of complex shape that can be found in cirrus clouds.

CP FT-0-2 7 2 17:20-17:40

Convergence of variational discretisations for a fourth-order nonlinear partial differential equation

Blake Ashworth	University of Sussex
Bertram Duering	University of Sussex
David McCormick	University of Sussex

Abstract: There is growing interest in studying structure preserving variational discretisations for higher order nonlinear partial differential equations constituting gradient flows in the L^2-Wasserstein metric. We focus on the fourth-order Derrida-Lebowitz-Speer-Spohn (DLSS) equation and present variational discretisations which adapt Diagonally Implicit Runge Kutta methods in place of the usual minimising movement scheme. We prove convergence of discrete solutions, and present numerical results confirming higher convergence rates for higher order schemes.

CP FT-0-2 7 3 17:40-18:00

Asymptotic Preserving Schemes for Some Singular Limits of the Euler Equations in a Gravitational Field

Arun Koottungal Revi	Indian Institute of Science Education and Research Thiruvananthapuram
Saurav Samantaray	Indian Institute of Science Education and Research Thiruvananthapuram

Abstract: We consider some distinguished singular limits of the Euler equations in a gravitational field arising from some interesting scalings of the Mach and Froude Numbers. We propose their numerical resolution via the Asymptotic Preserving methodology and analyse the stability and robustness these methods.

CP FT-0-2 7 4 18:00-18:20

A new family of high-order schemes for 3D elastic wave equation

Wensheng Zhang	Chinese Academy of Sciences

Abstract: We develop a new family of locally one-dimensional difference schemes with fourth-order accuracy both in space and time for the three-dimensional elastic wave equation. The constructed schemes are all four-layer in time and three-layer in space and only involve a three-point stencil in each spatial direction. The analysis shows our method has more relax stability than the classical schemes.

CP FT-0-2 7 5 18:20-18:40

A geometry-preserving method for compressible fluid flows on a FLRW cosmological background

Yangyang Cao	Sorbonne Université
Philippe LeFloch	sorbonne université

Abstract: We introduce a shock-capturing, high-order finite volume method for computing solutions to a class of nonlinear hyperbolic models describing the evolution of relativistic fluids on a curved background spacetime. Our aim is to develop a numerical algorithm that is sufficiently robust and accurate in order to investigate the propagation and nonlinear interaction of shock waves in presence of a curved geometry. More specifically, the geometry of interest here is the so-called Friedmann-Lemaitre-Robertson-Walker spacetime.

CP FT-0-2 7 6 18:40-19:00

Convergences of the squareroot approximation scheme to the Fokker--Planck operator

Heida Martin	WIAS

Abstract: We study the qualitative convergence a novel FV-discretization scheme of the Fokker-Planck equation (SQRA), that was proposed by [Lie, Fackeldey and Weber 2013] for high dimensional spaces. We show that SQRA has a natural gradient structure related to the Wasserstein gradient flow and that solutions to the SQRA converge to solutions of the Fokker-Planck equation. This is done using G-convergence for the underlying discrete elliptic operator.

CP GH-1-1 7 17:00-19:00

Simulation and Modelling VI

Chair Person: Cipriano Escalante	Universidad de Málaga

CP GH-1-1 7 1 17:00-17:20

An efficient non-hydrostatic approach for dispersive water waves

Cipriano Escalante	Universidad de Málaga
Enrique D. Fernández Nieto	Universidad de Sevilla
Tomás Morales De Luna	Universidad de Córdoba
Manuel J. Castro Díaz	Universidad de Málaga

Abstract: We propose to study non-hydrostatic shallow water type systems. Usually, a layer averaged model is introduced that includes dispersive effects via a non-hydostatic pressure term. This type of models may be generalized by using a multilayer approach. Here we propose to study layer depth-integrated non-hydostatic systems. An efficient numerical scheme will be proposed.

CP GH-1-1 7 2 17:20-17:40

Verification of a homogeneous two-phase flow code with complex equations of state

Lucie QUIBEL	EDF R&D
Olivier HURISSE	EDF R&D
Philippe HELLUY	Université de Strasbourg

Abstract: A pressurized water nuclear reactor works as a heat exchanger. In some hypothetical accidental scenarios, fast transients occur with important mass transfer between liquid and steam water. A realistic equation of state is needed to correctly describe the mixture. A two-phase flow model associated with look-up tables based on IAPWS-IF97 formulation has been verified with Riemann problems for several numerical schemes. Even with a complex equation of state, the correct convergence rate is recovered.

CP GH-1-1 7 3 17:40-18:00

Temporal series-based Adaptive Traffic Forecastic System Modelling for the future ecosystem of Smart Cities

Víctor Fernandez Pallarés	Universitat Politècnica de València
Juan Carlos Guerri Cebollada	Universitat Politècnica de València
Alicia Roca Martínez	Universitat Politècnica de València

Abstract: By the time goes on, mobility in the city is more relevant for our lives. To avoid traffic affecting us in our movements and help us arrive to our destinations in time without any traffic problem, we have designed a series-based system integrated with self-learning adaptive algorithms to forecast traffic dynamics in the city. These algorithms are built over a complex mathematical structure to build realistic models and so foresee possible disasters before they happen.

CP GH-1-1 7 4 18:00-18:20

Wave interaction with flexible porous plate in variable water depth

SANTANU KOLEY	BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE - PILANI, HYDERABAD CAMPUS

Abstract: The study deals with the scattering of obliquely incident gravity waves by a floating flexible horizontal porous plate in water of finite depth having variable bottom bed. The problem is analyzed under the assumptions of small amplitude water wave theory and structural responses. The boundary element method is applied to the fluid region having undulated bottom topography and the eigenfunction expansion method is applied to the fluid region having uniform water depths.

CP GH-1-1 7 5 18:20-18:40

The ENATE approach for steady incompressible Navier-Stokes (NS) equations

Víctor Javier Llorente Lázaro	University of Zaragoza
Antonio Pascau Benito	University of Zaragoza

Abstract: In this work, we presented an accurate approach of solving NS equations by a novel high-order exponential scheme known as ENATE "Enhanced Numerical Approximation of a Transport Equation". Numerical results with different Reynolds numbers achieve 4th-,6th-order accuracy.

CP GH-1-1 7 6 18:40-19:00

Perfect transmission through a network of Helmholtz resonators

Rodolfo Brandao	Imperial College London
Ory Schnitzer	Imperial College London

Abstract: We present an asymptotic analysis of acoustic propagation in channels blocked by Helmholtz resonators, i.e., cavities with small openings. We obtain closed-form approximations for the reflection and transmission coefficients for an arbitrary array of N=1,2,3,... directly connected resonators. The analysis is based on the method of matched asymptotic expansions in conjunction with a rescaling of the frequency close to each of the collective resonances of the array; perfect transmission is predicted at these resonances.

CP FT-4-5 7 17:00-19:00

Mathematical Topics and their Applications X

Chair Person: Helena Nussenzveig Lopes	Universidade Federal do Rio de Janeiro

CP FT-4-5 7 1 17:00-17:20

Confinement of Vorticity in Solutions of the Euler-Alpha Equations

Helena Nussenzveig Lopes	Universidade Federal do Rio de Janeiro
Milton Da Costa Lopes Filho	Universidade Federal do Rio de Janeiro
David Ambrose	Drexel University

Abstract:

We consider weak solutions of the Euler-alpha equations in the full plane. We take, as initial unfiltered vorticity, an arbitrary nonnegative, compactly supported, bounded Radon measure. We show that the support of the unfiltered vorticity is contained in a disk whose radius grows no faster than O((t
t)
1/4). This result is an adaptation of work by D. Iftimie, T. Sideris and P. Gamblin and, independently, to Ph. Serfati for the 2D Euler equations.

CP FT-4-5 7 2 17:20-17:40

Effect of abrupt change of the wall temperature in the kinetic theory

Hung-Wen Kuo	National Cheng Kung University

Abstract: Consider a semi-infinite expanse of a rarefied gas bounded by an infinite plane wall. We study the quantitative short time behavior of the gas in response to the abrupt change of the wall temperature on the basis of the linearized Boltzmann equation. We show that the short time solution consists of the free molecular flow and its perturbation, which exhibits logarithmic singularities along the characteristic line and on the boundary.

CP FT-4-5 7 3 17:40-18:00

A FAMILY OF GODUNOV-TYPE SOLVERS FOR THE PRESSURELESS GAS DYNAMICS AND RELATED MODELS

NAVEEN KUMAR GARG	Southern University of Science and Technology, SUSTech
G. D. VEERAPPA GOWDA	Tata Institute of Fundamental Research-Centre For Applicable Mathematics

Abstract: In this study, a class of Godunov-type solvers is formulated for weakly hyperbolic systems. The convexity of a second flux component of the one-dimensional pressureless flux function is used to construct a conservative Godunov-type solver. Since the considered systems satisfy the generalized Rankine-Hugoniot conditions, a non-conservative version is also developed and tested on various numerical examples. In particular, Godunov-type solvers developed here outclass other well-known solvers in capturing stationary δ and δ’−waves.

CP FT-4-5 7 4 18:00-18:20

Coupling of discontinuous Galerkin schemes for viscous flow in porous media with adsorption

Raimund Burger	UDEC
Sudarshan Kumar Kenettinkara	Indian Institute of Technology Guwahati
Ricardo Ruiz Baier	Oxford University
Hector Torres	University of La serena

Abstract: Polymer flooding is an important stage of enhanced oil recovery in petroleum reservoir engineering. A model of this process is based on the study of multicomponent viscous flow in porous media with adsorption. This model can be expressed as a coupled system of partial differential equations. In this work, we porpose an H(div)-conforming discontinuous Galerkin (DG) method together with a classical DG method for the discretization of the whole system. Numerical results will be presented.

CP FT-4-5 7 5 18:20-18:40

Decoys and dilution: the impact of incompetent hosts on prevalence of Chagas disease

Mondal Hasan Zahid	University of Texas

Abstract: Biodiversity is commonly believed to reduce risk of vector-borne zoonoses. This study focuses on the effect of biodiversity, specifically on the effect of decoy process on reducing Chagas disease infections. We use mathematical population models to observe the impact of the proximity of chickens. We consider three cases as distance varies between two hosts populations: short, intermediate, and far. Our finding shows the presence of chickens reduces parasite prevalence in humans only at intermediate distance.

CP FT-4-5 7 6 18:40-19:00

Identifying the Dominant transmission pathway in a multi-stage infection model of the Emerging Fungal Pathogen Batrachochytrium Salamandrivorans on the Eastern Newt

Rafiul Islam	Texas Tech University
Mattew Gray	Center for Wildlife Health, University of Tennessee
Angela Peace	Texas Tech University

Abstract: We developed compartmental host-pathogen models to examine the transmission dynamics of an emerging fungal pathogen on an amphibian population. Multiple stages of infection are incorporated into the model, allowing disease-induced mortality and zoospore shedding rates to vary as the disease progresses. Parameter sensitivity analysis is used to identify the important model parameters. Calculation of the basic reproductive number highlights the virulence of this pathogen and is used to determine the dominant transmission pathways.

CP A1-3-2 7 17:00-19:00

Numerical Analysis XIV

Chair Person: Gurusamy Arumugam	Indian Institute of Technology Gandhinagar

CP A1-3-2 7 1 17:00-17:20

Discontinuous Galerkin Methods for the Keller-Segel Chemotaxis System with General Chemotactic Sensitivity and Cross-diffusion

Gurusamy Arumugam	Indian Institute of Technology Gandhinagar
Jagmohan Tyagi	Indian Institute of Technology Gandhinagar

Abstract: In this paper, symmetric and nonsymmetric interior penalty discontinuous hp-Galerkin methods are applied to Keller-Segel system with cross-diffusion. In particular, the spatial and temporal discretizations of the system are based on the discontinuous Galerkin method and the explicit fourth order Runge-Kutta scheme respectively. Then the existence of solutions to the semidiscrete problem is proved by using Schauder’s fixed point theorem. Moreover apriori error estimates are derived. Finally numerical experiments illustrating the theoretical results are provided.

CP A1-3-2 7 2 17:20-17:40

Interface Control Domain Decomposition (ICDD) method: an overlapping approach to couple Stokes and Darcy equations

Paola Gervasio	University of Brescia
Marco Discacciati	Loughborough University
Alfio Quarteroni	Politecnico di Milano

Abstract: The real problem is the filtration of fluids from free regions to homogeneous porous media. The change of regime between the two physics occurs within a layer proportional to the porous scale. The coupling between the two different physics (Stokes and Darcy) is achieved by the ICDD method that is based on the minimization of a suitable functional measuring the jumps of velocity and pressure at the boundary of the layer.

CP A1-3-2 7 3 17:40-18:00

Globally divergence-free DG schemes for ideal compressible MHD

Rakesh Kumar	TIFR Centre for Applicable Mathematics
Praveen Chandrashekar	TIFR Centre for Applicable Mathematics
Dinshaw Balsara	University of Notre Dame

Abstract: We construct upto fourth order, globally divergence-free DG schemes for compressible MHD. The modes of the fluid variables are collocated at the zones of the mesh; the magnetic field components are collocated at the faces of the mesh. The fluid equations are evolved using classical DG; while the magnetic fields are evolved using a DG-like approach on the faces. Several test problems are presented where robustness and divergence-free property of schemes are ensured.

CP A1-3-2 7 4 18:00-18:20

Nitsche's method and discontinuous Galerkin method for Poisson equation with Robin boundary condition in a smooth domain

Yuki Chiba	The University of Tokyo
Norikazu Saito	The University of Tokyo

Abstract: If solving PDEs in a smooth domain, we should consider polyhedral approximations of domain. For the standard FEM, the methods and analysis are well developed so far. However, for other methods including the DG method, there is room for further study. In this paper, we consider the DG method and the Nitsche method for the Poisson equation under the Robin boundary condition in a smooth domain. We prove optimal order error estimates.

CP A1-3-2 7 5 18:20-18:40

Entropy Stable Space-Time Discontinuous Galerkin Schemes with Summation-by-Parts Property for Hyperbolic Conservation Laws

Gero Schnücke	University of Cologne
Lucas Friedrich	University of Cologne
Andrew R. Winters	University of Cologne
David C. Del Rey Fernandez	NASA Langley Research Center
Gregor J. Gassner	University of Cologne
Mark H. Carpenter	NASA Langley Research Center

Abstract: We present an entropy stable high order nodal space-time discontinuous Galerkin spectral element method for systems of hyperbolic conservation laws. The crux of the method is that discrete derivative approximations in space and time are summation-by-parts operators. This allows us to mimic results from the continuous entropy analysis on the discrete level. Importantly, the method described herein does not assume any exactness of quadrature in the variational forms.

CP A1-3-2 7 6 18:40-19:00

A finite volume lattice Boltzmann method on structured non-Cartesian meshes

Juan Antonio Reyes Barraza	University of Southampton
Ralf Deiterding	University of Southampton

Abstract: While large boundary approximation errors are intrinsic to the classical lattice Boltzmann method, we have developed a variant for high quality aerodynamics, in which streaming is implemented by transporting the partial densities with a time-explicit second-order-accurate finite volume scheme on structured non-Cartesian meshes. Several benchmarks in 2D (e.g., laminar flow around a cylinder or a NACA0012 wing profile) demonstrate the superior accuracy of the approach for single- as well as multi-relaxation time collision operators.

CP FT-1-7 7 17:00-19:00

Partial Differential Equations V

Chair Person: Kamlesh Kumar	IIT(BHU)

CP FT-1-7 7 1 17:00-17:20

Convergence Numerical Scheme for Fractional Order Generalized Telegraph-Type Equation

Kamlesh Kumar	IIT(BHU)

Abstract: In this work, a numerical scheme is analysed for solving a Generalized Time-Fractional Telegraph-Type Equation (GTFTTE) using Generalized Fractional Derivative (GFD). The convergence and stability of the presented numerical scheme is discussed. The GFD involves the scale and weight functions and it reduces to the traditional Caputo derivative for a particular choice of weight and scale functions. Furthermore, we describe the effects of scale and weight functions on the numerical solution of GTFTTE.

CP FT-1-7 7 2 17:20-17:40

An ε uniformly convergent hybrid scheme for a singularly perturbed parabolic boundary turning point problem.

Swati Yadav	University of Delhi
Pratima Rai	University of Delhi
Kapil Kumar Sharma	South Asian University

Abstract: This work presents the construction and analysis of a parameter uniform numerical scheme for the solution of singularly perturbed parabolic equations with boundary turning points. The proposed scheme consist of implicit Euler scheme for time discretization on uniform mesh and a hybrid scheme for spatial discretization on piecewise uniform Shishkin mesh. Error estimates are derived to establish almost second order convergence in space. Numerical experiments are carried out to demonstrate the theoretical results.

CP FT-1-7 7 3 **17:40-18:00**

Study and analysis of fractional order space-time nonlinear reaction-advection-diffusion Equation

Anup Singh IIT (BHU)

Abstract: Legendre collocation method is used to solve the fractional order two-dimensional advection-diffusion equation having a nonlinear source/sink term with initial and boundary conditions. The solution profiles of the normalized solute concentration for both reaction-advection-diffusion and reaction-diffusion systems are presented through graphs for different particular cases. The salient feature of the article is the pictorial presentations of the effect of fractional order spatial and time derivatives and also advection term on the solution profile.

CP FT-1-7 7 4 **18:00-18:20**

Virtual Element Methods for the Benjamin-Bona-Mahony (BBM) Equation.

Danumjaya Palla BITS-Pilani K K Birla Goa Campus
Balaje K BITS-Pilani K K Birla Goa Campus
Sanath Keshav BITS-Pilani K K Birla Goa Campus

Abstract: Virtual element method (VEM) is a recent numerical technique which is a generalization of the finite element method on polygons. In this paper, we employ the newly developed virtual element method to solve the BBM equation in two space dimensions. We prove some theoretical results including a priori bounds and optimal error estimates for the semi-discrete and completely discrete virtual element method. Finally, we perform some numerical experiments to validate the theoretical results.

CP FT-1-7 7 5 **18:20-18:40**

Theoretical and numerical analysis using domain decomposition method of non-linear partial differential equations.

Naceur Nahed Université de Lorraine

Abstract: The aim of this communication is to give a result about the existence of a weak positive solution of a non-linear elliptic equation in one and two dimensions. Then, we present an algorithm to compute a numerical approximation. First, a super-solution is computed using Newton method and domain decomposition technics. Starting with this super-solution, we construct a sequence of solutions of a regularized problem, which converges to the numerical positive solution of our equation.

CP FT-1-7 7 6 **18:40-19:00**

Variance reduction for effective energies of random lattices in the Thomas-Fermi-von Weizsäcker model

Julian Fischer IST Austria
Michael Kniely IST Austria

Abstract: We discuss the calculation of effective energies of random materials described by the Thomas-Fermi-von Weizsäcker equations via the method of representative volume elements (RVEs). A reduction of the variance of the energy when evaluated for the RVE can be achieved by choosing the RVE such that it represents the underlying material particularly well. We provide a rigorous analysis of this strategy proposed in a different context by Le Bris, Legoll, and Minvielle.

SL04 **19:15-20:00**

AWM - SIAM Sonia Kovalevsky Prize Lecture

Chair Person: Ami Radunskaya Pomona College
Chair Person: Lisa Fauci Tulane University

19:15-20:00

The Dynamics of Ocean Waves

Catherine Sulem University of Toronto

Abstract: Many aspects of mathematical analysis were originally motivated by the study of fluid dynamics; in particular, waves and currents in bodies of water. I will discuss how mathematical analysis combined with asymptotic theory and accurate numerical simulations contributes, in turn, to a better understanding of the dynamics of ocean waves both at the surface of the ocean and in its interior, in regular situations and in extreme events.

Thursday sessions

July, 18

IL14 **08:30-09:15**

Omar Ghattas

Chair Person: Douglas Arnold University of Minnesota

08:30-09:15

Large-scale stochastic PDE-constrained optimization

Omar Ghattas Texas University, Austin, Us

Abstract: Oden Institute for Computational Engineering and Sciences Departments of Geological Sciences and Mechanical Engineering University of Texas at Austin, USA We consider optimization problems governed by PDEs with infinite dimensional random parameter fields. Such problems arise in numerous applications: optimal design and control of systems with stochastic forcing or uncertain material properties or geometry; inverse problems with stochastic forward problems; or Bayesian optimal experimental design problems with the goal of minimizing the uncertainty or maximizing the information gain in the inferred parameters. Randomness in the PDEs implies randomness in the control/design objective (and any state constraints). This is addressed by formulating the optimization objective in terms of moments of the control/design objective or various risk measures. Monte Carlo evaluation of the objective as per the popular Sample Average Approximation (SAA) algorithm results in an optimization problem that is constrained by N PDE systems, where N is the number of samples. This results in an optimization problem that is prohibitive to solve, especially when the PDEs are expensive to solve and discretization of the infinite-dimensional parameter field results in a high-dimensional parameter space. We discuss high-order derivative-based approximations of the parameter-to-objective maps that exploit the structure of these maps, in particular their smoothness, geometry, and low effective dimensionality. Their use as a basis for variance reduction, in combination with randomized linear algebra algorithms, is demonstrated to accelerate Monte Carlo sampling by up to three orders of magnitude and permit efficient solution of large scale stochastic PDE-constrained optimization problems with up to with O(10^6) uncertain parameters and O(10^6) optimization variables. Applications to optimal control of turbulent flow, optimal design of acoustic metamaterials, and chance-constrained optimal control of groundwater flow are presented. This work is joint with Peng Chen (UT Austin) and Umberto Villa (Washington University).

IL15 **08:30-09:15**

Yunqing Huang

Chair Person: Henar Herrero Universidad de Castilla-La Mancha

08:30-09:15

Recent advances in mathmatical analysis and numerical simulation of invisibility cloaks with metamaterials

Yunqing Huang Xiangtan University, China

Abstract: In this talk we will give a brief review on the recent advances in mathmatical analysis and numerical simulation of invisibility cloaks with metamaterials. Carpet cloak model and some other applications are presented. Superconvergence results of the edge elements are provided.

IL13 **08:30-09:15**

Eitan Tadmor

Chair Person: Mari Paz Calvo Calvo Universidad de Valladolid

08:30-09:15

Emergent behavior in collective dynamics

Eitan Tadmor University Of Maryland, College Park

Abstract: A fascinating aspect of collective dynamics is self-organization of small scales into large-scale structures --- clusters, flocks, tissues, parties. Different patterns can be system-specific, yet emerging equilibria can be derived from a few fundamental principles. We discuss the dynamics driven by anticipation to align local parts of the crowd, and external forces that keep the crowd together. We address the question how short-range interactions lead to emergence of long-range patterns, comparing geometric vs. topological interactions.

IL16 **09:30-10:15**

Thomas A. Grandine

Chair Person: Volker Mehrmann TU Berlin

09:30-10:15

21st Century Industrial Computing at Boeing

Thomas A. Grandine The Boeing Company

Abstract: The Python programming language, created in 1991 and gaining in popularity ever since, offers an appealing means of programming high level constructs in a very succinct way. Many mathematical tools based on Python have matured during the last 15 years, including SciPy, NumPy, Matplotlib, Jupyter, Anaconda, and others. This richness of these tools, taken collectively, provides an appealing universe in which very large numbers of diverse mathematical calculations can be performed in an industrial setting. Particularly appealing in this paradigm is Python's ability to interface quickly and effectively with large numbers of other tools, making it possible to deploy mathematical algorithms and applications wherever they are needed. This talk will explore some of the many use cases for this approach and discuss the knowledge and skills needed by practitioners to perform effectively in this environment.

IL17 **09:30-10:15**

Claude Le Bris

Chair Person: Juan Luis Vazquez Univ. Autonoma de Madrid

09:30-10:15

Homogenization of materials with defects

Claude Le Bris Ecole des Ponts & Inria

Abstract: We present some recent mathematical contributions related to homogenization problems. The difficulty stems from the fact that the medium is not assumed periodic, but has a structure with a set of embedded defects, localized or not, or more generally a structure that, although not periodic, enjoys nice geometrical features. The purpose is then to construct a theoretical setting providing an efficient and accurate approximation of the multiscale solution. The questions raised range from the theory of PDEs (elliptic or not, linear or not) and homogenization theory to harmonic analysis and singular operators. Computational issues are also discussed.

IL18 **09:30-10:15**

Anna-Karin Tornberg

Chair Person: Ricardo Nochetto University of Maryland

09:30-10:15

Close interactions of drops and particles in viscous flow

Anna Karin Tornberg Kth Royal Institute Of Technology, Stockholm, Sweden

Abstract: Integral equation based numerical methods are attractive for the simulations of fluid mechanics at the micro scale such as in droplet-based microfluidics, with tiny water drops dispersed in oil, stabilized by surfactants. We have developed highly accurate numerical methods for drops with insoluble surfactants, both in two and three dimensions with the latter recently extended to include also electric fields. This involves addressing several fundamental challenges that are highly relevant also to other applications: accurate quadrature methods for singular and nearly singular integrals, adaptive time-stepping, and reparameterization of time-dependent surfaces for high quality discretization of the drops throughout the simulations. In this talk, particular emphasis will be on quadrature methods applied to the evaluation of nearly singular layer potentials including error estimates and their use for adaptive parameter selection.

IL19 **11:00-11:45**

Kristin Lauter

Chair Person: Nick Trefethen University of Oxford

11:00-11:45

Private AI

Kristin Lauter Microsoft Research And University Of Washington, USA

Abstract: As the world adopts Artificial Intelligence, the privacy risks are many. AI can improve our lives, but may leak or misuse our private data. Private AI is based on Homomorphic Encryption (HE), a new encryption paradigm which allows the cloud to operate on private data in encrypted form, without ever decrypting it, enabling private training and private prediction. This talk will explain the mathematics behind Homomorphic Encryption and show demos of HE in action.

IL21 **11:00-11:45**

Panagiotis E. Souganidis

Chair Person: José Antonio Carrillo De La Plata Imperial College London

11:00-11:45

Nonlinear Stochastic Partial Differential Equations

Panagiotis Souganidis University Of Chicago, Us

Abstract: Nonlinear stochastic partial differential equations of first- and second-order are used to describe models in phase transitions, patwhise stochastic control theory, and mean-field games. Examples are Hamilton-Jacobi, Hamilton-Jacobi-Bellman/Isaacs, level-set equations and scalar conservation laws. The study of such partial differential equations requires a novel approach to define solutions as well as to develop a well-posedness theory. In this lecture I describe the context in which these equations arise, explain the major difficulties and discuss the new notions. If time permits, I will also present results about the qualitative (stochastic) properties of the solutions.

IL20 **11:00-11:45**

Hiroshi Suito

Chair Person: Maurizio Falcone Università di Roma "La Sapienza"

11:00-11:45

Geometrical characteristics of human anatomical structure in thoracic diseases

Hiroshi Suito Tohoku University, Japan

Abstract: This talk presents a discussion of the geometrical characteristics of human organs related to thoracic diseases. For instance, differences in the vessel morphology can produce different flow structures, stress distributions, and ultimately different outcomes. Therefore, the characterization of the morphologies of these vessels poses useful and important clinical questions. Through close collaboration between mathematical scientists and medical doctors, these analyses have elicited greater understanding leading to better risk assessment.

IPL03 **12:00-12:45**

ICIAM Lagrange Prize

Chair Person: Luca Formaggia POLITECNICO DI MILANO - MOX -

12:00-12:45

Data structures in imaging

George Papanicolaou Stanford University, Eeuu

Abstract: I have been working on various aspects of imaging for more than twenty years with several colleagues with whom it has been an honor and a pleasure to work: L. Borcea, T. Callaghan, A. Chai, J. Garnier, A. Kim, M. Leibovich, M. Moscoso, A. Novikov, L. Ryzhik, K. Solna, and C. Tsogka. Imaging is an interdisciplinary field that is deeply imbedded into nearly all sciences and its emergence as mainstream applied mathematics is relatively recent but accelerating and spreading broadly. My interests have been mostly in image formation but this inevitably intersects with image precessing (and denoising) as well as image identification. After a brief overview of synthetic aperture imaging, an image formation method that has been widely used for more than half a century (radar, sonar, ...), I will first describe the structure of the recorded data and then the imaging algorithm and its performance. One would think that this is it. What more is there to do at a methodological level? It turns out that there are a lot of very interesting things to do, such as imaging both stationary and moving objects in a complex scene. I will present a way to deal with motion estimation (and other) issues by giving the data a tensor structure and then using tensor methods that are much more sensitive and flexible.

MS GH-3-2 8 **14:30-16:30**

Mathematical and numerical modeling of Lithium ion batteries and fuel-cells

Organizer: Rodolfo Bermejo	Universidad Politécnica de Madrid, ETSII
Organizer: Laura Saavedra	Universidad Politécnica de Madrid ETSIA

Abstract: The workshop will address in an interactive way the mathematical and numerical modeling of new electrochemical systems of energy conversion and storage such a Lithium-ion batteries and fuel-cells. The purpose of the workshop is to promote the presentation on the development and analysis of mathematical and numerical tools to model the thermodynamics and kinetics of ion-electron transport in solides.

14:30-15:00

Numerical analysis of a finite element model for Lithium-ion batteries

Rodolfo Bermejo	Universidad Politécnica de Madrid, ETSII

Abstract: We present a finite element model for the standard pseudo two dimensional (P2D) model that describes the electrodynamics of a Lithium-ion cell. The P2D model is a non linear system of parabolic-elliptic which is very much used in engineering to perform studies and simulations of Lithium-ion batteries. We also present the error analysis of such a model.

15:00-15:30

A goal oriented P(n+1)D Newman-type battery model

Thomas Carraro	Heidelberg University
Sven E. Wetterauer	Heidelberg University

Abstract: The P(n+1)D model is an extension of the Newmann-type lithium ion battery model that takes into consideration a given range of (spherical) particles. We present a dual based adaptive finite element method for its numerical solution. For the computation of the effective diffusion coefficients on the complex microstructure of the electrode we present a 3D adaptive cut-cell implementation based on a level set method and a goal oriented error estimator.

15:30-16:00

Mathematical modelling and analysis for Lithium-ion batteries

Angel Ramos	Universidad Complutense de Madrid

Abstract: We will present the mathematical modeling of the processes involved in the charge/discharge of a Lithium battery. The resulting model is a system of partial and ordinary differential equations, together with suitable boundary and initial conditions. We will also perform a mathematical analysis of the equations, including results of existence and uniqueness of solution.

16:00-16:30

Dimensionless analysis of solid polymer electrolyte based battery performance

Fernando Varas	Universidad Politécnica de Madrid ETSIA
Elixabete Ayerbe	CIDETEC
Idoia Urdampilleta	CIDETEC
José Manuel Vega	Univ. Politécnica de Madrid

Abstract: Solid polymer electrolyte (SPE) cells present many advantages compared to lithium ion cells in terms of both cells' energy density and safety. However, unresolved fundamental issues remain to fully understand the performance of this type of cells. The aim of this work is to contribute to the understanding of SPE cells performance by identifying relevant cell dimensionless numbers, shedding light on the effects of SPE cell design parameters on specific solid state battery performance limitations.

MS A1-1-3 8 14:30-16:30

Numerical Methods For Backward Stochastic Differential Equations - Part 1

For Part 2 see: MS A1-2-4 10

Organizer: Long Teng	University of Wuppertal
Organizer: José Germán López Salas	University of A Coruña

Abstract: In recent years the backward stochastic differential equation (BSDE) has become an important tool for formulating many problems in finance, e.g., pricing and hedging financial derivatives. Since the BSDE exhibits usually no analytical solution, advanced numerical techniques are imperative for the applications in financial industry. The aim is to develop effective and efficient schemes for solving BSDEs arising from the mathematical theory of pricing and hedging financial derivatives, especially in high dimensions. The motivation for this minisymposium is to exchange and discuss current insights and ideas, and to lay groundwork for future collaborations.

14:30-15:00

Multilevel Picard approximations for high-dimensional nonlinear parabolic partial differential equations

Thomas Kruse	University of Gießen
Martin Hutzenthaler	University of Duisburg-Essen
Tuan Nguyen	University of Duisburg-Essen
Arnulf Jentzen	ETH Zurich
Philippe Von Wurstemberger	ETH Zurich
Weinan E	Princeton University

Abstract: We present new approximation methods for high-dimensional PDEs and BSDEs. A key idea of our methods is to combine multilevel approximations with Picard fixed-point approximations. We prove in the case of semilinear heat equations with Lipschitz continuous nonlinearities that the computational effort of one of the proposed methods grows polynomially both in the dimension and in the reciprocal of the required accuracy. We illustrate the efficiency of the approximation methods by means of numerical simulations.

15:00-15:30

High accurate numerical methods for FBSDEs with applications

Weidong Zhao	Shandong University
Tao Zhou	Chinese Academy of Sciences, Beijing 100190, China. Email: tzhou@lsec.cc.ac.cn

Abstract: In this talk, we will present accurate numerical methods for solving nonlinear forward backward stochastic differential equations with applications in solving fully nonlinear second-order parabolic partial differential equations and stochastic optimal control problems.

15:30-16:00

"Regression Now" meets "Regression Later"

Nikolaus Schweizer	Tilburg University
Christian Bender	Saarland University
Christian Gaertner	Saarland University

Abstract: Approximating conditional expectations is a major challenge in the numerics of BSDEs. To this end, we propose a least-squares Monte Carlo scheme that combines advantages of two competing methods. Our algorithm enjoys both the flexibility of the "regression now'' method and the reduced variance of "regression later''. In typical applications, we achieve a balance between projection and statistical errors by increasing the number of sample paths linearly (up to a log-factor) with the basis functions.

16:00-16:30

Solving fully coupled FBSDEs by minimizing a directly calculable error functional

Stefan Ankirchner	Univeristy of Jena
Alexander Fromm	University of Jena

Abstract: The talk presents a new scheme for approximating solutions of forward-backward stochastic differential equations (FBSDEs). The scheme is particularly suitable for fully coupled FBSDEs. The approximation relies on a piecewise in time approximation by minimizing an error functional that measures how well a process triplet satisfies the FBSDE. The error functional is minimized in a finite-dimensional linear space based on iterated integrals. We provide sufficient conditions for the approximations to converge at the rate 1/2.

MS A6-5-3 8 14:30-16:30

The CJK-SIAMs joint mini-symposium on Mathematical Biology - Part 2

For Part 1 see: MS A6-5-3 7

Organizer: Jae Kyoung Kim	KAIST
Organizer: Lei Zhang	Peking University

Abstract: Data analysis and modeling of multiscale dynamics in biology and medicine from molecules to cells Biological systems are regulated across many orders of magnitude in space and time. To investigate dynamics of each scale, various tools for data analysis and modeling have been developed. Furthermore, integrating dynamics from one scale to another is critical. In this session, we will present recent progress in multi-scale modeling and data analysis such as accurate projection of high-dimensional system to low-dimensional system, topological data analysis and network analysis.

14:30-15:00

Network design principle for dual function of adaptation and noise attenuation

Lei Zhang Beijing International Center for Mathematical Research (BICMR)

Abstract: Many signaling systems execute adaptation under noisy circumstances. To explore such dual function, we first explore three-node enzymatic regulation networks, and identify an intrinsic trade-off existing between good sensitivity and noise attenuation. This trade-off can be minimized in four-node networks, in which the adaptation module and the noise attenuation module can be effectively decoupled to achieve dual function.

15:00-15:30

Mathematical modeling and quantifying virus dynamics in cell culture

Shingo Iwami Kyushu University

Abstract: Current studies of viral replication deliver detailed time courses of several virological variables, like the amount of virus and the number of target cells, measured over several days of the experiment. In order to decompose the kinetics of virus infection, I introduce a method to “quantitatively” describe the virus infection, and discuss the potential of the combinational analyses with experimental and computational virology.

15:30-16:00

Biological oscillators: Interactions detections and dynamics predictions

Wei Lin Fudan University

Abstract: This talk is to introduce our recent works on directional interactions detections and dynamics predictions. Based on the theory of dynamical systems, we develop the model-free frameworks to the realization of detections and predictions. Through comparing our frameworks with other existing methods in the literature, we show the advantages of our frameworks when they are used to deal with the data produced by dynamical oscillators as well as by real experimental observations.

16:00-16:30

Mathematical model of tumor growth and anti-invasion strategies

Yangjin Kim	Konkuk University
Avner Friedman	Ohio State University MBI
Hans Othmer	University of Minnesota
Donggu Lee	Konkuk University
Junho Lee	Konkuk University
Balveen Kaur	University of Texas

Abstract: In this talk, I will present some recent mathematical models of cancer growth and development which focus on designing anti-cancer strategies. We investigate the role of microenvironment in regulation of cellular dispersion and tumor growth. The results of the models will be compared with experimental data and some new directions of how to develop the new, innovative strategies of anti-invasion of tumor cells will be discussed.

MS GH-1-A 8 14:30-16:30

Multiscale and stochastic numerical methods for hyperbolic conservation laws - Part 1

For Part 2 see: MS GH-1-A 9

Organizer: Maria Lukacova University of Mainz

Organizer: Alexander Kurganov Southern University of Science & Technology

Organizer: Alina Chertock North Carolina State University

Abstract: It is known that designing numerical methods for hyperbolic conservation laws is challenging since the solution may develop singularities in finite time. In practical applications additional challenges arise due to multiscale phenomena: the presence of small scales causes stiffness which can make the conventional numerical methods to become inefficient or oven impractical. Another challenge is related to the uncertainty in the model equations and data. This minisymposium focuses on modern numerical methods that are designed to efficiently and accurately handle the above difficulties and their interplay and aims at bringing together researchers with diverse expertise on multiscale phenomena.

14:30-15:00

Deep Learning observables in computational fluid dynamics

Siddhartha Mishra Department of Mathematics, ETH Zürich

Abstract: We present a machine learning algorithm, based on deep artificial neural networks, to approximate the parameters to observable maps that arise in computational fluid dynamics. We select proper network architecture in order to ensure a very low prediction error with few training samples. We apply the algortihm for forward uncertainty quantification and demonstrate a speed up of one to two orders fo magnitude over (quasi)-Monte Carlo methods

15:00-15:30

Uncertainty quantification in low Mach number atmospheric flows

Maria Lukacova University of Mainz

Abstract: We present a stochastic Galerkin method for a coupled Navier-Stokes-cloud system that models dynamics of warm clouds. Our goal is to explicitly describe the evolution of uncertainties that arise due to unknown input data. The SG method combines a finite volume-finite difference method with the generalized polynomial chaos in the stochastic space. The SG method is second-order accurate in space-time and exponential convergent in the stochastic space. Numerical results demonstrate reliability of the SG method.

15:30-16:00

An asymptotic-preserving method for the compressible Euler equations of gas dynamics

Alina Chertock North Carolina State University

Abstract: The main difficulty associated with numerical simulations of the compressible Euler equations of gas dynamics is a severe restriction on the size of time steps when the Mach number tends to zero, which substantially affects the efficiency of the method. We propose an asymptotic presserving numerical method, which is stable and accurate for all-speed regimes independently of the size of time steps and conduct a number of numerical experiments demonstrating the properties of the method.

16:00-16:30

An Asymptotic Preserving Scheme for the Shallow Water Equations with Coriolis Forces

Alexander Kurganov Southern University of Science & Technology

Abstract: We consider the shallow water equations with Coriolis forces. In the low Froude number regime, the system is stiff and explicit numerical methods are inefficient. We design an implicit-explicit scheme, which is uniformly asymptotically consistent and stable for a variety Froude numbers. The scheme is based on splitting the flux into the stiff and nonstiff parts. For the latter we use a Riemann-problem-solver-free central-upwind flux, while the linear stiff part is discretized using central differences.

MS FT-S-1 8 14:30-16:30

Novel time discretisation methods and moment models for kinetic equations

Organizer: Giovanni Samaey KU Leuven - Dept. Computer Science

Organizer: Julian Köllermeier Peking University

Organizer: Thomas Rey Université Lille 1

MS Organized by: SIAG/CSE

Abstract: Kinetic equations model the evolution of many-particle systems in a position-velocity phase space and arise in many different applications, such as fluid flow, biology and plasma physics. They are often characterised by a time scale separation beteen the fast time scale of particle collisions and the slow time scale of evolution of a few low-order moments of the particle distribution (such as density, momentum, energy,...). This minisymposium discusses (i) novel time discretisation techniques to overcome the stiffness arising from the multiple time scales, and (ii) moment models that also reduce the dimensionality of the problem by averaging over velocity space.

14:30-15:00

Multilevel Monte Carlo methods for kinetic equations in the diffusive scaling

Giovanni Samaey	KU Leuven
Emil Løvbak	KU Leuven
Stefan Vandewalle	KU Leuven

Abstract: Particle based simulations of kinetic equations suffer from severe stiffness in the diffusive limit, i.e., when the rate of collisions approaches infinity, resulting in prohibitive time step constraints. Starting from an asymptotic-preserving Monte Carlo scheme that avoids this time step constraint, we apply a Multilevel Monte Carlo method as a variance reduction method. We present the scheme, show its convergence behavior and present discuss level placement strategies.

15:00-15:30

On filter methods and the numerical solution of hyperbolic moment equations

Julian Köllermeier Peking University

Abstract: I will present a filtered moment method that filters the higher order moment coefficients of a hierarchical hyperbolic moment model. The filtering is equivalent to an additional source term in the moment model. The application of the filter leads to accelerated convergence of the model. I will show the analogy to averaged solutions and motivate the use of filters together with numerical results. The filter method outperforms existing methods regarding accuracy without additional computational cost.

15:30-16:00

Large time behavior of numerical solutions to hypocoercive kinetic equations

Maxime Herda INRIA, Univ. Lille
Marianne Bessemoulin-Chatard CNRS, Univ. Nantes
Thomas Rey Univ. Lille

Abstract: In this talk, we will be interested in the asymptotic analysis of numerical schemes for linear kinetic equations, with either Fokker-Planck or linearized BGK collision operator. We will explain how to obtain appropriate estimates to show exponential return to equilibrium and asymptotic-preserving properties. Our approach is based on the adaptation of hypocoercivity methods to the discrete setting. Numerical simulations will illustrate the accuracy and efficiency of the schemes in capturing correct asymptotic behaviors.

16:00-16:30

Convergence Analysis of Grad's Hermite Expansion for Linear Kinetic Equations

Manuel Torrilhon RWTH Aachen

Abstract: In 1949 Grad proposed a Hermite series expansion for approximating solutions to kinetic equations which have an unbounded velocity space. However, poorly imposed boundary conditions lead to instabilities which results in non-converging solutions. For linear kinetic equations, these instabilities can be removed through recently proposed boundary conditions. In the present work, we study global L2-convergence of these approximations. We confirm the presented convergence rates through numerical experiments involving the linearised-BGK equation of rarefied gas dynamics.

MS FT-1-10 8 14:30-16:30

Some modern questions in the simulation of advection dominated problems - Part 2

For Part 1 see: MS FT-1-10 7
For Part 3 see: MS FT-1-10 10

Organizer: Remi Abgrall University of Zurich
Organizer: Guglielmo Scovazzi Duke university
Organizer: Mario Ricchiuto INRIA

Abstract: We propose a mini symposium about modern trends in the simulation of advection dominated problems, in particular fluid dynamics (classical, MHD, etc) when compressibility cannot be ignored: How to produce good meshes, especially for high order simulation in complicated geometries where curved meshes are needed There is a debate about body fitted methods versus non body fitted ones: where do we stand? The control of the numerical dissipation: energy/entropy stable, adaptation vs no adaptation, What is a solution: classical weak solutions vs statistical solutions, More recent paradigms: could machine learning tools bring something to this field ?

14:30-15:00

The Shifted Boundary Method: A new approach to embedded domain computations

Guglielmo Scovazzi Duke university
Alex Main Duke Univerisity / Ansys
Nabil Atallah Duke University
Kangan Li Duke University
Oriol Colomés Duke University
Ting Song Duke University /ExxonMobil URC
Léo Nouveau Duke University
Mehdi Khalloufi Duke University
Mario Ricchiuto INRIA - Bordeaux

Abstract: Standard embedded boundary methods obviate the need for continual re-meshing but require complex cell cutting operations at boundaries, with consequences on the overall conditioning and numerical stability of the ensuing algebraic problems. We present the Shifted Boundary Method, a new, stable, accurate (embedded) approximate boundary method that eliminates the need to perform cell cutting. We present its numerical analysis and applications in solid mechanics, fluid mechanics, porous media flows and shallow water flows.

15:00-15:30

Singularities of the Spatial Operator in the Incompressible Navier-Stokes and Stokes Equations

Jan Nordström Linköping University
Fredrik Lauren Linköping University

Abstract: We investigate singularities of the spatial operator in the incompressible Navier-Stokes and Stokes equations. It is shown how to avoid singularities by choosing specific boundary conditions. Common boundary conditions such as Dirichlet, Neumann, Robin, natural and stabilized natural are investigated. The focus is on the linearised continuous problem. However, we demonstrate that the analysis carries over to the fully nonlinear case, as well as to the discrete setting by using the summation-by-parts framework.

15:30-16:00

An entropy stable nodal discontinuous Galerkin method for the resistive MHD equations

Alexander Astanin University of Cologne
Gregor Gassner University of Cologne
Marvin Bohm University of Cologne
Florian Hindenlang IPP, Garching

Abstract: The resistive MHD equations are of great interest in many areas of plasma, space- and astrophysics. In this work it is focused on a discretely entropy stable discontinuous Galerkin Spectral Element method (DGSEM) on three-dimensional curvilinear unstructured hexahedral meshes for the resistive MHD equations with hyperbolic divergence cleaning, based on generalized Lagrangian multiplier (GLM), and additional shock-capturing mechanism. We investigate the feasibility of GPU-based acceleration for the computationally expensive split-form volume integrals.

16:00-16:30

Towards a general stabilisation method systems of conservation laws using a multilayer Perceptro

Remi Abgrall University of Zurich
Han Veiga Maria University of Zurich

Abstract: We show how machine learning techniques can be used for the design of limiters in compressible fluids approximation. We discuss the pros and cons: cost, grid, flexibility.

MS A6-1-2 8 14:30-16:30

Shape Analysis and Optimization - Part 1

For Part 2 see: MS A6-1-2 9
For Part 3 see: MS A6-1-2 10

Organizer: Welker Kathrin Helmut-Schmidt-University
Organizer: Kevin Sturm TU Wien, Institut für Analysis and Scientific

Abstract: Shape optimization is a classical topic which is of high importance in a wide range of applications, e.g., image segmentation, aerodynamic and acoustic design optimization. Analytical and computational approaches in shape optimization have a long history. In particular, challenges arise in the context of applications involving partial differential equations or uncertainties. In this minisymposia recents results in shape analysis and optimization will be presented. Topics range from stabilization of partial differential equations, over classical shape optimization and stochastic shape optimization to shape analysis.

14:30-15:00

Actuator placement and singular value optimization

Sturm Kevin TU Wien
Rodrigues Sergio Radon Institute

Abstract: We discuss an optimal actuator placement problem arising in the stabilisation of parabolic-like systems. We relate the actuator placement problem to the maximisation problem of the smallest singular value of generalised Vandermonde matrices. We show that optimal actuator positions are not necessarily unique, however, they all have one property in common: symmetry. The symmetry property still holds for larger class of singular value maximisation problems beyond the initial actuator placement problem.

15:00-15:30

Optimal actuator design for semilinear parabolic PDEs

Dante Kalise	Imperial College London
Karl Kunisch	RICAM and University of Graz, Austria
Kevin Sturm	TU Vienna, Austria
Kirsten Morris	University of Waterloo, Canada
M. Sajjad Edalatzadeh	University of Waterloo, Canada

Abstract: We present an approach to optimal actuator design based on shape and topology optimisation techniques. For linear diffusion equations, we determine the best actuator shape/location for a given initial condition or a set of initial conditions not exceeding a chosen norm. We compute shape and topological sensitivities of the corresponding cost functionals. Numerical results support the proposed methodology, and we discuss extensions to vibration control and nonlinear dynamics.

15:30-16:00

A Hybrid Finite-Dimensional RHC for Stabilization of Nonautonomous Parabolic Equations

Azmi Behzad	Austrian academy of sciences - RICAM
Karl Kunisch	University of Graz

Abstract: We deal with the stabilization of a class of nonautonomous linear parabolic equations by a finite-dimensional Receding Horizon Control (RHC). We discuss the stability and suboptimality of RHC with respect to different control costs. Particularly, we consider the case where the squared -norm as the control cost is chosen. This leads to a nonsmooth infinite-horizon problem which allows a stabilizing control with a low number of active actuators over time. Numerical experiments are also given.

16:00-16:30

Explicit local stabilizing feedback for the FitzHugh-Nagumo system

Rodrigues Sergio	Johann Radon Institute (RICAM)

Abstract: Global feedback stabilizability results are derived for nonautonomous coupled systems arising from the linearization around a given time-dependent trajectory of the FitzHugh-Nagumo system. The feedback is explicit and based on suitable oblique projections in Hilbert spaces. The actuators are a finite number of indicator functions acting only in the parabolic equation. Local feedback stabilizability to trajectories is derived for nonlinear coupled systems. Simulations are presented showing the stabilizing performance of the feedback control.

MS A6-4-3 8 14:30-16:30

Advances on Quantization with applications to finance

Organizer: Martino Grasselli	University of Padova and DVRC Paris

MS Organized by: SIAG/FME

Abstract: Quantization is a technique that comes originally from numerical probability, and consists in approximating random variables and stochastic processes taking infinitely many values, with a discrete version of them, in order to simplify the quadrature algorithms for the computation of expected values related to the problem of option pricing. In the literature, finite difference methods are heavily affected by the curse of dimensionality, while Monte Carlo methods need intense computational effort in order to have good precision. Quantization can give an alternative methodology for a broad class of models and derivatives. This minisymposium is sponsored by the SIAG/FME

14:30-15:00

Recent Developements in Quantization

Martino Grasselli	University of Padova and Devinci Research Center
Abass Sagna	University of Evry Val d'Essonne

Abstract: We introduce a functional quantization approach for non Markovian processes. Examples and applications to Finance reveal the great flexibility of the approach.

15:00-15:30

Convex order, quantization and monotone approximations of ARCH models

Gilles Pagès	Sorbonne Université
Jourdain Benjamin	ENPC-ParisTech

Abstract: Dual quantization of random vectors, introduced a few years ago in [Pagès-Wilbertz, 2012, SINUM] is based on Delaunay triangulation instead of Voronoi tessellation. It always satisfies a stationarity property regardless of its optimality but still shares the asymptotic properties of Voronoi quantization. Here, we devise a time-space Markovian dual quantization of martingale diffusions (ARCH Models) which preserves their monotony for the convex order. These are efficient tools to solve numercially the MOT problem in medium-dimensions.

15:30-16:00

BSDES OF XVA: A QUANTIZATION APPROACH

Alessandro Gnoatto	University of Verona
Martino Grasselli	Dipartimento di Matematica - Università degli Studi di Padova
Giorgia Callegaro	Dipartimento di Matematica - Università degli Studi di Padova

Abstract: The aim of our study is to provide new numerical methods for the computation of portfolio-wide counterparty risk and funding adjustments (xVA). Our approach involves techniques from numerical probability: in particular we aim at combining standard Monte Carlo discretizations of stochastic processes with quantization methods to overcome the curse of dimensionality that arises as the size of the derivative portfolio increases.

16:00-16:30

Quantization goes Polynomial

Andrea Pallavicini	Banca IMI
Giorgia Callegaro	University of Padova
Lucio Fiorin	University of Padova

Abstract: Quantization algorithms have been recently successfully adopted in option pricing problems to speed up Monte Carlo simulations thanks to the high convergence rate of the numerical approximation. In this paper we apply for the first time recursive marginal quantization to the family of polynomial processes, by exploiting, whenever possible, their peculiar properties. We derive theoretical results to assess the approximation errors, and we describe in numerical examples practical tools for fast exotic option pricing.

IM FT-4-2 8 14:30-16:30

Mathematical Solutions of Industrial Applications

Organizer: Takanori Ide	AISIN AW CO.,LTD.
Organizer: Tetsuya Sakurai	University of Tsukuba
Organizer: Nahid Emad	University of Versailles

Abstract: Mathematics plays an important role in modern industry, for instance as a tool for research & development and as algorithmic parts of products. This session presents success stories of industrial mathematics as a solution to various business challenges. Several domains of industry are considered: automotive, information and communications technology, manufacturing, medical imaging and nanotechnology. The following specific topics are included: 1. Data-driven development in industry, 2. Industrial applications of numerical linear algebra, 3. Inverse problems in medical X-ray imaging, 4. Optimization in industry. Each talk will discuss the motivation, approaches and implementations based on mathematics.

14:30-15:00

A novel dimensionality reduction method using a complex moment-based subspace

Akira Imakura	University of Tsukuba
Momo Matsuda	University of Tsukuba
Xiucai Ye	University of Tsukuba
Tetsuya Sakurai	University of Tsukuba

Abstract: Dimensionality reduction methods that project high-dimensional data to a low-dimensional space by matrix trace optimization are widely used for clustering and classification. The matrix trace optimization problem leads to an eigenvalue problem for a low-dimensional subspace construction. Most of the existing methods use only a few eigenvectors. In this talk, to improve the recognition performance, we propose a novel dimensionality reduction method using a complex moment-based subspace including multiple eigenvectors.

15:00-15:30

User behavior anomaly detection in the context of identify and access management

Abdoulaye Diop	University of Versailles/Atos
Nahid Emad	University of Versailles/ Paris Saclay
Thierry Winter	Atos Evidian
Mohamed Hilia	Atos

Abstract: Data assets protection is an important issue in the cybersecurity field. Companies use logical access control tools to protect their information against external threat, but they are lacking solutions for insider threat. In several fields, behavior anomaly detection is the method used by cyber specialists to effectively counter the threats of user malicious activities. In this talk, we will present a review of mathematical detection models of anomalous behavior based on data and graph analysis.

15:30-16:00

Binary classification of control results of automatic transmission using deep neural networks

Takefumi Kawakami	AISIN AW CO.,LTD.
Takanori Ide	AISIN AW CO.,LTD.
Kiyohisa Tomita	AISIN AW CO.,LTD.
Eiji Moriyama	AISIN AW CO.,LTD.
Hiroshi Tsutsui	AISIN AW CO.,LTD.
Kunihito Hoki	The University of Electro-Communications
Masakazu Muramatsu	The University of Electro-Communications

Abstract: In recent years, the development time of vehicles has further accelerated, and automation of the development is an urgent task. One example of time wasting tasks is gear-shift calibration. For this purpose, we studied OK/NG classification of shift quality using neural networks. The neural networks learned shift quality assigned by an expert engineer. Our experimental results show that the neural networks achieve performance comparable to that of the expert engineer.

16:00-16:30

A complex moment-based spectral method for detecting anomalous structures in large graphs

Tetsuya Sakurai	University of Tsukuba
Yasunori Funamura	University of Tsukuba
Xiucai Ye	University of Tsukuba
Akira Imakura	University of Tsukuba

Abstract: In this talk, we present a complex moment-based approach for finding anomalous structures in large graphs. In recent years, spectral methods have been proposed to find anomalous subgraphs in large graphs using eigenvectors corresponding to some largest positive eigenvalues of the graph's modularity matrix. In this study, we propose a method using a complex moment-based eigenvalue solver, which can efficiently compute eigenvectors with interior eigenvalues that could also indicate existence of anomalous subgraphs.

MS FT-4-7 8 14:30-16:30

Numerical methods for PDE-based multi-physics models in biomechanics - Part 3

For Part 1 see: MS FT-4-7 6
For Part 2 see: MS FT-4-7 7
For Part 4 see: MS FT-4-7 9
For Part 5 see: MS FT-4-7 10

Organizer: Ricardo Ruiz Baier	University of Oxford
Organizer: Kent-Andre Mardal	University of Oslo

Abstract: The scope of the proposed minisymposium deals with the numerical approximation of multiphysics models in biomechanics. First, a particular emphasis will be placed on rigorous convergence analysis, tailored domain decomposition techniques, recent mixed finite element and hybrid discretizations, boundary element methods, design and analysis of preconditioners. Secondly, the session will focus on the application of these new methodologies in the solution of PDE-based coupled models arising in biomechanics and related systems. For instance, we especially welcome submissions involving brain multiphysics, cardiac electromechanics, or respiratory system modelling; as well as more general fluid-structure interaction, and multiscale and/or multiphysics problems.

14:30-15:00

Scalable domain decomposition preconditioners for cardiac electro-mechanics

Luca Pavarino	University of Pavia
Piero Colli Franzone	University of Pavia
Simone Scacchi	University of Milano

Abstract: We introduce and study some scalable domain decomposition preconditioners for cardiac electro-mechanical 3D models discretized with splitting semi-implicit techniques in time and isoparametric finite elements in space. Scalability is achieved by a Multilevel Additive Schwarz preconditioners for the bioelectrical model and a BDDC-Newton-Krylov solver for the mechanical model. The resulting scalable solvers can be applied to the study of both physiological excitation-contraction cardiac dynamics and re-entrant waves in the presence of different mechano-electrical feedbacks.

15:00-15:30

A mechanobiochemical model for 3D cell migration

Laura Murphy	University of Sussex
Anotida Madzvamuse	University of Sussex

Abstract: I will present the development, analysis and numerical simulations of a model for 3D cell motility, which couples biochemical reactions and biomechanical forces. Since the model consists of highly non-linear PDEs, we employ the moving grid finite element method in simulations. We observe both simple and complex deformations. The computational framework is a strong foundation for studying experimentally driven reaction-kinetics involving actin, myosin and other molecular species which influence cell movement and deformation.

15:30-16:00

Stochastic Galerkin mixed finite element method for Biot's consolidation model with uncertain inputs

Arbaz Khan	University of Manchester
Catherine Powell	University of Manchester
David Silvester	University

Abstract: In this talk, we discuss a novel locking-free stochastic Galerkin mixed finite element method for the Biot consolidation model with uncertain Young’s modulus and hydraulic conductivity field. After introducing a five-field mixed variational formulation of the standard Biot consolidation model, we discuss stochastic Galerkin mixed finite element approximation, focusing on the issue of well-posedness and efficient linear algebra for the discretized system. We introduce a new preconditioner for use with MINRES and establish eigenvalue bounds.

16:00-16:30

Uncertainty quantification in the human brain using random fields

Vegard Vinje	Simula
Marie E. Rognes	Simula Research Laboratory
Matteo Croci	University of Oxford

Abstract: In this study we used multilevel Monte Carlo simulations on real-life geometries to address the relative importance of diffusion versus convection in stochastic models of the human brain. The glymphatic theory states that solutes are cleared from the brain by convective transport. However, recent studies have claimed that diffusion drives clearance in extracellular spaces. In our model, diffusion alone was not sufficient to explain transport of tracer as seen in MRI-images of studies in humans.

MS FT-S-6 8 14:30-16:30

Recent advances on numerical methods and applications of phase-field models - Part 4

For Part 1 see: MS FT-S-6 5
For Part 2 see: MS FT-S-6 6
For Part 3 see: MS FT-S-6 7

Organizer: Chuanju Xu	Xiamen University

Abstract: Interfacial dynamics in complex fluids presents tremendous challenges to science. From a fluid mechanical viewpoint, the essential physics is the coupling between interfacial movement and the flow of the bulk fluids. Phase field methods start from a multi-scale point of view and treat the interface as a microscopic transition zone of small but finite width. Then a set of governing equations can be derived that are thermodynamically consistent and mathematically well-posed. This mini-symposium will bring together numerical analysts and computational scientists working on phase field methods to present their recent advances in algorithm designs and applications of phase field methods.

14:30-15:00

Structure preserving schemes for complex nonlinear dissipative/conservative systems

Jie Shen — Purdue University and Xiamen University

Abstract: I will present a new approach to deal with nonlinear terms in a large class of gradient flows and Hamiltonian systems. The approach is not restricted to specific forms of the nonlinear part of the free energy or Hamiltonian. It leads to linear and unconditionally energy stable schemes which only require solving decoupled linear equations with constant coefficients. Hence, these schemes are extremely efficient and very accurate when combined with higher-order BDF schemes.

15:00-15:30

Error analysis of a decoupled, linear stabilization scheme for the Cahn-Hilliard model

Hui Zhang — Beijing Normal University,

Abstract: In this talk, we present rigorous error analysis for a first-order in time, linear, decoupled and energy stable scheme for solving the Cahn-Hilliard phase-field model of two-phase incompressible flows. The scheme combines the projection method, the explicit stabilizing decoupling technique, and the linear stabilization approach together. Optimal error estimates are derived for the semi-discrete-in-time scheme.

MS A6-3-4 8 — **14:30-16:30**

Recent Advances in Tomographic Imaging - Part 1

For Part 2 see: MS A6-5-4 6

For Part 3 see: MS A6-3-4 10

Organizer: Haltmeier Markus — Universitat Innsbruck

Organizer: Richard Kowar — University of Innsbruck

Abstract: Tomographic imaging is a central diagnostic tool in clinical practice. Examples include x-ray CT, photoacoustic tomography, emission tomography and MRI. One of the central mathematical aspects in tomography is the development efficient and accurate image reconstruction algorithms. Besides traditional reconstruction methods using analytical or iterative estimation techniques, recently, a new class of image reconstruction methods appeared which is based on techniques from deep learning. This can be used, for example, for improving image quality, reducing computation time or reducing radiation exposure. In this Minisymposium, leading experts will report on recent developments in image reconstruction and various tomographic modalities.

14:30-15:00

Compressed sensing photoacoustic tomography

Markus Haltmeier — University of Innsbruck

Peter Burgholzer — Research Center for Non-Destructive Testing (RECENDT)

Stephan Antholzer — University Innsbruck

Johannes Schwab — University Innsbruck

Abstract: Compressed sensing (CS) techniques allow reducing the number of measurements in photoacoustic tomography. High resolution imaging from CS data requires particular image reconstruction algorithms. The most established reconstruction techniques for that purpose use sparsity and ell1-minimization. Recently, deep learning appeared as a new paradigm for CS and other inverse problems. In this talk we develop, compare and evaluate several approaches and present numerical results for deterministic sparse measurements and for random measurements.

15:00-15:30

Modeling and image reconstruction in 3D Compton imaging

Gael Rigaud — University of Wuerzburg

Abstract: Compton scattering imaging (CSI) is an arising imaging concept measuring and exploiting the scattering radiation as an object of interest is illuminated by an ionizing source. Our work analyses the operators modeling the scattered radiation and addresses the problem of inverting the measured spectrum in order to reconstruct (or at least extract features of) the electron density.

15:30-16:00

Dual approach for TV-regularized Maximum Likelihood Expectation Maximization in tomography with Poisson data

Voichita Maxim — CREATIS, Université de Lyon

Elie Bretin — Institut Camille Jordan, Université de Lyon

Abstract: Tomography in nuclear medicine requires resolution of a linear inverse problem. As the radioactive decay follows a Poisson law, the projections of gamma emission from inside the body are also Poisson distributed. In this talk we will introduce a dual algorithm for total variation (TV) Poisson denoising. When combined with MLEM (maximum likelihood expectation maximization) iterations, a fast and convergent algorithm for the estimation of the TV maximum-a-posteriori solution is obtained.

16:00-16:30

Projection-Based 2.5D U-net Architecture for Fast Volumetric Segmentation

Christoph Angermann — University of Innsbruck

Markus Haltmeier — University of Innsbruck

Abstract: Convolutional neural networks are state-of-the-art for various segmentation tasks. While for 2D images these networks are also computationally efficient, 3D convolutions have huge storage requirements. To overcome this issue, we introduce a network structure for volumetric data without 3D convolutional layers. We include maximum intensity projections, use the 2D U-net and implement a trainable reconstruction algorihtm. For a tested binary segmentation task, the proposed architecture even shows better performance than the 3D U-net.

MS FE-1-G 8 — **14:30-16:30**

Computation of Special Functions and Related Aspects

Organizer: Amparo Gil — Universidad de Cantabria

Organizer: Javier Segura — Universidad de Cantabria

Organizer: Nico M. Temme — CWI

Abstract: Special functions appear in a vast number of scientific applications where numerical values for the functions are required. Algorithms and methods for the computation of special functions (or their inverses) are discussed. Related problems such as the evaluation of Gaussian quadrature rules or the use of multivariable orthogonal polynomials in computation, will be also considered. This minisymposium is sponsored by IFIP Working Group 2.5, http://wg25.taa.univie.ac.at

14:30-15:00

Asymptotic and Iterative Methods for Gaussian Quadratures

Javier Segura — Universidad de Cantabria

Amparo Gil — Universidad de Cantabria, Spain

Nico M. Temme — CWI, The Netherlands

Abstract: Asymptotics for classical orthogonal polynomials (Hermite, Laguerre, Jacobi) and their roots are shown to be accurate and efficient methods for the computation of classical Gauss quadratures of moderately large degrees. Alternatively, fast and globally convergent iterative methods are described which are valid without practical restrictions on the parameters and with arbitrary accuracy. We discuss the advantages of considering separate asymptotic and iterative methods for Gauss quadrature instead of the most usual hybrid approach combining them.

15:00-15:30

The Functional Inverse of the Gamma Function

Rob Corless — Western University

Leili Rafiee Sevyeri — Western University

Ana Camargos Couto — Western University

David Jeffrey — Western University

Abstract: A recent survey of the Gamma function by Jon Borwein and myself uncovered a significant gap: analysis and computation of the functional inverse. I will give an overview of this multivalued inverse function and some effective series for its computation. This is also connected with Stirling's original series for approximating the Gamma function, which can be approximately inverted for the principal branch by using the Lambert W function.

15:30-16:00

New uniformly convergent expansions of special functions in terms of elementary functions

Ester Perez-Sinusia — Universidad de Zaragoza

Chelo Ferreira — Universidad de Zaragoza

José Luis López — Universidad Pública de Navarra

Abstract: Expansions of special functions with respect to different systems are interesting from an analytical and numerical point of view. Usually, expansions for these functions are not simultaneously valid for small and large values of the variable. Using a simple technique, we derive new uniformly convergent expansions of several special functions in terms of elementary functions valid in a large region of the complex plane including small and large values of the variable and error bounds.

16:00-16:30

Computing with multivariable orthogonal polynomials

Alex Townsend	Cornell University
Sheehan Olver	Imperial College London
Geoffrey Vasil	Sydney University

Abstract: Expansions of univariate orthogonal polynomials are important in computational mathematics for computing with functions, solving differential equations, and signal processing. In this talk, we discuss bivariate analogues of orthogonal polynomials. In particular, we describe bivariate versions of Jacobi operators, Clenshaw's algorithm, and sparse differentiation operators. We use these tools to solve linear partial differential equations on triangles where solutions are represented by polynomials with degrees in the thousands.

MS GH-1-1 8 14:30-16:30

Parameter identification problems in magnetic particle imaging

Organizer: Tobias Kluth University of Bremen
Organizer: Anne Wald Saarland University

Abstract: Magnetic particle imaging (MPI) is an imaging modality to determine the concentration of nanoparticles from their nonlinear magnetization behavior. It benefits from a rapid data acquisition in 3D. The image reconstruction still relies on a time-consuming calibration process. This is due to still insufficient models and unknown parameters in the signal acquisition chain. In this mini-symposium, we aim at bringing together researchers working on magnetic particle imaging and related fields. We cover theoretical and practical topics in MPI focusing on mathematical and physical as well as algorithmic and computational issues related to the identification of parameters of interest in MPI.

14:30-15:00

Identification of parameter deviations in the MPI system function

Hannes Albers University of Bremen

Abstract: In Magnetic Particle Imaging, a key challenge is reducing the error of the modeled system function compared to the measured physical reality. We introduce an approach to identify and mitigate this error, i.e. improving the modeled system function, employing the Brownian and Néel particle magnetization models and utilizing parameter identification methods from the field of Inverse Problems on the resulting PDE-based formulation.

15:00-15:30

Parameter identification for the Landau-Lifshitz-Gilbert equation in Magnetic Particle Imaging

Tram Thi Ngoc Nguyen	Alpen-Adria-Universität Klagenfurt
Barbara Kaltenbacher	Alpen-Adria-Universität Klagenfurt
Thomas Schuster	Saarland University
Anne Wald	Saarland University,

Abstract: Magnetic particle imaging is a new imaging modality for medical applications. The technique takes advantage of the response of the nanoparticles to an oscillating magnetic field to construct their spatial-dependent concentration. Aiming at an accurate model for the system function to avoid the slow calibration, we use a model from micromagnetism governed by the Landau-Lifshitz-Gilbert equation and consider parameter identification in it. The problem is formulated in two settings: An all-at-once and a reduced version.

15:30-16:00

Magnetic field based system matrix corrections for multi-patch MPI reconstructions

Marija Boberg	University Medical Center Hamburg-Eppendorf
Martin Möddel	University Medical Center Hamburg-Eppendorf
Tobias Knopp	University Medical Center Hamburg-Eppendorf

Abstract: Magnetic particle imaging is an imaging modality, which determines the spatial distribution of super-paramagnetic nanoparticles by solving a linear system of equations. Using multi-patch approaches the field-of-view in MPI can be enlarged. Due to field imperfections a dedicated system matrix for each patch is required to reduce artifacts in the reconstructed image. However, this results in long calibration times. In this talk, techniques are presented to reduce the calibration time while maintaining high quality.

16:00-16:30

Background removal by mixing factor based filtering of the system matrix

Florian Lieb Hochschule Aschaffenburg

Abstract: The separation of particle and excitation signal of a measured Magnetic Particle Imaging (MPI) system matrix is important in the context of data-dependent parameter estimation. The proposed mixing factor based filtering method leads to an improved background removal compared to the subtraction of empty scanner measurements. Additionally, the method motivates a novel SNR measure for frequency selection which is entirely unbiased by background measurements. This entails less noisy and more detailed reconstructions.

MS FT-S-8 8 14:30-16:30

Numerical linear algebra advances for inverse problems and data assimilation - Part 1

For Part 2 see: MS FT-S-8 9
For Part 3 see: MS FT-S-8 10

Organizer: Melina Freitag	University of Bath
Organizer: Nancy K Nichols	University of Reading
Organizer: Silvia Gazzola	University of Bath
Organizer: Alison Ramage	University of Strathclyde

MS Organized by: SIAG/LA

Abstract: The solution of inverse problems and data assimilation requires efficient algorithms and tools from large scale linear algebra. The aim of this minisymposium is to present new developments in theory and numerical methods for inverse problems and data assimilation problems, including regularisation techniques, iterative solution methods, Krylov methods, preconditioning methods, reduced order modelling, and statistical approaches to inverse problems.

14:30-15:00

Krylov Subspace Regularization for Inverse Problems

James Nagy	Emory University
Silvia Gazzola	University of Bath
Chang Meng	Emory University

Abstract: In this talk we consider recent work on Krylov subspace-based regularization approaches that combine direct matrix factorization methods on small subproblems with iterative solvers. The methods are very efficient for large scale imaging problems and have the advantage that various regularization approaches can be used, and they can also incorporate methods to automatically estimate regularization parameters. This is joint work with Chang Meng (Emory University) and Silvia Gazzola (University of Bath).

15:00-15:30

Influence of finite precision on regularization by short-recurrence Krylov subspace methods

Iveta Hnetynková	Charles University
Marie Kubinova	Institute of Geonics, The Czech Academy of Sciences
Tomas Gergelits	Faculty of Mathematics and Physics, Charles University

Abstract: Various methods for solving ill-posed problems rely on the computation of orthonormal bases of Krylov subspaces by short recurrences. Here rounding errors cause loss of the global orthogonality of the vectors, computed subspaces can be rank-deficient and a significant delay of convergence occurs. We show how to relate computed and exact entities (such as solutions, residuals, etc.) in selected Krylov methods. This allows us to study to which extent here practical computations resemble exact ones.

15:30-16:00

Lanczos-based blind deconvolution methods

Kirk Soodhalter Trinity College Dublin

Abstract: Krylov subspace methods are an effective tool for treating large-scale discrete ill-posed problems. In this talk, we describe a family of blind deconvolution methods built on a Krylov subspace iteration that allow a user to adjust the blurring matrix used in the computations to achieve an improved restoration. We present numerical experiments demonstrating the effectiveness of this new method, including ones arising in adaptive optics applications.

16:00-16:30

Hybrid Projection Methods with Recycling for Large Inverse Problems

Jiahua Jiang	1990

Abstract: Iterative hybrid projection methods have proven to be very effective for solving large linear inverse problems. However, the main disadvantage is the need to store the basis vectors for solution computation. In this work, we present a framework that uses recycling approaches with the Golub-Kahan bidiagonalization to efficiently compute an accurate solution, even after the solution space has been compressed.

MS A1-3-1 8 14:30-16:30

Applications of agent-based modeling and simulation - Part 1

For Part 2 see: MS A1-3-1 9

Organizer: Rachael Miller Neilan	Duquesne University
Organizer: Angelika Manhart	Imperial College London

Abstract: Agent-based modeling is a powerful technique used to study properties of complex systems that emerge from the actions and interactions of individual entities and their environment. Agent-based models are used increasingly in all disciplines, both as a predictive tool and as a means of deriving partial differential equation models. This mini-symposium showcases the success of agent-based modeling in addressing problems in biology and medicine, as well as the utility of agent-based modeling in undergraduate education.

14:30-15:00

An Agent-Based Model of Neural Behavior and Bladder Pain

Rachael Miller Neilan	Duquesne University
Joshua Baktay	Duquesne University
Marissa Behun	Duquesne University
Neal McQuaid	Duquesne University
Benedict Kolber	Duquesne University

Abstract: Chronic bladder pain evokes asymmetric behavior in neurons across the left and right hemispheres of the amygdala. An agent-based model was created to simulate the firing of neurons over time and in response to bladder distention. Cumulative neural activity is used to measure temporal changes in bladder pain. We will show the model's ability to capture acute and chronic pain and its potential to predict changes in pain similar to those observed in the lab.

15:00-15:30

A New Agent-based Modeling Platform to Explore the Spread of Infectious Diseases on Contact Networks

Hannah Callender Highlander	University of Portland

Abstract: With undergraduate research as a priority, we have developed an agent-based modeling platform in NetLogo, called Infections On NeTWorks (IONTW), that allows students with relatively little background in mathematics and in programming to develop intuition and form testable conjectures for a variety of infectious diseases and network structures. Here I will give an overview of our modeling platform and share several research projects I have worked on with undergraduates using this software.

15:30-16:00

Modeling the Predation and Evolution of an Endangered Epiphytic Bromeliad: an Agent-Based Modeling Approach

Erin Bodine	Rhodes College
Alex Capaldi	Valparaiso University
Rachel Jabaily	Colorado College
Brad Oberle	New College of Florida
Brian Sidoti	New College of Florida
Caroline Bush	Rhodes College
Sam Crowell	Rhodes College
Rainer Jones	Rhodes College

Abstract: The large, long-lived, epiphytic, semelparous bromeliad Tillandsia utriculata is endangered in Florida due to predation from the invasive weevil Metamasius callizona. Recently, the T. utriculata population has shifted initiation of inflorescence production earlier which correlates to fewer seeds produced. We constructed an agent-based model to simulate the Florida T. utriculata population over many generations, and use the model to explore the impact of predation on future population viability due to shifts in timing of induction.

16:00-16:30

Deducing dynamical rules via machine learning and topology

John Nardini	NC State University
Dhananjay Bhaskar	Brown University
Angelika Manhart	Imperial College London
Jesse Milzman	University of Maryland, College Park
Kathleen Storey	University of Michigan
Lori Ziegelmeier	Macalester College

Abstract: We analyze simulations of agent-based models using a topological tool known as the CROCKER plot, which captures the persistent homology of a point cloud over time. We use topological data as input for machine learning techniques in order to classify emergent simulation behavior and identify model parameters generating this behavior. We compare the classification performance with a more traditional approach involving the calculation of order parameters that describe global properties (angular momentum, polarization) of swarms.

MS A3-3-1 8 14:30-16:30

Recent advances on electronic structure calculations - Part 1

For Part 2 see: MS A3-3-1 9

For Part 3 see: MS A3-3-1 10

Organizer: Zhenning Cai	National University of Singapore
Organizer: Chao Yang	Lawrence Berkeley National Laboratory
Organizer: Guanghui Hu	University of Macau

Abstract: This minisymposium focuses on recent progress of mathematical analysis and numerical methods for performing electronic structure calculations as well as the materials science and chemistry applications that benefit from this type of calculations. The topics covered in this minisymposium include, but are not limited to, efficient algorithms for large-scale DFT and TDDFT calculations, wavefunction based methods, structure optimization, nano-optics, quantum hydrodynamic models, many-body perturbation theory based approaches, and machine learning techniques that combine experimental data and simulation to improve materials modeling and design capabilities.

14:30-15:00

Global Minimization vs Self-Consistent Solutions in Electronic Structure Calculations

Stefano De Gironcoli	The International School for Advanced Studies

Abstract: I will briefly review the two main approaches to the solution of a general Electronic Structure problem in the context of Density Functional Theory: the self-consistent field approach and the global minimization approach. I'll draw attention to advantages and remaining problems of the two approaches.

15:00-15:30

Large-scale real-space DFT and TDDFT calculations using finite elements

Vikram Gavini	University of Michigan
Sambit Das	University of Michigan
Phani Motamarri	University of Michigan
Bikash Kanungo	University of Michigan

Abstract: We present recent developments in large-scale real-space Kohn-Sham DFT and TDDFT calculations using finite element discretization. In particular, the talk will demonstrate the efficacy, efficiency and scalability of higher-order and enriched finite-element discretizations in pseudopotential and all-electron DFT calculations. We will also present the performance of DFT-FE, a recently released massively parallel open-source real-space DFT code that is capable of efficiently handling systems with 100,000 electrons. Extensions to TDDFT calculations will also be briefly discussed.

15:30-16:00

Applicability of Kerker preconditioning scheme to the self-consistent density functional theory calculations of inhomogeneous systems

Xingyu Gao	IAPCM
Yuzhi Zhou	Institute of Applied Physics and Computational Mathematics, Beijing, China
Han Wang	Institute of Applied Physics and Computational Mathematics, Beijing, China
Yu Liu	Institute of Applied Physics and Computational Mathematics, Beijing, China

Haifeng Song — Institute of Applied Physics and Computational Mathematics, Beijing, China

Abstract: The Kerker preconditioner, based on the dielectric function of homogeneous electron gas, is designed to accelerate the self-consistent field (SCF) iteration in the density functional theory calculations. However, a question still remains regarding its applicability to the inhomogeneous systems. We develop a modified Kerker preconditioning scheme that captures the long-range screening behavior of inhomogeneous systems. The effectiveness and efficiency is shown by the tests on long-z slabs of metals, insulators, and metal-insulator contacts.

16:00-16:30

Towards accurate calculations of total energy and ionic force by an adaptive FEM framework of Kohn-Sham equation

Guanghui Hu — University of Macau

Abstract: We describe an adaptive finite element framework on solving the Kohn-Sham equation, which consists of SCF iteration for the linearization, and the LOBPCG for solving the generalized eigenvalue problems. Both the h-adaptive mesh methods and the OpenMP parallelization are considered for improving efficiency. In particular, the error estimation methods are discussed towards the accurate calcualtions of the ground state and ionic force through the Hellmann-Feynman approach. Numerical results show the effectiveness of our method.

MS A3-S-C1 8 — 14:30-16:30

Tensor Methods - Part 5

For Part 1 see: MS A3-S-C1 4
For Part 2 see: MS A3-S-C1 5
For Part 3 see: MS A3-S-C1 6
For Part 4 see: MS A3-S-C1 7
For Part 6 see: MS A3-S-C1 9

Organizer: Lieven De Lathauwer — KULeuven
Organizer: Konstantin Usevich — CRAN - CNRS - Université de Lorraine
Organizer: André Uschmajew — MPI MiS

Abstract: A significant research effort is currently dedicated to the extension of linear to multilinear algebra. This work involves a rethinking of both theoretical concepts and numerical computation. The developments gradually allow a transition from classical vector and matrix based methods in applied mathematics and mathematical engineering to methods that involve tensors of arbitrary order. Tensor decompositions open up various new avenues beyond the realm of matrix methods. Important applications include efficient computation in high dimensions, the unique recovery of latent variables in data analysis, and large-scale system identification and machine learning.

14:30-15:00

Approximate Matrix and Tensor Diagonalization by Unitary Transformations: Convergence of Jacobi-Type Algorithms

Konstantin Usevich — CRAN - CNRS - Université de Lorraine
Pierre Comon — CNRS, France
Jianze Li — Shenzhen Research Institute of Big Data, China

Abstract: Jacobi-type methods are commonly used in signal processing for approximate diagonalization of complex matrices and tensors by unitary transformations. In this talk, we propose a gradient-based Jacobi algorithm and prove several convergence results for this algorithm. We establish global convergence rates for the norm of the gradient and prove local linear convergence under mild conditions.The convergence results also apply to the case of approximate orthogonal diagonalization of real-valued tensors and simultaneous matrix/tensor diagonalization.

15:00-15:30

Learning with Tree Tensor Networks

Anthony Nouy — Centrale Nantes

Abstract: We consider the approximation of high-dimensional functions in a statistical learning setting, by empirical risk minimization over model classes of functions in tree-based tensor format. After recalling some properties of these model classes, we present adaptive algorithms, with procedures for the adaptation and selection of ranks and dimension trees. Numerical examples illustrate the performance of these algorihms for regression and density estimation. In collaboration with E. Grelier, R. Lebrun and B. Michel.

15:30-16:00

Tensor Methods for Model Reduction of Dynamical Systems

Antonio Falcó Montesinos — Universidad CEU Cardenal Herrera

Abstract: The aim of this talk is to ask the question as whether it is possible, for a given dynamical system defined by a vector field over an infinite dimensional space, to construct a reduced-order model over a infinite dimensional manifold. We prove that if the manifold under consideration is an immersed submanifold of the vector space, considered as ambient manifold, then it is possible to construct explicitly a reduced-order vector field over this submanifold.

16:00-16:30

Learning Paths from Signature Tensors

Max Pfeffer — Max Planck Institute MiS
Anna Seigal — UC Berkeley
Bernd Sturmfels — Max Planck Institute MiS

Abstract: We recover paths from their third order signature tensors. For this, we apply methods from tensor decomposition, algebraic geometry and numerical optimization to the group action of matrix congruence. Given a signature tensor in the orbit of another tensor, we compute a matrix which transforms one to the other. We establish identifiability results for different dictionaries. Numerical optimization is applied for recovery from inexact data and to compute the shortest path with given signature tensor.

MS FT-S-5 8 — 14:30-16:30

Recent developments of finite element error analysis

Organizer: Takuya TSUCHIYA — Ehime University
Organizer: Kenta KOBAYASHI — Hitotsubashi University

Abstract: Although, the mathematical theory of finite element analysis has been well developed, there still exist problems that should be considered. In this minisymposium, we will address recent developments on finite element error analysis related those problems. The subjects that will be discussed are as follows: (i) Error analysis of Lagrange, Crouzeix-Raviart, and Raviar-Thomas interpolations on non-regular triangulations. They are applied to the corresponding finite element error analysis. (ii) Superconvergence of HDG methods. (iii) Some nice property is shown of L^2 projection of P1 functions, and it is applied to Error estimates of a characteristc FEM for a convection-diffusion equation.

14:30-15:00

Error analysis of Raviart-Thomas and Crouzeix-Raviart FEM on non-regular mesh

Takuya TSUCHIYA — Ehime University

Abstract: We discuss the error analysis of the lowest degree Crouzeix-Raviart and Raviart-Thomas finite element methods applied to a two-dimensional Poisson equation. To obtain error estimations, we use the techniques developed by Babuska-Aziz and the authors, and we do not impose the shape-regularity assumption of trianglulations. We present error estimates in terms of the circumradius and diameter of triangles in which the constants are independent of the geometric properties of the triangulations.

15:00-15:30

The circumradius condition and its application

Kenta KOBAYASHI — Hitotsubashi University

Abstract: Recentry, we found that the finite element solution with P1 element converges to an exact solution if the maximum circumradius of the triangular elements converges to zero. We call such situation “circumradius condition” and claimed that the circumradius condition is more essential than the well-known maximum angle condition. We could extend these results to the higher order Lagrange elements. In the presentation, we will introduce the circumradius condition and its application using Delaunay triangulation.

15:30-16:00

A new HDG method using a hybridized flux

Issei OIKAWA — Hitotsubashi University

Abstract: We propose a new hybridizable discontinuous Galerkin (HDG) method for steady-state diffusion problems. In our method, both the trace and flux of the exact solution are hybridized. The Lehrenfeld-Schöberl stabilization is implicitly included in the method, so that the orders of convergence in all variables are optimal without postprocessing and computation of any projection. Numerical results are present to show the validation of our method.

16:00-16:30

Some property of the L2-projection to P1 functions and its application to 1D characteristc FEM

Takahito Kashiwabara — The University of Tokyo

Abstract: Some nice property is shown for the -projection of a piecewise linear function defined on a one-dimensional uniform mesh, which is periodic, to the P1 finite element space on another uniform mesh obtained from small translation of the original one. The result is then exploited to obtain error estimatation of a characteristc finite element method to convection-diffusion equations, which is valid for sufficiently large Péclet numbers.

MS ME-0-2 8 — 14:30-16:30

Non-local equations for diffusion and aggregation - Part 3

For Part 1 see: MS ME-0-2 6

For Part 2 see: MS ME-0-2 7

Organizer: Alexis Molino — University of Granada

Organizer: José A. Cañizo — Universidad de Granada

Abstract: Nonlocal Partial Differential Equations arise often in physical models, as a result of potential interactions between particles, or as a result of scattering or long-range interactions. They also arise in biological models and in population dynamics, and play a central role in kinetic theory. This session will focus on their mathematical theory, which is seeing important recent advances regarding existence and uniqueness results for solutions, and a good understanding of their asymptotic behavior. Diffusion and aggregation processes are central examples of this.

14:30-15:00

Hypocoercivity of linear kinetic equations via Harris's Theorem

Havva Yoldas — Basque Center for Applied Mathematics

José A. Cañizo — Universidad de Granada

Josephine Evans — CEREMADE

Chuqi Cao — CEREMADE

Abstract: We study hypocoercivity of the linear BGK and the linear Boltzmann equations. We present explicit convergence results in (weighted) total variation norms (alternatively (weighted) L^^{1} norms) by using a probabilistic method known as Harris's Theorem. The convergence rates are exponential when the equations are posed on the torus, or on the whole space with a confining potential growing at least quadratically at infinity. Moreover, we give algebraic convergence rates when subquadratic potentials are considered.

15:00-15:30

Validity of amplitude equations for non-local non-linearities

Sebastian Throm — Technical University of Munich

Christian Kuehn — TU Munich

Abstract: Modulation equations arise in describing the onset of instability in partial differential equations. More precisely, the goal consists in reducing the dynamics at the instability to relatively simple generic PDEs. In this talk, we will consider the Swift-Hohenberg equation - a benchmark problem for pattern-forming partial differential equations - with non-local reaction terms and we will justify that the solution is still well described by a corresponding Ginzburg-Landau equation on a long approximating time scale.

15:30-16:00

A unified PDE/numerical framework for nonlocal and local equations of porous medium type

Félix Del Teso — BCAM

Abstract: We consider the following problem of porous medium type: where is continuous and nondecreasing, and We present results such as existences, uniqueness, continuous dependence and convergence of numerical schemes for bounded distributional solutions.

IM FT-4-3 8 — 14:30-16:30

Geophysical Applications - Part 1

For Part 2 see: IM FT-4-3 9

For Part 3 see: IM FT-4-3 10

Organizer: Barucq Hélène — Inria

Organizer: Victor Calo — Curtin University

Organizer: David Pardo — UPV/EHU, BCAM, and Ikerbasque

Abstract: The main objective of this minisymposia is to exchange state-of-the-art interdisciplinary knowledge on applied mathematics, high performance computing, and geophysics to be able to better simulate and understand the materials composing the Earth's subsurface. This is essential for a variety of applications such as CO2 storage, hydrocarbon extraction, mining, better understanding of earthquakes, and geothermal energy production, among others. All these problems have in common the need to obtain an accurate characterization of the Earth's subsurface, and the use of advanced mathematical algorithms is critical to achieving that endeavor. We prioritize those talks that show industrial applications in Geophysics.

14:30-15:00

A Hybrid Approach for the Simulation of Laterolog Response in Axially Symmetric and Transversely Isotropic Formations

Gong Li Wang — Schlumberger

Xiaoyan Zhong — Schlumberger

Aria Abubakar — Schlumberger

Abstract: We extend a hybrid approach that has proved to be efficient for alternating current well logging problems to steady current well logging problems. The formation is transversely isotropic and is axially symmetric with resistivity discontinuities in both axial and radial directions. The problem is tackled by first solving for a Green's function with the hybrid method then solving a surface integral equation for surface current and voltage on the surface of the bulk electrodes.

15:00-15:30

Upscaling effective compressional wave velocities of real rock samples

Javier Omella — Basque Center for Applied Mathematics (BCAM)

Magdalena Strugaru — Basque Center for Applied Mathematics (BCAM)

Julen Álvarez-Aramberri — Basque Center for Applied Mathematics (BCAM) and Columbia University

Vincent Darrigrand — Universidad del Pas Vasco (UPV/EHU)

David Pardo — Universidad del País Vasco (UPV/EHU), Basque Center for Applied Mathematics (BCAM), Ikerbasque

Héctor González — Repsol Tech Lab

Carlos Santos — Repsol Tech Lab

Abstract: We propose a set of numerical methods and techniques to estimate the effective compressional wave velocity in heterogeneous rocks incorporating information of its internal structure. In the low/medium frequency spectrum, we solve the acoustic wave equation in the frequency domain by the Finite Element Method equipped with non-fitting meshes. Then, we post-process the solution to estimate the effective velocity. At high frequencies, we solve the Eikonal equation by the Fast Marching Method.

15:30-16:00

Realtime multi-objective optimization of well trajectory under geological uncertainty

Nazanin Jahani

Erich Suter — NORCE

Benoit Daireaux — NORCE

Reidar Bratvold — University of Stavanger

Aojie Hong — University of Stavanger

Xiaodong Luo — NORCE

Kristian Fossum — NORCE

Sergey Alyaev — NORCE

Abstract: To improve oil recovery, it is important to optimize the direction of drilling in response to downhole measurements. Continuous nature of drilling sets strong constraints on performance of the optimization methods. We present a systematic geosteering workflow for decision support under uncertainty. The uncertainty is captured by an ensemble of geological realizations. The realizations are updated when measurements become available and a dynamic programming is used to optimize the well path ahead.

16:00-16:30

A review of seismic full wave inversion and applications to synthetic data

Otilio Rojas — Barcelona Supercomputing Center

Jean Kormann	Montan University, Leoben, Austria.
Juan Esteban Rodríguez	Barcelona Supercomputing Center
Natalia Gutierrez	Barcelona Supercomputing Center
Josep De La Puente	Barcelona Supercomputing Center
Mauricio Hanzich	Barcelona Supercomputing Center

Abstract: Full Waveform Inversion (FWI) represents a imaging method able to improve Earth structural models to fine resolutions by processing the whole seismic waveforms. Suitable data processing strategies combined to appropriate data-synthetic misfits, can make of multiscale FWI a reliable and efficient model reconstruction procedure. On this talk, we review a general mathematical formulation of FWI and data processing devices. In addition, we present some applications to challenging synthetic datasets.

MS A3-2-2 8 14:30-16:30

Computational Fluid Dynamics: Modeling, Analysis, and Applications - Part 1

For Part 2 see: MS A3-2-2 9
For Part 3 see: MS A3-2-2 10

Organizer: Sarah Olson	Worcester Polytechnic Institute
Organizer: Sookkyung Lim	University of Cincinnati
Organizer: Hoa Nguyen	Trinity University

Abstract: Computational fluid dynamics has rapidly developed into an interdisciplinary field where numerical analysis and data structures are used to model and investigate fluid flows at multiple scales. This minisymposium will focus on recent developments spanning from mathematical analysis and algorithms to complex simulations of biological systems, as well as coordination between modeling and experiments. The diversity of the presentations highlights the importance of interdisciplinary research on computational fluid dynamics where novel models and algorithms can be leveraged to understand complex fluid flows in a variety of applications.

14:30-15:00

Simulations of vesicle dynamics in non-Newtonian fluid

Ming-Chih Lai	National Chiao Tung University

Abstract: In this talk, we introduce an immersed boundary method to simulate the dynamics of Newtonian vesicle in viscoelastic Oldroyd-B fluid under shear flow. The viscoelasticity effect of extra stress is well incorporated into the formulation using the indicator function. Our numerical methodology is validated in comparison with theoretical results in purely Newtonian fluid, and then a series of numerical experiments is conducted to study the effects of different dimensionless parameters on the vesicle motions.

15:00-15:30

Modeling E. coli Motility through Viscoelastic Networks in Stokes Flow

Hoa Nguyen	Trinity University
Mica Jarocki	Trinity University
Orrin Shindell	Trinity University
David Clark	Trinity University

Abstract: E. coli maneuver through complex fluid environments such as porous media containing polymeric filaments called viscoelastic networks. Using the method of regularized Stokeslets we model an E. coli cell initially encapsulated in this. The pore size and number of layers affect the interaction between the cell and network. Sometimes the network has a positive effect on the cell, increasing its velocity, and other times it has a negative effect on the cell, decreasing its velocity.

15:30-16:00

Modeling inextensible elastic filaments in viscous fluids

Henry Fu	University of Utah
Mehdi Jabbarzadeh	University of Utah

Abstract: The deformations of elastic filaments in viscous fluids occur frequently in biological contexts. These have been modeled extensible Kirchoff rods, but to improve computational efficiency one can treat them as inextensible, which removes stiff degrees of freedom. We describe the implementation of a model with inextensible constraints, its accuracy, and describe and quantify the computational advantages of our approach. We apply it to understand how bacterial flagellar dynamics are affected by deformation.

16:00-16:30

Electrodeformation of Bio-Engineered Vesicles

Robert Dillon	Washington State University
Adnan Morshed	Washington State University
Prashanta Dutta	Washington State University

Abstract: Under an applied electric field, the response of the vesicle membrane depends on fluid conductivity, vesicle size, shape, and the field magnitude. We use an immersed interface method for the electric field with an immersed boundary method for the fluid-structure interactions. Effects of conductivity on deformation rates are quantified and deformation induced flows are explored. Strong influence of the initial vesicle aspect ratio on the force distribution is observed across a range of conductivities.

MS FT-1-1 8 14:30-16:30

Numerical methods for kinetic and mean-field equations - Part 1

For Part 2 see: MS FT-1-1 9
For Part 3 see: MS FT-1-1 10

Organizer: Li Wang	University of Minnesota
Organizer: José Antonio Carrillo De La Plata	Imperial College London

Abstract: Kinetic and mean-field equations are derived from many-particle system, and have been widely applied in various contexts such as rarefied gas dynamics, plasma physics, biology, socio-economy, and many others. The high dimensionality, and multiple scales constitute the major challenge in computing these equations. Certain structures, such as positivity, conservation and entropy dissipation are also desirable for numerical solutions. This mini-symposium aims to bring together researchers in this area to assess the current state-of-the-arts methods and foster collaborations.

14:30-15:00

From particle codes to forward-backward Lagrangian schemes for transport equations

Martin Campos-Pinto	CNRS and Sorbonne Université
Charles Frédérique	Sorbonne Université, Paris

Abstract: Particle methods are ubiquitous in numerical physics, because of their simplicity and efficiency for high dimensional transport problems. However they are often affected by a high level of noise which relates to their weak convergence properties. In this talk I will describe a method to reconstruct accurate transport solutions, based on particles pushed forward by a reliable particle scheme. Applications include new design of backward semi-Lagrangian methods and post-processing denoising modules for existing particle codes.

15:00-15:30

Kinetic model of traffic flow: an Aw-Rascle model mesoscopic derivation.

Giacomo Dimarco	University of Ferrara

Abstract: Aw-Rascle hydrodynamic models overcome the problems related to inconsistency of classical second order approaches caused by information which travel in both directions. In the talk, we discuss a possible kinetic derivation of macroscopic traffic flow equations. In particular, we show that a Boltzmann-Enskog type equation is necessary to derive the Aw-Rascle equations by using general binary interaction laws.

15:30-16:00

Fully Discrete Positivity-Preserving and Energy-Decaying Schemes for Aggregation-Diffusion Equations with a Gradient Flow Structure

Jingwei Hu	Purdue University
Rafael Bailo	Imperial College London
Jose Carrillo	Imperial College London

Abstract: We propose a fully discrete, implicit-in-time finite volume scheme for general nonlinear nonlocal Fokker-Planck type equations with a gradient flow structure in any dimension. The scheme enjoys the positivity-preserving and energy-decaying properties unconditionally, essential for their practical use. Numerical experiments validate the scheme and show its ability to handle complicated phenomena in aggregation-diffusion equations such as free boundaries, metastability, merging and phase transitions.

16:00-16:30

PDE compression, low rank manifold learning of PDE solutions

Qin Li	UW-Madison

Abstract: All classical PDE numerical solvers are deterministic. Grids are sampled and basis functions are chosen a priori. We study if randomized solvers could be used to compute PDEs. More specifically, for PDEs that demonstrate multiple scales, we study if the macroscopic behavior in the solution could be quickly captured via random sampling. The concept recovers asymptotic preserving and numerical homogenization and is related to Kolmogorov N-width.

MS FT-0-3 8 14:30-16:30

Numerical Approximations of Geometric Partial Differential Equations - Part 5

For Part 1 see: MS FT-0-3 3
For Part 2 see: MS FT-0-3 4
For Part 3 see: MS FT-0-3 5
For Part 4 see: MS FT-0-3 6
Organizer: Alan Demlow Texas A&M University
Organizer: Andrea Bonito Texas A&M University
Organizer: Ricardo Nochetto University of Maryland

Abstract: Geometric partial differential equations have received much attention recently due to their appearance in models for a wide range of physical processes. This mini-symposium focuses on their numerical approximation, which must overcome highly nonlinear interactions inherent to the approximation of partial differential equations defined on approximate geometries. Experts in modeling, numerical analysis, and scientific computation will discuss recent advances ranging from fundamental considerations concerning the design and analysis of numerical methods to applications in biology, materials science, and fluid dynamics.

14:30-15:00

Simulation of twisted rods

Soeren Bartels University of Freiburg
Philipp Reiter University of Halle

Abstract: A physical wire can be modeled by a framed curve. We assume that its behavior is driven by a combination of bending energy and twist energy. The latter tracks the rotation of the frame about the centerline of the curve. To obtain a more realistic setting, we have to preclude self-intersections of the curve which can be achieved by adding a self-avoiding term. We discuss the discretization of this model and present numerical simulations.

15:00-15:30

A structure-preserving finite element method for uniaxial nematic liquid crystals

Juan Pablo Borthagaray University of Maryland
Ricardo H. Nochetto University of Maryland, College Park
Shawn W. Walker Louisiana State University

Abstract: In the Landau-de Gennes Q-tensor model for uniaxial nematic liquid crystals with variable degree of orientation, molecule distribution is given by a rank-one tensor and its degree of orientation by a scalar field. We present a structure-preserving discretization of the liquid crystal energy with piecewise linear finite elements that can handle the (degenerate elliptic) resulting problem without regularization. We present simulations illustrating the method's ability to handle non-trivial defects and colloidal and electric field effects.

15:30-16:00

Numerical Approximation of Prestrained Plates

Diane Guignard Texas A&M University
Andrea Bonito Texas A&M University
Ricardo Nochetto University of Maryland
Shuo Yang University of Maryland

Abstract: We study the elastic behaviour of prestrained plates. Their mathematical modeling consist of a nonlinear fourth order minimization problem with a nonlinear constraint. A discrete gradient flow is proposed to decrease the system energy and is coupled with discontinuous Galerkin finite elements. In this talk, we give a description of the model, introduce the numerical scheme and discuss some of its properties. We illustrate the performance of the proposed methodology through several numerical experiments.

16:00-16:30

Free Boundary Problems in Fluids and Materials

Eberhard Bänsch Universiät Erlangen - Nürnberg
Alfred Schmidt University of Bremen

Abstract: Free boundary problems with geometric conditions for the interfaces are typically models for situations where interfacial energies play an important role. This happens for example in micro scale models of phase transitions as well as models with fluidic interfaces in various scales, all important in technical applications. We give here an overview of related aspects of models and corresponding numerical methods, and present some representative applications and results.

MS ME-1-0 8 14:30-16:30

Analysis and approximation of PDEs modeling Biological processes - Part 1

For Part 2 see: MS ME-1-0 9
For Part 3 see: MS ME-1-0 10
Organizer: Guillen-Gonzalez Francisco Universidad de Sevilla
Organizer: Cristian Morales-Rodrigo Universidad de Sevilla
Organizer: María Ángeles Rodríguez-Bellido Universidad de Sevilla

Abstract: In the last decades, the synergy between biology and mathematics are enriching both fields. Biology is increasingly stimulating the creation of new mathematical theories to explain in a simplified way the complexity of the world of living organisms. On the other hand, the mathematical modeling of the biological phenomena can serve to advise on therapies through numerical experimentation, besides also can suggest new lines of research. In this minisymposium, some recent results and challenges will be treated in the analysis and approximation of PDEs modelling biologycal processes, specifically in chemotaxis, population dynamics and tumor evolution.

14:30-15:00

Chemorepulsion system: new energy identity and relation to Li-Yau-Hamilton inequality

Tomasz Cieslak Polska Akademia Nauk

Abstract: In my talk I will present the recent result, obtained together with Kentarou Fujie (Tohoku Univ.) concerning the fully parabolic chemorepulsion system. The new energy-like functional as well as its connections to the Li-Yau-Hamilton type inequalities will be discussed. Moreover, I will also speak about our time-global existence result for the fully parabolic system with chemorepellent moving much faster than cells.

15:00-15:30

On a chemotaxis system with non-constant chemotactic coefficient

Jose Ignacio Tello Universidad Politecnica de Madrid

Abstract: We consider a parabolic-elliptic system of chemotaxis, where the chemotactic coefficient, usually assumed constant, depends on the gradient of the chemical substance in the following way. $-div(\chi u|\nabla v|^{p-2}\nabla v)$ where u and v describe the evolution of a biological species and the concentration of the chemical substance respectively. We obtain L^{∞} bounds for a range of values .

15:30-16:00

A cross-diffusion population model with nonlocal diffusion

Gonzalo Galiano Casas Universidad de Oviedo

Abstract: We prove the existence and uniqueness of solution of a nonlocal cross-diffusion competitive population model for two species. The model may be considered as a version, or even an approximation, of the paradigmatic Shigesada-Kawasaki-Teramoto cross-diffusion model, in which the usual diffusion differential operator is replaced by an integral diffusion operator. The proof of existence of solutions is based on a compactness argument, while the uniqueness of solution is achieved through a duality technique.

16:00-16:30

On a singular chemotaxis model

Cristian Morales-Rodrigo Universidad de Sevilla

Abstract: This talk is devoted to a chemotaxis system with a singular drift term in a smooth bounded n-dimensional domain with n=1,2,3 . We will show for the existence of non-negative global weak solutions and the convergence to steady states.

MS FT-4-4 8 14:30-16:30

Advances in Monte Carlo Methods and Applications - Part 4

For Part 1 see: MS FT-4-4 5
For Part 2 see: MS FT-4-4 6
For Part 3 see: MS FT-4-4 7
For Part 5 see: MS FT-4-4 9
Organizer: David Aristoff Colorado State University

Organizer: Gideon Simpson Drexel University

Abstract: Monte Carlo methods continue to be the primary tool for a host of problems posed in high dimensional spaces in fields as diverse as materials science, data science, and uncertainty quantification. These applications demand both novel algorithms and mathematical analysis to ensure accuracy and optimal performance. This minisymposium will bring together researchers and practitioners to discuss the latest results on Monte Carlo algorithms and their application. Key topics will include Gibbs-Boltzmann sampling, free energy calculations, rare event simulation, uncertainty quantification, optimization, and ensemble and particle methods.

14:30-15:00

Nested sampling for materials: clusters, phase diagrams and dynamical paths

Gábor Csányi Cambridge

Abstract: Applications of nested sampling will be shown for clusters and condensed phases with periodic boundary and constant pressure conditions, to determine equilibrium phase diagram in a reasonably automated fashion. Solid-solid phase transitions are recovered without any a priori knowledge about the structures. Further applications include sampling transitions paths, the quantum partition function, and even the solution of an inverse problem in mechanics, determining the unknown material response parameters from noisy strain observations.

15:00-15:30

A Data-Driven Solver for Fokker-Planck Equations

Matthew Dobson University of Massachusetts Amherst

Yao Li University of Massachusetts Amherst

Jiayu Zhai University of Massachusetts Amherst

Abstract: Motivated by the study of weakly perturbed dynamical systems, we consider the solution of low-dimensional Fokker-Planck equations using a hybrid scheme that combines data from sampling techniques with the local solution of the Fokker-Planck equation. A Monte Carlo sampler is used as a preconditioner for a localized block solver, allowing an efficient, parallel, and localized solution of the global equations.

15:30-16:00

Stochastic time-integrators for coarse-grained molecular dynamics

Joshua Finkelstein Temple University

Abstract: The Langevin equation is a stochastic differential equation used in Molecular Dynamics for simulating molecular systems in a canonical ensemble. However, discretization of this equation for coarse-grained models may necessitate parameter choices outside of the range for which many current methods were developed. We formulate a new class of numerical schemes designed to perform better in this regime and reproduce key statistical physics quantities in the case of a free particle and harmonic oscillator.

16:00-16:30

Sampling from Rough Energy Landscapes

Gideon Simpson Drexel University

Petr Plechac University of Delaware

Abstract: We examine challenges to sampling from Boltzmann distributions associated with rough energy landscapes. Here, the roughness will correspond to highly oscillatory, but bounded, perturbations of a fundamentally smooth landscape. Through a combination of numerical experiments and asymptotic analysis, we demonstrate that the performance of Metropolis Adjusted Langevin Algorithm can be severely attenuated as the roughness increases, while Random Walk Metrpolis and certain other methods remain robust.

IM FT-4-1 8 14:30-16:30

Societal Impact of Industrial Mathematics and Supporting Infrastructures Worldwide - Part 1

For Part 2 see: IM FT-4-1 9

For Part 3 see: IM FT-4-1 10

Organizer: Manuel Cruz PT-MATHS-IN | LEMA-ISEP/IPP

Organizer: Carlos Parés Madroñal Universidad de Málaga

Abstract: The minisymposium "Societal Impact of Industrial Mathematics and Supporting Infrastructures Around the World" is intended to present to the attendees in which different ways several infrastructures around the world help to manage, aggregate, disseminate and help to develop industrial mathematics all over the world. Bringing together infrastructures from different countries and regions, with diverse realities we aim to form a common platform of understanding and promote new synergies. Also, by sharing the different experiences is expected to bring new insights of how industrial mathematics infrastructures can be more efficient in boosting the technological transfer between mathematics and industry.

14:30-15:00

PATENTS & MATHEMATICS Attila Ferenc Kimpan, European Patent Attorney, Partner Maiwald Patentanwalts GmbH, Munich Kimpan@maiwald.eu

Attila Kimpan Maiwald

Abstract: A talk about patents on “mathematical inventions”. There will be a short introduction on what patents are in general. The focus is on the European Patent Office and its legal framework, the “EPC”, through which patents can be obtained for Europe. We will look into how mathematics can be turned into a patent and particular challenges for Applicants. We present some examples of “mathematical inventions”. The emphasis is on the practical/commercial side of patens.

15:00-15:30

University-Industry Engagement Activities through Mathematics for Industry in Malaysia

Arifah Bahar UNIVERSITI TEKNOLOGI MALAYSIA

Zainal Abdul Aziz UTM Centre for Industrial and Applied Mathematics, Universiti Teknologi Malaysia

Zaitul Marlizawati Zainuddin UTM Centre for Industrial and Applied Mathematics, Universiti Teknologi Malaysia

Abstract: Industrial Mathematics programme was introduced in Malaysia in 1987 as an undergraduate degree at UTM. Since then university-industry engagement activities were carried out sporadically to sustain this programme. However the most uplifting advance to synergise university-industry-society is the establishment of UTM-Centre for Industrial and Applied Mathematics in 2012. This report will showcase the challenges and opportunities that had been experienced so far through various engagement activities. The significant impact of these activities will be highlighted.

15:30-16:00

EU-MATHS-IN: creating impact opportunities for mathematics IN Europe

Wil Schilders Eindhoven University of Technology

Abstract: We discuss our efforts, together with the support of a core team of large European industries, to create/improve the impact of mathematics on industry and society. Vision documents and strategic research agendas are key in this respect, as well as presenting mathematics as a key enabling technology towards policy makers. Being present in new European programs, such as the EuroHPC joint undertaking, is also crucial. Several actions of the EU-MATHS-IN network will be discussed.

16:00-16:30

An introduction to Mitacs: from applied mathematics to a leadership role in Canadian innovation

Alejandro Adem Mitacs

Abstract: In this talk we will describe the evolution of Mitacs, a Canadian non-profit organization focused on promoting research-based innovation and global mobility. Mitacs (formerly Mathematics of Information Technology and Complex Systems) was originally launched by the mathematical community in Canada to create connections with industry. Over a 20 year period it has grown to become a national organization open to all disciplines, offering thousands of industrial internships and international mobility opportunities.

MS A6-2-3 8 14:30-16:30

Applied Mathematics Education - Part 2

For Part 1 see: MS A6-2-3 7

Organizer: Jessica Libertini Virginia Military Institute

Organizer: Rosalie Bélanger-Rioux Harvard University

Organizer: Ron Buckmire Occidental College

MS Organized by: SIAG/AME

Abstract: The teaching of mathematical sciences needs to reflect the world we are in. From mathematical modeling and applied calculus to non-traditional courses and programs that engage learners in learning mathematics and applying it to the real world, many applied mathematicians are at the frontiers of teaching. Issues of diversity and inclusion are more and more pressing, and need to be addressed adequately, and humanely. This minisymposium will showcase educational innovations and engage participants in being reflective of their own teaching and course offerings, and of their impact on students of all backgrounds, the mathematical community, and the broader community.

14:30-15:00

Developing Non-Calculus Service Courses that Showcase the Applicability of Mathematics

Lucas Castle — Virginia Military Institute

Abstract: Students often take precalculus or college algebra as a terminal math course, leaving them with the impression that mathematics lacks real meaning. As applied mathematicians, we are well poised to intervene and design inspiring general education courses that reveal the utility of mathematics. In this talk, we share experiences working with faculty from a range of disciplines to develop a two-course sequence that explores mathematical concepts by answering questions that matter to our student population.

15:00-15:30

Developing courses and programs in Mathematical Biology

Maeve McCarthy — Murray State University

Abstract: This talk will describe two courses and a minor in Mathematical Biology developed at Murray State University. The first course focuses on ecological applications, while the second focuses on biomedical applications. With minimal prerequisites, each uses different aspects of mathematics. Students carry out both wet and computational labs, attend seminars, write papers and give presentations. The minor involves additional courses in statistics and biology and is gaining traction amongst the students.

15:30-16:00

Teaching Calculus as a Tool in the Digital Age

Emma Smith Zbarsky — Wentworth Institute of Technology
Gary Simundza — Wentworth Institute of Technology
Mel Henricksen — Wentworth Institute of Technology

Abstract: The calculus curriculum has seen remarkably little change over time even as the computational power available to students has increased. Our department has been working to actively address this question for the past four years. This talk will discuss the curriculum currently used for a year-long calculus sequence for students who will apply their knowledge in engineering and computer science, as well as the compromises and areas of opportunity we have found along the way.

16:00-16:30

Teaching mathematical modeling

Shelley Rohde — Metropolitan State University

Abstract: Teaching mathematical modeling is a challenge because it requires an open-ended approach. This talk will outline some approaches to guiding students through the mathematical modeling process and teaching them to build models of their own. We will also discuss examples for testing students on their mathematical modeling skills. Several materials in this talk are related to an undergraduate mathematical modeling course designed for mathematics majors and minors at Metropolitan State University of Denver.

MS ME-1-G 8 — 14:30-16:30

Trends in nonlocal PDEs - Part 2

For Part 1 see: MS ME-1-G 7

Organizer: Juan Luis Vazquez — Univ. Autonoma de Madrid
Organizer: Diaz Jesus Ildefonso — Universidad Complutense de Madrid

Abstract: Over the last decades there has been a strong research effort devoted to extend the theory of elliptic, parabolic and hyperbolic equations to models in which the Laplacian operator or its elliptic equivalents are replaced by different types of nonlocal integro-differential operators, most notably those called fractional Laplacian operators. The corresponding equations are motivated by applications in diverse fields: they reasonably account for observed anomalous diffusion, and they also appear in continuum mechanics, phase transition phenomena, population dynamics, optimal control, image processing... We gather in this minisymposium recent contributions of our collaborators that reflect different lines of current research.

14:30-15:00

Nonlinear and Nonlocal Degenerate Diffusions on Bounded Domains

Matteo Bonforte — Universidad Autonoma de Madrid

Abstract: We study quantitative properties of nonnegative solutions to a nonlinear and nonlocal diffusion equation posed in a bounded domain, with appropriate homogeneous Dirichlet boundary conditions. The diffusion is driven by a linear operator in a quite general class, that includes the three most common versions of the fractional Laplacians on a bounded domain, as well as many other examples. The nonlinearity is allowed to be degenerate, the prototype being —u—^{m-1}u, with $m > 1$.

15:00-15:30

Theoretical and numerical aspects for the porous medium equation with fractional pressure

Félix Del Teso — BCAM

Abstract: We will sumarize the results obtained in collaboration with D. Stan and J.L. Vázquez (on the theoretical part) and with E.R. Jakobsen (on numerical methods) for a porous medium equation with fractional pressure: The problems is posed in for m > 1 and σ ∈ (0, 2). We will discuss the velocity of propagation, existence of global-in-time weak solutions, uniqueness issues, asymptotic behaviour, relations to other fractional diffusion models, as well as convergent numerical schemes.

15:30-16:00

Nonlinear parabolic equations with fractional operators

Juan Luis Vázquez — Univ. Autónoma de Madrid

Abstract: Nonlocality plays now an important role in the mathematical modelling of diffusion phenomena. The talk presents work on the existence, regularity and typical or asymptotic behaviour of solutions of nonlinear degenerate parabolic equations driven by fractional operators, which introduce nonlocal effects. The main models we discuss are fractional porous medium equations and fractional thin film equations. We pay attention to the difference w.r.t. the standard models. The problems in bounded domains offer new challenges.

IM FT-2-2 8 — 14:30-16:30

BIGMATH: an ITN-EID project based on academic and industrial cooperation

Organizer: Alessandra Micheletti — Università degli Studi di Milano

Abstract: BIGMATH is an EU funded (grant agreement No. 812912) international PhD programme aimed to train a group of 7 young, creative mathematicians with strong theoretical and practical skills, needed to tackle the major challenges of the Big Data era. These abilities will result from a close partnership between 4 academic centers and a group of 6 industries. The main domains of interest of the project lie in the areas of optimization, statistics, and large-scale linear algebra for Big Data, which are the most relevant mathematical topics for effective machine learning techniques and ability to build good data-driven products (http://itn-bigmath.unimi.it/).

14:30-15:00

Birth, challenges and future perspectives of the BIGMATH Project

Alessandra Micheletti — Università degli Studi di Milano

Abstract: BIGMATH is an EU funded international PhD programme aimed to train a group of 7 young, creative mathematicians able to tackle the major challenges of the Big Data era. The students will develop 7 interdisciplinary projects, on a set of industrial applications, proposed by the 6 partner companies. In this talk a general overview of the project will be given, focussing on the particular joint academic-industrial training that will be offered inside the consortium.

15:00-15:30

Big data processing for multivariate, noisy, and time-correlated data: human face reconstruction

Filipa Valdeira Valdeira — Universita' degli Studi di Milano

Abstract: Modelling the human face is fundamental in a wide range of industries, as generating adequate partial face prosthetics or creating convincing digital humans. Nevertheless, most related problems are still open. Using 4D-data scanned from real human faces, we intend to generate more realistic descriptions, while improving the available mathematical tools/frameworks. Models will be derived using different statistical and machine learning techniques applied in real-time and their computation calls for innovative mathematical optimization techniques.

15:30-16:00

Statistical methods for imbalanced data: an application to credit risk

Claudia Nunes Instituto Superior Tecnico

Abstract: The large number of decisions involved in the consumer lending business is challenging. Companies from the financial sector are increasingly turning to data scientists. When it comes to credit risk, it is essential to generate numerical descriptors that describe the creditworthiness and estimate the probability of credit defult. In this framework of imbalanced data, we focus on supervised methods (regression and classification), where the identification of relevant and non-redundant features is a vital step.

16:00-16:30

Numerical optimization for big data: a practical problem.

Greta Malaspina University of Novi Sad
Natasa Krejic University of Novi Sad
Lense Swaenen Sioux LIME Eindhoven

Abstract: We discuss our research activity on numerical optimization methods for big data problems. This work has been conducted in close collaboration with an industrial partner and, for this reason, particular attention has been given to the practical applications of our results. The main topic of this presentation is therefore the introduction of the considered problem and the description of its specific properties and requirements that led to the development of the presented strategies.

MS A3-S-C2 8 14:30-16:30

Geometric shape generation: integrability, variational analysis and applications - Part 5

For Part 1 see: MS A3-S-C2 4
For Part 2 see: MS A3-S-C2 5
For Part 3 see: MS A3-S-C2 6
For Part 4 see: MS A3-S-C2 7
For Part 6 see: MS A3-S-C2 9

Organizer: Kenji Kajiwara Kyushu University
Organizer: Schief Wolfgang The University of New South Wales
Organizer: Miyuki Koiso Kyushu University
Organizer: Udo Hertrich-Jeromin TU Wien

Abstract: This minisymposium is aimed at the discovery of state of the art geometric shape generation, based on methods from smooth and discrete differential geometry. In response to needs and problems raised by industrial applications, various geometric methods to generate desirable or "good” shapes have been developed, that emphasize the underlying structure of an integrable systems or variational approach. The topics addressed will range from problems raised in architecture and industrial design to the mathematical framework used to tackle them, and the modeling and analysis of smooth or discrete curves and surfaces to be used in shape design.

14:30-15:00

Discrete constant mean curvature surfaces -Discretization of soap bubbles-

Masashi Yasumoto Osaka City University

Abstract: In the smooth case, constant mean curvature surfaces (CMC surfaces, for short) can be described as critical points of area with respect to a volume constraint. They can also be described by matrix-valued ordinary differential equations, called Lax pairs. In this talk we introduce a discrete version of Lax pairs for discrete CMC surfaces in various spaceforms and a geometric solution to such discrete Lax pairs, leading us to a construction of discrete CMC surfaces.

15:00-15:30

Global behavior of discrete surfaces

Wayne Rossman Kobe University
Seong-Deog Yang Korea University
Masashi Yasumoto Osaka City University
Joseph Cho Kobe University

Abstract: Although the global behavior of smooth surfaces with particular curvature characteristics (minimal, or constant mean curvature, or constant Gauss curvature, or linear Weingarten, for example) has been extensively studied, the global behavior of corresponding discrete surfaces is much less understood. Taking a differential geometric viewpoint, we will discuss recent work in this direction, paying particular attention to singular behaviors and nontrivial topologies these surfaces may have.

15:30-16:00

Defocusing mKdV flows on plane discrete/smooth curves

Hyeongki Park Kyushu University

Abstract: We formulate isoperimetric deformations of curves on the Minkowski plane and the centroaffine plane, which are governed by the defocusing mKdV equation. Discretizations of these theories preserving the underlying integrable structure are also considered. Moreover, we present two classes of exact solutions to the defocusing mKdV equation in terms of the τ functions. By using one of these classes, we construct an explicit formula for the corresponding motion of curves on the Minkowski plane.

16:00-16:30

Geometry of anisotropic surface energy

Yoshiki JIkumaru Kyushu University

Abstract: Anisotropic surface energy is the integral of an energy density that depends on the normal at each point over the considered hypersurface. We prove that, unlike the isotropic case, there exists a non-convex anisotropic energy density function such that there exist closed embedded equilibrium surfaces which are different from the energy minimizer. Moreover, we try to dicretize the anisotropic energy and apply them to the visualization of the anisotropic energy gradient flow.

MS FT-2-4 8 14:30-16:30

Reduced Order Modeling for Parametric CFD Problems - Part 2

For Part 1 see: MS FT-2-4 7
For Part 3 see: MS FT-2-4 9
For Part 4 see: MS FT-2-4 10

Organizer: Annalisa Quaini University of Houston
Organizer: Yanlai Chen University of Massachusetts, Dartmouth
Organizer: Gianluigi Rozza SISSA, International School for Advanced Studies Trieste

MS Organized by: SIAG/CSE

Abstract: Large-scale computing is recurrent in several contexts such as fluid dynamics, due to the high computational complexity in solving parametric and/or stochastic systems. This often leads to an unaffordable computational burden, especially when dealing with real-world applications, real-time or multi-query computing. In order to lessen this computational burden, reduced-order modeling (ROM) techniques play a crucial role: they aim to capture the most important features of the problem at hand without giving up accuracy. This minisymposium focuses on the development and application of ROM techniques in computational fluid dynamics for direct and inverse modeling, and for control, optimization and design purposes.

14:30-15:00

A localized Reduced-Order Modeling approach for PDEs with bifurcating solutions

Annalisa Quaini University of Houston
Martin Hess SISSA - International School for Advanced Studies
Alessandro Alla PUC-Rio
Gianluigi Rozza SISSA - International School for Advanced Studies
Max Gunzburger Florida State University

Abstract: We present a new reduced-order modeling (ROM) approach aimed at bifurcation problems. We use the k-means algorithm to cluster snapshots and construct local POD bases, one for each cluster. The method can detect which cluster a new parameter point belongs to. Then, the local basis corresponding to that cluster is used to determine a ROM approximation. Numerical experiments show the effectiveness of the method for bifurcation problems with continuous and discontinuous changes in the solution.

15:00-15:30

Tensor-space Galerkin POD for parametric flow equations

Jan Heiland Max Planck Institute for Dynamics of Complex Technical Systems
Benner Peter Max Planck Institute for Dynamics of Complex Technical Systems

Abstract: POD is a common and popular approach for order reduction of nonlinear models. Recently, we have extended the standard POD formulation such that the temporal dimension can be reduced by the same principles. In this talk, we illustrate how the tensor-space structure used for space-time POD extends to further dimensions to accommodate, e.g., a parameter dependency and how it applies to incompressible flow equations parametrized by the Reynolds number.

15:30-16:00

Model order reduction for advection dominated nonlinear hyperbolic problems

Davide Torlo Universität Zürich

Abstract: Model order reduction techniques have always shown difficulties in catching the behaviour of the advection dominated systems of equations, in particular hyperbolic conservation laws, due to the slow decay of the Kolmogorov n-width. What we propose is a calibration of the solution through a transformation of the domain, in a way to overlap the dicontinuities or waves for different parameters and timesteps. The reduced problem must then be computed on the obtained domain.

16:00-16:30

An output error estimate for projection based reduction of the isothermal Euler equations

Mohammad Hossein Abbasi Eindhoven University of Technology
Laura Iapichino Eindhoven University of Technology
Bart Besselink University of Groningen
Wil Schilders Eindhoven University of Technology
Nathan Van De Wouw Eindhoven University of Technology

Abstract: Many physical phenomena are modeled by systems of partial differential equations with time-varying and nonlinear boundary conditions. To incorporate these types of boundary conditions, a new surrogate formulation of the reduced basis ansatz is introduced. Moreover, a new bound and a new estimate for the error induced by model reduction are introduced. The proposed error bound gives a finite bound of the actual error, unlike existing error bounds that grow exponentially over time.

MS A1-1-2 8 14:30-16:30

Numerical and mathematical issues on vortex motions - Part 1

For Part 2 see: MS A1-1-2 9
Organizer: Hisashi Okamoto Gakushuin University
Organizer: Robert Krasny University of Michigan
Organizer: Sun-Chul Kim Chung-Ang University

Abstract: Our minisymposium is about fluid motions where vorticity dynamics is the main player. They are complex and perplexing. To understand such motions, analysis by mathematical models and computational experiments of them are required. Krasny, Nitsche and Sohn are experts on computational issues on vortex sheets and related fluid motions. Shoji worked on water waves on vortical flows. Jeong works for mathematical issues on the Euler equations. Okamoto and Kim are working for the role of vorticity at very high Reynolds numbers. Common themes are singular or nearly singular solutions of fluid mechanical PDEs and its efficient computational method.

14:30-15:00

Mathematical issues on high-Reynolds number flows

Hisashi Okamoto Gakushuin University

Abstract: I will talk about bifurcations and pattern formations which are observed in the Kolmogorv flows in two-dimensional tori. Some phonomana which are common to many external forces and various aspect ratios are reviewed and I will show some ideas which may potentially lead to theoretical elucidation of such patterns of streamlines.

15:00-15:30

Numerical Study of the Viscous Lamb Dipole

Robert Krasny University of Michigan

Abstract: We compare numerical solutions of the Navier-Stokes equation (NSE) and linear diffusion equation (LDE) with the Lamb dipole as initial condition. Unexpectedly, the maximum core vorticity decreases at nearly same rate for the NSE and LDE over a range of Reynolds numbers (Re). However at high Re, convection enhances the cancellation of opposite-signed vorticity in the dipole, while the opposite occurs at low Re. This is joint work with Ling Xu.

15:30-16:00

Complex variables approach to a free-boundary problem of 2d vortex patch

Sun-Chul Kim Chung-Ang University

Abstract: A free-boundary problem for two-dimensional Euler flows with uniform vorticity is considered in complex variables formulation on the surfaces of a plane and a sphere. Utilizing the stereographic projection and the argument principle, a circle turns out to be the unique solution for both cases, if the flow speed is constant on the boundary. Some generalization and open questions are also addressed.

16:00-16:30

Inviscid vortex shedding models for hovering flight

Sung-Ik Sohn Gangneung–Wonju National University

Abstract: The flight of insects has attracted much attention for last decades. Unsteady vortex separation during the thrust stroke of the wing motion plays a crucial role in the production of forces in the flapping flight. In this talk, we overview recent development of inviscid vortex shedding models, including issues, limitations and applications of the model. We also discuss the unsteady effects of accelerating and hovering wings and demonstrate the vortex shedding process.

MS FT-2-6 8 14:30-16:30

Advanced numerical methods for differential equations - Part 2

For Part 1 see: MS FT-2-3 7
Organizer: Lemou Mohammed CNRS, university of Rennes 1
Organizer: Mechthild Thalhammer University of Innsbruck
Organizer: Chartier Philippe Inria Rennes Bretagne Atlantique

Abstract: The intention of this minisymposium on "Advanced numerical methods for differential equations" is to bring together experts in the field, interconnected through their area of application or the numerical methods used. The scope of topics in particular includes Schrödinger equations, kinetic equations, exponential integrators, splitting methods.

14:30-15:00

Numerical and theoretical analysis of highly oscillatory problems with degenerate frequencies

Méhats Florian Université de Rennes 1

Abstract: Numerical and theoretical analysis of highly oscillatory problems with degenerate frequencies

15:00-15:30

Discretization of linear transport models using Trefftz discontinuous Galerkin method.

Morel Guillaume Inria Rennes Bretagne Atlantique
Buet Christophe CEA
Despres Bruno UPMC / LJLL

Abstract: This works deals with the study and analysis of a Trefftz Discontinuous Galerkin (TDG) scheme for a model problem of transport with linear relaxation. We show that natural well-balanced and asymptotic-preserving discretization are provided by the TDG method since exact solutions, possibly non-polynomials, are used locally in the basis functions. A special attention is devoted to the spherical harmonics (PN-model) approximation of the transport equation. Numerical examples are given on the P1 and P3 models.

15:30-16:00

Stability of the numerical IBVP for relaxation balance laws

Nicolas Seguin Université de Rennes 1
Boutin Benjamin Université de Rennes 1
Thi Hoai Thuong Nguyen Université de Rennes 1

Abstract: In the context of the IBVP for hyperbolic PDE's, the discretization of boundary condtion is a difficult task, even in the linear case. Moreover, when a stiff source term is added, tricky interactions between the stability of the boundary and the possible dissipation of the source term appears. This has been investigated by Xin and Xu in 2000. Our aim is to follow their study when discretizing in space the IBVP.

MS ME-1-I1 8 14:30-16:30

Data-driven modeling of complex dynamical systems - Part 1

For Part 2 see: MS ME-1-I1 9
For Part 3 see: MS ME-1-I1 10
Organizer: Steven Brunton University of Washington
Organizer: Jared Callaham University of Washington
Organizer: Themis Sapsis MIT

Abstract: Advances in machine learning are driving progress across science and engineering. Increasingly, these methods are used to analyze, predict, and control dynamical systems from measurement data. However, real-world data still presents a challenge because of rare phenomena, multiscale dynamics, noise, and latent variables. Moreover, many modern techniques in machine learning provide powerful representations based on data, but offer limited interpretability and generalizability. Thus, there is a tremendous opportunity to bring physics and machine learning closer together to address these fundamental challenges. This minisymposium brings together experts in data-driven dynamical systems to explore challenges and progress on these real-world issues.

14:30-15:00

Predicting the Eulerian energy spectrum from noisy Lagrangian tracers

Mustafa Mohamad	Courant Institute, New York University
Andrew Majda	Courant Institute, NYU

Abstract: The assimilation and prediction of a flow field given a stream of noisy measurements provided by Lagrangian tracers advected by the flow is discussed. We quantify recovery of the Eulerian energy spectra from observations of Lagrangian drifters by special Lagrangian data assimilation algorithms, based on conditionally Gaussian Kalman filters. Prediction of the Eulerian energy slope is demonstrated through combined assimilation and parameter estimation, and recovery skill of the spectrum in various regimes is demonstrated.

15:00-15:30

Data-driven forecasting of multiscale dynamics using diffusion kernels

Krithika Manohar	Caltech
Dimitrios Giannakis	NYU Courant Institute
Andrew Stuart	Caltech

Abstract: Complex systems with multiple timescales of dynamics pose tremendous challenges for data-driven modeling. In practice, complex systems in oceans and climate, when they exhibit scale separation, are often modeled by treating fast variables as stochastic effects. We apply kernel algorithms to data from a slow-fast dynamical system, and compute eigenfunctions of an associated diffusion operator. Using these eigenfunctions as a basis, we construct an operator semigroup modeling the slow dynamics, and study its predictive skill.

15:30-16:00

Parametrized manifold model of flow oscillators

Jean-Christophe Loiseau	Arts et Métiers ParisTech

Abstract: Recently, a lot of attention has been directed toward the use of deep learning models for flows as simple as the canonical cylinder flow. This work however highlights how models significantly less complex and more interpretable than deep learning ones can easily be obtained for this flow, thus making it a terrible test-case for deep learning. By focusing on parametrized manifolds, the present model provides accurate predictions for a wide range of Reynolds numbers.

16:00-16:30

Variational approximation of complex dynamical systems

Frank Noe	Freie Universität Berlin
Hao Wu	

Abstract: We develop the variational approach for Markov processes (VAMP), a principle to learn low-dimensional linear models of complex high-dimensional nonlinear dynamics. Deep neural networks, VAMPnets, can be trained with this principle to simultaneously obtain the nonlinear embedding to a low-dimensional space and the Koopman models describing the dynamics in that space. We show how VAMPnets provide efficient models to analyze and drive Molecular dynamics simulations.

MS A1-2-6 8 14:30-16:30

Mathematical Modeling of Infectious Diseases under a variety conditions - Part 1

For Part 2 see: MS A1-2-6 9

Organizer: Gilberto Gonzalez	New Mexico Tech, Socorro, New Mexico, USA
Organizer: Benito Chen-Charpentier	University of Texas at Arlington
Organizer: Abraham Jose Arenas Tawil	Universidad de Córdoba

Abstract: Mathematical modeling is a powerful tool that allows the study of the dynamics and possible outcomes of different diseases under a variety of conditions and supports control strategies against their spread. One important part of the modeling is the estimation of the parameters involved. This stage involves a global optimization problem that can be tackle with different techniques. Recently varieties of algorithms have been developed to solve this optimization problem and avoid local solutions. In this minisymposium, we would provide discussion of some approaches to do mathematical modeling of different infectious diseases of human, cell, virus and vector populations.

14:30-15:00

Parameter estimation for a Chikungunya epidemic model

Benito Chen-Charpentier	University of Texas at Arlington
Gilberto Gonzalez Parra	New Mexico Tech

Abstract: Chikungunya is a vector transmitted infectious disease that is expanding rapidly. Here we present a mathematical model of the propagation involving humans and vectors. Parameter estimation of differential equations is a difficult process due to the presence of instabilities and local minima. We present two alternatives to the traditional method of nonlinear least squares.

15:00-15:30

Mathematical modeling of toxoplasmosis considering environment and multiple hosts

Abraham Jose Arenas Tawil	Universidad de Córdoba
Benito Chen-Charpentier	University of Texas at Arlington
Gilberto Gonzalez Parra	University New Mexico Tech

Abstract: We present an epidemiological model to study the transmission dynamics of toxoplasmosis considering the environment and multiple hosts. In addition, we consider a continuous vaccination schedule for the cat's population. We explore the dynamics of toxoplasmosis at the population level using a mathematical model that includes the effect of oocyst. Numerical simulations are presented to investigate different scenarios. These simulations show the effectiveness of a constant vaccination program.

15:30-16:00

Optimal versus Impulse Control Strategies for Controlling Meningitis in Nigeria

Folashade Agusto	University of Kansas

Abstract: This seminar presents a model for Neisseria meningitidis and the application of optimal and impulse controls to investigate the best strategy for curtailing the disease in Nigeria. The control strategies uniquely incorporate the use of an impulsive-like optimal facial mask usage during a specific time frame. A comparison of the infection averted using the two controls shows the advantage of using facial masks as more infection are averted unlike in the absence of it.

16:00-16:30

Predicting with uncertainty the decline of infections of high risk Human Papillomavirus in the current vaccination strategy using a lifetime sexual partners network model

Rafael Villanueva	Universidad Politécnica de Valencia
Luis Acedo	IUMM - Universitet Politècnica de Valéncia
Clara Burgos-Simón	IUMM - Universitet Politècnica de Valéncia
David Martínez-Rodríguez	IUMM - Universitet Politècnica de Valéncia
Víctor Sánchez-Alonso	Universidad Rey Juan Carlos
Javier Villanueva-Oller	Universidad Rey Juan Carlos

Abstract: Using data from surveys, we build lifetime sexual partner (LSP) network models. On these networks, we define the transmission dynamics of the high risk Human Papillomavirus (HPV), those that are responsible of the cancer related to HPV. After model calibration with the available data, we determine the model parameter values that best explain the data. Using these model parameter values, we simulate the current vaccination scenario and predict the decline in the infection cases.

MS A1-2-3 8 14:30-16:30

Complex Fluids at Small Scales: Fluctuating Hydrodynamics and Brownian Dynamics - Part 2

For Part 1 see: MS A1-2-3 7

Organizer: Aleksandar Donev	New York University

MS Organized by: SIAG/CSE

Abstract: To model nano- and micro-fluidics devices and biological systems, we need to develop tools for hydrodynamic calculations at microscopic and mesoscopic scales. This minisymposium will focus on advances in multiscale numerical methods for simulating flows at small scales. Coarse-grained models cover a broad range of time and length scales by incrementally sacrificing physical fidelity for computational efficiency. Of particular interest will be fluctuating hydrodynamics of complex fluids such as reactive mixtures, colloidal passive and active suspensions, and multi-phase fluids. Topics include the inclusion of thermal fluctuations in computational models, as well as applications in the physical sciences, biology, and engineering.

14:30-15:00

Nanohydrodynamics near walls

Pep Español	Universidad Nacional de Educación a Distancia in Madrid
Diego Duque Zumajo	UNED
Jaime Arturo De La Torre	UNED

Abstract: A simple theory for discrete non-local hydrodynamics near parallel solid walls is presented. The theory describes the irreversible solid-liquid interaction through extended friction forces entering the equations of motion. At high resolution non-Markovian effects are detectable. The plateau problem in the Green-Kubo formulas is addressed. We derive and assess through simulations of an unsteady plug flow the slip boundary condition with a microscopic expression for the slip length.

15:00-15:30

Efficient time integration for Brownian HydroDynamics of rigid bodies

Blaise Delmotte	CNRS/Ecole Polytechnique
Westwood Tim	Imperial College
Keaveny Eric	Imperial College

Abstract: Small particles, such as colloids or microoganisms, live in a viscous world where the combined effects of Brownian motion and hydrodynamic interactions are predominant. Their motion is decribed by the so-called overdamped Langevin equations. These equations contain multiplicative noise and strongly coupled terms due to the long-range nature of hyddroynamic interactions . In this talk we will present our time integration schemes to efficiently include these terms in a scalable way.

15:30-16:00

Fast Stokesian Dynamics

James Swan	Massachusetts Institute of Technology
Andrew Fiore	MIT

Abstract: I present a new method for large scale dynamic simulation of colloidal particles with hydrodynamic interactions and Brownian forces, which I call Fast Stokesian Dynamics (FSD). This is a reformulation of the Stokesian Dynamics algorithm that is linear in the number of particles. This speed up is enabled by use of saddle point matrices, and their associated Schur compliments to precondition various portions of the algorithm as well as clever scheme for evaluating stochastic forces.

16:00-16:30

Ion transport in ultimate channels: Towards ionic machines

Sophie Marbach	Courant Institute, NYU
Nikita Kavokine	Ecole Normale Supérieure
Alessandro Siria	Ecole Normale Supérieure
Lyderic Bocquet	Ecole Normale Supérieure
David Dean	Université de Bordeaux

Abstract: Artificial porins are still far from reaching the advanced functionalities of biological machinery. One paradigm of biological channels is that they rely on external forces such as mechanic or electric gating to perform these tasks. We show here that nonequilibrium sieving, using mechanic or electric external drivings, allows for enhanced permeability, improved selectivity, and most interestingly quantised ion translocation, with a mechanism reminiscent of electronic Coulomb blockade. Our analytical findings are fully supported by simulations.

MS ME-1-1 8 — 14:30-16:30

Current Trends in Applications of Delay Equations - Part 2

For Part 1 see: MS ME-1-1 7

Organizer: Maria Vittoria Barbarossa	Heidelberg University, Institute of Applied Mathematics
Organizer: Felicia Magpantay	Queen's University
Organizer: Gergely Röst	Bolyai Institute, Szeged, Hungary

Abstract: Including the effects of past actions into dynamical systems, Delay differential equations (DDEs) allow for the description of potentially high dimensional dynamical effects and are a useful tool for modeling phenomena occurring in various fields of life and mechanical sciences. From the point of view of dynamical systems, DDEs represent an important class of infinite dimensional problems which can be studied by advanced analytical and numerical methods. This mini-symposium presents current research works in application of DDEs, with examples from population dynamics, epidemiology, cell biology and physiology.

14:30-15:00

A systematic approach for numerical bifurcation analyses of delay equations

Francesca Scarabel	York University

Abstract: Via pseudospectral discretization, a delay equation can be approximated by a system of ODE, whose dynamical and bifurcation properties can be studied with well-established software. The approach can be applied to differential and integral equations, with discrete and distributed delay, with finite and infinite delay. Besides the wide applicability, further advantages are the easy formulation of the approximating system and the exponential convergence properties. We illustrate the method using some examples from ecology and epidemiology.

15:00-15:30

Delay equations for immuno-epidemiology: on simple models and their complicated dynamics

Maria Vittoria Barbarossa	Heidelberg University, Institute of Applied Mathematics

Abstract: The dynamics of infectious diseases with waning and boosting of immunity can be more complex than most epidemiological models. Assuming that repeated exposure to the pathogen fully restores immunity, we derive an SIRS-type model with discrete and distributed delays. Interesting features of immune boosting appear with respect to the endemic equilibrium, which can go through multiple stability switches by changing the key model parameters.

15:30-16:00

Analysis of an equation with two time delays and delay-dependent coefficients, with an application to platelet modeling

Jacques Belair	Universite de Montreal

Abstract: A stage-structured population model motivated by the regulation of platelet production is derived and analysed for its stability. The mature population is described by a delay-differential equation with two time delays and the linear stability of its equilibria leads to an equation with delay-dependant coefficients. The roles of both the death rate and the survival time are investigated, and a nonlinear analysis leads to the existence of an invariant torus.

16:00-16:30

Periodic solutions of a stem cell population model with state-dependent delay

István Balázs	Bolyai Institute, Szeged, Hungary
Philipp Getto	TU Dresden
Gergely Röst	Bolyai Institute, University of Szeged, Hungary

Abstract: The presentation will be on the analysis of a differential equation that describes the regulated maturation of a stem cell population. The equation features distributed and state dependent delays. Recent results on well-posedness will be presented. Using fixed point theory, we prove existence of nontrivial slowly oscillating periodic solutions.

MS FT-1-SG 8 — 14:30-16:30

Numerical methods for hyperbolic problems and applications - Part 1

For Part 2 see: MS FT-1-SG 9

For Part 3 see: MS FT-1-SG 10

Organizer: Pep Mulet	Universitat de València
Organizer: Antonio Baeza	Department of Mathematics, University of Valencia

Abstract: First-order hyperbolic PDE systems appear in many scientific areas. The importance of obtaining good numerical approximations to their solutions is therefore crucial in these circumstances, since a closed solution is usually impossible to obtain when the equations are not linear. Due to the development of discontinuities in nonlinear hyperbolic systems, numerical methods for their approximate solution must have certain characteristics to ensure convergence to the right weak solutions. This minisymposium will be devoted to works that deal with different aspects of the design and analysis of these schemes, with special emphasis in obtaining high order of accuracy.

14:30-15:00

CFD modeling of glass melting in industry

Enrique Delgado Ávila	SISSA

Abstract: In this talk we present a CFD model for the thermal fluid flow of molten glass inside of a furnace. For this model, we consider that all fluid properties (viscosity, density...) depend on the temperature, leading with higly non-linear differential equations. We also provide some numerical results for the CFD model, computed in FEniCS.

15:00-15:30

Nonlinear waves in solids with slow dynamics

Guillaume Chiavassa	University Centrale-Marseille
Berjamin Harold	LMA
Lombard Bruno	LMA
Favrie Nicolas	IUSTI

Abstract: Geomaterials such as rocks and concrete are known to soften under dynamic loading, i.e, the speed of sound diminishes with forcing amplitude. To reproduce this behavior, we proposed an internal-variable model of continuum. The resulting equations of motion writes as a nonlinear and nonhomogeneous system of conservation laws. A finite volume method based on Roe linearization has been developed and applied to resonance simulations. Qualitative agreement with experimental results is observed.

15:30-16:00

On a class of two-dimensional incomplete Riemann solvers

Kleiton Andre Schneider	University of Málaga
José M. Gallardo	University of Málaga
Manuel J. Castro	University of Málaga

Abstract: We propose a general class of genuinely 2D incomplete Riemann solvers for systems of conservation laws. Extensions of Balsara's multidimensional HLL scheme to 2D PVM/RVM finite volume methods are considered. The numerical flux is constructed taking into account transversal features of the flow. The proposed methods are applicable to general hyperbolic systems, although we focus on applications to magnetohydrodynamics. Several numerical tests including genuinely 2D effects are presented to test the perfomances of the schemes.

16:00-16:30

Hybrid OpenMP/Cuda implementation of a deterministic solver for nanoMOSFETs.

Francesco Vecil	Université Clermont Auvergne

Abstract: The talk will focus on the implementation strategies, for a high-performance platform, of a Boltzmann-Schrödinger-Poisson (mesoscopic, deterministic) solver for the simulation of MOSFETs with ultra-short channels. Seven electron-phonon scattering phenomena are taken into account. The transport part (Boltzmann) is parallelized on the GPU using Cuda extension to C++ language, while the computation of the eigenstates (Schrödinger-Poisson block) is parallelized on the CPU using OpenMP. The speedup obtained will be discussed.

MS FE-1-3 8 **14:30-16:30**

Inverse Problems in Shape and Geometry - Part 1

For Part 2 see: MS FE-1-3 9
For Part 3 see: MS FE-1-3 10

Organizer: Roland Herzog	TU Chemnitz
Organizer: Bastian Harrach	Goethe University Frankfurt
Organizer: Jan-Frederik Pietschmann	TU Chemnitz

MS Organized by the GAMM activity group "Optimization with Partial Differential Equations" (OPDE)

Abstract: Inverse problems generally seek to determine the cause of an observation, based on some underlying model. The focus in this minisymposium is on inverse problems where the unknown cause is represented as a shape or geometry. Examples include the identification of an inclusion or the geometry of a scatterer. It is a common feature of these problems that the set of shapes does not bear the structure of a vector space. Speakers in this minisymposium will address a variety of problems, primarily based on models involving partial differential equations, and a broad range of topics spanning theory, algorithms and applications.

14:30-15:00

New stability results for inverse coefficient problems

Bastian Harrach	Goethe-Universität Frankfurt am Main

Abstract: Inverse coefficient problems for elliptic PDEs are highly non-linear and ill-posed in their idealized infinite-dimensional formulation. Newly emerging imaging and non-destructive testing methods often lead to finite-dimensional versions of such problems, where, e.g., a piecewise constant coefficient function on a given pixel partition is to be reconstructed from a finite number of measurements. We will present a new monotonicity-based approach to characterize the stability of the resulting finite-dimensional nonlinear problems.

15:00-15:30

Seeing inside the Earth with Riemannian and Finsler geometry

Teemu Saksala	Rice University
Maarten De Hoop	Rice University
Joonas Ilmavirta	University of Jyväskylä
Matti Lassas	Universty of Helsinki
Hanming Zhou	University of California Santa Barbara

Abstract: Earthquakes produce seismic waves which provide information about the deep structures of our planet. If the network of sensors is dense enough and they measure a large number of earthquakes, we can hope to recover the wave speed of the seismic wave from the travel time measurements. In this talk we will consider geometric inverse problems related to different data sets produced by seismic waves. We will state some uniqueness results for these problems.

15:30-16:00

Unique continuation: conditional stability estimates and stabilized FEM

Mihai Nechita	University College London

Abstract: We focus on the Helmholtz equation and discuss conditional stability results in the form of three-ball inequalities that are explicit in the wave number. These estimates hold under a convexity assumption and are derived from a Carleman inequality. Based on that, we prove convergence rates for a stabilised finite element method arising from PDE-constrained optimisation. The numerical approach is general and feasible for different PDEs. This is joint work with Erik Burman and Lauri Oksanen.

MS ME-0-7 8 **14:30-16:30**

Control and Inverse problems in PDE. Theory and applications - Part 2

For Part 1 see: MS ME-0-7 7
For Part 3 see: MS ME-0-7 9
For Part 4 see: MS ME-0-7 10

Organizer: Carlos Castro	UNIVERSIDAD POLITÉCNICA DE MADRID
Organizer: Juan Antonio Barceló	Universidad Politécnica de Madrid
Organizer: Fabricio Macia	Universidad Politécnica de Madrid
Organizer: Cristóbal Meroño	Universidad Politécnica de Madrid

Abstract: The aim of this minisymposium is to present new results in the areas of controllability and inverse problems for systems governed by partial differential equations. Bringing together both topics in a single minisymposium provides an opportunity to contrast the most recent results and techniques and estimulate collaborations between researchers coming from these areas.

14:30-15:00

Null controllability of the Kuramoto-Sivashinsky equation on a star-shaped tree

Liviu Ignat	ICUB, University of Bucharest and Institute of Mathematics Simion Stoilow
Cristian Cazacu	University of Bucharest
Ademir Pazoto	Federal University of Rio de Janeiro

Abstract: In this talk we discuss the null-controllability of the linear Kuramoto-Sivashinsky equation on a star-shaped tree with two types of coupling conditions and with controls acting on the external vertices of the tree. We show that when the so-called anti-diffusion parameter does not belong to a countable critical set, the system is null-controllable at any positive time. Partially supported by CNCS-UEFISCDI Grant No. PN-III-P1-1.1-TE-2016-2233.

15:00-15:30

Elastography: an inverse problem for the linear elasticity system

Faustino Maestre — Universidad de Sevilla

Abstract: In this talk we present recent results for an inverse problem governed by the linear alasticity system. We show an existence result under some regularity assumptions. In this framework, we finish showing some numerical experiments in order to check the efficiency of the method solving inverse problems and in particular in the reconstruction field.

15:30-16:00

On the control of coupled wave equations

Camille Laurent — Université Pierre et Marie Curie

Abstract: In this talk, we will report on a recent article with Yan Cui and Zhiqiang Wang about the control of systems of wave equations coupled by lower orders terms. We will describe the link with an ODE system along the Hamiltonian flow.

16:00-16:30

Spectral inequalities for the Schrxdinger operator -x + V(x) in R d.

Iván Moyano — University of Cambridge
Gilles Lebeau — Université de Nice-Côte d'Azur, France

Abstract:
We will first review some classical results on xspectral inequalitiesx, which yield a sharp quantification of the unique continuation of the spectral family associated with the Laplace-Beltrami operator in a compact manifold. Secondly, we will discuss how to obtain the spectral inequalities associated to the Schrodinger operator - x + V(x) in any dimension, where V=V(x) is a real analytic potential. In particular, we can handle some long- range potentials.

IM FT-2-3 8 — 14:30-16:30

Advances in computation and analysis of PDE's for multiphase system - Part 1

For Part 2 see: IM FT-2-3 9
For Part 3 see: IM FT-2-3 10
Organizer: Xiaolin Li — Stony Brook University
Organizer: Zhiliang Xu — University of Notre Dame
Organizer: Hyunsun Lee — Hawaii Pacific University

Abstract: Multiphase flows have many applications in science and engineering. This minisymposium brings together researchers who have been working on such problems using various analytical and numerical methods for solving PDEs and coupling the solution with the .interface dynamics. Topics in this minisymposium include fluid interface instabilities and fluid interaction with thin layer structures.

14:30-15:00

Inflation Research of flexible Folded fabric based on the fluid-structure interaction method

Li Yu — Nanjing University of Aeronautics and Astronautics

Abstract: The folding model has a great influence on the numerical results. Reverse modeling by force or motion of complicated folded fabric is proposed. Base on this method, some curved surface fabrics were taken to establish the folding model. Finally, the inflation process of parachute was investigated. The dynamic relationship between canopy shape and flow field was obtained, and the adverse inflation phenomena such as asymmetric inflation and whip were observed in simulation results.

15:00-15:30

An Operator Splitting Scheme for Solving Fluid and Massive Interface Interaction Problem

Zhiliang Xu — University of Notre Dame

Abstract: A few study focused on problems involving interaction of fluid with an elastic interface with mass. In this talk, we first present a discontinuous Galerkin method for solving equations defined on manifold. Based on this work, we also introduce an operator splitting scheme for simulating an elastic and massive interface moving in viscous, incompressible flows.

15:30-16:00

Immersed boundary simulations of a ballooning spider and dragline within a stratified fluid

Laura Ann Miller — University of North Carolina

Abstract: We numerically simulated the flight of spiders that use a type of aerial dispersal called ``ballooning". The immersed boundary method was used to compute drag forces and trajectories of a flexible fiber (silk dragline) attached to a point mass (spider). The dynamics of ballooning is significantly influenced by the spider mass and the length of the dragline. During flight, stratification layers may allow the spider to remain airborne for long periods of time.

16:00-16:30

Front Tracking Method at Its Best--Applications in Fluid Structure Interactions

Xiaolin Li — Stony Brook University
Tengbo Yang — Stony Brook University
Brandon Ballentine — Stony Brook University

Abstract: The Lagrangian front tracking method is algorithmically more challenging than the Eulerian methods. But for certain problems it is uniquely superior. In this talk, we will introduce a mesoscale dual-stress spring-mass model to mimic the fabric surface as an elastic membrane. This model is coupled with the incompressible fluid solver through the impulse method. We will apply this method to the simulations of parachute deceleration devices and the simulation of airbag system.

MS ME-1-3 8 — 14:30-16:30

Entropy methods for multi-dimensional systems in mechanics - Part 2

For Part 1 see: MS ME-1-3 7
For Part 3 see: MS ME-1-3 9
For Part 4 see: MS ME-1-3 10
Organizer: Cleopatra Christoforou — University of Cyprus
Organizer: Athanasios Tzavaras — KAUST

Abstract: Nonlinear Conservation Laws result from the balance laws of continuum physics and govern a broad spectrum of physical phenomena in compressible fluid dynamics, materials science, particle physics, semiconductors, and other applied areas. The minisymposium is focused on recent advances on conservation laws and related systems in mechanics that connect variational methods with dynamics and the general use of entropy methods in conservation laws and related systems. It aims to bring together researchers working in different aspects, highlight the role of PDEs in these applications, serve as a forum for the dissemination of new scientific ideas and discoveries and enhance communication.

14:30-15:00

Divergence-Measure Fields over Rough Open Sets and Entropy Methods for Multidimensional Systems of Balance Laws

Gui-Qiang Chen — University of Oxford

Abstract: We discuss some recent developments in the analysis of a class of weakly differentiable vector fields, called divergence-measure fields, over rough open sets and their natural connections with entropy methods for multidimensional systems of balance laws, as well as a longstanding fundamental problem in mechanics for the equivalence of entropy solutions with discontinuities/singularities between multidimensional PDE systems of balance laws and the mathematical formulation of balance laws via the Cauchy flux in the axiomatic foundation.

15:00-15:30

On the relative entropy method in quasiconvex elastodynamics and weak-strong uniqueness

Kostas Koumatos — University of Sussex
Stefano Spirito — University of L'Aquila

Abstract: A weak-strong uniqueness result is presented for dissipative measure-valued solutions to the system of conservation laws arising in elastodynamics. The novelty of this work is that the stored-energy function is assumed strongly quasiconvex. The proof borrows tools from the calculus of variations to prove a Garding type inequality involving quasiconvex functions, which allows to adapt the relative entropy method to quasiconvex energies.

15:30-16:00

Relative entropy for viscous compressible fluid mechanics

Didier Bresch — Université Grenoble Alpes, Université Savoie Mont-Blanc

Abstract: This talk concerns the introduction of appropriate augmented systems in compressible fluid mechanics and its consequences to get original well-posedness and singular perturbations results. It is based on joint works with mainly B. Desjardins, M. Gisclon, I. Lacroix-Violet, P. Noble, J.-P. Vila, E. Zatorska.

16:00-16:30

A saddle point problem in compressible hyperelasticity

Michael Westdickenberg RWTH Aachen University

Abstract: We discuss a saddle point problem motivated by a variational time discretization for compressible hyperelasticity, for a strain-energy functional that is convex in the Cauchy-Green deformation tensor.

MS A1-2-1 8 14:30-16:30

Numerical methods for multi-scale fluid problems - Part 2

For Part 1 see: MS A1-2-1 7

Organizer: Franck Emmanuel INRIA

Organizer: Jung Jonathan LMAP, UPPA & Inria Cagire, Inria BSO

Organizer: Laurent Navoret Université de Strasbourg / INRIA

Abstract: Many hyperbolic models for fluids involve characteristic speeds with large ratio. From a numerical point, this large ratio raises several problems. Indeed, this ratio can induce accuracy problems to solve the slow scale but also time integration problem because of the restriction due to the fast waves. Such situation arises for instance in the low Mach regime of the Euler/MHD systems, for the quasi-neutral limit in Euler-Poisson system or for fluid models with singular pressure. Specific methods in time and space have to be devised to capture the flow with a good precision and a reasonable computational cost.

14:30-15:00

A finite volume scheme for the Euler system with congestion

Navoret Laurent University of Strasbourg

Abstract: In this talk, we present an asymptotic preserving (AP) scheme for the Euler system with a singular pressure. This model describes the macroscopic motion of a crowd with congestion interactions. Such a model involves transitions from incompressible dynamics, where the maximal density is reached, to compressible dynamics, where the density is lower. AP schemes are needed to capture both dynamics. A second order accurate version of the scheme is also presented.

15:00-15:30

Low Mach number models: some advantages for numerical simulations of weakly compressible flows

Grec Bérénice MAP5 (Université Paris Descartes)

Abstract: In order to describe the coolant flow in a nuclear core, we consider a simplified model taking into account large heat transfers and phase transition, obtained asymptotically from compressible models in the low Mach number regime. This system is based on a decomposition of the pressure involving both thermodynamic (in the equation of state) and dynamic pressure (in the momentum equation). This impacts especially numerical aspects, allowing in particular to handle tabulated thermodynamic data.

15:30-16:00

A low Mach correction able to deal with low Mach acoustics

Perrier Vincent INRIA Sud Ouest

Jonathan Jung Pau University and INRIA

Abstract: In this talk, we consider the computation of acoustic perturbations in a low Mach number flow. The usual low Mach fixes, developed for stationary problems, will be proven to be inaccurate in this case. This inaccuracy will be analyzed, and a new scheme, able to compute both stationary and acoustic perturbations will be presented.

16:00-16:30

Compressible two-phase flow simulations of liquid droplet impacts

Padioleau Thomas CEA Saclay

Abstract: We want to estimate the impact pressure of liquid water droplets onto a wall. We use the five equations system with an isobaric closure between liquid and steam. To capture accurately the interface between the two fluids we use an acoustic-transport splitting along with an anti-diffusive solver for the transport system. Finally we will present numerical results obtained using a stiffened gas to model liquid water and a perfect gas to model steam water.

MS GH-3-5 8 14:30-16:30

Tools and Technologies of the SciDAC FASTMath Institute - Part 1

For Part 2 see: MS GH-3-5 9

For Part 3 see: MS GH-3-5 10

Abstract: The FASTMath (Frameworks, Algorithms and Scalable Technologies for Mathematics) Institute is a R&D project funded by the SciDAC Program at the U.S. Department of Energy (DOE). The goal of FASTMath is to develop and deploy scalable mathematical algorithms and software tools for reliable simulation of complex physical phenomena. The focus of FASTMath is strongly driven by the requirements of DOE application scientists who require fast, accurate, and robust forward simulation along with the ability to efficiently perform ensembles of simulations in optimization or uncertainty quantification studies. This minisymposium will provide an overview of FASTMath.

14:30-15:00

Multirate Time Integration with ARKode

Daniel Reynolds Southern Methodist University

David Gardner Lawrence Livermore National Laboratory

Rujeko Chinomona Southern Methodist University

Abstract: We discuss derivation and implementation of novel `multirate' time integration methods. While integrators that utilize different stepsizes per process are not new, traditional approaches suffer from poor stability and accuracy, while many modern approaches enforce rigid constraints on how components are evolved. Our methods extend MIS methods, allowing high order, extreme flexibility in the fast scale, and excellent stability. We discuss their implementation in the ARKode library, and present convergence and efficiency results.

15:00-15:30

Spectral Deferred Corrections and Adaptive Mesh Refinement in the AMReX Package

Michael Minion Lawrence Berkeley National Laboratory

Abstract: The use of block structured adaptive mesh refinement (AMR) for time dependent PDEs is a popular approach to reducing the computational cost for problems with disparate spatial and temporal scales. I will present a higher-order temporal method based on Spectral Deferred Corrections for the AMR framework, and discuss advantages and disadvantages of using this iterative approach. I will also discuss the incorporation into the massively parallel AMReX package and report on recent highlights.

15:30-16:00

An Overview of Linear Solvers Research in FASTMath

Ulrike Yang Lawrence Livermore National Laboratory

Abstract: Many applications require the solution of linear solvers. Emerging architectures are forcing the reevaluation of solvers to achieve continued high performance, including the development of new efficient solver kernels, the redesign of various solvers, and the addition of new solver capabilities. This talk will discuss linear solver research and recent developments in FASTMath software, which includes kernel libraries, Kokkos Kernels, multigrid solvers from hypre, PETSc and Trilinos, and direct solvers, STRUMPACK, and symPACK.

16:00-16:30

Exploiting Spatio-Temporal Structure for Forward Propagation of Uncertainty in Large Scale Models

Cosmin Safta Sandia National Laboratories

Alexander Gorodetsky University of Michigan

John Jakeman Sandia National Laboratories

Khachik Sargsyan Sandia National Laboratories

Daniel Ricciuto Oak Ridge National Laboratory

Abstract: Uncertainty Quantification studies for earth system models are challenged by their high computational cost and large number of parameters. Non-linear input-output dependencies limit the use of classical regression techniques. We adopt a low-rank parametric functional tensor train decomposition approach for constructing sparse surrogate models to approximate the E3SM land model. We expand the parametric representation to include spatio-temporal dependencies. We compare the accuracy of low-rank methods with sparse regression approximations in a Bayesian setting.

MS GH-1-3 8 14:30-16:30

Mathematical Models for Membrane Filtration - Part 1

For Part 2 see: MS GH-1-3 9

Organizer: Pejman Sanaei Courant Institute of Mathematical Sciences, New York University
Organizer: Daniel Fong U.S. Merchant Marine Academy

Abstract: Membrane filters -- essentially, thin sheets of porous medium which act as filters -- are in widespread industrial use (e.g. treatment of radioactive sludge, various purification processes in the biotech industry, the cleaning of air or other gases), and represent a multi-billion dollar industry in the world. Major multinational companies manufacture a huge range of membrane-based filtration products, and maintain a keen interest in improving and optimizing their filters. While the underlying applications and the details of the filtration may vary dramatically, the broad engineering challenge of efficient filtration is the same: to achieve finely-controlled separation at low power consumption.

14:30-15:00

Leveraging mathematics for industrial filtration challenges

Ian Griffiths Mathematical Institute, University of Oxford

Abstract: Filtration challenges arise in a wealth of scenarios, including dust capture from the air and removal of contaminants from drinking water. Here we present mathematical models based on homogenization theory and asymptotic analysis to describe different filtration set-ups. We show how the models can be used to design new dust filters with improved capacity and predict the performance of novel filters that remove arsenic from water, offering a route to pure water for developing countries.

15:00-15:30

Deterministic and stochastic models for membrane filters fouling

Pejman Sanaei New York University
Linda J. Cummings New Jersey Institute of Technology
Lou Kondic New Jersey Institute of Technology
Binan Gu New Jersey Institute of Technology
Shi Yue Liu New York University, Courant Institute of Mathematical Sciences
Zhengyi Chen New York University, Courant Institute of Mathematical Sciences

Abstract: In this work, I present two idealized mathematical models, in which a membrane consists of axisymmetric pores or a series of bifurcating pores (which decrease in size as the membrane is traversed) and particles are removed from the feed by adsorption within pores (which shrinks them) and deterministic/stochastic sieving (blocking by large particles). I discuss how filtration efficiency depends on the characteristics of the branching structure.

15:30-16:00

Pore Network Modeling of particle filtration for challenging applications

Vasudevan Venkateshwaran W. L. Gore & Associates
Uwe Beuscher W. L. Gore & Associates
Zhenyu He W. L. Gore & Associates

Abstract: A critical parameter in the modeling of particle filtration using pore network models is the pore size distribution of the filter medium. In this talk we will demonstrate the difficulty in interpreting pore size distribution from techniques like porometry and particle filtration experiments. We will also discuss the future outlook and challenges in using pore network models to describe experimental observations of porous filtration media

MS GH-1-G 8 14:30-16:30

Control, Optimization, and Numerical Methods for Infinite Dimensional Systems - Part 2

For Part 1 see: MS GH-1-G 7
For Part 3 see: MS GH-1-G 9
Organizer: Weiwei Hu Oklahoma State University
Organizer: Wei Gong Chinese Academy of Sciences

Abstract: The aim of this minisymposium is to bring together scientists working on control, optimization and numerical methods for addressing the emerging problems in infinite dimensional systems and the related applications. This minisymposium will present recent developments in the topics such as control and estimation with non-smooth and sparsity structures; control of hyperbolic systems; numerical schemes for solving control systems with delays, optimal control of stochastic PDEs and fractional optimal control problems, etc. This forum will foster the international collaborations as well as provide an opportunity for young researchers to present their work and learn the state-of-the-art progress in this field.

14:30-15:00

State-constrained semilinear elliptic optimization problems with unrestricted sparse controls

Eduardo Casas Universidad de Cantabria
Fredi Tröltzsch Technical University of Berlin

Abstract: In this talk, we consider optimal control problems of semilinear elliptic equations. The states are subject to pointwise constraints but there are no explicit constraints on the controls. A term is included in the cost functional promoting the sparsity of the optimal control. We prove existence of optimal controls and derive first and second order optimality conditions. In addition, we establish some regularity results for the optimal controls, the associated adjoint states and Lagrange multipliers.

15:00-15:30

Sparse and switching optimal control for infinite horizon problems with nonconvex penalizations

Zhiping Rao Wuhan University

Abstract: In this talk, a class of infinite horizon optimal control problems involving nonsmooth L^p-type cost functionals for the controls is discussed. These functionals enhance sparsity and switching properties of the optimal controls. The existence of optimal controls and their structural properties are analyzed on the basis of the first-order optimality conditions. A dynamical programming approach is used for the numerical realizations and the sparse structure of feedback optimal control is discussed in some special cases.

15:30-16:00

Optimal control of a semilinear heat equation with state and control constraints

Axel Kroener Humboldt Universitaet Berlin

Abstract: In this talk we consider an optimal control problem governed by a semilinear heat equation with bilinear control-state terms and subject to control and state constraints. The control has several components and the state constraints are of integral-type. We derive second order necessary and sufficient optimality conditions for the singular case that the control enters affine the cost function taking advantage of the Goh transform. This is joint work with F. Bonnans and M.S. Aronna.

16:00-16:30

Observer design for the state estimation of parabolic PDEs

Michael Demetriou Worcester Polytechnic Institute
Weiwei Hu Oklahoma State University

Abstract: We discuss the construction of filter gains with sparsity in observer designs for parabolic PDEs. This is motivated by considerations of computational savings in optimal sensor placement, where a hybrid Domain Decomposition (DD) based filter is presented. To implement the DD methods, it is key to understand the sparsity of the filter gains. We propose a feasible filter design based on the output measurement and establish rigorous analysis on the convergence of observation error.

MS A6-3-2 8 14:30-16:30

Stochastic differential equations and applications in Physics and Finance

Organizer: Andrea Pascucci University of Bologna

MS Organized by: SIAG/FME

Abstract: Stochastic ordinary and partial differential equations play a central role in the analysis of many models of financial mathematics and physics. The aim of this symposium is to discuss the new developments in the field of analytic and numerical methods for stochastic equations and their applications. Topics of interest include but not limited to: - second order partial differential equations of degenerate parabolic type - Kolmogorov equations - stochastic (partial) differential equations - free boundary and optimal stopping problems - American options - Asian/path-dependent options ** This minisymposium is sponsored by the SIAG/FME **

14:30-15:00

On stochastic Langevin and Fokker-Planck equations

Antonello Pesce Università di Bologna
Andrea Pascucci

Abstract: We consider a stochastic version of the Langevin equation: we discuss the relative filtering problem and we show existence, regularity and Gaussian-type estimates of a stochastic fundamental solution. Our method is based on a Wentzell's reduction of the SPDE to a PDE with random coefficients to which we apply a revised parametrix technique to construct a fundamental solution.

15:00-15:30

Liquidity induced asset bubbles via flows of ELMMs

Andrea Mazzon Ludwig-Maximilians Universität

Abstract: We consider a model for bubbles, where the market price W is determined by trades of investors and the fundamental price W^F is exogenously given. We show the existence of a flow of equivalent martingale measures for W, under which W^F equals the expectation of discounted future dividends. We study bubble evolution in a network through contagion processes spreading among investors. We investigate how the shape of the network impacts the growth of the bubble.

15:30-16:00

Deep learning based methods for stochastic optimal control

Kristoffer Andersson CWI
Kristoffer Andersson CWI
Adam Andersson Syntronic
Gustaf Ehn Syntronic
Arnulf Jentzen ETH Zurich
Mihály Kovács Chalmers University of Technology

Abstract: We present two methods for solving stochastic optimal control problems with finite time horizon. The first method is based on solving backward stochastic differential equations approximately by means of time discretization and deep learning. The second method solves the control problem by approximating the gradient of the associated value function with deep learning in order to minimize the cost functional. The methods are discussed and compared by means of the control cost for different examples.

16:00-16:30

Probabilistic results concerning smoothness of the value function and of the free boundary in optimal stopping

Tiziano De Angelis The University of Leeds

Abstract: I will present probabilistic proofs of some regularity properties for the value function and the optimal boundaries of optimal stopping problems. In particular this talk focusses on C^1 regularity of the value function and Lipschitz continuity of the optimal boundary. Most of our arguments rely on fundamental concepts from the theory of Markov processes and I will also illustrate situations in which our work improves or complements known facts from PDE theory.

MS ME-1-2 8 14:30-16:30

Recent Advances in Applied Integrable Systems: Theory and Computations - Part 2

For Part 1 see: MS ME-1-2 7
For Part 3 see: MS ME-1-2 9
For Part 4 see: MS ME-1-2 10

Organizer: Kenichi Maruno Waseda University
Organizer: Anton Dzhamay University of Northern Colorado

Abstract: Recent advances in the applications of integrable systems extend to a wide range of mathematics and physical sciences, such as random matrices, cluster algebra and combinatorics, probability theory, numerical computations, cellular automata, tropical geometry and ultra-discrete systems, differential geometry, computer visualizations, nonlinear physics, and many others. The purpose of this mini-symposium is to bring together active researchers from across the world to discuss recent developments in various aspects of applied integrable systems.

14:30-15:00

Integrable systems over novel fields

Rod Halburd University College London

Abstract: Natural analogues of differential and difference equations with solutions defined on functions fields over finite fields will be discussed. Analogues in this setting of important special functions such as the exponential, gamma and hypergeometric functions have been discovered by Carlitz, Goss, Thakur and others. We will describe some integrable equations in this setting and the role played by singularity analysis.

15:00-15:30

Coprimeness-preserving extensions to discrete integrable systems

Masataka Kanki Kansai University

Abstract: We present a class of equations with a so-called coprimeness property. The coprimeness property is one of the integrability detectors for discrete equations, with an emphasis on the algebraic aspect of the singularity confinement test. One of the equations we introduce is an extension of the discrete KdV equation to a higher dimensional integer lattice. The equation is non-integrable and yields a class of coprimeness-preserving equations including the Hietarinta-Viallet equation.

15:30-16:00

Dynamics of the box-ball system with random initial conditions

Satoshi Tsujimoto Kyoto University
David Croydon Kyoto University
Tsuyoshi Kato Kyoto University
Makiko Sasada Tokyo University

Abstract: We explore the dynamics of the BBS, introduced by Takahashi and Satsuma, started from random initial conditions. We show that the model can be described using the transformation of a nearest neighbour path encoding of the particle configuration given by `reflection in the past maximum'. Then we analyse various probabilistic properties of the BBS such as the asymptotic behavior of the integrated current of particles and of a tagged particle.

16:00-16:30

Continuous Game of Life using Max-Pluls Expression

Daisuke Takahashi Waseda University

Abstract: Game of life is a famous two-dimensional evolutional cellular automaton as a simple model of life creating various moving patterns. In my talk, a continuous version of this game is presented. It is constructed using max-plus expression and sum of values of neighboring domain. It includes the original game of life as a special case and some patterns of original game are unified as special solutions of max-plus version.

MS A3-3-2 8 14:30-16:30

Mathematical descriptions of traffic flow: micro, macro and kinetic models - Part 1

For Part 2 see: MS A3-3-2 9
For Part 3 see: MS A3-3-2 10

Organizer: Andrea Tosin Politecnico di Torino
Organizer: Gabriella Puppo La Sapienza Università di Roma

Abstract: Traffic flow is a complex phenomenon, which impacts heavily on society, economy and everyday life. In the last few years, several new technologies, such as driver assist devices or online congestion information, have raised the need for a better understanding of traffic. In this minisymposium, we will gather several researchers in the field to explore the mathematical foundations of traffic models from different perspectives. The motivation is both to assess the state of the art and the interplay between the different approaches and to discuss how to meet the new challenges of traffic control, autonomous vehicles and emission reduction.

14:30-15:00

From kinetic to macroscopic models and back

Gabriella Puppo La Sapienza Università di Roma
Michael Herty RWTH Aachen University
Sebastiano Roncoroni University of Reading
Giuseppe Visconti RWTH Aachen University

Abstract: We study kinetic models for vehicular traffic flow. Classical formulations, as the BGK equation, lead to unconditionally unstable solutions in the congested regime of traffic. We address this issue by deriving a modified formulation of the BGK-type equation. The new kinetic model allows to reproduce conditionally stable non-equilibrium phenomena in traffic flow. The BGK-type model introduced here also offers the mesoscopic description between the follow-the-leader model and the Aw-Rascle and Zhang model.

15:00-15:30

Non-local vehicular traffic flow models

Felisia Angela Chiarello Inria Sophia Antipolis - Méditerranée
Paola Goatin Inria Sophia Antipolis-Méditerranée

Abstract: In this talk, I will consider the framework of the non-local traffic flow models. I will prove the well-posedness of entropy weak solutions for a class of non-local scalar conservation laws. After that, I will prove the existence for small times of weak solutions for a class of non-local systems in one space dimension. Finally, I will present some numerical simulations illustrating the behavior of different classes of vehicles.

15:30-16:00

Multiscale models for traffic flow

Elisa Iacomini	Sapienza University - SBAI Department
Emiliano Cristiani	IAC-CNR

Abstract: In this talk I will present a new kind of model for traffic flow which couples a first-order macroscopic approach with a second-order microscopic approach, avoiding any interface or boundary conditions between them. The Euler- Godunov scheme associated to the model is conservative and it is able to reproduce typical traffic phenomena like stop & go waves, shown in the numerical tests.

16:00-16:30

Two-dimensional approaches for the mathematical modeling of traffic flow

Giuseppe Visconti	RWTH Aachen University
Michael Herty	IGPM, RWTH Aachen University, Aachen, Germany
Salissou Moutari	School of Mathematics and Physics, MSRC, Queen's University, Belfast, Northern Island, UK
Andrea Tosin	Department of Mathematical Sciences "G. L. Lagrange", Politecnico di Torino, Torino, Italy
Mattia Zanella	Department of Mathematical Sciences "G. L. Lagrange", Politecnico di Torino, Torino, Italy

Abstract: Lane changing is one of the most common maneuvers on motorways. Although traffic models are well known for their suitability to describe fast moving crowded traffic, especially at macroscopic level, most of these models are generally developed in a one-dimensional framework; henceforth lane-changing behavior is either not explicitly modeled or is explicitly forbidden. In this talk, we discuss recent mathematical models which account for lane-changing behavior on motorways, illustrating also some numerical experiments.

MS A1-1-1 8 14:30-16:30

Mathematical Theory and Applications of Deep Learning - Part 3

For Part 1 see: MS A1-1-1 6
For Part 2 see: MS A1-1-1 7

Organizer: Haizhao Yang	National University of Singapore
Organizer: Tingran Gao	University of Chicago

Abstract: The “unreasonable effectiveness” of deep learning for massive datasets posed numerous mathematical and algorithmic challenges along the path towards gaining deeper understandings of new phenomena in machine learning. This minisymposium aims at bringing together applied mathematicians interested in the mathematical aspects of deep learning, with diverse background and expertise ranging from approximation theory, optimization methods, and generalization performance to modeling high-dimensional scientific computing problems and nonlinear physical systems; the talks reflect the collaborative, multifaceted nature of the mathematical theory and applications of deep neural networks. The third part of this minisymposium concerns the applications of deep learning.

14:30-15:00

Parallel Transport Convolution: a new tool for convolutional neural network on manifolds

Rongjie Lai	Rensselaer Polytechnic Institute

Abstract: In this talk, I will discuss our recent work of a new way of defining convolution on manifolds and demonstrate its potential to conduct geometric deep learning on manifolds. This geometric way of defining convolution provides a natural combination of modeling and learning on manifolds. It enables further applications in comparing, classifying and understanding manifold-structured data by combing with recent advances in deep learning.

15:00-15:30

Solving PDEs with Deep Learning

Yuehaw Khoo	Stanford University

Abstract: Deep neural-network provides an alternative method for compressing high-dimensional functions arising from partial differential equations (PDE). In this talk, we focus on using artificial neural-networks for solving PDEs in two ways: (1) Using neural-networks to represent mappings between PDE coefficients and solutions. (2) Constructing a solution space with neural-networks when solving for a PDE. We apply the methods developed in scattering problems, stochastic homogenization, and when studying transition between states in stochastic systems.

MS FT-0-2 8 14:30-16:30

Nonlinear Spectral Decompositions with Applications in Imaging and Data Science - Part 2

For Part 1 see: MS FT-0-2 6

Organizer: Martin Benning	Queen Mary University of London
Organizer: Guy Gilboa	Technion
Organizer: Martin Burger	FAU Erlangen-Nürnberg

Abstract: In recent years, there have been many advances in the theory and application of nonlinear eigenvalue analysis. Formulations of nonlinear transforms, based on one-homogeneous functionals like the total-variation semi-norm, and their numerical counterparts have found their way into various applications including image fusion, denoising, invariant descriptors and more. In machine learning, nonlinear eigenvectors of the graph 1-Laplacian have successfully been used for classification and clustering. Despite these recent successes, major theoretical gaps and open problems remain in this area. In this two-part minisymposium researchers with different perspectives will present their latest results and discuss future trends in this emerging field.

14:30-15:00

Nonlinear Spectral Decompositions of One-Homogeneous Function

Michael Möller	Universität Siegen

Abstract: A classical way to decompose images and signals is to consider their representation as the superposition of eigenfunctions of a suitable linear operator. This talk gives an introduction to similar concepts for nonlinear transformations by considering variational, scale space, or inverse scale space methods with respect to convex one-homogeneous regularizers. The possibility to decompose input data into linear combinations of generalized eigenvectors is presented and some preliminary ideas for analyzing machine learning methods are discussed.

15:00-15:30

Spectral decompositions of optical flows

Martin Benning	Queen Mary University of London
Lukas Lang	University of Cambridge
Carola-Bibiane Schönlieb	University of Cambridge

Abstract: We propose a nonlinear spectral decomposition based on a nonlinear Bregman iteration for convex and non-convex optical flow formulations. We present an efficient numerical implementation and use this spectral decomposition in order to isolate, enhance or suppress motion at particular frequencies in video sequences.

15:30-16:00

Spectral representations for p-homogeneous regularization

Ido Cohen	Technion

Abstract: The TV-transform is based on linear decay and finite extinction of an eigenfunction under the TV-flow. We show that signals under the gradient flow of p-homogeneous functionals, $p \in (1|2)$, get extinct in finite time. Moreover, an eigenfunction of the variational derivative operator decays polynomially under this flow. Based on these attributes, we define a nonlinear transform, the p-transform, associated with eigenfunctions of the operator. This framework rigorously defines the notions of decomposition, reconstruction, filtering, and spectrum.

16:00-16:30

Deep Learning Decomposition for Inverse Problems

Christoph Brune	University of Twente
Yoeri Boink	University of Twente
Srirang Manohar	University of Twente

Abstract: Deep learning methods in combination with variational methods have strongly improved imaging and data science. However, a proper understanding of ill-posedness and regularization scales for deep learning methods solving inverse problems is largely missing and limits further understanding. We present a coupled latent space model which combines deep learning autoencoders and regularization theory for solving inverse problems via multiscale decompositions. This offers new tools and insights on adversarial stability for addressing the above limitation.

MS A6-2-1 8 **14:30-16:30**

Mathematical Models for Solid Mechanics and Soft Structures - Part 2

For Part 1 see: MS A6-2-1 7
For Part 3 see: MS A6-2-1 9
For Part 4 see: MS A6-2-1 10

Organizer: Marco Morandotti Politecnico di Torino
Organizer: Luca Lussardi POLITECNICO DI TORINO

Abstract: The modelling of materials has received more and more attention in the last decades due to the increasing capabilities and versatility of new material and composites. Applications ranging from solid mechanics to soft structures demand sophisticated models which today's mathematics can both provide and study. In this minisymposium we intend to gather international researchers in the field of applied mathematics to share their research on topics including continuum mechanics, soft structures, thin structures, homogenisation theory, material defects, and liquid crystals.

14:30-15:00

Analysis of a perturbed Cahn-Hilliard model for Langmuir-Blodgett films

Marco Morandotti Politecnico di Torino
Marco Bonacini University of Trento
Elisa Davoli University of Vienna

Abstract: A one-dimensional evolution equation including a transport term is considered; it models a process of thin films deposition. Existence and uniqueness of solutions, together with continuous dependence on the initial data and an energy equality are proved by combining a minimizing movement scheme with a fixed-point argument. Finally, it is shown that, when the contribution of the transport term is small, the equation possesses a global attractor and converges to a purely diffusive Cahn-Hilliard equation.

15:00-15:30

Equilibria configurations for epitaxial crystal growth with adatoms

Riccardo Cristoferi Heriot-Watt University
Marco Caroccia Università di Firenze-SNS
Laurent Dietrich Lycée Fabert

Abstract: Surface diffusion is one of the most important mechanisms driving crystal growth. Albeit usually neglected, adatoms (atoms freely diffusing on the surface of the crystal) seem to play a fundamental role in the description of the behaviour of a solid-vapor interfaces. In this talk I present a study of the energy generating the gradient-flow evolution equations introduced by Fried and Gurtin in order to describe the above phenomenon.

15:30-16:00

The Sadowsky functional for inextensible elastic ribbons

Maria-Giovanna Mora Università di Pavia
Peter Hornung Technische Universität Dresden
Lorenzo Freddi Università di Udine
Roberto Paroni Università di Pisa

Abstract: In 1930 Sadowsky posed the problem of determining the equilibrium configurations of an unstretchable Möbius strip. To tackle this problem he deduced the bending energy for a strip whose width is much smaller than the length. This energy depends on the curvature and torsion of the centerline of the band and it is singular at points with zero curvature. In this talk we will re-examine the derivation of the Sadowsky energy using Gamma-convergence.

16:00-16:30

A brief review on inelastic processes in Biomechancis

Alfio Grillo Politecnico di Torino

Abstract: I review some fundamental aspects of tumour growth and fibre rearrangement in fibre-reinforced biological tissues. I emphasise the inelastic features of both phenomena and introduce suitable variables to account for their description. Moreover, taking several suggestions from the literature, I merge some concepts of Differential Geometry with the formalism of Elastoplasticity so as to highlight the role played by metric, torsion and curvature on the evolution laws of the introduced variables.

MS ME-1-6 8 **14:30-16:30**

Mathematical Challenge to Understand Control Principle Underlying Animals' Adaptive Behavior

Organizer: Ryo Kobayashi Hiroshima University
Organizer: Akio Ishiguro Tohoku University

Abstract: Although even lower animals can move around in natural environments, it is difficult to make artifacts (typically robots) having such ability. This difficulty essentially comes from the idea of conventional control theory in which the interaction with the environment is treated as a disturbance i.e. undesirable factor. It is totally different from the animals' way. They adapt to their habitat environments and make use of them, and it is important to learn how they solve the control problem. In this mini symposium, challenges to construct a novel control principle for mobile robots will be introduced by learning from animals.

14:30-15:00

Towards the Construction of Dialogical Control

Ryo Kobayashi Hiroshima University

Abstract: Conventional control theory has developed highly sophisticated framework by separating the system and the environment. Although this framework has made big successes in the area where it is applicable, it does not work well for controlling mobile robots. We propose a novel control policy 'dialogical control' by learning from animals. It consists of three basic concepts, Hierarchical control, 'Tegotae'control and Yin-Yang control, which will be explained in this presentation.

15:00-15:30

Mechanism underlying generating ultra high fast movement in insect

Hitoshi Aonuma Hokkaido University

Abstract: Fast movement is one of the crucial behaviors to escape from predators. Japanese trap jaw ant performs quick jump to escape from a potential threaten. It hits the ground or a predator with the tip of the mandible at an ultra high speed to perform an escape jump by using the reaction force. We here performed kinematic analysis to demonstrate how such a small ant can generate ultrahigh fast movement of the mandible.

15:30-16:00

How Animals Coordinate Their Limbs?

Akira Fukuhara Tohoku University

Abstract: Legged animals exhibit versatile locomotion patterns by coordinating their limbs in response to locomotion speed, species, and environment. Although biological findings suggest that animals' adaptive locomotion patterns are partially generated through the interactions between the nervous system, biomechanical system, and environment, the underlying control mechanism is still unclear. In this presentation, we will introduce our studies aiming to understand the inter-limb coordination mechanism underlying animals' adaptive locomotion from the viewpoint of a decentralized control scheme.

16:00-16:30

Where does the intelligence come from? -- i-CentiPot solves the mystery of intelligence —

Koichi Osuka Osaka University

Abstract: In this note, we introduce our developed centipede like multi-legged robot named i-CentiPot. This robot is developed for showing our concept shown in the CREST project. In the project, we show that the existence of Implicit control is important. i-CentiPot plays a part of anchor example for our project. Using this robot, we try to show that the source of intelligence exists in the environment.

MS ME-0-5 8 **14:30-16:30**

Simulation, Modeling and Analysis of Semiconductors - Part 2

For Part 1 see: MS ME-0-5 7

Organizer: Nella Rotundo Weierstrass Institute for Applied Analysis
Organizer: Patricio Farrell Weierstrass Institute, Berlin

MS Organized by: SIAG/CSE

Abstract: At its core technological change depends fundamentally on the quality and efficiency of semiconductor devices. Due to miniaturization, the need for higher efficiency and new (organic) materials, advanced theory and numerical methods are required to correctly predict the flow of charge carriers in a device --- without the costly production of prototypes. This minisymposium aims at providing a vision of recent theoretical advances as well as suitable simulation techniques. Furthermore, it provides a platform for international experts in applied analysis and numerical methods to learn from another.

14:30-15:00

Analytical results for parabolic PDAE models arising in integrated circuit design

Giuseppe Alì	University of Calabria
Nella Rotundo	Weierstrass Institute for Applied Analysis and Stochastics, Berlin, Germany

Abstract: In refined network analysis, a compact network model is combined with distributed models for semiconductor devices. For linear RLC networks containing distributed semiconductor devices, we construct a mathematical model that joins the differential-algebraic initial value problem for the electric circuit with multi-dimensional parabolic-elliptic boundary value problems for the devices. For this mixed initial boundary value problem of partial differential-algebraic equations an existence and uniqueness result is given, and its asymptotic behavior is discussed.

15:00-15:30

A hybrid finite volume - finite element solver for nano-electronic devices using the deal.II library

Wenyu Lei	Scuola Internazionale Superiore di Studi Avanzati SISSA

Abstract: In this talk, we present a hybrid finite element-finite volume solver to simulate ferroelectric devices with arbitrary 3D geometries. The software consists of three parts: a collection of physical models, the numerical discretization modules, and a module for external linear system solvers. We provide some numerical results for the drift-diffusion problem coupled with the Ginzburg-Landau-Devonshire model, and for the simulation of devices with arbitrary doping distributions, not aligned with the simulation grid.

15:30-16:00

Simulation of graphene field effect transistors

Giovanni Nastasi	University of Catania

Abstract: Field effects transistors, where the active region is constituted by a single layer of graphene, are simulated. The model is based on a system of drift-diffusion equations for electrons and holes. The numerical method is based on the Scharfettel and Gummel scheme. A special treatment of the Poisson equation is adopted for considering the charge in the graphene sheet. The characteristic curves for fixed gate voltages and for fixed source-drain voltages have been obtained.

MS A6-1-1 8 **14:30-16:30**

PDE-constrained optimization under uncertainty - Part 1

For Part 2 see: MS A6-1-1 9

Organizer: Peng Chen — The University of Texas at Austin

Organizer: Omar Ghattas — Texas University, Austin, Us

Abstract: Many PDE models in computational science and engineering fields have uncertain parameters due to lack of knowledge or intrinsic variability of the inputs. Incorporating this uncertainty in the PDE-constrained optimization problem is crucial for making the optimal solution more robust and reliable. This minisymposium presents recent advances in computational methods, analyses, and applications to solve such problems, with emphases on (1) high-dimensional uncertainty; (2) different risk measures and probability constraints; (3) novel formulations and methods for data-driven optimization under uncertainty; and (4) application to problems governed by more challenging models, including multiphysics, multiscale, and fractional PDE problems.

14:30-15:00

A scalable method for PDE-constrained optimization under high-dimensional uncertainty

Peng Chen	The University of Texas at Austin
Umberto Villa	Washington University in St. Louis
Omar Ghattas	The University of Texas at Austin

Abstract: In this talk, we present a scalable method based on Taylor approximation for PDE-constrained optimal control problems under high-dimensional uncertainty. The computational complexity of the method does not depend on the nominal but only on the intrinsic dimension of the uncertain parameter, thus the curse of dimensionality is broken for intrinsically low-dimensional problems. We also use Taylor approximation as a control variate for variance reduction, achieving over 100X error reduction compared to Monte Carlo quadrature.

15:00-15:30

A multilevel stochastic gradient algorithm for PDE-constrained optimal control problems under uncertainty

Fabio Nobile	École polytechnique fédérale de Lausanne
Matthieu Martin	EPFL
Panagiotis Tsilifis	EPFL

Abstract: We consider an optimal control problem for an elliptic PDE with random coefficients. The control function is a deterministic, distributed forcing term that minimizes an expected quadratic regularized loss functional. For its numerical treatment we propose and analyze a multilevel stochastic gradient (MLSG) algorithm which uses at each iteration a full, or randomized, multilevel Monte Carlo estimator of the expected gradient, build on a hierarchy of finite element approximations of the underlying PDE.

15:30-16:00

Low-rank tensor methods for optimal control of uncertain flow problems

Peter Benner	MPI f. Dynamics of Complex Technical Systems
Sergey Dolgov	University of Bath
Akwum Onwunta	University of Maryland
Martin Stoll	TU Chemnitz

Abstract: We present a low-rank tensor solver to solve an optimal control problem governed by two-dimensional time-dependent Navier-Stokes equations with uncertain inputs. We use the stochastic Galerkin finite element method to discretize the problem, leading to a prohibitively high-dimensional saddle-point system with tensor product structure. For the resulting discrete problem, we approximate the solution in low-rank Tensor Train format, and propose a numerically efficient algorithm to solve the optimality equations directly in the low-rank representation.

16:00-16:30

Bayesian search methods for engineering design

Laurence Cook	MIT

Abstract: A challenge in engineering design is choosing suitable objectives and constraints from many quantities of interest, while ensuring an optimization is meaningful and computationally tractable. We introduce an optimization approach that makes effective use of information that would otherwise be discarded, allowing desirable designs to be reached more efficiently. Our approach uses a hierarchy of relations over finite approximations to design space. Such approximations are used within Bayesian, evloutionary, and many other optimization algorithms.

MS A6-5-4 8 **14:30-16:30**

Recent Advances in Infinite Dimensional Stochastic Analysis - Part 2

For Part 1 see: MS A6-5-4 7

Organizer: Nathan Glatt-Holtz — Tulane University

Organizer: Cecilia Mondaini — Drexel University

Abstract: Random effects as well as the presence of systematic uncertainties obviate the need for stochastic methods in a range of fields across the natural and social sciences and engineering. This session brings together a diverse group of researchers working on infinite dimensional stochastic systems. Our group will disseminate exciting recent advances in nonlinear stochastic partial differential equations (SPDEs) as wellas Bayesian statistical inversion problems addressed through Markov Chain Monte Carlo (MCMC) methods. (Part II)

14:30-15:00

Bayesian PDE Inversion in Electrical-Impedance Tomography

Clemens Heitzinger	Technische Universität Wien
Leila Taghizadeh	TU Wien

Abstract: We apply computational Bayesian PDE inversion to the nonlinear Poisson-Boltzmann equation in the context of electrical-impedance tomography in medicine in order to identify unknown physical and geometric properties. It is the first time that this nonlinear model equation is applied in this area. We show that the posterior measure is well-defined and that the Bayesian inversion problem is well-posed. Furthermore, we show numerical results for the reconstruction of the body interior.

15:00-15:30

Stochastic heat equation driven by a rough fractional Gaussian noises

David Nualart	University of Kansas
Le Chen	University of Nevada at Las Vegas
Yaozhong Hu	Edmonton University
Kamran Kalbasi	Universit of Warwick

Abstract: In this talk we present the existence of a solution via the Feyman-Kac representation for the stochastic heat equation with a multiplicative Gaussian noise which is a fractional Brownian motion in the time variable, with Hurst paramter less than 1/2, and it has a regular covariance in space. Precise matching upper and lower bounds for the moments will be obtained leading to intermittency properties of the solution.

15:30-16:00

Efficient sampling for the invariant distributions of SPDEs

Charles-Edouard Bréhier CNRS & Université Lyon 1

Abstract: We consider the question of sampling the invariant distribution of some ergodic (semilinear parabolic SPDEs) of the type du(t)=Au(t)dt+F(u(t))dt+dW(t), driven by space-time white noise. A standard integrator is the linear implicit Euler scheme, however its weak order of convergence is only equal to 1/2 (contrary to 1 in finite dimension). I will present techniques which help reduce the complexity of this infinite dimensional sampling problem. This is supported by theoretical analysis and numerical simulations.

MS ME-0-3 8 14:30-16:30

Delay and other dynamical systems with applications to mathematical biology - Part 2

For Part 1 see: MS ME-0-3 7

For Part 3 see: MS ME-0-3 9

Organizer: Elena Braverman Department of Mathematics and Statistics, University of Calgary

Abstract: The purpose of this minisymposium is to bring experts in delay differential, difference and partial differential equations and and to discuss recent advancement in the area, as well as applications of dynamical systems to emerging areas of mathematical biology. In theoretical advancement, the focus is on asymptotic behaviour, in particular local and global stability, and its control. The areas of application include population dynamics, in a laboratory setting such as a chemostat, and in nature, as well as gene regulatory networks. We plan to bring together a really international team of experts from more than 6 countries.

14:30-15:00

Prescribed asymptotic behavior of differential equations with applications

Agacik Zafer American University of the Middle East

Abstract: The asymptotic integration problem of second order differential equations has been investigated by many authors for the last several decades. In this talk, we will provide a new approach developed very recently to study the asymptotic integration of second-order differential equations. We will demonstrate the usefulness of our method by considering not only differential equations but also delay differential equations, difference equations as well as impulsive differential equations.

15:00-15:30

Permanence in a class of delay differential equations with mixed monotonicity

Ferenc Hartung University of Pannonia

Abstract: In this talk we consider a classes of delay differential equations with mixed monotone delayed terms in the equation. Sufficient conditions are presented for the permanence of the positive solutions. Our results give also lower and upper estimates of the limit inferior and the limit superior of the solutions via a special solution of an associated nonlinear system of algebraic equations. Several examples are presented to illustrate the applicability of the main results.

15:30-16:00

Growth and explosions in solutions of nonlinear stochastic functional differential equations

John Appleby Dublin City University

Abstract: In this talk, we discuss how noise can control or preserve dynamics in an underlying functional differential equation. We concentrate on very general scalar functional equations which have positive and monotone solutions in the absence of noise perturbation, and can even explode. The equation is then perturbed stochastically. Sharp conditions on the preservation of explosions or growth are obtained, as well as exact asymptotic estimates when the noise term grows sufficiently slowly.

16:00-16:30

On stability of nonlinear and neutral delay differential equations

Elena Braverman Department of Mathematics and Statistics, University of Calgary

Leonid Berezansky Ben-Gurion University of Negev, Israel

Abstract: Introduction of more than one delay in nonlinear equations can change qualitative properties of solutions. We consider the Mackey-Glass equation with non-monotone feedback with two delays incorporated in the nonlinear term. Next, we establish stability properties for linear neutral equations with variable delays and coefficients. Our main tools are the Bohl-Perron theorem, applying the properties of equations with the positive fundamental functions, apriori estimates of solutions and their derivatives, and various transformations of neutral equations.

MS ME-0-1 8 14:30-16:30

PDE's on mathematical Physics and Biology - Part 2

For Part 1 see: MS ME-0-1 7

Organizer: Cristina Brändle U. Carlos III Madrid

Organizer: Pablo Álvarez González HUCA

Organizer: Eduardo Colorado Universidad Carlos III de Madrid

Abstract: This minisymposium will be focused on different models concernig mathematical biology and mathematical physicis, both from an analytical and apllied point of view. In particular, the first part we will give an overview on different problems in population dynamics, such as invasion and spreading of populations, living in regions or in graphs. The second part will deal with problems involving the Schrödinger opertaor, comming from mathematical Physics. Precisely, it will be discussed results such as existence of ground states and stability of solutions.

14:30-15:00

Fractional elliptic problems involving Inverse fractional operators

Alejandro Ortega U. Carlos III

Pablo Álvarez-Caudevilla UC3M

Eduardo Colorado UC3M

Abstract: In this talk we will introduce some fractional elliptic problems involving inverse fractional elliptic operators. These problems arise from the study of steady states of high-order fractional parabolic equations of Cahn-Hilliard type.

15:00-15:30

Ground States for a Schrödinger System arizing in nonlinear optics

Filipe Oliveira U. Lisboa

Ademir Pastor Universidade de Campinas, Brazil

Abstract: This talk will be devoted to a nonlinear Schrödinger system that models the interaction between a optical beam and its third harmonic in a material with Kerr-type nonlinear response. We will present some recent results concerning the existence and the stability of ground state-solutions. Furthermore, we will discuss local and global well-posedness as well as some criteria for blow-up.

15:30-16:00

On the stability of standing waves for the Maxwell-Schrödinger system and the associated minimization problem

Tatsuya Watanabe Kyoto Sangyo University

Mathieu Colin INRIA CARDAMOM

Abstract: In this talk, we consider the orbital stability of standing waves for the Maxwell-Schrödinger system. In order to obtain the stability in the full gauge invariant form, it is necessary to study a constraint minimization problem with a static magnetic field. I introduce the solvability of this new minimization problem and its application to the stability of standing waves.

16:00-16:30

Eigenvalue estimates for some singularly perturbed problems

Veronica Felli Università degli Studi di Milano-Bicocca

Abstract: I will describe sharp eigenvalue estimates for some singularly perturbed elliptic problems, such as elliptic problems in perturbed domains obtained by attaching or removing a small set from a fixed region, elliptic problems with moving mixed boundary conditions and Aharonov-Bohm operators with moving poles. The sharp asymptotic behaviour of eigenvalues with respect to the perturbation parameter is shown to depend strongly on the vanishing order of the limit eigenfunction at the singularity.

MS A6-5-2 8 **14:30-16:30**

Modern mathematical techniques for dynamical biological data

Organizer: Keita Iida	The University of Tokyo
Organizer: Keiji Miura	Kwansei Gakuin University

Abstract: This session is motivated by the modern mathematical techniques extracting structural information from biological data ranging from biophysics to phylogenetics. Although it has been believed that intra- and inter-cellular heterogeneities, e.g., neuronal avalanche, fractal globule, gene expression noise, etc., serve biological functions or contain meaningful information, conclusive theoretical evidences have not yet been provided. In this session, we focus on mathematical challenges of characterizing such complex biosystems by means of, for example, eccentric data compression methods and rigorous calculation techniques, which provide a good starting point for quantitative evaluations and biological discussion.

14:30-15:00

Quantifying biological parameters on genetic switches

Keita Iida	The University of Tokyo
Nobuaki Obata	Tohoku University
Yoshitaka Kimura	Tohoku University

Abstract: The heterogeneity of stochastic gene expression has attracted considerable interest from biologists and mathematicians. The dynamics of protein production and degradation have been modeled as random processes. In our presentation, we propose a theoretical procedure in which we present a simple mathematical model of a gene regulatory system, derive an exact solution, and provide a Bayesian approach for estimating the biological parameters on genetic switches from single-cell experimental data.

15:00-15:30

Deciphering chromatin dynamics and structure by polymer modeling

Soya Shinkai	RIKEN

Abstract: Genomes are spatiotemporally organized within the cell nucleus. Recent genome-wide chromosome conformation capture (Hi-C) technologies have uncover the 3D genome organization. Furthermore, live-cell imaging experiments have revealed dynamic chromatin movements in living cells. To understand these genome data, polymer modeling is a powerful framework. I will talk our recent studies on deciphering chromatin dynamics and structure by polymer modeling, which allows for extracting physical insights behind the data.

15:30-16:00

Estimating Effective Dimensions of Experimentally Recorded Spike Trains by Neural Ring

Keiji Miura	Kwansei Gakuin University

Abstract: Typical neurophysiological experiments examine the neural responses to sensory stimuli. However, it is not necessarily clear if the neurons actually responded only to the sensory stimuli the experimenters presented. For example, the neurons can actually respond to some unnoticed parameters. To elucidate the dimension of the "hidden stimulus space" for a neuron, we applied the neural ring method to the spontaneous neural activities in rat hippocampus.

16:00-16:30

Tropical Principal Component Analysis and its Applications to Phylogenomics

Ruriko Yoshida	University of Kentucky College of Arts & Sciences
Leon Zhang	UC Berkeley
Xu Zhang	University of Kentucky

Abstract: Here we define and analyze two analogues of principal component analysis in the setting of tropical geometry. In one approach, we study the Stiefel tropical linear space of fixed dimension closest to the data points in the tropical projective torus; in the other approach, we consider the tropical polytope with a fixed number of vertices closest to the data points.

MS GH-0-2 8 **14:30-16:30**

Multifidelity methods for uncertainty quantification and optimization in complex systems - Part 3

For Part 1 see: MS GH-0-2 6
For Part 2 see: MS GH-0-2 7

Organizer: Alex Gorodetsky	University of Michigan
Organizer: Michael Eldred	Sandia National Laboratories
Organizer: Gianluca Geraci	Sandia National Laboratories
Organizer: John Jakeman	Sandia National Laboratories

Abstract: Algorithms that leverage multiple simulation fidelities can significantly reduce the cost of UQ, optimization, and control problems. These so-called multi-fidelity methods exploit different discretizations, scales, and descriptions of the underlying physics to gain marked improvement in overall computational efficiency. This mini-symposium aims to bring together researchers who develop and apply these algorithms. Algorithms and applications of interest include, but are not limited to: analyzing non-hierarchical models whose relationships are not know a-priori; handling dynamical systems that provide streaming data; using multiscale hierarchies; sampling methods for variance reduction; and surrogate-based approaches that exploit special types of structure.

14:30-15:00

IGA-based Multi-Index Stochastic Collocation for random PDEs on arbitrary domains

Lorenzo Tamellini	Istituto di Matematica Applicata e Tecnologie Informatiche (CNR-IMATI)
Joakim Beck	KAUST
Raul Tempone	KAUST, RWTH Aachen

Abstract: Multi-Index Stochastic Collocation (MISC) is a method of the multi-level family, aimed at reducing costs when repeatedly solving a parametric PDE for UQ purposes by exploiting a hierarchy of discretizations. In this talk, we show how to combine MISC with Isogeometric Analysis (IGA) solvers, leveraging on their tensor-structure. IGA solvers employ splines instead of finite elements to solve PDEs, which enables simpler meshing process, exact geometry representation and high-continuity basis functions.

15:00-15:30

Advanced strategies to enhance multifidelity sampling methods for UQ

Gianluca Geraci	Sandia National Laboratories
Alex A. Gorodetsky	University of Michigan
Michael S. Eldred	Sandia National Laboratories
John D. Jakeman	Sandia National Laboratories

Abstract: Uncertainty Quantification (UQ) is a fundamental task for obtaining reliable numerical predictions. In this talk we focus on multifidelity sampling strategies which emerged as a key tool for enabling UQ of complex engineering systems. The main idea is to leverage multiple low-fidelity models in order to build efficient statistical estimators which, optimally blending low- and high-fidelity evaluations, are characterized by a reduced variance while still exhibiting a small bias

15:30-16:00

Application of MFMC for predicting the Electron Cyclotron Drift Instability using the PIC Method

Todd Oliver	University of Texas
Christopher Simmons	University of Texas at Dallas
Craig Michoski	University of Texas at Austin
Salomon Janhunen	University of Texas at Austin
Robert Moser	University of Texas at Austin

Abstract: Multifidelity Monte Carlo (MFMC) methods combine models of varying fidelity to reduce the computational cost associated with achieving a target error in forward uncertainty propagation. In this talk, we apply MFMC methods to chaotic systems. In particular, we focus on an application in plasma dynamics, the electron-cyclotron drift instability, where a particle-in-cell method is used. Effects of both finite time averaging and finite number of particles on the quantities of interest are considered.

16:00-16:30

Measure approximations for efficient constrained multi-objective optimization under uncertainty

Pietro Marco Congedo	INRIA Saclay Île-de-France
Mickael Rivier	ArianeGroup

Abstract: The SABBa framework deals with robust and reliability-based optimization problems where statistical robustness and reliability measures can be estimated with tunable fidelity. Robustness and reliability measures are approximated by a Bounding-Box, which is roughly a uniform-density representation of objectives and constraints, supplemented with a surrogate-based representation of the objective functions. We present here an extension of this approach, allowing for objects other than Bounding-Boxes. Sampling and Gaussian measure estimates are presented and quantitatively compared.

MS GH-0-1 8 14:30-16:30

Reduced-order modeling and data-driven estimation in waves and fluids - Part 2

For Part 1 see: MS GH-0-1 7
Organizer: Christina Frederick NJIT
Organizer: Yoonsang Lee Dartmouth College

Abstract: The design of multiscale approaches is a top priority in many physical applications, including ocean acoustics, where costly simulations of high-frequency wave propagation pose major difficulties, and geophysical flow, where turbulence modeling must account for spatial scales ranging from a few meters to hundreds of kilometers. Low-cost reduced-order models must be designed to include important features that can then be recovered via inversion. Despite progress within specific areas, there is a lack of unified methodology. This minisymposium addresses reduced-order modeling approaches to efficiently incorporate accurate physics and data to solve challenging inverse problems in real-world settings.

14:30-15:00

A hybrid inverse problem in the fluorescence ultrasound modulated optical tomography

Yimin Zhong University of California, Irvine

Abstract: We investigate a hybrid inverse problem in fluorescence ultrasound modulated optical tomography (fUMOT) in the diffusive regime. We prove that the boundary measurement of the photon currents allows unique and stable reconstructions of the absorption coefficient of the fluo- rophores at the excitation frequency and the quantum efficiency coefficient simultaneously, provided that some background medium parameters are known.

15:00-15:30

Minimal models of micro-swimmers in confinement

Enkeleida Lushi NJIT

Abstract: We present a new model for micro-swimmers that includes the counter-rotation of the body and flagella, as seen in motile bacteria or spermatozoa. The disturbance fluid flow of one such swimmer now contains a torque-dipole singularity in addition to the force-dipole singularity. This gives rise to clock-wise circling at no-slip walls just as observed in experiments of bacteria on surfaces. We discuss swimmer motion in various confinements and interactiion of thousands of such swimmers.

15:30-16:00

Inverse problems in underwater acoustics using local simulations of Helmholtz equations and deep learning

Christina Frederick NJIT
Zoi-Heleni Michalopolou NJIT
Soledad Villar NYU

Abstract: Recently, we developed an approach for geoacoustic inversion in underwater acoustics using a combination of localized forward modeling and deep learning. The idea is to partition environments into much smaller “template” domains, where the sediment layer can be described using a few parameters. Then simulations of Helmholtz equations on these domains are used to train a recurrent neural net (RNN) for classification of seafloor properties, such as sediment type, roughness, and layer thickness.

16:00-16:30

SUNLayer: Stable denoising with generative networks

Dustin Mixon The Ohio State University

Abstract: It has been experimentally established that deep neural networks can be used to produce good generative models for real world data. It has also been established that such generative models can be exploited to solve classical inverse problems like compressed sensing and super resolution. We propose a theoretical setting that uses spherical harmonics to identify what mathematical properties of the activation functions will allow signal denoising with local methods.

MS ME-0-6 8 14:30-16:30

The Method of Lagrangian Descriptors and its Applications

Organizer: Víctor José García Garrido Universidad de Alcalá
Organizer: Ana M Mancho ICMAT (CSIC)
Organizer: Jezabel Curbelo Universidad Autónoma de Madrid

Abstract: In recent years, Mathematics has witnessed the application of ideas from Dynamical Systems to study the implications that transport and mixing processes have in a wide range of scientific areas. Lagrangian Descriptors is a technique based on the qualitative approach envisioned by Poincaré, with the goal of recovering the template of geometrical structures that divide phase space into regions with qualitatively distinct dynamics, which govern transport mechanisms in phase space. Some applications of this tool are, for instance, the development of reliable models in Geophysics to protect the environment against pollutant dispersal, or the study of reaction dynamics in Chemistry.

14:30-15:00

The Method of Lagrangian Descriptors

Víctor José García Garrido Universidad de Alcalá

Abstract: In this talk we intrroduce the method of Lagrangian Descriptors, a diagnostic for revealing phase space in Dynamical Systems. This tool exemplifies how mathematical techniques provide powerful insights to solve relevant problems in many scientific areas such as Geophysics and Chemistry. We illustrate its potential to analyze transport with some geophysical examples, where vector fields are obtained from complex datasets, and highlight its capabilities ifor exploring high-dimensional Hamiltonian systems by means of low dimensional slices.

15:00-15:30

Perspective on the application of Lagrangian Descriptors for the location of the dividing surface in high dimensional chemical reactions.

Rafael García-Meseguer University of Bristol

Abstract: The location of the Transition State dividing surface is key for the study of chemical reactions. For 2DoF models the dividing surface is defined by a periodic orbit in the viciniti of the saddle point. What we aim for is to show how this Periodic Orbit Dividing Surface changes with the mass in a simple 2DoF model and to present how we could extend this to higher dimensional systems with the aid of Lagrangian Descriptors.

15:30-16:00

Unveiling the Chaotic Structure in Phase Space of Molecular Systems with Lagrangian Descriptors

Florentino Borondo Rodríguez Universidad Autónoma de Madrid

Abstract: We explore the feasibility of using Lagrangian descriptors, defined using p-norms which greatly enhances their power to discern among the different structures existing in the phase space, to unveil the usually rich dynamics taking place in the vibrations of molecular systems, especially if they are floppy. As an illustration we use the LiCN molecule described by realistic potentials in two and three dimensions.

16:00-16:30

A Lagrangian Description of the West African Monsoon System

Coumba Niang Université Cheikh Anta Diop
Mancho Ana Maria Instituto de Ciencias Matematicas, CSIC-UAM-UC3M-UCM
Garcia-Garrido Victor Jose Instituto de Ciencias Matematicas, UAM
Rodriguez Fonseca Belen Departamento de Fisica de la Tierra y Astrofisica, Universidad Complutense de Madrid (UCM)
Mohino Elsa Departamento de Fisica de la Tierra y Astrofisica, Universidad Complutense de Madrid (UCM)

Abstract: The WAM system is a complex 3D convective system in which the understanding of fluid parcels evolution is challenging just because of the three-dimensionality of the system. Dynamical systems tools in recent years have enabled a deep understanding of transport in geophysical flows. In this work we use dynamical systems tools to investigate into the WAM system. These tools provide a partition of the troposphere into domains.

MS ME-0-8 8 14:30-16:30

Advances in local and nonlocal PDEs - Part 1

For Part 2 see: MS ME-0-8 9
For Part 3 see: MS ME-0-8 10
Organizer: Bruno Volzone Università degli Studi di Napoli "Parthenope"

Organizer: Filomena Feo Università degli Studi di Napoli "Parthenope"

Organizer: Yanghong Huang University of Manchester

Abstract: The aim of this minisymposium is to provide a forum to discuss the recent progress on topics in the field of local and nonlocal Partial Differential Equations and their applications to physics, engineering, optimization and finance and many more. There are many interesting open questions, both theoretical and inspired by concrete applications and this is an opportunity to overview the latest developments in these directions, to exchange ideas and to have in-depth discussion that will benefit each other.

14:30-15:00

Free boundary problems of Stefan type with nonlocal diffusion

Fernando Quirós	Universidad Autónoma de Madrid
Cristina Brändle	Universidad Carlos III de Madrid
Emmanuel Chasseigne	Universidad de Tours
Carmen Cortázar	Pontificia Universidad Católica de Chile
Noemí Wolanski	Universidad de Buenos Aires

Abstract: We consider two models of Stefan type with nonlocal diffusion having very different behaviours. The first one corresponds to the classical formulation of the local Stefan problem, and its solutions have a sharp interface between the solid and the liquid phases. On the contrary, the second one, which corresponds to the enthalpy formulation of the local problema, develops mushy regions, in which the material is neither in the solid phase, nor in the liquid one.

15:00-15:30

The filtration equation on Euclidean domains: the case of a two-power behavior

Matteo Muratori Politecnico di Milano

Abstract: We consider the nonlinear diffusion equation $ut=\Delta\varphi(u)$ on Euclidean domains, with homogeneous Neumann boundary conditions. Here $\varphi'(u)$ is nonnegative and bounded from below by $|u|m1-1$ for small u and by $|u|m2-1$ for large u, both exponents m1 and m2 being larger than one. We establish sharp short and long time $L\infty$ smoothing estimates. Similar issues have widely been investigated in the porous medium case m1=m2, and this work extends previous results in many directions.

15:30-16:00

Spectral properties of the fractional Fokker-Planck operator

Yanghong Huang University of Manchester

Abstract: In this talk, the spectral properties of the fractional Fokker-Planck operator, associated with the fractional heat equation, will be discussed. Different from its classical counterparts with the Laplace operator, the eigenfunctions in higher dimensions are no longer tensor products, but are more convenient written as the product of radial functions multiplied by spherical polynomials. Those properties of these radial functions as speical types of Fox's H function will be studied.

16:00-16:30

Modelling of complex dynamical network: from agent-based to continuum models

Diane Peurichard INRIA

Abstract: We derive kinetic and macroscopic models from agent-based models for complex dynamical networks. The model features particles having the ability to link/unlink with their close neighbors by repulsion. In the large scale limit, we obtain an aggregation diffusion equation which match the limiting behavior of the particle model. The stability analysis of the homogeneous states of the macroscopic model enable to identify precise criteria linking the aggregative capacity of the model to key model parameters.

MS GH-3-4 8 14:30-16:30

The CJK-SIAMs joint mini-symposium on Inverse Problems: Theory and Computation - Part 2

For Part 1 see: MS GH-3-4 7

Organizer: Gang Bao Zhejiang University

Organizer: Jin Keun Seo Yonsei University

Organizer: Zhiyuan Li Shandong University of Technology

Abstract: Recent advances on inverse problems that arise from various application areas will be reported. Of particular interest are inverse problems in wave propagation, fluorescence imaging, fractional diffusion, medical imaging, and computed tomography imaging. Mathematical and computational results will be discussed. The results are drawn from recent research projects funded by an ongoing international collaborative research project funded by China, Japan, and Korea.

14:30-15:00

Carleman estimate for a time-fractional advection-diffusion equation and application to an inverse problem

Xinchi Huang The University of Tokyo

Abstract: Recently introducing the time-fractional derivatives into the diffusion equation for a heterogeneous medium achieved great successes. This gives us a motivation to study the time-fractional diffusion equation (TFDE) intensively. In this talk, we consider a TFDE with first-order time derivative. With the presence of the first-order derivative, we can prove a Carleman estimate. Then we also derive the stability for an inverse source problem in terms of the Carleman estimate.

15:00-15:30

Optical medical imaging in the radiative transport regime

Manabu Machida Hamamatsu University School of Medicine

Abstract: Inverse problems in medical imaging with near-infrared light have been intensively studied. In particular, the importance of optical medical imaging in the intermediate region has been recognized, for example, for thyroid cancer. In this mesoscopic regime, light obeys the radiative transport equation. In this talk, I will consider an inverse problem of determining coefficients in the radiative tranport equation from boundary measurements.

15:30-16:00

A learning-based method for solving ill-posed nonlinear inverse problems: a simulation study of Lung EIT

Kang Chul Kim	Yonsei University
Jin Keun Seo	Yonsei University
Arigungerel Jargal	Yonsei University
Kyunghun Lee	Yonsei University
Bastian Harrach	Goethe University Frankfurt

Abstract: This paper proposes a new approach using variational autoencoder(VAE) for solving ill-posed nonlinear inverse problems. The proposed approach is explained using the example of lung electrical impedance tomography. The proposed method's paradigm is completely different from conventional approaches (penalty-based regularization methods); the proposed reconstruction uses a variety of training data sets to generate a low dimensional manifold of approximate solutions, which allows to convert the ill-posed problem to a well-posed one.

16:00-16:30

Framelet-pooling aided deep learning method for ill-posed inverse problems in medical imaging

Chang Min Hyun Yonsei university

Abstract: In this talk, we introduce a framelet-pooling aided deep learning method for ill-posed inverse problems in medical imaging such as undersampled CT and MRI. The method is designed to deal with the lack of training data, the curse of dimensionality problem, and the generalization issue. The key idea of the proposed method is to decompose high dimensional data to low dimensional components by analytic filters with preserving detailed information of original data.

MS A6-2-2 8 14:30-16:30

Eigenvalue problems: perturbation and structure preservation - Part 2

For Part 1 see: MS A6-2-2 7

Organizer: Julio Moro Universidad Carlos III de Madrid

Organizer: Christian Mehl TU Berlin

Abstract: Structure-preserving eigenvalue algorithms are a common tool in numerical practice, since they often speed up computations, are potentially more accurate, and usually produce computed quantities reflecting more intrinsically the specific properties of the underlying matrix structure. Analyzing such algorithms requires a corresponding perturbation theory, describing the behavior of eigenvalues under structure-preserving perturbations. Sometimes such a theory is tricky to derive, due to classical perturbation theory clashing with the specific spectral properties of the structure under examination. The goal of this minisymposium is to report recent developments on both structure preservation and perturbation theory, either separately, or interacting with each other.

14:30-15:00

Solving singular eigenvalueproblems with rank completing perturbations

Christian Mehl TU Berlin
Michiel Hochstenbach
Bor Plestenjak

Abstract: An algorithm for the computation of the eigenvalues of the regular part of a square singular pencil is developed. The main idea is to apply a perturbation that completes the rank of the pencil to full normal rank. The eigenvalues of the singular pencil are then also eigenvalues of the perturbed regular pencil. It is further shown how the desired eigenvalues can be identified using orthogonality relations of the corresponding eigenvectors.

15:00-15:30

Computing a nearest Hermitian definite pencil

Emre Mengi Koc University
Fatih Kangal Koc University

Abstract: A definite Hermitian pencil L(λ)=A-λB can be transformed into another T(λ)=C-λD where C is Hermitian, D is Hermitian positive definite. The eigenvalues of the latter pencil can be computed accurately and efficiently. We describe efficient ways to check whether a pencil is definite, if not, ways to obtain a nearest definite pencil. Central to our approach are nonsmooth, nonconvex eigenvalue optimization characterizations of the definiteness problems for which we present globally convergent numerical techniques.

15:30-16:00

Nearness problems for LTI systems using port-Hamiltonian systems

Punit Sharma Indian Institute of Technology Delhi

Abstract: In this talk, I will explain our ideas on the problem of computing the distance to stability for LTI systems. By making use of port-Hamiltonian systems, we define the DH matrix. We will show that a system is stable if and only if its state matrix is a DH matrix. These ideas can also be generalized for standard and descriptor discrete-time LTI systems.

16:00-16:30

Nearest matrix with repelled Jordan structure

Gorka Armentia Universidad del País Vasco UPV/EHU

Juan-Miguel Gracia Universidad del País Vasco UPV/EHU

Francisco Enrique Velasco Universidad del País Vasco UPV/EHU

Abstract: Let and let be the subset of matrices of whose Jordan structure is repelled by . We want to solve where denotes the spectral norm. We will explain the meaning of the terms Jordan structure and repelled. We will use the perturbation theory for the Jordan canonical form of matrices. A particular case is Wilkinson's Problem, solved by Malyshev.

MS A1-2-4 8 14:30-16:30

Asynchronous Iterative Methods - Part 2

For Part 1 see: MS A1-2-4 6
Organizer: Christian Glusa Sandia National Laboratories
Organizer: Frederic Magoulès CentraleSupelec

Abstract: Classical synchronous iterative methods alternate between local computation and boundary data exchange. In asynchronous iterative methods this dependency is relaxed and processing units are allowed to use whatever data is available at the beginning of a computation phase. Originally called `Chaotic Relaxation' for fixed-point iterations, asynchronous iterative methods are used in various areas of high-performance computing and numerical optimization. In this minisymposium, recent research is presented both on the theory and implementation of asynchronous iterative methods.

14:30-15:00

Algebraic View of Asynchronous Optimized Schwarz Methods

Daniel B. Szyld Temple University
Mireille El Haddad Saint Joseph University, Beirut
Fr\'ederic Magoul\'es CentraleSupelec, Paris

Abstract: Optimized Schwarz methods (OSM) are based on domain decomposition where the transmission conditions on the artificial interfaces are of Robin type, i.e., with a parameter which can be optimized. We discuss new proofs of convergence of an asynchronous version of OSM which are completely algebraic, that is, they apply to matrices which may or may not come from discretizations of differential equations. We assume optimal transmission conditions on the artificial interfaces.

15:00-15:30

Asynchronous preconditioner for nonlinear problem

Tromeur-Dervout Damien Université de Lyon

Abstract: We extend a numerical strategy based on asynchronous communications to partially update the preconditioning (Berenguer&Al2015) by the Sparse-Aitken-Schwarz domain decomposition method of the jacobian matrix involved in the solving of nonlinear problems with the Newton algorithm. Indeed, only an approximation of the Jacobian is necessary for preconditioning and therefore the local inverse matrices associated with certain subdomains in the Schwarz can be updated in a client-server approach with additional processors dedicated to this task.

15:30-16:00

Asynchronous One-Level and Two-Level Domain Decomposition Solvers

Christian Glusa Sandia National Laboratories

Abstract: Linear iterative solvers generally alternate between phases of data exchange and phases of local computation. Increasingly large problem sizes on more heterogeneous systems make load balancing and network layout very challenging tasks. We explore the use of an asynchronous scalable two-level domain decomposition solvers based on one-sided MPI primitives. We will discuss practical issues encountered in the development of a scalable solver and show experimental results obtained on a variety of state-of-the-art supercomputer systems.

MS A3-2-3 8 14:30-16:30

Modeling and simulation of microwave/RF heating: applications and challenges

Organizer: María Cruz Navarro Universidad de Castilla-La Mancha
Organizer: Laura Campañone CIDCA (CONICET)

Abstract: Microwave irradiation is a non-conventional energy source whose popularity and applications have increased in the last decades. It offers several advantages over conventional heating such as a rapid deep-inside heating. The applications of microwave heating and also radio frequency (RF) heating are extensive, from food technology to cancer therapies. Numerical investigation on microwave/RF heating permits a full spatio-temporal description of temperature in the sample and stands as an important tool for prediction. In this minisymposium we will address the mathematical modeling of microwave/RF heating in food technology, numerical techniques for microwave heating of liquids, and simulation of microwave tumor ablation.

14:30-15:00

Microwave heating of liquid samples: A spectral numerical model

María Cruz Navarro Lérida University of Castilla- La Mancha
Ángel Díaz-Ortiz Universidad de Castilla-La Mancha
Pilar Prieto Universidad de Castilla-La Mancha
Antonio De La Hoz Universidad de Castilla-La Mancha

Abstract: We report a new mathematical multi-dimensional model, based on spectral methods and using a second order time discretization scheme, to simulate radial microwave heating of liquids, coupling electromagnetism with fluid flow and convective heat transfer in a cylindrical vessel. The model includes the temperature dependence of the dielectric properties. Results are supported by experiments in a monomode microwave reactor. The solvents chosen are water and ethanol, used frequently for extraction and chemical synthesis.

15:00-15:30

Microwave applications in food technology: Mathematical modeling

Laura Analía Campañone CIDCA (CONITEC)

Abstract: The objective of the present talk is to put in relevance the experimental and theoretical studies of the mass and energy transfer during the heating and dehydration of foodstuffs. Various types of systems will be addressed. Computational modeling will show the use of simplifications (Lambert's Law) as well as more complex models, which consider Maxwell's laws. The coupled balances can be solved using the Crank Nicolson method and by using the commercial software COMSOL Multiphysics.

15:30-16:00

Microwave tumor ablation: Simulation and computer-aided design

Christopher Brace University of Wisconsin -- Madison

Abstract: Microwave thermal ablation is a clinical tool for treating focal tumors in the abdomen and chest. Current tools are clinically useful, but lack in predictability, precision and consistency of treatment effect. This presentation will outline recent advances and ongoing efforts to improve existing therapies by: modeling the relevant physical properties of tissue, generating property maps with medical imaging to develop personalized treatment plans, and optimizing treatment parameters and devices through numerical simulation.

MS FT-2-1 8 14:30-16:30

Recent developments in numerical analysis of integral and integro-differential equations - Part 2

For Part 1 see: MS FT-2-1 7

For Part 3 see: MS FT-2-1 9

For Part 4 see: MS FT-2-1 10

Organizer: Qiumei Huang Beijing University of Technology

Organizer: Hermann Brunner Hong Kong Baptist University

Abstract: Since integral equations, integro-differential equations and related functional equations with various types of delays play an important role as mathematical models in science, engineering and finance, recent years have seen major developments in the design and analysis of efficient numerical methods for such equations. It is the aim of this minisymposium to bring together leading experts in these fields, in order to describe recent achievements and further communication between numerical analysts and computational scientists working on these problems.

14:30-15:00

On C −algebra techniques in the numerical solution of singular integral equations

Peter Junghanns Chemnitz University of Technology

Robert Kaiser Chemnitz University of Technology

Abstract: The numerical analysis of Cauchy singular integral equations, arising, for example, in airfoil theory and elasticity theory, has a long history. Originally, the so-called classical collocation method was restricted to equations with constant coefficients. In this talk we describe one way to generalize the classical collocation method to equations with variable coefficients and with additional Mellin convolution operators and give necessary and sufficient conditions for the applicability of the proposed methods.

15:00-15:30

On discontinuous Galerkin methods and continuous Galerkin methods for second-kind Volterra integral equations

Hui Liang Harbin Institute of Technology, Shenzhen

Abstract: The discontinuous Galerkin (DG) and continuous Galerkin (CG) methods are employed respectively, to solve second-kind Volterra integral equations. The convergence for both of these two numerical methods are investigated. We show that the quadrature DG method based on piecewise polynomials of degree $m-1$ and uses exactly m quadrature points and nonzero quadrature weights, is equivalent to a discontinuous collocation method. However, the quadrature CG method is equivalent to a continuous collocation method.

15:30-16:00

Multilevel Augmentation methods for eigen-problems of compact integral operators

Guangqing Long Nanning Normal University of P.R.CHINA

Abstract: We develop a multilevel augmentation method for solving eigen-problem of compact integral operators with smooth kernels. The method first need to solve an eigen-prolem in a suitable initial coarse level and then seek a more accurate approximation from solving a linear system on a finer mesh. Moreover, we need only to deal with a small linear system corresponding to the initial coarse level when we solve the linear system on a finer mesh.

MS FE-1-1 8 14:30-16:30

Advances in Fractional Differential Equations: Discretization Methods and Efficient Solvers

Organizer: Mariarosa Mazza University of Insubria

Organizer: Fabio Durastante University of Pisa

MS Organized by: SIAG/LA

Abstract: Fractional Partial Differential Equations (FPDEs) are a generalization of the classical Partial Differential Equations (PDEs) obtained replacing standard derivatives with fractional ones. Their recent success is notably due to the non-local behavior of fractional differential operators that translates in an appropriate modeling of anomalous phenomena appearing in several applicative fields, like plasma physics or electrophysiology. The improved physical description, however, makes FPDEs computationally more demanding than standard PDEs. The aim of this minisymposium is to promote exchanges between researchers working on discretization methods and numerical linear algebra strategies tailored for FDEs, and to brainstorm on possible developments in these areas.

14:30-15:00

A Numerical Perspective on Fractional Differential Equations

Fabio Durastante University of Pisa

Daniele Bertaccini University of Rome Tor Vergata

Abstract: A wide number of numerical linear algebra problems arise when treating discretized fractional differential equations, e.g., the solution of dense linear systems, the computation of matrix equations, and of matrix functions. I will briefly review some of them for introducing a tensor structured preconditioner for the tensor train GMRES algorithm in the case of all–at–once formulations of FPDEs.

15:00-15:30

Numerical approximations of the fractional Laplacian on bounded domains via the method of semigroups.

Luca Gerardo-Giorda BCAM-BASQUE CENTER FOR APPLIED MATHEMATICS

Nicole Cusimano BCAM - Basque Center for Applied Mathematics

Felix Del Teso BCAM - Basque Center for Applied Mathematics

Gianni Pagnini BCAM - Basque Center for Applied Mathematics

Abstract: We propose novel discretizations of the spectral fractional Laplacian and a new approach to the solution of the corresponding fractional elliptic problem on bounded domains through the operator integral formulation and the method of semigroups. Combining finite elements for the heat semigroup with monotone quadratures for the considered singular integrals we obtain accurate numerical approximations. Our method can be implemented on possibly irregular bounded domains and can naturally handle different types of boundary constraints.

15:30-16:00

Symmetrization and the solution of linear systems arising from fractional diffusion problems

Jennifer Pestana University of Strathclyde

Abstract: Fractional diffusion equations are increasingly used in applications. Discretising these equations by shifted Grünwald-Letnikov finite difference approximations on uniform meshes lead to Toeplitz, block Toeplitz, and related matrices, all of which may be nonsymmetric. In this talk we will discuss how to symmetrize these nonsymmetric matrices, and the benefits of doing so. We will also propose preconditioning strategies for the symmetrized problems.

16:00-16:30

Rational Krylov methods for fractional diffusion problems

Stefano Massei EPF Lausanne

Leonardo Robol University of Pisa

Abstract: This work is concerned with the use and the convergence analysis of the Rational Krylov projection method for solving 2D fractional diffusion equations discretized by using the so-called matrix-transfer-technique. In particular, we show how this problem is linked to linear matrix equations and how this connection allows to prove upper bounds for the error decay of the method.

MS FE-1-4 8 14:30-16:30

Multiscale analysis and numerical methods for oscillatory PDEs - Part 4

For Part 1 see: MS FE-1-4 5

For Part 2 see: MS FE-1-4 6

For Part 3 see: MS FE-1-4 7

Organizer: Yongyong Cai Beijing Computational Science Research Center
Organizer: Hanquan Wang Yunnan University of Finance and Economics
Organizer: Carles Remi CNRS & Univ Rennes

Abstract: Oscillatory behaviors are ubiquitous in nature and arise in different disciplines, such as semiclassical limits of Schroedinger equations in computational chemistry, nonrelativistic limit of Klein-Gordon equation in particle physics, subsonic limits of Zakharov system in plasma physics, Vlasov-Poisson equation with strong magnetic field, Boltzmann equation in the diffusion limit, etc. These oscillatory PDEs typically involve two or more different temporal/spatial scales, where multiscale analysis has been playing an important role. This mini-symposium aims to bring experts together to exchange and discuss recent progresses on analysis and numerical methods in this area, and to identify future research directions with possible collabrations.

14:30-15:00

Uniformly accurate methods for the nonlinear Dirac equation in the non-relativistic limit regime

Yan Wang Central China Normal University

Abstract: In this talk, we present two kinds of uniformly accurate methods for the nonlinear Dirac equation in the non-relativistic limit regime: the multiscale time integrator and the nested Picard iterative integrator. Both could capture the high temporal oscillation without any restriction to the mesh size or time step.

15:00-15:30

Super-resolution of time-splitting methods for the Dirac equation in the nonrelativistic limit regime

Jia Yin National University of Singapore
Weizhu Bao National University of Singapore
Yongyong Cai Beijing Computational Science Research Center

Abstract: Error bounds of the Lie-Trotter (S1) and Strang splitting (S2) for the Dirac equation in the nonrelativistic limit regime are established. The splitting methods exhibit super-resolution. S1 shows 1/2 order convergence uniformly with respect to ε. If τ is non-resonant, S1 would yield uniform first order error bound. S2 is uniformly convergent with 1/2 order and under non-resonant time step size, it is improved to 3/2 order. Numerical examples are reported to validate our findings.

15:30-16:00

Long time error analysis of finite difference time domain methods for the nonlinear Klein-Gordon equation with weak nonlinearity

Yue Feng National University of Singapore
Weizhu Bao National University of Singapore
Wenfan Yi Hunan University

Abstract: We establish error bounds of the finite difference time domain (FDTD) methods for the long time dynamics of the nonlinear Klein-Gordon equation (NKGE) with a cubic nonlinearity characterized by ε^2 with $0 < \varepsilon \leq 1$ a dimensionless parameter.Four different FDTD methods are adapted to discretize the problem and rigorous error bounds of the FDTD methods are established for the long time dynamics up to the time at $O(1/\varepsilon^{\beta})$ with $0 \leq \beta \leq 2$.

16:00-16:30

Numerical methods for nonlinear Schrodinger equation with wave operator

Yichen Guo National University of Singapore

Abstract: We present an uniformly second order accruate nested Picard iterative interator to solve nonlinear Schrodinger equation with wave operator with a parameter . The solution to this equations oscillates with wavelength. We rigorously prove the error bounds for the NPI for both well-prepared and ill-prepared case and present an explanation for some numerical result showing higher convergence order.

MS A3-3-3 8 14:30-16:30

Uncertainty quantification in imaging - Part 2

For Part 1 see: MS A3-3-3 7
Organizer: Tanja Tarvainen University of Eastern Finland
Organizer: Tapio Helin LUT University
Organizer: Nuutti Hyvönen Aalto University

Abstract: Many problems in inverse problems and imaging are affected by uncertainties appearing in mathematical models or experimental measurements. These factors can be quantitatively characterised and analysed using methods of uncertainty quantification. This minisymposium brings together presentations which review inverse problems from the standpoint of uncertainty quantification, develop computational tools for tackling Bayesian inverse problems, and introduce new stochastic concepts suitable for the study of inverse problems in imaging. The applications include, but are not limited to, medical tomography, remote sensing and non-destructive testing.

14:30-15:00

Optimal projection angles in X-ray tomography

Juha-Pekka Puska Aalto University

Abstract: This talk considers (sequential) optimization of projection angles in (parallel beam) X-ray tomography. Assuming additive Gaussian noise model and Gaussian prior, the next projection angle is chosen based on the A or D optimality condition of Bayesian experimental design. In other words, either the determinant or the trace of the posterior covariance matrix after the projection is minimized. The optimization process can be carried out before the measurements based only on the available prior information.

15:00-15:30

Distance measures for Learning and Bayesian Inversion

Martin Burger FAU Erlangen-Nürnberg

Abstract: In this talk we discuss some aspects of Bregman and optimal transport distances for quantifying errors in Bayesian inverse problems and generalization errors in deep learning.

15:30-16:00

Inverse random source problems for time-harmonic acoustic and elastic waves

Jianlian Li Changsha University of Science & Technology
Tapio Helin Department of Mathematics and Statistics, University of Helsinki
Peijun Li Department of Mathematics, Purdue University

Abstract: We concern the random source problems for the time-harmonic acoustic and elastic wave equations. The source is assumed to be a microlocally isotropic generalized Gaussian random function such that its covariance operator is a classical pseudo-differential operator. For the inverse problem, we demonstrate that the amplitude of the scattering field averaged over the frequency band, obtained from a single realization of the random source, determines uniquely the principle symbol of the covariance operator.

16:00-16:30

Non-linear difference imaging

Aku Seppänen University of Eastern Finland

Abstract: Tomographic imaging often yields ill-posed inverse problems; their solutions are intolerant to modeling errors. For time-varying targets, it is sometimes possible to utilize measurements before and after changes, using difference imaging. This approach can reduce effects of modeling errors. However, reconstructions are often qualitative only, due to global linearizations of models. This talk focuses on an alternative approach: non-linear difference imaging. We demonstrate its ability to reconstruct changes quantitatively, and its tolerance to modeling errors.

CP A1-3-4 8 14:30-16:30

Numerical Analysis XVI

Chair Person: Adriano De Cezaro Federal University of Rio Grande

CP A1-3-4 8 1 14:30-14:50

On level set regularization approaches for inverse problems

Adriano De Cezaro Federal University of Rio Grande

Abstract: We discuss level set regularization approaches for the identification of piecewise constant parameters for inverse problems. The so-called standard level set regularization approach, for with the level set function is assumed to be smooth. A piecewise constant level set approach, for with we present the regularization properties for approximated solutions using an augmented Lagrangian formulation. We compare the performance of the proposed regularization approaches for the simultaneous coefficient identification in optical diffusion tomography.

CP A1-3-4 8 2 14:50-15:10

Full-wave simulation using domain decomposition

Daadaa Rihab Université de Lorraine

Abstract: In this communication we will present a non-overlapping numerical domain decomposition method for the full-wave simulation of lower hybrid electromagnetic wave propagation in plasma. A time harmonic approximation of the Maxwell equations is considered. A mixed augmented variational formulation is considered to handle divergence constraint and interface conditions. The P2-P1 Taylor-Hood finite element is used for numerical discretization. Theoretical and discrete Inf-Sup condition are proved. Several examples are presented for different wave frequencies.

CP A1-3-4 8 3 **15:10-15:30**

GPBi-CGstab(L): a Lanczos-type product method unifying Bi-CGstab(L) and GPBi-CG

Kensuke Aihara	Tokyo City University

Abstract: Bi-CGstab(L) and GPBi-CG are effective iterative solvers for linear systems. They are different generalizations of Bi-CGSTAB with different stabilizing polynomials. We propose GPBi-CGstab(L) that combines Bi-CGstab(L) and GPBi-CG. The new method uses comprehensive stabilizing polynomials with L+1 parameters: it is equivalent to Bi-CGstab(L) when one parameter is selected to 0, and it simplifies to GPBi-CG when L=1. Numerical experiments show the effectiveness of GPBi-CGstab(L) with the parameters determined to minimize the residual at each iteration.

CP A1-3-4 8 4 **15:30-15:50**

Fast computation of orthogonal systems with a skew-symmetric differentiation matrix

Arieh Iserles	University of Cambridge
Marcus Webb	KU Leuven

Abstract: In spectral methods for time-evolving PDEs on the real line, Hermite functions have a skew-symmetric, tridiagonal differentiation matrix --- which is advantageous for stability and energy conservation. In this talk, I will discuss joint work with Arieh Iserles (Cambridge) on some novel orthogonal bases on the real line, which also have skew-symmetric, tridiagonal differentiation matrices, but with the extra property that expansion coefficients can be computed using fast FFT-based orthogonal polynomial transforms.

CP A1-3-4 8 5 **15:50-16:10**

Greedy Selection in Kaczmarz-Type Methods

Jamie Haddock	UCLA
Deanna Needell	UCLA
Anna Ma	UCSD

Abstract: Stochastic iterative algorithms have gained recent interest for solving large-scale systems of equations, Ax=y. One such example is the Randomized Kaczmarz (RK) algorithm, which acts only on single rows of the matrix A at a time. While RK randomly selects a row, Motzkin's algorithm employs a greedy row selection; the Sampling Kaczmarz-Motzkin (SKM) algorithm combines these two strategies. In this talk, we present a convergence analysis for SKM which interpolates between RK and Motzkin's algorithm.

CP A1-3-4 8 6 **16:10-16:30**

Inner-iteration preconditioned block GMRES for least squares problems with multiple right-hand sides

ZEYU LIAO	SOKENDAI
HAYAMI KEN	SOKENDAI

Abstract: Consider using block GMRES to solve least squares problems with multiple right-hand sides. This generates the Krylov subspace and updates the QR decomposition for the Hessenburg matrix block-wise. In order to reduce number of iterations and CPU time, we propose combining block GMRES with block-wise inner iteration preconditioning. Numerical experiments show that the proposed method is efficient.

CP FT-S-4 8 14:30-16:30

Control and Systems Theory II

Chair Person: Karim Cherifi	Institute of electrical and electronic engineering (IGEE)

CP FT-S-4 8 1 **14:30-14:50**

Minimal Realization of Port Hamiltonian systems from input/output time domain data

Karim Cherifi	Institute of electrical and electronic engineering (IGEE)
Volker Mehrmann	TU Berlin

Abstract: Port Hamiltonian systems have been studied extensively during recent years as they exhibit a special structure. In order for these representations to be used widely, one has to be able to represent industrial systems in this form in an automatic way. The method we introduce, computes the port Hamiltonian minimal realization directly from time domain input/output data of the system. The method was implemented in software and tested for large scale systems.

CP FT-S-4 8 2 **14:50-15:10**

State Reconstruction of Gas Networks

Nadine Stahl	Trier University
Nicole Marheineke	University Trier

Abstract: In this talk, we focus on state reconstruction of gas networks. Here, difficulties due to nonlinearities and algebraic constraints as well as stochastic boundary conditions, which are introduced to better reflect realistic conditions, arise. To improve performance, we apply the filtering algorithm onto a reduced model which we achieve by model order reduction techniques. We investigate the resulting quality of the reconstructed state with respect to the achieved performance.

CP FT-S-4 8 3 **15:10-15:30**

Approximation of damped quadratic eigenvalue problem by dimension reduction

Matea Puvaca	University of Osijek
Ninoslav Truhar	University of Osijek
Zoran Tomljanović	University of Osijek

Abstract: This paper presents an approach to the efficient calculation of all or just one important part of the eigenvalues of the parameter dependent quadratic eigenvalue problem. With the new approach one can efficiently calculate eigenvalues even for the case when the parameters are of the modest magnitude. We derive two types of approximations with corresponding error bounds. Obtained results can be used in calculation of approximation of optimal contol for damped systems.

CP FT-S-4 8 4 **15:30-15:50**

Ellipsoidal Estimates of Reachable Sets for a Class of Nonlinear Control Systems

Tatiana Filippova	Krasovskii Institute of Mathematics and Mechanics, Russian Academy of Sciences

Abstract: The state estimation problems for control systems with unknown but bounded uncertainties are studied. The researches are motivated by control theory and applications e.g. related to satellite control problems with nonlinearity and disturbances. We consider a case, when the dynamical equations contain the quadratic nonlinearity and containt also an uncertain matrix. The main result consists in deriving the equations which describe the dynamics of ellipsoidal estimates of reachable sets of the control system under study.

CP FT-S-3 8 14:30-16:30

Linear Algebra and Geometry II

Chair Person: Biswajit Das	Indian Institute of Technology Guwahati

CP FT-S-3 8 1 **14:30-14:50**

Distance to a Nearest Matrix Polynomial Having a Specified Elementary Divisor at Zero.

Biswajit Das	Indian Institute of Technology Guwahati
Shreemayee Bora	Indian Institute of Technology Guwahati

Abstract: For a given regular matrix polynomial P(z) and a positive integer r, we consider the problem of finding the distance from P(z) to a nearest matrix polynomial having elementary divisor zj, j≥r, with respect to a prespecified norm. Such problems have been studied in the literature mostly for the case that only the constant coefficient of P(z) is perturbed. We characterize the distance in terms of an optimization problem and obtain bounds on the distance.

CP FT-S-3 8 2 **14:50-15:10**

A Min-Plus Analogue of Jordan Canonical Forms

Yuki Nishida	Doshisha University
Kohei Sato	National Institute of Technology, Oyama College
Sennosuke Watanabe	National Institute of Technology, Oyama College

Abstract: Min-Plus algebra is a semiring with two operations: addition “min” and multiplication “+”. We propose a Min-Plus analogue of matrix diagonalization. Unlike in conventional algebra, a generic Min-Plus square matrix has smaller numbers of eigenvalues and eigenvectors than its size. So we use the eigenvectors of the powers of the given matrix instead of the eigenvectors of the original one, which is similar to the construction of Jordan canonical forms of conventional matrices.

CP FT-S-3 8 3 **15:10-15:30**

A min-plus analogue of the qd algorithm and its generalization

Akiko Fukuda	Shibaura Institute of Technology
Sennosuke Watanabe	National Institute of Technology, Oyama College
Masafumi Kan	Shibaura Institute of Technology

Abstract: The discrete Toda equation is known as the recursion formula of the qd (quotient difference) algorithm for computing eigenvalues of tridiagonal matrices. Ultradiscretization, which is also known as the tropicalization, of the discrete Toda equation yields the ultradiscrete Toda equation. In this talk, we give an ultradiscrete analogue of the qd algorithm for tridiagonal matrices over the min-plus algebra. We also discuss a generalization of the ultradiscrete Toda equation and its related eigenvalue algorithm.

CP FT-S-3 8 4 **15:30-15:50**

On Eigenvalue Bounds for the Finite-State Birth-Death Process Intensity Matrix

Renzo Tan	Ateneo de Manila University
Len Garces	University of South Australia

Abstract: The paper sets forth a novel eigenvalue interlacing property across the general finite-state birth-death process intensity matrix and two clearly identified submatrices as an extension of Cauchy’s Interlace Theorem for Hermitian matrix eigenvalues. The supplemental proof involves an examination of probabilities acquired from specific movements across states and a derivation of a form for the eigenpolynomial of the matrix through convolution and Laplace transform. Consequently, the proposition generates bounds for each eigenvalue, easing numerical computation.

CP FT-S-3 8 5 **15:50-16:10**

Structural stability of matrix pencils under strict equivalence and of matrix pairs under contragredient equivalence

Tetiana Klymchuk	Universitat Politècnica de Catalunya
Maria Isabel Garcia Planas	Universitat Politècnica de Catalunya

Abstract: Let P = A−λB be a complex matrix pencil. We prove that all pencils in some neighborhood of P are strictly equivalent to P if and only if there is a natural number r such that the Kronecker canonical form of P or PT is a direct sum of canonical summands of sizes (r−1)*r and, possibly, r*(r+1). This fact is important if P is known only approximately; for example, if it is derived from measurements.

CP A1-3-2 8 **14:30-16:30**

General II

Chair Person: Sakthivel Kumarasamy	Indian Institute of Space Science and Technology

CP A1-3-2 8 1 **14:30-14:50**

Ergodicity of Stochastic Navier-Stokes Equations with Levy Noise

Sakthivel Kumarasamy	Indian Institute of Space Science and Technology
Manil Mohan	Indian Institute of Technology
Sivaguru Sritharan	Air Force Institute of Technology

Abstract: In this talk, we discuss the ergodic properties of 3D stochastic Navier-Stokes equations (SNSE) with Levy noise. The study of this model is motivated by the practical engineering scenario where the flow field is subjected to structural and environmental disturbances. Since we are considering 3D SNSE, we first construct a Markov family of martingale solutions. It is then used to obtain the existence of a unique invariant measure, which is ergodic and strongly mixing.

CP A1-3-2 8 2 **14:50-15:10**

Study of a simple 3D quadratic system with homoclinic flip bifurcations of inward twist case Cin.

Antonio Algaba Durán	Centro de Estudios Avanzados en Física, Matemática y Computación, Universidad de Huelva
M. Cinta Domínguez-Moreno	Centro de Estudios Avanzados en Física, Matemática y Computación, Universidad de Huelva
Manuel Merino Morlesín	Centro de Estudios Avanzados en Física, Matemática y Computación, Universidad de Huelva
Alejandro J. Rodríguez-Luis	E.T.S. de Ingeniería, Universidad de Sevilla

Abstract: We consider a quadratic two-parameter family of vector fields. From the information obtained in the analysis of the Hopf bifurcation of its only equilibrium, and by means of methods of numerical continuation, saddle-node of periodic orbits, period-doubling bifurcations as well as homoclinic connections appear. As far as we know, it is the first example of a 3D vector field exhibiting a homoclinic flip bifurcation of case inward twist Cin.

CP A1-3-2 8 3 **15:10-15:30**

Stability and oscillations of multistage SIS models depend on the number of stages

Gergely Röst	University of Szeged
Tamás Tekeli	University of Szeged

Abstract: We consider multistage SIS models of infectious diseases with multiple infectious stages. We calculate the basic reproduction number R_0 and prove that the disease dies out for R_0 <= 1, while a unique endemic equilibrium exists for R_0 >1. Our main result is that the endemic equilibrium is always stable when n <= 3, while for n>3, stability switches and oscillations are possible. We show that endemic bubbles may emerge in the global bifurcation diagram.

CP A1-3-2 8 4 **15:30-15:50**

Toward Nanopteron Traveling Waves in Mass-in-Mass Lattices in the Small Mass Limit

Timothy Faver	Leiden University

Abstract: The mass-in-mass (MiM) lattice is a granular metamaterial consisting of an infinite chain of identical particles that are both nonlinearly coupled to their nearest neighbors and linearly coupled to a distinct resonator particle. We study traveling waves in the MiM lattice as the mass of the resonator goes to zero. In this limit, we construct nanopterons, which are the superposition of exact periodic traveling waves and an exponentially localized remainder.

CP A1-3-2 8 5 **15:50-16:10**

Double Diffusive Convection in a Couple Stress Fluid Saturated Porous Layer with an Internal Heat Source : An Analytical Study

SRAVAN NAYEKA GAIKWAD	Gulbarga University, Kalaburagi

Abstract: This problem is studied analytically using linear and nonlinear stability analysis. The linear analysis is based on normal mode technique and the expressions for stationary, oscillatory and finite amplitude Rayleigh number are obtained. The nonlinear analysis is based on truncated representation of Fourier series which provides quantification of heat and mass transfer. The transient behavior of Nusselt and Sherwood numbers is studied by solving numerically a fifth order Lorentz type system using Runge Kutta method.

CP A1-3-2 8 6 **16:10-16:30**

On the convergence in unilateral contact problems for linearly elastic shells: Error estimates for the elliptic membrane case

Ángel Daniel Rodríguez Arós	Universidade da Coruña
María Teresa Cao Rial	Universidade da Coruña

Abstract: We consider a family of linearly elastic shells all sharing the same middle surface, in unilateral contact with a rigid foundation on the lower face. The shells are elliptic and their lateral face is clamped. Under these conditions, when the thickness tends to zero, the solution of the three-dimensional contact problem converges to the solution of a two-dimensional obstacle problem for an elastic membrane shell. We provide error estimates for the convergence.

CP A1-3-5 8 **14:30-16:30**

Modelling with PDE

Chair Person: Haspot Boris	Université Paris Dauphine

CP A1-3-5 8 1 **14:30-14:50**

Vortex solutions for the compressible Navier-Stokes equations with general viscosity coefficients in 1D: regularizing effects or not on the density

Haspot Boris	Université Paris Dauphine

Abstract: We consider Navier-Stokes equations for compressible viscous fluids in the one-dimensional case with general viscosity coefficients. We prove the existence of global weak solution when the initial momentum belongs to the set of the finite measure and when the initial density is in the set of bounded variation functions. Furthermore we show that if the coupling between density and velocity is sufficiently strong then the initial density which admits initially shocks is instantaneously regularized.

CP A1-3-5 8 3 14:50-15:10

The well-posedness and its short-time asymptotics of the reaction-diffusion-particle model for camphor motion in two dimension

Masaharu Nagayama	Hokkaido University
Gen Nakamura	Hokkaido University
Masaaki Uesaka	Hokkaido University

Abstract: We consider the mathematical model which describes the self-propelled motion of camphor particle on the water surface in two dimension. This model consists a reaction-diffusion equation of the camphor concentration on the water surface and an ODE of the camphor motion. We establish the well-posedness of this system in two dimension. Moreover, by introducing the suitable space-time scaling, we obtain the approximate solution valid in short time.

CP A1-3-5 8 4 15:10-15:30

On a fixed point study of an inverse Cauchy problem governed by Stokes equation.

Hamid OUAISSA	University Sultan Moulay Slimane
Abdelkrim CHAKIB	University Sultan Moulay Slimane
Abdeljalil NACHAOUI	University of Nantes
Mourad NACHAOUI	University Sultan Moulay Slimane

Abstract: We interested in an inverse problem governed by Stokes equation. Inspired by domain decomposition methods, we develop a technique based on its reformulation into a fixed point one involving a Steklov like operator. We show the existence result using the topological degrees of Leray-Schauder. We propose even a fixed point algorithm. This approach offers the opportunities to exploit other DD algorithms for the resolution. Finally, We investigate the numerical approximation, using Robin-Robin algorithm and FEM.

CP A1-3-5 8 5 15:30-15:50

Patch-Wise Local Projection Stabilized NonConforming Finite Element method for Advection-reaction equation.

Deepika Garg	Indian Institute of Science Bangalore
SashiKumaar Ganesan	Indian Institute of Science
Raghurama Rao	Indian Institute of Science

Abstract: In this article, we analyze the patch-wise local projection finite element method stabilization for Advection-reaction equation. It is a composition of the standard Galerkin finite element method, the patch-wise local projection stabilization and weakly imposed Dirichlet boundary conditions on the discrete solution. We prove that the bilinear form corresponding to the method satisfies an inf-sup condition with respect to the SUPG norm and establish an optimal error estimate in this norm.

CP A1-3-5 8 6 15:50-16:10

Solving nonlinear parabolic PDEs in several dimensions

Jesus Martin-Vaquero	Universidad de Salamanca

Abstract: Many physical and industrial processes are modelized with nonlinear parabolic partial differential equations (PDEs) in several dimensions. These equations are frequently discretized in the spatial variables to transform them into very large systems of stiff ordinary differential equations (ODEs), and later we can numerically solve them. Several ideas to solve these huge stiff systems of ODEs will be described and analyzed in this presentation.

CP FT-1-8 8 14:30-16:30

Applied Mathematics for Industry and Engineering VIII

Chair Person: Georg Vossen	Niederrhein University of Applied Sciences

CP FT-1-8 8 1 14:30-14:50

Modelling and Stability Analysis of Laser Cutting via Asymptotic Expansion of Higher Orders

Georg Vossen	Niederrhein University of Applied Sciences
Dominik Itner	University of Duisburg-Essen

Abstract: A model for laser cutting describing the movements of the two melt flow boundaries will be presented. The model is an asymptotic expansion approximation of a free boundary problem resulting in a system of two nonlinear coupled PDEs. The effects of several physical phenomena such as flow convection, diffusion and surface tension on linear stability of the stationary solution will be investigated. The results are illustrated with real world data from laser cutting experiments.

CP FT-1-8 8 2 14:50-15:10

Mixed-integer programming model for waste reduction in the cutting process of a steel factory in Colombia

Daniel Morillo Torres	Pontificia Universidad Javeriana
Mauricio Torres Baena	Pontificia Universidad Javeriana
Ana Maria Maya Ochoa	Pontificia Universidad Javeriana
Sebastian Abad Campo	Pontificia Universidad Javeriana

Abstract: This project focuses on developing an exact solution approach to minimize the high waste costs of the corrugated bar cutting process at a leading steel company in Colombia. The problem is modelled as a one-dimensional cutting stock problem (1DCSP), whose objective is to find a production plan with minimum waste. The results obtained achieve a waste reduction of 80% compared to the current policy implemented by the company.

CP FT-1-8 8 3 15:10-15:30

Adaptive Routing Algorithm for Wireless Ad Hoc Networks based on Stochastic Branching Process

Hyunsun Lee	Hawaii Pacific University
Yi Zhu	Hawaii Pacific University

Abstract: We propose the Multicast Cardinality and Smart Selection (MCSS) scheme for wireless ad hoc networks, based on a modified stochastic branching process, to support data exchange in fast switching topology. A network of smart devices with different velocity is featured in our simulations to replicate more realistic communication scenarios. We aims at balancing reachability, node usage, and average branching factor in multi-hop data dissemination by locally regulating the transmission probability and adaptively selecting neighbor nodes.

CP FT-1-8 8 4 15:30-15:50

Energy Efficient Data Collection using Multiple Mobile Sinks in Wireless Sensor Networks

Vishnuvarthan Rajagopal	Anna University Regional Campus
Bhanumathi Velusamy	Anna University Regional Campus

Abstract: Energy efficient data collection is one of the major challenges in Wireless Sensor Networks (WSNs). Proposed Learning Automaton based Energy Efficient Data Collection (LA-EEDC) algorithm leverage benefits of Learning automata (LA) and Multiple Mobile Sinks (MMS). MMS solves energy-hole problem while LA uses a minimum number of nodes for forwarding data to sink. LA-EEDC ensures energy-conserving data transmission with a high packet delivery ratio, increased network lifetime, thereby increasing the quality of service significantly.

CP FT-1-8 8 5 15:50-16:10

On the modeling and simulation of melt-blowing processes for the technical textile industry

Manuel Wieland	Fraunhofer ITWM
Walter Arne	Fraunhofer ITWM
Nicole Marheineke	Universität Trier
Raimund Wegener	Fraunhofer ITWM

Abstract: Melt-blowing is a production method for fibers that is economically attractive due to low cost. In the process polymeric fiber jets are extruded into a turbulent high-speed airflow leading to a drastic thinning of the fiber diameters down to micro-/nano-scale. For this multiphase-multiscale problem we present an efficient simulation framework. We show the significance of considering an asymptotic viscoelastic jet model and incorporating turbulent effects in order to achieve realistic fiber thinning in industrial setups.

CP FT-1-8 8 6 16:10-16:30

Inverse Problem of Obtaining the Thermophysical Properties of the Solids Using the Measured Distribution of Temperature Within the System of Contacting Solids

Sergei Fomin	CSU Chico
Vladimir Chugunov	Moscow City University
Kyle Hammer	CSU Chico
Scotty Tilton	Montana State University
Fabio Capovilla-Searle	Case Western Reserve University

Abstract: A model of obtaining thermophysical properties of solids is proposed. The boundary value problem that models temperature distributions within the system of three contacting solids, which contains the inner heat source, was solved analytically. Minimizing a functional, which represents the difference between the obtained and experimentally measured temperatures, the unknown thermal conductivity and diffusivity of one of the contacting solids are obtained.

Some simplifications of this computational algorithm are proposed and validated.

CP A1-3-3 8 14:30-16:30

Education

Chair Person: Iden Rainal Ihsan Universitas Islam Nusantara

CP A1-3-3 8 1 14:30-14:50

Optimizing Students Combinatorial Thinking Skill Through Design-based Research

Iden Rainal Ihsan	Universitas Islam Nusantara
Natanael Karjanto	University College, Sungkyunkwan University, Natural Science Campus

Abstract: This study is design-based research. The first phase, analyzing the needs and context of learning activities for developing a framework of thinking. The second phases, validating the instructional design for further improvement. The third phase, providing evaluation questions to students to find out the result of the application of the design. As a result, an instructional design in counting begins with review of concept of finite sets, small group discussion, class discussion, self-reflection, and evaluation.

CP A1-3-3 8 2 14:50-15:10

Higher Education Institution and Government Partnerships to Implement In-Country Science Programmes in the Pacific Region

Bibhya Sharma	The University of the South Pacific
Swasti Narayan	The University of the South Pacific
Bijeta Kumar	The University of the South Pacific

Abstract: The In-country Science Programme model has been designed by the Science Faculty at The University of the South Pacific. The model is an innovative capacity building solution providing selected science programmes at the Pacific campuses where such programmes were not historically offered. The programme is run in partnership with regional governments and cohort of science students. The paper presents an in-depth analysis of the cohorts' performance and heralds innovative strategies for cohort based government partnerships.

CP A1-3-3 8 3 15:10-15:30

Bridging Mathematics Gaps of First Year University Students with an Online Mathematics Diagnostic Tool

Swasti Narayan	The University of the South Pacific
Bibhya Sharma	The University of the South Pacific
Vineet Singh	The University of the South Pacific

Abstract: The Online Mathematics Diagnostics Tool (OMDT) has been designed and developed at the University of the South Pacific to bridge the Mathematics gaps of the first year students who come with varying level of Mathematics from different curriculum backgrounds. The paper presents an in-depth analysis on the performance of the students in first year Mathematics Courses at the Science Faculty before and after completing the diagnstic test and discusses the effectiveness of the tool.

CP A1-3-3 8 4 15:30-15:50

Characteristics of the development of understanding of economics concepts based on the function-derivative relationship

ANGEL ARIZA	UNIVERSITY OF ALICANTE

Abstract: The development of the understanding of economics concepts which are based on the function-derivative relationship is analysed throughout a metric derived from fuzzy logic. Our results show that the transition between levels of understanding is determined by (i) the conversions between the graphic and algebraic register and (ii) the graphic interpretation of the second derivative and its calculation in the algebraic register. These results are used to validate the choice of fuzzy measures.

CP FT-4-5 8 14:30-16:30

Biology, Medicine and other natural sciences V

Chair Person: Varvara Turova Technical University of Munich

CP FT-4-5 8 1 14:30-14:50

Mathematical modeling of cerebral circulation in preterm infants

Varvara Turova	Technical University of Munich
Nikolai Botkin	Technical University of Munich
Irina Sidorenko	Technical University of Munich
Laura Eckardt	University of Duisburg-Essen
Ursula Felderhoff-Müser	University of Duisburg-Essen
Esther Rieger-Fackeldey	Technical University of Munich
Renée Lampe	Technical University of Munich

Abstract: Cerebral circulation in preterm infants has specific features, including the presence of the germinal matrix, a highly vascularized structure with fragile blood vessels, and impaired autoregulation mechanism leading to dangerous fluctuations of the cerebral blood flow. Mathematical models taking into account these peculiarities and aiding prediction and prevention of unfavorable outcomes are developed based on optimal control theory and analysis (with machine learning algorithms) of experimental clinical data collected from preterm infants.

CP FT-4-5 8 2 14:50-15:10

Bayesian reconstruction of optical parameters and their reliability in quantitative photoacoustic tomography

Niko Hänninen	University of Eastern Finland
Aki Pulkkinen	University of Eastern Finland
Tanja Tarvainen	University of Eastern Finland

Abstract: Quantitative photoacoustic tomography is a hybrid imaging modality in which the aim is to estimate optical parameter distributions inside a domain from initial pressure distribution induced by an externally introduced light pulse. In this work, this problem is approached in a Bayesian framework. We study the reliability of the estimates and utilize the Bayesian approximation error method to compensate for modeling errors in the forward model. The approach is tested with numerical simulations.

CP FT-4-5 8 3 15:10-15:30

Approximate marginalization of an unknown speed of sound in photoacoustic tomography

Jenni Tick	University of Eastern Finland
Aki Pulkkinen	University of Eastern Finland
Tanja Tarvainen	University of Eastern Finland

Abstract: In photoacoustic tomography, an initial acoustic pressure distribution created by an externally introduced light pulse is reconstructed from time-varying ultrasound measurements made on the surface of the object. In practical applications, accurate knowledge of the speed of sound, which is required for an accurate solution of the inverse problem, is typically not available. In this work, Bayesian approximation error approach is utilized in compensating uncertainties due to the unknown speed of sound.

CP FT-4-5 8 4 15:30-15:50

Postmenopausal Longitudinal Bone Mineral Density (BMD) Trajectory Improves Prediction Accuracy of Fracture Risk

Keisuke Ejima	Indiana University

Abstract: Abrupt change in bone mineral density (BMD) is observed among postmenopausal women. The potential utility of the BMD trajectory as a predictor of fracture risk was assessed in this population. The individual longitudinal BMD data were categorized into three groups using growth mixture model. Fracture risk was assessed using the Cox model with and without BMD trajectory. The results suggested considering BMD trajectory improves the predictive accuracy of fracture risk.

CP FT-4-5 8 5 15:50-16:10

Learning dynamical information from static protein and sequencing data

Philip Pearce	Massachusetts Institute of Technology
Francis Woodhouse	University of Cambridge
Aden Forrow	Massachusetts Institute of Technology
Ashley Kelly	Durham University
Halim Kusumaatmaja	Durham University
Jorn Dunkel	Massachusetts Institute of Technology

Abstract: Many complex processes, from protein folding to virus evolution, can be described as stochastic exploration of a high-dimensional energy landscape. Despite this ubiquity, little is known about the reliable inference of state transition dynamics in such settings. Here a general framework is presented for learning the dynamics of an approximately Fokker-Planck type Markovian system. The method is found to reconstruct accurately the folding networks of several proteins and the dynamics of gene regulatory networks.

CP FT-4-5 8 6 16:10-16:30

Optimal recovery of a radiating source with multiple frequencies along one line

Tommi Brander	Norwegian University of Science and Technology
Joonas Ilmavirta	University of Jyväskylä
Teemu Tyni	University of Oulu

Abstract: An unknown source of radiation is located in a medium with known attenuation. The attenuated radiation is measured. We recover the source by using multiple frequencies of the radiation, but only measurements along a single line. The recovery is up to a sigma-algebra generated by the attenuation, and is unstable. We explain a physical scenario, the theorem, and show numerical results.

CP FT-1-7 8 14:30-16:30

Biology, Medicine and other natural sciences IV

Chair Person: Luca Meacci Universidade de São Paulo

CP FT-1-7 8 1 14:30-14:50

A two-component discrete-continuum red blood cell mathematical model

Luca Meacci	Universidade de São Paulo
Gustavo C. Buscaglia	Universidade de São Paulo
Roberto F. Ausas	Universidade de São Paulo
Fernando Mut	George Mason University

Abstract: We present a mathematical and computational model to study normal and pathological behavior of red blood cells in slow transient processes (micropipette aspiration, optical tweezing, etc.). The formulation considers the cytoskeleton as a discrete non-linear elastic structure. The novelty is to couple it with continuum model (two-dimensional fluid) of the lipid membrane, instead of the usual discrete/particle models. The interaction of the cytoskeleton with the membrane is through adhesion forces adapting efficient solid-solid adhesion algorithms.

CP FT-1-7 8 2 14:50-15:10

Can topology-based features improve diagnosis of Atrial Fibrillation?

Paul Samuel Ignacio	University of Iowa
Christopher Dunstan	University of Maryland Baltimore County
Esteban Escobar	California State Polytechnic University
Luke Trujillo	Harvey Mudd College
David Uminsky	University of San Francisco

Abstract: Atrial Fibrillation is a heart condition caused by atrial spasms leading to numerous health complications. State-of-the-art models employ complex algorithms that extract expert-informed features to improve diagnosis. We examine how topological features, uninformed by medical knowledge, can be tapped to aid in diagnosing Atrial Fibrillation. Via delay embeddings, we transform electrocardiograms to high-dimensional point-clouds, converting periodic signals to algebraically-computable topological signatures. We train simple classifier models using these signatures, and benchmark performance against state-of-the-art models.

CP FT-1-7 8 3 15:10-15:30

A study of blood flow regulation on collateral circulation using multiscale flow model

Ulin Nuha Abdul Qohar	University of Bergen
Antonella Zanna Munthe-Kaas	University of Bergen
Jan Martin Nordbotten	University of Bergen
Erik Andreas Hanson	University of Bergen

Abstract: Collateral circulation is important to maintain blood supply to the organ when parts of it are damaged due to injury or surgery. A multi-scale flow model was developed to evaluate collateral circulation on the existing vascular structure in the organ and the blood flow regulation in injured organ and provided clinical information for diagnostics and for surgical planning. The result showed that the auto-regulation in collateral circulation was driven by the elasticity of vessels.

CP FT-1-7 8 4 15:30-15:50

Derivation of potential energy function from quantitative cell survival data

Shinji Nakaoka	Hokkaido University

Abstract: We construct a quantitative mathematical model for cellular proliferation kinetics described by partial differential equations. We show that a potential energy function representing the ability of a cell to survive is derived from our equations. We also confirmed that the derived potential energy function can be obtained as a feasible state under the maximum entropy principle.

CP FT-1-7 8 5 15:50-16:10

Optimal treatment strategies using dendritic cell vaccination for a tumor model with parameter identifiability

Subhas Khajanchi	Presidency University

Abstract: We report a mathematical model for immune-tumor interplays with immunotherapeutic drug and optimal treatment strategy. The model consists of tumor cells, CD4+T, CD8+T, dendritic cells(DCs), IL-2 and DC-vaccination. We have designed the treatment regimen in such a manner that it minimizes tumor burden and toxicity of DC-vaccination. The model undergoes sensitivity analysis and parameters are obtained from existing literatures. We explore the effects of DC vaccination and describe under what circumstances tumor can be eliminated.

CP A3-3-L1 8 14:30-16:30

Applied Mathematics for Industry and Engineering VII

Chair Person: Yves Lucet University of British Columbia

CP A3-3-L1 8 1 14:30-14:50

Optimizing road design alignments: from research to commercial product

Yves Lucet	University of British Columbia
Warren Hare	University of British Columbia

Abstract: We summarize 8 years of industry-sponsored research on optimizing road alignments to minimize costs under safety and construction constraints. Since 2010, the project has produced multiple theses, several articles, one patent, and one commercial product. The problem splits into earth work (minimize material movement), vertical alignment (minimize cuts and fills), and horizontal alignment (select the road location). By providing both an historical perspective and key milestones, we recall current achievements and point out future work.

CP A3-3-L1 8 2 14:50-15:10

Bayesian Calibration of Active Nitridation Reaction Efficiency of Graphite from Plasma Wind Tunnel Experiments

Anabel Del Val	von Karman Institute for Fluid Dynamics
Pietro Congedo	INRIA Saclay Île-de-France
Olivier Chazot	von Karman Institute for Fluid Dynamics
Thierry Magin	von Karman Institute for Fluid Dynamics

Abstract: Attempts to model the surface chemistry of ablating materials for spacecraft reentry usually neglect the effect of carbon nitration. Nevertheless, nitridation can highly impact other surface chemical processes through consumption of available atomic nitrogen. We propose a Bayesian inference approach which takes on experiments on graphite ablation in nitrogen plasmas and a numerical model with ablative boundary condition coupled to the flowfield aiming at the calibration of carbon nitridation reaction efficiencies in relevant reentry environments.

CP A3-3-L1 8 3 15:10-15:30

A DEA model to sustainability improvement an electricity supply chain : The effects of dual-role factors on flaring gas controls and power plants electricity consumptions

Mojgan Pouralizadeh	Islamic Azad university,Rasht Branch
Alireza Amirteimoori	Islamic Azad university,Rasht Branch

Abstract: The purpose this study is to evaluate the sustainability and efficiency a supply chain in presence dual-role factors, inverse intermediate measures as non-discretionary inputs and indesirable products.This paper focuses on investment opportunities for technology innovation in order to reducing various industrial pollutions.Furthermore,to demonstrate the capability of the proposed approach this framework is implemented for assesment of a supply chain identified by oil and gas companies,power plants,transmission companies,dispatching companies and final consumers in Iran power industry.

CP A3-3-L1 8 4 15:30-15:50

Characterization and simulation of voltage and current on electric power transmission lines

Olabode Matthias Bamigbola	University of Ilorin
Yidiat Omolade Aderinto	University of Ilorin

Michael Olufemi Oke Ekiti State University

Abstract: In electrical engineering, mathematical modeling plays prominent roles in knowledge generation and application, and aids formulation of sound policies in electric power system. Applying Kirchoff current and voltage laws to an electrical circuit, models of voltage and current flow on transmission lines were generated as hyperbolic partial differential equations, and their complete solutions obtained. The models were simulated using data obtained from a typical transmission station to deduce optimal values of key transmission parameters.

CP A3-3-L1 8 5 **15:50-16:10**

A model of Phosphorus recycling at the plant scale

Alina Dubovskaya University of Limerick
Iain Moyles York University
Andrew Fowler University of Limerick

Abstract: We present a mathematical model of natural recycling of Phosphorus (P) through the surface accumulation of leaf litter in order to study the impact of storage mechanisms of P on its overall cycle. We demonstrate that P concentrations sharply decrease within a depth of 50 cm. We estimate an optimal P fertiliser input rate that minimises losses to the system. We discuss the importance of microbial activity in phosphorus cycle dynamics.

CP A3-3-L1 8 6 **16:10-16:30**

Adaptive asynchronous time-stepping, stopping criteria, and a posteriori error estimates for fixed-stress iterative schemes for coupled poromechanics problems

Elyes Ahmed University of Bergen
Jan Martin Nordbotten University of Bergen
Florin Adrian Radu University of Bergen

Abstract: We develop adaptive iterative coupling schemes for the Biot system modeling coupled poromechanics problems. Precisely, adaptive fixed-stress algorithms are build on conforming reconstructions of the pressure and displacement together with equilibrated flux and stresses reconstructions. These ingredients are used to derive a posteriori error estimates for the fixed-stress algorithms, distinguishing the different error components. Numerical experiments illustrate the efficiency of our estimates and the performance of the adaptive iterative coupling algorithms.

IPL04 **17:00-17:45**

ICIAM Su Buchin Prize

Chair Person: Pingwen Zhang Peking University

17:00-17:45

Time change in modelling, stochastic calculus and control

Giulia Di Nunno Nunno University Of Oslo, Norway

Abstract: Time change is a powerful technique for generating noises and providing flexible models. Its main idea stands in the representation of complicated stochastic structures by some known processes and a randomly perturbed time line. We shall provide an excursus through related stochastic calculus, chaos structure and information, integral representations and stochastic differentiation. These will then be applied to backward stochastic differential equations and optimal control problems. Motivation of our work is taken from stochastic finance.

IPL05 **17:45-18:30**

ICIAM Maxwell Prize

Chair Person: Edriss Titi Texas A&M University

17:45-18:30

From d'Alembert paradox to 1984 Kato criteria via 1941 1/3 Kolmogorov law and 1949 Onsager conjecture.

Claude Bardos Université Paris Denis Diderot, France

Agnieszka Swierczewska-Gwiazda University of Warsaw,
Piotr Gwiazda Polish Academy of Sciences
Edriss Titi DEPARTMENT OF APPLIED MATHEMATICS AND THEORETICAL PHYSICS, UNIVERSITY OF CAMBRIDGE
Emile Wiedemann nstitut für Angewandte Analysis Universität Ulm

Abstract: Proving local conservation of energy under convenient hypothesis , will introduce supplementary conditions for global conservation of energy in a domain with boundary and no anomalous energy dissipation in the zero viscosity limit. Then will compare with a theorem of Kato in the presence of a Lipschitz solution of the Euler equations when no anomalous energy dissipation is equivalent to persistence of regularity in the zero viscosity limit, contributing to the resolution of d'Alembert Paradox.

SL05 **19:45-20:45**

PUBLIC LECTURE: Can Mathematics help in the war against disease?

Chair Person: José Antonio Carrillo De La Plata Imperial College London

19:45-20:45

Can Mathematics help in the war against cancer?

Victor M. Pérez-García Mathematical Oncology Laboratory (MOLAB), University of Castilla-La Mancha

Abstract: The fight against disease is one of the greatest challenges in modern society. Mathematics has contributed substantially to the development of many disciplines, such as Physics and Engineering. Life Sciences, and specifically Medicine, are, however, perceived as 'different', because of the complexity of life itself. In this talk I shall discuss how Mathematics may lead to important breakthroughs in the fight against disease, and what advances are to be expected in the coming decades. I will describe examples involving brain tumors where Applied Mathematics is being used to improve our knowledge and clinical practice well beyond the current standard.

Friday sessions
July, 19

IL23 **08:30-09:15**

Sylvia Serfaty

Chair Person: M. Elena Vázquez Cendón Universidade de Santiago de Compostela

08:30-09:15

Systems of points with Coulomb interactions

Sylvia Serfaty Courant Institute, New York University

Abstract: Large ensembles of points with Coulomb interactions arise in various settings of condensed matter physics, classical and quantum mechanics, statistical mechanics, random matrices and even approximation theory, and they give rise to a variety of questions pertaining to analysis, Partial Differential Equations and probability. We will first review these motivations, then present the "mean-field" derivation of effective models and equations describing the system at the macroscopic scale. We then explain how to analyze the next order behavior, giving information on the configurations at the microscopic level and connecting with crystallization questions, and finish with the description of the effect of temperature.

IL22 **08:30-09:15**

Karen Willcox

Chair Person: Peregrina Quintela Estévez University of Santiago de Compostela

08:30-09:15

Predictive data science for physical systems: From model reduction to scientific machine learning

Karen Willcox Institute for Computational Engineering and Sciences, UT Austin

Benjamin Peherstorfer Courant Institute
Boris Kramer MIT
Elizabeth Qian MIT

Abstract: Achieving predictive data science for physical systems requires a synergistic combination of data and physics-based models, as well as a critical need to quantify uncertainties. For many frontier science and engineering challenge problems, a purely data-focused perspective will fall short -- these problems are characterized by complex multi-scale multi-physics dynamics, high-dimensional uncertain parameters that cannot be observed directly, and a need to issue predictions that go beyond the specific conditions where data may be available. Learning from data through the lens of models is a way to bring structure to an otherwise intractable problem: it is a way to respect physical constraints, to embed domain knowledge, to bring interpretability to results, and to endow the resulting predictions with quantified uncertainties. This talk highlights how formulations and methods from projection-based model reduction can be combined with machine learning methods to achieve this. Our examples, drawn from a variety of engineering applications, demonstrate the importance of embedding physical constraints within learned models, and also highlight the important point that the amount of model training data available in an engineering setting is often much less than it is in other machine learning applications, making it essential to incorporate knowledge from physical models.

IL24 **08:30-09:15**
Marcelo Viana
Chair Person: Jesús Sanz-Serna
Serna
08:30-09:15

Lyapunov exponents, from the 1960s to the 2020s
Marcelo Viana Impa, Rio De Janeiro, Brazil

Abstract: A survey of results, classical and recent, in the mathematical theory of Lyapunov exponents, with a view to the future of the field.

IL26 **09:30-10:15**
Leah Edelstein-Keshet
Chair Person: Ami Radunskaya Pomona College
09:30-10:15

Pattern formation inside living cells
Leah Edelstein-Keshet Mathematics Dept. Ubc, Vancouver, Ca

Abstract: Cell motility is powered by the dynamics of structural proteins (actin). The proteins that regulate actin (GTPases) spontaneously form patterns inside a cell. I will survey mathematical models for this chemical pattern formation. Reaction-diffusion models of GTPases have interesting wave-pinning behavior. Feedback from actin, mechanical tension, cell size change, and other factors results in other exotic wavelike patterns. I will discuss implications to single and multiple cell behavior.

IL25 **09:30-10:15**
Nicholas J. Higham
Chair Person: Cleve Moler MathWorks
09:30-10:15

Exploiting Low Precision Arithmetic in the Solution of Linear Systems
Nicholas Higham University of Manchester, Uk

Abstract: The landscape of scientific computing is changing, because of the growing availability and usage of low precision floating-point arithmetic, which provides advantages in speed, energy, communication costs and memory usage over single and double precisions. Of particular interest are the IEEE half precision (fp16) and bfloat16 arithmetics, the hardware support for which is primarily motivated by machine learning. Given the availability of these arithmetics, mixed precision algorithms that work in single or double precision but carry out part of a computation in half precision are now of great interest for scientific computing.
We consider solving a linear system Ax=b, with double precision *A* and *b*, by the use of a half precision LU or Cholesky factorization and mixed-precision iterative refinement. Among the points we discuss are
- how to avoid underflow and overflow, given the limited range of fp16 arithmetic,
- how to carry out error analysis for algorithms that use fp16 or bfloat16 arithmetic,
- how to handle symmetric positive definite systems, where rounding to half precision may destroy definiteness,
- how to simulate low precision arithmetic when hardware implementations are not available,
- the attainable speedups over state of the art solvers on current GPUs.

IL27 **09:30-10:15**
JAC Weideman
Chair Person: Pablo Pedregal U. de Castilla-La Mancha
09:30-10:15

Dynamics of Complex Singularities of Nonlinear PDEs: Analysis and Computation
Jac Weideman Stellenbosch University, South Africa

Abstract: Solutions to nonlinear evolution equations exhibit a wide range of interesting phenomena such as shocks, solitons, recurrence, and blow-up. As an aid to understanding some of these features, the solutions can be viewed as analytic functions of a complex space variable. The dynamics of poles and branch-point singularities in this complex plane can often be associated with nonlinear properties of the solution. For example, shock formation and multivaluedness in the inviscid Burgers equation can be understood as a conjugate pair of branch-point singularities that travel in the complex plane and meet on the real axis at the particular instant the shock is formed. In the first part of the talk we shall survey some of the analytical results in this area by revisiting, this time from a complex viewpoint, a few classic papers from the last century. This includes the 1950/1951 papers by Hopf and Cole (on the linearization of the Burgers equation) and the 1965 paper by Zabusky and Kruskal (on recurrence in the Korteweg-de Vries equation). In the second part of the talk we shall survey some of the numerical methods that can be used to approximate singularity dynamics in those cases where explicit solutions are unavailable.

MS FE-1-3 9 **11:00-13:00**
Inverse Problems in Shape and Geometry - Part 2
For Part 1 see: MS FE-1-3 8
For Part 3 see: MS FE-1-3 10
Organizer: Roland Herzog TU Chemnitz
Organizer: Bastian Harrach Goethe University Frankfurt
Organizer: Jan-Frederik Pietschmann TU Chemnitz

MS Organized by the GAMM activity group "Optimization with Partial Differential Equations" (OPDE)

Abstract: Inverse problems generally seek to determine the cause of an observation, based on some underlying model. The focus in this minisymposium is on inverse problems where the unknown cause is represented as a shape or geometry. Examples include the identification of an inclusion or the geometry of a scatterer. It is a common feature of these problems that the set of shapes does not bear the structure of a vector space. Speakers in this minisymposium will address a variety of problems, primarily based on models involving partial differential equations, and a broad range of topics spanning theory, algorithms and applications.
11:00-11:30

Enhancing joint reconstruction and segmentation with non-convex Bregman iteration

Martin Benning	Queen Mary University of London
Veronica Corona	University of Cambridge
Matthias Ehrhardt	University of Bath
Lynn Gladden	University of Cambridge
Richard Mair	University of Cambridge
Andi Reci	University of Cambridge
Stefanie Reichelt	University of Cambridge
Andrew Sederman	University of Cambridge
Carola-Bibiane Schönlieb	University of Cambridge

Abstract: We explore a mathematical approach that combines reconstruction and segmentation in a unified framework. We derive a variational model that consists of a total-variation-based reconstruction from undersampled measurements and a Chan-Vese based segmentation. We extend the scheme to a Bregman iteration framework that improves the reconstruction and the segmentation. We develop an alternating minimisation scheme that solves the non-convex optimisation problem with provable convergence guarantees, and conclude with numerical results for synthetic and real data.
11:30-12:00

Total variation of the normal as a prior in geometric inverse problems

Roland Herzog TU Chemnitz
Ronny Bergmann TU Chemnitz
Marc Herrmann University of Würzburg
Stephan Schmidt University of Würzburg
José Vidal Núñez TU Chemnitz

Abstract: The total variation (TV) is an important regularizing seminorm in inverse problems. We consider problems where the shape is among the unknowns. We define the notion of total variation of the surface normal as a prior for this class of problems and discuss this term in the continuous and discrete settings. We also address a suitable numerical scheme to deal with the non-smoothness arising from the TV of the normal and present numerical results.

12:00-12:30

A data-driven approach to image denoising in X-ray computed tomography

Hyoung Suk Park National Institute for Mathematical Sciences
Jineon Baek National Institute for Mathematical Sciences, Korea
Sun Kyoung You Chungnam National University College of Medicine and Chungnam National University Hospital,Korea
Jae Kyu Choi Tongji University, China
Jin Keun Seo Yonsei University, Korea

Abstract: We propose a data-driven method for image denoising in X-ray computerized tomography (CT). The proposed method approximately estimates the Maximum a Posteriori, which can be expressed as minimizing the Kullback-Leibler divergence between data distribution and the distribution generated by the generative adversarial network. Prior information on target CT images can be incorporated from a data distribution. We performed numerical simulation and clinical experiments to show the validity of the proposed approach.

12:30-13:00

On localizing and concentrating electromagnetic fields

Yi-Hsuan Lin University of Jyvaskyla
Bastian Harrach
Hongyu Liu

Abstract: We consider field localizing and concentration of electromagnetic waves governed by the time-harmonic anisotropic Maxwell system in a bounded domain. It is shown that there always exist certain boundary inputs which can generate electromagnetic fields with energy localized/concentrated in a given subdomain while nearly vanishing in another given subdomain.

MS ME-1-2 9 11:00-13:00

Recent Advances in Applied Integrable Systems: Theory and Computations - Part 3

For Part 1 see: MS ME-1-2 7
For Part 2 see: MS ME-1-2 8
For Part 4 see: MS ME-1-2 10
Organizer: Kenichi Maruno Waseda University
Organizer: Anton Dzhamay University of Northern Colorado

Abstract: Recent advances in the applications of integrable systems extend to a wide range of mathematics and physical sciences, such as random matrices, cluster algebra and combinatorics, probability theory, numerical computations, cellular automata, tropical geometry and ultra-discrete systems, differential geometry, computer visualizations, nonlinear physics, and many others. The purpose of this mini-symposium is to bring together active researchers from across the world to discuss recent developments in various aspects of applied integrable systems.

11:00-11:30

Integrable evolutions of twisted polygons in centro-affine R^n

Annalisa Calini College of Charleston
Gloria Marí-Beffa University of Wisconsin-Madison

Abstract: This talk focuses on a natural geometric flow for polygons in centro-affine geometry derived from discretizations of the Adler-Gel’fand-Dikii flows for curves in projective space. We prove the compatibility of the two Hamiltonian structures in arbitrary dimension by lifting them to a pair of pre-symplectic forms on the moduli space of centro-affine arc length parametrized polygons. We also describe their kernels and discuss the integrability of the polygonal flows.

11:30-12:00

On mixed ultradiscrete soliton solution

Hidetomo Nagai Tokai university

Abstract: We propose a mixed ultradiscrete soliton solution. It includes two different types of soliton solutions. The equation and solution are derived from the generalized discrete BKP through ultradiscretization and reduced to the ultradiscrete KdV in a special case. We also discuss the time evolution rule for this equation.

12:00-12:30

Non-commutative continued fractions and KP maps

Adam Doliwa University of Warmia and Mazury

Abstract: Motivated by non-commutative KP maps we study continued fractions in non-commuting symbols. We present first several most pertinent analogs of results of the classical theory. Then we describe the KP maps from the point of view of the non-commutative analog of the Galois theorem on periodic continued fractions.

12:30-13:00

An expression of lambda determinant derived from Toda lattice equation

Yasuhiro Ohta Kobe University

Abstract: The lambda determinant is expressed in the form of usual determinant by using the Casorati determinant representation of the solution for two-dimensional discrete Toda lattice equation. The recursive definition of the lambda determinant is reduced to the two-dimensional discrete Toda lattice equation through gauge transformation.

MS A3-2-3 9 11:00-13:00

Multi-scale modeling and simulation in metal forming - Part 1

For Part 2 see: MS A3-2-3 10
Organizer: Dirk Roose KU Leuven - Dept. Computer Science
Organizer: Axel Klawonn Universität zu Köln

MS (co-)organized by the GAMM activity group "Computational Science and Engineering" (CSE)

Abstract: Simulation nowadays plays an important role in the design and implementation of metal forming operations. During sheet metal forming and forging, the mechanical properties of the material evolve, in a heterogeneous way, due to the evolution in microstructure and crystal orientation. Hence physics-based or phenomenological material models at all levels must be coupled to achieve accurate simulations at the macroscopic level. This also requires novel numerical methods, high performance computing, and parallel scalable algorithms. This mini-symposium will give an overview of ongoing research in Europe. Emphasis lies on modeling issues, accurate numerical methods, scalable algorithms, efficient software and validation.

11:00-11:30

Multi-scale modelling of sheet metal forming: From the atom to the component scale

Fengbo Han
Franz Roters Max-Planck-Institut für Eisenforschung
Dierk Raabe Max-Planck-Institut für Eisenforschung
Martin Diehl Max-Planck-Institut für Eisenforschung

Abstract: The average response of metallic materials is to a large extend determined by their crystallographic texture. In the case of multiphase materials, e.g. dual phase steels, the properties of the additional phases (e.g. strength, spatial distribution, and volume fraction) are similarly important. We present here a two-scale simulation approach using a spectral method based solver to directly incorporate above mentioned microstructural details in to component scale simulations.

11:30-12:00

Coupled multiscale modeling for hot forging of Ni and Ti alloys

Olga Bylya University of Strathclyde

Abstract: Modeling of hot forging is well matured. However, proper constitutive modeling is still a challenge. Real industrial forgings involve more complex thermo-mechanical history and sometimes extremely large deformations, which cannot be properly represented in laboratory tests, used for development and calibration of a majority of visco-plastic models. This paper presents a possible approach of a coupled multiscale modeling approach for Ni and Ti alloys. Calibration methodology and the range of applicability will be discussed.

12:00-12:30

Large scale homogenization using FE2TI

Oliver Rheinbach — Technische Universität Freiberg

Abstract: FE2TI is a code combining computational homogenization (FE^2) and domain decomposition (e.g., linear and nonlinear FETI-type) solvers. At each Gauß integration point of the macroscopic problem a microscopic problem is attached. The microscopic problems can be solved in parallel but are coupled through the macroscopic problem. Our software is developed in the project EXASTEEL (German priority program SPPEXA - Software for Exascale Computing). Weak scaling results to up to a million parallel processes are presented.

12:30-13:00

Large scale simulations of sheet metal forming with contact using FE2TI

Axel Klawonn	Universität zu Köln
Oliver Rheinbach	TU Bergakademie Freiberg
Martin Lanser	University of Cologne
Matthias Uran	University of Cologne

Abstract: Dual-phase (DP) steels combine high strength with formability. Their excellent properties result from micro-heterogeneities and complex interactions between the ferritic and martensitic phases in the microstructure. Our software package FE2TI, combining a parallel FE^2 approach with FETI-DP methods, has been enhanced by a contact algorithm to allow for realistic simulations of deformation processes. Large contact simulations and parallel scalability to more than 1 million MPI ranks are presented.

MS ME-1-3 9 — 11:00-13:00

Entropy methods for multi-dimensional systems in mechanics - Part 3

For Part 1 see: MS ME-1-3 7
For Part 2 see: MS ME-1-3 8
For Part 4 see: MS ME-1-3 10

Organizer: Cleopatra Christoforou	University of Cyprus
Organizer: Athanasios Tzavaras	KAUST

Abstract: Nonlinear Conservation Laws result from the balance laws of continuum physics and govern a broad spectrum of physical phenomena in compressible fluid dynamics, materials science, particle physics, semiconductors, and other applied areas. The minisymposium is focused on recent advances on conservation laws and related systems in mechanics that connect variational methods with dynamics and the general use of entropy methods in conservation laws and related systems. It aims to bring together researchers working in different aspects, highlight the role of PDEs in these applications, serve as a forum for the dissemination of new scientific ideas and discoveries and enhance communication.

11:00-11:30

EDP convergence for the membrane limit in the porous medium equation

Alexander Mielke	WIAS and HU Berlin
Thomas Frenzel	WIAS Berlin
Matthias Liero	WIAS Berlin

Abstract: The porous medium equation ic considered as a gradient flow for the relative entropy and the Otto-type dissipation. We study the spatially inhomogeneous case with a thin layer with small mobility. Assuming suitable scalings, the limits lead to membrane models with suitable transmission conditions. We derive the associated gradient structure, which is encodes the physically correct kinetic relation for flux depending on the difference of the chemical potentials. Surprisingly, the kinetic relation is nonlinear.

11:30-12:00

Finite Energy Weak Solutions of the Navier-Stokes-Kortewek equations

Stefano Spirito	University of L'Aquila
Paolo Antonelli	GSSI - Gran Sasso Science Institute

Abstract: In this talk I will present some results concerning the analysis of finite energy weak solutions of the Navier-Stokes-Korteweg equations, which model the dynamic of a viscous compressible fluid with diffuse interface. A general theory of global existence is still missing, however for some particular cases of physical interest I will present results regarding the global existence. The talk is based on a series of joint works with Paolo Antonelli

12:00-12:30

Entropy Method on Uniqueness of Isometric Immersions

Cleopatra Christoforou — University of Cyprus

Abstract: Recent results on the connection between isometric immersions and Euler equations are discussed. The problem of global isometric immersion of a two-dimensional Riemannian manifold with negative Gauss curvature into three-dimensional Euclidean space has been studied using methods coming from Continuum Physics and non-smooth global isometric immersions have been established. The relative entropy method in this context provides a $C^{1,1}$ versus smooth uniqueness result of isometric immersions.

12:30-13:00

Relative entropy based model-adaptive numerical schemes in fluid mechanics

Jan Giesselmann — Technical University of Darmstadt

Abstract: One challenge in fluid mechanics is to efficiently simulating fluid mixtures undergoing chemical reactions. Such flows may be described by various models whose complexity differs greatly. For efficient simulations complex models should only be used where necessary, while simpler models should be used where sufficient. Decisions on where to use which model can be based on a posteriori computable bounds for the distance between solutions to different models. We derive such estimates using relative entropy.

MS FT-1-1 9 — 11:00-13:00

Numerical methods for kinetic and mean-field equations - Part 2

For Part 1 see: MS FT-1-1 8
For Part 3 see: MS FT-1-1 10

Organizer: Li Wang	University of Minnesota
Organizer: José Antonio Carrillo De La Plata	Imperial College London

Abstract: Kinetic and mean-field equations are derived from many-particle system, and have been widely applied in various contexts such as rarefied gas dynamics, plasma physics, biology, socio-economy, and many others. The high dimensionality, and multiple scales constitute the major challenge in computing these equations. Certain structures, such as positivity, conservation and entropy dissipation are also desirable for numerical solutions. This mini-symposium aims to bring together researchers in this area to assess the current state-of-the-arts methods and foster collaborations.

11:00-11:30

Stability-enhanced AP IMEX-LDG schemes for linear kinetic transport equations under a diffusive scaling

Fengyan Li — Rensselaer Polytechnic Institute

Abstract: We consider linear kinetic transport equations in a diffusive scaling and design and analyze high order AP methods within the DG method framework. The objective is to achieve unconditional stability in the diffusive regime with high order accuracy. Initial layers are taken into account. The ingredients include: model reformulations, local DG methods in space, suitable IMEX-RK methods in time, and strategies for non-well prepared initial. We perform asymptotic and stability analyses and report numerical examples.

11:30-12:00

Multi-species BGK models taking ions and electrons into account: Modelling and numerics

Marlies Pirner	Vienna University
Jeffrey Haack	Los Alamos National Laboratory
Cory Hauck	Oak Ridge National Laboratory
Christian Klingenberg	University of Wuerzburg
Sandra Warnecke	University of Wuerzburg

Abstract: We present a physical situation where a kinetic model for plasma warrants the inclusion of velocity dependent coliision frequencies into a multi-species kinetic BGK model. In such a model the standard Maxwellian distributions are be replaced by new attractors such that we still have all the conservation properties. We will prove existence and uniqueness of these attractors and explain how this motivates the numerics.

12:00-12:30

A fast implicit solver for semiconductor models in one space dimension

Paul Liau — Oak Ridge National Laboratory

Abstract: We propose a fully implicit scheme for simplified Boltzmann-Poisson systems with a linear relaxation-type collision kernel. At each time step, the system is formulated as a fixed-point problem, which is then solved with a variety of iterative solvers. A synthetic acceleration scheme has been implemented to accelerate the iterative solvers using the solution to a drift-diffusion equation as a preconditioner. Four iterative solvers and their accelerated variants have been compared on various semiconductor modeling problems.

MS FE-1-1 9 11:00-13:00

Numerical methods for multi-physics coupled problems - Part 1

For Part 2 see: MS FE-1-1 10

Organizer: Xiaoming Wang Southern University of Science and Technology

Abstract: Many natural, science and engineering problems involve multi-physics leading to coupled systems. Well-known examples include the coupled atmosphere-ocean system, the surface-groundwater system, fluid-structure interaction among many others. These systems are usually very complex and highly nonlinear. Numerical methods is one of the primary tools in studying the behavior of such kind of systems. The efficient and accurate numerical treatment of such problems is usually a challenge due to their multi-physics, multi-scale and coupled nature. The goal of this minisymposium is to convene a few experts in the area to showcase recent advances and discuss future directions.

11:00-11:30

Coupling and decoupling of free flows and flows in porous media

Xiaoming Wang Southern University of Science and Technology

Abstract: Many natural and engineering problems involve the coupling of free flow and porous media flow. We report on recent progress in three related important issues: 1) How do the free flow couple with flow in porous media? 2) Are there accurate and efficient numerical schemes that decouples the two subsystems? 3) Are there physically important regimes where the subsystems decouple naturally?

11:30-12:00

Dynamic boundary conditions in general diffusion

Chun Liu Illinois Institute of Technology

Hao Wu Fudan University

Abstract: In this talk, I will employ the energetic variational approaches for those problems with active boudnary effects. In particular, we will derive a set of dynamic boundary conditions that account for the force balances on the boundaries.

12:00-12:30

An efficient numerical method for topology optimisation for fluids

Xiao-Ping Wang Hong Kong University Of Science And Technology, China

Abstract: We propose an efficient threshold dynamics method for topology optimization for fluids modeled with the Stokes equation. We show that the minimization problem can be solved with an iterative scheme. Extensive numerical experiments in both two and three dimensions show that the proposed iteration scheme is robust, efficient and insensitive to the initial guess and the parameters in the model.

12:30-13:00

Unconditionally positivity preserving and energy dissipative schemes for Poisson--Nernst--Planck

Jie Shen Purdue University and Xiamen University

Abstract: We present a set of numerical schemes for the Poisson--Nernst--Planck equations. We prove that both time discretized and fully discretized schemes are uniquely solvable and preserve the positivity unconditionally. Furthermore, the first-order scheme is proven to be unconditionally energy dissipative. We shall present numerical results to validate these properties. Moreover, our numerical results indicate that the second-order scheme is also energy dissipative.

MS A1-1-1 9 11:00-13:00

Nonlocal methods for image and data analysis - Part 1

For Part 2 see: MS A1-1-1 10

Organizer: Luca Calatroni CMAP, École Polytechnique

Organizer: Matthew Thorpe University of Cambridge

Organizer: Daniel Tenbrinck Department Mathematik, FAU Nürnberg-Erlangen

Abstract: With the emergence of machine learning, data-driven nonlocal methods have become increasingly popular due to their capability of exploiting self-similarity of hidden patterns in the data not necessarily in close proximity. Such methods have effectively been used for several classification and clustering applications, and applied to a wide range of image processing problems such as inpainting and segmentation. In this two-part mini-symposium we will review the recent progresses in this field, focusing both on the modelling and theoretical set-up of nonlocal methods and on the design of efficient optimisation algorithms making them applicable in practice to large-size problems.

11:00-11:30

Properly weighted graph Laplacian for semi-supervised learning

Jeff Calder University of Minnesota

Dejan Slepcev Carnegie Mellon University

Abstract: Graph-based semi-supervised learning with low labeling rates has received significant attention recently, due to degeneracies of graph Laplacian regularization in this setting. Recent work has attempted to address this by simply re-weighting the graph Laplacian. We prove that other approaches remains ill-posed for very low labeling rates, and show how to properly re-weight the graph Laplacian. We prove that our method is well-posed with very few labels, and present results of classifying MNIST digits.

11:30-12:00

Model Reduction for Input-Output Maps

Nikola Kovachki Caltech

Andrew Stuart Caltech

Abstract: We develop a general framework for a data-driven approximation to input-output maps between infinite dimensional spaces by utilizing the recent success of deep learning. For a class of such maps and a suitably chosen probability measure on the inputs, we prove generalization bounds and convergence of our approximation. Numerically, we demonstrate the effectiveness of our method on parametric PDE problems, showing robustness to size of the discretization.

12:00-12:30

Non-Local p-Laplacian Evolution and Variational Problems on Graphs

Jalal Fadili Normandie Université-ENSICAEN

Abstract: Combining tools from graph theory, convex analysis, non-linear semigroup theory and evolution equations, we give a rigorous interpretation to the continuous limit of the discrete non-local p-Laplacian evolution and variational problems on graphs. We prove that the solutions of the sequence of discrete problems converge to the solution of the continuous problem governed by the graphon. We also provide error bounds and convergence rates.

12:30-13:00

Optimal parameters selection in nonlocal image denoising

Juan Carlos De Los Reyes Centro de Modernización Matemática/Escuela Politécnica Nacional de Quito

Abstract: In order to determine the optimal parameters in non-local image denoising, we consider a bilevel optimization approach with the non-local denoising models as constraints. In the flavor of supervised machine learning, the approach presupposes the existence of a training set of clean and noisy images. The problems are treated as mathematical programs with variational constraints and differentiability of the solution operators are investigated. Optimality conditions are derived for different cost functionals and non-local variational models.

MS ME-0-1 9 11:00-13:00

Non Local Balance Laws and their applications

Organizer: Paola Goatin Inria

Organizer: Elena Rossi Inria Sophia Antipolis Méditerranée

Abstract: Aim of this minisymposium is to provide an overview of both analytical and numerical aspects of non-local balance and conservation laws, as well as their applications. Here, non-local means that the equation itself or the data depend on an integral evaluation of the unknown variable. Equations of this type arise in the modeling of various phenomena: vehicular traffic, crowd dynamics, supply chains, granular material, sedimentation. The proposed minisymposium will allow to get an insight into recent results, paying particular attention to real world applications.

11:00-11:30

Modelling crowd dynamics through balance laws in bounded domains

Elena Rossi	Inria Sophia Antipolis Méditerranée
Rinaldo M. Colombo	Università degli Studi di Brescia

Abstract: We consider a class of systems of non-local conservation laws in bounded domains, motivated by the modelling of crowd dynamics. Besides the analytical well-posedness results, we introduce a non-local operator aware of boundaries (i.e. walls and obstacles), describing the interactions among individuals at different positions. An ad hoc numerical algorithm allows us to compute the solutions to the equations under consideration and to perform some integrations showing the behaviour of the model in realistic situations.

11:30-12:00

Applications of nonlocal hyperbolic conservation laws

Simone Göttlich	University of Mannheim

Abstract: We focus on finite volume approximations to solve a nonlocal material flow model. Based on the numerical discretization with dimensional splitting, we prove the convergence of the approximate solutions, where the main difficulty arises in the treatment of the discontinuity in the flux function. In particular, we compare a Roe-type scheme to the Lax-Friedrichs method and provide a numerical study highlighting the benefits of the Roe discretization. A comparison to real data is also presented.

12:00-12:30

On convergence of nonlocal conservation laws towards local conservation laws and nonlocal delay conservation laws

Alexander Keimer	University of California
Lukas Pflug	FAU Erlangen-Nuremberg

Abstract: We will present recent results on nonlocal conservation laws when the nonlocal area of integration tends to zero. For specific classes of problems we show that the solution of the nonlocal conservation law converges to the solution of the local conservation law. We also present recent results on nonlocal conservation laws with delay, motivated by traffic flow where the reaction time of drivers might actually impact the velocity in a delayed sense.

12:30-13:00

High order finite difference WENO schemes for non-local balance laws

Luis Miguel Villada Osorio	Universidad del Bío Bío

Abstract: In this talk is focuses on the numerical solution of nonlinear convection-diffusion-reaction systems with nonlocal flux by an efficient finite differences method that combines weighted essentially non-oscillatory (WENO) reconstruction, an implicit-explicit Runge-Kutta (IMEX-RK) method for time stepping and a technique based on Fast Fourier Transform (FFT) to handle the nonlocal term. Numerical experiments for spatially two-dimensional problems motivated by applications to eco-epidemiological models, collective behaviour in biology, crowd dynamics are presented.

MS A6-4-2 9 — 11:00-13:30

Recent Advances/Applications of Iterated Function Systems and Fractal Functions

Organizer: Arya Kumar Bedabrata Chand	IIT Madras
Organizer: Maria Antonia Navascues	University of Zaragoza

Abstract: Fractal is a novel tool for approximation of non-linear objects and patterns in nature and society. Iterated function system is the most popular way to construct fractals. The shape preserving aspects of fractal functions/surfaces, random fractal functions, and their applications in geometric modeling are recent developments for industrial problems. The aim of this symposium is to bring together researchers, scientists, engineers, students to discuss and exchange ideas in the following topics: Iterated Function Systems Fractal Interpolation and Approximation Shape Preserving Fractals Geometric modeling using Fractals Random Fractals Fractal Tiling Fractal Signal/Image Compression Fractal and Box-counting Dimensions Fractals in medical imaging

11:00-11:30

Fractal Functions: from iterative functional systems to dimension theory

Cristina Serpa	CMAFCIO and ISEL
Jorge Buescu	Centro de Matemática, Aplicações Fundamentai e Investigação Operacional

Abstract: Abstract We consider systems of iterative functional equations with explicit dependence on the independent variable. We give recent developments in terms of a general theoretical framework and provide applications. This includes general necessary conditions for existence of solutions, called compatibility conditions, and a result on existence and uniqueness. For metric/topological spaces continuity of solutions is characterized. We give explicit and constructive solutions. We relate the fractal structure of solutions with fractal and Hausdorff dimensions.

11:30-12:00

Fractal Splines in Solution of Differential and Integral Equations

Arya Kumar Bedabrata Chand	IIT Madras
Kurma Rao Tyada	IIT Madras
Vijender Nallapu	VIT, CHENNAI

Abstract: The cubic spline fractal interpolation function through moments is used for the solutions of a 2nd order linear two-point boundary value problem (BVP) with the Dirichlet's boundary conditions. Using the discretized version of the differential equation, the moments are computed to construct the cubic fractal spline solution of the BVP, where non-smooth nature of the original function is captured. Fractal spline solution is proposed for the integral equation involving a continuous nowhere differentiable function.

12:00-12:30

Attractors of Sequences of Maps between Spaces with Application to Subdivision

Peter Robert Massopust	Technische Universität München

Abstract: We consider a countable sequence of metric spaces $\{(X_i|d_i)\}$ and an associated countable sequence of maps $\{T_i\}$, $T_i\colon X_iX_{i-1}$ and derive conditions for the convergence of backward trajectories of the $\{T_i\}$ to a unique attractor. An example of such trees of maps are trees of function systems leading to the construction of scale dependent and location dependent fractals. (This is joint work with Nira Dyn and David Levin.)

12:30-13:00

Dimension of some dynamically defined function graphs

Karoly Simon	Budapest University of Technology and Economics
Balazs Barany	Budapest University of Tecgnology and Economics
Michal Rams	Institute of Mathematics Polish academy of Sciences

Abstract: The motivation of our research was to answer a fractal image compression related question asked by Michael Barnsley. We combine techniques from one-dimensional dynamics and fractal geometry to compute the Hausdorff dimension of function graphs including generalized fractal interpolation functions and generalized Takagi functions. The function graphs under consideration are repellers of some piecewise affine and piecewise expanding maps. In general, the underlying dynamics cannot be described by any subshift of finite type.

13:00-13:30

The construction and box dimension of bilinear fractal interpolation surfaces

Huojun Ruan	School of Mathematical Sciences, Zhejiang University
Zhen Liang	Zhejiang University

Abstract: I will firstly talk about the general construction of fractal interpolation surfaces on rectangular grids. Then I will talk about the construction and box dimension of bilinear fractal interpolation surfaces.

MS FT-2-2 9 — 11:00-13:00

Approximation and PDE for high dimensions and manifolds - Part 1

For Part 2 see: MS FT-2-2 10

Organizer: Ian Sloan	University of New South Wales

Abstract: Approximation problems nowadays appear in many different settings, frequently high-dimensional, often for functions living on manifolds. Uncertainty quantification often leads to partial differential equations (PDE) with many parameters. In this two part minisymposium the talks will explore many of the key contemporary developments in these areas.

11:00-11:30

High dimensional computation

Ian Sloan University of New South Wales

Abstract: In this talk I shall give a brief introduction to recent work on the design and analysis of high dimensional integration and approximation, especially in the context of quasi-Monte Carlo methods.

11:30-12:00

Multilevel Quasi Monte Carlo methods for elliptic PDEs driven by spatial white noise

Matteo Croci University of Oxford
Michael B. Giles University of Oxford
Marie E. Rognes Simula Research Laboratory
Patrick E. Farrell University of Oxford

Abstract: This talk focuses on the efficient sampling of spatial white noise for the solution of white noise-driven PDEs using quasi-random points in a FEM and multilevel Quasi Monte Carlo setting. We express white noise as a wavelet series expansion that we sample via a hybrid QMC/MC approach. We show how this sampling can be performed in linear time and memory complexity in the number of mesh cells via a supermesh construction even on non-nested hierarchies.

12:00-12:30

Kernel-based reconstructions for parametric PDEs

Holger Wendland University of Bayreuth
Rüdiger Kempf University of Bayreuth
Christian Rieger University of Bonn

Abstract: In uncertainty quantification, an unknown quantity has to be reconstructed which depends typically on the solution of a parametric PDE. To approximate this quantity one thus has to solve the PDE numerically for several instances of the parameters and then reconstruct the quantity from these simulations. As the number of parameters may be large, this becomes a high dimensional reconstruction problem. In this talk, I will discuss kernel-based reconstruction methods on sparse grids.

12:30-13:00

Local Lagrange polynomials and the BBO paradigm

Joseph Ward Texas A & M University

Abstract: In their 2003 paper "Survey of Meshless and Generalized Finite Element Methods: A Unified Appproach", Babuska, Banerjee and Osborne (BBO) outlined a general program and basic properties that any good meshfree method should possess. In this talk we will focus on trial (approximation) spaces whose bases consist of local Lagrange functions constructed using polyharmonic or Matern kernels. We will discuss several approximation properties of these spaces in terms of the BBO paradigm.

MS GH-0-2 9 11:00-13:00

Transport phenomena on textured surfaces: mathematical modelling and applications - Part 1

For Part 2 see: MS GH-0-2 10

Organizer: Darren Crowdy Imperial College London

Abstract: In the past two decades numerous laboratories have microfabricated surfaces with the chemical and textural properties to mimic superhydrophobic surfaces (SHs) found in nature, the most well-known being the self-cleaning properties of the lotus leaf. This has been made possible by the continuing advances in nano/micro fabrication technology. This 2-part minisymposium will bring together engineers, physicists, and applied mathematicians in a multi-physics framework to discuss recent modelling advances.

11:00-11:30

A theory for the drag reduction of surfactant-contaminated superhydrophobic surfaces in laminar flows

Fernando Temprano-Coleto UCSB

Abstract: Surfactants are increasingly being considered in the study of flows over superhydrophobic surfaces (SHS), since even trace amounts of these substances induce Marangoni stresses that can prevent their drag reduction. We build a theory for surfactant-contaminated SHS by combining scaling relations for the surfactant transport with analytical solutions for laminar channel flow. Our model predicts the drag as a function of the dimensionless groups of the problem, and it is evaluated against numerical simulations.

11:30-12:00

Rotation of a superhydrophobic cylinder in a viscous liquid

Michael Siegel New Jersey Institute of Technology
Ehud Yariv Technion

Abstract: We consider a model of a superhydrophobic cylinder rotating in a viscous liquid. The boundary of the cylinder is assumed to contain alternating no-slip and no-shear surfaces (of possibly different sizes), with transverse flow. Our main interest is in computing the hydrodynamic torque on the cylinder. An explicit solution to the flow problem is obtained using classical theory of complex variables, combined with asymptotic analysis. This work is joint with Ehud Yariv (Technion).

12:00-12:30

Nusselt Numbers from Matched Asymptotic Expansions for Internal Liquid Flows in the Cassie State over Parallel and Transverse Ridges

Marc Hodes Tufts University
Daniel Kane Tufts University
Toby Kirk Oxford University

Abstract: We develop expressions for Poiseuille and Nusselt numbers for internal, liquid flows in the Cassie state through a microchannel textured on one side with parallel or transverse ridges by the use of matched asymptotic expansions. In the case of the Nusselt numbers, our results are new and we compare them to previous analytical and numerical ones. The implications of our results on the direct liquid metal cooling of microelectronics are discussed.

12:30-13:00

Hydrodynamic friction reduction using textured superhydrophobic surfaces

Clarissa Schoenecker TU Kaiserslautern

Abstract: Superhydrophobic surfaces can provide a significant slip to a fluid, making them attractive for the development of drag-reducing coatings. In this talk, an analytical model is presented that describes the flow field and the effective slip length for flow over a microstructured surface with rectangular grooves of arbitrary geometry and filled with a Newtonian fluid of arbitrary viscosity. By making use of complex analysis, it provides explicit expressions for the design of drag-reducing surfaces.

MS ME-1-G 9 11:00-13:00

Rings, wrinkles, and vortices: Singularities, nonlinear PDE, and materials science - Part 1

For Part 2 see: MS ME-1-G 10

Organizer: Maria Westdickenberg RWTH
Organizer: Lia Bronsard McMaster University

Abstract: Models from materials science pose significant mathematical challenges including how to handle singularities and how to identify effective energies and macroscopic behavior in the presence of small-scale oscillations or defects. In the opposite direction, recent advances in nonlinear PDE and the calculus of variations offer insights into modelling, numerical simulation, and industrial applications involving semiconductors, liquid crystals, fluid flows, and elasticity. We survey recent progress.

11:00-11:30

Multiscale problems in dislocation theory

Lucia Scardia Heriot-Watt University
Maria Giovanna Mora Universita' di Pavia
Mark Peletier Eindhoven University of Technology
Adriana Garroni Sapienza Universita' di Roma
Patrick Van Meurs Kanazawa University
Luca Rondi Universita' di Milano

Abstract: Dislocations are defects in the arrangement of atoms in metals, and they are the microscopic reason for the permanent deformation of metals at the macroscopic scale. In this talk I will present some results on the behaviour of large numbers of interacting dislocations, both from a static and from a dynamic perspective.

11:30-12:00

Interaction of a pair of vortices in two-component Ginzburg-Landau systems

Maria Aguareles Universitat de Girona

Abstract: In this talk we focus on a pair of interacting vortices for a two-component Ginzburg-Landau system in the whole plane. In particular we consider vortices with both fractional and integer degrees and we derive a law of motion for the centres of these vortices. We show that the vortices' velocities depend logarithmically on the vortices separation distance. We also study the effect of the parameters of the system on the law of motion.

12:00-12:30

Design of nematics through colloidal homogenisation

Arghir Zarnescu — BCAM (Basque Center for Applied Mathematics)

Abstract: We work within the framework of Landau-de Gennes variational theory of nematics and show how one can obtain from a given nematic material, say A, a desired aposteriori prescribed nematic material, say B, through a suitable homogenisation procedure of suitably chosen (depending on A and B) colloidal inclusions. This is joint work with Giacomo Canevari (Basque Center for Applied Mathematics).

12:30-13:00

Point and ring defects in nematic colloids

Xavier Lamy	Université Paul Sabatier
Stanley Alama	McMaster
Lia Bronsard	McMaster
Dmitry Golovaty	U of Akron

Abstract: I will present several results about the type of defects occurring near a colloid particle surrounded by nematic liquid crystal.

MS FE-1-G 9 — 11:00-13:00

Recent Advancements in Model Reduction for Stochastic and Nonlinear Systems - Part 1

For Part 2 see: MS FE-1-G 10

Organizer: Martin Redmann — Weierstrass Institute Berlin

Organizer: Pawan Goyal — Max Planck Institute, Magdeburg

Abstract: Many phenomena in real life can be described by partial differential equations. To find an accurate model, nonlinearities and uncertainties have to be taken into account along with a high order spatial discretization, leading to large-scale nonlinear/stochastic dynamical systems. As a result, it is hard to use these models in engineering studies such as control and optimization. To mitigate this issue, model order reduction (MOR) techniques are often used to reduce the order of large-scale nonlinear/stochastic systems and hence, reduce the computational complexity. In this minisymposium, we will discuss recent advances and perspectives in field of MOR for nonlinear/stochastic systems.

11:00-11:30

System-theoretic Model Reduction for Polynomial Systems

Peter Benner	MPI f. Dynamics of Complex Technical Systems
Pawan Goyal	Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg
Igor Pontes Duff	Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg

Abstract: System-theoretic model reduction methods for linear control systems have been successfully used in control and other engineering fields for decades. Most of them are related either to balanced truncation or rational interpolation of the associated transfer function. Generalizing these concepts to nonlinear systems in a computationally feasible way has been an open problem until recently. In this talk, we show how well-known methods for linear systems can be generalized to control systems with polynomial nonlinearity.

11:30-12:00

Infinite dimensional model approximation and its applications

Charles Poussot-Vassal — ONERA

Abstract: Infinite dimensional dynamical models naturally appear in industrial and academic applications. As an illustration, one may consider the solution of linear partial differential equations, or the control and analysis of delayed ordinary differential equations. For practitioners, this model class leads to many numerical and practical issues, starting from the simulation, the analysis, the optimization and the control. In this talk, we illustrate on industrial use-cases, how helpful model approximation can be to overcome these limitations.

12:00-12:30

Adaptive parameter sampling using surrogate error model

Lihong Feng	Max Planck Institute Magdeburg, Germany
Sridhar Chellappa	Max Planck Institute for Dynamics of Complex Technical Systems
Peter Benner	Max Planck Institute for Dynamics of Complex Technical Systems

Abstract: In the context of reduced basis method, the choice of an appropriate training set is critical in obtaining good reduced models over the entire parameter domain. In this talk, we propose an algorithm to adaptively construct the training set based on a surrogate error model obtained through radial basis function interpolation of the output error estimator. The proposed method is validated through numerical results on benchmark examples.

12:30-13:00

On variations of the discrete empirical interpolation for nonlinear model reduction

Zlatko Drmac	University of Zagreb
Serkan Gugercin	Department of Mathematics, Virginia Polytechnic Institute and State University
Benjamin Peherstorfer	Courant Institute of Mathematical Sciences, New York University
Arvind Saibaba	Department of Mathematics, North Carolina State University

Abstract: Empirical interpolation method (EIM) and its discrete versions DEIM/QDEIM are powerful model reduction tools in a variety of applications. We present numerical algorithm for a weighted DEIM/QDEIM, that can also be interpreted as a numerical implementation of the Generalized EIM. Further, we establish connections between sampling point selection of DEIM and clustering the trajectories. We also discuss the effects of randomized and deterministic oversampling in enhancing stability in the case of noisy data.

MS GH-0-1 9 — 11:00-13:00

Phase field method and applications in biology and materials science - Part 1

For Part 2 see: MS GH-0-1 10

Organizer: Lei Zhang — Peking University

Organizer: Yasumasa Nishiura — Tohoku University

Abstract: The phase field method is a powerful mathematical approach for solving interfacial problems. It has become an important and extremely versatile technique for modeling and simulating microstructure evolution at the mesoscale, such as phase transformations, vesicle dynamics, solidification dynamics, crack propagation and so on. We will present recent progress of numerical methods for various phase field models and share its new applications in biology and materials science.

11:00-11:30

From Janus to Ashura -A hierarchical structure of nanopolymer particles-

Yasumasa Nishiura	Tohoku University
Edgar Avalos	Tohoku University, AIMR
Takashi Teramoto	Asahikawa Medical University
Hiroshi Yabu	Tohoku university, AIMR

Abstract: Unique morphologies including Janus, Ashura and core-shell types and their combinations have been found both in experiments and the theoretical model. The model is a four-coupled Cahn-Hilliard equations. The affinity between the solvent and the polymers as well as interfacial interaction among polymers has been built in the model. This work opens the way to create polymer particles having sophisticated nanostructures with controlling their morphologies guided by theoretical model.

11:30-12:00

On efficient numerical methods for phase field equations

Zhonghua Qiao — The Hong Kong Polytechnic University

Abstract: We overview our recent works on modern computational methods for the approximate solution of phase-field problems. It is known that the phase field models satisfy a nonlinear stability relationship called gradient stability. We will discuss implicit-explicit time discretization methods which satisfy the energy stability. A time-adaptive strategy will be presented for solving the phase-field problems. Several numerical results will be given to demonstrate the efficiency and reliability of the proposed numerical methods.

12:00-12:30

A cytoplasmic pattern formation in asymmetric cell division and cell geometry

Tomohiro Nakahara	Hiroshima University
Sungrim Seirin-Lee	Hiroshima University

Abstract: Asymmetric cell division is one of elegant pattern formation process where a mother cell creates polarity in both membrane and cytosol, simultaneously. In C. elegans embryo, the contribution of downstream polarity of MEX-5/6 to the robust formation of the upstream polarity of PARs are critical but it has been poorly understood. In this study, we explore the role and underlying mechanism of cytoplasmic polarity of MEX-5/6 by developing a mathematical model that reflects cell geometry.

MS GH-1-1 9 11:00-13:00

Data driven industrial models and numerical optimisation techniques

Organizer: Choi-Hong Lai University of Greenwich

Abstract: There are significant interests in the construction of mathematical models using experimental and/or field data for many industrial processes. The main aim of this mini-symposium is to provide a communication platform for researchers from different background applications to share their experiences in using large amount of historical data for the extraction and identification of mathematical models in their own field of studies. Data uncertainties and inaccuracy will be treated. The topics of this minisymposium includes, but not limited to, data modelling for different industrial applications, image processing and computational finance, and their related mathematical theories and methods.

11:00-11:30

Shape group Boltzmann machine for simultaneous object segmentation and action classification

Chen Fei	Fuzhou University, China

Abstract: Traditionally, object segmentation and action classification in vision have been solved as two independent problems, even though it is often the case that the solution to one impacts the solution to the other. In this paper, a general variational framework is developed to use shape group Boltzmann machine to simultaneously segment object and classify action from multiple images. The collaboration between high-level and low-level can efficiently improve the results of segmentation and action classification simultaneously.

11:30-11:35

A generalised defect correction method for nonlinear option pricing

Choi-Hong Lai	University of Greenwich

Abstract: The Black-Scholes partial differential equation with nonlinear volatility and correction for discrete hedging is considered. The technique of defect correction method is adapted to handle the nonlinear partial differential equations. Several examples to motivate the use of defect correction method and the adaptation of it to handle asymptotic expansion. The nonlinear correction term is to be discussed in detail. Computational results of a European option pricing example is used to demonstrate the defect correction method.

12:00-12:30

Risk Sensitivity Analysis of Hedge Fund Distribution Replication Model

Meiqing Wang	Fuzhou University
Huiping Sun	Fuzhou University
Fang Lin	Fuzhou University
Qianying Hong	

Abstract: Hedge fund distribution replication technology replicates the distribution function of a given hedge fund's return by using some portfolio of low-cost but highly transparent and highly liquid financial instruments, aims to acquire an approximate return of the hedge fund. In this paper we will analyze the risk sensitivity of the hedge fund distribution replication model, that is, the variance of the portfolio weights due to the estimation errors.

12:30-13:00

A Review of Recent Advances in Image Cosegmentation techniques

Haiping Xu	Minjiang University

Abstract: Recent advances in the corporate processing of images have exhibited its advantages over the individual processing. Image co-segmentation aims to segment shared objects from two or more relevant images. Although numerous techniques have been proposed, it is still lacking a deep review of image co-segmentation techniques. In this paper, we provides a review on the image co-segmentation techniques. We expect this review to be beneficial to both fresh and senior researchers in this field.

MS ME-1-1 9 11:00-13:00

Dynamical systems with applications to science and engineering

Organizer: J. Alberto Conejero Universitat Politècnica de València
Organizer: Juan L. G. Guirao. Universidad Politécnica de Cartagena

Abstract: In this minisymposium, we will present recent developments and discoveries in the field of continuous and discrete dynamical systems. Contributions will combine recent theoretical results with applications to industrial problems appearing in different areas such as: the design of opportunistic communication networks, the description of biological processes, and the search of patterns in electric signals.

11:00-11:30

Dynamics of the data dissemination in 5G opportunistic networks

J. Alberto Conejero	Universitat Politècnica de València
Carlos Orea	GRC - Universitat Politècnica de València
Enrique Hernández-Orallo	GRC - Universitat Politècnica de València
Marina Murillo-Arcila	iMAC - Universitat Jaume I
Juan-Carlos Cano	GRC - Universitat Politècnica de València
Carlos T. Calafate	GRC - Universitat Politècnica de València
Pietro Manzoni	GRC - Universitat Politècnica de València

Abstract: Ne 5G wireless technologies, such as WiGig, can offer multi-gigabit speeds, low latency, and security-protected connectivity between nearby devices. We study the impact of high-speed and short-range wireless communications technologies for data dissemination in mobile opportunistic networks, that can eventually be supported by infrastructure. We use SIR models, combined with real data, to study the diffusion of messages through the opportunistic contacts between mobile nodes in order to test the diffusion coverage.

11:30-12:00

On the dynamics associated to the Black-Scholes equation

Alfred Peris	Universitat Politecnica de Valencia
Olga Baranova	Universitat Politècnica de València
Salud Bartoll	Universitat Politècnica de València
Felix Martinez-Gimenez	Universitat Politècnica de València
Francisco Rodenas	Universitat Politècnica de València

Abstract: We study the solution semigroup associated to the Black-Scholes equation concerning one of the strongest versions of chaos for continuous dynamical systems, namely the specification property. In this case, the phase space plays a key role for this kind of dynamics. The specification property for C0-semigroups (SgSP) implies other well-known dynamical properties: mixing, Devaney's chaos, distributional chaos and frequent hypercyclicity.

12:00-12:30

Generalized Stieltjes and other integral operators on Sobolev-Lebesgue spaces

Jesús Oliva	
Pedro Miana	Universidad de Zaragoza

Abstract: For $\mu > \beta > 0$, the generalized Stieltjes operators are defined in Sobolev spaces of fractional order of derivation and embedded in L^p . If $1/p < \beta < 1/p + \mu$, then operators $S_{\beta,\mu}$ are bounded commute and factorize with generalized Cesáro operator. We represent explicitly their spectrum set. We show connections with the Fourier and the Hilbert transform and a convolution product defined by the Hilbert transform. This is a joint work with Pedro Miana.

12:30-13:00

Visibility Graphs of Fractional Wu-Baleanu Time Series

Cristóbal Rodero-Gómez	King's College London
J. Alberto Conejero	Instituto Universitario de Matemàtica Pura y Aplicada, UPV, València, Spain
Carlos Lizama	Dpt. de Matemática y Ciencias de la Computación, USACH, Chile
Ainara Mira-Iglesias	FISABIO, Valencia, Spain

Abstract: We study time series generated by the fractional discrete maps introduced by Wu and Baleanu. For the values of the parameters that yield chaotic time series, we have studied the Shannon entropy of the degree distribution of the visibility graphs associated. We have compared it with the exponent of the power law fitting to the degree distribution for the different values of the fractionary exponent and the scaling factor of the model.

MS GH-1-G 9 11:00-13:00

Control, Optimization, and Numerical Methods for Infinite Dimensional Systems - Part 3

For Part 1 see: MS GH-1-G 7
For Part 2 see: MS GH-1-G 8

Organizer: Weiwei Hu — Oklahoma State University
Organizer: Wei Gong — Chinese Academy of Sciences

Abstract: The aim of this minisymposium is to bring together scientists working on control, optimization and numerical methods for addressing the emerging problems in infinite dimensional systems and the related applications. This minisymposium will present recent developments in the topics such as control and estimation with non-smooth and sparsity structures; control of hyperbolic systems; numerical schemes for solving control systems with delays, optimal control of stochastic PDEs and fractional optimal control problems, etc. This forum will foster the international collaborations as well as provide an opportunity for young researchers to present their work and learn the state-of-the-art progress in this field.

11:00-11:30

A posteriori error estimates of Galerkin spectral methods for fractional optimal control problems

Yanping Chen — South China Normal University

Abstract: In this talk, Galerkin spectral discretization of a control constrained space-time fractional optimal control problem is investigated analytically. Both temporal and spatial directions for this problem are discretized by spectral methods. Based on this scheme, a priori and a posteriori error estimates of the optimal control problem are analyzed. Additionally, a priori and a posteriori error estimates of spectral approximation for the fractional optimal control problem with state constraints are rigorously established.

11:30-12:00

Optimal control in oscillatory domains and homogenization

Akambadath Keerthiyil Nandakumaran — Indian Institute of Science Bangalore

Abstract: We discuss asymptotic analysis of optimal control problems in domains with rapidly(highly) oscillating boundaries. First we present the work which we are carrying out in my group and later we present some specific results. We introduce unfolding operators through which we characterize the optimal controls. Finally, we do homogenization process and obtain limit control problem.

12:00-12:30

Numerical Approximations for Optimal Control Problems of Stochastic PDEs

Hyung-Chun Lee — Ajou University

Abstract: In this talk, we consider optimal control problems for the stochastic PDEs with random inputs. To determine an applicable deterministic control, we consider the several cases which we compare for efficiency and feasibility. We prove the existence of optimal states, adjoint states and optimality conditions for each cases. The optimality system is then discretized by a finite element method for physical space and Monte Carlo method for probability space, respectively. The numerical experiments are performed.

MS GH-1-3 9 11:00-13:00

Mathematical Models for Membrane Filtration - Part 2

For Part 1 see: MS GH-1-3 8

Organizer: Pejman Sanaei — Courant Institute of Mathematical Sciences, New York University
Organizer: Daniel Fong — U.S. Merchant Marine Academy

Abstract: Membrane filters -- essentially, thin sheets of porous medium which act as filters -- are in widespread industrial use (e.g. treatment of radioactive sludge, various purification processes in the biotech industry, the cleaning of air or other gases), and represent a multi-billion dollar industry in the world. Major multinational companies manufacture a huge range of membrane-based filtration products, and maintain a keen interest in improving and optimizing their filters. While the underlying applications and the details of the filtration may vary dramatically, the broad engineering challenge of efficient filtration is the same: to achieve finely-controlled separation at low power consumption.

11:00-11:30

An improved model for flow and fouling in a pleated membrane filter

Daniel Fong — U.S. Merchant Marine Academy
Pejman Sanaei — New York University

Abstract: Pleated filter cartridges are widely used to remove undesired impurities from a fluid. Although this arrangement offers a high ratio of surface filtration area to volume than a flat membrane filter, the performance is inferior. In this work, we present an extension to the purely 2D model in Sanaei et. al., JFM, 2016, to investigate the effects of axial variations in pressure drop and to introduce a more sophisticated description of the cartridge geometry.

11:30-12:00

Understanding the benefits of porosity gradients in membrane filtration via homogenization

Mohit Dalwadi — University of Oxford
Maria Bruna — University of Oxford
Ian Griffiths — University of Oxford

Abstract: Filters for which the porosity decreases with depth can improve filtration efficiency. However, the underlying mechanisms for this are unclear. We present a model to investigate this phenomenon. We use asymptotic homogenization to systematically upscale the problem from the pore to the filter scale, including the time-dependent effect of pore constriction. We show how porosity-graded filters can be more efficient, and use our model to determine the 'ideal' filter, which blocks everywhere at once.

12:00-12:30

Modelling Purification of Flue Gas in Porous Catalytic Media

Kristian Kiradjiev — Mathematical Institute, University of Oxford
Chris Breward — University of Oxford
Ian Griffiths — University of Oxford
Donald Schwendeman — RPI
Uwe Beuscher — Gore
Vasudevan Venkateshwaran — Gore

Abstract: In this talk, we present a mathematical model for flue-gas purification in a porous filter with catalyst. In particular, we consider a device that converts sulphur dioxide into liquid sulphuric acid which accumulates, causing clogging. Using the theory of homogenisation, we develop a multiscale model that takes into account local properties of the filter to describe the overall device operation. We explore the effect of changing various dimensionless parameters on the filter efficiency.

MS FT-4-7 9 11:00-13:00

Numerical methods for PDE-based multi-physics models in biomechanics - Part 4

For Part 1 see: MS FT-4-7 6
For Part 2 see: MS FT-4-7 7
For Part 3 see: MS FT-4-7 8
For Part 5 see: MS FT-4-7 10

Organizer: Ricardo Ruiz Baier — University of Oxford
Organizer: Kent-Andre Mardal — University of Oslo

Abstract: The scope of the proposed minisymposium deals with the numerical approximation of multiphysics models in biomechanics. First, a particular emphasis will be placed on rigorous convergence analysis, tailored domain decomposition techniques, recent mixed finite element and hybrid discretizations, boundary element methods, design and analysis of preconditioners. Secondly, the session will focus on the application of these new methodologies in the solution of PDE-based coupled models arising in biomechanics and related systems. For instance, we especially welcome submissions involving brain multiphysics, cardiac electromechanics, or respiratory system modelling; as well as more general fluid-structure interaction, and multiscale and/or multiphysics problems.

11:00-11:30

Variational coupling for multi-physics simulation in HPC

Rolf Krause — Universita della Svizzera Italiana
Patrick Zulian — USI Lugano

Maria Nestola USI Lugano

Abstract: The numerical solution of coupled problems in biomechanics requires stable transfer operators for quantities such as displacements and stresses. In particular for non-matching meshes - volume or surfaces- a stable imformation transfer has to be guaranteed. We employ (pseudo-) L2 projections. We discuss the realization in the context of massively parallel computations. Examples from biomechnics, including contact in joints and fluid-structure interaction for heart valves illustrate the capabilities of our coupling approach.

11:30-12:00

Monotone nonlinear DDFV scheme for degenerate and anistropic Keller-Segel model

Mazen Saad Ecole Centrale Nantes

Abstract: Our aim is to analyze the convergence of a combined FV/FE scheme for a degenerate Keller-Segel model with general tensors over general meshes. We focus on the construction of positives schemes to ensure the discrete maximum principle and therefore the confinement of the density of cells and the positivity of the chemical concentration. We consider a nonlinear Control Volume Finite Element scheme based on the Godunov scheme to approximate the degenerate diffusion fluxes.

12:00-12:30

A fluid-structure interaction problem with slip boundary condition of friction type on the interface

Leonardo Baffico Université de Caen Normandie

Abstract: We study an unsteady fluid-structure interaction problem modelized by the incompressible Navier-Stokes equation and a generalized membrane equation. On the fluid-structure interface we use a slip boundary condition of friction type, known as Tresca boundary condition. After a system energy study, we will present a discretization based on the Characteristic-ALE method and on a four-field mixed variational formulation. Finally, we will present some numerical simulations inspired from the study of blood flows in arteries.

MS ME-0-3 9 **11:00-13:00**

Delay and other dynamical systems with applications to mathematical biology - Part 3

For Part 1 see: MS ME-0-3 7
For Part 2 see: MS ME-0-3 8

Organizer: Elena Braverman Department of Mathematics and Statistics, University of Calgary

Abstract: The purpose of this minisymposium is to bring experts in delay differential, difference and partial differential equations and and to discuss recent advancement in the area, as well as applications of dynamical systems to emerging areas of mathematical biology. In theoretical advancement, the focus is on asymptotic behaviour, in particular local and global stability, and its control. The areas of application include population dynamics, in a laboratory setting such as a chemostat, and in nature, as well as gene regulatory networks. We plan to bring together a really international team of experts from more than 6 countries.

11:00-11:30

Asymptotic properties of linear delayed differential systems with constant coefficients and constant delays

Zdenek Svoboda Brno University of Technology

Abstract: Some asymptotic properties of solutions to linear differential systems with constant coefficients and constant delays will be discussed using fundamental matrices given in the form of special delayed matrix functions. The Lambert function is used to analyse asymptotic properties of these matrix functions.

11:30-12:00

Dynamics of Some Compartmental Models

Elvan Akin Missouri University S&T
Gulsah Yeni Missouri University S&T

Abstract: In this talk, we derive exact solutions to SIR (susceptible-infected-recovered) and SIS (suspectible-infected-suspectible) epidemic models described by two dimensional nonlinear systems of first order dynamic equations on time scales and discuss the asymptotic behaviors of the number of suspectibles and infectives. Our approach is based on the Bernoulli dynamic equation. We also illustrate our results with examples where the number of infectives in the population is obtained on different time scales.

12:00-12:30

Persistence in nonautonomous quasimonotone parabolic partial fuctional differential equastions w

Rafael Obaya Universidad de Valladolid

Abstract: This talk provides a dynamical frame to study non-autonomous parabolic partial differential equations with finite delay. Assuming monotonicity of the linearized semiflow, conditions for the existence of a continuous separation of type II over a minimal set are given . Then practical criteria for the uniform or strict persistence of the systems above a minimal set are obtained

12:30-13:00

Relative controllability of linear delayed discrete systems with constant coefficients

Josef Diblík Brno University of Technology

Abstract: A problem of relative controllability described by the discrete systems is considered. By a formula that uses special matrix functions (discrete delayed matrix sine and cosine) to compute solution of the initial problem, a criterion is found for relative controllability. A control function in terms of special matrix functions, solving the problem on relative controllability, is constructed. The results are illustrated by examples.

MS A6-3-3 9 **11:00-13:30**

New Developments in Computational Modeling of Cryosphere Systems

Organizer: Irina Tezaur Sandia National Laboratories

Abstract: Recent changes in the cryosphere – the frozen part of the earth system – have had a major impact on global climate. Accurate and efficient computer modeling of these climate components and their interaction is essential, as it can direct infrastructure planning and inform public policy. This minisymposium focuses on new computational methodologies for simulating cryosphere systems (land ice, sea ice, permafrost) and their interaction. Some of the topics covered are: new discretizations/solvers; new constitutive models for ice/permafrost rheology; mechanics-based formulations of ice/permafrost demise; multiscale methods for coupling models with different spatial/temporal scales; approaches for model initialization/calibration, UQ, data assimilation.

11:00-11:30

Strongly-coupled thermo-mechanical model of permafrost for the simulation of Arctic coastal erosion

Alejandro Mota Sandia National Laboratories

Abstract: We advance a strongly coupled thermo-mechanical model for the simulation of erosion of the permafrost of the Arctic coast of Alaska. The PDEs governing the mechanical and thermal behavior of a combination of ice and frozen soil are solved in a monolithic fashion by means of the finite element method. We present the results of modeling representative geometries devised from field surveys and data collected from the Northern Alaskan coast.

11:30-12:00

Methane hydrate modeling across the scales

Malgorzata Peszynska Oregon State University

Abstract: Methane hydrate plays an important role in the planetary scale climate model: it is stable at (IThP) low temperature and high pressure conditions, and dissociates large volumes of gas outside (IThP). We discuss hydrate models at the basin and reservoir scales including well-posedness and numerical analysis. These depend on the dynamics of hydrate the pore scale, but imaging and experiments are difficult due to (IThP), thus we propose pore-scale models which can be surrogates.

12:00-12:30

Fracture of an ice floe: modelisation and simulation

Dmitri Balasoiu Université Grenoble Alpes

Abstract: We developed a fracturation model fast enough to be part of our granular model for sea ice contact, where a high number (~1 million) of ice floes are colliding. The model is based on the variational Griffith's criterion of Francfort and Marigo. Instead of the usual phase-field approximation, we make the assumption that fractures are polylines. We prove the existence of solutions, and develop an ad-hoc finite-element method where the fracture location is mesh-independent.

12:30-13:00

Predicting Arctic Sea Ice Concentration with Data-Driven Models

Matt Peterson Sandia National Laboratories

Abstract: We present preliminary results on training data-driven models to predict Arctic summer sea ice concentration levels data from prior months such as air temperature, sea surface temperature, current sea ice concentration, and solar radiation. Our eventual goals are to develop similar models to predict ice concentration levels throughout the summer season, and compare models based on observational data to equivalent models based on simulated data to identify possible improvements to the climate simulation models.

13:00-13:30

Finite Element Ice Sheet Modelling - Error Analysis and New Techniques

Josefin Ahlkrona	Stockholm University
Daniel Elfverson	Umeå University

Abstract: The Finite Element Method (FEM) is an attractive numerical discretisation technique, due to its strong mathematical foundation and its flexibility. In many cases standard FEM techniques developed for general computational fluid dynamics problems are applied in glaciology. However, glaciology offers peculiar challenges such as moving meshes and varying viscosity. In this talk we present new methods for modelling the thin ice domain and moving ice surface, especially adapted to the p-Stokes ("full Stokes") equations.

MS A6-5-3 9 — 11:00-13:00

Recent Advances in Modelling Complex Oscillations in the Brain's Physiopathology

Organizer: Maurizio De Pitta	BCAM -- BASQUE CENTER FOR APPLIED MATHEMATICS
Organizer: Serafim Rodrigues	BCAM-Basque Center for Applied Mathematics

Abstract: Complex oscillatory dynamics is ubiquitous in the brain's pathophysiology yet our understanding of their emergence and death is challenged by the complexity of the brain as a system, whose dynamics unfolds on multiple spatial and temporal scales. This workshop showcases analytical and numerical approaches recently developed to characterise oscillatory dynamics of complex cellular networks of the brain, with the overarching goal to characterise non-equilibrium dynamics of neural tissue in relation with complex brain's computations. The panel features speakers with multidisciplinary background in mathematics, physics, and bioengineering who are expected to attract a wide audience.

11:00-11:30

Multistable neuron-glial networks in health and disease

Maurizio De Pitta	BCAM -- BASQUE CENTER FOR APPLIED MATHEMATICS

Abstract: Modeling of realistic brain networks to incorporate glial cells into neuronal circuits makes neurons' couplings time-dependent while challenging prediction of networks' dynamics. In the thermodynamic limit, reduction of point-process neuronal and glial activities to Langevin-type equations can predict the network's mean-field dynamics. Self-consistency equations for the stationary state reveal multistability, in agreement with simulations of stochastic neuron-glial networks, ultimately linking glia to emergence of persistent patterns of pathophysiologically-relevant neuronal activity.

11:30-12:00

Canards and spike-adding in neural bursters

Mathieu Desroches	Inria Sophia Antipolis Méditerranée
Tasso Kaper	Boston University (USA)
Martin Krupa	Université Côte d'Azur (Nice, France)
Serafim Rodrigues	BCAM - Basque Center for Applied Mathematics (Bilbao, Spain)

Abstract: In this talk, I will present recent work on multiple timescale dynamical systems displaying complex oscillations with both slow and fast processes, the latter being referred to as bursts in the neuronal context. I will showcase several examples both biophysical origin as well as mathematical caricatures that are both able to retain the salient features of the detailed biological models and more amenable to mathematical analysis.

12:00-12:30

Dynamics of Emergence, Self-Organization and Propagation of Cortical Slow Oscillations

Belen Sancristóbal	University Pompeu Fabra
Jordi Garcia-Ojalvo	Universitat Pompeu Fabra
Maria V Sanchez-Vives	IDIBAPS
Mara Dierssen	CRG

Abstract: By means of a conductance based neuronal network we have studied several dynamical properties of the slow oscillations, which are the hallmark of NREM sleep and deep anesthesia. In particular, I will show how they emerge and propagate across a 2D modeled structure and I will present experimental data to validate our numerical results. Moreover, we have studied the behavior of such network under certain connectivity disruptions that are characteristic of the Down Syndrome phenotype.

12:30-13:00

Rigorous results on asymptotic behaviour of structured neuron population models

José A. Cañizo	Universidad de Granada
Havva Yoldas	BCAM / Universidad de Granada

Abstract: Based on probabilistic arguments, we give a proof that several models for neuron populations structured by the time since the last discharge approach an equilibrium exponentially fast. We work in a regime in which the links between neurons are weak, the so-called "weakly nonlinear" setting. In other settings it is expected that a periodic behaviour takes place, but there is no mathematical proof of this except in very particular cases.

MS GH-3-5 9 — 11:00-13:00

Tools and Technologies of the SciDAC FASTMath Institute - Part 2

For Part 1 see: MS GH-3-5 8

For Part 3 see: MS GH-3-5 10

Abstract: The FASTMath (Frameworks, Algorithms and Scalable Technologies for Mathematics) Institute is a R&D project funded by the SciDAC Program at the U.S. Department of Energy (DOE). The goal of FASTMath is to develop and deploy scalable mathematical algorithms and software tools for reliable simulation of complex physical phenomena. The focus of FASTMath is strongly driven by the requirements of DOE application scientists who require fast, accurate, and robust forward simulation along with the ability to efficiently perform ensembles of simulations in optimization or uncertainty quantification studies. This minisymposium will provide an overview of FASTMath.

11:00-11:30

Scalable High Order Finite Elements with MFEM

Tzanio Kolev	Lawrence Livermore National Laboratory
Mark Stowell	Lawrence Livermore National Lab
Veselin Dobrev	Lawrence Livermore National Lab
Aaron Fisher	Lawrence Livermore National Lab
Jean-Sylvain Camier	Lawrence Livermore National Lab
Jakub Cerveny	Lawrence Livermore National Lab

Abstract: In this talk we present an overview of MFEM (mfem.org), a scalable library for finite element discretization of PDEs on general unstructured grids which is part of FASTMath. We describe our recent research in mesh optimization, unstructured adaptive mesh refinement, high-order methods and discretizaiton-enhanced preconditioning. We will also discuss the software abstractions provided by the library, the implementation of GPU-optimized algorithms, and present results from collaborations with SciDAC and ECP applications.

11:30-12:00

The SUNDIALS Suite of Nonlinear Differential-Algebraic Solvers: Status and Plans

Carol Woodward	Lawrence Livermore National Laboratory
Daniel Reynolds	Southern Methodist University
David Gardner	Lawrence Livermore National Laboratory
Alan Hindmarsh	Lawrence Livermore National Laboratory
Cody Balos	Lawrence Livermore National Laboratory

Abstract: SUNDIALS is a suite of robust and scalable solvers for systems of ordinary differential equations, differential-algebraic equations, and nonlinear equations. As part of the DOE's Exascale Computing Program and FASTMath Institute, SUNDIALS is enabling time integrators for exascale architectures. Each package in SUNDIALS is built on a common vector and solver API allowing for application-specific structures and solvers, encapsulated parallelism, and algorithmic flexibility. We will summarize capabilities of SUNDIALS and overview current development efforts.

12:00-12:30

The Toolkit for Advanced Optimization: Bound-Constrained Optimization Methods

Todd Munson Argonne National Laboratory
Alp Dener Argonne National Laboratory
Adam Denchfield University of Illinois at Chicago

Abstract: The Toolkit for Advanced Optimization delivers reliable, efficient algorithms for solving numerical optimization problems for high-performance computers. In this talk, I will focus on our efforts to improve the reliability and efficiency of the bound-constrained optimization methods by delving into preconditioned nonlinear conjugate gradient and quasi-Newton methods. Numerical results using the CUTEst suite of test problems will be provided to showcase the benefits of preconditioning these methods.

12:30-13:00

A 2D Task-based Fan-both Factorization Algorithm for Sparse Symmetric Matrices

Mathias Jacquelin Lawrence Berkeley National Laboratory

Abstract: In this work, we present a new 2D data distribution of a sparse symmetric matrix, which balances the workload and the number of nonzero entries explicitly. We have incorporated low-overhead task-based Cholesky and LDLt algorithms in the symPACK solver using this new distribution, implemented using a custom runtime environment based on the UPC++ communication framework. We analyze the performance achieved during the numerical factorization as well as that of the solution phase.

MS A3-3-1 9 **11:00-13:00**

Recent advances on electronic structure calculations - Part 2

For Part 1 see: MS A3-3-1 8
For Part 3 see: MS A3-3-1 10

Organizer: Zhenning Cai National University of Singapore
Organizer: Guanghui Hu University of Macau
Organizer: Chao Yang Lawrence Berkeley National Laboratory

Abstract: This minisymposium focuses on recent progress of mathematical analysis and numerical methods for performing electronic structure calculations as well as the materials science and chemistry applications that benefit from this type of calculations. The topics covered in this minisymposium include, but are not limited to, efficient algorithms for large-scale DFT and TDDFT calculations, wavefunction based methods, structure optimization, nano-optics, quantum hydrodynamic models, many-body perturbation theory based approaches, and machine learning techniques that combine experimental data and simulation to improve materials modeling and design capabilities.

11:00-11:30

New features and performance improvements in the SIESTA code

Alberto Garcia Institut de Ciencia de Materials de Barcelona

Abstract: SIESTA is a density-functional-theory code, widely used in many disciplines for its ability to treat relatively large systems, which stems from its basis set of strictly localized atomic orbitals. In the past few years a number of new implementations have expanded its functionality and enabled its use in massively parallel architectures. Significant further improvements are foreseen within the MaX (Materials at the Exascale) Center of Excellence project funded by the EU (http://www.max-centre.eu).

11:30-12:00

Efficient Numerical Methods for Accelerating Ab Initio Molecular Dynamics Simulations

Eiji Tsuchida National Institute of Advanced Industrial Science and Technology

Abstract: In ab initio molecular dynamics simulations, the trajectory is generated by integrating the Newton's equations of motion for the atoms, where the interatomic forces are obtained by solving the Kohn-Sham equations for the electrons. We present several independent numerical algorithms for efficient solution of these equations with emphasis on our recent work, such as iterative diagonalization in mixed precision arithmetic and enhanced sampling of the phase space through optimization of time steps and atomic masses.

12:00-12:30

Implementation of the Projector Augmented-Wave (PAW) Method: The Use of Atomic Datasets in the Standard PAW-XML Format

Jun Fang IAPCM
Xingyu Gao Institute of Applied Physics and Computational Mathematics
Haifeng Song Institute of Applied Physics and Computational Mathematics

Abstract: The PAW atomic dataset plays an essential role in the implementation and application of the PAW method. The intensive use of proprietary datasets in previous years has led to difficulties in both the cross-validation of codes and the understanding of accuracy and transferability of atomic data. We focus on the open-source Jollet–Torrent–Holzwarth dataset library in the PAW-XML format and propose an intermediate dataset which facilitates the implementation and covers the differences between PAW datasets.

MS FT-0-2 9 **11:00-13:00**

Mean Field Games: New Trends and Applications - Part 3

For Part 1 see: MS FT-0-2 2
For Part 2 see: MS FT-0-2 3
For Part 4 see: MS FT-0-2 4
For Part 5 see: MS FT-0-2 5
For Part 6 see: MS FT-0-2 1

Organizer: Francisco José Silva Alvarez Techniques Université de Limoges
Organizer: Adriano Festa L'Aquila university
Organizer: Daniela Tonon Paris Dauphine University

Abstract: Mean Field Games (MFGs) problems have been introduced by Lasry-Lions and Huang-Caines-Malhamé in 2006. This theory describes Nash equilibria of some differential games with infinitely many players. In light of the numerous applications of MFGs, which include Economics, Finance and Social Sciences, several mathematical techniques are currently employed for its development. The scope of this minisymposium is to bring together several specialists in MFGs in order to present recent progress on the area and open problems. Among the topics covered in the minisymposium sessions are: analytic, probabilistic and numerical aspects of MFGs, and the applications mentioned in the paragraph above.

11:00-11:30

A numerical method for non-linear Fokker Planck equations and applications to Mean Field Games

Elisabetta Carlini Sapienza Università di Roma

Abstract: We propose a fully discrete scheme, of semi-Lagrangian type, for a system of non linear and non local Fokker-Planck-Kolmogorov equations. We show a convergence result under large time steps. We apply the scheme to solve a new Hughes-type model, for which we prove an existence result by applying the convergence analysis, and to a two populations Mean Field Games.

11:30-12:00

First order proximal methods in Mean Field Games with local couplings

Luis Briceño-Arias Universidad Técnica Federico Santa María
Dante Kalise Imperial College
Silva Alvarez Francisco J. Université de Limoges

Abstract: We address the numerical approximation of Mean Field Games with local couplings. For power-like Hamiltonians, we consider stationary systems with density constraints in order to model hard congestion effects. For finite difference discretizations of the Mean Field Game system, we follow a variational approach. We prove that the aforementioned schemes can be obtained as the optimality system of suitably defined optimization problems. Next, we study and compare several efficiently convergent proximal first-order methods.

12:00-12:30

Weak error expansion for Mean Field SDE.

Jean-François Chassagneux Université Paris Diderot

Abstract: We study the weak approximation error by particle system of Mean Field SDE. We prove an expansion of this error in terms of the number of particle. Our strategy of proof follows the approach of Talay-Tubaro for weak approximation of SDE by an Euler Scheme. We thus

consider a PDE on the Wasserstein space (called the Master Equation in MFG) and, relying on smoothness properties of the solution, obtain our expansion.

12:30-13:00

Dynamic Programming for Finite Ensembles of Nanomagnetic Particles

Max Jensen	Sussex University
Ananta Majee	IIT Delhi
Andreas Prohl	Universität Tübingen
Christian Schellnegger	Universität Tübingen

Abstract: We discuss optimal control of stochastic Landau-Lifshitz-Gilbert equations to guide a finite spin system into a target state. We show the wellposedness of the Bellman PDE on a state manifold and establish the regularity of the value function and the optimal controls to prove the existence of a strong solution of the stochastic optimal control problem. Numerical experiments in a high-dimensional setting are presented.

MS FT-S-6 9 11:00-13:00

Recent Advances in Least Squares Problems - Part 1

For Part 2 see: MS FT-S-6 10

Organizer: Ken Hayami	National Institute of Informatics
Organizer: Yimin Wei	Fudan University

MS Organized by: SIAG/LA

Abstract: Recent advances in the numerical solution of least-squares problems will be presented. For linear least squares problems, an iterative method with an error minimization property, recent developments in preconditioning for sparse problems, and a method for avoiding catastrophic fill in large-scale problems, will be presented. Also, preconditioners for rank-deficient least squares problems, and analysis of GMRES for EP and GP singular systems will be presented. Randomized algorithms for total least squares problems, iterative methods for nonnegative Tikhonov regularization, and a method for computing multiple solutions of nonlinear least squares problems with applications to pharmacokinetic models will also be presented.

11:00-11:30

LSLQ: An iterative method for linear least-squares with an error minimization property

Michael Saunders	Stanford University
Ron Estrin	Stanford University
Dominique Orban	Ecole Polytechnique, Montreal

Abstract: LSLQ uses the Golub-Kahan process to compute iterates equivalent to SYMMLQ applied to the normal equation. The norm of the approximate solution increases, and the error norm decreases. Bounds on the error norm lead to error bounds for the iterates of LSQR. For an inversion problem arising in geophysics, LSLQ allows approximate computation of the gradient of a penalty function that is to be minimized.

11:30-12:00

Recent developments in preconditioning for sparse least squares problems.

Miroslav Tuma	Charles University in Prague
Jennifer Scott	University of Reading

Abstract: The efficient solution of large linear least squares problems where the system matrix A contains some rows that are much denser than the others is challenging. This talk discusses preconditioned iterative methods. We will present a strategy that extends A by a block obtained from a transformation of the dense rows such that the extended matrix can be considered sparse. We will demonstrate that the approach can be efficient but further research is still needed.

12:00-12:30

Avoiding catastrophic fill in large-scale least squares problems

Jennifer Scott	STFC
Miroslav Tuma	Charles University, Prague

Abstract: The effectiveness of sparse matrix techniques for directly solving least squares problems is severely limited if the system matrix contains dense rows. We partition the rows into sparse rows and dense rows and employ a block approach that exploits this. A potential difficulty is that the normal matrix corresponding to the sparse rows is often rank-deficient. We propose ways to overcome this and illustrate their effectiveness using problems from practical applications.

12:30-13:00

Preconditioners for rank deficient least squares problems

Jose Mas	Universitat Politècnica de València
José Marín	Universitat Politècnica de València
Juana Cerdán	Universitat Politècnica de València
Danny Joel Guerrero	

Abstract: We present a method for computing sparse preconditioners for iteratively solving rank deficient least squares problems (LS) by the LSMR method. The main idea of the method proposed is to update an incomplete factorization computed for a regularized problem to recover the solution of the original one. The numerical experiments show that the preconditioner proposed, in most cases, can be successfully applied to accelerate the convergence of the iterative Krylov subspace method.

MS ME-0-8 9 11:00-13:00

Advances in local and nonlocal PDEs - Part 2

For Part 1 see: MS ME-0-8 8

For Part 3 see: MS ME-0-8 10

Organizer: Bruno Volzone	Università degli Studi di Napoli "Parthenope"
Organizer: Yanghong Huang	University of Manchester
Organizer: Filomena Feo	Università degli Studi di Napoli "Parthenope"

Abstract: The aim of this minisymposium is to provide a forum to discuss the recent progress on topics in the field of local and nonlocal Partial Differential Equations and their applications to physics, engineering, optimization and finance and many more. There are many interesting open questions, both theoretical and inspired by concrete applications and this is an opportunity to overview the latest developments in these directions, to exchange ideas and to have in-depth discussion that will benefit each other.

11:00-11:30

Ground states of aggregation-diffusion free energies

Edoardo Mainini	University of Genoa

Abstract: We consider macroscopic descriptions of interacting particles where repulsion is modelled by nonlinear power-law diffusion and attraction by the Riesz potential, leading to variants of the Keller-Segel model of chemotaxis. In case the diffusion dominates the attraction, we show that global minimizers of the free energy exist and are radially symmetric, compactly supported and smooth inside their support. We also discuss their uniqueness and their behaviour as the interaction kernel becomes more singular.

11:30-12:00

Extinction Rates for Fast Diffusion Equations on Generic Bounded Domains

Matteo Bonforte	Universidad Autonoma de Madrid

Abstract: We investigate the homogeneous Dirichlet problem for the Fast Diffusion Equation $u_t = \Delta u^m$, posed in a smooth bounded domain, in the exponent range $m_s = (N-2)_{+/(N+2)<m<1}$. It is known that bounded positive solutions $u(t|x)$ extinguish in a finite time $T = T(u_0)$ and approach a separate variable solution $u(t|x) \sim (T-t)^{1/(1-m)}S(x)$, as tT^-. We investigate the fine asymptotic behaviour, which amounts to derive (sharp) rates of convergence for the relative error. Joint work with A. Figalli.

12:00-12:30

Global dynamics and steady states of Keller-Segel models with quadratic diffusion

Qi Wang	Southwestern University of Finance and Economics
Jose Antonio Carrillo	Imperial College
Xinfu Chen	University of Pittsburgh
Zhian Wang	Hong Kong Polytechnic University
Lu Zhang	Southern Methodist University

Abstract: In this talk, we show that a Keller-Segel chemotaxis model in an interval with nonlinear diffusion and NBC has an intricate bifurcation diagram depending on the chemotaxis rate. For example, there exists a critical value of the rate below which the constant solution is globally asymptotically stable, while there are compact supported steady states otherwise. Metastability behavior and phase transitions are illustrated numerical simulations.

12:30-13:00

The porous medium equation with reaction on manifolds

Gabriele Grillo	Politecnico di Milano

Abstract: We consider the porous medium equation with power-type reaction terms upon negatively curved Riemannian manifolds, and solutions corresponding to bounded, nonnegative and compactly supported data. If $p>m$, small data give rise to global-in-time solutions while solutions associated to large data blow up in finite time. If $p<m$, large data blow up at worst in infinite time, and under the stronger restriction $p\in(1, (1 +m)/2]$ all data give rise to solutions existing globally in time, whereas solutions corresponding to large data blow up in infinite time. The results are in several aspects significantly different from the Euclidean ones, as has to be expected since negative curvature is known to give rise to faster diffusion properties of the porous medium equation.

MS A6-2-1 9 11:00-13:00

Mathematical Models for Solid Mechanics and Soft Structures - Part 3

For Part 1 see: MS A6-2-1 7
For Part 2 see: MS A6-2-1 8
For Part 4 see: MS A6-2-1 10
Organizer: Marco Morandotti Politecnico di Torino
Organizer: Luca Lussardi POLITECNICO DI TORINO

Abstract: The modelling of materials has received more and more attention in the last decades due to the increasing capabilities and versatility of new material and composites. Applications ranging from solid mechanics to soft structures demand sophisticated models which today's mathematics can both provide and study. In this minisymposium we intend to gather international researchers in the field of applied mathematics to share their research on topics including continuum mechanics, soft structures, thin structures, homogenisation theory, material defects, and liquid crystals.

11:00-11:30

A phase-field approach to quasistatic evolution for a cohesive fracture model

Marco Bonacini University of Trento

Abstract: In this talk we present a notion of irreversibility for the evolution of cracks in presence of cohesive forces, which allows for different responses in the loading and unloading processes, motivated by a variational approximation with damage models. We investigate its applicability to the construction of a quasistatic evolution in a simple one-dimensional model. This is a joint work with S. Conti and F. Iurlano.

11:30-12:00

Two-well rigidity and multidimensional sharp-interface limits for solid-solid phase transitions

Elisa Davoli University of Vienna
Manuel Friedrich University of Muenster

Abstract: We establish a quantitative rigidity estimate for two-well frame-indifferent nonlinear energies, in the case of one rank-one connection. Building upon this novel rigidity result, we then analyze solid-solid phase transitions in any arbitrary space dimensions, under a suitable anisotropic penalization of second variations. By means of Gamma-convergence, we show that, as the size of transition layers tend to zero, singularly perturbed two-well problems approach an effective sharp-interface model.

12:00-12:30

Surface defects in smectic thin films

Giacomo Canevari Università degli Studi di Verona
John M. Ball Heriot-Watt University (Edinburgh, UK) and University of Oxford (UK)
Bianca Stroffolini Università Federico II (Naples, Italy)

Abstract: Smectic liquid crystals are a phase of matter, where the constituent molecules form well-defined layers. The orientation of the layers need not be smoothly varying across the material sample, and there might be jumps, as demonstrated by recent experimental work by E. Lacaze (CNRS, Sorbonne Université) and her group. In this talk, we discuss some preliminary results towards the mathematical analysis of defect patterns in thin film of smectic A phases.

12:30-13:00

Mathematical modelling of dislocation motion via Discrete Dislocation Dynamics

Thomas Hudson University of Warwick

Abstract: Dislocations are line defects found in crystals, and act as the carriers of plastic deformation for these materials. Understanding and accurately modelling the complex collective evolution of dislocations is therefore viewed as a key challenge in obtaining predictive models of plasticity. In this talk, I will present results which discuss the precise mathematical formulation and well-posedness of the relevant evolution problem in three dimensions.

MS A6-3-2 9 11:00-13:00

Mean Field Games: Theory and Applications - Part 1

For Part 2 see: MS A6-3-2 10
Organizer: Yuchong Zhang University of Toronto
Organizer: Ruimeng Hu Columbia University

MS Organized by: SIAG/FME

Abstract: The mean-field game(MFG) theory is the study of decision making/equilibria in games with infinitely many small players interacting through the distribution of the entire system. It provides a useful approximation for many otherwise intractable large-scale systems. Over the past decade, MFG models have become increasingly prevalent in mathematical finance, economics and a variety of other social-scientific and engineering disciplines. Recent development has been made in MFGs with branching, impulse control, aggregation,etc.,and in the study of solvability and convergence. The objective of this mini-symposium is to facilitate the exchange of ideas and recent developments. **This mini-symposium is sponsored by the SIAG/FME**.

11:00-11:30

Large tournament games

Yuchong Zhang University of Toronto
Erhan Bayraktar University of Michigan
Jaksa Cvitanic California Institute of Technology

Abstract: We consider a stochastic game in which each player works toward accomplishing her goal and is rewarded based on the ranking of the time to completion. We prove existence, uniqueness and stability of the mean field game equilibrium. When players are homogeneous, the equilibrium has an explicit characterization. We find that the welfare may be increasing in the cost of effort in its low range, as the cost reduces players' eagerness to work too hard.

11:30-12:00

Mean-Field Games with Differing Beliefs for Algorithmic Trading

Sebastian Jaimungal University of Toronto
Philippe Casgrain University of Toronto

Abstract: This paper studies how interacting heterogenous agents, who disagree on what model the real-world follows, optimize their trading actions when the market contains latent factors. We analyse the mean-field game limit and show the Nash equilibria is characterized by a non-standard vector-valued FBSDE. We prove the MFG strategy forms an ε-Nash equilibrium for the finite player game, present an LSMC algorithm for computing the optimal control, and carry out simulations.

12:00-12:30

Binary mean field stochastic games: stationary equilibria and comparative statics

Minyi Huang Carleton University

Abstract: We study a class of mean field games modeled by Markov decision processes with positive externalities and binary actions, and examine structured solutions in terms of threshold policies. Comparative statics, widely studied in various decision problems, concern the behavior of the solution when the model parameters change. We show how to quantitatively characterize our solution variation via perturbation analysis of the parameterized equilibrium solution. (This is a joint work with Y. Ma)

12:30-13:00

Mean field leader follower games with terminal state constraint

Guanxing Fu Humboldt-Universität zu Berlin
Ulrich Horst Humboldt-Universität zu Berlin

Abstract: We analyze linear McKean-Vlasov FBSDEs arising in leader-follower games with mean-field type control and terminal state constraints. We establish an existence and uniqueness of solutions result as well as a convergence result of the solutions with respect to certain perturbations of the drivers. The general results are used to solve a novel single-player model of portfolio liquidation under market impact with expectations feedback as well as a novel Stackelberg game of optimal portfolio liquidation.

IM FT-4-3 9 11:00-13:00

Geophysical Applications - Part 2

For Part 1 see: IM FT-4-3 8
For Part 3 see: IM FT-4-3 10

Organizer: Barucq Hélène Inria
Organizer: David Pardo UPV/EHU, BCAM, and Ikerbasque
Organizer: Victor Calo Curtin University

Abstract: The main objective of this minisymposia is to exchange state-of-the-art interdisciplinary knowledge on applied mathematics, high performance computing, and geophysics to be able to better simulate and understand the materials composing the Earth's subsurface. This is essential for a variety of applications such as CO2 storage, hydrocarbon extraction, mining, better understanding of earthquakes, and geothermal energy production, among others. All these problems have in common the need to obtain an accurate characterization of the Earth's subsurface, and the use of advanced mathematical algorithms is critical to achieving that endeavor. We prioritize those talks that show industrial applications in Geophysics.

11:00-11:30

Space-time Trefftz-DG methods on tent pitching meshes for elastoacoustic wave propagation

Julien Diaz Inria
Barucq Hélene Inria
Calandra Henri Total
Shishenina Elvira Inria

Abstract: We present a Trfftz approximation of transient wave problems involving discontinuous basis functions. The formulation of the problem includes a tent pitcher algorithm which results in convering the spaced-time domain by tent-like elements respecting the propagation cone inherited from the finite propagation speed principle. The resulting scheme is explicit, contrary to the classical Trefftz methods, which requires the inversion of a huge matrix. We show that the method can model easily elastoacoustic coupling.

11:30-12:00

Multilevel assimilation of geophysical data

Trond Mannseth NORCE Norwegian Research Centre AS
Kristian Fossum NORCE Norwegian Research Centre
Svenn Tveit NORCE Norwegian Research Centre

Abstract: The ensemble size in ensemble-based assimilation of geophysical data is restricted due to computational complexity of the forward model. Multilevel forward simulations allows for increasing the ensemble size without increasing computational cost. Geophysical data often contain large amounts of information that is challenging to assimilate properly. Multilevel data representation allows for gradual assimilation of the total information content. We discuss multilevel simulations and multilevel data representation for problems with geophysical data.

12:00-12:30

Finite element upscaling to characterize the seismic response of hydrocarbon reservoirs

Juan Santos Universidad de Buenos Aires

Abstract: An hydrocarbon reservoir is a fluid-saturated poroelastic medium (a Biot medium). In a Biot medium two compressional waves, one fast and one slow and one shear wave can propagate. Fast waves traveling in a Biot medium induce fluid-pressure gradients at mesoscopic-scale heterogeneities, generating wave induced fluid flow (WIFF). I present a FE upscaling procedure to characterize the seismic response at the macroscale of a highly heterogeneous Biot medium

12:30-13:00

Future high impact geophysical technologies for defining the subsurface

Brett Harris Curtin University

Abstract: The question I address is; what new technologies have potential to revolutionize the process of subsurface discovery? My focus will be on mineral discovery but the ideas can be generalized across all subsurface disciplines. I’ll consider, (i) the rise of fibre optic sensor systems in geophysics and in particular distributed acoustic sensing, (ii) technologies for imaging during drilling for real time trajectory control and (iii) co-acquisition and cooperative inversion of seismic and electromagnetic methods.

MS ME-0-5 9 11:00-13:00

Singular parabolic equations and the motion of interfaces - Part 1

For Part 2 see: MS ME-0-5 10

Organizer: Norbert Pozar Kanazawa University
Organizer: Piotr Rybka The University of Warsaw

Abstract: Interfaces are omnipresent. We are interested in those which are closely related to singular parabolic equations. Examples are facets appearing in the total variation flow type problems, free boundaries in Stefan-type problems or surfaces driven by geometric laws. We want to present the state of the art in the analysis and computation of these problems. In particular, we are interested in the progress of viscosity and variational methods of treatment. In addition we want to discuss the evolution of networks and the influence of dynamic boundary conditions.

11:00-11:30

Recent results on the approximation of crystalline curvature flows

Antonin Chambolle Ecole Polytechnique, CNRS

Abstract: In this talk we will review our recent results on the crystalline mean curvature flows, obtained with M. Morini (Parma), M. Novaga (Pisa), M. Ponsiglione (Roma 1) over the past 4 years. We will briefly explain how a distributional weak notion of flow allows to show comparison results, and how we treat general (convex) mobilities and forcing terms. We will point out some difficulties which still arise, and future directions / works in progress.

11:30-12:00

Evolution of grain boundaries

Matteo Novaga University of Pisa

Abstract: I will consider the motion by curvature of a network of curves in the plane, discussing existence, uniqueness, singularity formation and asymptotic behavior of the flow.

12:00-12:30

Analysis of the Kobayashi-Warren-Carter model of grain boundary motion

Salvador Moll Universitat de València
Ken Shirakawa Chiba University
Hiroshi Watanabe Oita University

Abstract: In this talk, a phase field system of grain boundary, known as “Kobayashi-Warren-Carter model”, is considered. It consists in two parabolic PDEs, derived as gradient flows of a free-energy of two unknown variables: the orientation order and angle of grain. I will report recent results concerning the Dirichlet problem. I will present existence of energy dissipating solutions and large time behavior of the solutions, including a complete characterization of the ω-limit set in 1-D

12:30-13:00

Linking Allen--Cahn, MBO and mean curvature flow on graphs

Jeremy Budd TU Delft
Yves Van Gennip TU Delft

Abstract: An emerging technique in classification problems considers the dynamics of flows defined on finite graphs, notably Allen—Cahn flow (Bertozzi, Flenner, 2012) and the MBO algorithm (Merkurjev, Kostic, Bertozzi, 2013). In the continuum, it is well-known that these flows converge to mean curvature flow. This talk presents work towards deriving analogous links in the graph context, concretely in the case of MBO and Allen—Cahn and more tentatively in the case of mean curvature flow.

MS GH-1-A 9 11:00-13:00

Multiscale and stochastic numerical methods for hyperbolic conservation laws - Part 2

For Part 1 see: MS GH-1-A 8

Organizer: Maria Lukacova University of Mainz
Organizer: Alina Chertock North Carolina State University
Organizer: Alexander Kurganov Southern University of Science & Technology

Abstract: It is known that designing numerical methods for hyperbolic conservation laws is challenging since the solution may develop singularities in finite time. In practical applications additional challenges arise due to multiscale phenomena: the presence of small scales causes stiffness which can make the conventional numerical methods to become inefficient or oven impractical. Another challenge is related to the uncertainty in the model equations and data. This minisymposium focuses on modern numerical methods that are designed to efficiently and accurately handle the above difficulties and their interplay and aims at bringing together researchers with diverse expertise on multiscale phenomena.

11:00-11:30

Learning Unknown Hamiltonian Systems from Data

Dongbin Xiu	Ohio State University
Kailiang Wu	Ohio State University
Tong Qin	Ohio State University

Abstract: We present a numerical framework for approximating unknown Hamiltonian systems using observation data. A distinct feature of the proposed method is that it is structure-preserving (SP) and enforces conservation of the learned Hamiltonian, achieved by directly approximating the underlying unknown Hamiltonian. We present the technical detail of the proposed algorithm, along with its error estimate.

11:30-12:00

Angular momentum preserving finite volume scheme in Lagrangian frame

Labourasse Emmanuel	cea
Després Bruno	Université Paris Sorbonne

Abstract: In this talk, we propose an extension of finite volume schemes in Lagrangian frame that preserves the angular momentum in fully discrete form. To do this, the angular momentum is treated as a key variable of the scheme. It acts on the nodal Riemann solver, changing the velocity. Accordingly, the entropy of the character pattern is lost, even in the first-order. Thus we discuss the limitation procedures mandatory to enforce the stability of the scheme.

12:00-12:30

All-Mach Number High Order Semi-implicit IMEX Schemes for the Euler Equations of Isentropic Gas Dynamics

Sebastiano Boscarino	University of Catania

Abstract: We construct and analyze new high order schemes for the numerical solution of the isentropic Euler equations. Material waves are treated explicitly, while acoustic waves implicitly, thus avoiding CFL restrictions for low Mach flows. High order accuracy in space and time is obtained by combining finite difference WENO schemes and semi-implicit IMEX methods. Such schemes are asymptotic preserving and asymptotic accurate as the Mach number vanishes. Tests in one and two space dimensions are showed.

MS A3-S-C1 9 11:00-13:00

Tensor Methods - Part 6

For Part 1 see: MS A3-S-C1 4
For Part 2 see: MS A3-S-C1 5
For Part 3 see: MS A3-S-C1 6
For Part 4 see: MS A3-S-C1 7
For Part 5 see: MS A3-S-C1 8

Organizer: Lieven De Lathauwer	KULeuven
Organizer: Konstantin Usevich	CRAN - CNRS - Université de Lorraine
Organizer: André Uschmajew	MPI MiS

Abstract: A significant research effort is currently dedicated to the extension of linear to multilinear algebra. This work involves a rethinking of both theoretical concepts and numerical computation. The developments gradually allow a transition from classical vector and matrix based methods in applied mathematics and mathematical engineering to methods that involve tensors of arbitrary order. Tensor decompositions open up various new avenues beyond the realm of matrix methods. Important applications include efficient computation in high dimensions, the unique recovery of latent variables in data analysis, and large-scale system identification and machine learning.

11:00-11:30

Space-Filling Curves for Core Tensor Operations

Filip Pawłowski	ENS Lyon and Huawei Technologies
Bora Uçar	ENS Lyon
Albert-Jan Yzelman	Huawei Technologies

Abstract: We propose a novel data structure for tensor, in which tensors are blocked, and blocks are stored according to the Morton order. Our goal is to achieve high performance and mode-obliviousness in common tensor operations. We describe sequential and multi-core algorithms which use this layout for the most bandwidth-bound kernel, the tensor-vector multiplication, and compare them against the state-of-the-art variants on various architectures. The layout easily applies to other kernels, such as the tensor-matrix multiplication.

11:30-12:00

Nonlinear Singular Value Decomposition with Applications

Mariya Ishteva	Vrije Universiteit Brussel
Philippe Dreesen	VUB

Abstract: While linear functions are widely used and well-understood, for nonlinear (multivariate vector) functions it is unclear how to i) define their complexity, ii) reduce the complexity and iii) increase their interpretability. To solve these problems, we propose a decomposition of nonlinear functions, which can be viewed as a generalization of the singular value decomposition. We discuss its computation based on tensor techniques and its application to nonlinear system identification problems.

12:00-12:30

On different notions of ranks

Qi Yang	University of Chicago
Lek-Heng Lim	University of Chicago

Abstract: This talk is motivated by several conjectures on different notions of ranks for a given structured tensor arising from signal processing and complexity theory, which ask if these different ranks are the same for a given structured tensor. In the talk, we will formulate these conjectures in a general framework, introduce useful geometric tools, and show some results about these conjectures via analyzing the geometry behind.

12:30-13:00

Using Heterogeneous Sources of Information to Combat Data Sparsity: the Recommender Systems Case

Evgeny Frolov	Skolkovo Institute of Science and Technology

Abstract: We propose a new hybrid approach for tensor-based recommender systems. It fuses collaborative information about user behavior with additional side information in an intuitive and straightforward way. It not only helps to address the problem of extreme data sparsity, but also allows to naturally exploit patterns in the observed user-item interactions for constructing a compact and meaningful representation of user intents. We demonstrate the effectiveness of the proposed model on several standard benchmark datasets.

MS A6-4-3 9 11:00-13:00

Selected topics in mathematics of finanse

Organizer: Lukasz Stettner	Institute of Mathematics Polish Acad. Sci.

Abstract: The purpose of the session is to present various aspects of modern mathematics of finance. We will be interested in markets with friction. For such markets we consider game options or portfolios with proportional transaction costs leading to the notion of shadow price. Another important aspect of the markets is uncertainty. We shall overcome it considering robust mean variance portfolio selection and shall also study estimation and testing of risk measures.

11:00-11:30

Shadow price in multi asset markets

Lukasz Stettner	Polish Academy of Sciences
Tomasz Rogala	Cardinal Stefan Wyszynski University

Abstract: We consider market with general proportional transaction costs with several assets, where bid and ask prices are general discrete time nonnegative stochastic processes. We are looking for a price, called shadow price which is between bid and ask price and is such that optimal utility from terminal wealth is the same as on the market with bid and ask prices. The approach is direct and is based on induction with a sequence of static models.

11:30-12:00

The Doob-Meyer-Mertens representation and optimal stopping problem under nonlinear evaluation

Marek Rutkowski	University of Sydney
Nie Tianyang	Shandong University
Peng Shige	Shandong University

Abstract: We extend results from Grigorova et al. (2017) on nonlinear evaluations associated with solutions to BSDEs and nonlinear optimal stopping problem with irregular reward. We examine optimal stopping under a general nonlinear evaluation and study the nonlinear Snell envelope by introducing the concept of the backward stochastic equation and establishing the Doob-Meyer-Mertens representation for a nonlinear supermartingale. To obtain more explicit representation for the nonlinear Snell envelope, we establish results concerning reflected backward stochastic equations.

12:00-12:30

Adaptive robust portfolio selection under model uncertainty

Tomasz Bielecki	Illinois Institute of Technology
Tao Chen	University of California Santa Barbara, Santa Barbara, CA, USA
Igor Cialenco	Illinois Institute of Technology, Chicago, IL, USA
Areski Cousin	Institut de Recherche en Mathematique Avancee, Strasbourg, France
Monique Jeanblanc	Universite d'Evry, Evry, France

Abstract: We propose a new methodology for solving an uncertain stochastic Markovian control problem in discrete time. We call the proposed methodology the adaptive robust control. The success of our approach is to the great extend owed to the recursive methodology for construction of relevant confidence regions. We illustrate our methodology by considering an optimal portfolio allocation problem. We also provide some discussion regarding applying of our methodology to a robust Markowitz mean-variance problem.

12:30-13:00

Unbiased estimation and backtesting of risk measures

Marcin Pitera	Jagiellonian University

Abstract: We introduce a novel notion of risk unbiasedness motivated by economic principles and show how to refine many well-known estimators, e.g. VaR plug-in estimator. Next, we connect our framework to backtesting and show that our approach naturally leads to the classical exception rate backtest. In fact, our framework allows to establish the dual connection between the considered family of risk measures and the associated performance measure. We use similar link to define (dual) ES backtest.

MS ME-1-5 9 11:00-13:00

Numerical verification methods and their application to differential equations - Part 1

For Part 2 see: MS ME-1-5 10

Organizer: Kazuaki Tanaka	Waseda University
Organizer: Nobito Yamamoto	The University of Electro-Communications
Organizer: Michael Plum	Karlsruhe Institute of Technology

Abstract: In recent decades, the concept of "numerical verification" and "computer-assisted proofs" is gaining increasing attention and importance. These methods prove results which are rigorous in the strict mathematical sense, using a combination of analytical arguments (e.g. fixed-point theorems) and numerical computations. In particular, their application to various kinds of ordinary and partial differential equation problems has turned out to be a powerful approach for proving results which could not be obtained by purely analytical means. This minisymposium focuses on some general tools appearing in numerical verification methods, as well as their application to ordinary and partial differential equations.

11:00-11:30

Fixed-point theorems as tools of verified numerics on ODEs

Nobito Yamamoto	The University of Electro-Communications

Abstract: In this mini symposium we intend to clarify what tools we have for verified numerics and what is the usage of each tool. I will make a short introduction of our MS to the people who are thinking about application of verified numerics to their own problem. Some examples of numerical verification of ODEs are shown using fixed point theorems as tools.

11:30-12:00

The Taylor model approach for solving ODEs implemented in MATLAB/INTLAB

Florian Buenger	Hamburg University of Technology

Abstract: Solving initial value problems (IVPs) for ordinary differential equations (ODEs) y'=f(t,y), y(t0)=y0, where the initial value y0 may be an interval vector, is a substantial topic in the field of verified computation. Starting from Lohner's famous AWA many other effective verified IVP solvers were developed. We list different approaches with brief explanations. The so-called Taylor model method is described in greater detail along with notes on its concrete implementation and effective use in MATLAB/INTLAB.

12:00-12:30

Rigorous integration of smooth vector fields around spiral saddles with an application to the cubic Chua's attractor

Warwick Tucker	Uppsala University
Zbigniew Galias	AGH University of Science and Technology, Krakow, Poland

Abstract: We present a general framework for integrating smooth vector fields near a fixed point with a spiral saddle. We restrict our study to the three-dimensional setting, where the stable manifold is of spiral type (and thus two-dimensional), and the unstable manifold is one-dimensional. As an application, we apply our work to a concrete situation: the cubic Chua's equations. Here, we present a computer assisted proof of the existence of a trapping region for the flow.

12:30-13:00

A computer-assisted proof of the critical Reynolds number for the Orr-Sommerfeld equation

Yoshitaka Watanabe	Kyushu University

Abstract: This talk presents some computer-assisted proofs of solutions for the Orr-Sommerfeld equation describing hydrodynamic stability of the Navier-Stokes equations. Some numerical verification results including the critical Reynolds number and future works will be reported.

MS A1-2-6 9 11:00-13:00

Mathematical Modeling of Infectious Diseases under a variety conditions - Part 2

For Part 1 see: MS A1-2-6 8

Organizer: Gilberto Gonzalez	New Mexico Tech, Socorro, New Mexico, USA
Organizer: Abraham Jose Arenas Tawil	Universidad de Córdoba
Organizer: Benito Chen-Charpentier	University of Texas at Arlington

Abstract: Mathematical modeling is a powerful tool that allows the study of the dynamics and possible outcomes of different diseases under a variety of conditions and supports control strategies against their spread. One important part of the modeling is the estimation of the parameters involved. This stage involves a global optimization problem that can be tackle with different techniques. Recently varieties of algorithms have been developed to solve this optimization problem and avoid local solutions. In this minisymposium, we would provide discussion of some approaches to do mathematical modeling of different infectious diseases of human, cell, virus and vector populations.

11:00-11:30

Mathematical modeling of control strategies against Chikungunya virus spread

Gilberto Gonzalez	New Mexico Tech
Miguel Diaz-Rodriguez	Universidad de Los Andes. Merida, Venezuela
Abraham Arenas	Universidad de Cordoba, Monteria, Colombia

Abstract: We study the control of a Chikungunya epidemic model solving several optimal control problems. We implement three strategies to control the spread of the Chikungunya virus in the human and vector population. The first control strategy is an educational campaign promoting to use bednets, avoid water stagnation, wear long sleeve shirt, among others. The second one is treatment of the infected individual, and the third one is based on spraying insecticides.

11:30-12:00

Harvesting timber strategies that minimizes beetle infestation and guarantees age-structured forests: a mathematical framework

Maria Leite	University of South Florida
Benito Chen-Charpentier	University of Texas at Arlington
Folashade Agusto	University of Kansas

Abstract: The interactions of the external pressure (e.g., diseases, harvesting, fire) and their effects on the viability of forests are highly complex and not well understood. Such situation poses additional challenges to the complex task of managing natural resources. We will present differential equations processes-based mathematical models incorporating the link among harvesting and forest disease. We will discuss findings concerning the investigation of dynamical properties of the models and of the application of optimal control theory.

12:00-12:30

Mathematical modeling and analysis of the spread of RSV

Abraham Jose Arenas Tawil — Universidad de Córdoba
Myladis Rocio Cogollo Flórez — Departamento de Matemáticas y Estadística, Universidad de Córdoba, Colombia
Gilberto González-Parra — Faculty of the Mathematics Department New Mexico Tech, NM, USA.

Abstract: The respiratory syncitial virus is one of the most common causes of mortality in children in the world. In this talk, we will use different mathematical model approaches to describe or explain the dynamics of RSV on the human population. We use real time series from Colombia to describe the different approaches including big data approach.

MS A3-3-3 9 — **11:00-13:00**

Uncertainty Quantification and Reproducibility - Part 1

For Part 2 see: MS A3-3-3 10
Organizer: Andrew Dienstfrey — NIST
Organizer: Ronald Boisvert — National Inst. of Standards and Technology

Abstract: Reproducibility of scientific results has been called into question recently. Although most attention has focused on biomedicine and psychology, such questions have led to a great deal of self-reflection in the computational science community as well. At the same time, there has been a surge of interest in uncertainty quantification in scientific computing as a process to render computational results actionable for decision makers. In this minisymposium we will explore these two concepts in relationship to each other, and their respective roles in establishing credibility of computational results. [This minisymposium is sponsored by IFIP Working Group 2.5, https://wg25.taa.univie.ac.at/.]

11:00-11:30

The Influence of Methods of Uncertainty Quantification on the Comparability of Research Results

Maurice Cox — National Physical Laboratory

Abstract: Without statements of uncertainty, comparability of research results cannot be assessed. For scalar results, a measure of comparability is the En score as used in metrology. If |En| < 2, under appropriate assumptions the results are comparable “at approximately the 95 % level”. A corresponding expression exists for vector results with associated covariance matrices. These considerations are discussed together with the fact that uncertainties can be evaluated in different ways (GUM, Monte Carlo, Bayes, etc.).

11:30-12:00

Reproducibility - Algorithms, Pros and Cons

Siegfried Rump — Hamburg University of Technology

Abstract: The sum of floating-point numbers in floating-point arithmetic is not associative, and the result of standard floating-point summation of a vector may be arbitrarily far apart depending on the ordering of the summands. The goal of reproducible summation is to avoid that flaw, i.e. to deliver always the same result independent of the ordering, We present different algorithms and discuss pros and cons of the algorithms, and of the task as well.

12:00-12:30

Numerical Stability of Neuroimaging Analysis Pipelines

Tristan Glatard — Concordia University

Abstract: We focus on the computational reproducibility of neuroimaging analysis pipelines with respect to small data, software, and infrastructure perturbations. First, we review a set of experiments quantifying the effect of the operating system, data analysis toolbox, and one-voxel perturbation of the input data. Furthermore, we present a few ideas to address these issues, related to the bootstraping of perturbed analyses, and to the identification of problematic code sections in pipelines.

12:30-13:00

Reproducible Research: a help or hindrance to scientific progress?

Chris Drummond — National Research Council

Abstract: Reproducible research, a large and growing movement, aims to change current scientific practice. It is motivated by a putative crisis in the general public's confidence in science, due the increasing number of frauds reported in the media. Exponents claim that its principles are simply those of science from its inception. I argue that there is little to support this claim and that the changes being may well hinder scientific progress rather than help it.

MS A3-2-2 9 — **11:00-13:00**

Computational Fluid Dynamics: Modeling, Analysis, and Applications - Part 2

For Part 1 see: MS A3-2-2 8
For Part 3 see: MS A3-2-2 10
Organizer: Sarah Olson — Worcester Polytechnic Institute
Organizer: Sookkyung Lim — University of Cincinnati
Organizer: Hoa Nguyen — Trinity University

Abstract: Computational fluid dynamics has rapidly developed into an interdisciplinary field where numerical analysis and data structures are used to model and investigate fluid flows at multiple scales. This minisymposium will focus on recent developments spanning from mathematical analysis and algorithms to complex simulations of biological systems, as well as coordination between modeling and experiments. The diversity of the presentations highlights the importance of interdisciplinary research on computational fluid dynamics where novel models and algorithms can be leveraged to understand complex fluid flows in a variety of applications.

11:00-11:30

Pulsating Soft Corals

Shilpa Khatri — University of California Merced

Abstract: Soft corals of the family Xeniidae have a pulsating motion, a behavior not observed in many other sessile organisms. Direct numerical simulations of the pulsating corals and the resulting fluid flow by solving the Navier-Stokes equations coupled with the immersed boundary method will be discussed. We will explore how the mixing created by the corals is modified as we vary parameters of the fluid flow and the pulsating motion.

11:30-12:00

In vitro and in vivo fluid-structure interaction models of prosthetic heart valves

Boyce Griffith — University of North Carolina at Chapel Hill

Abstract: This talk will describe work to develop validated fluid-structure interaction (FSI) models of prosthetic heart valves using the immersed boundary (IB) method. I will discuss IB formulations that yield accuracy comparable to that provided by specialized finite element methods for incompressible elasticity. Results from experimental validation studies that use an in vitro experimental model of heart valve dynamics will be presented along with results from a new subject-specific FSI models of the heart.

12:00-12:30

Fluctuating Hydrodynamic Approaches for Curved Fluid Interfaces: Extended Saffman-Delbruck Theory.

Paul Atzberger — University of California Santa Barbara

Abstract: We develop using exterior calculus and immersed boundary approaches computational methods for solving fluctuating hydrodynamic equations on curved surfaces. We extend Saffman-Delbruck theory to capture the collective drift-diffusion dynamics of proteins within curved lipid bilayer membranes. We show how the surface curvature can significantly impact hydrodynamic dissipation within the two dimensional fluid having potentially important implications for self-assembly and other kinetic processes within lipid bilayer membranes. We further discuss the accuracy and convergence of solvers.

12:30-13:00

Hydrodynamic Interactions of Swimmers

Sarah Olson — Worcester Polytechnic Institute

Abstract: Microorganisms such as sperm often swim in close proximity. In this talk, we highlight results showing how swimming speeds and trajectories vary between a single swimmer and two or more swimmers in different fluid environments. Each swimmer is modeled via a centerline representation where forces are solved for using elastic rod theory and regularized fundamental solutions are used to determine the velocities. We highlight how motility changes in the presence of a wall.

MS A1-1-3 9 — **11:00-13:00**

Deep Learning and Inverse Problems - Part 1

For Part 2 see: MS A1-1-3 10

Organizer: Joana Grah	Graz University of Technology
Organizer: Martin Benning	University of Cambridge
Organizer: Felix Lucka	CWI & UCL

Abstract: In recent years, we have seen an extensive interest in incorporating deep learning techniques to solve a variety of classical inverse problems. In the majority of cases, these methods have empirically proven to outperform previous state-of-the-art methods based on variational, PDE-related and statistical approaches. However, a significant drawback of deep learning is its incomplete mathematical theory and a lack of profound understanding of its superior performance but also of its limitations. In this minisymposium, leading researchers will discuss how to close these gaps in order to bridge the theories of deep learning and inverse problems.

11:00-11:30

Image segmentation via multi-task learning with lazy labels

Rihuan Ke	University of Cambridge
Aurélie Bugeau	University of Bordeaux
Nicolas Papadakis	CNRS, IMB
Peter Schuetz	Unilever R&D Colworth
Carola-Bibiane Schönlieb	University of Cambridge

Abstract: The need for labour intensive pixel-wise annotation is a major limitation of many fully supervised learning methods for image segmentation. We introduce a deep convolutional neural network for multi-class segmentation that circumvents this problem by being trainable on ‘lazy’ labels: coarse data labels combined with a very small number of strongly annotated images. Image segmentation is then stratified into three connected tasks: rough instance detection, separation of wrongly connected objects, and full object segmentation.

11:30-12:00

Solving inverse problems with learned regularizers

Markus Haltmeier	University of Innsbruck
Johannes Schwab	University Innsbruck
Stephan Antholzer	University Innsbruck
Housen Li	University Göttingen

Abstract: Recently, deep learning and neural network based algorithms appeared as new paradigm for solving inverse problems. In this talk we propose and analyze variational methods for inverse problems using a neural network as regularizer. We present a convergence analysis, derive convergence rates, and propose a possible training strategy. Numerical results are presented where the network approach demonstrates good performance even for unknowns very different from the training data.

12:00-12:30

Monte Carlo wavelets: a randomized approach to frame discretization

Valeriya Naumova	Simula Metropolitan Center

Abstract: We consider a family of continuous wavelets on general domains and a corresponding stochastic discretization. Using tools from the theory of reproducing kernel Hilbert spaces and associated integral operators, we define a family of continuous wavelets. Then, we propose a stochastic discretization based on Monte Carlo estimates of the integral operators and corresponding convergence results. This is a joint work with S. Vigogna, E. De Vito, L Rosasco (UNIGE) and Z. Kereta (Simula).

12:30-13:00

Deep Bayesian Inversion: Computational uncertainty quantification for large scale inverse problems

Ozan Öktem	KTH - Royal Institute of Technology
Jonas Alder	KTH - Royal Institute of Technology

Abstract: Bayesian inversion offers a framework for solving inverse problems but its applicability is limited by the difficulty to choose a ‘good’ prior and the computational challenges. We show how to train a conditional Wasserstein GAN against supervised data so that the generator can be used to sample from the posterior. This is computationally feasible and no explicit prior needs to be chosen. The suggested approach is demonstrated for image-guided medical diagnostics using computed tomography.

MS FT-S-7 9 11:00-13:00

Recent advances in a posteriori error estimation and adaptive methods - Part 1

For Part 2 see: MS FT-S-7 10

Organizer: Bertrand Fleurianne	Humboldt Universität zu Berlin
Organizer: Weimar Markus	Ruhr University Bochum

Abstract: Typical approaches towards numerical solutions of complex problems might lead to systems with millions of unknowns. Therefore, adaptive strategies suggest themselves in order to increase efficiency. However, although numerical experiments strongly indicate that the use of adaptivity finally pays off, a sound theoretical justification still has to be developed for large classes of problems. Reaching this goal requires a deep understanding of structural properties such as, e.g., regularity of the unknown solutions in various function spaces. On the other hand, elaborated a posteriori error analysis is needed in order to design efficient algorithms of adaptive finite element or wavelet type.

11:00-11:30

Stress-reconstruction and a posteriori error estimation for linear elasticity

Bertrand Fleurianne	Humboldt Universität zu Berlin
Kober Bernhard	
Moldenhauer Marcel	
Starke Gerhard	

Abstract: A stress equilibration procedure for linear elasticity is proposed and analyzed. Based on the displacement-pressure approximation computed with a stable finite element pair, it constructs an H(div)-conforming, weakly symmetric stress reconstruction. Our construction leads then to reconstructed stresses by Raviart- Thomas elements which are weakly symmetric. The computation is performed locally on a set of vertex patches covering the computational domain.

11:30-12:00

Equilibrated Flux a posteriori Estimates for the p-Laplace Problem

Diening Lars	Universität Bielefeld

Abstract: This talk is devoted to the adaptive finite element method for the p-Laplace problem. We use the method of equilibrated fluxes to construct suitable a posteriori estimators. Our goal is to prove optimality of the AFEM loop. This is a joint work with Christian Kreuzer, Ian Smears and Martin Vohralik.

12:00-12:30

A posteriori error analysis for the mixed Laplace eigenvalue problem

Boffi Daniele	Università di Pavia

Abstract: We review some a posteriori error estimators for the Laplace problem in mixed form and show how to extend them to the corresponding eigenvalue problem. In the case of Raviart-Thomas finite elements of arbitrary degree, using the Prager-Synge hypercircle approach with local flux reconstructions, a fully computable upper bound for the flux error in the L2-norm is derived. Efficiency of the local error estimators is proven and numerical experiments with convergence rates will be provided.

12:30-13:00

Optimal Convergence Rates of the Least-Squares Method

Carstensen Carsten	Humboldt Universität zu Berlin

Abstract: The least-squares functional allows reliable and efficient error control with global upper and lower bounds and can be a very accurate error estimator for some related norm as it is often asymptotically exact from Carstensen and Storn (SIAM J. Numer. Anal. 2018). The elementwise contributions to the global L2 norms serve well as refinement indicators in adaptive mesh-refining algorithms but the convergence analysis is less well understood in contrast to seperate marking with optimal rates.

MS A6-1-1 9 11:00-13:00

PDE-constrained optimization under uncertainty - Part 2

For Part 1 see: MS A6-1-1 8

Organizer: Peng Chen	The University of Texas at Austin
Organizer: Omar Ghattas	Texas University, Austin, Us

Abstract: Many PDE models in computational science and engineering fields have uncertain parameters due to lack of knowledge or intrinsic variability of the inputs. Incorporating this uncertainty in the PDE-constrained optimization problem is crucial for making the optimal solution more robust and reliable. This minisymposium presents recent advances in computational methods, analyses, and applications to solve such problems, with emphases on (1) high-dimensional uncertainty; (2) different risk measures and probability constraints; (3) novel formulations and methods for data-driven optimization under uncertainty; and (4) application to problems governed by more challenging models, including multiphysics, multiscale, and fractional PDE problems.

11:00-11:30

Adjustable stochastic optimal control with shared support

Georg Stadler — Courant Institute, New York University

Chen Li — New York University

Abstract: We propose a formulation for optimal control of PDEs with uncertain parameters that seeks controls that are adjustable, i.e., they depend on the realization of the stochastic parameter. However, all optimal controls must share the same support set which, in applications, is interpreted as the set where control devices should be placed. Mathematically, this amounts to a nonsmooth optimization problem over variables defined in physical and random space.

11:30-12:00

A robust optimization approach for PDE-constrained optimization under uncertainty

Stefan Ulbrich — TU Darmstadt

Philip Kolvenbach — TU Darmstadt

Oliver Lass — TU Darmstadt

Abstract: We consider robust nonlinear PDE-constrained optimization problems with ellipsoidal uncertainty sets yielding a min--max formulation. Using second-order Taylor approximations of the objective and constraint functions w.r.t. uncertain parameters, the inner maximization problems are reduced to trust-region subproblems. We consider two solution methods for the approximated robust counterpart: a nonsmooth formulation using the maximum-value functions of the inner problems, and an MPCC formulation. We apply the method to shape optimization for electrical engines and mechanical structures.

12:00-12:30

A primal-dual algorithm for risk-averse PDE-constrained optimization

Thomas Surowiec — Philipps-Universität Marburg

Drew Kouri — Sandia National Laboratories

Abstract: We propose an algorithm for risk-averse PDE-constrained optimization problems, which exploits the rich structure of convex risk measures. The steps of the algorithm are derived from several observations on the application of the classical method of multipliers to the particular problem class. Using the theory of epi-regularization of risk measures, convergence results for convex and nonconvex problem settings are proven. The performance of the algorithm is demonstrated via several examples from the literature.

MS FT-1-SG 9 — 11:00-13:00

Numerical methods for hyperbolic problems and applications - Part 2

For Part 1 see: MS FT-1-SG 8

For Part 3 see: MS FT-1-SG 10

Organizer: Pep Mulet — Universitat de València

Organizer: Antonio Baeza — Department of Mathematics, University of Valencia

Abstract: First-order hyperbolic PDE systems appear in many scientific areas. The importance of obtaining good numerical approximations to their solutions is therefore crucial in these circumstances, since a closed solution is usually impossible to obtain when the equations are not linear. Due to the development of discontinuities in nonlinear hyperbolic systems, numerical methods for their approximate solution must have certain characteristics to ensure convergence to the right weak solutions. This minisymposium will be devoted to works that deal with different aspects of the design and analysis of these schemes, with special emphasis in obtaining high order of accuracy.

11:00-11:30

A central WENO scheme through a global average weight

Antonio Baeza — Department of Mathematics, University of Valencia

Raimund Bürger — CI2MA and Departamento de Ingeniería Matemática, Universidad de Concepción, Chile

Pep Mulet — Departament de Matemàtiques, Universitat de València, Spain

David Zorío — CI2MA, Universidad de Concepción, Chile

Abstract: A novel central weighted essentially non-oscillatory (central WENO; CWENO)-type scheme for the numerical solution of hyperbolic conservation laws is presented. This procedure is based on the construction of a global average weight using a combination of the smoothness indicators associated to every candidate stencil, without using ideal weights. Moreover, this procedure also prevents some cases of accuracy loss near smooth extrema that are experienced by classical WENO and CWENO schemes.

11:30-12:00

Efficient High-Order methods for the simulation of dispersive shallow-water flows

ECCOMAS Prize for the Best Ph.D. Thesis of 2018

Cipriano Escalante Sánchez — Universidad de Málaga

Michael Dumbser — Universidad de Trento

Manuel J. Castro Díaz — Universidad de Málaga

Abstract: In this talk, we present different techniques for the numerical approximation of shallow-water type systems of hyperbolic/elliptic nature. In particular, we present different strategies based on finite-volume/finite-difference, Discontinuous Galerkin methods and approximated hyperbolic systems. During the talk, the accuracy and efficiency of the resulting numerical methods applied to real problems will be shown.

12:00-12:30

A POD-Galerkin reduced order method for Navier-Stokes equations based on a hybrid FV-FE solver

Saray Busto Ulloa — University of Trento

Giovanni Stabile — MathLab, SISSA (International School for Advanced Studies)

Gianluigi Rozza — MathLab, SISSA (International School for Advanced Studies)

María Elena Vázquez-Cendón — Department of Applied Mathematics, Universidade de Santiago de Compostela

Abstract: The aim of this talk is to present a novel POD-Galerkin strategy based on a semi-implicit hybrid finite volume/finite element solver of the incompressible Navier-Stokes equations coupled with an additional transport equation. The unstructured staggered mesh considered and the FV-FE formulation lead to the definition of reduced basis spaces in both frameworks. A Poisson equation for the pressure is derived using a projection method. Three-dimensional tests are used to assess the performance of the methodology.

12:30-13:00

Multi-scale numerical modeling of sorption kinetics

Clarissa Astuto — University Of Catania

Giovanni Russo — University of Catania, Department of Mathematics and Computer Science, Italy

Armando Coco — Oxford Brookes University, School of Engineering, Computing and Mathematics, Great Britain

Antonio Raudino — University of Catania, Department of Chemical Sciences, Italy

Antonio Grassi — University of Catania, Department of Pharmacy, Italy

Giuseppe Lombardo — University of Catania, Department of Pharmacy, Italy

Abstract: The trapping of diffusing particles is an interesting topic applied to model different real problems. The particles are attracted and trapped near the surface of the bubble. The numerical simulation presents multi-scale challenge:the range of the bubble potential measures few microns while the bubble radius measures some millimeters. A reduced model solves the multi-scale problem in space: the interaction with the bubble is modeled with a boundary condition deduced from conservation properties.

IM FT-2-3 9 — 11:00-13:00

Advances in computation and analysis of PDE's for multiphase system - Part 2

For Part 1 see: IM FT-2-3 8

For Part 3 see: IM FT-2-3 10

Organizer: Xiaolin Li — Stony Brook University

Organizer: Hyunsun Lee Hawaii Pacific University
Organizer: Zhiliang Xu University of Notre Dame

Abstract: Multiphase flows have many applications in science and engineering. This minisymposium brings together researchers who have been working on such problems using various analytical and numerical methods for solving PDEs and coupling the solution with the .interface dynamics. Topics in this minisymposium include fluid interface instabilities and fluid interaction with thin layer structures.

11:00-11:30

A 3D IB method for non-Newtonian-fluid flexible-structure interaction

Luoding Zhu Indiana University Purdue University at Indianapolis

Abstract: We introduce a new immersed boundary method for FFSI problems involving non-Newtonian fluids in three dimensions. The non-Newtonian fluids are described by the FENE-P model. The fluid flow is modelled by the lattice Boltzmann equations (the D3Q19 model). The deformable structure and the fluid-structure-interaction are treated by the immersed boundary method. As a test for the new method, four toy FFSI problems are considered involving an elastic flexible sheet interacting with a FENE-P fluid.

11:30-12:00

Lagrangian particle methods for multiphysics problems and applications

Roman Samulyak Stony Brook University
Nizar Naitlho Stony Brook University
Yuan Shaohua Stony Brook University

Abstract: Algorithms for improving discontinuity solutions and multiscale coupling using the Lagrangian particle (LP) method for compressible fluid dynamics will be discussed. LP uses generalized finite differences for approximating differential operators on particle clouds and spatially-unsplit, non-oscillatory discretization methods. The method is applicable to a variety of problems ranging from fluid instabilities to granular flows. An example of multiscale coupling of LP-based models for impurities in nuclear fusion devices to global MHD codes will be discussed.

12:00-12:30

xRage/Flash Code Comparison for Richtmyer-Meshkov Instability

John Grove Los Alamos National Laboratory

Abstract: A comparison of Richtmyer-Meshkov instability was conducted using the Los Alamos xRage code and the University of Chicago code Flash. Both codes use adaptive mesh refinement, Flash uses block AMR, while xRage uses cell-by-cell refinement. We ran three simulation classes, each at five difference levels of refinement. In addition, xRage was run using volume of fluid interface tracking. We will discuss solution similarities and differences as well as a discussion of timings.

12:30-13:00

Interface dynamics: new mechanisms of stabilization/destabilization and structure of flow fields

Snezhana Abarzhi The University of Western Australia

Abstract: Interfacial mixing plays a key role in non-equilibrium dynamics of fluids, plasmas, materials. This work focuses on the long-standing problem of stability of a phase boundary - a fluid interface that has a mass flow across it. We develop the general theoretical framework directly linking the microscopic interfacial transport to the macroscopic flow fields, discover the new mechanisms of interface stabilization and destabilization for both inertial and accelerated dynamics, and chart perspectives for future research.

MS FT-S-5 9 11:00-13:00

Mimetic Finite Diffence Methods and Applications - Part 1

For Part 2 see: MS FT-S-5 10
Organizer: Jose Castillo San Diego State University

MS Organized by: SIAG/CSE

Abstract: Mimetic finite difference methods have been used more and more recently very effectively. The method presented here is based on constructing discrete analogs of the primary operators divergence, gradient and curl. In this session we present recent development of this method including an updated mimetic library that allows to easily implent the method in a way range of aplications. Stability, adaptivity as well as implementaion on overlapping gris will be presented. Some of of the applications are in seismic wave modeling, porous media and image processing.

11:00-11:30

Time Space Mimetic Finite Differences for Wave Motion

Jose Castillo San Diego State University

Abstract: Mimetic discretization methods provide a discrete analog of vector calculus and have been used in many applications very effectively. For time dependent problems, different time discretizations have been used. Symplectic integrators, developed for Hamiltonian systems which are represented by ordinary differential equations. Symplectic integrators guarantee energy conservation because of the existence of a conserved quantity close to the original Hamiltonian. We will present examples using mimetic difference operators with symplectic integrators for wave motion.

11:30-12:00

Advances in mimetic elastic modelling with HPC

Josep De La Puente Barcelona Super Computing Center
Otilio Rojas BSC

Abstract: Seismic modelling in 3D realistic scenarios requires low-dispersion and efficient algorithms. Mimetic methods offer a good compromise between both, particularly for elastic problems. We will show advances in the methodology and practical examples where these methods have an impact, in particular when coupled with HPC strategies.

12:00-12:30

Lax-Wendroff and Rapid Expansion time integrations on finite difference modeling of wave propagation

Otilio Rojas Barcelona Supercomputing Center
Josep De La Puente Barcelona Supercomputing Center
Carlos Spa Universidad Tecnica Federico Santa Maria

Abstract: This exploratory work couples high-order time integrations to a 1-D finite-difference discretization of the wave equation, with eight order differencing at grid interior. We first implement the Lax-Wendroff procedure and compare results to the second-order Leapfrog. Then, we apply a truncated Chebyshev matrix expansion to approximate the exponential of the semidiscrete FD operator. In both cases, the stability limits for homogeneous propagation are established, and then we consider velocity heterogeneities to assess dispersion and dissipation.

12:30-13:00

High Order Mimetic Finite Differences on Overlapping Grids

Angel Boada San Diego State University

Abstract: High Order Mimetic Finite Difference Operators Divergence, Gradient, and Curl have been used effectively in many applications. Overlapping grids are a type of block structured body-fitted conforming grids that are used to resolve fine-scale features in a particular domain. In this talk, we examine the viability of High Order Mimetic Finite Differences on Overlapping Grids by solving representative PDEs, while exploring different interpolation techniques on these grids. Numerical results will be presented.

IM FT-4-2 9 11:00-13:00

Preparing Future Industrial Mathematicians Through Industry-Academic Partnerships

Organizer: Lisa Davis Montana State University
Organizer: Suzanne Weekes Worcester Polytechnic Institute

Abstract: In this minisymposium, we hear how faculty and scientists in government, business, and industry work together to provide hands-on opportunities for mathematical sciences students that help prepare them for a broad range of careers. These experiences include undergraduate and graduate students working (on campus) on industry-inspired research problems with industry and faculty supervision. On-site experiences at companies, government labs, or engineering and science labs on university campuses are described. Students also participate in professional development workshops that cultivate their writing, networking and interview skills.

11:00-11:30

Montana Partnership for Broadening Career Pathways for Mathematics and Statistics PhD Students

Lisa Davis Montana State University

Abstract: MT PEAKS is a partnership among two doctoral programs at MSU and business, industry and government (BIG) collaborators. The goal is to broaden the training of doctoral students in mathematics and statistics to pursue career paths beyond the traditional academic tract. Key student activities include a BIG-inspired interdisciplinary research project, two Materials Science lab rotations and a BIG internship. The speaker will reflect on successes and lessons learned from the program's inaugural cohort.

11:30-12:00

Research Experiences on Industrial Math Problems

Suzanne Weekes Worcester Polytechnic Institute

Abstract: There is great benefit for university faculty, students, and mathematical scientists working in industry and government to collaborate. In this talk, we make clear these benefits, share our experiences, and point out opportunities that exist for industry/government-university partnerships. The speaker has been involved in the WPI REU Program in Industrial Mathematics and Statistics and the Preparation for Industrial Careers in Mathematical Sciences (PIC Math) program and she will highlight these and other initiatives.

12:00-12:30

Undergraduates at Los Alamos National Laboratory: Predicting Risk and Analyzing Non-Traditional Data

Carrie Manore Los Alamos National Laboratory

Abstract: Undergraduates have gained important experience while contributing substantially to research at Los Alamos National Laboratory. I will present a few undergraduate projects at LANL. These include analysis of Google Health Trends to predict Zika in Colombia; a model for VA suicide prevention; using parallel computing to analyze terabytes of satellite, weather, and public health data for Brazil; and forecasting dengue. Many of these students have gone on to graduate schools and/or returned to LANL.

12:30-13:00

Interoperational Mathematical Collaboration: Academia and Industry, from an Industrial Research Perspective

Bob LaBarre United Technologies Research Center

Abstract: Calling on my 40+ years as an industrial research mathematician, and drawing from collaborations with faculty members all around the world, some successful and others less successful, I will dispel some myths about collaboration, identify the potholes and point to methods that can make such collaborations meaningful and beneficial. Building a lasting collaborative relationship takes time and involves trust. Whether you are successful often depends on how hard you are willing to work at it.

MS A3-S-C2 9 11:00-13:00

Geometric shape generation: integrability, variational analysis and applications - Part 6

For Part 1 see: MS A3-S-C2 4
For Part 2 see: MS A3-S-C2 5
For Part 3 see: MS A3-S-C2 6
For Part 4 see: MS A3-S-C2 7
For Part 5 see: MS A3-S-C2 8
Organizer: Kenji Kajiwara Kyushu University
Organizer: Schief Wolfgang The University of New South Wales
Organizer: Miyuki Koiso Kyushu University
Organizer: Udo Hertrich-Jeromin TU Wien

Abstract: This minisymposium is aimed at the discovery of state of the art geometric shape generation, based on methods from smooth and discrete differential geometry. In response to needs and problems raised by industrial applications, various geometric methods to generate desirable or "good" shapes have been developed, that emphasize the underlying structure of an integrable systems or variational approach. The topics addressed will range from problems raised in architecture and industrial design to the mathematical framework used to tackle them, and the modeling and analysis of smooth or discrete curves and surfaces to be used in shape design.

11:00-11:30

New shapes, new materials and new processes

Konrad Polthier Freie Universität Berlin

Abstract: New 3D scanners provide insight on various length scales and unveil an increasingly larger variety of geometric forms in nature. New 3D fabrication technologies produce physical shapes with a variety of new materials and of new internal structures. The mathematical language for shapes needs to be revisited, including algorithmic geometry processing and modelling. The talk studies examples from biology,computer graphics and industrial CAD to illustrate mathematical questions and new concept from discrete differential geometry.

11:30-12:00

Discrete quadrics and incircular nets: geometry and design

Alexander Bobenko Technical University of Berlin

Abstract: Incircular nets are congruences of straight lines with the combinatorics of the square grid, with all elementary quadrilaterals possessing an incircle. Checkerboard nets are combinatorially colored as a checkerboard, such that all black coordinate quadrilaterals possess inscribed circles. We intergrate explicitly these nets and show their relation to discrete (confocal) conics. Obtained patterns can be used in particular in architectural design. The results are joint with W. Schief, Y. Suris and J. Techter.

12:00-12:30

O surface theory. Applications in geometry and statics

Wolfgang Schief University of New South Wales

Abstract: O surface theory provides a systematic procedure of isolating and discretising integrable classes of special surfaces, thereby generalising and discretising the extensive work on special surfaces recorded in Eisenhart's classical monograph Transformations of Surfaces. We briefly review O surface theory and present applications in geometry and shell membrane theory.

MS ME-0-2 9 11:00-13:00

Interacting particle systems: Mean-field limits and applications to machine learning - Part 1

For Part 2 see: MS ME-0-2 10
Organizer: Matias Delgadino Imperial College
Organizer: Grigorios Pavliotis Imperial College
Organizer: José Antonio Carrillo De La Plata Imperial College London

Abstract: Systems of stochastic/deterministic interacting particles arise in many areas of analysis and applications, ranging from statistical mechanics and plasma physics to optimization algorithms and deep learning. The study of mean field limits for such systems has attracted attention in several communities including PDE and mathematical physics. Variational methods and the theory of gradient flows have emerged as natural tools for studying such systems. The goals of the proposed minisymposium are to bring together experts working on the theoretical analysis as well as on modern applications of the theory of interacting particle systems to areas such as machine learning.

11:00-11:30

Mean field limit by Gamma convergence

Matias Delgadino Imperial College
Jose Antonio Carrillo Imperial College
Greg Pavliotis Imperial College

Abstract: We give a proof of the mean-field limit for λ-convex potentials using a purely variational viewpoint. We take advantage that all evolutions of the involved quantities can be written as gradient flows of functionals at different levels: in the set of symmetric probability measures on N variables and in the set of probability measures on probability measures. This basic fact allows us to rely on Γ-convergence tools for gradient flows to finish the proof.

11:30-12:00

Mean Field limits for Coulomb flows

Sylvia Serfaty Courant Institute, New York University

Abstract: We consider a system of N particles evolving according to the gradient flow of their Coulomb or Riesz interaction, or a similar conservative flow. By Riesz interaction, we mean inverse power s of the distance with s between d-2 and d where d denotes the dimension. We prove a convergence result as N tends to infinity to the expected limiting evolution equation.

12:00-12:30

Fluctuations around the mean-field limit

Mitia Duerinckx ENS Lyon

Abstract: This talk is concerned with fluctuations around the mean-field approximation for a system of interacting classical particles. We focus on the behavior close to a global equilibrium, in which setting a rigorous analysis can be performed. In this linearized regime, the equation for fluctuations is shown not to coincide with the linearization of the Lenard-Balescu kinetic equation that is predicted by physicists, thus posing some questions on the validity of the latter.

12:30-13:00

Meanfield limits on graphs and the upwind transportation metric

Andre Schlichting Unversity of Bonn
Antonio Esposito Università degli Studi dell'Aquila
Francesco Patacchini Carnegie Mellon University
Dejan Slepcev Carnegie Mellon University

Abstract: We propose a nonlocal gradient structure approximating the aggregation equation motivated by classical upwind scheme widely used for the numerical approximation of first order equations. We show, that the nonlocal upwind metric is very well suited for the variational formulation of first-order equations on graphs and graphons. Although, the induced distance is a quasi-metric (non-symmetric), we explain, how in a proper local limit the L2-Wasserstein gradient flow formulation for the aggregation equation is recovered.

MS A3-2-1 10 **11:00-13:00**

Mathematical and numerical modelling of compressible multiphase flows - Part 2

For Part 1 see: MS A3-2-1 9
Organizer: Nicolas Seguin Université de Rennes 1
Organizer: Herard Jean-Marc EDF

Abstract: Mathematical modelling and simulations of multiphase flows are of major importance in different industries (oil companies, safety for nuclear power plants...). The objective of the proposed sessions is to provide an overview on recent advances in this field. The two parts focus on the mathematical research in the framework of two-phase and three-phase flows, considering miscible or immiscible components. Some contributions detail the derivation of PDE models, with emphasis on their thermodynamical consistency, and on the well-posedness of discontinuous solutions. Other contributions provide new advanced schemes in order to get accurate and stable approximations of solutions.

11:00-11:30

Closure conditions for a one temperature non-equilibrium multi-component model

Siegfried Mueller RWTH Aachen
Hantke Maren Institut f\"ur Mathematik, Martin-Luther-Universitaet Halle - Wittenberg

Abstract: A class of nonequilibrium models for compressible multicomponent fluids is investigated. These models are subject to the choice of interfacial pressures and interfacial velocity as well as relaxation terms for velocity, pressure and chemical potentials. Sufficient conditions are derived that ensure physical properties such as a non-negative entropy production and thermodynamical stability as well as mathematical properties such as hyperbolicity. For the relaxation of chemical potentials a three-component model gas-water-vapor is considered.

11:30-12:00

A compressible three-phase flow model with two miscible phase

Hélène Mathis Université de Nantes
Jean-Marc Hérard EDF

Abstract: This work is devoted to the modelling of a compressible mixture of a liquid, its vapor and a gas. The gas and the vapor are miscible while the liquid is immiscible with the gaseous phases. This assumption leads to non symmetric constraints on the void fractions. We derive a three-phase three-pressure model endowed with an entropic structure and analyze its properties: hyperbolicity, symmetrization, mechanical relaxation in agreement with the Dalton's law...

12:00-12:30

Some mathematical models and numerical schemes for vapor explosion

Jean-Marc Hérard EDF Lab

Abstract: We present multiphase flow models in order to compute vapor explosion in a meaningful way. We use the entropy inequality in order to derive relevant closure laws and get unique jump conditions. Suitable schemes are also adressed. [1] A three-phase flow model with two miscible phases, J.M. Hérard, H. Mathis, Mathematical Modeling and Numerical Analysis, 2019. [2] Relaxation and simulation of a barotropic three-phase flow model, H.Boukili, J.M.Hérard, Mathematical Modeling and Numerical Analysis, 2019.

12:30-13:00

A relaxation scheme for a hyperbolic multiphase flow model

Khaled Saleh Université Lyon 1

Abstract: We develop a relaxation finite volume scheme for a multiphase flow model. The scheme applies to general equations of state, preserves positive densities, phase fractions and internal energies, is able copes with arbitrarily small values of phase fractions. A fully discrete energy inequality is also proven under a classical CFL condition. The relaxation scheme is shown to be much more accurate than Rusanov's scheme and to perform much better in terms of computational cost.

MS A1-3-1 9 **11:00-13:00**

Applications of agent-based modeling and simulation - Part 2

For Part 1 see: MS A1-3-1 8
Organizer: Rachael Miller Neilan Duquesne University
Organizer: Angelika Manhart Imperial College London

Abstract: Agent-based modeling is a powerful technique used to study properties of complex systems that emerge from the actions and interactions of individual entities and their environment. Agent-based models are used increasingly in all disciplines, both as a predictive tool and as a means of deriving partial differential equation models. This mini-symposium showcases the success of agent-based modeling in addressing problems in biology and medicine, as well as the utility of agent-based modeling in undergraduate education.

11:00-11:30

Collective swimming through obstacles

Angelika Manhart Imperial College London
Pierre Degond Imperial College

Abstract: Agent-based and Partial differential equation (PDE) based modeling are powerful methods to understand self-organization. We combine these methods to capture the collective dynamics of swimmers moving through tethered obstacles. A focus are the density patterns created by the non-local pushing forces between the swimmers and the obstacles. We start with a stochastic, agent-based model of both swimmers and obstacles. Then we systematically derive a PDE-based description using a specialized coarse-graining method and appropriate limits.

11:30-12:00

Agent-based and continuous models of locust hopper bands: Insights gained through the lens of dynamical systems

Andrew Bernoff Harvey Mudd College

Abstract: Juvenile locusts form hopper bands, coordinated groups that march in columnar structures containing millions of individuals. We derive an agent-based model (ABM) that incorporates intermittent motion, alignment, and attraction/repulsion and observe hopper bands forming as an instability. A second ABM introduces food/foraging. Here homogenization yields a hyperbolic system of PDEs. Both the ABM and the PDEs manifest pulses as observed in the field. Both models allow reductions that can be analyzed via dynamical systems methods.

12:00-12:30

Exploring the mechanisms of tissue morphogenesis and regeneration via agent-based modelling

Diane Peurichard INRIA

Abstract: We explore adipose tissue morphogenesis,homeostasis and reaction to rupture via the use of agent-based formalism. We first present an agent based model featuring cells interacting in a dynamically connected fiber network. With minimal biological phenomena, the model show a very good agreement with real data and suggests that adipose tissue self organization could be the result of simple mechanical interactions between few key elements.In a second part the model is extended to study scar healing/regeneration.

12:30-13:00

Dynamics of Social Interactions and Agent Spreading in Social Insect Colonies: Effects of Environmental Events and Spatial Heterogeneity

Yun Kang Arizona State University
Xiaohui Guo Arizona State University
Jun Chen Arizona State University
Jennifer Fewell Arizona State University

Abstract: The relationship between division of labor and worker spatial behavior in social insect colonies provides a useful context to study how social interactions influence the spread of agent (e.g., information or virus) under varied environmental conditions. We use variation in movement patterns associated with different tasks to build and study an agent based model to understand how different spatial and enviornmental attributes affect social contact and spreading dynamics.

MS A6-1-2 9 11:00-13:00

Shape Analysis and Optimization - Part 2

For Part 1 see: MS A6-1-2 8
For Part 3 see: MS A6-1-2 10
Organizer: Welker Kathrin — Helmut-Schmidt-University
Organizer: Kevin Sturm — TU Wien, Institut für Analysis and Scientific

Abstract: Shape optimization is a classical topic which is of high importance in a wide range of applications, e.g., image segmentation, aerodynamic and acoustic design optimization. Analytical and computational approaches in shape optimization have a long history. In particular, challenges arise in the context of applications involving partial differential equations or uncertainties. In this minisymposia recents results in shape analysis and optimization will be presented. Topics range from stabilization of partial differential equations, over classical shape optimization and stochastic shape optimization to shape analysis.

11:00-11:30

On necessary optimality for shape optimization problems constrained by variational inequalities

Welker Kathrin — Helmut Schmidt University
Schulz Volker — Trier University
Luft Daniel — Trier University

Abstract: We consider shape optimization problems constrained by variational inequalities (VI) in shape spaces, which are highly challenging because of two main reasons. First, one needs to operate in inherently non-linear and infinite-dimensional spaces. Second, the existence of the shape derivative is not guaranteed, which imply that the problem cannot be solved without any regularization techniques. We investigate analytically and computationally a VI constrained shape optimization problem with respect to its first-order necessary optimality conditions.

11:30-12:00

On efficient numerical methods for shape optimization

Schulz Volker — Trier University

Abstract: Shape optimization is a very active field of research with challenges from theory, as well as, from applications. This talk discusses novel approaches to the numerical solution of shape optimization problems. These are based on the investigation of 2nd order shape information and an appropriate coupling with mesh deformation strategies. Theoretical insight, as well as, numerical results are provided.

12:00-12:30

Free and Moving Boundary Problems and Transfinite Interpolations

Delfour Michel — Université de Montréal
André Garon — Ecole Polytechnique, Montreal, Canada

Abstract:
This paper is motivated by applications in numerical analysis of free/moving boundary problems, ALE methods, and iterative schemes in shape/topological optimization. It generalizes the Transfinite Mean value Interpolation of Dyken-Floater and introduce the k-Transfinite Barycentric Interpolation on compact H
d-rectifiable subsets E of R
n, 0
d¡n. Dynamical versions are introduced to iteratively construct the rate of change of the position of the points of R
n E from the rate of change of the points of E.

12:30-13:00

Recent advances in nonsmooth shape optimization

Antoine Laurain — University of São Paulo

Abstract: We will see some recent results about distributed and boundary expressions of first and second order shape derivatives for several classes of nonsmooth domains such as Lipschitz domains or polygons. Depending on the type of nonsmoothness, different boundary expressions can be derived from the distributed expressions, which requires a careful study of the regularity of the solution to the underlying PDE. We will show applications to shape Hessians for polygons and to level set methods.

MS FT-2-4 9 11:00-13:00

Reduced Order Modeling for Parametric CFD Problems - Part 3

For Part 1 see: MS FT-2-4 7
For Part 2 see: MS FT-2-4 8
For Part 4 see: MS FT-2-4 10
Organizer: Annalisa Quaini — University of Houston
Organizer: Yanlai Chen — University of Massachusetts, Dartmouth
Organizer: Gianluigi Rozza — SISSA, International School for Advanced Studies Trieste

MS Organized by: SIAG/CSE

Abstract: Large-scale computing is recurrent in several contexts such as fluid dynamics, due to the high computational complexity in solving parametric and/or stochastic systems. This often leads to an unaffordable computational burden, especially when dealing with real-world applications, real-time or multi-query computing. In order to lessen this computational burden, reduced-order modeling (ROM) techniques play a crucial role: they aim to capture the most important features of the problem at hand without giving up accuracy. This minisymposium focuses on the development and application of ROM techniques in computational fluid dynamics for direct and inverse modeling, and for control, optimization and design purposes.

11:00-11:30

Certified Offline-Free Reduced Basis methods for stochastic differential equations driven by arbitrary types of noises

Yanlai Chen — University of Massachusetts, Dartmouth
Yong Liu — University of Science and Technology of China
Tianheng Chen — Brown University
Chi-Wang Shu — Brown University

Abstract: We present a new reduced basis method tailored for the linear ordinary and partial differential equations driven by arbitrary types of noise. Main novel ingredients are a new space-time-like treatment for ODEs and PDEs based on time-stepping, an accurate yet efficient compression technique for the spatial component of the space-time snapshots of RBM, a non-conventional ``parameterization" of a non-parametric problem, and finally a RBM that is free of any dedicated offline procedure and online efficient.

11:30-12:00

A L1-based Reduced Over Collocation method for parametrized nonlinear partial differential equations

Lijie Ji — Shanghai Jiaotong University
Yanlai Chen — Department of Mathematics,University of Massachusetts Dartmouth
Sigal Gottlieb — Department of Mathematics,University of Massachusetts Dartmouth
Yvon Maday — Sorbonne Universities, UPMC Univ Paris 06
Zhenli Xu — School of Mathematical Sciences, Shanghai Jiao Tong University

Abstract: In this report, we introduce the L1-based reduced over collocation method (L1-ROC) that is stable and Empirical Interpolation-Free. There are two ingredients of the L1-ROC method. First is a strategy to collocate at (up to) the same number as many locations as the number of basis. Second is a recently introduced L1 approach for the strategic selection of parameter values to build the reduced solution space.

12:00-12:30

Online adaptive basis refinement and compression for reduced-order models

Philip Etter — Stanford University
Kevin Carlberg — Sandia National Laboratories

Abstract: We present a novel adaptive reduced-order model (ROM) refinement and compression algorithm for efficiently gauranteeing the accuracy of ROM solutions. This work extends ROM h-refinement [Carlberg, 2015] by introducing (1) a new vector-space seiving based refinement mechanism and (2) an effecient online compression algorithm for refined ROM bases. These contributions enable our algorithm to serve as both a failsafe for ROMs and an efficient online basis adaptation mechanism, significantly outperforming vanilla ROM h-refinement in practice.

12:30-13:00

Analysis of Proper Generalized Decomposition for parametric symmetric multidimensional elliptic

Mejdi Azaiez Bordeaux INP, France
Chac\'on Rebollo Tomas University of Sevilla Span
G\'omez M\'armol Macarena University of Sevilla Span

Abstract: In this talk we prove the linear convergence of the Power Iterate method applied to compute the modes of the PGD expansion, for both symmetric and non-symmetric problems, when the data are small. We also find a spectral convergence ratio of the PGD expansion in the mean parametric norm, for meaningful parametric elliptic problems.

MS FT-2-1 9 **11:00-13:00**

Recent developments in numerical analysis of integral and integro-differential equations - Part 3

For Part 1 see: MS FT-2-1 7
For Part 2 see: MS FT-2-1 8
For Part 4 see: MS FT-2-1 10

Organizer: Qiumei Huang Beijing University of Technology
Organizer: Hermann Brunner Hong Kong Baptist University

Abstract: Since integral equations, integro-differential equations and related functional equations with various types of delays play an important role as mathematical models in science, engineering and finance, recent years have seen major developments in the design and analysis of efficient numerical methods for such equations. It is the aim of this minisymposium to bring together leading experts in these fields, in order to describe recent achievements and further communication between numerical analysts and computational scientists working on these problems.

11:00-11:30

Long time behaviour of the approximate solution to quasi-convolution Volterra equations

Eleonora Messina Universita di Napoli “Federico II”
Antonia Vecchio IAC-CNR, Napoli. Italy.

Abstract: We consider Volterra integral and integro-differential equations with quasi-convolution kernels, namely involving a convolution contribution plus a non-convolution term. We focus on problems of this type and exploit some known results about convolution equations, in order to describe the asymptotic dynamics of numerical approximations and connect the results to the behaviour of the analytical solution.

11:30-12:00

Numerical solution of fractional integro-differential equations

Arvet Pedas University of Tartu
Enn Tamme University of Tartu
Mikk Vikerpuur University of Tartu

Abstract: Some regularity properties of the solutions to a class of boundary value problems for integro-differential equations with Caputo fractional derivatives are derived. Based on these results and spline collocation techniques, effective methods for the numerical solution of the problem are constructed. Optimal convergence estimates are derived and a global superconvergence result is presented. For confirmation of the obtained theoretical results some numerical examples are given.

12:00-12:30

Spectral Collocation Method for Several Classes of Nonlinear Fractional Partial Differential Equations

Yin Yang Xiangtan University

Abstract: In this talk, the time fractional Schrodinger equation is converted into a Volterra integral PDE, and then use Jacobi-Gauss integral formula and Lagrange interpolation polynomial at JGL collocation nodes to approximate the function. The spatial fractional Ginzburg-Landau equation is discretized into ordinary differential equations by Jacobi polynomial, and then transformed into algebraic equations by JGR spectral collocation method. Rigorous convergence analysis show that the proposed numerical method has high precision and exponential convergence。

MS ME-1-4 9 **11:00-13:00**

Modeling signal transduction/gene regulatory networks - Part 1

For Part 2 see: MS ME-1-4 10

Organizer: Tomas Gedeon Montana State University
Organizer: Konstantin Mischaikow Rutgers University

Abstract: The minisymposium will provide an overview of the current state of modeling signal transduction/gene regulatory network dynamics. It will also serve as a meeting point of different approaches to modeling of dynamics of these complex systems, ranging from Boolean networks to parameterized models of ordinary differential equations. Specific challenges of biological networks including lack of first principle models and the existence of large numbers of parameters that are difficult to identify from experiments will be discussed.

11:00-11:30

Model selection and model interrogation by DSGRN

Tomas Gedeon Montana State University

Abstract: Dynamic Signatures Generated by Regulatory Networks (DSGRN) provides a queryable description of global dynamics over the entire parameter space. We describe an application to E2F-Rb network, that controls mammalian cell cycle restriction point and has been implicated in many cancers. We show that a large portion of the parameters support either the proliferative state,quiescent state, or hysteresis between them. We sample robustness of this dynamics in the space of nearby networks.

11:30-12:00

DSGRN: A Novel Approach to Organizing Dynamics of Regulatory Networks

Konstantin Mischaikow Rutgers University
Tomas Gedeon Montana State University
Bree Cummins Montana State University
Hiroshi Kokubu Kyoto University
Hiroe Oka Ryukoku University
Marcio Gameiro University Sao Paulo - Sao Carlos
Shane Kepley Rutgers University
Lun Zhang Rutgers University
Kelly Spendlove Rutgers University

Abstract: We discuss a new approach to dynamical systems, which moves the focus away from trajectories and invariant sets, and towards robust, scalable and computable descriptions of dynamics in terms of directed graphs and algebraic topological invariants. As a consequence one can obtain a rigorous finite queryable description of global dynamics that is valid over large regions of parameter space. To make these ideas explicit they will be described in the context of gene regulatory networks.

12:00-12:30

A study of hysteresis in three-node gene regulatory networks

Marcio Gameiro University of Sao Paulo at Sao Carlos

Abstract: Understanding the dynamics of gene regulatory networks is a central problem in systems biology. I will present our analysis of the dynamics of three-node gene regulatory networks using novel combinatorial and algebraic topological methods based on Conley theory to try to understand which networks most robustly support the phenotypic behavior of a hysteretic switch.

12:30-13:00

Morse decomposition of switching systems

Hiroe Oka Ryukoku university
Tomas Gedeon Montana State University
Shaun Harker Rutgers University
Hiroshi Kokubu Kyoto University
Konstantin Mischaikow Rutgers University

Abstract: Switching systems are PL vector fields with discontinuous nonlinearities, which were introduced by L. Glass and others as a class of ODEs modeling gene regulatory networks. Using the combinatorial-topological method called DSGRN (due to K. Mischaikow, T. Gedeon et al.), I’ll show how the Morse decompositions of such systems can be obtained that remain valid under singular perturbation into smooth vector fields.

MS FT-4-4 9 **11:00-13:00**

Advances in Monte Carlo Methods and Applications - Part 5
For Part 1 see: MS FT-4-4 5
For Part 2 see: MS FT-4-4 6
For Part 3 see: MS FT-4-4 7
For Part 4 see: MS FT-4-4 8
Organizer: David Aristoff Colorado State University
Organizer: Gideon Simpson Drexel University

Abstract: Monte Carlo methods continue to be the primary tool for a host of problems posed in high dimensional spaces in fields as diverse as materials science, data science, and uncertainty quantification. These applications demand both novel algorithms and mathematical analysis to ensure accuracy and optimal performance. This minisymposium will bring together researchers and practitioners to discuss the latest results on Monte Carlo algorithms and their application. Key topics will include Gibbs-Boltzmann sampling, free energy calculations, rare event simulation, uncertainty quantification, optimization, and ensemble and particle methods.

11:00-11:30

Effective dynamics for reversible and non-reversible SDEs: a quantitative study

Frédéric Legoll ECOLE DES PONTS PARISTECH
Tony Lelievre ENPC and Inria
Upanshu Sharma ENPC

Abstract: Coarse-graining is central to reducing dimensionality in molecular dynamics, and is typically characterized by a mapping which projects the full state of the system to a smaller class of variables. The reversible setting has been extensively studied in the literature. Starting here with a non-reversible dynamics, we introduce and analyze an effective dynamics which approximates the (non-closed) projected dynamics. We also discuss its link with the notions of mean force and free energy.

11:30-12:00

Long-time dynamics without predefined states: a data-driven Parallel Replica Dynamics approach

Danny Perez Los Alamos National Laboratory

Abstract: We present a data-driven version of Parallel Replica Dynamics that does not require the a priori definition of metastable states. In this new method, states are defined on-the-fly during the simulation. To do so, the algorithm requires only the specification of a (potentially large) number of atomistic descriptors in terms of which the states will be implicitly defined. We demonstrate the new approach through long-time simulations of biomolecules and of soft defects in metals.

12:00-12:30

Parareal algorithm in the context of molecular dynamics

Upanshu Sharma Ecole des Ponts ParisTech
Frédéric Legoll École des Ponts ParisTech
Tony Lelièvre École des Ponts ParisTech

Abstract: The Parareal algorithm is a parallel-in-time integration method wherein certain expensive computations can be performed in parallel. Its central ingredients are a fine and a coarse model for the system under consideration, for instance, integrators with fine and coarse time-steps for differential equations. In this work we analyse the utility of the parareal algorithm in the context of molecular dynamics, by choosing the coarse model to be a simplification of the potential energy landscape.

12:30-13:00

Sampling Probability distributions and exploiting symmetry: a Monte Carlo success story

Manon Michel Laboratoire de Mathématiques Blaise Pascal

Abstract: This talk will deal with recent non-reversible MCMC algorithms, based on piecewise deterministic Markov processes. First developed for multiparticle systems, the goal was to emulate the successes of cluster algorithms for spin systems and was achieved through the replacement of the time reversibility by symmetries of the sampled probability distribution itself. I will present the successes achieved by those schemes as well as the remaining open questions.

MS FE-1-2 9 **11:00-13:00**

Eigenvalue Optimization - Part 1
For Part 2 see: MS FE-1-2 10
Organizer: Matthias Voigt Technische Universität Berlin
Organizer: Emre Mengi Koc University

Abstract: The optimization of eigenvalues plays an important role in various fields of applied mathematics such as in graph optimization problems, as well as robustness analysis and controller design for dynamical systems. Such problems are often non-smooth, non-convex and/or large-scale, thus pose mathematical challenges in terms of the theory as well as the algorithms and the numerical methods. This minisymposium aims at bringing together researchers from optimization, numerical analysis, and engineering to discuss recent advances and applications of eigenvalue optimization.

11:00-11:30

Projection Based Subspace Methods for Hermitian Eigenvalue Optimization

Ding Lu UC Davis
Daniel Kressner EPFL
Bart Vandereycken University of Geneva

Abstract: Certain optimization problems over the numerical range of a matrix lead to the minimization of the largest eigenvalue of a Hermitian matrix that depends on one parameter. Two examples are Crawford number computation and max-ratio minimization. We study two projection-based subspace methods for such problems: one uses schemes of eigenvector sampling, and the other uses local subspace searching with gradients. We discuss the convergence of both algorithms and demonstrate their performance by examples with applications.

11:30-12:00

Estimation of the stability radii for large-scale port-Hamiltonian systems

Emre Mengi Koc University
Nicat Aliyev Koc University
Volker Mehrmann TU-Berlin

Abstract: Linear time-invariant port-Hamiltonian (PH) systems are structured control systems with autonomous parts in the form x’=(J -R)Qx for a skew-Hermitian J, symmetric positive semidefinite R, positive definite Q. They are Lyapunov stable, yet can become unstable due to unstructured perturbations. We propose subspace frameworks to compute the stability radii of large-scale linear PH systems. The proposed frameworks operate on the eigenvalue optimization characterizations of the stability radii, and converge rapidly.

12:00-12:30

A subspace method for H-infinity-norm minimization

Matthias Voigt Technische Universität Berlin
Aliyev Nicat Istanbul Sabahattin Zaim University
Benner Peter Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg
Mengi Emre Koc University, Istanbul

Abstract: We propose a subspace framework for the minimization of the H-infinity-norm of the transfer function of a large-scale parameter-dependent descriptor system. The algorithm is a greedy interpolatary approach inspired by our recent work for the computation of the L-infinity-norm. Here we minimize the H-infinity-norm of a reduced-order system obtained by two-sided Petrov-Galerkin projections. Then we expand the subspaces so that Hermite interpolation properties hold in order to achieve a convergence result.

12:30-13:00

Criss-cross algorithms for computing the spectral value set abscissa and radius

Tim Mitchell Max Planck Institute for Dynamics of Complex Technical Systems
Peter Benner Max Planck Institute for Dynamics of Complex Technical Systems

Abstract: We extend and improve upon the original criss-cross algorithms for computing the pseudospectral abscissa and radius. Our new methods are the first to guarantee computation of the spectral value set abscissa and radius, generalizations of the aforementioned pseudospectral measures. Furthermore, the several improvements we propose not only result in meaningful run-time speedups but also make the routines more accurate and reliable, benefits which are all relevant for both spectral value set and pseudospectral problems.

MS A6-2-2 9 **11:00-13:00**

Bohemian Matrices and Applications - Part 1

For Part 2 see: MS A6-2-2 10

Organizer: Nicholas Higham	University of Manchester, Uk
Organizer: Rob Corless	Western University

Abstract: Bohemian matrices are matrices with entries drawn from a fixed discrete set of small integers (or some other discrete set). The term is a contraction of BOunded HEight Matrix of Integers. Such matrices arise in many applications, and include (0,1) graph incidence matrices and (-1,1) Bernoulli matrices. The questions of interest range from identifying structures in the spectra of particular classes of Bohemian matrix to searching for most ill conditioned matrices within a class, and applications include stress-testing algorithms and software. This minisymposium will report recent theoretical and computational progress as well as open questions.

11:00-11:30

Optimization Problems Over Bohemian Matrices

Nicholas Higham	University of Manchester, Uk

Abstract: We discuss some optimization problems associated with particular classes of Bohemian matrices, including (a) what is the most non-normal Bohemian matrix and (b) what is the most ill conditioned normal Bohemian matrix. In particular, we will discuss the extend to which the Wilson matrix is a most ill conditioned matrix of its type. Our investigations combine theory with computational experiments.

11:30-12:00

Mining the Bohemian Matrix Characteristic Polynomial Database

Rob Corless	Western University
Steven Thornton	Western University
J. Rafael Sendra	University of Alcala
Eunice Chan	Western University
Laureano Gonzalez-Vega	University of Cantabria
Juana Sendra	Politecnica de Madrid

Abstract: Bohemian Matrix families are sets of matrices with entries from a fixed finite population, such as {-1,0,1}. Eigenvalues of such matrix families are of interest, even if the matrices are small: see the images at bohemianmatrices.com for instances. Numerical computation of eigenvalues is less attractive than is computing characteristic polynomials, because of a significant compression: there may be billions of matrices but only millions of polynomials. This talk explores hybrid symbolic-numeric algorithms for this exploration.

12:00-12:30

On Reversible Square Matrices and Divisor Functions

Matthew Lettington	Cardiff University
Martin Neil Huxley	Cardiff University
Karl Michael Schmidt	Cardiff University
Sally Louise Hill	Cardiff University

Abstract: We demonstrate that the enumeration of all nxn principal reversible squares achieved by Ollerenshaw can be formulated in terms of number theoretic divisor functions, in particular as sums over products of the jth non-trivial divisor functions. Due to a bijection this formula also counts that number of n+n sum systems. Sum systems are of interest because they comprise all 2D frames-of-reference of a certain type in the positive quadrant for the first n^2 non-negative integers.

12:30-13:00

On Bohemian Correlation Matrices

Laureano González Vega	Universidad de Cantabria

Abstract: Bohemian matrices are families of matrices whose entries come from a fixed discrete set of small integers. A symmetric matrix is a correlation matrix if it has ones on the diagonal and its eigenvalues are nonnegative. We will introduce a new characterization of correlation matrices that will be used to show that the number of Bohemian Correlation Matrices over -1, 0 and 1 corresponds to OEIS A000110 and to solve some correlation matrix completion problems.

MS ME-1-9 9 **11:00-13:00**

Inverse Problems and Imaging: Theoretical and Computational Aspects - Part 1

For Part 2 see: MS ME-1-9 10

Organizer: Fernando Guevara Vasquez	The University of Utah
Organizer: Kui Ren	Columbia University
Organizer: Yang Yang	Michigan State University

Abstract: The field of Inverse problems has developed rapidly in the past several years, both on the mathematical side where many theoretical understanding has been constructed for linear and nonlinear problems related to partial differential equations and on the computational side where efficient computational methods have been developed for solving large scale image reconstruction problems. This minisymposium intends to bring together leading experts in the field to show case some recent progresses and discuss future directions in this exciting research area.

11:00-11:30

Inverse wave problems in the reduced order model domain

Jörn Zimmerling	University of Michigan
Liliana Borcea	University of Michigan
Vladimir Druskin	WPI
Alexander Mamonov	University of Houston

Abstract: We propose an imaging method in highly scattering media based on reduced-order models. From the measured data, we construct a small dynamical system, a so-called reduced order model, which explains the observed data and has the structure of a discretized wave operator. Rather than minimizing a data misfit, we propose to minimize the misfit in these reduced-order models. We show that this mitigates the nonlinearity of this problem.

11:30-12:00

Computational methods for subwavelength imaging in fluorescence microscopy

Howard Levinson	University of Michigan

Abstract: We propose a two step iterative algorithm to reconstruct the optical properties of a scattering medium from unknown internal sources. The proposed method alternately solves an inverse scattering problem for the medium and an inverse source problem for the undetermined sources. The application is based on photoactivated localization microscopy. Numerical simulations illustrate subwavelength resolution.

12:00-12:30

Direct reconstruction in elastography

Pierre Millien	ESPCI
Ammari Habib	Eth Zurich
Bretin Elie	Insa Lyon
Seppecher Laurent	EC Lyon

Abstract: The aim of this talk is to present and analyze a new direct method for solving the linear elasticity inverse problem. Given measurements of some displacement fields inside a medium, we show that a stable reconstruction of elastic parameters is possible, even for discontinuous parameters and without boundary information. We provide a general approach based on the weak definition of the stiffness-to-force operator to see the problem as a linear system.

12:30-13:00

Optical imaging of colloids

Arnold Kim	University of California, Merced
Chysoula Tsogka	University of California, Merced

Abstract: A colloidal suspension is a collection of nanometer to micron scaled particles in a fluid used to study self-assembly. A key to studying colloids lies in imaging these particles accurately and efficiently within a standard microscope setup. In this talk, we introduce this imaging problem, propose an imaging method that uses space, angle or wavelength diversity at the source to compensate for the intensity-only measurements, and demonstrate its effectiveness through numerical simulations.

MS A6-5-2 9 **11:00-13:00**

Complex dynamics of biological and artificial neural networks - Part 1

For Part 2 see: MS A6-5-2 10

Organizer: Valeri Makarov	Complutense University of Madrid
Organizer: Roberto Barrio	Universidad de Zaragoza, Spain
Organizer: Boris Gutkin	NRU Higher School of Economics

Abstract: The cognitive performance of modern AI systems based on von Neumann architecture leave far behind the human brain. Thus, one of the global problems of the 21st century is to understand the brain. It is coped by studying biological and artificial neural networks (NN). Nowadays artificial NN gain power, yet there is a significant gap between these two approaches. This minisymposium collects renowned experts in NN and aims at addressing this dichotomy, providing novel results on the complex dynamics of biological NN and methods of learning and error correction in artificial NN.

11:00-11:30

Fast social-like learning of complex behaviors in neural networks

Valeri Makarov Complutense University of Madrid

Abstract: Complex behaviors of animals can be decomposed into sequences of n motor motifs. We model the learning of one out of $(n - 1)!$ possible behaviors in a neural network and show that the learner can rewire "on the fly" its synaptic couplings in no more than $(n - 1)$ training cycles. Then the synaptic weights converge exponentially to the target values. We validate the learning model by implementing the teacher-learner concept in mobile robots.

11:30-12:00

Insect moving CPGs: patterns and bifurcations

Roberto Barrio Universidad de Zaragoza, Spain
Alvaro Lozano Centro Universitario Defensa, Zaragoza, Spain
Marcos Rodriguez Computational Dynamics group (CoDy), UZ, Spain
Sergio Serrano University of Zaragoza, Zaragoza, Spain

Abstract: We study small CPGs (6-neuron model) for insect locomotion. First we develop a detailed biparametric "roadmap". We introduce numerical techniques based on the combined use of several 3-cell analysis related to each side of the insect or the analysis of the complete system by performing automatic detection techniques combined with quasi-Monte-Carlo sweeping methodologies. These methods permit us to obtain a complete scheme of the patterns evolution on the movement gaits of the insect.

12:00-12:30

Stochastic separation theorems and fast error correction in legacy neural networks

Ivan Tyukin University of Leicester
Alexander N. Gorban University of Leicester

Abstract: Explosive progress in computing produced Artificial Intelligence (AI) systems that are capable to spot minute patterns in large data sets and outperform humans in complicated cognitive tasks. However, the super-human power of modern AIs to learn from massive volumes of data make their conclusions vulnerable to errors arising from data uncertainties and implementation constraints. In this talk we present a mathematical framework for overcoming this barrier via enabling AI systems to learn on the job.

12:30-13:00

Dynamical effects of higher-order interactions in phase oscillator networks

Christian Bick University of Exeter

Abstract: The function of coupled oscillatory units depends on their collective dynamics, such as synchronization. The classical Kuramoto model assumes simple additive interactions between oscillators determined by the sine of oscillator phase differences. We show that more general higher-order interactions between identical phase oscillators allow for a range of collective effects, ranging from chaotic fluctuations to sequential dynamics between patterns where frequency synchrony is localized in the network.

MS A1-1-2 9 11:00-13:00

Numerical and mathematical issues on vortex motions - Part 2

For Part 1 see: MS A1-1-2 8

Organizer: Hisashi Okamoto Gakushuin University
Organizer: Sun-Chul Kim Chung-Ang University
Organizer: Robert Krasny University of Michigan

Abstract: Our minisymposium is about fluid motions where vorticity dynamics is the main player. They are complex and perplexing. To understand such motions, analysis by mathematical models and computational experiments of them are required. Krasny, Nitsche and Sohn are experts on computational issues on vortex sheets and related fluid motions. Shoji worked on water waves on vortical flows. Jeong works for mathematical issues on the Euler equations. Okamoto and Kim are working for the role of vorticity at very high Reynolds numbers. Common themes are singular or nearly singular solutions of fluid mechanical PDEs and its efficient computational method.

11:00-11:30

Numerical Study of Double Emulsions Flowing Through a Tapered Nozzle in Axisymmetric Stokes Flow

Monika Nitsche University of New Mexico

Abstract: This talk presents a numical study of double emulsions travelling through and exiting a microfluidic nozzle, using an axisymmetric Stokes model. The goal is to study droplet breakup previously observed in laboratory experiments, with applications for example to drug delivery. We derive the coupled boundary integral equations for the flow velocity, address several of the numerical issues in the evaluation of the singular and near-singular integrals, and conclude with some results for the full simulation.

11:30-12:00

Progeressive water waves on two vortical layers

Mayumi Shoji Japan Women's University
Hisashi Okamoto Gakushuin University

Abstract: Stationary waves of constant propagation speed on rotational flow of two layers are computed. Considering two-layer vorticity is a step closer to the real water wave. It is hard to classify the structures of solutions mathematically, thus we resort to a numerical method with systematic computations in order to see them all. The important point is to use a formation including stagnation points. There will be shown some numerical results for several cases.

12:00-12:30

Existence of unimodal solutions for the Proudman-Johnson equation: a computer-assisted proof

Tomoyuki Miyaji Meiji University

Abstract: We consider unimodal solutions of the Proudman-Johnson equation which is derived from the two-dimensional Navier-Stokes equation. The unimodal solution is a model of a large coherent vortex appearing in 2D Navier-Stokes flows at large Reynolds numbers. We appy methods of computer-assisted proof based on interval arithmetic, the multiple-shooting method, and the interval Newton method. As a result, we prove that unimodal solutions exist at large Reynolds numbers.

12:30-13:00

Dynamics of singular vortex patches: symmetries and well-posedness

In-Jee Jeong Korea Institute for Advanced Study
Tarek Elgindi UCSD

Abstract: For a vortex patch with initially smooth boundary, the patch boundary remains smooth for all time. We consider patches with corner singularities. Depending on whether the initial patch satisfies an appropriate rotational symmetry condition, the corner structure may propagate (globally in time) or lost immediately. We also present a formal computation which shows that initial patches with a single acute corner cusps immediately.

MS A6-2-3 9 11:00-13:00

Mathematical Imaging Models for Cultural Heritage Conservation

Organizer: Simone Parisotto University of Cambridge
Organizer: Luca Calatroni CMAP, École Polytechnique

Abstract: Over the last thirty years, the use of digital image processing methods applied to Cultural Heritage conservation became an extremely active area of research. Non-destructive techniques supporting the work of art conservators range nowadays from compressed sensing to high-resolution image restoration models and have been successfully applied to enhance and/or fuse information in images acquired via different modalities both in the visible and in the invisible spectrum. In the mini-symposium we aim to promote the scientific discussions in this area by gathering experts in the field and presenting their contributions in the restoration of several artwork pieces.

11:00-11:30

Unveiling the invisible: non-destructive image analysis of frescoes and manuscripts

Luca Calatroni CMAP, École Polytechnique
Simone Parisotto University of Cambridge, UK
Carola-Bibiane Schönlieb DAMTP, CIA, CCIMI, University of Cambridge, UK
Paola Ricciardi Fitzwilliam Museam, University of Cambridge, UK
Stella Panayotova Fitzwilliam Museam, University of Cambridge, UK

Rob Hocking DAMTP, University of Cambridge, UK
Marie D'Autume CMLA, ENS Cachan, CNRS, FR
Claudia Daffara Dipartimento di Informatica, University of Verona, IT

Abstract: We discuss a range of mathematical methods for digital restoration of frescoes and illuminated manuscripts. These tools represent an incredible opportunity for digital manipulation, since they leave these objects physically untouched. Furthermore, these techniques also serve as an example for the possibilities that both mathematics and digital restoration offer as a generic semi-supervised toolkit for the arts. In this talk, we focus in particular on the problems of image inpainting, data integration and contrast equalisation.

11:30-12:00

Signal and Image Processing Supporting the Technical Study, Conservation and Preservation of Art

Miguel Rodrigues University College London

Abstract: The cultural heritage sector is experiencing a digital revolution driven by the growing adoption of non-invasive, non-destructive imaging and analytical approaches generating multi-dimensional data from entire artworks to support art investigation. However, the availability of such rich datasets poses major challenges: traditional approaches are not adequate to inspect this wealth of data. This talk overviews how advances in signal & image processing, machine learning, and AI are advancing the study, conservation and preservation of art.

12:00-12:30

Evolving from local to Web/VR visualization for CH dissemination and conservation

Marco Potenziani Visual Computing Lab - ISTI - CNR

Abstract: Many applications require to share the visual models produced for supporting the cooperative work of professionals or scholars. This is an emerging need in the DH/CH community. In this framework, the web is the ideal distribution channel for sharing contents. But publishing on the web complex visual media was not easy until recently. The focus of the talk will be to discuss practical solutions for the easy publication of high-fidelity visual models on the web.

12:30-13:00

The physical data acquired in coherent and non-coherent optical techniques for cultural heritage

Claudia Daffara University of Verona

Abstract: Reliable modelling of image data passes for the knowledge of their intrinsic physical aspects regarding the techniques, i.e. acquisition methods and devices, as well as general physical phenomena of radiation-matter interaction. This is expecially true in CH as experiments are far from ideal modelling with synthetic data because of the complex investigated artworks. On this regard we discuss some recent nondestructive imaging techniques based on optical radiation in reflectance and emission and on coherent light.

MS ME-1-0 9 11:00-13:00

Analysis and approximation of PDEs modeling Biological processes - Part 2

For Part 1 see: MS ME-1-0 8
For Part 3 see: MS ME-1-0 10
Organizer: Guillen-Gonzalez Francisco Universidad de Sevilla
Organizer: María Ángeles Rodríguez-Bellido Universidad de Sevilla
Organizer: Cristian Morales-Rodrigo Universidad de Sevilla

Abstract: In the last decades, the synergy between biology and mathematics are enriching both fields. Biology is increasingly stimulating the creation of new mathematical theories to explain in a simplified way the complexity of the world of living organisms. On the other hand, the mathematical modeling of the biological phenomena can serve to advise on therapies through numerical experimentation, besides also can suggest new lines of research. In this minisymposium, some recent results and challenges will be treated in the analysis and approximation of PDEs modelling biologycal processes, specifically in chemotaxis, population dynamics and tumor evolution.

11:00-11:30

Phase-field modeling of biological cells in flow

Sebastian Aland HTW Dresden

Abstract: We develop a phase-field model for fluid-structure interaction, that is capable to handle very large deformations as well as topology changes like contact of the solid to the domain boundary. The model is based on a fully Eulerian description of the velocity fields coupled to an Oldroyd-B-like equation for the elastic stresses. We use the model to simulate a viscoelastic biological cell traversing a fluid channel and present applications of the model in medical diagnostics.

11:30-12:00

Delay formulation of structured populations with infinite dimensional state variables

Angel Calsina Universidad Autonoma de Barcelona

Abstract: Models for distributions of individuals with respect to internal variables (such as age, size, ...) can be written by means of integral equations for the (histories) of the birth rate and the interaction variables. This formulation has the advantage that allows a rigorous qualitative theory. We will consider a model of competition for light in a forest with infinite dimensional interaction variable and will study a characteristic equation for the stability of the steady states.

12:00-12:30

Bioconvective fluids with viscosity depending on the concentration of microorganism.

Blanca Climent Ezquerra Universidad de Sevilla

Abstract: The model describes the hydrodynamics of a shallow suspension of negatively geotactic microorganisms, against the gravity, and it consists of the equations for the motion of the culture fluid of Navier-Stokes type and the equation for the concentration of microorganisms. Existence, uniquenesss and regularity of solution results are presented, as well as some convergence rates of solutions of spectral Galerkin approximations.

MS FT-S-8 9 11:00-13:00

Numerical linear algebra advances for inverse problems and data assimilation - Part 2

For Part 1 see: MS FT-S-8 8
For Part 3 see: MS FT-S-8 10
Organizer: Melina Freitag University of Bath
Organizer: Nancy K Nichols University of Reading
Organizer: Alison Ramage University of Strathclyde
Organizer: Silvia Gazzola University of Bath

MS Organized by: SIAG/LA

Abstract: The solution of inverse problems and data assimilation requires efficient algorithms and tools from large scale linear algebra. The aim of this minisymposium is to present new developments in theory and numerical methods for inverse problems and data assimilation problems, including regularisation techniques, iterative solution methods, Krylov methods, preconditioning methods, reduced order modelling, and statistical approaches to inverse problems.

11:00-11:30

On the identification of the regularization parameter in ill-posed problems

Caterina Fenu University of Cagliari
Lothar Reichel Kent State University
Giuseppe Rodriguez Università degli Studi di Cagliari
Hassane Sadok Université du Littoral Côte d'Opale

Abstract: We are concerned with the solution of discrete ill-posed problems where the matrix is large and its singular values decay gradually to zero without a significant gap. A good approximation of the solution can often be computed by regularizing. Here we will discuss two of the most popular regularization methods, namely the Tikhonov regularization method, coupled with the Generalized Cross Validation, and the Truncated Singular Value Decomposition, with a method based on an extrapolation procedure.

11:30-12:00

An interior point method for tomographic reconstruction

Tyrone Rees STFC Rutherford Appleton Laboratory

Abstract: The technique of tomography computes a representation of a cross section through a sample. For any given data, the computed image is generally obtained by solving form of inverse problem. In this talk we will present an algorithm to solve such problems using an interior point method. We will show the effectiveness of this algorithm on data from the Diamond Light Source in Oxfordshire, UK. This is joint work with Lukas Schork and Jennifer Scott.

12:00-12:30

Structure preserving preconditioning for image deblurring

Marco Donatelli	University of Insubria
Pietro Dell'Acqua	Free University of Bozen
Claudio Estatico	University of Genova
Mariarosa Mazza	University of Insubria
Lothar Reichel	Kent State University

Abstract: We investigate regularizing preconditioners for accelerating the convergence of iterative regularization methods for image deblurring. Classical regularizing preconditioners are usually based on the circular convolution, which is equivalent to impose periodic boundary conditions. We show that a preconditioner preserving the same structure of the convolution operator can be more effective than the circulant approach both for the quality of the restoration and the robustness of the regularization parameter. Moreover, a non-stationary preconditioning strategy is exploited.

12:30-13:00

Minimizing convex quadratics with variable precision Krylov methods

Ehouarn Simon	University of Toulouse
Gratton Serge	Université de Toulouse, INP, IRIT
Toint Philippe	NAXYS, University of Namur

Abstract: Iterative algorithms for the solution of convex quadratic optimization problems are investigated, which exploit inaccurate matrix-vector products. Theoretical bounds on the performance of a Conjugate Gradients and a Full-Orthogonalization methods and new practical algorithms are derived. Numerical experiments suggest that these methods have significant potential, notably in the context of multi-precision computations.

MS ME-0-7 9 11:00-13:00

Control and Inverse problems in PDE. Theory and applications - Part 3

For Part 1 see: MS ME-0-7 7
For Part 2 see: MS ME-0-7 8
For Part 4 see: MS ME-0-7 10

Organizer: Carlos Castro	UNIVERSIDAD POLITÉCNICA DE MADRID
Organizer: Juan Antonio Barceló	Universidad Politécnica de Madrid
Organizer: Fabricio Macia	Universidad Politécnica de Madrid
Organizer: Cristóbal Meroño	Universidad Politécnica de Madrid

Abstract: The aim of this minisymposium is to present new results in the areas of controllability and inverse problems for systems governed by partial differential equations. Bringing together both topics in a single minisymposium provides an opportunity to contrast the most recent results and techniques and estimulate collaborations between researchers coming from these areas.

11:00-11:30

A new reconstruction algorithm for the fixed angle inverse scattering problem

Carlos Castro	Universidad Politécnica de Madrid
Juan Antonio Barceló	Universidad Politécnica de Madrid
Teresa Luque	Universidad Complutense de Madrid
Mari Cruz Vilela	Universidad Politécnica de Madrid

Abstract: We propose a new iterative method to recover a real compact supported potential of the Schödinger operator from their fixed angle scattering data. The method combines a fixed point argument with a suitable approximation of the resolvent operator by partial sums associated to its Born series. Unlike other iterative methods in the literature, each iteration is explicit and therefore faster. We study the convergence of the numerical method and implementation details.

11:30-12:00

Topological derivative based methods for inverse multiple scattering problems in electromagnetism

María Luisa Rapún	Universidad Politécnica de Madrid, UPM
Frédérique Le Louër	Université de Technologie de Compiègne

Abstract: In this work we deal with the problem of recovering the shape of multiple electromagnetic scatterers from reduced observation data. We propose a one-step and an iterative method based on the computation of topological derivatives. Closed-form formulae are obtained by combining the use of shape derivatives and asymptotic expansions. The performance of the method will be illustrated in several situations including high noise levels, limited aperture configurations and multiple scatterers of different sizes and shapes.

12:00-12:30

The Calderón inverse problem with Lipschitz conductivities

Keith Rogers	CSIC - ICMAT

Abstract: We will consider the mathematical model for Electrical Impedance Tomography in three or more dimensions. That is the problem of recovering the conductivity of a body from electrical measurements on the boundary. I will present a reconstruction formula that is valid for Lipschitz conductivities which are sufficiently close to one, and sketch arguments which allow the closeness condition to be removed in the context of uniqueness. This is joint work with Pedro Caro.

12:30-13:00

A convergent algorithm to recover small potentials with low regularity from backscattering data

Cristóbal Meroño	Universidad Politécnica de Madrid
Carlos Castro	Universidad Politécnica de Madrid
Juan Antonio Barceló	Universidad Politécnica de Madrid

Abstract: In the backscattering inverse problem one tries to recover a potential by observing how it scatters back free waves (the echoes). It is already known that there is uniqueness for small potentials in the backscattering problem under different assumptions on regularity. In this work we show that in every dimension n >1 there is an explicit convergent algorithm to recover small potentials. This algorithm works even under low regularity assumptions in the L2 Sobolev scale.

MS GH-3-3 9 11:00-13:00

Energy-efficient High Temperature Processes via Shape Optimisation

Organizer: René Pinnau	TU Kaiserslautern
Organizer: Nicolas Gauger	Computing Center (RHRK)

Abstract: We consider mathematical models and optimisation techniques for a melting furnace in phosphate production. In this high temperature process radiation plays a predominant role. The main design goals are a reduction of the energy consumption as well as the product quality. In particular, we are going to focus on shape optimisation techniques for an improved design of the melting furnace. Those will rely on a hierarchy of models incorporating the multi-physics of the process.

11:00-11:30

Modelling the Melting Furnace in Phosphate Production

Christian Leithäuser	Fraunhofer ITWM

Abstract: The talk introduces the energy-intensive industrial process of phosphate production and presents a multiphysics model for the melting furnace. This model consists of two coupled components: the first considers turbulent air flow, radiation and temperature transport in the whole furnace including the gas burner, while the second component considers chemical reactions and water vaporization within the melt zone only. The goal is to embed this model into a hierarchy and use space mapping for optimization.

11:30-12:00

Shape Optimisation with Application in Phosphate Production

Nicolas Dietrich	TU Kaiserslautern
Thomas Marx	TU Kaiserslautern
René Pinnau	TU Kaiserslautern

Abstract: Phosphate as an industrial product is an essential ingredient in, e.g., agriculture and the food industry. The production process is very energy consuming and takes place in high temperature melting furnaces. Naturally, the shape of the furnace has a high influence on its efficiency. In order to describe mathematically the temperature distribution within a furnace, we use the Rosseland approximation and discuss the problem in the context of shape optimization.

12:00-12:30

Optimising High Temperature Processes using Shape Calculus

Thomas Marx	TU Kaiserslautern
Dietrich Nicolas	TU Kaiserslautern
René Pinnau	TU Kaiserslautern

Abstract: High Temperature Processes have a wide field of applications in industrial processes. Since solving the Radiative Heat Transfer Equations is very expensive due to the high dimenensional phase space, we consider the SP1 approximation which includes reflecting boundary effect. We use this approximation as a constraint in the shape optimization problem. The optimal shapes are finally compared to the results obtained by the Rosseland approximation.

12:30-13:00

Adjoint-based sensitivity analysis in high-temperature multi-physics problems using AD

Ruben Sanchez Fernandez	TU Kaiserslautern
Emre Özkaya	TU Kaiserslautern
Nicolas R. Gauger	TU Kaiserslautern

Abstract: We present a methodology to compute accurate adjoint sensitivities in problems involving Computational Fluid Dynamics and Radiative Heat Transfer. It is based on the application of Algorithmic Differentiation to the governing equations of the problem reformulated as a fixed-point iterator. This overcomes the traditional adjoint requirement of assembling the exact Jacobian of the multidisciplinary problem. We demonstrate the accuracy of the sensitivities obtained with the proposed method, and their applicability to shape design optimization problems.

MS A3-3-2 9 11:00-13:00

Mathematical descriptions of traffic flow: micro, macro and kinetic models - Part 2

For Part 1 see: MS A3-3-2 8
For Part 3 see: MS A3-3-2 10

Organizer: Andrea Tosin	Politecnico di Torino
Organizer: Gabriella Puppo	La Sapienza Università di Roma

Abstract: Traffic flow is a complex phenomenon, which impacts heavily on society, economy and everyday life. In the last few years, several new technologies, such as driver assist devices or online congestion information, have raised the need for a better understanding of traffic. In this minisymposium, we will gather several researchers in the field to explore the mathematical foundations of traffic models from different perspectives. The motivation is both to assess the state of the art and the interplay between the different approaches and to discuss how to meet the new challenges of traffic control, autonomous vehicles and emission reduction.

11:00-11:30

Macroscopic Models for Traffic Instabilities, and Stable Averaged Equations

Benjamin Seibold	Temple University

Abstract: Phantom traffic jams and stop-and-go traffic waves can be explained via instabilities and nonlinear traveling waves, respectively, in second-order traffic models. We study the dynamics and structural properties of these non-equilibrium features, and propose new model equations that describe the average flow profile on scales larger than the traffic waves. We demonstrate the substantial difference that this limit process can make when considering fuel consumption, emissions, and accident risk of traffic flow.

11:30-12:00

A collapsed generalized Aw-Rascle-Zhang model to evaluate traffic emissions

Caterina Balzotti	Sapienza University - SBAI Department
Maya Briani	Istituto per le Applicazioni del Calcolo - Consiglio Nazionale delle Ricerche
Barbara De Filippo	Istituto per le Applicazioni del Calcolo - Consiglio Nazionale delle Ricerche
Benedetto Piccoli	Department of Mathematical Sciences - Rutgers University

Abstract: We exploit the Collapsed Generalized Aw-Rascle-Zhang model to estimate the density, speed and acceleration of vehicles along a road. These variables are used to compute the emission rate of the No_x, since the chemical reactions triggered by their contact with the UV rays lead to the production of ozone. We model these chemical reactions with a system of ODE and we study their dynamic in relation to the traffic of the road.

12:00-12:30

Coupling conditions for a discrete-velocity traffic flow model

Raul Borsche	TU Kaiserslautern
Axel Klar	TU Kaiserslautern

Abstract: In this talk we introduce coupling conditions for a nonlinear discrete-velocity relaxation model for traffic flow. On a single road the solutions of the discrete-velocity model converges to those of LWR equation when the relaxation time goes to zero. In this limit we analyze the dynamics at the coupling point by studying the structure of kinetic boundary layers. With theses tools new coupling procedure for the limit equations can be derived.

12:30-13:00

A macroscopic traffic flow model with finite buffers on networks: well-posedness with Hamilton-Jacobi equations

Nicolas Laurent-Brouty	Inria Sophia Antipolis - Méditerranée

Abstract: We present a macroscopic traffic flow model on networks which guarantees spill-back phenomena at junctions. We introduce buffers and time dependent split ratios at the junctions, which represent how traffic is routed through the network. We then use a Hamilton-Jacobi formulation to derive a fixed-point problem, which is used to prove well-posedness of the model. Finally, we detail how to apply our framework to a non-trivial road network, with several intersections and finite-length links.

MS GH-3-2 9 11:00-13:00

Sensitivity Analysis in Computationally Intensive Applications - Part 1

For Part 2 see: MS GH-3-2 10

Organizer: Joseph Hart	Sandia National Laboratories
Organizer: Bart Vanbloemenwaanders	Sandia National Laboratories

MS Organized by: SIAG/CSE

Abstract: Many problems in engineering and science involve both computationally intensive models and high dimensional parametric uncertainty. This combination creates numerous challenges for practitioners seeking to design robust and reliable systems. This minisymposium will focus on methodological advances and applications of sensitivity analysis and dimension reduction techniques, with an emphasis on computational scalability. The role of sensitivity analysis and dimension reduction will be considered in a broader analysis and design workflow. This may include, but not be limited too, robust and risk-averse optimization, surrogate modeling, forward propagation of uncertainties, rare event simulation, inverse problems, and optimal experimental design.

11:00-11:30

Iterative uncertainty and sensitivity analysis

Bertrand Iooss	EDF R&D
Alejandro Ribes	EDF R&D

Abstract: While building and using numerical simulation models, uncertainty and sensitivity analysis are invaluable tools. We focus on new issues relative to large scale numerical systems when the storage of all the simulation results is impossible. We then compute the statistical criteria on the fly. The general mathematical and computational issues of these iterative statistical estimates will be posed. A particular attention will be paid to the estimation of quantiles and variance-based sensitivity indices.

11:30-12:00

Hyper-differential sensitivity analysis for PDE-constrained optimization: Methods and software

Joseph Hart	Sandia National Laboratories
Bart Van Bloemen Waanders	Sandia National Laboratories

Abstract: Hyper-differential sensitivities (HDS) analyze the dependence of PDE-constrained optimization solutions to parameter perturbations. Such analysis may be used to prioritize uncertainties in the service of data acquisition, uncertainty quantification, and model development. Low rank structure is exploited through a Singular Value Decomposition which is numerically implemented with randomized algorithms using multi-level parallelism in C++. The mathematical foundation and computational infrastructure for HDS is presented along with numerical prototypes.

12:00-12:30

Making the best use of permutations to compute sensitivity indices with replicated orthogonal arrays

Clémentine Prieur	Université Grenoble Alpes
Gilquin Laurent	IFP Energies nouvelles
Arnaud Elise	Université Grenoble Alpes
Janon Alexandre	Université Paris-Saclay

Abstract: We propose an efficient replication-based strategy to estimate the full set of first- and second-order Sobol' indices. It relies on a Sobol' pick-freeze estimation scheme and requires only two replicated designs based on randomized orthogonal arrays of strength two. The precision of this procedure is assessed with bootstrap confidence intervals, presented for the first time in the replication framework. Our developments are compared to known approaches and validated on numerical test cases.

12:30-13:00

Surrogate-enabled sensitivity analysis and parameter inference of high-dimensional models

Cosmin Safta	Sandia National Laboratories
Khachik Sargsyan	Sandia National Laboratories
Daniel Ricciuto	Oak Ridge National Laboratories

Abstract: This work demonstrates sparse surrogate construction followed by dimensionality reduction and surrogate- enabled Bayesian inference of model inputs to achieve data-informed uncertain predictions of an expensive computational model. We will rely on polynomial chaos (PC) surrogates as flexible functional representation of uncertain inputs and outputs. High-dimensionality is tackled by Bayesian compressed sensing leading to a sparse set of polynomial bases and allowing efficient global sensitivity analysis and dimensionality reduction.

MS ME-1-6 9 11:00-13:00

The interplay between mathematical engineering and networked control systems - Part 1

For Part 2 see: MS ME-1-6 10

Organizer: María Barbero Liñán	Universidad Politécnica de Madrid
Organizer: Leonardo Colombo	Instituto de Ciencias Matematicas
Organizer: Héctor García De Marina	University of Southern Denmark

Abstract: The need for fast and accurate algorithms for simulations and implementations of distributed control laws in complex systems requires a multidisciplinarity and transfer of knowledge between engineering sciences, physics and mathematics. The aim of this mini-symposium is to be a crossroad to discuss new trends and challenges in control of network systems, numerical algorithms for simulations of physical and robotics systems, and their possible interactions to conduct new directions of research based on industrial needs. The mini-symposium consists of two parts: (i) Geometric Integration and Applications, and (ii) Dynamics and control of networked systems.

11:00-11:30

Building the bridge between mathematical engineering and robotics in formation control

Héctor García De Marina — University of Southern Denmark

Abstract: The gradient-based control is an established tool for stabilizing formations of autonomous agents in a distributed way. Although this kind of controllers does not often require the exchange of information among neighboring agents, the resulting 'undirected nature' of the sensing graph requires a pair of neighboring agents to have precisely the same understanding on their environment, which in practice is difficult to achieve. We investigate the impact of having different understandings on gradient-based distributed controllers.

11:30-12:00

Geometric numerical integration in simulation and optimal control

Sigrid Leyendecker — University of Erlangen-Nuremberg

Abstract: This talk focuses on geometric integrators and their use for numerical optimal control methods. Studying nonlinear mechanical systems from a geometric point of view, one finds that symmetries and invariants contain valuable information. These structural properties play a fundamental role when designing numerical simulation tools. The fidelity of the approximate solution is improved compared to standard methods by representing symmetries and invariants correctly. Further, their preservation stabilises the simulation, thus enables coarser grids and longterm-simulation.

12:00-12:30

Discontinuous Galerkin Variational Integrators

Michael Kraus — Max Planck Institute for Plasma Physics

Abstract: A new framework for variational integrators based on a discontinuous Galerkin approach will be presented. This framework unifies many of the known variational integrators and, at the same time, allows for the construction of completely new families of integrators, in particular offering a natural treatment of degenerate Lagrangians and Dirac constraints.

12:30-13:00

INTEGRATION SCHEMES THAT PRESERVE THE TWO LAWS OF THERMODYNAMICS

David Portillo	UNIVERSIDAD POLITECNICA DE MADRID
Ignacio Romero	UNIVERSIDAD POLITECNICA DE MADRID

Abstract: We present the basic theory for describing the formulation of time stepping algorithms that preserve the two laws of thermodynamics for dissipative problems. The formulation of such methods is based on two ideas: expressing the evolution equation as a metriplectic system and enforcing from their inception certain directionality and degeneracy condition on the discrete vector fields. These methods can be applied to a vast class of thermomechanical system as well as fluid dynamics.

MS ME-1-I1 9 11:00-13:00

Data-driven modeling of complex dynamical systems - Part 2

For Part 1 see: MS ME-1-I1 8

For Part 3 see: MS ME-1-I1 10

Organizer: Steven Brunton	University of Washington
Organizer: Themis Sapsis	MIT
Organizer: Jared Callaham	University of Washington

Abstract: Advances in machine learning are driving progress across science and engineering. Increasingly, these methods are used to analyze, predict, and control dynamical systems from measurement data. However, real-world data still presents a challenge because of rare phenomena, multiscale dynamics, noise, and latent variables. Moreover, many modern techniques in machine learning provide powerful representations based on data, but offer limited interpretability and generalizability. Thus, there is a tremendous opportunity to bring physics and machine learning closer together to address these fundamental challenges. This minisymposium brings together experts in data-driven dynamical systems to explore challenges and progress on these real-world issues.

11:00-11:30

Sparse learning of stochastic dynamic equations

Cecilia Clementi — Rice University

Abstract: There is great interest in the extraction of physically relevant information from massive datasets. Recently, a framework called Sparse Identification of Nonlinear Dynamics (SINDy) has been introduced to identify the governing equations of dynamical systems from simulation data. We extend SINDy to stochastic dynamical systems. We discuss algorithms to solve the sparse regression problem arising from the practical implementation and show that cross-validation is an essential tool to determine the right level of sparsity.

11:30-12:00

Simultaneous discovery of coordinates and parsimonious dynamics using autoencoders

Kathleen Champion — University of Washington, Applied Mathematics

Abstract: Understanding dynamics from scientific data requires methods for providing interpretable reduced descriptions of the data: in particular, discovering parsimonious, low-dimensional models that capture the behavior of potentially high-dimensional systems. Standard approaches for discovering simple dynamical models are reliant on finding a proper set of coordinates for the dynamics. We present a method using a custom autoencoder to simultaneously discover effective coordinates along with parsimonious nonlinear dynamical systems models.

IM FT-4-1 9 11:00-13:00

Societal Impact of Industrial Mathematics and Supporting Infrastructures Worldwide - Part 2

For Part 1 see: IM FT-4-1 8

For Part 3 see: IM FT-4-1 10

Organizer: Manuel Cruz	PT-MATHS-IN | LEMA-ISEP/IPP
Organizer: Carlos Parés Madroñal	Universidad de Málaga

Abstract: The minisymposium "Societal Impact of Industrial Mathematics and Supporting Infrastructures Around the World" is intended to present to the attendees in which different ways several infrastructures around the world help to manage, aggregate, disseminate and help to develop industrial mathematics all over the world. Bringing together infrastructures from different countries and regions, with diverse realities we aim to form a common platform of understanding and promote new synergies. Also, by sharing the different experiences is expected to bring new insights of how industrial mathematics infrastructures can be more efficient in boosting the technological transfer between mathematics and industry.

11:00-11:30

Center for Mathematical Modeling, U. Chile-CNRS: Two decades linking mathematics with Industry

Alejandro Maass	Center for Mathematical Modeling, Universidad de Chile, UMI-CNRS

Abstract: In this talk we will present the Center for Mathematical Modeling (CMM). The CMM is today a world-class center of excellence for research and advanced training in applied mathematics, internationally recognized as a platform for mathematical industrial modeling with a deep impact in innovation. In all its strategic applied research the CMM has participated in major challenges of Chilean economy and public policies.

11:30-12:00

Center of Modeling and Simulation of Strasbourg

Céline Caldini-Queiros	Center of Modeling and Simulation of Strasbourg
Belhachmi Zakaria	UHA
Bertrand Frédéric	Université de Strasbourg
Chabannes Vincent	Université de Strasbourg
Fahs Fatima	Université de Strasbourg
Helluy Philippe	Université de Strasbourg
Hild Romain	Université de Strasbourg
Maumy-Bertrand Myriam	Université de Strasbourg
Prud'homme Christophe	Université de Strasbourg
Wahl Jean-Baptiste	Université de Strasbourg

Abstract: The Modeling and Simulation Center of Strasbourg was created in 2013 by Christophe Prud'homme and supported by the IRMA Laboratory and the CNRS, the Initiative of Excellence of the University of Strasbourg. The main lines of operation of Cemosis are understanding of the industrial problem, expert identification, the establishment of a work plan in project mode, provision of dedicated resources.

12:00-12:30

ITMATI: a success model to transfer Mathematical Technology and Innovation to the Industry.

Peregrina Quintela	ITMATI - Technological Institute for Industrial Mathematics

Abstract: The Technological Institute for Industrial Mathematics (ITMATI) is a milestone of sharing resources among Galician universities. It works like a hub of mathematical technology, developing new mathematical tools, and tuning the existing ones, to become them fully adapted to the specific demands of its customers. In this lecture we will focus on the key points that led it to be a successful model for knowledge transfer and as innovation facilitator in the industry.

12:30-13:00

Impact study of the economic crisis on research and transfer of mathematical technology in Spain

José Luis Ferrin	Faculty of Mathematics - University of Santiago de Compostela

Abstract: The objective of this talk is to show how the economic crisis has impacted on the research and transfer of mathematical technology in Spain. This will be analysed in terms of production of JCR scientific articles and projects and contracts with total or partial financing of a company. This will be done with data extracted from researchers of the five areas of knowledge in Mathematics..

CP FT-4-5 9 **11:00-13:00**

Mathematical Topics and their Applications XI

Chair Person: Saurabh Dixit — Indian Institute of Science

CP FT-4-5 9 1 **11:00-11:20**

Data Assimilation by constraining the nominal dynamics to the observational manifolds

Saurabh Dixit	Indian Institute of Science
Soumyendu Raha	Indian Institute of Science

Abstract: We describe a new approach for data assimilation, which involves projecting the nominal dynamics onto the constraint manifolds formed by the observations, using Lagrange Multipliers. Together with the observa- tional constraints this leads to a system of Differential Algebraic Equa- tions(DAE). Filtering is achieved by the numerical solution of this DAE. The variation of the Lagrange Multiplier with various state variables is studied and used for prediction. This approach is illustrated with examples.

CP FT-4-5 9 2 **11:20-11:40**

Coupled reaction-diffusion and difference system of cell-cycle dynamics for hematopoiesis process with Dirichlet boundary conditions

Chekroun Abdennasser	Tlemcen university

Abstract: This talk deals with a mathematical model describing the cell-cycle dynamics for hematopoietic stem cell population, taking into account their spatial distribution. The model is an age-structured reaction-diffusion system with Dirichlet conditions. The characteristics method reduces its to a coupled reaction-diffusion equation and difference equation with delay. We study the existence, uniqueness, persistence of solutions. We also investigate the stability of the trivial steady state, and the existence of the positive one.

CP FT-4-5 9 3 **11:40-12:00**

Phase-transforming Helical Miura Origami: Theory and Prototype

Fan Feng	University of Minnesota
Paul Plucinsky	University of Minnesota
Frank Yu	Wayzata High School
Richard James	University of Minnesota

Abstract: A helical Miura origami (HMO) is constructed by applying an Abelian helical group on a partially folded Miura parallelogram. By setting group parameters satisfying special discreteness conditions, we construct closed HMO numerically. Inspired by the phase transformation theory of atomic helical structures we recently developed, we build HMO with two phases separated by the compatible horizontal and helical interfaces. Overall motion, like twist and extension, can be obtained by transforming one phase to the other.

CP FT-4-5 9 4 **12:00-12:20**

An enriched experience of exploring scientific publication landscape through HyperBagGraphs

OUVRARD Xavier	University of Geneva & CERN
LE GOFF Jean-Marie	CERN
MARCHAND-MAILLET Stéphane	University of Geneva

Abstract: Conducting a bibliographic research is commonly achieved using verbatim search-engine interfaces. We propose an interactive 2.5D visualisation interface for navigating data, formulating complex visual queries and performing contextual searches. Multiset families, called HyperBagGraphs, are used to model co-occurrence networks of online search outputs and visualise the different dimensional perspectives as hbgraphs. This approach - generalisable to any kind of datasets - is currently applied to online queries on Arxiv, enriched of multiple other online ressources.

CP FT-4-5 9 5 **12:20-12:40**

The Distribution of Numbers of Operating Points of Power Networks

Julia Lindberg	University of Wisconsin-Madison
Alisha Zachariah	University of Wisconsin-Madison
Nigel Boston	University of Wisconsin-Madison
Bernard Lesieutre	University of Wisconsin-Madison

Abstract: The operating points of an n-node power network are real solutions of the power flow equations. Our work finds the distribution of the number of real solutions, which is important in determining the stability of the network. In general, the number of nontrivial operating points equals the number of real solutions of a single polynomial. We use this polynomial to visualize regions with a fixed number of solutions, finding that some cluster around hyperplanes.

CP FT-4-5 9 6 **12:40-13:00**

Towards Model-Based Geometry Reconstruction of Quantum Dots from TEM

Anieza Maltsi	Weierstrass Institute
Thomas Koprucki	Weierstrass Institute
Tore Niermann	Technische Universität
Timo Streckenbach	Weierstrass Institute
Karsten Tabelow	Weierstrass Institute

Jörg Polzehl Weierstrass Institute

Abstract: We present a mathematical model for imaging of semiconductor quantum dots (QDs) by transmission electron microscopy (TEM). This includes elasticity theory for the strain profile coupled with the Darwin-Howie-Whelan equations, describing the propagation of the electron wave through the sample. We demonstrate nonlocal effects in the imaging process due to strain by numerical simulations. We introduce a novel concept for 3D model-based geometry reconstruction of QDs from TEM including machine learning and elastic shape analysis.

CP FT-1-7 9 11:00-13:00

Partial Differential Equations VII

Chair Person: Antim Chauhan Indian Institute of Technology Roorkee

CP FT-1-7 9 1 11:00-11:20

Strong Shock Waves in a Van der Waals gas of Varying Density

Antim Chauhan Indian Institute of Technology Roorkee

Rajan Arora Indian Institute of Technology Roorkee

Amit Tomar Amity University Noida

Abstract: The converging problem of cylindrically/spherically symmetric strong shock wave collapsing at the axis/centre of symmetry, are studied in Van der Waals of varying density. The perturbation approach used in this work provides a global solution to the shock implosion problem. We analyze the flow parameters by expanding the solution in powers of time and found the similarity exponents as well as the corresponding amplitudes in the vicinity of the shock-collapse.

CP FT-1-7 9 2 11:20-11:40

Two-phase two-component flow in porous media in low solubility regime

Mladen Jurak Faculty of Science

Ivana Radisic Faculty of Mechanical Engineering and Naval Architecture

Ana Zgaljic Keko Faculty of Electrical Engineering and Computing

Abstract: We study a system of equations governing liquid and gas flow in porous media. The gas phase is homogeneous while the liquid phase is composed of a liquid component and dissolved gas component. The gas component is weakly soluble in the liquid. This hypothesis is given precise mathematical meaning. We formulate a weak solution of the initial-boundary value problem and prove the existence theorem by passing to the limit in regularizations of the problem.

CP FT-1-7 9 3 11:40-12:00

The existence of weak solution for modified Kelvin-Voigt fluid model

Mikhail Turbin Voronezh State University

Abstract: The existence theorem of weak solution for the modified Kelvin-Voigt fluid model is proved. The proof is based on the approximation-topological approach. Namely, we approximate the operator equation equivalent to the original problem by some operator equation with better properties and the solvability of this approximation equation is proved. Then, on the base of a priori estimates of solution and passage to the limit, the existence of weak solution to the original problem is obtained.

CP FT-1-7 9 4 12:00-12:20

Weak-strong uniqueness results for interface evolution problems in continuum mechanics

Julian Fischer IST Austria

Sebastian Hensel IST Austria

Abstract: We establish weak-strong uniqueness results for certain interface evolution problems. In particular, for the free boundary problem for the Navier-Stokes equation describing the evolution of two fluids separated by a sharp interface with surface tension, we show that Abels' varifold solutions are unique as long as a strong solution exists. Our approach relies on a suitable relative entropy functional which provides a tilt-excess type control of the interface error.

CP FT-1-7 9 5 12:20-12:40

Weak entropy solutions in the context of induction hardening

Lasarzik Robert WIAS Berlin

Abstract: This talk focusses on a thermodynamically consistent model describing induction hardening of steel. The associated system of partial differential equations models electro-thermal and phase transition effects in the material. We focus on the analysis and report some recent progress concerning the solvability of this system. The existence and weak-strong uniqueness is addressed. Additionally, we discuss the associated control problem and bring it into the context of the stability of the solution concept.

CP FT-1-7 9 6 12:40-13:00

The cubic Schrödinger and Sine-Gordon regimes of the anisotropic Landau-Lifshitz equation.

André De Laire Université de Lille

Philippe Gravejat Université de Cergy-Pontoise

Abstract: The Landau-Lifshitz equation describes the macroscopical dynamics of the magnetization in a ferromagnetic material. In the physical literature there are formal arguments showing that, depending on the anisotropy of the materials, the Landau-Lifshitz equation can be approximated by the cubic nonlinear Schrodinger equation or by the Sine-Gordon equation. In this talk, we rigurosly establish these aproximations, by using well-tailored energy estimates with good symmetrization properties, that lead to estimates of the differences in Sobolev norms.

CP A1-3-4 9 11:00-13:00

Applied Mathematics for Industry and Engineering IX

Chair Person: Jose A. Cuminato University of São Paulo

CP A1-3-4 9 2 11:00-11:20

Asymptotic and numerical study of the planar stick-slip flow for viscoelastic fluids

Jose A. Cuminato University of São Paulo

Irineu Palhares University of São Paulo

Abstract: The stick-slip flow is a challenging viscoelastic benchmark due to the presence of the stick-slip transition point, where a sudden change happens in the boundary conditions. The stress singularity of the Oldroyd-B, PTT and Giesekus models are verified for transient and steady planar stick-slip flow. Numerical simulations of the steady stick-slip flow along streamlines in the presence of solvent viscosity, considering a given and simplified Newtonian velocity field version of the constitutive equations, are presented.

CP A1-3-4 9 3 11:20-11:40

Numerical Simulation of Certain Graphene based Schottky Junction Solar Cell

PRAGATI TRIPATHI SHARDA UNIVERSITY

A. H. SIDDIQI SHARDA UNIVERSITY

R. C. SINGH SHARDA UNIVERSITY

Abstract: The paper elaborates the study of various parameters affecting the efficiency of graphene in order to enhance output voltage of solar cell. The mathematical modeling of graphene has been done by considering the standard solar spectrum parameters to examine the various factors of solar cell. The factors like current density, absorption coefficient, and wavelength of sun spectrum, Fermi & Dirac Point level and Carrier Generation Rate are studied by relating the parameters and their characteristics.

CP A1-3-4 9 4 11:40-12:00

Analysis of the unsteady thermal response of geothermal heat exchangers using matched asymptotic expansion techniques

Miguel Hermanns Universidad Politécnica de Madrid

Abstract: The correct sizing of geothermal heat exchangers for the efficient heating and cooling of buildings plays a crucial role in the successful harnessing of geothermal energy. By using matched asymptotic expansion techniques, the large disparity of time and length scales in the problem is exploited, leading to analytical solutions that are of high relevance for the industry. Proof of it is that the work performed so far has been supported by the industry.

CP A1-3-4 9 5 12:00-12:20

Demand and supply management for smart grid with supervised learning-based deep neural network

Muralitharan Krishnan Sunkyunkwan University

Sangwoon Yun Sunkyunkwan University

Yoon Mo Jung Sunkyunkwan University

Abstract: Bringing an equilibrium between the energy supply and demand improves the efficiency of the power grids. Mismatch between energy generation and consumption results in monetary loss for both service providers and consumers. To solve these shortcomings, we propose a real-time demand and supply management algorithm for smart grid with the help of supervised learning-based deep neural network. The proposed approach achieves the accurate energy usage prediction model which increases the cost-benefit at both the ends.

CP A1-3-4 9 6 **12:20-12:40**

How to use observation error information to improve weather forecasts

Jemima Tabeart	University of Reading
Sarah Dance	University of Reading
Amos Lawless	University of Reading
Nancy Nichols	University of Reading
Joanne Waller	University of Reading
Stefano Migliorini	UK Met Office
Fiona Smith	UK Met Office

Abstract: In numerical weather prediction, data assimilation algorithms combine observations with a numerical model in order to produce the best initial state of the atmosphere and ocean. We explain the importance of including correlated observation error information, and discuss practical methods to ensure this inclusion is computationally efficient. We illustrate these reconditioning methods via a case study using the Met Office 1D-Var system, finding that such methods improve convergence, but alter other aspects of the system.

CP A1-3-5 9 11:00-13:00

Control and Systems Theory III

Chair Person: Zhang Christophe Laboratoire Jacques-Louis Lions

CP A1-3-5 9 1 **11:00-11:20**

Rapid and finite-time stabilization of hyperbolic systems with a distributed scalar input

Zhang Christophe	Laboratoire Jacques-Louis Lions

Abstract: We discuss recently obtained stabilization results of hyperbolic systems in one space dimension, with a scalar internal control. These results are obtained using a form of backstepping method, where the systems are mapped to stable target systems using general kernel operators. This method yields explicit feedbacks that achieve exponential stabilization. In some cases, finite-time stabilization can be achieved, with a positive minimal time.

CP A1-3-5 9 2 **11:20-11:40**

Boundary feedback stabilization in fluid mechanics : 1-d density-velocity systems, source term and shock steady-states.

Amaury Hayat	Sorbonne Université
Georges Bastin	Université catholique de Louvain
Jean-Michel Coron	Sorbonne Université
Peipei Shang	Tongji University

Abstract: Density-velocity systems cover many nonlinear equations in fluid dynamics, as the isentropic Euler equations, the Saint-Venant (or shallow water) equations, etc. We show that they have a special structure enabling the stabilization of any of their regular steady-states by simple boundary controls, whatever the source term, even if the physical quantities (slope, friction model, section profile, etc.) are unknown. This feat comes from the existence of a remarkable local entropy. We then address shock steady-states.

CP A1-3-5 9 3 **11:40-12:00**

Exact null-controllability of interconnected linear infinite-dimensional control systems

Benzion Shklyar	Holon Institute of Technology

Abstract: We deal with exact null-controllability problem for a linear infinite-dimensional control system, consisting of two serially connected distributed control systems, where the first control system is governed by a control of the second one. A control may be either distributed or boundary. Exact null-controllability conditions are obtained. Applications to the exact null-controllability for interconnected control system of the heat equation and the delay differential system are considered.

CP A1-3-5 9 4 **12:00-12:20**

Results on the controllability of the wave equation with dynamic boundary conditions.

Imen Benabbas	University of Science and Technology Houari Boumediene-USTHB
Djamel-Eddine Teniou	University of Science and Technology Houari Boumediene-USTHB

Abstract: We are interested in the controllability of the wave equation with mixed Dirichlet-Ventcel boundary conditions. Our approach relies on non-harmonic Fourier series and Ingham's theorems. Careful analysis of the corresponding spectral properties reveals the existing Ingham's inequalities to be useless. Our main result consists of a new variant of the latter that, enables us to prove several observability theorems. Unlike previous results in the literature, here the boundary controllability is ensured through Dirichlet action only.

CP A1-3-5 9 5 **12:20-12:40**

Controllability and Stability of an Inverse Problem for the coefficient in a Swift-Hohenberg Equation

BARANI BALAN NATESAN	CENTRAL UNIVERSITY OF TAMIL NADU

Abstract: In this talk, we establish the stability results concerning the inverse problem of recovering a coefficient in the Swift-Hohenberg (SH) equation with Neumann boundary data and study the controllability to the trajectories of the corresponding control system. Carleman estimate for the linearized problem with the help of the boundary/internal observation play a vital role to prove both the Lipschitz type stability estimate and the trajectory controllability of the SH equation.

CP A1-3-5 9 6 **12:40-13:00**

Robust stabilization of nonlinear partial differential equations by boundary control

Marshal Anthoni Selvaraj	Anna University Regional Campus

Abstract: In this work, the problem of robust global stabilization by nonlinear boundary feedback control for the Burgers Equation is considered. The aim is to derive boundary control laws which make the system globally exponentially stable in spite of uncertainty in the viscosity parameter. Lyapunov technique together with Poincaré's inequality is employed to obtain the required result. Finally, numerical simulation is provided to verify the effectiveness of the obtained control design.

CP A1-3-2 9 11:00-13:00

General III

Chair Person: Xiao Fang The Chinese University of Hong Kong

CP A1-3-2 9 1 **11:00-11:20**

Wasserstein-2 bounds in normal approximation under local dependence

Xiao Fang	The Chinese University of Hong Kong

Abstract: We obtain a general bound for the Wasserstein-2 distance in normal approximation for sums of locally dependent random variables. The proof is based on an asymptotic expansion for expectations of second-order differentiable functions of the sum. We apply the main result to obtain Wasserstein-2 bounds in normal approximation for sums of m-dependent random variables, U-statistics and subgraph counts in the Erdos-Renyi random graph.

CP A1-3-2 9 2 **11:20-11:40**

MILP-Based Algorithm for the Global Solution of Dynamic Economic Dispatch Problems with Valve-Point Effects

Van Hoorebeeck Loïc	UCLouvain
Absil Pierre-Antoine	UCLouvain
Papavasiliou Anthony	UCLouvain

Abstract: The Dynamic Economic Dispatch problem consists in satisfying the demand for electric power among scheduled generating units over a time interval. The consideration of the valve-point effect makes the problem more challenging due to the non-linear and non-smooth constraints that are required for representing the model. We present a method, based on a sequence of piecewise linear approximations, that produces upper and lower bounds guaranteed to converge to the global solution.

CP A1-3-2 9 3 **11:40-12:00**

Multi-objective solid transportation-location problem with variable carbon emission in inventory management: a hybrid approach

Sankar Kumar Roy	Vidyasagar University
Soumen Kumar Das	Vidyasagar University
Magfura Pervin	Vidyasagar University

Abstract: This paper is to integrate among facility location, solid transportation, and inventory under multi-objective environment. The aims of this formulation are to seek optimal locations for facilities in the Euclidean plane, to find amount of transported goods, and to reduce overall transportation cost and time, and inventory cost including carbon emission cost. A new hybrid approach is improved based on a heuristic and the intuitionistic fuzzy programming. The findings are validated by an application example.

CP A1-3-2 9 4 12:00-12:20

Optimal emission location strategies in a multiregional transboundary pollution differential game with spatially distributed controls

Paula M. López Pérez	IMUVA and Universidad de Valladolid
Guiomar Martín Herrán	IMUVA and Universidad de Valladolid
Javier De Frutos Baraja	IMUVA and Universidad de Valladolid

Abstract: A differential game modelling strategic interactions among agents in a multiregional transboundary pollution control problem is analysed. The dynamics of the state variable (pollution stock) is defined by a parabolic PDE. Pollution control is spatially distributed among several agents with predetermined spatial relationships. For a particular specification, the feedback Nash equilibrium is characterized analytically. At the equilibrium, both, the level and location of emissions of each region, depend on the geographical relationship among agents.

CP A1-3-2 9 5 12:20-12:40

The Rational-Order Pyramid Transform for Image Compression

Atsushi Imiya	Chiba University
Kento Hosoya	Chiba University
Kouki Nozawa	Chiba University

Abstract: The pyramid transform of rational-orders is developed. The pyramid transform is achieved by subsampling after linear smoothing. The rational-order pyramid transform is decomposed into subsampling by linear interpolation and the traditional pyramid transform. By controlling ratio between subsampling for linear interpolation and subsampling in the pyramid transform, the rational-order pyramid transform is computed. The rational-order pyramid transform reduces the size of images to any rational size and yields images with desired resolutions.

CP A1-3-2 9 6 12:40-13:00

A Variation to the Variable Elimination Algorithm in Bayesian networks

Linda Smail	Zayed University

Abstract: Given a Bayesian Network relative to a set I of random variables, we are interested in computing the probability distribution P(S), where S is a subset of I. The general idea of the Variable Elimination algorithm is to manage the successions of summations on all variables out of S. We propose a variation of the Variable Elimination algorithm that will make intermediate computation written as conditional probabilities and not simple potentials.

CP FT-S-3 9 11:00-13:00

Applied Math for Engineering

Chair Person: Garry Maskaly Los Alamos National Laboratory

CP FT-S-3 9 2 11:00-11:20

Developable patches bounded by NURBS curves

Alicia Cantón	Universidad Politecnica de Madrid
Leonardo Fernández-Jambrina	Universidad Politecnica de Madrid
Francisco Pérez-Arribas	Universidad Politecnica de Madrid
Eugenia Rosado María	Universidad Politecnica de Madrid
María Jesús Vázquez-Gallo	Universidad Politecnica de Madrid

Abstract: In this paper we construct developable surface patches between two rational spline curves, though the parametrisation of the patch is not NURBS. We reduce the problem to an algebraic equation of degree $2n-2$. This means degree four for standard cubic NURBS and the equation may be solved numerically or analitically. In the case of spline curves on parallel planes, the degree goes down to $n-1$. The result can be extended to approximately developable patches.

CP FT-S-3 9 3 11:20-11:40

Traffic flow Impact of self driving cars: a mathematical modeling perspective.

Filippo Posta	Estrella Mountain Community College

Abstract: This study reports on the deterministic effects of self-driving cars on established non-deterministic mathematical models of traffic flow. Beginning with the one lane Nagel Schreckenberg cellular automata model we will present how the fundamental relation changes from this foundational model to more complicated and more realistic ones that include highway and city traffic.

CP FT-S-3 9 4 11:40-12:00

Analytical, Numerical and Geometric Methods with Applications to Fractured Porous Media Modeling

Pushpi Paranamana	Rutgers University-Newark
Eugenio Aulisa	Texas Tech University
Magdalena Toda	Texas Tech University
Akif Ibragimov	Texas Tech University

Abstract: In this work, we model the flow filtration of slightly compressible fluids in fractured-porous media, using Darcy-Frorchheimer equations. Using methods in differential geometry, we develop a model to investigate the flow inside fractures with complex geometries and variable thickness. A reduced model is obtained as a low dimensional BVP, which is of practical use. Theoretical and numerical analysis was performed to show that the solutions between the original model and the reduced model are close.

CP FT-S-3 9 5 12:00-12:20

Mathematical Modeling of Electroosmotic Flow and Joule Heating Effects in a Slowly Varying Micro-Channel

Gopal Chandra Shit	Jadavpur University, Kolkata

Abstract: We have studied the Joule effects on electro-osmotic flow of biofluid in a non-uniform micro-channel whose walls are varying sinusoidally. The electro-osmotic flow is driven by the combined influence of pressure gradient and axially imposed electric field, describing the Poisson–Boltzmann equation. The effect of slip velocity due to hydrophobic interactions at the fluid-solid interface is taken into account. The study reveals that the Joule heating parameter has controlling effect on the temperature distribution.

CP FT-S-3 9 6 12:20-12:40

Adaptive meshes using auxiliary inequality based method for convection dominated problems

Vivek Kumar Aggarwal	Delhi Technological University

Abstract: In this paper a general discrete inequality based on the entropy has been discussed and demonstrated that enforcing this auxiliary inequality can be utilized to solve a number of steady and time-dependent problems. We demonstrate that, for any existing central difference based method, addition of this auxiliary inequality at the discrete level, enables one to achieve several desired purposes. Some examples have also been solved to show the efficency of the method.

CP A1-3-3 9 11:00-13:00

Partial Differential Equations VI

Chair Person: Mani Mehra IIT Delhi

CP A1-3-3 9 1 11:00-11:20

Compact finite difference method for time fractional Black-Scholes partial differential equation

Mani Mehra	IIT Delhi
Kuldip Patel	IISER

Abstract: High-order compact finite difference method is proposed for the solution of time fractional convection--diffusion equations. The proposed compact finite difference method has (2-alpha) order accuracy in temporal variableand fourth order accuracy in spatial variable. As an application in mathematical finance, proposed method is applied to time fractional Black-Scholes partial differential equation. Numerical illustrations are presentation to validate the theoretical results.

CP A1-3-3 9 2 11:20-11:40

MULTIPLE SOLUTIONS FOR NONLOCAL FOURTH-ORDER SYSTEMS OF (p(x); q(x))-KIRCHHOFF TYPE

Khalil BEN HADDOUCH	National School of Applied Sciences, Sidi Mohamed Ben Abdellah University
Zakaria EL ALLALI	Faculty Multidisciplinary of Nador,University Mohammed Premier
Said TAARABTI	Faculty Multidisciplinary of Nador,University Mohammed Premier

Abstract: This paper is concerned with the existence of solutions for a class of nonlocal fourth-order (p(x); q(x))-Kirchhoff systems. Under some suitable conditions and by applying an equivalent variational approach to a recent Ricceri's three critical points theorem, we established the existence of at least three weak solutions.

CP A1-3-3 9 3 11:40-12:00

On the existence of capacity solutions of nonlinear parabolic-elliptic system of PDEs in modular spaces

Moussa Hicham Université Moulay Ismaïl
Ortegón Gallego Francisco Universidad de Cádiz
Rhoudaf Mohamed Université Moulay Ismaïl
Sabiki Hajar Université Ibn Tofail

Abstract: The concept of capacity solution was first introduced by X. Xu in 1993 in the analysis of the thermistor problem. This is a nonlinear parabolic-eliptic system of PDEs coupling the electric potential and the temperature in a semiconductor device. We study some generalizations of this problem where the elliptic part of the parabolic equation is a Leray-Lions monotone operator acting on a Orlicz-Sobolev inhomogeneous space or on a Musielak-Sobolev inhomogeneous space.

CP A1-3-3 9 4 12:00-12:20

ON THE FRACTIONAL LAZER-MCKENNA CONJECTURE WITH SUPERLINEAR POTENTIAL

Dieb Abdelrazek University Ibn khaldoun of Tiaret
Abdellaoui Boumedienne University ABB of tlemcen
Mahmoudi Fethi University of Tunis El Manar

Abstract: In this work we deal with the multiplicity of solutions for a nonlocal superlinear elliptic problem of Ambrosetti-Prodi type. We prove the non-local version of a conjecture due to Lazer and McKenna-Lazer by constructing solutions with sharp peaks near local maximum points of the first positive eigenfunction of the fractional Laplacian with Dirichlet boundary condition. The main ideas of the proof rely in using the Lyapunov-Schmidt reduction method.

CP A1-3-3 9 5 12:20-12:40

On a Glioblastoma nonlinear Diffusion Model

Antonio Fernández Romero Universidad de Sevilla
Francisco Guillén González Universidad de Sevilla
Antonio Suárez Fernández Universidad de Sevilla

Abstract: We present a differential system modeling Glioblastoma growth with tumor cells, necrotic density and the oxygen concentration. Tumor satisfies a diffusion-reaction PDE where the velocity of diffusion is a nonlinear function increasing with the vasculature while necrosis and vasculature satisfy ODE equations. We prove some estimates and the existence of global in time weak solutions. Later, we design a scheme conserving all properties of the continuous problem which we show simulations related to medical research.

CP A1-3-3 9 6 12:40-13:00

Maxwell's equations in heterogeneous materials

Dongwoo Sheen Seoul National University

Abstract: Maxwell's equations in heterogeneous materials is considered. The materials include two subsets Ω_f^ϵ and Ω_μ^ϵ. Ω_f^ϵ is a connected region; Ω_μ^ϵ, containing blocks with diameter $\mu \in (0|1]$, is a periodic disconnected set with period $\epsilon \in (0|1]$.We know the behavior of the materials with respect to electromagnetic waves is characterized by its electric permittivity. Let $\tau \in (0|\infty)$ denote the electric permittivity ratio of the disconnected set to the connected region. Uniform estimate in ϵ, μ, τ for electromagnetic fields is presented.

CP FT-S-1 9 11:00-13:00

Control and Systems Theory IV

Chair Person: Anil Kumar BITS Pilani KK Birla Goa Campus

CP FT-S-1 9 1 11:00-11:20

A Mixed Finite Element Method for Elliptic Optimal Control Problems Based on Biorthogonal Systems

Anil Kumar BITS Pilani KK Birla Goa Campus
B. P. Lamichhane University of Newcastle

Abstract: We consider an optimal control problem governed by elliptic differential equations posed in a three-field formulation. Using gradient as a new unknown, we write a weak equation for the gradient using a Lagrange multiplier. To discretize the gradient, we use a biorthogonal system which leads to a very efficient numerical scheme. Numerical example is also presented to demonstrate the convergence of the finite element approach.

CP FT-S-1 9 2 11:20-11:40

Finite-time extended passive analysis for fuzzy Markov jump systems

KAVIKUMAR RAMASAMY ANNA UNIVERSITY REGIONAL CAMPUS

Abstract: This paper addresses the problem of finite-time boundedness and extended passive analysis for discrete-time fuzzy Markov jump systems with time-varying delay. By using the Lyapunov stability theory together with Abel lemma-based finite sum inequality and linear matrix inequality approach, sufficient conditions for stochastic finite-time boundedness and extended passive performance of the considered system are obtained. Finally, a numerical example is given to show the effectiveness and usefulness of the proposed results.

CP FT-S-1 9 3 11:40-12:00

Obtaining the optimal VAR frm control theory

Carmen Perea Universidad Miguel Hernández
Victoria HERRANZ Universidad Miguel Hernández
Belén Sánchez Universidad Miguel Hernández
Jose Juan López Espín Universidad Miguel Hernández
Antonio Peñalver Universidad Miguel Hernández

Abstract: The VAR model is one of the most used for the analysis of multivariate time series. It has proved to be useful for describing the dynamic behavior of economic and financia! time series. Although it can be used in other areas like medica!. The aim of this work is to propose different VAR models as a linear control system and study the controllability and observability properties to establish the optimal model.

CP FT-S-1 9 4 12:00-12:20

Controllability of nonlinear stochastic systems with delays in both state and control variables

KARTHIKEYAN SHANMUGASUNDARAM Periyar University
SATHYA MURUGESAN Periyar University
BALACHANDRAN KRISHNAN Bharathiar University

Abstract: This paper is concerned with the problem of controllability of nonlinear stochastic dynamical systems with multiple state and control delays in finite dimensional spaces. Sufficient conditions for the relative controllability of the above system are established and the results are obtained by using fixed point arguments. An example is provided to illustrate the application of the obtained results.

CP FT-S-1 9 5 12:20-12:40

Numerical solution of the stochastic linear quadratic regulator problem

Lena-Maria Pfurtscheller University of Innsbruck
Tijana Levajković TU Wien
Hermann Mena Yachay Tech University

Abstract: The stochastic linear quadratic regulator problem arises naturally in science and engineering, e.g. electronics circuits and mathematical finance. Using polynomial chaos expansion, we provide a numerical framework to solve this problem. The resulting system consists of a set of deterministic differential equations, which we solve by appropriate numerical methods and thus obtain an approximation of the stochastic problem. Numerical experiments show the good performance of the proposed method.

CP FT-1-8 9 11:00-13:00

Finance and Management Science

Chair Person: John Freddy Moreno Trujillo Universidad Externado de Colombia

CP FT-1-8 9 1 11:00-11:20

Non-linear partial differential equations and pricing of financial derivative

John Freddy Moreno Trujillo Universidad Externado de Colombia

Abstract: The valuation of financial derivatives under non-restrictive market assumptions implies in many cases solving partial non-linear differential equations (PDEs). Two cases are considered: 1. A market with bilateral default risk and 2. A market with liquidity problems. In both cases, the EDP can be expressed as a Hamilton-Jacobi-Bellman equation associated with the corresponding stochastic optimal control problem. An approach to solutions based on branching processes is presented.

CP FT-1-8 9 2 11:20-11:40

A spectral method for an Optimal Investment problem with Transaction Costs under Potential Utility

Victor Gatón Bustillo University of Valladolid

Javier De Frutos Baraja University of Valladolid

Abstract: This work concerns the numerical solution of the finite-horizon Optimal Investment problem with transaction costs under Potential Utility, where an evolutive HJB equation with gradient constraints has to be solved. The reformulation of the problem as a non-linear parabolic double obstacle problem and the employment of polar coordinates allows to pose the problem in one spatial variable in a finite domain, avoiding many technical difficulties. The proposed spectral numerical method becomes very efficient.

CP FT-1-8 9 3 **11:40-12:00**

Real option with the regime-switching jump-diffusion model on finite time horizon

Sunju Lee Chungnam National University
Younhee Lee Chungnam National University

Abstract: A real option under regime-switching jump-diffusion models is considered on finite time horizon. When an underlying cash flow follows a regime-switching jump-diffusion model, the purpose of the investor is to determine an optimal investment time to maximize the discounted expectation of a payoff function. The objective function and the optimal investment time are concerned with a Hamilton-Jacobi-Bellman problem. Numerical simulations are performed to analyze the various phenomena of the real option with regime-switching processes.

CP FT-1-8 9 4 **12:00-12:20**

Evaluation of equity-based debt obligations

Alexander Fromm University of Jena

Abstract: We consider a class of participation rights, i.e. obligations issued by a company to investors who are interested in performance-based compensation. Albeit having desirable economic properties equity-based debt obligations pose challenges in accounting and contract pricing. We formulate and solve the associated mathematical problem in a discrete time, as well as a continuous time setting. In the latter case the problem is reduced to a forward-backward system and solved using the method of decoupling fields.

CP FT-1-8 9 5 **12:20-12:40**

Expected exponential utility maximization problem for bitcoin mining companies

Kazuhiro Yasuda Hosei university

Abstract: In this talk, we consider an expected utility maximization problem for bitcoin mining companies with the exponential utility. The wealth process of the mining company is defined as the sum of profit and loss from the mining and trading in the bitcoin market. Here we assume that the bitcoin price process follows the Black-Scholes model. We obtain the explicit expression of the value function and the optimal trading strategy.

CP FT-1-8 9 6 **12:40-13:00**

Testing of Binary Regime Switching Models using Squeeze Duration Analysis

Milan Kumar Das IISER Pune
Anindya Goswami IISER Pune

Abstract: We have developed a statistical technique to test the model assumption of binary-regime switching extension of the geometric Brownian motion (GBM) model by proposing a new discriminating statistics. Given a time series data, by performing several systematic experiments, we have successfully shown that the sampling distribution of the test statistics differs drastically if the model assumption changes from GBM to Markov-modulated-GBM, or to semi-Markov-modulated-GBM. Furthermore, we tested the regime switching hypothesis with Indian sectoral indices.

MS ME-1-2 10 **14:30-16:30**

Recent Advances in Applied Integrable Systems: Theory and Computations - Part 4

For Part 1 see: MS ME-1-2 7
For Part 2 see: MS ME-1-2 8
For Part 3 see: MS ME-1-2 9
Organizer: Kenichi Maruno Waseda University
Organizer: Anton Dzhamay University of Northern Colorado

Abstract: Recent advances in the applications of integrable systems extend to a wide range of mathematics and physical sciences, such as random matrices, cluster algebra and combinatorics, probability theory, numerical computations, cellular automata, tropical geometry and ultra-discrete systems, differential geometry, computer visualizations, nonlinear physics, and many others. The purpose of this mini-symposium is to bring together active researchers from across the world to discuss recent developments in various aspects of applied integrable systems.

14:30-15:00

Asymptotic analysis of probabilistic cellular automata utilizing GKZ hypergeometric function

Kazushige Endo Waseda University

Abstract: Probabilistic Burgers Cellular Automaton (PBCA) is equivalent to parallel updated Totally Asymmetric Simple Exclusion Process (TASEP). In this presentation, utilizing transition matrices and primitive combinatorial methods, we propose some conjectures for asymptotic distribution of PBCA and derive Fundamental Diagram (FD) which shows relations between density and mean flow of particles by the conjectures. Moreover, we show FD is some kind of GKZ hypergeometric functions and derive FD for infinite lattice utilizing GKZ hypergeometric functions.

15:00-15:30

Algebraic entropy and chaos in cluster algebras

Atsushi Nobe Chiba University
Junta Matsukidaira Professor Ryukoku University

Abstract: Integrability of a one-parameter family of second order nonlinear difference equations, each of which is arising from seed mutations of a rank 2 cluster algebra, is discussed. Four members of the family posses integrable structure, while the remining infinitely-many members do not. In order to evaluate their dynamics, algebraic entropy of the birational maps equivalent to the difference equations are explicitly computed via initial value problems to second order linear difference equations.

15:30-16:00

Integrability aspects of consistent systems of difference equations

Pavlos Xenitidis Liverpool Hope University

Abstract: Consistent systems of difference equations constitute an interesting and delicate generalization of quad equations. They involve only one dependent variable and are composed of two or more higher order equations which are compatible with each other. In this talk we will discuss some properties of such systems and define their integrability. Moreover we will construct two hierarchies of consistent systems and establish their integrability by deriving their lowest order symmetries.

16:00-16:30

Integrable discretizations of the complex WKI equation and vortex filaments

Kenichi Maruno Waseda University
Satomi Nakamura Waseda University
Shinya Kido Waseda University

Abstract: We consider integrable discretizationsof some integrable systems such as the mKdV equation and the complex WKI equation based on geometric approach (the correspondence between integrable systems and motion of space curves). We also show that the complex WKI equation describes the motion of a vortex filament. We perform numerical computations of a vortex filament by using the discrete complex WKI equation.

MS FT-2-4 10 **14:30-16:30**

Reduced Order Modeling for Parametric CFD Problems - Part 4

For Part 1 see: MS FT-2-4 7
For Part 2 see: MS FT-2-4 8
For Part 3 see: MS FT-2-4 9
Organizer: Annalisa Quaini University of Houston
Organizer: Yanlai Chen University of Massachusetts, Dartmouth
Organizer: Gianluigi Rozza SISSA, International School for Advanced Studies Trieste

MS Organized by: SIAG/CSE

Abstract: Large-scale computing is recurrent in several contexts such as fluid dynamics, due to the high computational complexity in solving parametric and/or stochastic systems. This often leads to an unaffordable computational burden, especially when dealing with real-world applications, real-time or multi-query computing. In order to lessen this computational burden, reduced-order modeling (ROM) techniques play a crucial role: they aim to capture the most important features of the problem at hand without giving up accuracy. This minisymposium focuses on the development and application of ROM techniques in computational fluid dynamics for direct and inverse modeling, and for control, optimization and design purposes.

14:30-15:00

Optimal sensor placement and data assimilation: A model order reduction approach

Karen Veroy-Grepl RWTH Aachen University
Nicole Aretz-Nellesen RWTH Aachen University
Martin Grepl RWTH Aachen University

Abstract: We present a model order reduction approach for the 3D-VAR method of variational data assimilation for parametrized PDEs. Here, we (1) prove a necessary and sufficient condition for the identification of "good" measurement spaces which can be used to optimally select measurement functionals; (2) propose a certified reduced basis method for the estimation of the model correction, state, adjoint, and misfit; and (3) introduce different approaches for the generation of the RB spaces.

15:00-15:30

A reduced basis method for Stein variational Bayesian inversion

Peng Chen The University of Texas at Austin
Omar Ghattas The University of Texas at Austin

Abstract: In this talk, we present a reduced basis method for computational reduction in PDE-constrained Stein variational Bayesian inversion. We employ Stein variational methods to push particles/samples drawing from the prior distribution to those that approximate the posterior distribution in the Bayesian framework. An online adaptive reduced basis method is proposed and analyzed to solve the underlying forward PDE model at the particles updated in each variational optimization step.

15:30-16:00

Boussinesq approximation for POD-based linear-quadratic model predictive control

Luca Mechelli University of Konstanz
Stefan Volkwein University of Konstanz

Abstract: We consider an optimal boundary control problem subjected to linear time-dependent convection-diffusion (CD) equation together with bilateral control and pointwise state constraints, regularized through a virtual control approach. A reduced-order approach based on POD is applied. An Economic Model Predictive Control strategy is considered to treat the long-time horizon and the problem's parameters' changes. Only to generate snapshots and improve the model, we combine CD with time-dependent Navier-Stokes equations in the so-called Boussinesq Approximation (BA).

16:00-16:30

The reduced basis method in constrained optimal control with PDEs

Michael Hinze University of Koblenz-Landau
Ahmad Ali Ahmad University of Hamburg, Germany

Abstract: With this talk we present a novel reduced-basis approach for optimal control problems with constraints, which seems to deliver lower dimensional RB spaces as reported in the literature so far for the same problem class, but with the same approximation properties, and which allows to prove an error equivalence as known from finite element a posteriori error analysis. Numerical test confirm our theoretical findings.

MS A3-2-3 10 14:30-16:30

Multi-scale modeling and simulation in metal forming - Part 2

For Part 1 see: MS A3-2-3 9
Organizer: Dirk Roose KU Leuven - Dept. Computer Science
Organizer: Axel Klawonn Universität zu Köln

MS (co-)organized by the GAMM activity group "Computational Science and Engineering" (CSE)

Abstract: Simulation nowadays plays an important role in the design and implementation of metal forming operations. During sheet metal forming and forging, the mechanical properties of the material evolve, in a heterogeneous way, due to the evolution in microstructure and crystal orientation. Hence physics-based or phenomenological material models at all levels must be coupled to achieve accurate simulations at the macroscopic level. This also requires novel numerical methods, high performance computing, and parallel scalable algorithms. This mini-symposium will give an overview of ongoing research in Europe. Emphasis lies on modeling issues, accurate numerical methods, scalable algorithms, efficient software and validation.

14:30-15:00

Simulation of sheet metal forming of DP steels incorporating uncertainties

Niklas Miska Ruhr-Universität Bochum
Daniel Balzani Ruhr-Universität Bochum

Abstract: A sheet metal forming process is exposed to uncertainties such as e.g. a variability in the material properties of the sheet metal or a lack of knowledge regarding maximum admissible values of a defined failure criterion. A suitable method, the extended Optimal Uncertainty Quantification, will be presented for an example of a Dual-Phase steel sheet forming process. The method is characterized by only taking into account available information and avoiding uncertified assumptions on the data.

15:00-15:30

Aspects on multiscale modeling of dual phase steel

Lisa Scheunemann Universität Duisburg-Essen

Abstract: The contribution presents various aspects in multiscale modeling of dual phase steel, such as a multiscale modeling approach in the framework of the FE^2 method in order to incorporate the underlying microstructure. Furthermore, statistically similar representative volume elements are use to increase computational efficiency of the two-scale simulations. Furthermore, an initial volumetric stain approach can be considered for realistic descriptions of the varying material behavior in the ferritic matrix resulting from the production process.

15:30-16:00

Anisotropic adaptive meshing for multiphase problems

Thierry Coupez MINES ParisTech

Abstract: Numerical simulation is still depending on meshing and adaptive meshing capabilities when moving interface and multiphase problems are involved. Our approach is based on an implicit representation of the interfaces and the full usage of anisotropic adaptive meshing techniques, a posteriori error estimate and metric calculation. Stabilized finite element solver can afford such anisotropic meshes. Applications in forming process will show that a large range of scales can be well represented in a unique mesh

16:00-16:30

Dynamic spatial clustering for efficient multi-scale modelling in metal forming

Dirk Roose KU Leuven - Dept. Computer Science
Md Khairullah +
Jerzy Gawad KU Leuven (now NLMK)
Bert Van Bael KU Leuven, Dept. of Materials Engineering

Abstract: Multi-scale simulation of plastic deformation of metallic materials requires in principle the computation of the evolution of texture and associated material properties at each finite element integration point. However, zones of nearly homogeneous strain responses can be identified by a clustering algorithm and the texture and material properties can be approximated from the properties at a representative point within each zone. We show how this clustering reduces the computational cost, while maintaining high accuracy.

MS A1-1-2 10 14:30-16:30

Numerical modeling in geophysics

Organizer: Henar Herrero Universidad de Castilla-La Mancha

Abstract: Fluid dynamics including thermal process is present in a wide variety of geophysical phenomena appearing in meteorology, oceanography or the mantle. Their study requires the numerical resolution of systems of differential equations that model the physical phenomena.

14:30-15:00

Generation of a magnetic field by a double vortex in a rotating cylinder

Damián Castaño Universidad de Castilla la Mancha
María Cruz Navarro Universidad de Castilla la Mancha
Henar Herrero Universidad de Castilla la Mancha

Abstract: In this talk, we use simulations of the magnetohydrodynamic equations coupled with heat to show the generation of magnetic field by the dynamical interaction of a pair of vortices in a fluid electrically conducting within a cylindrical domain nonhomogeneously heated from below, setting in a rotation frame. For large enough rotation rates, we show that the formation of a pair of vortices inside the primary whirls gives rise to a magnetic field.

15:00-15:30

Chaotic and oscillatory flows in the Magnetized spherical Couette system

Ferran Garcia	Helmholtz-Zentrum Dresden-Rossendorf
Martin Seilmayer	Helmholtz-Zentrum Dresden-Rossendorf
André Giesecke	Helmholtz-Zentrum Dresden-Rossendorf
Frank Stefani	Helmholtz-Zentrum Dresden-Rossendorf

Abstract: Experiments on the magnetized spherical Couette system are presently being carried out at Helmholtz-Zentrum Dresden-Rossendorf (HZDR). A liquid metal (GaInSn) is confined within two differentially rotating spheres and exposed to a magnetic field parallel to the axis of rotation. Bifurcation diagrams for modulated rotating waves and chaotic flows are obtained for investigating the nonlinear saturation of the radial jet, return flow, and shear layer instabilities, as found in previous studies.

15:30-16:00

Ocean data and dynamical systems

Ana María Mancho Sánchez	CSIC-ICMAT

Abstract: There exists nowadays an increasing amount of ocean velocity data, available from satellite altimeter observations of the ocean surface, or accurate numerical simulations. The availability of accurate ocean velocity fields open new possibilities to address important ocean challenges. We will describe two selected ocean applications, based on the analysis of ocean velocity data with dynamical system tools that confirm the synergy and success of this combination. Support is acknowledged from ONR grant No. N00014-17-1-3003

16:00-16:30

Evidences of presisiting structures in thermal shear layers

Sergio Hoyas	Universidad Politécnica de Valencia
Francisco Alcantara-Avila	UPV
Sergio Gandía-Barberá	UPV
María Jezabel Pérez-Quiles	UPV

Abstract: DNS of passive thermal turbulent Couette flow at Re=180, 250, and 500, and Pr=0.71 are presented. Time averaged thermal flow shows the existence of long and wide thermal structures, named CTFS (Couette Thermal Flow Superstructures). They are defined as coherent regions of hot and cold temperature fluctuations. They are linked to the velocity structures present in Couette flows. Since their width is related to the channel one, the statistics of CTF are to box dependent

MS A6-5-2 10 — 14:30-16:30

Complex dynamics of biological and artificial neural networks - Part 2

For Part 1 see: MS A6-5-2 9

Organizer: Valeri Makarov	Complutense University of Madrid
Organizer: Boris Gutkin	NRU Higher School of Economics
Organizer: Roberto Barrio	Universidad de Zaragoza, Spain

Abstract: The cognitive performance of modern AI systems based on von Neumann architecture leave far behind the human brain. Thus, one of the global problems of the 21st century is to understand the brain. It is coped by studying biological and artificial neural networks (NN). Nowadays artificial NN gain power, yet there is a significant gap between these two approaches. This minisymposium collects renowned experts in NN and aims at addressing this dichotomy, providing novel results on the complex dynamics of biological NN and methods of learning and error correction in artificial NN.

14:30-15:00

Understanding the functional signal flow in multi-modular neuronal networks with emergent oscill

Boris Gutkin	Ecole Normale Superieure
Gregory Dumont	ENS

Abstract: We analyse the emergence of phase-locking in delayed-coupled spiking neural circuits showing global gamma oscillations. Using an exact reduction method, we derive the macroscopic phase resetting-curves. From there we determine the structure of macroscopic coherence states for weakly coupled networks. We exhibit symmetry breaking under delay, giving an explanation to the experimentally observed phase-locking modes and exhibit directed signal transfer. The study received support from the Russian Science Foundation grant (Contract No. 17- 11-01273).

15:00-15:30

Asynchrony, noise-induced synchronization and clamping in large networks of excitable elements

Jonathan Touboul	Brandeis University

Abstract: Large-scale networks of excitable elements subject to noise are widely used in applications, particularly to describe neural networks of the brain. I will present recent works on the dynamics of such networks, particularly around a transition from asynchrony to clamping through synchronized oscillations as noise is increased. I will further characterize the loss of synchrony arising in response to periodic input. I will eventually explore applications to Deep Brain Stimulation treatments of Parkinson's disease.

15:30-16:00

Firing rate models for neuronal networks with electrical and chemical synapses

Ernest Montbrió	Universitat Pompeu Fabra
Bastian Pietras	Vrije Universiteit Amsterdam (VU), The Netherlands
Federico Devalle	Universitat Pompeu Fabra (UPF), Spain
Alex Roxin	Centre de Recerca Matemàtica (CRM), Spain
Andreas Daffertshoffer	Vrije Universiteit Amsterdam (VU), The Netherlands

Abstract: Chemical and electrical synapses constitute the principal interaction mechanisms between neurons. Mean field descriptions (called firing rate models) are powerful mathematical tools for the analysis of the collective dynamics of large networks of neurons with chemical synapses. Here we derive a novel firing rate model with both chemical and electrical coupling. The model allows us to study the complementary role of electrical and chemical synapses in shaping the dynamics of large networks of spiking neurons.

16:00-16:30

Neuronal mechanisms for sequential activation of memory items

Martin Krupa	Université Côte d'Azur-INRIA
Elif Köksal-Ersöz	INSERM
Carlos Aguilar	Amaris
Pascal Chossat	INRIA-CNRS-Univ. Côte d'Azur
Frédéric Lavigne	BCL-CNRS-Univ. Côte d'Azur

Abstract: We present a biologically inspired model of activation of memory items in a sequence. Our model depends on biological parameters, including neuronal gain, strength of inhibition, synaptic depression and noise. We show that, as a function of the parameter settings, our model switches between two types of sequences: regular or irregular, corresponding to two different types of cerebral functions.

MS ME-0-2 10 — 14:30-16:30

Interacting particle systems: Mean-field limits and applications to machine learning - Part 2

For Part 1 see: MS ME-0-2 9

Organizer: Matias Delgadino	Imperial College
Organizer: José Antonio Carrillo De La Plata	Imperial College London
Organizer: Grigorios Pavliotis	Imperial College

Abstract: Systems of stochastic/deterministic interacting particles arise in many areas of analysis and applications, ranging from statistical mechanics and plasma physics to optimization algorithms and deep learning. The study of mean field limits for such systems has attracted attention in several communities including PDE and mathematical physics. Variational methods and the theory of gradient flows have emerged as natural tools for studying such systems. The goals of the proposed minisymposium are to bring together experts working on the theoretical analysis as well as on modern applications of the theory of interacting particle systems to areas such as machine learning.

14:30-15:00

Fighting the curse of dimensionality in kinetic simulations of plasmas

Antoine Cerfon	NYU

Lee Ricketson	Lawrence Livermore National Laboratory

Abstract: A popular Monte-Carlo method for solving the Vlasov equation is the Particle-In-Cell (PIC) method. The distribution function is represented as particles with finite spatial size, and the self-consistent fields moving the particles are computed on an Eulerian mesh. In PIC, discrete particle noise dominates the numerical error, requiring a large number of particles per grid cell for accuracy. We present a noise reduction scheme for PIC, allowing for much fewer particles for accurate simulations.

15:00-15:30

Consensus-based optimisation: An interacting particle system for global optimisation

Oliver Tse	Eindhoven University of Technology
José Antonio Carrillo	Imperial College
Young-Pil Choi	Inha University
Claudia Totzeck	TU Kaiserslautern
René Pinnau	TU Kaiserslautern
Stephan Martin	SAP Walldorf

Abstract: We introduce a consensus-based model for global optimisation, in which a system of agents interact to achieve consensus at the global minima. We discuss issues regarding solvability of the model on the microscopic and mesoscopic scales, and further provide decay estimates, on the mesoscopic scale, towards a consensus.

15:30-16:00

Nonlocal-interaction equations on graphs and their continuum limits

Dejan Slepcev	Carnegie Mellon University
Francesco Patacchini	Carnegie Mellon University
Andre Schlichting	University of Bonn
Antonio Esposito	University of L'Aquila

Abstract: Nonlocal-interaction equation equations on graphs are gradient flows with respect to the graph-Wasserstain metric of the nonlocal-interaction energy. We show that for graphs representing data sampled from a manifold, the solutions of the nonlocal-interaction equations on graphs converge to solutions of an integral equation on the manifold. We also show that the limiting equation is a gradient flow of the nonlocal-interaction energy with respect to a nonlocal analogue of the Wasserstein metric.

MS FT-S-6 10 14:30-16:30

Recent Advances in Least Squares Problems - Part 2

For Part 1 see: MS FT-S-6 9

Organizer: Ken Hayami	National Institute of Informatics
Organizer: Yimin Wei	Fudan University

MS Organized by: SIAG/LA

Abstract: Recent advances in the numerical solution of least-squares problems will be presented. For linear least squares problems, an iterative method with an error minimization property, recent developments in preconditioning for sparse problems, and a method for avoiding catastrophic fill in large-scale problems, will be presented. Also, preconditioners for rank-deficient least squares problems, and analysis of GMRES for EP and GP singular systems will be presented. Randomized algorithms for total least squares problems, iterative methods for nonnegative Tikhonov regularization, and a method for computing multiple solutions of nonlinear least squares problems with applications to pharmacokinetic models will also be presented.

14:30-15:00

On GMRES for linear EP and GP systems

Miroslav Rozloznik	Czech Academy of Sciences
Keiichi Morikuni	University of Tsukuba

Abstract: We study numerical behavior of the GMRES method for solving singular linear systems. We assume that the matrix is range-symmetric (EP), or if its range and nullspace are disjoint (GP) and the system is consistent. We show that the accuracy of GMRES may deteriorate due to the inconsistency of system; the distance of the initial residual to the null-space of matrix; and/or the extremal principal angles between the ranges of the matrix and its transpose.

15:00-15:30

Randomized algorithms for total least squares problems

Yimin Wei	Fudan University

Abstract: We develop randomized algorithms for the total least squares problem with a single right-hand side. We present the Nyström method for the medium-sized problems. For the large-scale and ill-conditioned cases, we introduce the randomized truncated total least squares with the known or estimated rank as the regularization parameter.We analyze the accuracy of the algorithm randomized truncated total least squares and perform numerical experiments to demonstrate the efficiency of our randomized algorithms.

15:30-16:00

Modulus-Based Iterative Methods for Nonnegative Tikhonov Regularization in General Form

Ning Zheng	RIKEN Center Advanced Intelligence Project
Alessandro Buccini	Kent State University
Ken Hayami	National Institute of Informatics / SOKENDAI (The Graduate University for Advanced Studies)
Lothar Reichel	Kent State University

Abstract: Tikhonov regularization is commonly applied to the solution of linear discrete ill-posed problems. In many applications the desired solution is known to be nonnegative. The present paper describes iterative methods, based on modulus methods, for computing nonnegative approximate solutions of Tikhonov regularization problems in general form. Computed examples illustrate the performances of the methods considered.

16:00-16:30

Cluster Gauss-Newton method for sampling multiple global minimisers of nonlinear least squares problems

Yasunori Aoki	National Institute of Informatics
Ken Hayami	National Institute of Informatics
Kota Toshimoto	RIKEN
Yuichi Sugiyama	RIKEN

Abstract: A parameter estimation problem of a complex mathematical model can be formulated as a nonlinear least squares problem with non-unique global minimiser. One can repeat a conventional iterative algorithm from multiple initial iterates to obtain multiple minima; however, it can be computationally intensive. We propose the Cluster Gauss-Newton method for efficiently finding multiple global minimisers. We apply this algorithm to parameter estimation problem of phisiology based pharmacokinetic models that are used in pharmaceutical drug development.

MS ME-1-3 10 14:30-16:30

Entropy methods for multi-dimensional systems in mechanics - Part 4

For Part 1 see: MS ME-1-3 7

For Part 2 see: MS ME-1-3 8

For Part 3 see: MS ME-1-3 9

Organizer: Cleopatra Christoforou	University of Cyprus
Organizer: Athanasios Tzavaras	KAUST

Abstract: Nonlinear Conservation Laws result from the balance laws of continuum physics and govern a broad spectrum of physical phenomena in compressible fluid dynamics, materials science, particle physics, semiconductors, and other applied areas. The minisymposium is focused on recent advances on conservation laws and related systems in mechanics that connect variational methods with dynamics and the general use of entropy methods in conservation laws and related systems. It aims to bring together researchers working in different aspects, highlight the role of PDEs in these applications, serve as a forum for the dissemination of new scientific ideas and discoveries and enhance communication.

14:30-14:59

Relative Entropy for 3-d Polyconvex Thermoelasticity and Applications

Myrto Galanopoulou	KAUST
Athanasios Tzavaras	KAUST
Cleopatra Christoforou	University of Cyprus

Abstract: We embed the equations of polyconvex thermoviscoelasticity into an augmented, symmetrizable, hyperbolic system. Following the relative entropy formulation, we prove convergence from thermoviscoelasticity to smooth solutions for the system of adiabatic thermoelasticity and convergence from thermoviscoelasticity to smooth solutions of thermoelasticity in the zero-viscosity limit. We present a weak-strong uniqueness result for the equations of adiabatic thermoelasticity in the class of entropy weak solutions and in the class of dissipative measure-valued solutions.

15:00-15:30

GENERAL SUPERPOSITIONS OF GAUSSIAN BEAMS AND PROPAGATION ERRORS

Hailiang Liu	Iowa State University
James Ralston	UCLA
Peimeng Yin	Iowa State University

Abstract: Gaussian beams are asymptotically valid high frequency solutions concentrated on a single curve through the physical domain, and superposition of Gaussian beams provides a powerful tool to generate more general high frequency solutions to PDEs. We present a superposition of Gaussian beams over an arbitrary bounded set in phase space, and show how to obtain the the propagation error of sharp order. Moreover, we study the sharpness of this estimate in examples.

15:30-16:00

Metastability for hyperbolic variations of Allen-Cahn and Cahn-Hilliard equations

Corrado Lattanzio	University of L’Aquila
Raffaele Folino	University of L'Aquila
Corrado Mascia	Sapienza University of Rome

Abstract: In this talk we present recent results about metastability for hyerbolic variations of the classical Allen-Cahn and Cahn-Hilliard equations. The modified eqaution is obtained by replacing the Fourier law for the flux by the Maxwell-Cattaneo law, giving rise to a damped hyperbolic model. Int his way the flux will have its own dynamics, thus incorporating a relaxation time-scale which modelst a time-delay in the flux recostruction and yelds friction and inertial effects in the equation.

16:00-16:30

On conservation of entropy for weak solutions of conservation laws

Tomasz Debiec	University of Warsaw

Abstract: Systems of PDEs describing physical phenomena usually come with one or several conserved quantities, like entropy or energy. However, such a formally conserved quantity may fail to be constant in time for low-regular weak solutions. We will firstly consider the relation between conservation of energy and regularity of weak solutions to systems of fluid dynamics (incompressible and compressible Euler). Then we discuss the extension of such results to general systems of conservation laws.

MS ME-1-9 10 14:30-16:30

Inverse Problems and Imaging: Theoretical and Computational Aspects - Part 2

For Part 1 see: MS ME-1-9 9

Organizer: Fernando Guevara Vasquez	The University of Utah
Organizer: Yang Yang	Michigan State University
Organizer: Kui Ren	Columbia University

Abstract: The field of Inverse problems has developed rapidly in the past several years, both on the mathematical side where many theoretical understanding has been constructed for linear and nonlinear problems related to partial differential equations and on the computational side where efficient computational methods have been developed for solving large scale image reconstruction problems. This minisymposium intends to bring together leading experts in the field to show case some recent progresses and discuss future directions in this exciting research area.

14:30-15:00

Conductivity Imaging with Johnson-Nyquist noise

Fernando Guevara Vasquez	The University of Utah

Abstract: The Johnson-Nyquist noise is a random current originating from thermal fluctuations of charge carriers in a conductor. The resulting voltage has mean zero and variance that is proportional to the temperature and the resistance. We show that by local heat application and electrical measurements at the boundary of a body, one could in principle image the conductivity of the material.

15:00-15:30

A coupled physics inverse problem in electro-seismic imaging

Yang Yang	Michigan State University
Jie Chen	Microsoft (USA)
Peijun Li	Purdue University (USA)
Yixian Gao	Northeast Normal University (China)

Abstract: We will discuss a coupled physics inverse problem arising in electro-seismic imaging whose model couples Biot's equations with Maxwell's equations. We will describe a time reversal approach to reconstruct the source data in the Biot's equations, and then prove that some parameters in the Maxwell's equations can be uniquely and stably determined from the internal measurement. This is based on joint work with Jie Chen, Yixian Gao and Peijun Li.

15:30-16:00

Inverse Scattering Problems with Phaseless Data

Bo Zhang	Academy of Mathematics and Systems Science

Abstract: In this talk, we give a brief review on uniqueness results and numerical methods for inverse scattering problems with phaseless data, obtained recently in our group. This talk is based on joint works with X Ji, X Liu, X Xu and H Zhang.

16:00-16:30

Fluorescence ultrasound modulated optical tomography in the diffusive regime

Wei Li	Lousiana State University
Yang Yang	Michigan State University
Yimin Zhong	University of California Irvine

Abstract: We investigate a hybrid inverse problem in fluorescence ultrasound modulated optical tomography (fUMOT) in the diffusive regime. We prove that the absorption coefficient of the fluorophores at the excitation frequency and the quantum efficiency coefficient can be uniquely and stably reconstructed from boundary measurement of the photon currents, provided some background medium parameters are known. Explicit reconstructive procedures are proposed and numerically implemented as well.

IM FT-4-2 10 14:30-16:30

Case studies in industrial mathematics from MACSI

Organizer: Sarah Mitchell	University of Limerick

Abstract: MACSI, based in the University of Limerick (Ireland), is a network of mathematical and statistical modellers that works closely with scientists and industrial companies around the world on interdisciplinary problems. It has enabled industrial companies to improve their products and processes through the application of cutting-edge mathematical modelling techniques. This mini-symposia unites researchers who have recently collaborated with MACSI, either through direct employment or in active participation in MACSI’s European Study Groups for Industry workshops(MACSI brought these to Ireland and has organised 9 successful events). The talks reflect current research that is linked to MACSI which has industrial applications.

14:30-15:00

New advances in modelling the continuous casting of metals

Sarah Mitchell	University of Limerick
Michael Vynnycky	University of Limerick

Abstract: The casting of metals is known to involve complex interaction between turbulent momentum and heat transfer in the presence of solidification, and therefore modelling has predominantly focused on large-scale numerical simulation. Whilst there is certainly a need for this type of modelling, this talk highlights an alternative approach which captures the key features using simplified analytical models. This talk will focus on recent examples involving mould taper, oscillation-mark formation and solidification shrinkage of binary alloys.

15:00-15:30

Chemical transport and degradation in soils: A comparison of different modelling approaches

Cameron Hall	University of Bristol
Iain Moyles	York University
Gary O'Keeffe	University of Limerick
Alina Dubovskaya	University of Limerick
James Fannon	University of Limerick
Susan Fennell	University of Limerick
Robert Garvey	University of Limerick
Laura Keane	University of Limerick

Abstract: Modern agriculture often involves the use of pesticides, fertilisers, and other agricultural chemicals. While agrichemicals can be useful, it is essential to ensure that they do not affect the groundwater and mathematical modelling is very important for this. In this talk, I will present analysis done with industry partner Syngenta of the performance of different modelling approaches (differential equation models and agent based modelling) that can be used to describe agrichemical dynamics in soil.

15:30-16:00

Withdrawal of liquid from a column of porous media containing a density-layered fluid.

Graeme Hocking Murdoch University
Suha Al-Ali Murdoch University
Duncan Farrow Murdoch University

Abstract: An industrial process involves a chemical process in a vertical column of a porous substrate, containing layers of fluid of differing density. If the process requires the removal of the upper fluid without extracting the lower fluid, then it is possible provided the withdrawal rate is kept below some critical value. Here we use some traditional methods to compute exact steady solutions to the problem and a novel spectral method to consider the unsteady case.

16:00-16:30

The use of the perimeter-area method to characterise aggregates by fractal dimension.

Brendan Florio University of Western Australia
Phillip Fawell CSIRO Mineral Resources
Michael Small University of Western Australia

Abstract: The fractal dimension is an important parameter in the modelling of flocculation (or aggregation). Such processes are typical in industrial systems seeking separation of the solid and liquid components. The perimeter-area method, derived by Mandelbrot to measure the fractal dimension of ore chips, is now routinely used in aggregation literature. Using ideal fractal objects, we show that the perimeter-area method requires special care when applied to cluster-type objects, such as aggregates.

MS ME-1-5 10 14:30-16:30

Numerical verification methods and their application to differential equations - Part 2

For Part 1 see: MS ME-1-5 9

Organizer: Kazuaki Tanaka Waseda University
Organizer: Michael Plum Karlsruhe Institute of Technology
Organizer: Nobito Yamamoto The University of Electro-Communications

Abstract: In recent decades, the concept of "numerical verification" and "computer-assisted proofs" is gaining increasing attention and importance. These methods prove results which are rigorous in the strict mathematical sense, using a combination of analytical arguments (e.g. fixed-point theorems) and numerical computations. In particular, their application to various kinds of ordinary and partial differential equation problems has turned out to be a powerful approach for proving results which could not be obtained by purely analytical means. This minisymposium focuses on some general tools appearing in numerical verification methods, as well as their application to ordinary and partial differential equations.

14:30-15:00

Computer-assisted existence and multiplicity proofs for nonlinear elliptic boundary value problems

Michael Plum Karlsruhe Institute of Technology

Abstract: For semilinear elliptic boundary value problems on bounded or unbounded domains, a general computer-assisted method for proving the existence of a solution in a “close” and explicit neighborhood of a numerical approximate solution is proposed. The verification of the conditions posed for the underlying fixed-point argument requires various analytical and numerical techniques. The method is used to prove existence and multiplicity results for various specific examples where purely analytical methods had not been successful.

15:00-15:30

Rigorous solution-enclosures of elliptic problems and its application to the best embedding constants

Kazuaki Tanaka Waseda University
Kouta Sekine Toyo University

Abstract: This talk provides application of the numerical verification method proposed in previous talks to rigorous enclosures of the best values of the Sobolev embedding constants. We estimate the best constants by computing numerical inclusions of the corresponding extremal functions on the basis of the numerical verification method. Rigorous enclosures of the best constants on certain domains will be presented.

15:30-16:00

Computer-assisted Existence Proofs for Navier-Stokes Equations on an Unbounded Strip with Obstacle

Jonathan Wunderlich Karlsruhe Institute of Technology

Abstract: We consider the Navier-Stokes equations on an unbounded strip with obstacle. Starting from an approximate solution, we compute a bound for its defect, and a norm bound for the inverse of the linearization at the approximate solution. For the latter, eigenvalue bounds play a crucial role, especially for the eigenvalues ``close to'' zero. With these data in hand, we can use a fixed-point argument to obtain the existence of a solution “nearby“ the approximate one.

16:00-16:30

Computer-assisted proof for the stationary solution existence of the Navier-Stokes equation

Xuefeng Liu Niigata University
Mitsuhiro Nakao Waseda University
Shin'inchi Oishi Waseda University

Abstract: As one of the Millennium Prize Problems, the problem of existence and smoothness of the Navier–Stokes equation draws the attention of mathematician from the world. Meanwhile, the verified computing with assistance of computers has proved to be a promising approach to investigate the solution existence to nonlinear equation systems. In this talk, I will report the latest progress about the solution verification for the stationary Navier–Stokes equation over non-convex 3D domains.

MS A6-3-4 10 14:30-16:30

Recent Advances in Tomographic Imaging - Part 3

For Part 1 see: MS A6-3-4 8
For Part 2 see: MS A6-5-4 6

Organizer: Haltmeier Markus Universitat Innsbruck
Organizer: Richard Kowar University of Innsbruck

Abstract: Tomographic imaging is a central diagnostic tool in clinical practice. Examples include x-ray CT, photoacoustic tomography, emission tomography and MRI. One of the central mathematical aspects in tomography is the development efficient and accurate image reconstruction algorithms. Besides traditional reconstruction methods using analytical or iterative estimation techniques, recently, a new class of image reconstruction methods appeared which is based on techniques from deep learning. This can be used, for example, for improving image quality, reducing computation time or reducing radiation exposure. In this Minisymposium, leading experts will report on recent developments in image reconstruction and various tomographic modalities.

14:30-15:00

Stochastic gradient methods in quantitative photoacoustic tomography

Lukas Neumann University Innsbruck
Markus Haltmeier University Innsbruck
Simon Rabanser University Innsbruck

Abstract: Block coordinate descent methods are iterative schemes characterized by performing updates in the direction of subgroups of coordinates. Such methods proofed efficient in optimization problems and convergence in the objective function is known. However, convergence in the pre-image, as typically needed in inverse problems, is not known and does not hold in general. We present a convergence analysis for a special class of inverse problems and numerical tests for an application from multi-spectral X-ray tomography.

15:00-15:30

Image reconstruction and modelling of uncertainties in photoacoustic tomography

Tanja Tarvainen Department of Applied Physics, University of Eastern Finland
Jenni Tick University of Eastern Finland
Teemu Sahlström University of Eastern Finland
Aki Pulkkinen University of Eastern Finland

Abstract: Uncertainties and errors in forward models due to, for example, numerical approximations or uncertainties in simulation geometry, can lead to large errors in the solution of the inverse problem. In this talk, we consider modelling of such uncertainties through

Bayesian approximation error modelling with applications in photoacoustic tomography.

15:30-16:00

A Joint Deep Learning Approach for Automated Liver and Tumor Segmentation

Nadja Gruber	Technical University Innsbruck
Markus Haltmeier	Department of Mathematics, University of Innsbruck
Stephan Antholzer	Department of Mathematics, University of Innsbruck

Abstract: The segmentation of liver lesions (HCC) in CT images allows assessment of tumor load, treatment planning, prognosis and monitoring of treatment response. We propose a network architecture that consists of two consecutive nested fully CNNS together with a joint minimization strategy. We compare the nested network architecture to a one-step approach, where a neural network performs both segmentation tasks simultaneously.

16:00-16:30

Inversions of conical Radon transforms in Compton camera arising in SPECT imaging

Sughwan Moon	Kyungpook National University

Abstract: Several types of conical Radon transform have been arisen in the last decade in the context of Compton cameras for single photon emission computed tomography (SPECT). In this talk, we study the conical Radon transform for which the central axis of the cones of integration is fixed. We present its several inversion formulas as well as a stability estimate and uniqueness.

MS A3-2-1 9 14:30-16:30

Mathematical and numerical modelling of compressible multiphase flows - Part 1

For Part 2 see: MS A3-2-1 10

Organizer: Nicolas Seguin	Université de Rennes 1
Organizer: Herard Jean-Marc	EDF

Abstract: Mathematical modelling and simulations of multiphase flows are of major importance in different industries (oil companies, safety for nuclear power plants...). The objective of the proposed sessions is to provide an overview on recent advances in this field. The two parts focus on the mathematical research in the framework of two-phase and three-phase flows, considering miscible or immiscible components. Some contributions detail the derivation of PDE models, with emphasis on their thermodynamical consistency, and on the well-posedness of discontinuous solutions. Other contributions provide new advanced schemes in order to get accurate and stable approximations of solutions.

14:30-15:00

Different techniques of derivation of two-phase flow models

Nicolas Seguin	Université de Rennes 1

Abstract: When considering classical applications in Thermohydraulics, two-phase flows cannot be completely described. Averaging processes are then used to obtain sets of PDEs which allows to use a full model everywhere without accounting for tiny inclusions. We will present some of the averaging tools and try to review the possible averaged two-phase flow models that can be reached.

15:00-15:30

Pressure evolution equations in two-phase flow models

Tore Flåtten	University of Stavanger

Abstract: For incompressible single-phase flows, the pressure field can be obtained from the condition that the volume flow remains divergence free. For compressible flows, a pressure evolution equation can be expressed by adding a pressure transport term, scaled by the isentropic compressibility, to the incompressibility condition. In this talk, we explore in a systematic manner how this observation can be extended to two-phase flow models.

15:30-16:00

Eulerian models and numerical methods to simulate two-phase flows with separate or dispersed phases

Florence Drui	CEA/DEN/DM2S/SEMT/DYN

Abstract: With the objective of simulating both separated and disperse two-phase flows, we propose a connection between compressible models, used in simulations of interfacial flows, and bubbly fluids models. Moreover we have developped numerical methods for the simulation of multiple-scale interfacial flows. Our tools are based on finite volume methods and adaptive mesh refinement in a high performance context. Simulations of dam breaking are compared with experiments and performance results are presented.

16:00-16:30

Thermal relaxation modeling for seven equation models

Maria Giovanna Rodio	CEA
Jean Marc Herard	EDF
Olivier Hurisse	EDF

Abstract: The present work focuses on the development of a two-phase flow model based on a no-phasic equilibrium between the two phases and aims to study non-instantaneous relaxation hypotheses of a temperature. Since the temperature relaxation term is dependent on a characteristic time, τT , usually constant, the first contribution is to assess the influence of τT by means of a sensitivity analysis. Then a modeling of this parameter is proposed and validated.

MS FT-S-7 10 14:30-16:30

Recent advances in a posteriori error estimation and adaptive methods - Part 2

For Part 1 see: MS FT-S-7 9

Organizer: Bertrand Fleurianne	Humboldt Universität zu Berlin
Organizer: Weimar Markus	Ruhr University Bochum

Abstract: Typical approaches towards numerical solutions of complex problems might lead to systems with millions of unknowns. Therefore, adaptive strategies suggest themselves in order to increase efficiency. However, although numerical experiments strongly indicate that the use of adaptivity finally pays off, a sound theoretical justification still has to be developed for large classes of problems. Reaching this goal requires a deep understanding of structural properties such as, e.g., regularity of the unknown solutions in various function spaces. On the other hand, elaborated a posteriori error analysis is needed in order to design efficient algorithms of adaptive finite element or wavelet type.

14:30-15:00

A posteriori estimates for random systems of hyperbolic conservation laws

Jan Giesselmann	Technical University of Darmstadt
Rohde Christian	University of Stuttgart
Meyer Fabian	University of Stuttgart

Abstract: We consider systems of hyperbolic conservation laws with random initial data and flux functions. We discuss a posteriori error estimates for stochastic collocation schemes which use Runge-Kutta discontinuous Galerkin schemes for solving deterministic problems at the sampling points. We derive a posteriori error estimates which account for stochastic as well as space-time discretization errors and explain how to use them to drive space-time-stochastic adaptation.

15:00-15:30

A convergent time-space AFEM for parabolic problems motivated by equal error distribution

Kreuzer Christian	TU Dortmund

Abstract: We present a fully discrete space-time adaptive method for linear parabolic problems based on a higher order dG(s)-time stepping scheme and finite elements in space. The adaptive strategy is motivated by the principle of equally distributing the a posteriori indicators in time and termination of the method with error below a prescribed tolerance is guaranteed.

15:30-16:00

A multilevel algebraic error estimator and the corresponding iterative solver with p-robust behavior

Ani Miraci	Inria Paris
Jan Papež	Inria Paris
Martin Vohralík	Inria Parik

Abstract: In this work, we consider conforming finite element discretizations of arbitrary polynomial degree $p \geq 1$ of the Poisson problem. We propose a multilevel a posteriori estimator of the algebraic error and an associated iterative algebraic solver. We prove that the estimator is reliable and efficient and that the solver contracts the algebraic error on each iteration. Actually, we show that these two results are equivalent and hold uniformly with respect to polynomial degree p.

16:00-16:30

A posteriori error estimation of the algebraic error in numerical PDEs

Jan Papez Inria Paris

Abstract: Using the Poisson model problem and conforming finite element discretisation (of arbitrary polynomial degree), we present a methodology for computing upper and lower bounds on the algebraic error. The bounds do not contain any unspecified constants and allow estimating the local distribution of the algebraic error over the discretisation domain. We present a variant of the estimate for an arbitrary iterative solver (such as PCG) and a variant for multilevel solvers.

MS A1-2-4 10 **14:30-16:30**

Numerical Methods For Backward Stochastic Differential Equations - Part 2

For Part 1 see: MS A1-1-3 8

Organizer: Long Teng University of Wuppertal

Organizer: José Germán López Salas University of A Coruña

Abstract: In recent years the backward stochastic differential equation (BSDE) has become an important tool for formulating many problems in finance, e.g., pricing and hedging financial derivatives. Since the BSDE exhibits usually no analytical solution, advanced numerical techniques are imperative for the applications in financial industry. The aim is to develop effective and efficient schemes for solving BSDEs arising from the mathematical theory of pricing and hedging financial derivatives, especially in high dimensions. The motivation for this minisymposium is to exchange and discuss current insights and ideas, and to lay groundwork for future collaborations.

14:30-15:00

A review of tree-based approaches to solve forward-backward stochastic differential equations

Long Teng University of Wuppertal

Abstract: In this work, we study solving (decoupled) forward-backward stochastic differential equations (FBSDEs) numerically using the regression trees. Based on the general theta-discretization for the time-integrands, we show how to efficiently use regression tree-based methods to solve the resulting conditional expectations. Various numerical experiments including Heston stochastic volatility model and the high-dimensional Rainbow option pricing are provided to demonstrate the accuracy and the performance of the tree-based approach.

15:00-15:30

Regression Monte Carlo schemes for BSDEs

Jose German Lopez Salas University of A Coruña

Emmanuel Gobet Ecole Polytechnique, Paris

Carlos Vazquez University of A Coruña

Abstract: We present a new quasi-regression Monte Carlo algorithm approximating the solution of BSDEs, and we analyze the convergence of the method, which also approximates the solution to the related semi-linear PDE equation obtained through the well known Feynman-Kac representation. For the sake of enriching the algorithm with high order convergence a weighted approximation of the solution is computed and appropriate conditions on the parameters of the method are inferred.

15:30-16:00

Stochastic grid bundling method for BSDEs

Ki Wai Chau Delft University of Technology

Abstract: In this work, we apply the Stochastic Grid Bundling Method (SGBM) to numerically solve backward stochastic differential equations (BSDEs). The SGBM algorithm is based on conditional expectations approximation by means of bundling of Monte Carlo sample paths and a local regress-later regression within each bundle. The basic algorithm for solving the backward stochastic differential equations will be introduced and an upper error bound is established for the local regression.

16:00-16:30

Numerical approximation of McKean Anticipative BSDEs arising in initial margin requirements

Ankush Agarwal University of Glasgow

Abstract: We introduce a new class of anticipative backward stochastic differential equations with a dependence of McKean type on the law of the solution, that we name MKABSDE. We show how such stochastic equations arise within the modern paradigm of derivative pricing where a central counterparty (CCP) requires the members to deposit variation and initial margins to cover their exposure.

MS ME-1-0 10 **14:30-16:30**

Analysis and approximation of PDEs modeling Biological processes - Part 3

For Part 1 see: MS ME-1-0 8

For Part 2 see: MS ME-1-0 9

Organizer: Guillen-Gonzalez Francisco Universidad de Sevilla

Organizer: María Ángeles Rodríguez-Bellido Universidad de Sevilla

Organizer: Cristian Morales-Rodrigo Universidad de Sevilla

Abstract: In the last decades, the synergy between biology and mathematics are enriching both fields. Biology is increasingly stimulating the creation of new mathematical theories to explain in a simplified way the complexity of the world of living organisms. On the other hand, the mathematical modeling of the biological phenomena can serve to advise on therapies through numerical experimentation, besides also can suggest new lines of research. In this minisymposium, some recent results and challenges will be treated in the analysis and approximation of PDEs modelling biologycal processes, specifically in chemotaxis, population dynamics and tumor evolution.

14:30-15:00

Numerical Approximations of Hydrodynamic Liquid Crystal Models with Application in Cell Cytokinesis

Jia Zhao Utah State University

Qi Wang University of South Carolina

Greg Forest University of North Carolina at Chapel Hill

Abstract: In this talk, I will first present a general approach for deriving thermodynamically consistent hydrodynamic liquid crystal models using the generalized Onsager principle and the variational principle. Then, I will introduce the newly proposed energy quadratization (EQ) strategy to develop efficient, high-order accurate and energy-stable numerical approximations for a class of thermodynamically consistent liquid crystal models. Applications of this modeling and numerical paradigm to cell cytokinesis will be discussed.

15:00-15:30

Hybrid simulation methods for reaction-diffusion equations

Juan Calvo Yagüe Blanco Universidad de Granada

De La Cruz Roberto University of Birmingham

Guerrero Pilar Universidad Carlos III

Alarcón Tomás Centre de recerca Matemàtica

Abstract: Hybrid computational models combine discrete and continuous representations, providing a suitable balance between an accurate description and a reasonable simulation time. After briefly reviewing the main ideas on which these representations are based for the case of reaction-diffusion systems we introduce an adaptation of this methodology to tackle heterogeneous cell populations, structured in spatial and age variables; this enables us to assess the role of stochastic fluctuations at the leading edge of invasion fronts.

15:30-16:00

Approximation by Finite Elements for chemo-repulsion models

Maria Angeles Rodriguez-Bellido Universidad de Sevilla

Francisco Guillén-González Universidad de Sevilla, Spain

Diego Armando Rueda-Gómez Universidad Industrial de Santander, Colombia

Abstract: Chemo-repulsion models are a challenging topic trying to explain the repulsive relations between a chemical signal and a cellular density. We design several discrete schemes for different production terms considered in the chemical equation, with the objective of using Finite Element methods. Among other properties, we analyse the energy stability, solvability, mass conservation, and positivity of the variables for each discrete scheme.

16:00-16:30

A finite element design for a non-local aggregation equation

Juan Vicente Gutierrez-Santacreu Universidad de Sevilla

Abstract: In this talk we will present a fully discrete approximation of a non-local aggregation equation with degenerate diffusion that arises in many models in biology. The numerical algorihm is based on a finite-element method together with a stabilitising diffusion term and an Euler time integration. We will mainly focus on how to attain positivity for discrete solutions which need the acuteness on partitions of the computational domain. Finally, we will report on corresponding numerical experiments.

MS GH-1-1 10 14:30-16:30

Study of Newtonian and non-Newtonian Fluid Flows

MS A1-1-1 10 14:30-16:30

Nonlocal methods for image and data analysis - Part 2

For Part 1 see: MS A1-1-1 9

Organizer: Luca Calatroni CMAP, École Polytechnique

Organizer: Daniel Tenbrinck Department Mathematik, FAU Nürnberg-Erlangen

Organizer: Matthew Thorpe University of Cambridge

Abstract: With the emergence of machine learning, data-driven nonlocal methods have become increasingly popular due to their capability of exploiting self-similarity of hidden patterns in the data not necessarily in close proximity. Such methods have effectively been used for several classification and clustering applications, and applied to a wide range of image processing problems such as inpainting and segmentation. In this two-part mini-symposium we will review the recent progresses in this field, focusing both on the modelling and theoretical set-up of nonlocal methods and on the design of efficient optimisation algorithms making them applicable in practice to large-size problems.

14:30-15:00

Iterative regularisation via accelerated dual diagonal descent

Luca Calatroni CMAP, École Polytechnique

Abstract: We analyse convergence and stability properties of an accelerated dual diagonal iterative algorithm applied to solve a wide class of linear inverse problems with general data and regularisation terms. For the convergence analysis we define appropriate discrete Lyapunov functionals and show faster rates by proving their monotone decreasing. Stability and finite early stopping results are proved in terms of suitable notions of approximation codifying the inexact computation of proximal steps in the presence of noise.

15:00-15:30

Variational Graph Methods for Efficient Point Cloud Sparsification

Daniel Tenbrinck FAU Erlangen-Nürnberg

Fjedor Gaede WWU Münster

Martin Burger FAU Erlangen-Nürnberg

Abstract: In this talk we propose a hierarchical graph-based method for point cloud sparsification based on the Cut Pursuit algorithm. We investigate the influence of different regularization functionals in the variational model on the results of 3D point cloud sparsification on both noisy as well as unperturbed model data. We compare the runtime efficiency of this approach with a direct minimization of the objective functional.

15:30-16:00

Nonlocal Models with Nonstandard Interaction Domains: application to image processing.

Marta D'elia Sandia National Laboratories

Abstract: Numerical solution of nonlocal models via FEM can be prohibitively expensive; this is due to the fact that points in a domain interact with a neighborhood of points. Standard neighborhoods are Euclidean ("round"); this creates computational challenges and inaccuracies. However, in some applications, such as imaging, the most natural choice are "square" neighborhoods: these are much easier to implement and require less computational time. We analyze and illustrate their potential through imaging applications.

16:00-16:30

Nonlocal methods for image segmentation using adaptive patches

Maria Oliver Parera UPF

Gloria Haro Universitat Pompeu Fabra

Vadim Fedorov Universitat Pompeu Fabra

Coloma Ballester Universitat Pompeu Fabra

Abstract: It is proposed a variational segmentation method that considers adaptive patches to characterize the local structure of each homogeneous texture region of the image. The patches are computed using an affine covariant structure tensor defined at every pixel of the image domain, so that they automatically adapt its shape and size. The output of the method is a partition of the image in regions together with a patch representative of the texture of each region.

MS ME-0-8 10 14:30-16:30

Advances in local and nonlocal PDEs - Part 3

For Part 1 see: MS ME-0-8 8

For Part 2 see: MS ME-0-8 9

Organizer: Bruno Volzone Università degli Studi di Napoli "Parthenope"

Organizer: Yanghong Huang University of Manchester

Organizer: Filomena Feo Università degli Studi di Napoli "Parthenope"

Abstract: The aim of this minisymposium is to provide a forum to discuss the recent progress on topics in the field of local and nonlocal Partial Differential Equations and their applications to physics, engineering, optimization and finance and many more. There are many interesting open questions, both theoretical and inspired by concrete applications and this is an opportunity to overview the latest developments in these directions, to exchange ideas and to have in-depth discussion that will benefit each other.

14:30-15:00

An existence result for a class of nonlinear problems with unbounded coefficients and L^1-data

Filomena Feo Università degli Studi di Napoli "Parthenope"

Olivier Guibé University of Rouen

Abstract: We consider a class of nonlinear problems involving a matrix A(x,u) which blows up for a finite value m of the unknown u. We will focus on the case where the solution u can reach the value m, using a suitable definition of renormalized solutions and proving the existence of such solutions.

15:00-15:30

Lewy-Stampacchia's inequality for a pseudomonotone parabolic problem

Olivier Guibé LMRS - Université de Rouen Normandie

Abdelhafid Mokrane École Normale Supérieure d'Alger

Yassine Taharoui École Normale Supérieure d'Alger

Guy Vallet Université de Pau (France)

Abstract: In the framework of monotone operators, Lewy-Stampacchia's inequality for parabolic equations is studied by F. Donati. For pseudo-monotone operators the main difficulties are the non-uniqueness and the lack of regularity of . For a fairly general pseudo-monotone operator we introduce a specific perturbation of the operator which allows one to prove the existence of a solution to the obstacle problem.

15:30-16:00

Fully anisotropic elliptic equations with a zero order term

Giuseppina Di Blasio Università degli Studi della Campania

Filomena Feo Università degli Studi di Napoli “ Pathenope”

Angela Alberico Istituto per le Applicazioni del Calcolo “M. Picone” (I.A.C.)

Abstract: Integral estimates for weak solutions to a class of Dirichlet problems for nonlinear, fully anisotropic, elliptic equations with a zero order term are obtained by symmetrization techniques. The anisotropy of the principal part of the operator is governed by a general N-dimensional Young function which needs neither be radial nor have a polynomial growth and is not even assumed to satisfy the so-called Δ_2-condition.

16:00-16:30

Nonlinear Aggregation-Diffusion Equations: Radial Symmetry and Long Time Asymptotics

José Antonio Carrillo De La Plata Imperial College London

Abstract: We analyse under which conditions equilibration between two competing effects, repulsion modelled by nonlinear diffusion and attraction modelled by nonlocal interaction, occurs. I will discuss several regimes that appear in aggregation diffusion problems with homogeneous kernels. I will also discuss the diffusion dominated case in which this balance leads to continuous compactly supported radially decreasing equilibrium configurations for all masses.

MS A6-2-1 10 14:30-16:30

Mathematical Models for Solid Mechanics and Soft Structures - Part 4
For Part 1 see: MS A6-2-1 7
For Part 2 see: MS A6-2-1 8
For Part 3 see: MS A6-2-1 9
Organizer: Marco Morandotti Politecnico di Torino
Organizer: Luca Lussardi POLITECNICO DI TORINO

Abstract: The modelling of materials has received more and more attention in the last decades due to the increasing capabilities and versatility of new material and composites. Applications ranging from solid mechanics to soft structures demand sophisticated models which today's mathematics can both provide and study. In this minisymposium we intend to gather international researchers in the field of applied mathematics to share their research on topics including continuum mechanics, soft structures, thin structures, homogenisation theory, material defects, and liquid crystals.

14:30-15:00

Stochastic Homogenisation of Free-Discontinuity Problems

Filippo Cagnetti University of Sussex
Gianni Dal Maso SISSA
Lucia Scardia Heriot-Watt University
Caterina Zeppieri University of Münster

Abstract: We will discuss the stochastic homogenisation of free-discontinuity functionals. Assuming stationarity for the random volume and surface integrands, we prove the existence of a homogenised functional, whose volume and surface integrands are characterised by asymptotic formulas involving minimisation problems on larger and larger cubes with special boundary conditions. This is a joint work in collaboration with Gianni Dal Maso (SISSA), Lucia Scardia (Heriot-Watt University), and Caterina Zeppieri (University of Münster).

15:00-15:30

Homogenisation of high-contrast Mumford-Shah energies

Caterina Zeppieri University of Münster

Abstract: In this talk we present some homogenization results for free-discontinuity functionals, of Mumford-Shah-type, with degenerate periodic coefficients. These kind of functionals naturally arise in the variational modelling of the so-called high-contrast brittle composite materials. We show that the degenerate behavior of the coefficients leads, in the homogenized limit, to the emergence of nonstandard macroscopic effects.

15:30-16:00

Homogenization of multivalued monotone operators with variable growth exponent

Valeria Chiadò Piat Politecnico di Torino
Svetlana Pastukhova Russian Technological University, Moscow

Abstract: We consider the Dirichlet boundary value problem for an elliptic multi-valued maximal monotone operator satisfying growth estimates of power type with a variable exponent. This exponent and also the symbol of the operator oscillate with a small period with respect to the space variable. We prove a homogenization formula for this problem, thus, generalizing previous results for multivalued operators with standard growth and for single-valued operators with variable growth.

16:00-16:30

Inverse quasiconvexification

Pablo Pedregal Universidad de Castilla-La Mancha

Abstract: We will introduce and address the problem of finding, or even better characterizing, densities whose quasiconvexification is an appropriate quasiconvex integrand given a priori. The process is, for this reason, rightly identified as inverse quasiconvexification. Beyond some formal general results, we will present some interesting specific situations motivated by inverse conductivity problems.

MS FT-4-7 10 **14:30-16:30**

Numerical methods for PDE-based multi-physics models in biomechanics - Part 5
For Part 1 see: MS FT-4-7 6
For Part 2 see: MS FT-4-7 7
For Part 3 see: MS FT-4-7 8
For Part 4 see: MS FT-4-7 9
Organizer: Ricardo Ruiz Baier University of Oxford
Organizer: Kent-Andre Mardal University of Oslo

Abstract: The scope of the proposed minisymposium deals with the numerical approximation of multiphysics models in biomechanics. First, a particular emphasis will be placed on rigorous convergence analysis, tailored domain decomposition techniques, recent mixed finite element and hybrid discretizations, boundary element methods, design and analysis of preconditioners. Secondly, the session will focus on the application of these new methodologies in the solution of PDE-based coupled models arising in biomechanics and related systems. For instance, we especially welcome submissions involving brain multiphysics, cardiac electromechanics, or respiratory system modelling; as well as more general fluid-structure interaction, and multiscale and/or multiphysics problems.

14:30-15:00

Domain decomposition solvers for mixed FEM applied to elasticity with weak symmetry

Stefano Zampini KAUST

Abstract: We will present the implementation of the Balancing Domain Decomposition by Constraints (BDDC) method within the PETSc library, and accessible through a variety of open-source finite element libraries like FEniCS and MFEM. Numerical results will be shown in order to assess the quality and the generality of the implementation, providing results ranging from heterogeneous elliptic PDEs to indefinite linear systems. Applications to linear systems arising from elasticity with weak symmetry will be also presented.

15:00-15:30

Simplifying mesh generation in large-scale simulations via embedded finite elements

Francesc Verdugo CIMNE
Francesc Verdugo CIMNE
Alberto F. Martín CIMNE
Santiago Badia CIMNE / UPC

Abstract: Embedded finite element methods are particularly well suited for biomedical simulations based on CT-scan images. However, they have known drawbacks. One of the most notorious is the small cut cell problem, which usually results in severely ill-conditioned operators. This poses serious challenges to large-scale computations that require iterative linear solvers. In this work, we present the parallelization of the AgFEM method, which enables the usage of embedded methods in large-scale runs.

15:30-16:00

Convergence analysis of fixed-stress split iterative method for multiple-network poroelasticity models

Johannes Kraus University of Essen
Qingguo Hong The Pennsylvania State University
Maria Lymbery University of Duisburg-Essen
Mary Wheeler The University of Texas at Austin

Abstract: We consider a flux-based multiple-porosity/multiple-permeability poroelasticity (MPET) model describing multiple-network flow and deformation in a poroelastic medium. The focus of the talk is on extending the so called fixed-stress split iterative method, a commonly used coupling technique for the flow and mechanics equations defining poromechanical systems, to the MPET model. We prove linear convergence of this fixed-point iteration and that its contraction rate does not depend on any of the physical parameters in the model.

MS ME-0-5 10 **14:30-16:30**

Singular parabolic equations and the motion of interfaces - Part 2
For Part 1 see: MS ME-0-5 9
Organizer: Norbert Pozar Kanazawa University
Organizer: Piotr Rybka The University of Warsaw

Abstract: Interfaces are omnipresent. We are interested in those which are closely related to singular parabolic equations. Examples are facets appearing in the total variation flow type problems, free boundaries in Stefan-type problems or surfaces driven by geometric laws. We want to present the state of the art in the analysis and computation of these problems. In particular, we are interested in the progress of viscosity and variational methods of treatment. In addition we want to discuss the evolution of networks and the influence of dynamic boundary conditions.

14:30-15:00

The least gradient problem with respect to a non-smooth or non-strictly convex norm

Ken Shirakawa Chiba University

Hiroshi Watanabe — Oita University

Abstract: In this talk, a system of one-dimensional parabolic system is considered. This system is based on a phase-field model of grain boundary motion. The focus of this talk is on a special kind of solution, named "crystalline solution", which is to reproduce the structural characteristics in polycrystal body, authentically. The main results are concerned with the existence and uniqueness, and the results are to address some of open questions in our system.

15:00-15:30

The total variation flow with the dynamic boundary conditions

Piotr Rybka — The University of Warsaw

Abstract: We combine the total variation flow suitable for crystal modeling and image analysis with the dynamic boundary conditions. We analyze the behavior of facets at the parts of the boundary where these conditions are imposed. We devote particular attention to the radially symmetric data. We observe that the boundary layer detachment actually can happen at concave parts of the boundary.

15:30-16:00

Existence of W1,1 solutions to a class of variational problems with linear growth

Michał Łasica — University of Warsaw
Piotr Rybka — University of Warsaw

Abstract: Given a bounded Lipschitz domain , a convex function of asymptotically linear growth, and , we consider minimization problem for the functional . We prove that if and is convex, then this problem has a solution in . This is not necessarily the case if any of these two assumptions is not satisfied. We deduce an analogous result for the gradient flow of the functional .

16:00-16:30

Viscosity approach to the crystalline mean curvature flow and its applications

Norbert Pozar — Kanazawa University

Abstract: Evolving curves and surfaces whose motion is governed by singular anisotropic surface energies appear in models of crystal growth, image processing and computer graphics. The singular anisotropy brings significant mathematical challenges to the study of this anisotropic mean curvature flow. In this talk based on joint work with Yoshikazu Giga, we review some of the results towards a general well-posedness theory for this problem focusing on the viscosity solutions approach as well as their applications.

MS A3-3-1 10 — 14:30-16:30

Recent advances on electronic structure calculations - Part 3

For Part 1 see: MS A3-3-1 8
For Part 2 see: MS A3-3-1 9
Organizer: Zhenning Cai — National University of Singapore
Organizer: Guanghui Hu — University of Macau
Organizer: Chao Yang — Lawrence Berkeley National Laboratory

Abstract: This minisymposium focuses on recent progress of mathematical analysis and numerical methods for performing electronic structure calculations as well as the materials science and chemistry applications that benefit from this type of calculations. The topics covered in this minisymposium include, but are not limited to, efficient algorithms for large-scale DFT and TDDFT calculations, wavefunction based methods, structure optimization, nano-optics, quantum hydrodynamic models, many-body perturbation theory based approaches, and machine learning techniques that combine experimental data and simulation to improve materials modeling and design capabilities.

14:30-15:00

Gradient Flow Based Discretized Kohn-Sham Density Functional Theory

Aihui Zhou — Academy of Mathematics and Systems Science, Chinese Academy of Sciences

Abstract: In this presentation, we talk about a gradient flow based discretized Kohn-Sham density functional theory for atomic and molecular systems. We show the asymptotical behavior of the gradient flow model and then present an orthogonality preserving temporal scheme to discretize the model. Based on a midpoint scheme, we design a SCF iteration scheme for minimizing the Kohn-Sham energy and show that the SCF iteration scheme produces convergent approximations to a local minimizer under reasonable assumptions.

15:00-15:30

Multipliers Correction Methods for Optimization Problems with Orthogonality Constraints

Xin Liu — Academy of Mathematics and Systems Science

Abstract: We establish an algorithm framework for solving optimization problems with orthogonality constraints. This framework combines a function value reduction step with a multiplier correction step. Under this framework, three algorithms called gradient reflection, gradient projection and columnwise block coordinate descent, respectively, are proposed. Preliminary numerical experiments demonstrate that our new framework is of great potential in solving Kohn-Sham total energy minimization problems.

15:30-16:00

Continuum limit and preconditioned Langevin sampling of the path integral molecular dynamics

Zhennan Zhou — Peking University
Jianfeng Lu — Duke University

Abstract: We investigate the continuum limit that the number of beads goes to infinity in the ring polymer representation of thermal averages. Studying the continuum limit of the trajectory sampling equation sheds light on possible preconditioning techniques for sampling ring polymer configurations with large number of beads. We propose two preconditioned Langevin sampling dynamics, which are shown to have improved stability and sampling accuracy.

16:00-16:30

Inchworm algorithm for open quantum systems

Zhenning Cai — National University of Singapore
Jianfeng Lu — Duke University
Siyao Yang — National University of Singapore

Abstract: We investigate in this work a recently proposed diagrammatic quantum Monte Carlo method — the inchworm Monte Carlo method — for open quantum systems. We establish its validity rigorously based on resummation of Dyson series. Moreover, we introduce an integro-differential equation formulation for open quantum systems, which illuminates the mathematical structure of the inchworm algorithm. This new formulation leads to an improvement of the inchworm algorithm by introducing classical deterministic time-integration schemes.

MS FT-2-2 10 — 14:30-16:30

Approximation and PDE for high dimensions and manifolds - Part 2

For Part 1 see: MS FT-2-2 9
Organizer: Ian Sloan — University of New South Wales

Abstract: Approximation problems nowadays appear in many different settings, frequently high-dimensional, often for functions living on manifolds. Uncertainty quantification often leads to partial differential equations (PDE) with many parameters. In this two part minisymposium the talks will explore many of the key contemporary developments in these areas.

14:30-15:00

A spectral method for the stochastic Stokes equations on the unit sphere

Quoc Thong Le Gia — University of New South Wales
Joseph Peach — University of New South Wales, Sydney, Australia

Abstract: We construct numerical solutions to the stochastic Stokes equations on the unit sphere with additive noise using a spectral method which involves divergence-free vector spherical harmonics. Under certain assumptions on the isotropy of the noise, expected mean square errors of the random solution are given. Two sets of numerical experiments are carried out to illustrate the theory.

15:00-15:30

Approximation and orthogonality on quadratic curves and surfaces

Yuan Xu — University of Oregon

Abstract: We consider orthogonal polynomials on quadratic curves on the plane, on quadratic surfaces of revolution, and inside the domain bounded by quadratic surfaces. As an example, we will shows that orthogonal polynomials on the surface of a cone are eigenfunctions of a second order differential operator if the orthogonality is defined with respect to a family of measures that contains t^{-1} if the apex of the cone is at the origin.

MS A6-5-3 10 14:30-16:30

The mathematics behind the numerical simulation in the aortic valve

Organizer: Marcos Loureiro-García Health Research Institute Galicia Sur
Organizer: Generosa Fdez-Manin University of Vigo
Organizer: Cesar Veiga Health Research Institute Galicia Sur

Abstract: Aortic valve (AV) stenosis is one of the major causes of morbidity and mortality in the elderly. The use of mathematical models to simulate the AV behaviour or some of the applied therapies to this disease can provide extra information when making decisions. This minisymposia combines researchers who work on the AV field but have different perspectives on the same topic. Presentations go from a more theoretical research which is carried on at university departments, including validation with experimental results, to the clinical side view from researchers who work at a hospital with patient-specific data.

14:30-15:00

Predicting a warning pressure for balloon-expandable transcatheter aortic valve deployment

Marcos Loureiro Garcia Health Research Institute Galicia Sur

Abstract: Several issues need to be addressed while planning Transcatheter Aortic Valve Implantation (TAVI) such as device size selection. By using numerical simulation, different devices could be virtually deployed assessing their positioning before the intervention using FEM. Results such as maximum tension induced when the TAVI contacts the aortic tissue can be evaluated and a warning pressure alarm can be set in agreement with clinical data. Further studies and validations need to be done.

15:00-15:30

The beneficial role of patient-specific computer simulation in transcatheter aortic valve implantation

Giorgia Rocatello Ghent University

Abstract: In the field of transcatheter aortic valve replacement, computer simulations used in conjunction with preoperative patient-specific images can provide detailed information on the performance of the device implanted in a patient-specific anatomy to better understand the risk of complications, as well as the underlying reason. Such information can be of clinical value to properly plan the procedure (e.g. most appropriate device size and position) as well as to improve the design of new devices.

15:30-16:00

Healthy Aortic Valve Dynamics - Extension after PIV Validation of a Fluid Structure Interaction

Jacob Salmonsmith University College London
Anna Maria Tango University College London
Andrea Ducci University College London
Gaetano Burriesci University College London

Abstract: Understanding the operating mechanism of the aortic valve is essential to interpreting and treating associated pathologies, but there is no consensus in the literature. In this study, a numerical replication of a Particle Image Velocimetry study was validated, and then modified to remove some of the bench-top limitations. The modifications led to substantial changes, such as increased range of leaflet motion and reduction of vortices, suggesting a new, more efficient, operating mechanism.

MS A3-2-2 10 14:30-16:30

Computational Fluid Dynamics: Modeling, Analysis, and Applications - Part 3

For Part 1 see: MS A3-2-2 8
For Part 2 see: MS A3-2-2 9

Organizer: Sarah Olson Worcester Polytechnic Institute
Organizer: Sookkyung Lim University of Cincinnati
Organizer: Hoa Nguyen Trinity University

Abstract: Computational fluid dynamics has rapidly developed into an interdisciplinary field where numerical analysis and data structures are used to model and investigate fluid flows at multiple scales. This minisymposium will focus on recent developments spanning from mathematical analysis and algorithms to complex simulations of biological systems, as well as coordination between modeling and experiments. The diversity of the presentations highlights the importance of interdisciplinary research on computational fluid dynamics where novel models and algorithms can be leveraged to understand complex fluid flows in a variety of applications.

14:30-15:00

A variation of regularized Stokeslets for filaments in three dimensions

Ricardo Cortez Tulane University

Abstract: We present a variation of the method of regularized Stokeslets for the case of forces and torques distributed over thin filaments in 3D. A filament is approximated by relatively few connected line segments and the force varies linearly in each segment. Explicit formulas are derived. We show simulations of a sperm flagellum of length L composed of 24 segments where the regularization parameter is as small as L/300.

15:00-15:30

Methods for suspensions of passive and active filaments

Eric Keaveny Imperial College London
Simon Schoeller Imperial College London
Adam Townsend Imperial College London
Timothy Westwood Imperial College London

Abstract: Although prevalent in biological and industrial settings, the direct simulation of filament suspensions remains a computational challenge due to numerical stiffness, coupled fluid-structure interactions, and constraints on filament deformation. In this talk, I will address these challenges for 3D filament motion using a combination of unit quaternions, implicit geometric time integration, quasi-Newton methods, and fast matrix-free methods for hydrodynamic interactions. Simulations of up to one thousand filaments will be presented to demonstrate the framework's effectiveness.

15:30-16:00

Bacterial swimmers: propulsion and reorientation

Sookkyung Lim University of Cincinnati

Abstract: Flagellated swimming bacteria are self-propelled micro-swimmers in nature, and the swimming strategies of such bacteria vary depending on the number and the position of flagella on the cell body. In this talk, we will introduce two microorganisms, multi-flagellated E. coli and single-flagellated Vibrio A. The focus of the talk will be on how bacteria reorient swimming direction.

16:00-16:30

Modeling the Synchronization of Flagella on the Exterior of a Sphere

Karin Leiderman Colorado School of Mines
Forest Mannan Colorado School of Mines
Miika Jarvela Colorado School of Mines

Abstract: Flagella are hair-like appendages attached to microorganisms that allow the organisms to traverse their fluid environment. The algae Volvox are spherical swimmers with potentially thousands of individual flagella on their surface and their coordination is not fully understood. In this work, we developed a mathematical model of flagella on the outer surface of a sphere submerged in a fluid. The goal was to determine if factors related to the spherical shape affected flagellar synchronization. We modeled each beating flagella tip as a small rotating sphere, attached to a point just above the spherical surface by a spring. This was achieved by using a regularized image system for Stokes flow outside of a sphere. Previous models showed synchronization when flagella were attached to a sphere but this was largely because the flagella were beating in the same direction all the way around the sphere. It is known that Volvox flagella beat toward one pole, where some are beating in opposite directions, which somehow helps with directed motion and rotation. By including more biologically realistic assumptions about flagellar beating in our model, we were able to simulate and understand how groups of flagella synchronize to aid in directed motion.

MS FT-2-1 10 14:30-16:30

Recent developments in numerical analysis of integral and integro-differential equations - Part 4

For Part 1 see: MS FT-2-1 7
For Part 2 see: MS FT-2-1 8
For Part 3 see: MS FT-2-1 9

Organizer: Qiumei Huang Beijing University of Technology
Organizer: Hermann Brunner Hong Kong Baptist University

Abstract: Since integral equations, integro-differential equations and related functional equations with various types of delays play an important role as mathematical models in science, engineering and finance, recent years have seen major developments in the design and analysis of efficient numerical methods for such equations. It is the aim of this minisymposium to bring together leading experts in these fields, in order to describe recent achievements and further communication between numerical analysts and computational scientists working on these problems.

14:30-15:00

The hp-version Galerkin and collocation time-stepping methods for Volterra integro-differential equations with vanishing delays

Lijun Yi Shanghai Normal University

Abstract: In this talk we shall present the hp-version continuous Galerkin and collocation methods for Volterra integro-differential equations with vanishing delays. We derive several a-priori error estimates that are completely explicit with respect to the local time steps, the local polynomial degrees, and the local regularity of the exact solution. Numerical examples are provided to illustrate the theoretical results.

15:00-15:30

Nonuniform time-stepping approaches for reaction-subdiffusion problems

Jiwei Zhang Wuhan University

Abstract: Nonuniform time-stepping methods are promising for Caputo reaction-subdiffusion problems. We develop a general framework for the stability and convergence analysis with three tools: a family of complementary discrete convolution kernels, a discrete fractional Gr¨onwall inequality and a global (convolutional) consistency analysis, which is not limited to a specific time mesh by building a convolution structure of local truncation error.

15:30-16:00

EFFICIENT MULTISTEP METHODS FOR TEMPERED FRACTIONAL CALCULUS: ALGORITHMS AND SIMULATIONS

Ling Guo Shanghai Normal University
Fanhai Zeng Queensland University of Technology
Ian Turner Queensland University of Technology
Kevin Burrage University of Oxford
George Karniadakis Brown University

Abstract: In this work, we extend the fractional linear multistep methods to the tempered fractional integral and derivative operators. We develop two fast methods with linear complexity to calculate the discrete convolution for the approximation of the (tempered) fractional operator. The effectiveness of the methods is verified through a series of numerical examples for long-time integration, including a numerical study of a fractional reaction-diffusion model.

MS FT-S-5 10 14:30-16:30

Mimetic Finite Diffence Methods and Applications - Part 2

For Part 1 see: MS FT-S-5 9

Organizer: Jose Castillo San Diego State University

MS Organized by: SIAG/CSE

Abstract: Mimetic finite difference methods have been used more and more recently very effectively. The method presented here is based on constructing discrete analogs of the primary operators divergence, gradient and curl. In this session we present new development of this method including advances of a mimetic library that allows to easily implent the method in a way range of aplications. Stability, adaptivity as well as implementaion on overlapping gris will be presented. Some of of the applications are in seismic wave modeling, porous media and image processing.

14:30-15:00

Increase of the stability region of explicit mimetic difference methods on a convection diffusion problem by discrete mollification

Julio Carrillo Universidad Industrial de Santander
Giovanni Ernesto Calderón Silva Universidad de los Andes, Venezuela
Deyanira Maldonado Guerrero Universidad Industrial de Santander, Colombia

Abstract: On this article is shown a discrete mollification of a time-stepping mimetic difference method for a one-dimensional convection-diffusion equation. This new scheme has proved to be an effective way to increase the stability region of the mimetic difference method. The numerical experiments indicate the speed-up of that mollified mimetic method when enhanced with even reflection for the treatment of the boundary conditions.

15:00-15:30

Adaptive Process in Mimetic Difference Methods

Jorge Villamizar Universidad de Los Andes, ULA; Universidad Industrial de Santander, UIS.
Giovanni Calderón Universidad Industrial de Santander, UIS. Universidad de Los Andes, ULA.
José Castillo Computational Science Research Center, San Diego State University.
Julio C. Carrillo E. Escuela de Matemáticas, Universidad Industrial de Santander, UIS.

Abstract: We present an adaptive process to produce an optimal mesh on that is calculated the approximated solution of a two-dimensional boundary value problem when solved with a mimetic difference method. From the discrete version of the gradient operator, we make the error estimate. The numerical experiments show the optimal behavior of the procedure.

15:30-16:00

Local ABC with farfield expansions: a finite element approach

David Modesto Barcelona Supercomputing Center (BSC-CNS)
Vianey Villamizar Brigham Young University
Antonio Huerta Polytechnic University of Catalonia

Abstract: Using efficient and accurate local absorbing boundary conditions (ABC) is a common challenge when addressing wave problems over unbounded domains. Here, a recently devised ABC based on Karp's farfield expansions is used to impose continuity conditions on the artificial boundary. The talk focusses on the high order FEM implementation for Helmholtz problems. Results demonstrate how these ABCs preserve the convergence of the method for short and long waves, exhibiting superior performance to perfectly matched layers.

16:00-16:30

High Order Mimetic Methods on Curvilinear Grids

Jose Castillo San Diego State University

Abstract: High Order Mimetic methods, based on discrete mimetic divergence and gradient operators, have been used successfully on several applications. These operators satisfy the same properties that the continuum divergence and gradients operators do so they are more faithful to the physics. Here, we investigate the extension of these operators to general curvilinear grids. In particular, we investigate the discrete conservation of mass, momentum and energy for some wave models for complex physical space domains.

MS A6-5-4 10 14:30-16:30

Analytic and Computational Simulation in Biomedical Engineering and Bioscience

Organizer: Ryan Evans NIST
Organizer: Anthony Kearsley National Institute of Standards and Technology

Abstract: Biomedical engineering and bioscience have fundamentally improved drug delivery and deepened our understanding of medicine. In this minisymposium a collection of specific applications will be examined, including biological field effect transistors, micro-electro-mechanical systems, and intra-cellular transport. Analysis and simulation of such nonlinear phenomena are complicated by the presence of multiple disparate time and length scales, singularities, and free boundaries. The theme of this mini-symposium is the development of novel analytic and computational approaches to better understand the behavior of these complex and important systems.

14:30-15:00

Boundary homogenization of patchy membranes and the role of clustering in chemoreception

Alan Lindsay University of Notre Dame
Andrew Bernoff Harvey Mudd College

Abstract: Cells interact through contacts with diffusing signaling molecules at receptors on the membrane surface. The organization or 'clustering' of receptors plays an important but not well understood biophysical role. In this talk I describe results that reveal the influence of clustering for receptors arranged on spheres or periodically on infinite planes. Optimizing arrangements are identified. A suite of Kinetic Monte Carlo methods is introduced to verify theoretical results and explore the space of clustering configurations.

15:00-15:30

Bending instabilities in elasto-capillary systems

Nicholas Brubaker California State University, Fullerton

Abstract: Deforming an elastic plate around a liquid drop is an energetically efficient way to build microscale structures. However, accessing the full design space of the structure requires being able to completely wrap the plate around the drop. Full wrapping is predicated on inducing a bending instability that occurs when the drop's surface tension dominates the plate's rigidity. We elucidate this bifurcation in some simplified models and discuss its ubiquity in many other elasto-capillary systems.

15:30-16:00

Transport Phenomena in Biological Field Effect Transistors

Ryan Evans National Institute of Standards and Technology

Abstract: Biological field effect transistors (Bio-FETs) are measurement devices designed to provide physicians with rapid and accurate biomarker measurements. They record measurable voltage changes resulting from surface reactions inside the instrument. We present a singular and nonlinear integrodifferential equation model that yields excellent agreement with experimental data and is the first of its kind to robustly estimate parameters associated with Bio-FET experiments.

16:00-16:30

A comparison of effective statistics for various molecular motor systems

Joseph Klobusicky Rensselaer Polytechnic Institute

Abstract: For this talk, we develop a model of procession for attached and unattached molecular motors, as well as molecular cargo, through a system of stochastic differential equations. By exploiting multiscale behavior for this system, we are able to approximate motion by a Markov chain model, and derive effective statistics for motor behavior. We mention several subtleties related to measuring velocities and diffusivities, and also compare qualitative behavior between simulations of our model and experimental observations.

MS FE-1-2 10 14:30-16:30

Eigenvalue Optimization - Part 2

For Part 1 see: MS FE-1-2 9

Organizer: Matthias Voigt Technische Universität Berlin
Organizer: Emre Mengi Koc University

Abstract: The optimization of eigenvalues plays an important role in various fields of applied mathematics such as in graph optimization problems, as well as robustness analysis and controller design for dynamical systems. Such problems are often non-smooth, non-convex and/or large-scale, thus pose mathematical challenges in terms of the theory as well as the algorithms and the numerical methods. This minisymposium aims at bringing together researchers from optimization, numerical analysis, and engineering to discuss recent advances and applications of eigenvalue optimization.

14:30-15:00

Exponential stabilization by linear feedback

Nicola Guglielmi Gran Sasso Science Institute
Valeria Simoncini University of Bologna, Italy

Abstract: Given a non dissipative system $x' = Ax$, we consider the control system $x' = Ax - Bu$ with control $u = Kx$. A is an $n \times n$ matrix and B is an $n \times q$ rectangular matrix with $q \ll n$. The (known) condition of existence of a feedback which makes the system dissipative is revisited with an invariant subspace perspective. Few computational approaches are investigated.

15:00-15:30

Perturbation Theory for Quadratic Eigenvalue Problem - Applied on Damped Mechanical Systems

Zoran Tomljanovi? Josip Juraj Strossmayer University of Osijek

Abstract: We present a novel approach for efficiently approximating the eigenvalues of the parameter dependent quadratic eigenvalue problem that arise when considering damped mechanical systems. We consider the first order approximation for eigenvalues based on Taylor's formula, and for this approximation we give an upper bound. Moreover, we present a new type of perturbation bounds for eigenvectors that can be used for analysis of the behavior of individual eigenvectors.

15:30-16:00

Calculation of statistical moments of the rightmost eigenvalue using projection

Koen Ruymbeek KU Leuven - Dept. Computer Science

Abstract: We present a method to calculate the expected value and variance of the largest/smallest eigenvalue of a matrix pencil depending on parameters. The idea is to approximate the minimal eigenvalue of a large-scale matrix pencil by the minimal eigenvalue of a smaller matrix pencil, obtained by projection of the large-scale matrix on a well-chosen subspace. Here we can relax the convergence conditions based on the distribution. The idea is based on previous work.

16:00-16:30

Bundle methods and the 'exact subgraph approach' for graph optimization problems

Franz Rendl Klagenfurt University

Abstract: Bundle methods imitate the steepest descent method from smooth optimization and are a very efficient tool in situations where optimization problems with many constraints have to be solved with low accuracy. We apply this approach to Semidefinite-Optimization relaxations for Max-Cut and Stable-Set. We work on the dual problem, where only the 'exact subgraph constraints' are dualized. This results in a non-smooth convex problem. We explain how to solve it and present computations for Max-Cut.

MS GH-1-3 10 14:30-16:30

Computational Techniques for Free Boundary Problems and Applications

Organizer: Frederic Gibou UCSB

MS Organized by: SIAG/CSE

Abstract: Free boundary problems are ubiquitous in science and engineering and are among the most challenging to solve numerically. In this minisymposium, we will focus on recent advances in computational techniques that enable the simulation of interface problems. Applications will range from multiphase flows to problems encountered in materials science or in biology.

14:30-15:00

Balance of stresses across sharp interfaces in two-phase flow simulations

Raphael Egan UCSB

Abstract: We address challenges revealed when developing a sharp-interface two-phase flow solver with full-implicit treatment of viscosity. A simplified scalar problem is presented, along with an improvement to the “Ghost Fluid Method” by Liu, et al. 2000. We show the ability to recover convergence of flux components in infinity norm. The accurate treatment of interface stresses in free-surface flows is considered. Finally, the general case is discussed with regard to its integration in such a solver

15:00-15:30

Level-Set Approach to Free Boundary Problems on Parallel Octree Grids

Frederic Gibou UCSB

Abstract: We will present an overview of recent advances in the computation of free boundary problems using Octree data structures in a massively parallel environment. Applications will be given in fluids and materials simulations.

15:30-16:00

Parallel Octree Simulations of Incompressible Flows Coupled with Soluble Surfactant

Fernando Temprano-Coleto UCSB

Abstract: We present a computational treatment for incompressible flows with soluble surfactant. The problem requires solving four strongly-coupled PDE's, with one of them defined in a codimension-one irregular interface. We use adaptive Quad/Octree cartesian grids, handled in parallel by means of the p4est library, and a level-set treatment of irregular interfaces. Convergence is shown in several benchmarks, which are specifically designed to verify the approximation of every term in the governing equations.

16:00-16:30

Simulation of multicomponent alloy solidification

Daniil Bochkov	UCSB
Frederic Gibou	University of California, Santa Barbara

Abstract: We present a computational method for simulation of the solidification of multi-alloys based on a novel Newton-type iterative scheme for solving a system of non-linearly coupled PDEs describing the solidification process. The computational method employs adaptive quad-tree grids to address the multiscale nature of the process, the moving solidification front is described by the level-set method and PDEs constituting the mathematical model are solved in irregular domains formed by the front in a "sharp" fashion.

IM FT-2-3 10 14:30-16:30

Advances in computation and analysis of PDE's for multiphase system - Part 3

For Part 1 see: IM FT-2-3 8

For Part 2 see: IM FT-2-3 9

Organizer: Xiaolin Li	Stony Brook University
Organizer: Hyunsun Lee	Hawaii Pacific University
Organizer: Zhiliang Xu	University of Notre Dame

Abstract: Multiphase flows have many applications in science and engineering. This minisymposium brings together researchers who have been working on such problems using various analytical and numerical methods for solving PDEs and coupling the solution with the interface dynamics. Topics in this minisymposium include fluid interface instabilities and fluid interactions with thin layer structures.

14:30-15:00

Identification of jet noise source using casualty method

Hyunsun Lee	Hawaii Pacific University

Abstract: An acoustic analogy analysis based on a decomposition of the source term in Lighthill's equation into sub-terms is discussed in light of a high-fidelity large-eddy simulation of a subsonic turbulent cold jet exhausting from a baseline round nozzle. These sub-terms show the nonlinear reciprocal interaction of density, velocity, vorticity, and dilatation fields. To understand the sound generation mechanism, intrinsic links between turbulent flow and emitted acoustic signals are made by adapting cross-correlations.

15:00-15:30

An Efficient WENO Limiter for Discontinuous Galerkin Transport Scheme on the Cubed Sphere

Xinghui Zhong	Zhejiang University
Ramachandran Nair	National Center for Atmospheric Research
Wei Guo	Texas Tech University

Abstract: A simple and efficient limiter based on the WENO methodology is incorporated in the DG transport framework on the cubed sphere. The resulting scheme is high-order accurate, non-oscillatory, and positivity-preserving for solving transport equations based on the cubed-sphere geometry.

15:30-16:00

Numerical method for phase transition with application in airplane icing prediction

Chunling Zhu	Nanjing University of Aeronautics and Astronautics

Abstract: A phase transient numerical method based on Cartesian adaptive technique is developed to predict aircraft icing. The governing equations of the compressible inviscid flow of air and the motion equations of droplets are established. A new method for identifying the impingement of droplets on the wall is developed. The Cartesian adaptive technique is introduced to update and encrypt the boundary mesh. The unsteady characteristics of the ice process are considered.

16:00-16:30

Quantitative Theories for Unstable Interface Mixing

Qiang Zhang	Hong Kong City University

Abstract: We present an analytical theory for the growth rates and amplitudes of fingers in Richtmyer-Meshkov instability for compressible fluids with arbitrary density ratios and arbitrary incident shock strength. It contains no fitting parameters and the theoretical predictions are in remarkably good agreements with the results from numerical simulations and with the data from experiments from early to late times. We also present asymptotic scaling behavior among spikes and bubbles for systems of differential density ratios.

MS ME-0-1 10 14:30-16:30

Inverse source scattering problems

Organizer: Yukun Guo	Harbin Institute of Technology
Organizer: Minghui Song	Harbin Institute of Technology

Abstract: Acoustic source imaging problems play an important role in diverse areas such as antenna synthesis, biomedical imaging, sound source localization and identification of pollutant in the environment. In the last several decades, the inverse acoustic source scattering problems have attracted more and more attention, and significant progress has been made on uniqueness, stability analyses and numerical approaches. This minisymposium aims to mathematical and computational studies of inverse source scattering problems. It seeks to bring together leading experts in the field to present recent developments, promote exchange of ideas, and discuss new directions.

14:30-15:00

On the construction of weakly neutral inclusions of general shape

Xiaofei Li	Zhejiang University of Technology
Hyeonbae Kang	Inha University

Abstract: Upon insertion of an inclusion into an otherwise uniform field, if the field outside is not perturbed at all, then the inclusion is called a neutral inclusion. It is called a weakly neutral inclusion if the field is perturbed mildly. Inclusions neutral to multiple uniform fields are of circular or spherical shape if the background conductivity is isotropic. We consider the problem of constructing inclusions of general shape which are weakly neutral to multiple fields.

15:00-15:30

A Multi-Frequency Inverse Source Problem for the Helmholtz equation in three dimensions

Adrian Kirkeby	Technical University of Denmark

Abstract: The inverse source problem concerns the reconstruction of a source term in the Helmholtz equation from boundary measurements. We consider the problem where measurements are taken at a finite number of frequencies. We characterize certain finite dimensional subspaces containing sources that can be stably reconstructed from such measurements; the characterization depends on the measurement frequencies and problem geometry only. We device a fast method for reconstructing sources, and demonstrate our findings with numerical examples.

15:30-16:00

Time domain scattering problem for three-dimensional Maxwell's equations

Jue Wang	Harbin Engineering University
GANG BAO	Zhejiang University
BIN HU	Zhejiang University
PEIJUN LI	Purdue University

Abstract: This talk is focused on the analysis of the diffraction of an electromagnetic plane wave by a biperiodic structure. The wave propagation is governed by the time-domain Maxwell equations in 3D. A coordinate transformation is proposed to reduce equivalently the diffraction problem into an initial-boundary value problem. Then we proved that the reduced problem has a unique weak solution. The stability and a priori estimates with explicit time dependence are established for the weak solution.

16:00-16:30

Reconstruction of acoustic sources from multi-frequency phaseless data

Yukun Guo	Harbin Institute of Technology
Deyue Zhang	Jilin University
Jingzhi Li	Southern University of Science and Technology
Hongyu Liu	Hong Kong Baptist University

Abstract: This talk is concerned with the inverse source problem of reconstructing an unknown acoustic excitation from multifrequency phaseless measurements. We develop a novel strategy to recover the radiated fields via adding some reference point sources. This technique leads to a simple phase retrieval formula. The stability of this approach is rigorously analyzed. Once the phase information is available, the multi-frequency inverse source problem is solved by the Fourier method. Validating numerical examples will be presented.

MS A3-3-3 10 **14:30-16:30**

Uncertainty Quantification and Reproducibility - Part 2

For Part 1 see: MS A3-3-3 9

Organizer: Andrew Dienstfrey NIST

Organizer: Ronald Boisvert National Inst. of Standards and Technology

Abstract: Reproducibility of scientific results has been called into question recently. Although most attention has focused on biomedicine and psychology, such questions have led to a great deal of self-reflection in the computational science community as well. At the same time, there has been a surge of interest in uncertainty quantification in scientific computing as a process to render computational results actionable for decision makers. In this minisymposium we will explore these two concepts in relationship to each other, and their respective roles in establishing credibility of computational results. [This minisymposium is sponsored by IFIP Working Group 2.5, https://wg25.taa.univie.ac.at/.]

14:30-15:00

Stochastic Modeling of Numerical Reproducibility

Michael Mascagni National Institute of Standards and Technology/Florida State University

Abstract: We use a neuronal modeling code used by the author to show nonreproducibility. The model used is very standard in neuroscience, and we find issues for reproducibility that arise from floating-point arithmetic (two different ways), and the intrinsic mathematical functions. This work is related to work at NIST to highlight numerical reproducibility at two international workshops per year.

15:00-15:30

Verificarlo: Floating-point Computing Validation on New Architecture and Large-scale Systems

Eric Petit Intel Corporation

De Oliveira Pablo University of Versailles

Chatelain Yohan University of Versailles

Defour David University of Perpignan

Abstract: The recent trends in HPC systems – massive parallelism, large vector, asynchronism – and the increase in computational power allow larger, more complex, and higher resolution numerical simulations. These progress however are rising new concerns beyond system design. One of this challenge is the validation and portability of the numerical quality of a simulation, especially regarding the round-off error implied by the usage of a finite representation of real numbers.

15:30-16:00

Reproducible Linear Algebra from Application to Architecture

Jason Riedy Georgia Institute of Technology

James Demmel Demmel University of California, Berkeley

Peter Ahrens Ahrens Massachusetts Institute of Technology

Abstract: All computing must be parallel to take advantage of modern systems like multicore processors, GPUs, and distributed systems. Results that are not bit-wise reproducible introduce doubt on many levels. Sometimes that is appropriate. Reproducibility limitations occur because underlying libraries do not specify their reproducibility requirements. New advances in interfaces, algorithms, and architectures allow selecting among those requirements in the future. This talk covers many of the upcoming options and their trade-offs.

16:00-16:30

Using Probabilistic Hardware to Increase Energy Efficiency of Computation

Sarah Michalak Los Alamos National Laboratory

Abstract: While computer hardware faults can lead to incorrect answers, leveraging hardware faults to permit a reliability-energy trade-off has also been considered. This work investigates whether use of probabilistic hardware, or hardware that produces more than one answer to an operation with a single correct answer, can lead to increased energy efficiency for integer computations. A framework to guide testing and evaluation of energy efficiency of probabilistic hardware and early results are presented.

MS A1-2-6 10 **14:30-16:30**

Variational Models and Algorithms for Mesh Denoising

Organizer: Jose Vidal-Nunez TU CHEMNITZ

Organizer: Stephan Schmidt Würzburg University

MS Organized by the GAMM activity group "Optimization with Partial Differential Equations" (OPDE)

Abstract: Meshes are widely employed in computer science and vision since they are easy to manipulate by software. During the scanning process, measurements errors motivate the use of a preprocessing step in order to clean up the mesh before further computations. This process is known as mesh denoising. Many algorithms and theoretical approaches have been developed so far to distinguish noise from features in the process of denoising a given mesh. Focusing on the role of variational methods, the idea of this mini-symposium is to present models and applications into this field by using the ROF model and the total variation.

14:30-15:00

Mesh denoising and total variation of the normal on triangluated surfaces

Jose Vidal-Nunez TU Chemnitz

Roland Herzog TU Chemnitz

Marc Herrmann University Wuerzburg

Stephan Schmidt University Wuerzburg

Abstract: We present a novel approach to solve geometry processing problems including mesh denoising. Our method is based on an anisotropic version of the total variation of the normal and the geodesic distance on the sphere for piecewise flat surfaces. We numerically solve the model applying split-Bregman iterations in different real geometries as benchmark. In addition, we further investigate not only an isotropic variation of the normal vector field, but also directional definitions of this functional.

15:00-15:30

Surface Denoising based on Normal Filtering in a Robust Statistics Framework

Sunil Kumar Yadav Freie Universität Berlin

Abstract: The robust statistics framework is focused on developing different estimators, which are robust to outliers. In surface denoising and robust statistic framework, sharp features are considered as outliers and a proper estimator will avoid these outliers to preserve sharp features and remove undesired noise components from a noisy surface. This talk is focused on the face normal filtering in the robust statistics framework using different robust estimators for feature-preserving surface denoising.

15:30-16:00

Edge-aware Image Filters via Domain Splitting L1 Gaussian Convolutions

Shin Yoshizawa Image Processing Research Team, RIKEN

Abstract: Fundamental solution of the diffusion equation, a process of minimizing the Dirichlet energy, gives a Gaussian convolution and it has been played an important role in additive noise reduction. In this talk, we introduce a fast and accurate approximation algorithm of L1 Gaussian convolutions and its application to edge-aware image filters. Our algorithm is based on splitting a pixel domain into representative regions where we can efficiently and accurATLY perform discrete convolutions.

MS FT-1-1 10 **14:30-16:30**

Numerical methods for kinetic and mean-field equations - Part 3

For Part 1 see: MS FT-1-1 8

For Part 2 see: MS FT-1-1 9

Organizer: Li Wang University of Minnesota

Organizer: José Antonio Carrillo De La Plata Imperial College London

Abstract: Kinetic and mean-field equations are derived from many-particle system, and have been widely applied in various contexts such as rarefied gas dynamics, plasma physics, biology, socio-economy, and many others. The high dimensionality, and multiple scales constitute the major challenge in computing these equations. Certain structures, such as positivity, conservation and entropy dissipation are also desirable for numerical solutions. This mini-symposium aims to bring together researchers in this area to assess the current state-of-the-arts methods and foster collaborations.

14:30-15:00

The Elo rating system with dynamic strength: modeling and simulation

Marie-Therese Wolfram University of Warwick

Abstract: We study a new kinetic rating model for a large number of players, which is motivated by the Elo rating system. Each player is characterised by an intrinsic strength and a rating, which are both updated after each game. We analyse the respective Boltzmann type equation and derive the corresponding Fokker-Planck equation. We investigate the existence of solutions and their behaviour in the long time limit. Furthermore, we illustrate the dynamics with various numerical experiments.

15:00-15:30

Unified gas-kinetic scheme for multi-scale transport

Kun Xu Hong Kong University of Science and Technology
Kun Xu Hong Kong University of Science and Technology

Abstract: In this talk, we will introduce the multiscale modeling and the framework of unified gas-kinetic scheme (UGKS). Under the UGKS framework, the discrete-velocity-based, particle-based, and wave-particle-based UGKS will be introduced. The applications include the rarefied flow, radiative transfer, neutron transport, plasma, and two phase dispersive flow. The flow physics in different regimes can be accurately captured without the constraints on the cell size and time step to the particle mean free path and collision time.

15:30-16:00

Convergence of a Finite Volume Scheme for a System of Interacting Species with Cross-diffusion

Markus Schmidtchen Imperial College London

Abstract: We present the convergence of a positivity preserving finite volume scheme for a coupled system of two non-local partial differential equations with cross-diffusion. The key to proving the convergence result is to establish positivity in order to obtain a discrete energy estimate to obtain compactness. We numerically observe the convergence to reference solutions with a first order accuracy in space. Moreover we recover segregated stationary states in spite of the regularising effect of the self-diffusion.

16:00-16:30

A High-Order Low-Order (HOLO) Multiscale Nonlinear Convergence Accelerator for the Rosenbluth-Fokker-Planck Collision Operator and Applications to ICF

William Taitano Los Alamos National Laboratory

Abstract: The RFP operator has a wide range of applications for describing weakly coupled plasmas. Due to the nonlinear-integral nature of the RFP operator, implicit solvers face enormous challenges in dealing with the dense component of the Jacobian. In our talk, we discuss an efficient approach that utilizes a set of auxiliary-hydrodynamic equations to deal with this challenge. We demonstrate the efficiency and accuracy properties of the method with applications to ICF problems.

MS GH-3-4 10 14:30-16:30

Mathematical Modelling in the Metallurgical Industry

Organizer: Raquel González Fariña University of Oxford

Abstract: In the metallurgical industry, silicon and ferroalloys are widely produced using submerged arc furnaces. Such furnaces are highly complex and operate at very high temperatures. Since experimentation in such environments is prohibitively difficult, mathematical modelling is a useful approach for better understanding the physical and chemical processes taking place within these furnaces, leading to improved furnace operation. We present mathematical models of four distinct processes occurring within such furnaces, namely the chemical reactions between gases and solids in granular particles, formation and growth of microsilica particles, electrical behaviour within a furnace, and heat and mass transfer within a Søderberg electrode.

14:30-15:00

Homogenisation of a shrinking core model for gas-solid reactions in granular particles

Ben Sloman Elkem ASA
Colin Please University of Oxford
Robert Van Gorder University of Otago

Abstract: The shrinking core model assumes a sharp divide between reacted and unreacted solid materials, which is not present in some physical systems. Our homogenised model allows for a diffuse reaction front in granular particles. It is derived by assuming a shrinking core model governs behaviour in microscale grains, then exploiting the small ratio of grain to particle lengthscales. We analyse the model asymptotically in the limits where chemical kinetics and diffusion are the rate-limiting steps.

15:00-15:30

Dynamics from a coupled chemical-thermal-microsilica particle formation model

Raquel González Fariña University of Oxford
James Oliver University of Oxford
Andreas Münch University of Oxford
Robert Van Gorder University of Otago

Abstract: Microsilica particles arise as a byproduct of silicon furnaces, created inside flames due to the combustion reaction of silicon monoxide with oxygen. These nanoparticles grow as silicon dioxide condenses on the surface of existing particles. Being able to control their size is vital since this affects the performance of the material. Thus, we present a mathematical model that relates the local thermal and chemical conditions of the furnace to the formation and growth of particles.

15:30-16:00

Electrical current distribution in the silicon furnace

Ellen Luckins University of Oxford
James Oliver University of Oxford
Colin Please University of Oxford
Robert Van Gorder University of Otago

Abstract: The energy required for the chemical reactions in a silicon furnace is provided by passing an electric current through the material, both as an electric arc, and by conducting through the partially-reacted raw materials. An appropriate spatial distribution of the electric current is important for efficient silicon production. We present models coupling the electromagnetic and thermal processes in the furnace, with particular emphasis on the electric arc.

16:00-16:30

Extreme viscosity variation in Søderberg electrodes

Alissa Kamilova University of Oxford
Ian Hewitt University of Oxford
Peter Howell University of Oxford
Ben Sloman Elkem
Aasgeir Valderhaug Elkem

Abstract: The Søderberg electrode is the most commonly used electrode system for the production of ferroalloys and calcium carbide. The viscosity of the paste, the raw material that makes the electrodes, is highly sensitive to changes in temperature, causing it to soften, flow, and bake as the temperature increases in the electrode. A coupled fluid flow and heat transfer mathematical model was derived and solved to understand the effects of the extreme viscosity variation of paste.

MS GH-1-G 10 14:30-16:30

Transport Simulations for Computer Graphics

Organizer: Ryan McClarren University of Notre Dame
Organizer: Martin Frank Karlsruhe Institute of Technology (KIT)

Abstract: The simulation of light transport is an essential problem for rendering computer graphics, and therefore of importance to the movie and game industry. The standard methods that are used are variants of the Monte-Carlo method. This session aims at bringing together researchers and practitioners from computer graphics with applied mathematicians that solve transport problems using PDE methods, in the hope that both communities can benefit from each other.

14:30-15:00

Robust and accurate filtered spherical harmonics expansions for radiative transfer

Ryan McClarren University of Notre Dame

Abstract: This talk will present that method of filtering for spherical harmonics expansions for radiation transport problems. The goal is to present the benefits of these approaches and bridge the gap to other potential application areas, including computer graphics. I will discuss the original idea of a spherical spline feature and as well as present the newer method of L1-based filters.

15:00-15:30

Transport in Correlated Media for Computer Graphics

Adrián Jarabo Universidad de Zaragoza

Abstract: We introduce a radiative framework for computer graphics, that takes into account the spatial correlation of scattering particles in media, resulting in non-exponential extinction that cannot be predicted by classic radiative transfer. We extend the Generalized Boltzmann Equation, lifting the limitations of the original formulation, including boundary conditions, mixtures of scatterers, and heterogeneity, and present a model suitable for graphics based on optical properties of the media and statistical distributions of scatterers.

15:30-16:00

Has rendering converged yet? A snapshot of known peculiarities and promising avenues in MC light transport

Tobias Zirr Karlsruhe Institute of Technology

Abstract: In computer graphics, Monte Carlo light transport has found widespread adoption due to its ability to accurately simulate complex lighting, which is crucial for photo-realistic image synthesis. The talk will detail practicability constraints and open problems in current graphics research, with a focus on questions common to all advanced techniques. The questions bear chances for progress in a more unified theory for many Monte Carlo approaches, which might be of interest outside computer graphics.

16:00-16:30

Nonclassical particle transport in heterogeneous materials

Thomas Camminady Karlsruhe Institute of Technology (KIT)

Martin Frank Karlsruhe Institute of Technology

Abstract: We are going to present a possible distribution for the distance to collision of particle that experience a non-classical and heterogeneous material where the Beer-Lambert law does no longer hold. The distribution considers the "memory" of particles; a fundamental property of non-classical transport. For the proposed distribution, sampling algorithms and numerical results will be outlined.

MS ME-0-7 10 14:30-16:30

Control and Inverse problems in PDE. Theory and applications - Part 4

For Part 1 see: MS ME-0-7 7

For Part 2 see: MS ME-0-7 8

For Part 3 see: MS ME-0-7 9

Organizer: Carlos Castro UNIVERSIDAD POLITÉCNICA DE MADRID

Organizer: Juan Antonio Barceló Universidad Politécnica de Madrid

Organizer: Fabricio Macia Universidad Politécnica de Madrid

Organizer: Cristóbal Meroño Universidad Politécnica de Madrid

Abstract: The aim of this minisymposium is to present new results in the areas of controllability and inverse problems for systems governed by partial differential equations. Bringing together both topics in a single minisymposium provides an opportunity to contrast the most recent results and techniques and estimulate collaborations between researchers coming from these areas.

14:30-15:00

Localisation of eigenfunctions and geometric control

Fabricio Macia Universidad Politécnica de Madrid

Abstract: The geometric conditions under which observability estimates for the waves and Schrödinger equations on a compact manifold hold are discussed. We will present a simple example in which observability for eigenfucntions of the Laplace operator on the manifold holds under a scrictly weaker condition than that is necessary for observability for the corresponding Schrödinger and wave equations.

15:00-15:30

Some numerical techniques for geometric inverse problems

Anna Doubova Doubova Universidad de Sevilla

Enrique Fernández-Cara Universidad de Sevilla

Pitágoras Carvalho Universidade Estadual do Piauí

Jairo Rocha Universidade Federal da Paraíba

Abstract: We will consider geometric inverse problem for some PDEs, where the goal is to determine the unknown part of the domain from an external measurements. We will focus our talk on the numerical reconstruction of the unknown domain based on the meshless method of fundamental solutions. We consider~2D and 3D problems for linear and semilinear elliptic equations and we present the results of several numerical experiments.

MS A6-1-2 10 14:30-16:30

Shape Analysis and Optimization - Part 3

For Part 1 see: MS A6-1-2 8

For Part 2 see: MS A6-1-2 9

Organizer: Welker Kathrin Helmut-Schmidt-University

Organizer: Kevin Sturm TU Wien, Institut für Analysis and Scientific

Abstract: Shape optimization is a classical topic which is of high importance in a wide range of applications, e.g., image segmentation, aerodynamic and acoustic design optimization. Analytical and computational approaches in shape optimization have a long history. In particular, challenges arise in the context of applications involving partial differential equations or uncertainties. In this minisymposia recents results in shape analysis and optimization will be presented. Topics range from stabilization of partial differential equations, over classical shape optimization and stochastic shape optimization to shape analysis.

14:30-15:00

Shape Optimization for Interface Identification Problems with Stochastic Modeling

Geiersbach Caroline University of Vienna

Kathrin Welker Helmut-Schmidt-University

Estefania Loayza Chemnitz University of Technology

Abstract: In this talk, we present a shape optimization problem constrained by a random elliptic partial differential equation. The model is motivated by an application in interface identification where coefficients and inputs are subject to uncertainty. The problem is posed as a minimization of the expectation of a random shape functional. To solve the problem, we adapt the classical stochastic gradient algorithm by Robbins and Monro (1951), and show the effectiveness of the approach numerically.

15:00-15:30

Optimum experimental design for interface identification problems

Siebenborn Martin Universität Hamburg

Tommy Etling TU Chemnitz

Roland Herzog TU Chemnitz

Abstract: We present an optimum experimental design approach for interface identification problems in diffusion processes. Starting from a shape optimization algorithm we develop a method describing optimal sensor placements in space and time. The goal is to improve the estimation precision within subspaces of the infinite dimensional, nonlinear shape space and to find shape variations of best and worst identifiability.

15:30-16:00

Discretize-then-optimize approach for PDE-constrained shape optimization problems

Loayza Estefania TU Chemnitz

Roland Herzog Chemnitz University of Technology

Ronny Bergmann Chemnitz University of Technology

Abstract: This work aims to present the novel notion of discrete shape manifold, which will allow solving PDE-constrained shape optimization problems using a discretize-then-optimize approach. This manifold will be endowed with a complete Riemannian metric that prevents mesh destruction. The computation of discrete shape derivatives and its relation with the usual approach will be discussed. Finally, we will present the application of this approach to the solution of simple 2D optimization problems.

16:00-16:30

Optimizing reliability using auto-generated structured meshes

Hahn Camilla Bergische Universität Wuppertal

Matthias Bolten University of Wuppertal

Abstract: We propose a re-meshing approach based on Composite Finite Elements. It involves re-meshing only on the boundary of a structured mesh. The resulting meshes are very regular where most of the grid and the entries of the governing PDE are not altered. At the same time, the regular structure contributes to means of efficient implementation on modern computer architectures. We show results for the optimization of failure probabilities of mechanical components under load.

MS GH-0-2 10 **14:30-16:30**

Transport phenomena on textured surfaces: mathematical modelling and applications - Part 2

For Part 1 see: MS GH-0-2 9

Organizer: Darren Crowdy Imperial College London

Abstract: In the past two decades numerous laboratories have microfabricated surfaces with the chemical and textural properties to mimic superhydrophobic surfaces (SHs) found in nature, the most well-known being the self-cleaning properties of the lotus leaf. This has been made possible by the continuing advances in nano/micro fabrication technology. This 2-part minisymposium will bring together engineers, physicists, and applied mathematicians in a multi-physics framework to discuss recent modelling advances.

14:30-15:00

Complex analysis methods in transport phenomena involving superhydrophobic surfaces

Darren Crowdy Imperial College London

Abstract: We survey recent theoretical results on the slip properties of superhydrophobic and liquid-infused surfaces obtained using the methods of complex analysis and conformal geometry. A key role will be played by the idea of "reciprocity" to gain insights into new phenomena, such as the role of meniscus curvature, subphase fluid and non-Newtonian fluid effects.

15:00-15:30

Longitudinal pressure-driven flows in shallow superhydrophobic channels

Ehud Yariv Technion

Abstract: We consider the canonical problem of pressure-driven flow between two bounding walls, each endowed with a periodic structure of shear-free stripes. Motivated by numerical observations of anomalously large velocities, we address the limit of shallow channels. Matched asymptotic expansions reveal an asymptotically large velocity enhancement. It is associated with an unconventional Poiseuille-like flow profile where the parabolic velocity variation takes place in a direction parallel (rather than perpendicular) to the boundaries.

15:30-16:00

Effect of Insoluble Surfactant on Stability of Flows over Superhydrophobic Surfaces

Michael Mayer Tufts University

Abstract: Recent work on flows over superhydrophobic surfaces has focused on increased drag caused by surfactant-induced surface tension gradients. A linear stability analysis of a linear-shear flow in Stokes regime over a transverse-ridge-type superhydrophobic surface with insoluble, surfactant-laden, flat menisci is performed. The results show the flow to be robust at high Marangoni number, with neutrally stable growth rates. More interesting results appear for small Marangoni number, which is also discussed.

16:00-16:30

Asymptotic solutions for flow in textured channels with curved menisci and thermocapillary stress

Toby Kirk University of Oxford
Georgios Karamanis Tufts University
Darren Crowdy Imperial College London
Marc Hodes Tufts University

Abstract: Pressure-driven flow through a microchannel patterned with parallel ridges is considered in the presence of heat transfer, capturing the coupled effects of curvature and thermocapillary stress along the menisci. The flow is three-dimensional and we analyse the problem using a suite of asymptotic limits and numerical solutions (CFD). The degradation/enhancement of slip due to heating/cooling is exacerbated for large meniscus protrusions, with a possible stability criteria found for strong enough heating.

MS ME-1-6 10 **14:30-16:30**

The interplay between mathematical engineering and networked control systems - Part 2

For Part 1 see: MS ME-1-6 9

Organizer: María Barbero Liñán Universidad Politécnica de Madrid
Organizer: Héctor García De Marina University of Southern Denmark
Organizer: Leonardo Colombo Instituto de Ciencias Matematicas

Abstract: The need for fast and accurate algorithms for simulations and implementations of distributed control laws in complex systems requires a multidisciplinarity and transfer of knowledge between engineering sciences, physics and mathematics. The aim of this mini-symposium is to be a crossroad to discuss new trends and challenges in control of network systems, numerical algorithms for simulations of physical and robotics systems, and their possible interactions to conduct new directions of research based on industrial needs. The mini-symposium consists of two parts: (i) Geometric Integration and Applications, and (ii) Dynamics and control of networked systems.

14:30-15:00

Distributed hybrid control of multi-robot systems under spatiotemporal specifications

Dimos Dimarogonas KTH Royal Institute of Technology

Abstract: In this talk, we review some of our recent results in applying transient control techniques, and in particular Model Predictive Control, Barrier Certificates based design and Prescribed Performance Control, to distributed multi-robot task planning under spatiotemporal specifications. We consider the case of infeasible specifications and propose a least violating control strategy as a remedy. The results are supported by relevant experimental validations.

15:00-15:30

Modelling event-based controller’s traffic for optimal controller scheduling

Manuel Mazo Delft University of Technology

Abstract: We describe a scheme to capture the possible sequences of inter-event times that event-based controllers generate. The resulting model abstractions are timed-automata, in which: transitions between discrete states represent communication events; states correspond to regions of the control system's state-space; and through guards and invariants the inter-event-behaviour is captured. The abstractions can be furthermore extended to include controllable actions, e.g. controlling an artificial delay, and even costs, opening the door to synthesize optimal schedullers.

15:30-16:00

Synchronization of phase-coupled oscillators in a frequency-dependent network

Matin Jafarian KTH Royal Institute of Technology

Abstract: We study frequency synchronization of the continuous-time Kuramoto oscillators in a bidirectional tree network and discuss the dependency of the result on the graph structure. In addition, we consider the case where the exogenous frequencies, and thus the interconnection weights, are combined with noises. We then present the notion of stochastic phase-cohesiveness based on the concept of recurrent Markov chains and studies the conditions under which a discrete-time stochastic Kuramoto model is phase-cohesive.

16:00-16:30

Distributed event-triggered control for large-scale systems

María Guinaldo Universidad Nacional de Educación a Distancia

Abstract: Different control strategies for distributed control are presented, where the transmission and control update policies are event driven to optimize the limited resources (bandwidth, energy, etc.) of networked systems. We specially focus in those systems where the number of agents or subsystems is large, and how to deal with the coupling and uncertainties that characterize the interconnection between agents.

IM FT-4-3 10 **14:30-16:30**

Geophysical Applications - Part 3

For Part 1 see: IM FT-4-3 8
For Part 2 see: IM FT-4-3 9

Organizer: Barucq Hélène Inria
Organizer: David Pardo UPV/EHU, BCAM, and Ikerbasque
Organizer: Victor Calo Curtin University

Abstract: The main objective of this minisymposia is to exchange state-of-the-art interdisciplinary knowledge on applied mathematics, high performance computing, and geophysics to be able to better simulate and understand the materials composing the Earth's subsurface. This is essential for a variety of applications such as CO2 storage, hydrocarbon extraction, mining, better understanding of earthquakes, and geothermal energy production, among others. All these problems have in common the need to obtain an accurate characterization of the Earth's subsurface, and the use of advanced mathematical algorithms is critical to achieving that endeavor. We prioritize those talks that show industrial applications in Geophysics.

14:30-15:00

Full waveform inversion using multi-components data

Florian Faucher Inria

Abstract: We study the inverse problem for time-harmonic wave in the context of seismic for subsurface Earth identification. The reconstruction follows an terative minimization algorithm, according to the Full Waveform Inversion method. Making full use of the new dual-sensors data, we define a misfit functional based upon reciprocity, that allows arbitrary positions of the computational sources. We illustrate with acoustic experiments in three dimensions, and further extend the method for elasticity.

15:00-15:30

Seismic Modeling and Imaging of 3D Multiscale Geological Media: Scalable Parallel Algorithms

Vladimir Cheverda Institute of Petroleum Geology and Geophysics

Galina Reshetova Institute of Petroleum Geology and Geophysics

Abstract: We propose a finite difference technique based on locally refined in time-and-space grids to simulate the interaction of seismic waves with hydrocarbon reservoirs. Domain Decomposition provides subdomains containing the reference medium (coarse grid) and reservoir (fine grid). The data exchange between subdomains within groups is done by iSend/iReceive commands. The data exchange between the groups is done by coupling the coarse and fine grids. The study is supported by the Russian Science Foundation project 17-17-01128.

15:30-16:00

Enhancement of unconventional oil and gas production forecasting using mechanistic-statistical modeling

Justin Montgomery MIT

Abstract: Effectively managing oil and gas resource development requires accurate production forecasts. However, the standard forecasting approach for unconventional wells is estimating parameters in a production decline curve model—an ill-posed inverse problem known to yield unreliable predictions. A hierarchical Bayesian formulation of this approach allows for better quantification of uncertainty and the ability to incorporate other physical information and historical production data to substantially improve accuracy.

MS FE-1-3 10 **14:30-16:30**

Inverse Problems in Shape and Geometry - Part 3

For Part 1 see: MS FE-1-3 8

For Part 2 see: MS FE-1-3 9

Organizer: Roland Herzog TU Chemnitz

Organizer: Bastian Harrach Goethe University Frankfurt

Organizer: Jan-Frederik Pietschmann TU Chemnitz

MS Organized by the GAMM activity group "Optimization with Partial Differential Equations" (OPDE)

Abstract: Inverse problems generally seek to determine the cause of an observation, based on some underlying model. The focus in this minisymposium is on inverse problems where the unknown cause is represented as a shape or geometry. Examples include the identification of an inclusion or the geometry of a scatterer. It is a common feature of these problems that the set of shapes does not bear the structure of a vector space. Speakers in this minisymposium will address a variety of problems, primarily based on models involving partial differential equations, and a broad range of topics spanning theory, algorithms and applications.

14:30-15:00

On finding a cavity in a thermoelastic body using a single displacement measurement over a finit time interval

Masaru Ikehata Hiroshima University

Abstract: A mathematical formulation of an estimation problem of a cavity inside a three-dimensional thermoelastic body using time domain data is considered. The governing equation of the problem is given by a system of equations in the linear theory of thermoelasticity which is a coupled system of the elastic wave and heat equations. A new version of the time domain enclosure method which is originally developed for the classical wave equation is established.

15:00-15:30

Computational framework for applying electrical impedance tomography to head imaging.

Valentina Candiani Aalto University

Nuutti Hyvönen Aalto University

Antti Hannukainen Aalto University

Abstract: We introduce a computational framework for applying absolute EIT to head imaging without accurate information on the head shape or the electrode positions. A library of fifty heads is employed to build a principal component model for the typical variations in the shape of the human head, which leads to a parametrization with only a few free parameters. The estimation of these parameters and the electrode positions is incorporated in a regularized Newton-type reconstruction algorithm.

15:30-16:00

Finding insulating and superconductive inclusions by enclosure method

Tommi Brander Norwegian University of Science and Technolog

Joonas Ilmavirta University of Jyväskylä

Manas Kar Indian Institute of Science Education and Research Bhopal

Abstract: We consider a non-linear conductivity equation in a domain with constant conductivity, but with an area of infinite or zero conductivity (an inclusion). The forward problem can be solved by variational means, without any recourse to special boundary conditions on the boundary of the inclusion. We also give a partial solution to the inverse problem of finding the inclusion: By using the enclosure method, we can estimate the convex hull by a larger convex set.

16:00-16:30

Computing the convex source support of electrical impedance tomography problems on domains with unknown geometry

Janosch Rieger Monash University

Bastian Harrach Goethe University Frankfurt, Germany

Abstract: We consider an electrical impedance tomography problem on an unknown domain that contains a known region of interest. First theoretical and numerical results suggest that it is possible to compute the convex source support associated with a voltage measurement numerically in this situation, and that this approximation indeed detects inhomogeneities in otherwise homogeneous material.

MS FE-1-G 10 **14:30-16:30**

Recent Advancements in Model Reduction for Stochastic and Nonlinear Systems - Part 2

For Part 1 see: MS FE-1-G 9

Organizer: Martin Redmann Weierstrass Institute Berlin

Organizer: Pawan Goyal Max Planck Institute, Magdeburg

Abstract: Many phenomena in real life can be described by partial differential equations. To find an accurate model, nonlinearities and uncertainties have to be taken into account along with a high order spatial discretization, leading to large-scale nonlinear/stochastic dynamical systems. As a result, it is hard to use these models in engineering studies such as control and optimization. To mitigate this issue, model order reduction (MOR) techniques are often used to reduce the order of large-scale nonlinear/stochastic systems and hence, reduce the computational complexity. In this minisymposium, we will discuss recent advances and perspectives in field of MOR for nonlinear/stochastic systems.

14:30-15:00

H2-Optimal Model Reduction for Quadratic-Bilinear Systems

Serkan Gugercin Virginia Tech

Peter Benner Max Planck Institute Magdeburg, Germany

Pawan Goyal Max Planck Institute Magdeburg, Germany

Abstract: In this talk, we show how input-independent (optimal) H2-based model reduction can be extended from linear to quadratic-bilinear (QB) nonlinear dynamical systems. We establish a truncated H2-norm for QB systems, and then derive the optimality conditions for approximation in this norm, leading to an iterative algorithm to form a reduced model to approximately satisfy the optimality criterion. Various numerical examples illustrate the effectiveness of the method and its superiority over trajectory-based approaches such as POD.

15:00-15:30

Faster point selection schemes for masked nonlinear model reduction

Ralf Zimmermann University of Southern Denmark

Abstract: As a rule, model reduction via projection-based approaches fails to provide considerable savings if applied to nonlinear systems. This is alleviated by masked projection approaches, such as the MPE and the (oversampled) (D)EIM, where the evaluation of the nonlinearities is reduced to a few selected “magic points”. Yet, the costs of selecting suitable magic points may even surpass those of a full model simulation. In this talk, we discuss ideas for an accelerated point selection.

15:30-16:00

Hilbert space techniques in the theory of balanced truncation

Simon Becker Cambridge University
Hartmann Carsten BTU Cottbus

Abstract: In this talk I will present an extension of the balanced truncation model order reduction method for both finite and infinite-dimensional linear systems to bilinear, stochastic system, and delay systems. Our framework, which uses a new decomposition of the gramians, allows us to get error bounds on the dynamics and transfer functions of the truncated system and prove convergence results. This is joint work with Carsten Hartmann.

16:00-16:30

Model Reduction for Stochastic Bilinear Systems

Martin Redmann Weierstrass Institute for Applied Analysis and Stochastics

Abstract: We investigate a large-scale stochastic system with bilinear drift and linear diffusion term which can represent a semi-discretized SPDE. We apply model order reduction to reduce the order of the spatially-discretized system and hence reduce computational complexity. We identify states which contribute only very little to the system dynamics and remove these states in order to obtain a reduced order model. We present an L^2-error bound for the approach and illustrate its performance.

MS A6-4-3 10 14:30-16:30

Stochastic models for power markets

Organizer: Michael Ludkovski UC Santa Barbara
Organizer: Alvaro Cartea Oxford U

Abstract: The electricity generation, distribution and retail markets are undergoing rapid changes due to a confluence of factors. Widespread renewable electricity generation, electronic trading markets, new past-the-meter demand response capabilities, and decentralized grid management all raise a host of novel quantitative challenges. The minisymposium will present the latest developments in stochastic modeling of electricity markets, ranging from contract design to optimal trading to numerical methods. ** This minisymposium is sponsored by the SIAG/FME **

14:30-15:00

A Principal--Agent approach for Electricity Capacities compensation design

Clemence Alasseur Electricite de France

Abstract: We propose a Principal-Agent approach for electricity capacities compensation design. The Principal represents the aggregation of electricity consumers subject to the physical risk of blackout, and the Agent represents the electricity capacity owners, who are subject to financial risks. Following Cvitanic et al. (2017), we propose an optimal contract, from consumers’ perspective, which incentivizes both parties to perform an optimal level of investments while sharing the physical and financial risks.

15:00-15:30

A Fundamental Model for Continuous Intraday Electricity Trading of 15-Minute Contracts

Marcel Kremer University of Duisburg-Essen
Ruediger Kiesel University of Duisburg-Essen
Florentina Paraschiv Norwegian University of Science and Technology

Abstract: We develop a fundamental model for the German continuous intraday electricity market of 15-minute contracts. A threshold regression model is used to examine how 15-minute intraday trading depends on the slope of the merit order curve. Empirical evidence suggests (i) mean reversion in the price formation process, (ii) strong explanatory power of prices of neighboring contracts, (iii) an asymmetric effect of renewable forecasts, (iv) that trade data are the main driver of 15-minute intraday trading.

15:30-16:00

Optimal cross-border electricity trading

Maria Flora Universita di Verona
Alvaro Cartea University of Oxford
Tiziano Vargiolu University of Padova
Georgi Slavov Marex Spectron Ltd

Abstract: We show that electricity flows between interconnected locations have a direct and indirect impact on electricity prices in various locations. We solve the optimal control problem of an agent who uses the interconnector to take positions in a subset of locations that are part of the interconnected network. We obtain the optimal electricity trading strategy in closed-form, and show that including the price impact in the model significantly improves the performance of the strategy.

16:00-16:30

Stochastic Control Problems for Electricity Microgrid Management

Michael Ludkovski UC Santa Barbara
Aditya Maheshwari UC Santa Barbara
Alessandro Balata Leeds U
Jan Palczewski Leeds U

Abstract: We discuss the dynamic emulation algorithm (DEA) for microgrid management, where the controller optimizes dispatch of a diesel generator while maintaining low probability of blackouts. DEA is a regression Monte Carlo method that employs statistical learning techniques, especially Gaussian process regression. We incorporate learning the implicit admissible control sets implied by local probabilistic constraints through adding a logistic or quantile regression module to DEA. Results are illustrated with two case-studies and extensive numerical benchmarks.

MS ME-1-4 10 14:30-16:30

Modeling signal transduction/gene regulatory networks - Part 2

For Part 1 see: MS ME-1-4 9

Organizer: Tomas Gedeon Montana State University
Organizer: Konstantin Mischaikow Rutgers University

Abstract: The minisymposium will provide an overview of the current state of modeling signal transduction/gene regulatory network dynamics. It will also serve as a meeting point of different approaches to modeling of dynamics of these complex systems, ranging from Boolean networks to parameterized models of ordinary differential equations. Specific challenges of biological networks including lack of first principle models and the existence of large numbers of parameters that are difficult to identify from experiments will be discussed.

14:30-15:00

Ramps and steps as models of gene regulation and biochemical kinetics.

Roderick Edwards University of Victoria
Graham Quee University of Victoria

Abstract: Gene regulation and biochemical networks are usually modelled using Michaelis-Menten or Hill function interactions, producing high-dimensional nonlinear systems. A well-explored qualitative approach to aid analysis is to approximate steep Hill functions by step functions, but this leads to mathematical difficulties with discontinuous vector fields. Here we explore an alternative approach using ramp functions instead of step functions, which are continuous, and better approximate Michaelis-Menten and not-so-steep Hill interactions.

15:00-15:30

Reconciling qualitative and abstract (and scalable) modeling of biological regulatory

Loïc Paulevé CNRS, LaBRI

Abstract: Boolean networks are a widely used framework to model the qualitative dynamics of biological networks. They require little parameters and hence aim at offering robust predictions. However, we show that the traditional interpretation of Boolean networks with asynchronous or synchronous updates can miss important behaviours, hence tempering predictions. We propose a new interpretation of Boolean networks which captures all behaviours achievable in any quantitative refinements, with a much lower computational complexity.

15:30-16:00

Analysis of complex genetic-metabolic networks with piecewise affine models

Madalena Chaves	INRIA

Abstract: Interactions between gene regulatory networks and metabolism may lead to complex dynamics. Using a qualitative formalism based on piecewise linear models, we will characterize a regulatory mechanism that drives the emergence of periodic oscillations in metabolic networks subject to genetic feedback regulation. For a pathway that closely resembles the "metabolator" synthetic circuit, we prove the existence of two co-existing oscillatory behaviors: damped oscillations towards a fixed point or sustained oscillations along a periodic orbit.

16:00-16:30

A comprehensive study of hysteresis in three node gene regulatory networks

Shane Kepley	Rutgers University
Marcio Gameiro	
Tomas Gedeon	
Konstantin Mischaikow	

Abstract: A computational framework known as Dynamic Signatures Generated by Regulatory Networks (DSGRN) has been developed which makes it possible to compute coarse global dynamics over large regions of parameter space. We employed DSGRN to exhaustively compute the coarse global dynamics across all parameter values, for a large class of three node networks. The robustness of each network is scored providing a database of 3 node building blocks which are robust promoters of hysteresis.

MS ME-1-I1 10 14:30-16:30

Data-driven modeling of complex dynamical systems - Part 3

For Part 1 see: MS ME-1-I1 8

For Part 2 see: MS ME-1-I1 9

Organizer: Steven Brunton	University of Washington
Organizer: Themis Sapsis	MIT
Organizer: Jared Callaham	University of Washington

Abstract: Advances in machine learning are driving progress across science and engineering. Increasingly, these methods are used to analyze, predict, and control dynamical systems from measurement data. However, real-world data still presents a challenge because of rare phenomena, multiscale dynamics, noise, and latent variables. Moreover, many modern techniques in machine learning provide powerful representations based on data, but offer limited interpretability and generalizability. Thus, there is a tremendous opportunity to bring physics and machine learning closer together to address these fundamental challenges. This minisymposium brings together experts in data-driven dynamical systems to explore challenges and progress on these real-world issues.

14:30-15:00

Unsupervised identification of dominant balance regimes

Jared Callaham	University of Washington
J. Nathan Kutz	University of Washington
Steven L. Brunton	University of Washington

Abstract: Accurate and interpretable models are critical for understanding and interacting with complex systems. Although highly reliable, detailed physics models are themselves often complicated enough to defy straightforward analysis. A historically successful approach has been to identify limiting regimes in which the dynamics are determined by a dominant balance between terms in the model. We generalize this intuition by using recent model discovery and machine learning methods to search for distinct dynamical regimes in such systems.

15:00-15:30

Probabilistic modeling of physical systems with adversarial deep learning

Paris Perdikaris	University of Pennsylvania
Yibo Yang	University of Pennsylvania

Abstract: We present a deep learning methodology that enables the construction of predictive data-driven surrogates for stochastic systems. Leveraging recent advances in variational inference, we put forth a scalable computational framework for discovering surrogate models from paired input-output observations of a system that may be stochastic in nature, originate from different information sources of variable fidelity, or be corrupted by complex noise processes. We also show how physical constraints can be employed as informative priors.

15:30-16:00

Data-driven modeling of the spatio-temporal evolution of geophysical turbulence

Pedram Hassanzadeh	Rice
Ashesh Chattopadhyay	Rice University
Krishna Palem	Rice University
Devika Subramanian	Rice University

Abstract: An echo state network (ESN) and a convolutions auto-encoder (CAE) are used for data-driven spatio-temporal prediction of two prototypes of geophysical turbulence: an extended Lorenz 96 system and a two-layer quasi-geostrophic model. In both cases, the training only used partial observations of the past states. The importance of incorporating some constraints from the governing equations in the data-driven framework is explored and potentials for integrating the two approaches (ESN+CAE) are discussed.

16:00-16:30

Rare event simulation in nonlinear dynamical systems via the Koopman operator

Ben Zhang	MIT
Tuhin Sahai	United Technologies Research Center
Youssef Marzouk	Massachusetts Institute of Technology

Abstract: We explore using eigenfunctions of the stochastic Koopman operator (SKO) to construct efficient importance sampling estimators for stochastic differential equations (SDEs). Statistics of SDEs are often found via Monte Carlo simulation. These statistics are governed by the Kolmogorov backward equation, which has the SKO as its PDE operator. Furthermore, it is well-known that having solutions to the backward equation can lead to low-variance estimators. By combining these concepts, we compute rare event probabilities efficiently.

MS FT-S-8 10 14:30-16:30

Numerical linear algebra advances for inverse problems and data assimilation - Part 3

For Part 1 see: MS FT-S-8 8

For Part 2 see: MS FT-S-8 9

Organizer: Melina Freitag	University of Bath
Organizer: Nancy K Nichols	University of Reading
Organizer: Alison Ramage	University of Strathclyde
Organizer: Silvia Gazzola	University of Bath

MS Organized by: SIAG/LA

Abstract: The solution of inverse problems and data assimilation requires efficient algorithms and tools from large scale linear algebra. The aim of this minisymposium is to present new developments in theory and numerical methods for inverse problems and data assimilation problems, including regularisation techniques, iterative solution methods, Krylov methods, preconditioning methods, reduced order modelling, and statistical approaches to inverse problems.

14:30-15:00

A low-rank approach to the solution of weak constraint variational data assimilation problems

Melina Freitag	University of Bath
Daniel Green	University of Bath

Abstract: Weak constraint four-dimensional variational data assimilation is an important method for incorporating data into a model. The system arising within the minimisation process can be formulated as a saddle point problem. In this talk, we present a low-rank approach which exploits the structure of this system using techniques and theory from solving matrix equations. Numerical experiments with the linear advection-diffusion equation, and the nonlinear Lorenz-95 model demonstrate the effectiveness of a low-rank Krylov subspace solver.

15:00-15:30

Multilevel preconditioning for data assimilation with 4DVar

Alison Ramage	University of Strathclyde
Igor Gejadze	IRSTEA, Montpelier, France
Kirsty Brown	University of Strathclyde

Abstract: The 4D-Var method is frequently used for variational data assimilation problems in applications like numerical weather prediction and oceanographic modelling. One key challenge is that the state vectors used in realistic applications contain a very large number of unknowns so it can be impossible to assemble, store or manipulate the matrices involved explicitly. We present a multilevel limited-memory approximation to the inverse Hessian and illustrate its effectiveness as a preconditioner within a Gauss-Newton iteration.

15:30-16:00

Conditioning, reconditioning and preconditioning of the data assimilation problem

Nancy Nichols	University of Reading
Jemima Tabeart	University of Reading
Sarah Dance	University of Reading
Amos Lawless	University of Reading
Joanne Waller	University of Reading

Abstract: Data assimilation aims to find the maximum a posteriori Bayesian estimate of the state of a very large dynamical system given partial observations of the system. The conditioning of the problem, and hence the computational work needed to solve it, depends strongly on the statistics of the errors in the observations and in the prior estimate of the state. Here we examine techniques for improving the conditioning of the problem.

16:00-16:30

An algebraic construction of data-consistent approach for statistical inverse problems

Thanh Tan Bui — The University of Texas

Abstract: Bayesian prior can be understood as a regularization that penalizes parameters uninformed by the data. Ideally it should not interfere with well-informed parameters. Unfortunately, well-informed parameters are not known a priori and none of the existing prior elicitation approaches could avoid polluting data-informed directions in the parameter space. We tackle the challenge by deriving a data-consistent approach, that automatically prevents any prior from regularizing the well-informed parameter directions. Our derviation and analysis is purely algebra.

MS GH-3-2 10 **14:30-16:30**

Sensitivity Analysis in Computationally Intensive Applications - Part 2

For Part 1 see: MS GH-3-2 9

Organizer: Joseph Hart — Sandia National Laboratories

Organizer: Bart Vanbloemenwaanders — Sandia National Laboratories

MS Organized by: SIAG/CSE

Abstract: Many problems in engineering and science involve both computationally intensive models and high dimensional parametric uncertainty. This combination creates numerous challenges for practitioners seeking to design robust and reliable systems. This minisymposium will focus on methodological advances and applications of sensitivity analysis and dimension reduction techniques, with an emphasis on computational scalability. The role of sensitivity analysis and dimension reduction will be considered in a broader analysis and design workflow. This may include, but not be limited too, robust and risk-averse optimization, surrogate modeling, forward propagation of uncertainties, rare event simulation, inverse problems, and optimal experimental design.

14:30-15:00

Entropic variable boosting for stress models in sensitivity analysis

Jean-Michel Loubes — Université Toulouse

Abstract: In this paper, we present a new explainability formalism to make clear how each covariate impacts the predictions given by black-box decision rules.

15:00-15:30

Gradient based methods for nonlinear dimensionality reduction

Olivier Zahm	INRIA
Daniele Bigoni	MIT
Youssef Marzouk	MIT
Clémentine Prieur	Université Grenoble Alpes

Abstract: We propose gradient-based methods to detect and exploit the low-effective dimension of a multivariate function, meaning when the function is essentially constant along a subpace of the input parameter domain. Our methodology consists in minimizing an upper-bound of the approximation error obtained via Poincaré-type inequalities. We then explain how this methodology naturally extends to nonlinear dimension reduction, e.g. when the function is not constant along a subspace but along a low-dimensional manifold.

15:30-16:00

Hyper-differential sensitivity analysis for PDE-constrained optimization: Applications

Bart Vanbloemenwaanders — Sandia National Laboratories

Abstract:
Hyper-differential sensitivities (HDS) analyze the dependence of PDE-constrained optimization solutions to parameter perturbations. Such analysis may be used to prioritize uncertainties in the service of data acquisition, uncertainty quantification, and model development. HDS is demonstrated (1) to prioritize the influence of uncertain boundary conditions and material properties on control strategies, (2) to analyze the stability of optimal solutions under uncertainty, and (3) to augment optimal experimental design for data acquisition.

MS FE-1-1 10 **14:30-16:30**

Numerical methods for multi-physics coupled problems - Part 2

For Part 1 see: MS FE-1-1 9

Organizer: Xiaoming Wang — Southern University of Science and Technology

Abstract: Many natural, science and engineering problems involve multi-physics leading to coupled systems. Well-known examples include the coupled atmosphere-ocean system, the surface-groundwater system, fluid-structure interaction among many others. These systems are usually very complex and highly nonlinear. Numerical methods is one of the primary tools in studying the behavior of such kind of systems. The efficient and accurate numerical treatment of such problems is usually a challenge due to their multi-physics, multi-scale and coupled nature. The goal of this minisymposium is to convene a few experts in the area to showcase recent advances and discuss future directions.

14:30-15:00

BOundary Update via Resolvent for fluid-structure interaction

Catalin Trenchea	University of Pittsburgh
Martina Bukac	University of Notre Dame

Abstract: We propose a BOundary Update using Resolvent (BOUR) partitioned method, second-order accurate in time, unconditionally stable, for the interaction between a viscous, incompressible fluid and a thin structure. The energy based stability analysis shows that the scheme is unconditionally stable. Error analysis of the semi-discrete problem yields second-order convergence in time. The two numerical examples confirm the theoretical convergence analysis results and show an excellent agreement of the proposed partitioned scheme with the monolithic scheme.

15:00-15:30

Adaptive methods for fluid-fluid interaction

Jeffrey Connors	University of Connecticut
Robert Dolan	University of Connecticut

Abstract: A heat convection model for two fluids coupled across an interface is used to investigate adaptive time stepping, motivated by air-sea interaction for climate, regional modeling or weather forecasting applications. A condition is derived to detect coupling instabilities, which provides a criterion for adaptivity. Computational examples illustrate the effects of varying the approximation order for the coupling, changing the length of a coupling interval and tightening the coupling via iteration.

15:30-16:00

Dynamic draft under constant environmental conditions

Óscar Crego Martínez Martínez	University Of Santiago De Compostela
Alfredo Bermúdez	Univ. of Santiago de Compostela
Andrés Prieto	Univ. of Santiago de Compostela

Abstract: In thiswork,we will describe the solid-fluid coupled model which allowus to compute the position of the vessel along the wave join with the improvements to simulate some effects as the squat effect and the motion of the vessel. Also we will show some numerical difficulties that appear to solve the problem, as the calibration of some model parameters or the unboundedness of the domain. Finally, we will show some realistic examples.

MS A6-3-2 10 **14:30-16:30**

Mean Field Games: Theory and Applications - Part 2

For Part 1 see: MS A6-3-2 9

Organizer: Yuchong Zhang — University of Toronto

Organizer: Ruimeng Hu — Columbia University

MS Organized by: SIAG/FME

Abstract: The mean-field game(MFG) theory is the study of decision making/equilibria in games with infinitely many small players interacting through the distribution of the entire system. It provides a useful approximation for many otherwise intractable large-scale systems. Over the past decade, MFG models have become increasingly prevalent in mathematical finance, economics and a variety of other social-scientific and engineering disciplines. Recent development has been made in MFGs with branching, impulse control, aggregation,etc.,and in the study of solvability and convergence. The objective of this mini-symposium is to facilitate the exchange of ideas and recent developments. **This mini-symposium is sponsored by the SIAG/FME**.

14:30-15:00

Learning MFGs

Xin Guo University of California, at Berkeley

Abstract: We formulate a class of MFGs with unknown rewards and unknown dynamics as a generalized mean-field-game (GMFG), with incorporation of action distributions. We first analyze the existence of the solution to this GMFG, and show that naively combining Q-learning with the three-step fixed- point approach in classical MFGs yields unstable algorithms. We then propose an alternating approximating Q-learning algorithm and establish its rate of convergece, along with numerical perofrmance.

15:00-15:30

Fine Properties of the Optimal Skorokhod Embedding Problem

Marcel Nutz Columbia University

Abstract: We study the problem of stopping a Brownian motion at a given distribution ν while optimizing a reward function. (1) We establish that the set of stopping times embedding ν is weakly dense in the set of randomized embeddings. (2) We establish existence of dual solutions as well as absence of a duality gap. (Joint work with Mathias Beiglbock and Florian Stebegg)

15:30-16:00

Periodic solutions in Mean-Field Games with aggregation

Marco Cirant Università di Padova

Abstract: Mean-Field Game systems describe the collective behaviour of a large population of rational agents in a noisy environment. Assuming that individuals aim at aggregating, we discuss the existence of equilibria that qualitatively exhibit a periodic behaviour in time. We will show how local and global bifurcation methods lead to the existence of such equilibria, with a focus on the analysis of the space-time Fourier coefficients of the linearized PDE system, and some numerical experiments.

16:00-16:30

Mean field game in Principal-Agent problem

Zhenjie Ren Université Paris-Dauphine
Kaitong Hu Ecole Polytechnique Paris
Junjian Yang TU Wien

Abstract: We shall review the dynamic programming approach to solve the Principal-Agent (moral hazard) problem, and naturally observe that when the number of the agents or/and that of the principals goes to infinity and if their dynamics have mean-field interactions, it will lead to a mean field game. We shall mainly discuss a model connected to the mean field planning problem, and the other one where one agent can choose to work for different principals.

MS GH-0-1 10 14:30-16:30

Phase field method and applications in biology and materials science - Part 2

For Part 1 see: MS GH-0-1 9

Organizer: Lei Zhang Peking University
Organizer: Yasumasa Nishiura Tohoku University

Abstract: The phase field method is a powerful mathematical approach for solving interfacial problems. It has become an important and extremely versatile technique for modeling and simulating microstructure evolution at the mesoscale, such as phase transformations, vesicle dynamics, solidification dynamics, crack propagation and so on. We will present recent progress of numerical methods for various phase field models and share its new applications in biology and materials science.

14:30-15:00

Defects and the Dynamics of Liquid Crystals

Yucheng Hu Tsinghua University

Abstract: Two commonly used continuous models for liquid crystals are the Oseen-Frank model and the Landau-de Gennes model. Non-orientable configurations cannot be described by the Oseen-Frank model because the model does not respect the head-to-tail symmetry. In this talk we will first show that, for confined liquid crystals, the phase transition processes predicted by the two models may be quite different. Then we will discuss how to restore the head-to-tail symmetry in vector-based models.

15:00-15:30

Mathematical Model of Step Dynamics on Growing Crystal Surface

Ryo Kobayashi Hiroshima University
Hitoshi Miura Nagoya City University

Abstract: Allen-Cahn equation is a basic equation describing phase transition in which the driving force is constant, thus reproduce only simple patterns. If it is coupled with the diffusion equation with latent heat term, it can reproduce such complex patterns as dendrites. On the other hand, if we set the space where the equation runs somewhat complex, it can exhibit various beautiful patterns corresponding to the step dynamics of growing crystals.

15:30-16:00

Shape representation of cells and phase field method

Masakazu Akiyama Hokkaido University

Abstract: In morphogenesis, there are various ways of expressing shapes, such as reaction-diffusion systems, Vertex Dynamics Model, particle methods. Recently, the method of expression using Phase Filed method has been used. On the other hand, it is known that morphogenesis occurs when cell clusters are enveloped in certain membranes. Therefore, in order to calculate such phenomena, we developed a new method combining the particle method and the phase filed method.

MS A6-2-2 10 14:30-16:30

Bohemian Matrices and Applications - Part 2

For Part 1 see: MS A6-2-2 9

Organizer: Nicholas Higham University of Manchester, Uk
Organizer: Rob Corless Western University

Abstract: Bohemian matrices are matrices with entries drawn from a fixed discrete set of small integers (or some other discrete set). The term is a contraction of BOunded HEight Matrix of Integers. Such matrices arise in many applications, and include (0,1) graph incidence matrices and (-1,1) Bernoulli matrices. The questions of interest range from identifying structures in the spectra of particular classes of Bohemian matrix to searching for most ill conditioned matrices within a class, and applications include stress-testing algorithms and software. This minisymposium will report recent theoretical and computational progress as well as open questions.

14:30-15:00

Bohemian Matrices in MATLAB

Cleve Moler MathWorks

Abstract: Bohemian Matrices in MATLAB Hilbert, Laplacian, Morse, Rosser, Frank, PageRank, Wilkinson, Kahan, Parter — these are a few of the test matrices we have available in MATLAB. I will describe some of their familiar, and not so familiar, properties.

15:00-15:30

Symbolic computation treatment of Bohemian matrices

J. Rafael Sendra Universidad de Alcalá
Tiam Koukpari University of Western Ontario

Abstract: An important issue in nowadays research in Bohemian matrices is the development of experiments that could help to conjecture properties of this type of matrices. When the population of entries is finite, and the size of the matrix is fixed, the experiments can be performed by testing the finitely many (usually huge) examples. In this talk we will discuss and illustrate how symbolic computation techniques may be used in the design of these experiments.

15:30-16:00

Investigation of Numerical Stability of Algebraic Linearizations

Eunice Chan Western University

Abstract: Chan et al. introduced a new construction of linearizations to solve matrix polynomials of the form $za(z)b(z) + c$. We will be giving the preliminary results of the backward stability of the solutions given by this new linearization using one of the techniques given by Higham et al. (2007), which perturbs the coeffients of the matrix polynomials and sees how much the solutions change. We hope to find the upper bound of the backward error.

16:00-16:30

Companion rings and their applications to algebraic topology and group theory

Vanni Noferini	University of Essex
Gerald Williams	University of Essex

Abstract: Various properties of the abelianization of a cyclically presented group can be deduced by the Smith normal form of an integer circulant matrix. Motivated by this, we present various results on the Smith form of matrices that are polynomials in the companion matrix of a polynomial with coefficients in an elementary divisor domain. Applications will be discussed: most notably, we exactly compute homologies of 3-dimensional Brieskorn manifolds, which are objects of interest for algebraic topologists.

MS FT-1-SG 10 14:30-16:30

Numerical methods for hyperbolic problems and applications - Part 3

For Part 1 see: MS FT-1-SG 8
For Part 2 see: MS FT-1-SG 9

Organizer: Pep Mulet	Universitat de València
Organizer: Antonio Baeza	Department of Mathematics, University of Valencia

Abstract: First-order hyperbolic PDE systems appear in many scientific areas. The importance of obtaining good numerical approximations to their solutions is therefore crucial in these circumstances, since a closed solution is usually impossible to obtain when the equations are not linear. Due to the development of discontinuities in nonlinear hyperbolic systems, numerical methods for their approximate solution must have certain characteristics to ensure convergence to the right weak solutions. This minisymposium will be devoted to works that deal with different aspects of the design and analysis of these schemes, with special emphasis in obtaining high order of accuracy.

14:30-15:00

WENO reconstructions of unconditionally optimal high order

Pep Mulet	University of Valencia
David Zorío	Universidad de Concepción, Chile
Antonio Baeza	Universitat de València, Spain
Raimund Bürger	Universidad de Concepción, Chile

Abstract: We present a modified Weighted Essentially Non-Oscillatory reconstruction technique that prevents accuracy loss near critical points. This approach only uses local data from the reconstruction stencil and does not rely on any sort of scaling parameters. The key novel ingredient is a non-dimensional and scale-independent weight design based on a new smoothness indicator, which defines the first WENO reconstruction procedure that never loses accuracy on smooth data.

15:00-15:30

High order numerical schemes for linear elasticity and dynamic rupture propagation

Maurizio Tavelli	University of Trento
Michael Dumbser	University of Trento
Evgeniy Romenskiy	University of Trento
Simone Chiocchetti	University of Trento

Abstract: We solve the linear elasticity equations in complex geometries using two different approaches. In the first part we present a new high order DG scheme for linear elasticity on staggered unstructured meshes. In the second part, we address the problem of complex geometries with a novel diffuse interface method on adaptive Cartesian meshes. Finally, we will move to the Godunov, Peshkov and Romensky model in order to describe non-linear elasto-plastic phenomena such as dynamic rupture.

15:30-16:00

Optimal definition of the nonlinear weights in multidimensional Central WENOZ reconstructions

Isabella Cravero	University of Turin
Matteo Semplice	Dipartimento di Matematica, Università di Torino
Giuseppe Visconti	RWTH Aachen University

Abstract: Central WENO reconstruction procedures have shown good performances in finite volume and finite difference schemes for hyperbolic conservation and balance laws. Their most recent formulations include WENOZ-type nonlinear weights, based on an additional smoothness indicator τ. This is a linear combination of the WENO indicators. We introduce results on the asymptotic expansion of multi-dimensional Jiang-Shu smoothness indicators for the rigorous design of CWENOZ schemes and we discuss optimal definition of τ for the CWENOZ schemes.

16:00-16:30

Third order WENO scheme with optimal accuracy near critical points

David Zorío	University of Concepción
Antonio Baeza	Universitat de València
Raimund Bürger	Universidad de Concepción
Pep Mulet	Universitat de València

Abstract: A novel third order Weighted Essentially Non-Oscillatory (WENO) scheme, attaining unconditionally third order accuracy when the data is smooth enough, even in presence of critical points, and second order accuracy if a discontinuity crosses the data, is presented. Numerical experiments show that this scheme is more efficient in terms of the CPU cost/error ratio than its traditional third order counterparts, as well as several higher order WENO schemes that are found in the literature.

MS A1-1-3 10 14:30-16:30

Deep Learning and Inverse Problems - Part 2

For Part 1 see: MS A1-1-3 9

Organizer: Joana Grah	Graz University of Technology
Organizer: Felix Lucka	CWI & UCL
Organizer: Martin Benning	University of Cambridge

Abstract: In recent years, we have seen an extensive interest in incorporating deep learning techniques to solve a variety of classical inverse problems. In the majority of cases, these methods have empirically proven to outperform previous state-of-the-art methods based on variational, PDE-related and statistical approaches. However, a significant drawback of deep learning is its incomplete mathematical theory and a lack of profound understanding of its superior performance but also of its limitations. In this minisymposium, leading researchers will discuss how to close these gaps in order to bridge the theories of deep learning and inverse problems.

14:30-15:00

Learning the invisible in inverse problems

Gitta Kutyniok	Technische Universität Berlin

Abstract: We will demonstrate the success of hybrid approaches, while focussing on the problem of limited-angle computed tomography. We will develop a solver for this severely ill-posed inverse problem by combining the model-based method of sparse regularization by shearlets with the data-driven method of deep learning. Our approach is faithful in the sense that we only learn the part which cannot be handled by model-based methods. We then show that our algorithm significantly outperforms previous methodologies.

15:00-15:30

Deep neural networks motivated by PDEs

Lars Ruthotto	Emory University

Abstract: This talk bridges the gap between partial differential equations (PDEs) and convolutional neural networks (CNNs). The talk outlines how this interpretation can improve the effectiveness of deep neural networks. First, the talk introduces new types of neural networks inspired by parabolic, hyperbolic, and reaction-diffusion PDEs, respectively. Second, the talk outlines how to accelerate training by exploiting multi-scale structures or reversibility properties of the underlying PDEs.

15:30-16:00

A Projectional Method for Inverse Problems

Sören Dittmer	University of Bremen
Peter Maass	Uni Bremen

Abstract: Recently the field of inverse problems has seen a growing usage of mathematically only partially understood learned and non-learned priors. We present a projectional approach to inverse problems which addresses the incorporation of these priors, while still guaranteeing data consistency. We show the application of this projectional method via Plug-and-Play priors and via an end-to-end training approach.

16:00-16:30

Learning reconstruction schemes for 3D clinical CT

Erich Kobler	Graz University of Technology
Ricardo Otazo	Memorial Sloan Kettering Cancer Center
Thomas Pock	Graz University of Technology

Abstract: In this presentation we show our latest results on learning reconstruction schemes for 3D clinical CT. We motivate our approach by the popular Variational Networks (VNs) that have been successfully applied to various inverse problems and link variational methods and deep learning. We show how VNs can be applied to 3D clinical CT reconstruction. Moreover, we motivate novel modeling and training strategies that enable an efficient training by splitting regularization and data consistency updates.

MS FT-1-10 10 14:30-16:30

Some modern questions in the simulation of advection dominated problems - Part 3

For Part 1 see: MS FT-1-10 7
For Part 2 see: MS FT-1-10 8

Organizer: Remi Abgrall	University of Zurich
Organizer: Guglielmo Scovazzi	Duke university
Organizer: Mario Ricchiuto	INRIA

Abstract: We propose a mini symposium about modern trends in the simulation of advection dominated problems, in particular fluid dynamics (classical, MHD, etc) when compressibility cannot be ignored: How to produce good meshes, especially for high order simulation in complicated geometries where curved meshes are needed There is a debate about body fitted methods versus non body fitted ones: where do we stand? The control of the numerical dissipation: energy/entropy stable, adaptation vs no adaptation, What is a solution: classical weak solutions vs statistical solutions, More recent paradigms: could machine learning tools bring something to this field ?

14:30-15:00

Sharp-interface methods for compressible multi-phase flow including heat conduction phenomena

Christoph Mueller	University of Stuttgart
Claus-Dieter Munz	University of Stuttgart

Abstract: Sharp-interface methods for compressible multi-phase flow allow a detailed description of the phase interface. We present an algorithm to couple both phases that incorporates flow dynamics, surface tension and heat transfer. It is used in a ghost-fluid, level-set method and is based on a hyperbolic model for compressible flow with heat transfer, the Godunov-Peshkov-Romenski model. Problems that are dominated by heat transfer across the interface are considered.

15:00-15:30

On the Connection between Residual Distribution and Flux Reconstruction and their Application

Philipp Öffner	University of Zurich
Rémi Abgrall	University of Zurich
Élise Delphine Le Mélédo	University of Zurich

Abstract: We are considering the connection between the Residual Distribution Schemes (RD) and the Flux Reconstruction (FR) approach. We demonstrate that flux reconstruction can be recast into the RD framework and vice versa. Because of this close connection we are able to apply known results from RD schemes to FR methods. We concentrate on entropy stability and show how to construct entropy stable FR schemes. We finish by showing some first simulations on polygon meshes.

15:30-16:00

On the low Mach number limit of the Active Flux scheme

Barsukow Wasilij	Universität Zürich
Jonathan Hohm	Wuerzburg University
Christian Klingenberg	Wuerzburg University
Philip L. Roe	University of Michigan

Abstract: The Active Flux scheme is a finite volume scheme with continuous reconstruction. The intercell flux is obtained using additional degrees of freedom distributed along the cell boundary thus making it higher order. For their time evolution an exact or approximate evolution operator is employed, which ensures the correct direction of information propagation and provides stability. The Active Flux scheme for linear acoustics is low Mach number compliant without the need for any fix.

16:00-16:30

High order ADER schemes for a unified first order hyperbolic formulation of Newtonian and general relativistic continuum physics

Evgeniy Romenskiy	University of Trento
Michael Dumbser	Laboratory of Applied Mathematics, University of Trento, Italy
Ilya Peshkov	Institut de Mathématiques de Toulouse, Université Toulouse III, France
Francesco Fambri	Laboratory of Applied Mathematics, University of Trento, Italy
Olindo Zanotti	Laboratory of Applied Mathematics, University of Trento, Italy

Abstract: We present high order accurate finite volume and discontinuous Galerkin schemes for the solution of a new unified symmetric hyperbolic and thermodynamically compatible formulation of Newtonian continuum physics, including a general description of fluid and solid mechanics and electrodynamics. We then extend this new model to full general relativity. In the last part of the talk we introduce a new, strongly hyperbolic first order reduction of the Einstein field equations and present some numerical results.

IM FT-4-1 10 14:30-16:30

Societal Impact of Industrial Mathematics and Supporting Infrastructures Worldwide - Part 3

For Part 1 see: IM FT-4-1 8
For Part 2 see: IM FT-4-1 9

Organizer: Manuel Cruz	PT-MATHS-IN | LEMA-ISEP/IPP
Organizer: Carlos Parés Madroñal	Universidad de Málaga

Abstract: The minisymposium "Societal Impact of Industrial Mathematics and Supporting Infrastructures Around the World" is intended to present to the attendees in which different ways several infrastructures around the world help to manage, aggregate, disseminate and help to develop industrial mathematics all over the world. Bringing together infrastructures from different countries and regions, with diverse realities we aim to form a common platform of understanding and promote new synergies. Also, by sharing the different experiences is expected to bring new insights of how industrial mathematics infrastructures can be more efficient in boosting the technological transfer between mathematics and industry.

14:30-15:00

The Society of Industrial and Applied Mathematics (SIAM) – More than 50 Years of Serving Industry

James Crowley	Society for Industrial and App
Amr El-Bakry	ExxonMobil Upstream Research Co.

Abstract: We will present SIAM efforts in serving industrial mathematics in the United States and around the worlds since its inception in 1952. In particular, we will focus on services that the society provided and how it adapted over time to meet the industry sector's needs while providing the platform for academic and industrial innovations. We will also cover future plans for enhancing the society's impact and engagement with the industry sector.

15:00-15:30

Initiative of APCMfI for promoting international collaboration of industrial mathematics in East

Yasuhide Fukumoto	Institute of Mathematics for Industry, Kyushu

Abstract: The Asia-Pacific Consortium of Mathematics for Industry (APCMfI) was established in October 2014, with secretariats in Canberra and Fukuoka, to serve as a platform for promoting collaboration of mathematics for industry (MfI) in East, South-East Asia and Oceania, and has been developing with gluing Asia-Pacific MfI communities. We present the overview of APCMfI and its initiatives for research and nurturing young talents, particularly unique activities with taking advantage of small time difference between member institutions.

15:30-16:00

ECMI: Innovative and collaborative industrial mathematics in Europe

Aderito Araujo	UNIVERSITY OF COIMBRA

Abstract: In this talk we present a brief review of how industrial mathematics organised itself in Europe and gave rise to the European Consortium for Mathematics in Industry (ECMI), the series of European Study Groups with Industry, and to new modes of productive contacts between industry and applied mathematicians in academia. We will also emphasise the unique strength of mathematics as a technology transfer tool and discuss the ECMI strategy for the coming years.

16:00-16:30

AMIES: French agency for mathematics in interaction with enterprises and the society

Véronique Maume Deschamps — CNRS - AMIES

Abstract: AMIES’ main aim is to provide french companies, and in particular SMEs, with an entry point to high level mathematics. AMIES acts at the french level with several programs and is in charge of animating a network of local structures which conduct operationally the collaborations between enterprises and mathematicians. AMIES is a national node and founding member of Eu-Maths-In. We shall present some AMIES' realizations and the 2020-2024 AMIES' project: Mathematics for Inductry 4.0.

MS ME-1-G 10 — 14:30-16:30

Rings, wrinkles, and vortices: Singularities, nonlinear PDE, and materials science - Part 2

For Part 1 see: MS ME-1-G 9

Organizer: Maria Westdickenberg — RWTH

Organizer: Lia Bronsard — McMaster University

Abstract: Models from materials science pose significant mathematical challenges including how to handle singularities and how to identify effective energies and macroscopic behavior in the presence of small-scale oscillations or defects. In the opposite direction, recent advances in nonlinear PDE and the calculus of variations offer insights into modelling, numerical simulation, and industrial applications involving semiconductors, liquid crystals, fluid flows, and elasticity. We survey recent progress.

14:30-15:00

The Cost of Crushing: Curvature-Driven Wrinkling of Thin Elastic Shells

Ian Tobasco — University of Michigan

Abstract: Recent experiments demonstrate the striking formation of “wrinkling domains” by thin and ultra-thin floating shells. We develop a rigorous method for deducing these domains via Gamma-convergence. The basic limiting objects are short maps from the shell to the plane, and defect measures to encode the wrinkling patterns. Convex analysis yields the limiting Euler-Lagrange equations: a new boundary value problem whose solution completely characterizes optimal defect measures, and explains the observed domains.

15:00-15:30

Renormalization and energy conservation for Euler equations.

Camilla Nobili — University of Hamburg

Abstract: Motivated by the Batchelor theory of 2D turbulence we show that vanishing viscosity limits give rise to renormalized solutions of the 2D Euler-vorticity equation even when the initial vorticity is only L^1. In the second part of the talk we investigate renormalization properties and energy conservation for the 3D axisymmetric Euler equations.

15:30-16:00

Optimal convergence rates for the Cahn-Hilliard equation on the line

Sarah Biesenbach — RWTH Aachen University

Felix Otto — MPI for Mathematics in the Sciences

Maria G. Westdickenberg — RWTH Aachen University

Abstract: We explain how to derive optimal algebraic-in-time rates for the decay to equilibrium under the assumption that the initial data has a finite (not small) distance to the limit state. The method exploits the gradient flow structure, Nash-type inequalities and a duality argument to establish sharp estimates. We present two examples. This is joint work with Felix Otto and Maria Westdickenberg.

16:00-16:30

Global Jacobian and Gamma-convergence in a Ginzburg-Landau model for boundary vortices

Radu Ignat — Institut de Mathematiques de Toulouse

Matthias Kurzke — University of Nottingham

Abstract: We will introduce the notion of global Jacobian that can detect both interior and boundary vortices and we will prove an important stability property. This property will enable us to study boundary vortices in a Ginzburg-Landau model with a weak anchoring boundary energy term. We will prove an asymptotic expansion by Gamma-convergence at the second order for this mixed boundary/interior energy in a regime where boundary vortices are preferred.

MS A3-3-2 10 — 14:30-16:30

Mathematical descriptions of traffic flow: micro, macro and kinetic models - Part 3

For Part 1 see: MS A3-3-2 8

For Part 2 see: MS A3-3-2 9

Organizer: Andrea Tosin — Politecnico di Torino

Organizer: Gabriella Puppo — La Sapienza Università di Roma

Abstract: Traffic flow is a complex phenomenon, which impacts heavily on society, economy and everyday life. In the last few years, several new technologies, such as driver assist devices or online congestion information, have raised the need for a better understanding of traffic. In this minisymposium, we will gather several researchers in the field to explore the mathematical foundations of traffic models from different perspectives. The motivation is both to assess the state of the art and the interplay between the different approaches and to discuss how to meet the new challenges of traffic control, autonomous vehicles and emission reduction.

14:30-15:00

Uncertainty damping in kinetic traffic modelling by driver-assist controls

Mattia Zanella — Politecnico di Torino

Abstract: We develop a hierarchical description of controlled multiagent systems in the presence of uncertain quantities by means of kinetic-type control strategies with applications to traffic models. Binary feedback controls are designed at the level of agent-to-agent interactions and then upscaled to the global flow via a kinetic approach based on the Boltzmann equation. The action of the control is capable to restrain structural uncertainties naturally embedded in realistic dynamics and to promote effective decision-making tasks.

15:00-15:30

Stability analysis for optimal velocity models on the infinite lane

Hannes Von Allwörden — University of Hamburg

Ingenuin Gasser — University of Hamburg

Abstract: We present a stability analysis for a general class of optimal velocity models on the infinite lane. The related analysis on the a circular road is well understood. However, the generalisation of such results to the infinte lane setting is challenging. The problem under consideration becomes infinite dimensional and different stability concepts such as platoon-, string- or convective stabilty have to be employed.

15:30-16:00

Modeling autonomous vehicles in traffic flow

Maria Laura Delle Monache — Inria Grenoble - Rhône Alpes

Thibault Liard — Inria Grenoble - Rhône Alpes

Benedetto Piccoli — Rutgers University

Raphael Stern — TU Munich

Dan Work — Vanderbilt University

Abstract: In this talk, we introduce a PDE-ODE model to describe autonomous vehicles (AVs) among human bulk traffic. The PDE describes the traffic flow and the ODEs describe the AVs trajectories. We will show rigorous mathematical results for existence, uniqueness and well-posedness and ad-hoc numerical scheme. Then, we show that when the AVs act as tracer vehicles, it is possible to fully reconstruct the exact traffic state by using only the data collected by the AVs.

MS A6-1-1 10 — 14:30-16:30

Mathematical Modeling of Control Strategies for Diseases

Organizer: Luis Melara — Shippensburg University

Organizer: Abdessamad Tridane — United Arab Emirates University

Abstract: This session will cover a breadth of topics involving optimal control, optimization techniques modeling drugs and therapies with applications to various diseases. The types diseases types of diseases are not restricted to infectious diseases in populations but may also include metabolism and genetic diseases, for example. The preventive and intervention strategies are a representation of commonly used mathematical approaches for addressing diseases

14:30-15:00

Optimal control of treatments for retinitis pigmentosa

Luis Melara — Shippensburg University

Abstract: Retinitis Pigmentosa (RP) is a degenerative eye disease affecting millions of people worldwide. This presentation will begin with a brief background on RP and previous work done on the mathematical modeling of two treatments for RP: Rod-derived Cone Viability Factor (RdCVF) and Mesencephalic-Astrocyte-derived-Neurotrophic Factor (MANF). We will then introduce an optimal control model mixing both RdCVF and MANF treatments. Numerical results are presented and discussed.

15:00-15:30

A two-strain dengue model with vertical transmission and optimal strategies

Sunmi Lee — Kyung Hee University
David Murillo — Arizona State University

Abstract: A two-strain dengue model with vertical transmission in the mosquito population is considered. We model the effect of a control strategy aimed at reducing human-mosquito transmissions in an optimal control framework. As the likelihood of vertical transmission increases, outbreaks become more difficult and expensive to control. However, even for low levels of vertical transmission, the additional, uncontrolled, transmission from infected mosquito to eggs may undercut the effectiveness of any control function.

15:30-16:00

Cooperative Systems Approach for Some Epidemic Models With Latent Classes

Abdessamad Tridane — United Arab Emirates University

Abstract: This talk aims to investigate the global stability analysis, via the theory of cooperative systems, of a general epidemic model with latent classes. The model studied cover different types of epidemic model with latent classes, where cooperative system approach show that R0 is a sharp threshold with the disease dying out when R0 < 1 and becomes endemic when R0 > 1. We apply our findings to Tuberculosis and Ebola epidemic models.

MS GH-3-5 10 — 14:30-16:30

Tools and Technologies of the SciDAC FASTMath Institute - Part 3

For Part 1 see: MS GH-3-5 8
For Part 2 see: MS GH-3-5 9

Abstract: The FASTMath (Frameworks, Algorithms and Scalable Technologies for Mathematics) Institute is a R&D project funded by the SciDAC Program at the U.S. Department of Energy (DOE). The goal of FASTMath is to develop and deploy scalable mathematical algorithms and software tools for reliable simulation of complex physical phenomena. The focus of FASTMath is strongly driven by the requirements of DOE application scientists who require fast, accurate, and robust forward simulation along with the ability to efficiently perform ensembles of simulations in optimization or uncertainty quantification studies. This minisymposium will provide an overview of FASTMath.

14:30-15:00

Solving Large-scale Eigenvalue Problems in DOE Science Applications

Chao Yang — Lawrence Berkeley National Laboratory

Abstract: Eigenvalue problems arise in several DOE applications. In some applications, we need to compute a few eigenpairs of an extremeley large but sparse matrix. In other applications, the number of eigenpairs to be computed can be quite large even though it is still a small fraction of the dimension of the matrix. We will discss efficient algorithms for solving these types of problems and their implementation on massively parallel computers.

15:00-15:30

Uncertainty Quantification in Large Scale Computational Models

Habib Najm — Sandia National Laboratories
Cosmin Safta — Sandia National Laboratories
Khachik Sargsyan — Sandia National Laboratories
Xun Huan — Sandia National Laboratories
Joseph Oefelein — Sandia National Laboratories
Guilhem Lacaze — Sandia National Laboratories
Michael Eldred — Sandia National Laboratories
Gianluca Geraci — Sandia National Laboratories

Abstract: Uncertainty quantification (UQ) in large scale computational models faces the challenges of high dimensionality and high computational cost. Exploring such high-dimensional spaces typically necessitates the use of a large number of computational samples, which, given the cost of large scale computational models, is prohibitively expensive. I will discuss a UQ workflow to address this challenge, employing global sensitivity analysis with polynomial chaos regression and compressive sensing, coupled with multilevel Monte Carlo and/or multilevel multifidelity methods.

15:30-16:00

What is FASTMath?

Esmond Ng — Lawrence Berkeley National Laboratory

Abstract: The FASTMath (Frameworks, Algorithms and Scalable Technologies for Mathematics) Institute is a R&D project in applied mathematics and is funded by the SciDAC (Scientific Discovery Through Advanced Computing) Program at at the U.S. Department of Energy (DOE). In this talk, we briefly describe the SciDAC Program and the role that FASTMath plays, as well as some of the achievements FASTMath has made.

16:00-16:30

Regularization Algorithms for Reconstructing Sparse Data with Structures

Hoang Tran — Oak Ridge National Laboratory

Abstract: We discuss recent advances in convex and nonconvex optimization approaches for the reconstruction of high-dimensional data, which exploit not only the sparsity of the data, but also the inherent structures in that sparsity. Examples include lower structure in polynomial expansions, tree structure in wavelet representation of images, and joint sparsity in multiple measurement vector problems. We will verify the advantage and efficiency of our methods via examples in uncertainty quantification, imaging and experimental data processing.

CP A1-3-3 10 — 14:30-16:30

Dynamical Systems II

Chair Person: Lale Asik — Texas Tech University

CP A1-3-3 10 1 — 14:30-14:50

Dynamics of a Producer-Grazer Model Incorporating the Effects of Phosphorus Loading on Grazer's Growth

Lale Asik — Texas Tech University
Angela Peace — Texas Tech University

Abstract: We extend the Peace et al. (2014) stoichiometric knife-edge model by mechanistically deriving and tracking phosphorus loading in order to investigate the growth response of the grazer to the producer of varying the ratio of phosphorus to carbon. Bifurcation diagram and simulations show that our model behaves qualitatively similar to the Peace et al. model. Furthermore, the structure of our model can easily be extended to incorporate seasonal phosphorus loading.

CP A1-3-3 10 2 — 14:50-15:10

Investigation of Dynamical Properties of Two-parameter Family of Functions including Logarithmic Map and Existence of Chaotic Behaviour in its Real Dynamics

Mohamamd Sajid — Qassim University

Abstract: The focus of this paper is to obtain the dynamical properties of two-parameter family of functions including a logarithmic map. To investigate the dynamical properties of our family, the real fixed points and periodic points of functions in our family are to be computed and their stability is to discuss. The existence of chaos in the real dynamics explores by looking period-doubling in the bifurcation diagrams and it is quantified by computing positive Lyapunov exponents.

CP A1-3-3 10 3 — 15:10-15:30

Emergence of anomalous flocking in the fractional Cucker-Smale model

Seung-Yeal Ha — Seoul National University
Jinwook Jung — Seoul National University
Peter Kuchling — Bielefeld University

Abstract: As a mathematical model incorporating the interplay of memory effect and flocking dynamics, we introduce the fractional Cucker-Smale (C-S) model derived from replacing the usual time derivative by the Caputo fractional time derivative. For the proposed model, we give a sufficient framework which admits the emergence of anomalous flocking at the algebraic rate and an ℓ^2-stability estimate with respect to initial data. Also, we provide numerical examples and compare them with theoretical results.

CP A1-3-3 10 4 **15:30-15:50**

Real-time determination of musculoskeletal properties using kinematic quantities of the musculoskeletal system and Bayesian Approach methods

Roja Zakeri	Claremont Graduate University
Praveen Shankar	California State University, Long Beach

Abstract: Neurodegenerative disease remains undiagnosed in early stages because of incapability of clinical methods to quantifying and detecting musculoskeletal properties. Due to difficulties to evaluate musculoskeletal properties accurately, we include unmeasurable properties as unknown parameters of the state space model. A methodology based on Bayesian approach and Particle Monte Carlo Markov Chain technique has been developed to estimate unknown parameters in nonlinear model, by using realtime kinematic quantities collected by available tools such as stereophotogrammetric systems

CP A1-3-3 10 5 **15:50-16:10**

Recent advances for rumors propagation on social networks

BERNARD Severine	Université des Antilles
PIETRUS Alain	Université des Antilles
VALMONT Kendy	Université des Antilles

Abstract: In recent years, social networks became new spaces of discussions which can be dangerous for our societies because it can destabilize human behaviors and collective feelings. Namely e-rumor, the propagation of informations on social networks is a multi-dimensional diffusion process mainly driven by socio-psychological elements. The first e-rumor models are based on the epidemic ones. Some control studies of fakes news have been made as well as the dynamical study of deterministic and stochastic models.

CP A1-3-4 10 14:30-16:30

Simulation and Modelling VII

Chair Person: Constance Schober — University of Central Florida

CP A1-3-4 10 1 **14:30-14:50**

Dynamics of the Kudryashov generalized KdV Equation

Constance Schober	University of Central Florida

Abstract: Using a refined perturbation expansion of the Fermi-Pasta-Ulam (FPU) equations of motion, the Kudryashov generalized Korteweg-de Vries (KGKdV) equation and the general form of higher order KdV equations are derived. An integrator which accurately handles stiff equations without filtering is developed for the KGKdV equation, allowing one to carefully examine transport of energy in the system for a variety of perturbation strengths and initial wavefields.

CP A1-3-4 10 2 **14:50-15:10**

Integral Formulation for Fluid Flow in Congested Media Modelling

Clément Colas	EDF R&D / I2M
Martin Ferrand	EDF R&D
Jean-Marc Hérard	EDF R&D / I2M
Jean-Claude Latché	IRSN / I2M
Erwan Le Coupanec	EDF R&D

Abstract: We focus on a numerical method to compute fluid flows in a medium congested by obstacles. The integral formulation consists in integrating the Euler equations over the fluid part of a control volume including both fluid and solid zones. This technique uses a pressure correction algorithm preserving the positivity of the density and the internal energy. Riemann problem verification test cases are performed including shock tube and shock wave interaction with a wall boundary configurations.

CP A1-3-4 10 3 **15:10-15:30**

Tikhonov-Type Regularization and Finite Element Method Applied to Source Estimation in the Atmosphere

Roseane Albani	Federal University of Santa Catarina

Abstract: In this work, we consider the source identification problem in air pollution modeling. We combine adaptive meshes and a stabilized finite element method for advective-diffusive problems to obtain the forward problem solution. To solve the source identification problem, we compare different techniques from Tikhonov-type regularization, in order to deal with noise in the data and modeling uncertainty. We provide numerical experiments using real meteorological and concentration data sets.

CP A1-3-4 10 4 **15:30-15:50**

Robust optimization of PDEs with uncertain parameters

Van Barel Andreas	KU Leuven
Vandewalle Stefan	KU Leuven

Abstract: We solve the robust optimization problem using MG/OPT (a multigrid framework for optimization). For each MG/OPT level, the gradient and the Hessian, whose expressions contain expected value operators, are estimated using a multilevel Monte Carlo method. This allows the method to deal with a large number of uncertainties. The method is compared with other similar methods and strategies. The convergence behavior is illustrated for a model elliptic diffusion problem.

CP A1-3-4 10 5 **15:50-16:10**

Optimal control of nonlinear renewal equation

Bhargav Kumar Kakumani	Tata Institute of Fundamental Research

Abstract: We study the optimal control for a nonlinear renewal equation popularly known as McKendrick–von Foerster (MV) equation. We establish necessary optimality conditions using the concept of normal cone. We prove the existence and uniqueness of optimal control using the Ekeland variational principle. Finally, we compute the optimal control numerically by an algorithm based on projected gradient method.

CP A1-3-4 10 6 **16:10-16:30**

Optimization and control of high field magnets

Romain Hild	Université de Strasbourg
Christophe Prud'homme	Université de Strasbourg
Christophe Trophime	LNCMI

Abstract: We present our work on model reduction for the computation of 3D magnetic field. From the modeling point of view, a non linear parametrized thermoelectric problem needs to be solved and the Biot-Savart law is used to compute the magnetic field. To do the geometrical optimization of a magnet to improve the homogeneity of the magnetic field efficiently, we proposed to use the reduced basis method and the Empirical Interpolation Method within the SER algorithm.

CP FT-S-1 10 14:30-16:30

Applied Mathematics for Industry and Engineering X

Chair Person: Attila Kovacs — University Of Oxford

CP FT-S-1 10 1 **14:30-14:50**

Mathematical Modelling of Alumina Feeding

Attila Kovacs	University Of Oxford
Chris Breward	University Of Oxford
James Oliver	University Of Oxford
Andreas Münch	University Of Oxford

Abstract: In the production of aluminium, the addition of alumina (feeding) into the electrolysis cell is still not well understood. It encapsulates many different physical effects and affects the overall behaviour and the efficiency of the production cell. We use the framework of heat and mass transfer in the presence of an infiltrating phase-changing porous flow and disintegration to model this process and reduce the system to gain insights into improvements.

CP FT-S-1 10 2 **14:50-15:10**

Some new insights in uncertainty analysis for multivariate response models, including dynamic models

Matieyendou LAMBONI	University of Guyane

Abstract: Computer models are developed to simulate physical systems of interest for supporting decision making. The models are often complex so that classical analysis are intractable (model calibration, evaluation, diagnostic). Quantifying the association between the variability of the model outputs (dynamic or multiple) and the inputs allows for better understanding the system. This abstract aims at giving the current situation of the mathematical analysis in uncertainty quantification for multivariate response models, and its potential applications everywhere.

CP FT-S-1 10 3 **15:10-15:30**

On the numerical procedure for the design of the contra-rotating propellers system

Jing Tian Tian	Towson University

Abstract: In this work, we conduct a study of using the mathematical and computational techniques to solve a problem in engineering and mechanics which has widely applications in our daily life. We establish a numerical/computational procedure for the design of the contra-rotating propellers system by investigating the flow characteristics with the help of computational and mathematical techniques. The results of the numerical simulations will be provided.

CP FT-S-1 10 4 **15:30-15:50**

Multi-output Conditional Inference Trees applied to the Electricity Market: Variable Importance Analysis

Ismael Ahrazem Dfuf	Universidad Politécnica de Madrid
José Manuel Mira McWilliams	Universidad Politécnica Madrid
Camino González Fernández	Universidad Politécnica Madrid

Abstract: We propose an alternative framework to assess the variable importance in multivariate response scenarios based on the permutation importance technique, applying the conditional inference trees algorithm and a φ-divergence measure. Our solution was tested in simulated examples as well as a real case, where we ranked the most relevant predictors for price and demand of electricity jointly. The new method outperforms in most cases the outcomes achieved by the recently proposed techniques, IPM and SMuRFS.

CP FT-S-1 10 5 **15:50-16:10**

Index Tracking and Enhanced Tracking using Mixed Conditional Value-at-Risk

Anubha Goel	Indian Institute of Technology, Delhi
Amita Sharma	Indian institute of information and technology, guwahati
Aparna Mehra	Indian Institute of Technology, Delhi

Abstract: We design models for Index Tracking and Enhanced Indexing using mixed conditional value at risk. A Markov chain based filtering strategy for filtering some stocks out of the pool is introduced to enhance the performance of the proposed models by gaining more information about the assets relative to the index and reducing the computational efforts. The empirical performance of the proposed models is analyzed over 17 worldwide indices using the rolling window approach.

CP FT-S-1 10 6 **16:10-16:30**

A comparation of methods for solving a Simultaneous Equation Model

Belén Pérez-Sánchez	Universidad Miguel Hernández de Elche
José Juan López-Espín	Universidad Miguel Hernández de Elche
Mari Carmen Perea Marco	Universidad Miguel Hernández de Elche
Martin Gonzalez Espinosa	Universidad Miguel Hernández de Elche

Abstract: Simultaneous Equations Models are statistical models formed by a set of regression equations that reflect the simultaneity among the set of dependent variables and explanatory variables of a model. In this work different models have been generated by simulation, varying the sample size as well as the number of endogenous and exogenous variables. The K values of BMOM have been optimized to minimize the Akaike Information Criterion allowing comparison between different methods of estimation.

CP FT-1-8 10 14:30-16:30

Computational Geometry and Fluids Physics

Chair Person: Alexandre Chemin Université Catholique de Louvain

CP FT-1-8 10 1 **14:30-14:50**

Representing three-dimensional cross fields using 4th order tensors

Alexandre Chemin	Université Catholique de Louvain
François Henrotte	Université Catholique de Louvain
Jean-François Remacle	Université Catholique de Louvain
Jean Van Schaftingen	Université Catholique de Louvain

Abstract: A computationally efficent method to represent 3D cross fields based on 4th order tensors is developed. The algebraic structure of tensors used (representation lays in a 9 dimensional linear space), their correspondance with spherical harmonics and the projection method on SO(3) are detailed. The use of this cross field representation leads to a gain on computational time regarding existing methods in the current state of the art.

CP FT-1-8 10 2 **14:50-15:10**

Multi-block decomposition and meshing of 2D domain using Ginzburg-Landau PDE

Jovana Jezdimirovic	Université Catholique de Louvain
Alexandre Chemin	Université catholique de Louvain
Jean-François Remacle	Université catholique de Louvain

Abstract: A novel approach to generate multi-block decomposition of the arbitrary 2D domain relying on Ginzburg-Landau PDE is presented. We have proved that solutions of particular PDE imply integrable vector fields and have adequate distribution of singularities. Minimal graph was generated by separatrices and extraordinary vertices of domain (singularities, corners and separatrices intersections) and obtained quadrilateral blocks were parameterized. As a result, a mechanism to obtain multi-block structured all-quad mesh in automatic manner is developed.

CP FT-1-8 10 3 **15:10-15:30**

Robust numerical path tracking in polynomial homotopy continuation

Simon Telen	KU Leuven
Marc Van Barel	KU Leuven
Jan Verschelde	University of Illinois at Chicago

Abstract: Homotopy continuation is an important strategy for solving systems of polynomial equations and for tackling other problems in computational algebraic geometry. State of the art implementations suffer from `path jumping', which often causes the loss of some solutions. We propose a new algorithm that uses Padé approximants for detecting difficult regions along the path. This results in an adaptive stepsize path tracker which proves to be more robust than existing algorithms.

CP FT-1-8 10 4 **15:30-15:50**

Effect of Cross Diffusion on Double Diffusive Convection in Binary Nanofluids for Absorption Applications with an Internal Heat Source

Sravan Nayeka Gaikwad	Gulbarga University
Dnyaneshwar Madhav Surwase	Gulbarga University

Abstract: This flow problem is studied by performing linear and nonlinear stability analyses. For linear stability analysis, normal mode technique is used and the expressions for Rayleigh number is obtained whereas for nonlinear stability analysis, the truncated representation of Fourier series is used, which provides quantification of heat and mass transfer. The effects of nanoparticles and various parameters like internal heat source, soret and dufour on the stability of the system are analyzed graphically.

CP FT-1-8 10 5 **15:50-16:10**

Low-temperature energy recovery through acoustic heat engines driven by boundary mass exchange

Avshalom Offner	Technion – Israel Institute of Technology
Rui Yang	Technion – Israel Institute of Technology
Daniel Felman	Technion – Israel Institute of Technology
Nimrod Elkayam	Technion – Israel Institute of Technology
Yehuda Agnon	Technion – Israel Institute of Technology
Guy Z. Ramon	Technion – Israel Institute of Technology

Abstract: Self-sustained acoustic oscillations may be excited in a gaseous mixture by a temperature gradient, to be used for energy recovery applications. The temperature required may be significantly lowered by adding a ‘reactive’ component able to sorb/de-sorb to/from a boundary, thus drawing/releasing latent heat. Here, such a system is analysed within the long-wave theory, revealing an increase in acoustic power production alongside a decrease in the required temperature difference, in good agreement with experimental observations.

CP FT-1-8 10 6 **16:10-16:30**

Natural Convection with Heat Transfer In a Rectangular Enclosure containing one Discrete Heater

VUSALA AMBETHKAR	UNIVERSITY OF DELHI
LAKSHMI RANI BASUMATARY	UNIVERSITY OF DELHI

Abstract: The natural convection of 2D steady with transfer in rectangular enclosure having upper surface in moving and no-slip boundary conditions on other sides has been studied numerically. The governing equations are solved by using upwind finite volume method based on SIMPLE algorithm. Temperature distribution and average Nusselt number have been computed. Grid independence test and code validations have been achieved. The numerical solutions obtained here have been compared with the benchmark solutions in good agreement.

CP FT-1-7 10 14:30-16:30

Control and Systems Theory V

Chair Person: Luca Saluzzi Gran Sasso Science Institute

CP FT-1-7 10 1 **14:30-14:50**

A Dynamic Programming approach on a tree structure for finite horizon optimal control problems and its applications

Luca Saluzzi	Gran Sasso Science Institute
Alessandro Alla	PUC-Rio
Maurizio Falcone	La Sapienza

Abstract: The Dynamic Programming approach to optimal control problems is based on the characterization of the value function as the solution of a Hamilton-Jacobi-Bellman equation. The classical numerical scheme is based on a projection on a fixed triangulation. We will present a new approach where the value function is numerically computed on a tree structure built directly by the discrete dynamics. We will show the effectiveness of the method for the control of PDES.

CP FT-1-7 10 2 **14:50-15:10**

Turnpike solutions for sustainable pelagic fishery model

Erica Cruz-Rivera	Universidad del Valle
Hector Ramirez	Universidad de Chile
Olga Vasilieva	Universidad del Valle

Abstract: In this talk we show the existence of turnpike solutions for a model of fish stock exploitation with a harvesting function of Cobb-Douglas type. Indeed, under the usual assumption of bounded fishing effort, we provide an explicit form for the fishing exploitation strategy. This strategy smoothly depends on the nonnegative parameter measuring the sensitivity of catch yields, which permits to perform sensitivity analysis of diverse relevant quantities of the model with respect to this parameter

CP FT-1-7 10 3 **15:10-15:30**

Bounding Computational Complexity under Cost Function Scaling in Predictive Control

Ian McInerney	Imperial College London
Eric Kerrigan	Imperial College London
George Constantinides	Imperial College London

Abstract: We present an upper bound for the computational complexity of first-order optimization algorithms for constrained LQR problems with state, input and cross-term weights. We derive horizon-independent bounds on the condition number and extremal eigenvalues of the Hessian matrices via a system-theoretic analysis of appropriate Toeplitz operators. Comparing the iteration bounds with the closed-loop performance shows that small improvements in performance come at the expense of greatly increased computational cost.

CP FT-1-7 10 4 **15:30-15:50**

Optimization of chemical batch reactors using temperature control

Toufik Bakir	Université de Bourgogne
Bernard Bonnard	Université de Bourgogne et INRIA Sophia Antipolis
Jérémy Rouot	Université de Bourgogne et INRIA Sophia Antipolis

Abstract: Our aim is to synthesize optimal temperature control to maximize the yield of a chemical network modeled by mass action kinetic using two testbed cases: a sequence A->B->C of two irreversible reactions the weakly reversible McKeithan network : T+M->A->B and A->T+M and B->T+M. The Maximum Principle led to parameterize minimizing solutions using an Hamiltonian dynamics and the geometric control techniques allow to synthesize the optimal controls.

CP FT-1-7 10 5 **15:50-16:10**

Optimal control of a HIV model with state constraints and multiple delays

Cristiana J. Silva	CIDMA, University of Aveiro
Helmut Maurer	Institute of Computational and Applied Mathematics, University of Munster

Abstract: We propose a delayed model for HIV infection and solve an optimal control problem (OCP) with multiple delays, subject to state constraints. We obtain optimal controls of bang-bang type both for the non-delayed and delayed OCP. We study boundary arcs of state constraints and junction properties of the control and adjoint variables at entry and exit points of boundary arcs. Moreover, we derive an explicit formula of the multiplier associated with the state constraint.

CP FT-1-7 10 6 **16:10-16:30**

State-feedback optimal control for selective catalytic reduction technology using infinite-dimensional representation

Ahmed Aksikas	University of Alberta
Ilyasse Aksikas	Qatar University
Robert Hayes	University of Alberta
Fraser Forbes	University of Alberta

Abstract: This project is devoted to design an optimal controller for SCR system. The SCR is described by parabolic-hyperbolic PDEs. The objective is to manipulate the ammonia in order to reduce the NOx and ammonia slip. Infinite-dimensional space representation has been used in order to solve the LQ-control problem. Ammonia dosage is expressed as state-feedback to reach the main objective. A state observer is designed to estimate the states and it is integrated in the algorithm.

CP A1-3-5 10 14:30-16:30

Mathematical Topics and their Applications XII

Chair Person: Jaime Andrade Universidad del Bío-Bío

CP A1-3-5 10 1 **14:30-14:50**

Dynamics of the restricted $(N+1)$-body problem on S^2

Jaime Andrade	Universidad del Bío-Bío
Claudio Vidal	Universidad del Bío-Bío

Abstract: We consider the motion of an infinitesimal mass particle on the bidimensional sphere S^2 influenced by the presence of N bodies of unit mass placed at the vertices of a regular polygon and rotating uniformly in a fixed parallel (primaries). This problem depends on two parameters: the number of bodies $N \geq 3$ and the polar angle θ_0 determined by the position of the primeries. Results concerning stability, bifurcation and regularisation will be included.

CP A1-3-5 10 2 **14:50-15:10**

Regularity results for a double time-delayed 2D-Navier-Stokes model

Julia García Luengo	Universidad Politécnica de Madrid
Pedro Marín Rubio	Universidad de Sevilla
Gabriela Planas	Universidade Estadual de Campinas

Abstract: In this talk, we analyze some regularity properties of a double time-delayed 2D-Navier-Stokes model, including delays in the convective and the forcing terms. Interestingly, this 2D-model behaves similarly as a 3D-model without delay, and extra conditions in order to have uniqueness are required for well-posedness. We establish regularization results of the solutions, existence of pullback attractors for several associated dynamical systems and relationships among these objects. Joint work with Pedro Marín-Rubio and Gabriela Planas.

CP A1-3-5 10 3 **15:10-15:30**

Dynamical System for a viscoelastic fluid in a closed loop.

Angela Jimánez-Casas	Universidad Pontificia Comillas de Madrid
Justine Yasappan	Universidad Pontificia Comillas
Mario Castro	Universidad Pontificia Comillas

Abstract: We consider a device composed of a closed loop containing a fluid who motion is driven by several actions such as gravity and natural convection (thermosyphons). In this work we consider a viscoelastic fluid described by the Maxwell constitutive equation and their dynamics are governing for a coupled differential nonlinear systems. This work is a generalization of some previous results on standard (Newtonian) fluids obtained by A. Rodríguez-Bernal, E.S. Van Vleck, A. Jiménez-Casas, among others.

CP A1-3-5 10 4 **15:30-15:50**

A reaction-diffusion model with nonlocal viscosity and Lyapunov structure

RUBÉN CABALLERO TORO	UNIVERSIDAD MIGUEL HERNÁNDEZ DE ELCHE
JOSÉ VALERO CUADRA	UNIVERSIDAD MIGUEL HERNÁNDEZ DE ELCHE
PEDRO MARÍN RUBIO	UNIVERSIDAD DE SEVILLA

Abstract: In this work we consider a class of reaction-diffusion equations in bounded domains with Dirichlet boundary conditions, where a nonlocal term is present in the diffusion coefficient. We first study the issues of existence and uniqueness for the parabolic setting.

Then, we investigate in details the associated stationary problem as well as the structure of the attractor.

CP A1-3-5 10 5 **15:50-16:10**

Numerical Study of Nonlinear Stability on Rayleigh-Benard Convection in Rotating Ferromagnetic Liquids

Pradeep G. Siddheshwar	Bangalore University
Manjunath S.	B. N. M. Institute of Technology
Sushma T. S.	B. N. M. Institute of Technology

Abstract: The ?ve-mode Lorenz model arising in the study of Rayleigh-Benard convection in rotating ferromagnetic liquids is reduced to a single-dimensional cubic-quintic Ginzburg-Landau equation. The reduction tool used is the center manifold theorem. Such a reduction is possible since Lorenz model is autonomous. We analyse the reduced cubic-quintic Ginzburg-Landau equation by extracting information on the bifurcation aspects of the problem. We ?nd the heat transport of the system using the solution of the Ginzburg-Landau equation.

CP A1-3-5 10 6 **16:10-16:30**

Modeling the Spread of Radioactive Contaminant in Fractured Aquifers Surrounded by Porous Rock

Sergei Fomin	CSU Chico
Vladimir Chugunov	Moscow City University
Susan Ye	Brown University
Eric Montoya	CSU Chico

Abstract: Mathematical model of spreading the radioactive contaminant in fractured porous media is proposed. This is a topic of consideration for nuclear power plants and nuclear waste repositories, where radioactive waste must be isolated from the environment and especially groundwater sources. By solving a system of fractional differential equations that model the radioactive contaminant transport in the fractured aquifer and surrounding porous rocks, the maximum possible zones of contamination are determined.

CP FT-S-3 10 **14:30-16:30**

Numerical Analysis XVIII

Chair Person: Tianyi Shi — Cornell University

CP FT-S-3 10 1 **14:30-14:50**

What kind of tensors are compressible?

Tianyi Shi	Cornell University
Alex Townsend	Cornell University

Abstract: Tensors often have too many entries to be stored explicitly so it is essential to compress them into data sparse formats. I will identify three methodologies that can be used to explain when a tensor is compressible. Each methodology leads to bounds on the compressibility of certain tensors, partially explaining the abundance of low-rank tensors in applied mathematics. Equipped with these theoretical results, I will develop a fast spectrally-accurate 3D Poisson solver.

CP FT-S-3 10 2 **14:50-15:10**

Symmetry and exact solutions of a viscoelastic hyperbolic equation

Almudena Del Pilar Márquez Lozano	Universidad de Cádiz
María De Los Santos Bruzón Gallego	Universidad de Cádiz

Abstract: In this work we consider a viscoelastic hyperbolic equation depending on a non-linear damping term and non-linear functions. The partial differential equation models the behaviour of viscoelasticity in physical processes such as viscoelastic fluids. We perform a Lie symmetry analysis. Furthermore, we obtain exact solutions of considerable interest in mathematical physics by using the symmetry reductions to derive new exact invariant solutions with respect to the symmetries.

CP FT-S-3 10 3 **15:10-15:30**

The Interval Molecular Euclidean Distance Matrix Completion Problem: Theoretical and Computational Aspects

Carlile Lavor	UNIVERSITY OF CAMPINAS
Weldon Lodwick	UNIVERSITY OF COLORADO DENVER
Luiz Salles-Neto	FEDERAL UNIVERSITY OF SÃO PAULO

Abstract: The Euclidean Distance Matrix Completion Problem is a classical mathematical problem. This research defines an interval version of this problem motivated by data of distances obtained from actual experiments from Nuclear Magnetic Resonance machines in the process of determining the molecular conformation of protein molecules. We called this problem the Interval Molecular Euclidean Distance Matrix Completion Problem. The theory and an algorithm to obtain unknown distances from typical NMR data for a protein are presented.

CP FT-S-3 10 4 **15:30-15:50**

A descent algorithm for the Grassmannian minimax center

Emilie Renard	Université catholique de Louvain
P.-A. Absil	Université catholique de Louvain
Kyle Gallivan	Florida State University

Abstract: Our goal is to extract the common part of different datasets. For this we look for a subspace minimizing the maximal distance to each dataset, that is, the minimax center of the subspaces associated to each dataset. To tackle this non-convex, non-smooth and constrained problem, we see each subspace as a point on the Grassmann manifold. We are then able to develop a descent direction approach with a proof of convergence.

CP FT-S-3 10 5 **15:50-16:10**

A MATLAB package for EMI data inversion

Gian Piero Deidda	University of Cagliari
Patricia Díaz De Alba	University of Cagliari
Caterina Fenu	University of Cagliari
Gabriele Lovicu	University of Cagliari
Giuseppe Rodriguez	University of Cagliari

Abstract: Electromagnetic induction surveys are among the most popular techniques for nondestructive investigation of soil properties in order to detect the presence of either ground inhomogeneities or of particular substances. This work introduces a MATLAB package for the inversion of electromagnetic data collected by a ground conductivity meter. The package allows the user to experiment with synthetic and real data sets and different numerical strategies, in order to compare them and draw conclusions.

CP FT-S-3 10 6 **16:10-16:30**

Quotient geometry with simple geodesics on the manifold of fixed-rank positive-semidefinite matrices

Estelle Massart	UCLouvain
P.-A. Absil	UCLouvain

Abstract: The set of full-rank positive-semidefinite matrices is a Riemannian manifold. We identify it with a quotient of the set of full-rank rectangular matrices by the orthogonal group. We obtain expressions for endpoint geodesics and for the injectivity radius. This enables us to explain why discontinuities may appear when running some curve fitting algorithms on this manifold. We illustrate this on an application in wind field modeling, which involves covariance matrix interpolation.

CP FT-4-5 10 **14:30-16:30**

Biology, Medicine and other natural sciences VI

Chair Person: Isabel N. Figueiredo — University of Coimbra

CP FT-4-5 10 1 **14:30-14:50**

Colonic polyp identification using a fast anomaly detection scheme

Isabel N. Figueiredo	University of Coimbra
Mahdi Dodangeh	University of Coimbra
Luis Pinto	University of Coimbra
Pedro Figueiredo	University of Coimbra
Richard Tsai	University of Texas at Austin

Abstract: Detection of polyps is an important step in colon cancer prevention. We exploit the potential of a partial differential equation reformulation of a similarity-based anomaly detection algorithm, for automatic colonic polyp identification in medical images. This algorithm involves a triple multi-criteria dissimilarity measure, called Pareto depth, relying on shape, texture and color descriptors. The preliminary results confirm this strategy is fast and clearly outperforms the performance of each criterion in the detection of colonic polyps.

CP FT-4-5 10 2 **14:50-15:10**

An accurate and efficient discretization for stochastic models of cell migration and cell proliferation with crowding effects

Nabil Fadai	Queensland University of Technology
Ruth Baker	University of Oxford
Matthew Simpson	Queensland University of Technology

Abstract: While previously studied agent-based lattice models have successfully described how cells proliferate, die, and migrate in limiting cases, they fail to accurately account for other underlying mechanisms when groups of cells are prone to crowding and clustering. We propose a new model that accounts for clusters by determining a critical distance at which agents influence each other's actions. This model faithfully reproduces results from previously studied limiting cases and provides insight into clustering-prone parameter regimes.

CP FT-4-5 10 3 **15:10-15:30**

Dynamic changes in cells exposed to pulsed radiofrequency and focus on microtubules

Sundeep Singh	Wilfrid Laurier University
Roderick Melnik	BCAM - Basque Center for Applied Mathematics, Bilbao, Spain.Wilfrid Laurier University

Abstract: While pulsed radiofrequency (PRF) treatments are less destructive compared to their continuous counterparts, they can still adversely affect microtubules and microfilaments of the cells by both, directly (acting by PRF electric fields on their charged structures) and indirectly (causing damage to the mitochondria and degrading the microtubules and microfilaments). In this contribution we utilize a novel fully coupled thermo-electric mathematical model to quantitatively assess this phenomenon and discuss its consequences for medical applications.

CP A1-3-2 10 **14:30-16:30**

Numerical Analysis XVII

Chair Person: Antonio Pascau Llorente	EINA University of Zaragoza

CP A1-3-2 10 1 **14:30-14:50**

ENATE, a highly parallelizable scheme for transport equations

Antonio Pascau	EINA University of Zaragoza
Victor Javier Llorente	EINA University of Zaragoza

Abstract: ENATE, a numerical approximation to transport equations, has been presented to the scientific community in several papers. The scheme is exact in 1D and logically can also be employed in 2D and 3D problems. In the presentation the way to easily parallelize the scheme when used in several dimensions will be pointed out and several examples that underpin its great accuracy shown.

CP A1-3-2 10 2 **14:50-15:10**

WENO schemes using data bounded high order reconstructions.

Ritesh Dubey	Research Institute, SRMIST
Sabana Parveen	Research Institute, SRMIST

Abstract: In this work necessary conditions are deduced on non-linear weights to yield data bounded high order ENO/WENO reconstructions. These conditions are used to give data bounded region for non-linear WENO weights to be satisfied. Non-linear weights are constructed and used to construct WENO schemes up to 5th order. Numerical results show that proposed schemes captures the flow feature accurately without giving oscillations.

CP A1-3-2 10 3 **15:10-15:30**

Numerical Approximation of Nonlinear Second Order Boundary Value Problems via Hybrid Boundary Value Method

Grace O. ALAO	Covenant University
Raphael B. ADENIYI	University of Ilorin
Sheila A. BISHOP	Covenant University

Abstract: Hybrid Boundary Value Method (HyBVM) is a new scheme, based on the Linear Multistep Method (LMM). The LMM is constructed via interpolation and collocation procedures while utilizing data at both step and off-step points. The LMM is then implemented as HyBVM to approximate second order nonlinear Boundary Value Problems (BVPs) directly without necessarily converting them to their equivalent Initial Value Problems (IVPs). Also, the convergence and the stability theory of the new method are discussed.

CP A1-3-2 10 4 **15:30-15:50**

Accurate computations with h-Bernstein-Vandermonde matrices

ANA MARCO	UNIVERSIDAD DE ALCALÁ
JOSÉ-JAVIER MARTÍNEZ	UNIVERSIDAD DE ALCALÁ
RAQUEL VIAÑA	UNIVERSIDAD DE ALCALÁ

Abstract: An accurate and fast algorithm for computing the bidiagonal decomposition of strictly totally positive h-Bernstein-Vandermonde (hBV) matrices is presented. The hBV matrices are a generalization of the Vandermonde matrices obtained when replacing the monomial basis by the h-bernstein basis, a generalization of the Bernstein basis used in the area of CAGD. This bidiagonal decomposition is the initial step for solving in an accurate and efficient way several numerical linear algebra problems for these matrices.

CP A1-3-2 10 5 **15:50-16:10**

Bivariate polynomial regression by using the Bernstein basis

ANA MARCO	UNIVERSIDAD DE ALCALÁ
JOSÉ-JAVIER MARTÍNEZ	UNIVERSIDAD DE ALCALÁ
RAQUEL VIAÑA	UNIVERSIDAD DE ALCALÁ

Abstract: In this work, an algorithm for computing the bivariate regression polynomial in the bivariate tensor product Bernstein basis is given. The algorithm exploits the generalized Kronecker product structure of the Moore-Penrose inverse of the coefficient matrix of the linear system corresponding to the least squares polynomial fitting problem, and also the structure of the involved Bernstein-Vandermonde matrices. The numerical advantages of using the Bernstein basis instead of the monomial basis are shown.

CP A1-3-2 10 6 **16:10-16:30**

Accurate computation of the roots of orthogonal polynomials with totally positive Jacobi matrices

Ana Marco	Universidad de Alcalá
José-Javier Martínez	Universidad de Alcalá
Raquel Viaña	Universidad de Alcalá

Abstract: As we know from the work of Golub and Welsch, the roots of orthogonal polynomials can be computed as eigenvalues of the corresponding (symmetric and tridiagonal) Jacobi matrices. An important additional property of the Jacobi matrices, which arises in some families of orthogonal polynomials, is their total positivity. For this case it is shown how the use of algorithms for computing eigenvalues of totally positive matrices improves the accuracy of the computation of those roots.

POSTERS

PA Session

Monday, July 15
Tuesday, July 16

PA-001

Chaotic dynamics in disordered nonlinear lattices

Bob Senyange	University of Cape Town
Bertin Many	University of Cape Town
Haris Skokos	University of Cape Town

Abstract: We extend the findings of Skokos et al (Phys. Rev. R, 2013) and study the chaotic behaviour of two typical disordered nonlinear lattices, the Klein-Gordon (KG) model and Discrete Nonlinear Schrodinger Equation (DNLS), for different initial excitations. We compute the most commonly used chaos indicators, i.e. the maximum Lyapunov Characteristic Exponent (mLCE) and classify the different dynamical behaviours of the models according to the time evolution of the mLCE and the corresponding deviation vector distribution.

PA-002

Data driven parametrization of memory effect in the overdamped Langevin equation

Felix Xiaofeng Ye	Johns Hopkins University
Fei Lu	Johns Hopkins University

Abstract: Mathematical modeling for complex systems and processes requires concepts and techniques from stochastic dynamics. For stochastic systems with high dimensions, constructing an accurate stochastic reduced model is difficult and expensive. Inspired by Mori-Zwanzig formalism, we will present the results on constructing the generalized Langevin equations for the stochastic reduced model. Methods to learn the Markovian terms and memory terms are discussed. Numerical examples, including the linear case will be shown.

PA-003

Fast-wave averaging with phase changes: Application to moist atmospheric dynamics

Yeyu Zhang	University of Wisconsin-Madison
Leslie Smith	University of Wisconsin-Madison
Sam Stechmann	University of Wisconsin-Madison

Abstract: The reduced limiting dynamics for strong rotation and stratification Boussinesq equation is developed including the presence of phase changes of water. The impact from water and rainfall on dynamics of resonant triad interactions doesn't exist without phase changes. However, due to the nonlinearity entering through the effects of phase changes, it's quite possible that the waves could impact the phase interface and cause a time-averaged velocity and also theoritical conclusion is potentially supported by 3D-simulation.

PA-004

Finite time blow up in a diffusive Leslie-Gower-type tritrophic food chain model.

Vikas Kumar	IIT Mandi
Nitu Kumari	IIT Mandi

Abstract: In this work, a Leslie-Gower-type tritrophic food chain model has been analyzed where the middle predator population consumes their own species to survive. We have observed that the solutions of the model system can blow-up in finite time, for sufficiently large initial conditions and even in some parametric restrictions (in both ODE and PDE). We perform linear stability analysis to obtain Turing instability conditions and obtained Turing patterns (in 1d and 2d) via numerical simulation.

PA-005

From synchronization to extreme events among interacting moving oscillators

SAYANTAN NAG CHOWDHURY	INDIAN STATISTICAL INSTITUTE
SOUMEN MAJHI	INDIAN STATISTICAL INSTITUTE
DIBAKAR GHOSH	INDIAN STATISTICAL INSTITUTE

Abstract: We present a model of moving autonomous agents where the network connectivity pattern changes over time due to the motion of the agents, We perform analysis over such a platform while casting the agents' dynamics by that of chaotic oscillators. Whenever all the interacting zones are attractive, it induces complete global synchronization whereas additional repulsive zones strongly deflect the synchrony and short-lasting, recurrent deviations characterizing extreme events emerge in the network.

PA-006

Generating Topological Template From Symbolic Dynamics of Diamagnetic Kepler Problem

Zuo-Bing Wu	Institute of Mechanics, Chinese Academy of Sciences

Abstract: In this paper, a method to generate topological template in terms of symbolic dynamics for the diamagnetic Kepler problem is proposed. The rotation numbers computed from the topological template are in agreement with those from their original definition. This work was supported by the National Natural Science Foundation of China through the Grants Nos. 11172310 and 11472284.

PA-007

"Mathematical model to describe the environmental propagation of Salmonella"

Joan Poveda Giner	UPV
Begoña Cantó	UPV
Carmen Coll	UPV
María Jesús Pagán	UPV
Elena Sánchez	UPV

Abstract: We present a discrete dynamic model in difference equations to model the propagation of Salmonella in process of hygiene and food safety. For that we obtain the basic reproductive number. This number determine the number of new infected individuals obtained from a primary source. Finally, using the basic reproductive number we present a bounded to determine the maximum period in which the proposed control actions must be applied so that the disease is eradicated.

PA-008

MINIMAL AND MAXIMAL SOLUTION FOR NONLINEAR VOLTERRA TYPE RANDOM INTEGRAL EQUATIONS

Siddharth Shete	Swami Ramanand Teerth Marathwada University,

Abstract: In this research paper we prove the existence of minimal and maximal solution for Nonlinear Volterra type random integral equations in separable Banach space under mixed generalized compactness, contraction conditions.

PA-009

On attractors for impulsive dynamical systems

José Manuel Uzal	Universidade de Santiago de Compostela

Abstract: Impulsive dynamical systems describe the evolution of systems where the continuous development of certain processes is interrupted by instantaneous changes in their state at certain moments of time. In this poster, we present some results on the theory of impulsive dynamical systems in both the autonomous and non autonomous cases and different concepts of attractors, and we study its existence along with some of their properties.

PA-010

Periodic solutions in a AFM

Johan Sebastian Duque	Universidad Tecnológica de Pereira

Alexander Gutierrez	Universidad Tecnológica de Pereira

Abstract: In this work, we presented a non-linear model of an atomic force microscope (AFM) considering Lennard-Jones potential and squeeze film damping friction. In particular, we are interested in the existence-uniqueness and stability of periodic solutions when introducing a periodic forcing into the system. The analytic and numerical approach is presented to verify the solutions.

PA-011

Positive strongly decreasing solutions of Emden-Fowler type second-order difference equations with regularly varying coefficients

Aleksandra Kapešić	Faculty of Sciences and Mathematics
Jelena Manojlović	Faculty of Sciences and Mathematics

Abstract: Positive decreasing solutions of the nonlinear difference equation $\Delta(p_n|\Delta x_n|^{\alpha-1}\Delta x_n) = q_n|x_{n+1}|^{\beta-1}x_{n+1}, \quad n \geq 1, \quad \alpha > \beta > 0,$ are studied under the assumption that p, q are regularly varying sequences. Necessary and sufficient conditions are established for the existence of regularly varying strongly decreasing solutions and it is shown that the asymptotic behavior of all such solutions is governed by a unique formula.

PA-012

Stability analysis using dynamical systems in modified gravity

Parth Mukeshbhai Shah	BITS Pilani, KK Birla Goa Campus
G. C. Samanta	BITS Pilani, KK Birla Goa Campus

Abstract: Modified gravity theories have received increased attention lately to understand the late time acceleration of the universe. Among numerous extensions to Einstein's theory of gravity, $f(R)$ theories have received several acknowledgments. In our current work we try to understand the acceleration of the universe in modified geometric space using dynamical system analysis. This technique also allows understanding the behavior of the universe and its stability analysis which could then be compared with observational data.

PA-013

The price dependence on quantity harvested in bioeconomic models

Nossaiba Baba	University of Hassan II

Abstract: In this work, we developed a bioeconomic model combining a competition model and a prey-predator model of three fish populations. We have calculated that we maximize fishermen's benefits by respecting two constraints, the first sustainable management of resources and the preservation of fish biodiversity. The main objective of this work was mainly to consider that the price of the population was modified, which is closer to reality. which assume that prices are constant.

PA-014

Tracing Inter-Personal Contact of Ebola Virus Disease with quarantine: Optimal Control

Chinwendu Emilian Madubueze	University of Agriculture, Makurdi, Nigeria

Abstract: A deterministic model of EVD that incorporates the effect of tracing inter-personal contact of EVD infective and quarantine is discussed. The existence and stabilities of equilibrium states of EVD model are established. Furthermore, optimal control model is presented by incorporating control efforts for tracing the infected individuals as well as exposed. The result indicated that tracing inter-personal contact of EVD infectives and quarantine them can help eliminate the spread of EVD in the population.

PA-015

Travelling waves in Metamaterials

Makrina Agaoglou	University of Bristol
Michal Feckan	Comenius Univeristy
Michal Pospisil	Comenius University
Vassilios Rothos	Aristotle University of Thessaloniki
Hadi Susanto	University of Essex

Abstract: In this work we investigate a one-dimensional parity-time (PT)-symmetric magnetic metamaterial consisting of split-ring dimers having gain or loss. Employing a Melnikov analysis we study the existence of localized travelling waves, i.e. homoclinic or heteroclinic solutions. We find conditions under which the homoclinic or heteroclinic orbits persist. Our analytical results are found to be in good agreement with direct numerical computations.

PA-016

A locally-refined quadtree finite-volume staggered-grid scheme

Melanie Lipp	University of Stuttgart
Rainer Helmig	University of Stuttgart

Abstract: Coupled porous-medium-flow free-flow processes appear in a wide range of applications. To sufficiently resolve the free flow close to a rough interface, for instance for simulating soil-water evaporation, a locally-refined staggered-grid scheme with hanging nodes has been implemented for the Navier-Stokes equations in the open-source simulator DuMuX with the motivation to increase efficiency.

PA-017

Fluid Flow and Heat Transfer of a Viscous Incompressible Fluid between a Rotating Solid Disk and a Stationary Permeable Disk using the Brinkman-Darcy Model

DAYLE JOGIE	ST. GEORGE'S COLLEGE
BALSWAROOP BHATT	THE UNIVERSITY OF THE WEST INDIES

Abstract: Momentum and heat transfer has been studied for the case of a viscous incompressible fluid between a rotating solid and a stationary permeable disk. Navier-Stokes equations govern the flow in the free fluid, while Brinkman and Darcy equations are utilized in the porous domain. A two-step numerical process is employed for solution; series expansions in MAPLE, followed by bvp4c in MATLAB. Dependencies on relevant parameters such as Reynolds number and permeability are subsequently discussed.

PA-018

Magnetohydrodynamic Flow and Heat Transfer of Ferrofluid over a Horizontal Circular Cylinder with Thermal Radiation Effect

Siti Hanani Mat Yasin	Universiti Malaysia Pahang
Muhammad Khairul Anuar Mohamed	DRB-HICOM University of Automotive Malaysia
Zulkhibri Ismail @ Mustofa	Universiti Malaysia Pahang
Mohd Zuki Salleh	Universiti Malaysia Pahang

Abstract: Magnetohydrodynamic flow and heat transfer of ferrofluid over a horizontal circular cylinder with constant wall temperature and thermal radiation effect is investigated. For this purpose, ferrofluid which contains magnetite, Fe3O4 and water are considered. The nonlinear of partial differential equations are solved numerically using Keller-box method. Numerical results for the solutions of ferrofluid flow and heat transfer characteristics are prominently affected by magnetic parameter, volume fraction of ferroparticles parameter and radiation parameter were discussed.

PA-019

Monte-Carlo particle methods for non-equilibrium multiphase flows

Mohsen Sadr	RWTH Aachen University
Hossein Gorji	EPFL
Manuel Torrilhon	RWTH Aachen University

Abstract: Multiphase flows far from equilibrium can be described accurately via the Enskog-Vlasov kinetic equation, in contrast to continuum models which suffer from the closure problem. In this study, an efficient yet accurate Monte-Carlo method is introduced as a solution method of the Enskog-Vlasov equation. Here, collisions are modelled by a continuous stochastic process, while long-range interactions are captured by the elliptic opertor. Good agreements with benchmark results are observed in evaporation and inverted-temperature gradient scenarios.

PA-020

Numerical models for nonlinear ultrasound in bubbly liquids

Maria Teresa Tejedor Sastre	Universidad Rey Juan Carlos
Christian Vanhille	Universidad Rey Juan Carlos

Abstract: This work studies the nonlinear propagation of ultrasound in bubbly liquids. Numerical models in several dimensions are developed to solve a system formed by the wave and a Rayleigh-Plesset equations, which describes the nonlinear interaction between acoustic field and bubble vibrations. Our results show different characteristics of the waves in the nonlinear and dispersive media. This work is funded by AEI-ERDF (Spain, DPI2017-84758-P).

PA-021

Transformation of long surface waves in the coastal zone with a variable bathymetry

Andrei Ermakov	University of Southern Queensland
Yury Stepanyants	University of Southern Queensland

Abstract: The transformation of long linear waves in a coastal zone of an ocean with the variable bathymetry is considered. The coefficients of transmission and reflection are calculated as the functions of frequency and the total depth drop for three typical models: (i) piece-linear, (ii) piece-quadratic, and (iii) hyperbolic tangential depth profiles. Wave scattering on three models of underwater barrier/trench are also studied; the results obtained are compared with each other and with earlier obtained.

PA-022

Bidiagonal decomposition and accurate computations with Laguerre matrices

Héctor Orera	Universidad de Zaragoza
Jorge Delgado	Universidad de Zaragoza
Juan Manuel Peña	Universidad de Zaragoza

Abstract: Matrices with all minors nonnegative are called totally positive (TP) matrices. Nonsingular TP matrices admit a unique bidiagonal decomposition, which can be used as a parameterization to perform many algebraic computations with high relative accuracy (HRA). We have developed an accurate method to obtain the bidiagonal decomposition of collocation matrices of generalized Laguerre polynomials and of Lah matrices, which is the key tool to compute their eigenvalues, singular values and inverses with HRA.

PA-023

An innovative approach to solve triangular type-2 intuitionistic fuzzy matrix games

Tina Verma	Indian Institute of Technology Ropar

Abstract: Matrix games deals with real life situations and for matrix games, the payoffs should be known in advance. The payoffs for the matrix games were considered as real numbers which are unable to represent real life situations. To be more realistic, the classical theory is generalised by fuzzy set theory which involves linguistic terms, uncertainty. An approach for solving matrix games with triangular type-2 intuitionistic fuzzy payoffs is proposed and used it for water management.

PA-024

Decentralized and Asynchronous Spillover Algorithm for Capacitated Lot Sizing Problem

Marin Lujak	IMT Lille Douai
Eva Onaindia	Universitat Politècnica de València
Alberto Fernandez	University Rey Juan Carlos

Abstract: In this paper, we study decentralized approaches to the capacitated lot sizing problem (CLSP). Apart from production and manufacturing, CLSP formulation can be effectively used in many other scenarios like grid computing, energy management, healthcare, and transportation. We develop a decentralized mathematical model for the CLSP and a time-effective and optimal decentralized heuristic algorithm based on the spillover effect. We demonstrate the functioning of the algorithm and compare it with the results obtained in CPLEX.

PA-025

Dynamic Pricing In Insurance

Yuqing Zhang	The University of Manchester
Neil Walton	The University of Manchester

Abstract: We study the dynamic pricing in insurance from the perspective of an insurance company. We consider the problem of online revenue management for selling a new product. The insurance company can only observe realised demand and incurred claims but does not know the underlying functions for the product. We develop two pricing models: parametric and non-parametric models to balance between exploration (demand/claims learning) and exploitation (pricing) trade-off, to maximize revenues.

PA-026

Effective Competency-based Differential Evolution Algorithm for Numerical Optimization

Harish Sharma	Rajasthan Technical University Kota India

Abstract: In Differential Evolution (DE) algorithm, every solution is given an equal chance to take part in the solution search process and in case of stagnation; it is difficult to get out from this situation. Therefore, a competency-based position update process is integrated with DE to boost the speed of convergence in addition to the diversification ability of the algorithm. The efficiency of the proposed algorithm is analyzed over a set of 20 real-world optimization problems.

PA-027

Group decision making in multi-objective optimization

Surafel Luleseged Tilahun	Department of Mathematical Sciences, University of Zululand

Abstract: Optimization problems, formulated from a real scenario, involves multiple and often conflicting objectives. A compromised solution is said to be Pareto optimal if it is not possible to improve any of the objectives without worsening another. Choosing one among this set of Pareto optimal solutions depends on the preference of a decision maker. In some cases there will be multiple decision makers, possibly with conflicting preference. This research presents group preference in multi-objective optimization.

PA-029

Maximum entropy distiributions in Wasserstein balls

Luis Felipe Vargas	Universidad de Los Andes
Mauricio Velasco	Universidad de Los Andes

Abstract: We present a method for finding the probability distribution of maximum entropy contained in the Wasserstein ball of a given radius centered in the empirical measure defined by n data-points in ^{k}. Such distributions are the most general (minimizing the amount of prior information) and are therefore of central importance in statistical inference. The poster will contain new theoretical results on how to efficiently describe such probability distributions as well as some practical implementation results.

PA-030

Non-convex Analysis of Multi-Graph Matching

Vahan Huroyan	University of Arizona
Gilad Lerman	University of Minnesota
Deepti Pachauri	3M

Abstract: The Multi-Graph Matching (MGM) problem assumes a set of graphs with fixed number of vertices and one-to-one correspondence maps between the vertices of each pair. Given only noisy measurements of the mutual correspondences, the MGM problem asks to improve the correspondence maps between pairs. We propose an iterative algorithm (with guarantees of linearly convergence) to solve the non-convex MGM problem. Numerical experiments demonstrate the competitive speed and accuracy of our method compared to state-of-the-art methods.

PA-031

Predispatch of a Hydrothermal System with Maneuvers and Ramp Constraints

Silvia Carvalho	UFSCAR
Mayk Coelho	UNIFAL
Aurelio Oliveira	UNICAMP

Abstract: The primal-dual interior point methods will be developed for the problem of loss minimization in the generation and transmission of predispatch of a hydrothermal system where programmed maneuvers and ramp constraints occur. The thermal generating units have ramp constraints because they need a certain amount of time to change de level of power delivery. The consideration of additional maneuvers and constraints approximates the model of the predispatch problem of the Brazilian system.

PA-032

Reinforcement Learning for Optimizing Air Traffic Control

Lingyi Yang	University of Oxford
Samuel Cohen	University of Oxford
Jaroslav Fowkes	University of Oxford

Abstract: Landings at airports are constrained by runway availability. As demand for air travel continues to rise, we need to determine how arrival management can be optimized to ensure minimal delay. Reinforcement learning methods have become increasingly popular in applications. We use these methods to design a system that can recommend instructions for air traffic control. We reduce the state/action space by applying function approximation and show results on a simplified model.

PA-033

Scenario Clustering and Reduction for Decision Problems under Uncertainty

Elvira Moreno	Universidad de los Andes
Mauricio Junca	Universidad de los Andes

Abstract: We study methods for scenario clustering applicable to reduce the size of decision problems under uncertainty, particularly those with a large number of scenarios. In brief, these methods consist on defining a graph structure over the set of scenarios and implementing appropriate clustering algorithms, so that scenarios belonging to the same cluster lead to mutually agreeable decisions. The problem is hence significantly reduced, as only one representative of each cluster needs to be considered.

PA-034

SOLVING THE RADIATION THERAPY DESIGN PROBLEM USING INTERIOR POINT METHODS

JACKELINE DEL CARMEN HUACCHA NEYRA	UNIVERSIDADE ESTADUAL DE CAMPINAS, UNICAMP
AURELIO RIBEIRO LEITE DE OLIVEIRA	UNIVERSIDADE ESTADUAL DE CAMPINAS, UNICAMP

Abstract: A Radiation Therapy Design Problem consists in minimize the total radiation dosage at the patient. In this work, the dosage values are represented by fuzzy numbers. The transition from healthy tissue to tumour cells is continuous and the surprise function is adopted. This formulation has been solved by a general purpose software. We propose to solve it by a specially tailored Prima-Dual Interior Point Method and present numerical experiments with real world large-scale problems.

PA-035

Stabilized Barzilai-Borwein methods

Oleg Burdakov	Linköping University
Yu-Hong Dai	Academy of Mathematics and Systems Science, Chinese Academy of Sciences
Na Huang	China Agricultural University

Abstract: In this poster, we will introduce the stabilized Barzilai-Borwein method for the linear systems and the unconstrained optimization problems. The stabilization approach consists in bounding the distance between each pair of successive iterates. It is aimed at decreasing the number of iterations. Under suitable assumptions, we show that the stabilized Barzilai-Borwein method converges to the solution of the problems. Numerical experiments are also presented to demonstrate the usefulness of the stabilized Barzilai-Borwein method.

PA-036

The Equilibrium Existence of a Strategic Influence Game in Social Networks

Xujin Chen	Chinese Academy of Sciences
Xudong Hu	Chinese Academy of Sciences
Xiaoying Wu	Chinese Academy of Sciences

Abstract: We study the game model of strategic influence in a social network, recently investigated by Grabisch et al..We focus on an rule for agent opinion update that is different from the counterpart in the work by Grabisch et al., and exemplify that this rule relaxes the conditions for the existence of pure-strategy equilibria in a sequence of networks. We also give a sufficient and necessary condition for the existence of equilibria.

PA-037

Time-sparse discretization for parabolic optimal control with measures

Evelyn Herberg	Universität Koblenz Landau
Michael Hinze	Universität Koblenz Landau
Henrik Schumacher	RWTH Aachen

Abstract: We consider a parabolic optimal control problem governed by space-time measure controls and compare two approaches to discretize this problem. The first approach has been considered by Casas, E. & Kunisch, K. and employs a discontinuous Galerkin method for the state discretization. In the second approach we use variational discretization of the control problem utilizing a Petrov-Galerkin approximation of the state which induces controls that are composed of Dirac measures in space and time.

PA-038

On a boundary value problem with a Nagumo Condition

Rabah Khaldi	University Badji Mokhtar Annaba
Assia Guezane Lakoud	University Badji Mokhtar Annaba

Abstract: This poster concerns the existence and localization of solutions for a generalized Emden-Fowler equation involving a conformable derivative and with a Dirichlet boundary condition. Our approach is based on the lower and upper solutions method and Schauder fixed point theorem.

PA-039

Stability of solutions to fractional differential equations with time-delays

Assia Guezane-Lakoud	Badji Mokhtar Annaba University
Rabah Khaldi	Badji Mokhtar Annaba University

Abstract: In this presentation we discuss, by the help of fixed point theorems, the existence, uniqueness and stability of solutions for a nonlinear fractional boundary value problem with variable delays.

PA-040

The family of periodic orbits generated by the 4-body Schubart orbit

Valerie Chopovda	Massey University
Winston Sweatman	Massey University

Abstract: We present a one-parameter planar family of periodic orbits for the equal-mass 4-body problem. This family begins and ends with the Schubart interplay orbit.

PA-041

The SUNDIALS Suite of Nonlinear and Differential/Algebraic Equation Solvers

David Gardner	Lawrence Livermore National Laboratory
Carol Woodward	Lawrence Livermore National Laboratory
Daniel Reynolds	Southern Methodist University

Alan Hindmarsh Lawrence Livermore National Laboratory
Cody Balos Lawrence Livermore National Laboratory

Abstract: SUNDIALS is a suite of robust and scalable time integrators and nonlinear solvers. The six SUNDIALS packages (CVODE(S), ARKode, IDA(S), and KINSOL) are built on shared APIs for vector, matrix, linear solver, and nonlinear solver moules. This module design allows for user-defined/application-specific data structures and solvers, encapsulated parallelism, and algorithmic flexibility. This poster presentation will overview the capabilities of SUNDIALS packages and discuss recent efforts on the development and implementaiton of multirate integration methods.

PA-042

A Low-Communication Method to Solve Poisson's Equation on Locally-Structured Grids

Peter McCorquodale Lawrence Berkeley National Laboratory
Phillip Colella Lawrence Berkeley National Laboratory
Brian Van Straalen Lawrence Berkeley National Laboratory
Christos Kavouklis Lawrence Livermore National Laboratory

Abstract: This poster describes an algorithm, Method of Local Corrections (MLC), and high-performance implementation for solving Poisson's equation with infinite-domain boundary conditions, on locally-refined nested rectangular grids. Communication is about 1/10 of that for traditional multigrid iteration. Most time is spent in 3D FFTs on small domains. We find comparable solve times between HPGMG on a uniform grid with 109 grid points, and MLC on 109 grid points adaptively distributed with much higher finest-level grid resolution.

PA-043

A multiscale approximation of a Cahn–Larché system with phase separation on the microscale

Lisa Reischmann University of Augsburg
Malte Peter University of Augsburg

Abstract: Motivated by phase separation processes observed in lipid monolayers, we consider the Cahn–Hilliard equation coupled with the equations of linear elasticity, the so-called Cahn–Larché system, in a multiscale setting. We assume the pattern of the evolving microstructure to have an intrinsic length scale, which, after nondimensionalisation, leads to a scaled model suitable for periodic-homogenisation techniques. We further present a linearised Cahn–Larché system, derive the associated limit problem and discuss its properties.

PA-044

Applications of a geometric partial differential equation

Francisco Milán Universidad de Granada

Abstract: The Hessian one equation and its complex resolution provides an important tool in the study of improper affine spheres. Conversely, the properties of these surfaces play an important role in the development of geometric methods for the study of their PDEs. We review some results of this good interplay related with the classical Ribaucour transformations, the Cauchy problem and their admissible singularities, mainly, isolated singularities and singular curves with cuspidal edges and swallowtails.

PA-045

Average vector field method of the strongly coupled nonlinear Schrödinger equation

Canan Akkoyunlu istanbul kültür üniversity

Abstract: In this paper, average vector field method (AVF) is derived for strongly coupled Schrödinger equation (SCNLS). The SCNLS equation is discretized in space by finite differences and is solved in time by structure preserving AVF method. Numerical results for different paremeter compare with the Lobatto IIIA-IIIB method. The results indicate that AVF method are effective to preserve global energy and momentum.

PA-046

Conforming and non-conforming Finite Element Methods for the Landau-de Gennes Minimization Problem of Liquid Crystals

Ruma Rani Maity Indian Institute of Technology Bombay
Apala Majumdar University of Bath
Neela Nataraj Indian Institute of Technology Bombay

Abstract: We consider a system of second-order non-linear elliptic partial differential equations modeling equilibrium configurations of a two dimensional planar bistable nematic liquid crystal device. We analyze conforming and non-conforming finite element methods to approximate the regular solutions of the non-linear partial differential equations. The existence and local uniqueness of discrete solution of the non-linear problem is established using a fixed point argument. A priori error estimates in energy norm and L^2- norm has been derived.

PA-047

Existence and asymptotic behaviour of travelling waves in non-linear diffusion evolution equations

Alejandro Gárriz Facultad de Ciencias

Abstract: I will first study the existence of solutions of evolution equations in their more general form, accepting a wide variety of diffusion, convection and reaction terms, that causes the differential equation to be fully non-linear. This study will be developed through the study of an integral equation related to the problem. Later on I will consider the propagation and asymptotic behaviour of a particular case, the p-laplacian porous medium equation with reaction

PA-048

Existence result of renormalized solutions for generalized porous medium equations with initial measure data

Abdellaoui Mohammed University of Fez, Faculty of Sciences Dhar El Mahraz
Azroul Elhoussine University of Fez, Faculty of Sciences Dhar El Mahraz

Abstract:

We study the existence of renormalizeed solutions of a system of nonlinear porous medium equations with natural gradient term g(u)—u—p and measure initial data b(x,u0) of the form b(x,u) t - div(a(t,x,u,u))+g(u)—u—p=f in (0,T), u=0 on (0,T), b(x,u)(0)=b(x,u 0) in. We prove the compactness of the truncation of solutions in the energy space and we show that the integrability of g at infinity is a necessary and sufficient condition for a stability result.

PA-049

Fundamental solution of second-order parabolic equations in non-divegence form

Sungjin Lee Yonsei university
Seick Kim Yonsei university

Abstract: Fundamental solutions play an important role in studying parabolic partial differential equations. When the coefficients are sufficiently smooth, say Holder continuous, then the existence and pointwise estimates of fundamental solutions are well established. However, when the coefficients are merely continuous, then fundamental solutions do not necessarily exist as functions. We show that if the mean oscillation of the coefficients satisfy the Dini condition, then the fundamental solution exists and has the usual Gaussian bounds.

PA-050

Ion-Acoustic Shock Waves in Inhomogeneous Magnetized Plasma Modeled by Modified KdV-Burgers' Equation with Variable Coefficients

Vikas Kumar DAV College Pundri, Kaithal

Abstract: In this work, modified KdV-Burgers' equation is studied by the Lie symmetry approach. The infinitesimals of the group of

transformations which leaves this equation invariant are furnished along with the admissible forms of the variable coefficients. The optimal system of one-dimensional subalgebras of the Lie symmetry algebras is determined. These are then used to establish Ion-Acoustic Shock Waves with the help of power series method. Further, some numerical solutions are obtained.

PA-051

NONLINEAR HEAT FLOW PROBLEMS ACROSS IRREGULAR INTERFACES

Simone Creo	Sapienza Università di Roma
Maria Rosaria Lancia	Sapienza Università di Roma

Abstract: We consider nonlinear (possibly nonlocal) heat transfer across thin highly conductive irregular layers, in particular of fractal type. Mathematically, these problems are modeled by Venttsel' problems for the p-Laplace operator. Existence, uniqueness and regularity results will be discussed as well as the numerical approximation of the problem at hand.

PA-052

On the evolution of Vortex Filament Equation for regular M-polygons with nonzero torsion.

Francisco De La Hoz Mendez	UPV\EHU
Sandeep Kumar	Basque Center for Applied Mathematics
Luis Vega Gonzalez	Basque Centre for Applied Mathematics

Abstract: The Vortex Filament equation describes the self-induced motion of a vortex filament in three dimensions. In this poster, we consider M sided polygonal curves with a nonzero torsion which approximate the continuos curves such as helix and straight line. Using both theoretical and numerical arguments, we describe the evolution of these curves and show that the trajectory of a single point exhibits a multi-fractal phenomenon and resembles to a version of Riemann's non-differentiable function.

PA-053

Optimal classification, exact solutions and wave interactions for Euler sustem with large friction

Sueet Millon Sahoo	Indian Institute of Technology, Kharagpur

Abstract: We derive Lie symmetry group classification and construct all the invariant functions which help us to find optimal systems for Euler system with large friction. Further, the evolution of a characteristic shock and its interaction with weak discontinuity are studied with the help of exact solution. The properties of reflected, transmitted waves and the jump in shock acceleration influenced by the incident wave amplitude are completely characterized.

PA-054

Reiterated Periodic Homogenization of integral functionals with convex and nonstandard growth integrands.

Fotso Tachago Joel	The University of Bamenda
Nnang Hubert	University of Yaounde 1: Hih University of Yaounde I, EcoleNormale Superieure de Yaounde
Zappale Elvira	University of Salerno

Abstract: Reiterated Periodic Homogenization is adapted to Orlicz-Sobolev setting. It is shown by the reiterated periodic two-scale convergence method that the sequence of minimizers of class of highly oscillatory minimizations problems involving convex functional, converges to the minimizers of a homogenized problem with a suitable convex function.

PA-055

Role of flexible porous breakwaters in reducing structural responses of a very large floating structure

SOFIA SINGLA	IIT ROPAR
SUBASH CHANDRA MARTHA	IIT ROPAR
TRILOCHAN SAHOO	IIT KHARAGPUR

Abstract: The boundary value problem for the reduction of hydroelastic response of a very large floating structure by flexible porous vertical barriers over a flatbed is examined for its solution. The problem is formulated on the assumption of linearized water wave theory and small amplitude structural response. Eigenfunction expansion method is used to solve the problem involving Laplace's equation and mixed boundary conditions. The effectiveness of barriers is analyzed through reflection and transmission coefficients.

PA-056

Singular perturbations and nanopteron traveling waves in nonlinear lattices

Timothy Faver	Leiden University

Abstract: Material heterogeneities in infinite nonlinear lattices often induce singular perturbations in the lattice equations of motion. We study how these singular perturbations may excite nanopteron traveling waves in diatomic lattices under the ``long wave'' and ``equal mass'' limits. Such waves consist of an exponentially localized ``core'' asymptotic to a small-amplitude ``far-field'' periodic oscillation. We highlight the physical relevance of the different limits under which the nanopteron emerges and emphasize the common underlying mathematical techniques.

PA-057

Spectral properties of layer potentials arising from conductivity problems in composite media

Dong-ha Kim	Yonsei University

Abstract: Layer potentials are successfully used in solving boundary value problems for Laplace equations or more general elliptic equations. Recently, layer potential methods are also used in studies related to composite media with smooth inclusions. Suppose there are two inclusions D_1 and D_2 that are touching or nearly touching. We investigate spectral properties normal derivative on ∂D_1 of the single layer potential on ∂D_2 and obtain estimates independent of seperation.

PA-058

Stabilization for a Wave Equation in Inhomogeneous Medium with Localized Nonlinear Damping

Marcelo Cavalcanti	State University of Maringá
Valéria Domingos Cavalcanti	State University of Maringá
Ryuichi Fukuoka	State University of Maringá
Ademir Pampu	State University of Maringá
María Rosario Astudillo Rojas	Federal University of Paraná

Abstract: We consider the semilinear wave equation posed in an inhomogeneous medium with smooth boundary subject to a non linear damping distributed around a neighborhood of the boundary according to the Geometric Control Condition. We also include a nonlinearity which is subcritical in the sense that it grows as a power of at most $p < 5$ in three dimensions. We show that the energy of the wave equation goes uniformly to zero.

PA-059

Symmetry Analysis and Power Series Solutions of Space-time Fractional Drinfeld-Sokolov-Satsuma-Hirota System

KOMAL SINGLA	Thapar Institute of Engineering & Technology
Meenakshi Rana	Thapar Institute of Engineering & Technology

Abstract: This work investigates the exact series solutions for a nonlinear fractional system of partial differential equations named Drinfeld-Sokolov-Satsuma-Hirota system with their time and space fractional derivatives. The symmetry approach along with the power series expansion technique is applied to determine the solutions of the considered fractional system.

PA-060

The Stefan problem with non-Fourier heat conduction

Marc Calvo Schwarzwälder Centre de Recerca Matemàtica
Timothy G. Myers Centre de Recerca Matemàtica
Matthew G. Hennessy University of Oxford

Abstract: Nanoscale applications often require knowledge of the thermal response of the device. Fourier's law is known to fail at small length- and time-scales and thus the classical equations have to be modified to account for the non-classical features, such as memory and non-local effects, that Fourier's law is not able to capture. We explore different non-classical heat transfer models and study how these alter the dynamics of a solidification process.

PA-061

Transmission problems for Brinkman-type systems in Lipschitz domains in R^3

Andrei-Florin Albisoru Babes-Bolyai University

Abstract: The aim of the presentation is to establish a well-posedness result for a transmission problem for the classical and the generalized Brinkman systems in complementary Lipschitz domains in R^3. We take into account the well-posedness result for a transmission problem for the standard Brinkman systems on complementary Lipschitz domains in R^3. Secondly, we prove our main result using a method based on Fredholm operator theory and the result from the first step.

PA-062

Unsupervised Deep Learning Algorithm for PDE-based Inverse Problems

Leah Bar Tel-Aviv University
Nir Sochen Tel-Aviv University

Abstract: We propose a neural network-based algorithm for solving inverse problems for partial differential equations in unsupervised fashion. The solution is approximated by a deep neural network which is the minimizer of a cost function, and satisfies the PDE, boundary conditions, and additional regularizations. The method is mesh free and can be easily applied to an arbitrary regular domain. We focus on 2D second order elliptical system with non-constant coefficients, with application to Electrical Impedance Tomography.

PA-063

Wave interactions and stability of the Riemann solution for a strictly hyperbolic system of conservation laws

Anupam Sen Indian Institute of Technology Kharagpur

Abstract: We study the interaction of delta shock wave with classical elementary waves such as shock waves, rarefaction waves and contact discontinuities for the one-dimensional strictly hyperbolic system of conservation laws with split delta function. We prove that Riemann solutions are stable under local small perturbations of the Riemann initial data. The global structure and large time asymptotic behaviour of the perturbed Riemann solutions are constructed and analyzed case by case.

PA-064

New estimation method of the two-dimensional autoregressive model. Application to image processing.

Grisel Maribel Britos Universidad Nacional de Córdoba
Silvia María Ojeda Universidad Nacional de Córdoba

Abstract: In this work, we present an estimator of the parameters of an AR-2D model. It uses an auxiliary model (BIP-AR) that limits the propagation of noise in an AR process. In addition, we analyzed the behavior of these new estimator (BMM 2D) and four well known estimators for the case of processes contaminated by Gaussian noise. We also show an application to the image processing obtaining favorable results for our estimator.

PA-065

Probabilistic information theory supplemented by Artificial Neural Network to study the meteorological consequences of a severe weather system in India

Surajit Chattopadhyay Amity University, Kolkata
Goutami Chattopadhyay University of Calcutta

Abstract: Probabilistic information theory through maximization of Shannon entropy is employed to test the relative contributions of some parameters in creating severe pre-monsoon thunderstorms. It follows as a consequence of this information theoretic approach through the formation of Lagrange function that surface temperature is the most important parameter among those considered. Finally, the artificial neural network in the form of multilayer perceptron with backpropagation learning is attempted to develop a predictive model for surface temperature.

PA-066

A Deterministic Model of Electron Transport for Electron Probe Microanalysis

Jonas Buenger RWTH Aachen University
Silvia Richter RWTH Aachen University
Manuel Torrilhon RWTH Aachen University

Abstract: Electron probe microanalysis involves the inverse problem of reconstructing the distribution of chemical elements within a solid material from characteristic x-ray measurements. To overcome limitations on the spatial resolution imposed by classical forward models we developed a new model, which is based on deterministic modelling of electron transport. It allows an efficient numerical solution, is flexible in accuracy and well suited for computationally efficient inversion using the adjoint state method in gradient-based optimisation.

PA-067

A study of spatial dynamics under the Prisoners' Dilemma and Hawk-Dove Games

Sangman Jung Kyung Hee University
Sunmi Lee Kyung Hee University

Abstract: In this work, we investigate the effects of two games on spatial dynamics: Prisoners' Dilemma and Hawk-Dove games. We employ three different approaches, including a lattice network model, replicator equations, and partial differential equations. We study spatial dynamics under various conditions: different payoff, and initial configurations. The results are compared with the ones of replicator equations and partial differential equations.

PA-068

Adaptive global magnetic-hydrodynamic simulations using sparse point representation

Maibys Sierra Lorenzo Meteorology Institute
Margarete Oliveira Domingues National Intitute for Space Research
Odim Mendes National Intitute for Space Research
Ángela León Mecías Havana University

Abstract: Global magneto-hydrodynamic (MHD) models are important tools to study solar wind–magnetosphere interactions. In regular meshes, MHD models demands a huge amount of CPU time. To bypass these constrains we combine a 3D global MHD code that use finite difference methods in space discretization with the interpolating wavelet technique, Sparse Point Representation. We reduce significantly the CPU time preserving the accuracy of the model. This combination can be also useful to other finite difference models.

PA-069

Crowding and queuing in pedestrian crowds

Michael Fischer Österreichische Akademie der Wissenschaften
Marie-Therese Wolfram Österreichische Akademie der Wissenschaften

Abstract: Pedestrian crowds exhibit complex behaviour. The geometry (corridor or open space) as well as social cues influence exit-behaviour and observed pedestrian densities, as experiments conducted at Forschungszentrum Juelich reveal. We investigate the impact of these parameters in a cellular automata approach and on the corresponding PDE level using computational and analytic tools. In the latter case, we

are interested in showing existence and uniqueness of solutions to the nonlinear Fokker-Planck equation using entropy methods.

PA-070

Efficient monolithic projection method with staggered time discretization for natural convection problems

Xiaomin Pan	Yonsei University
Ki-Ha Kim	Yonsei University
Jung-Il Choi	Yonsei University

Abstract: We improve a previous method (J.Comput.Phys. , vol. 334, 2017, 582--606), FDMPM-1P, using staggered time discretization for natural convection problems. The governing equations are discretized with Crank-Nicolson scheme, where temperature and pressure are evaluated at half-integer time levels, while velocity at integer time levels. Numerical simulations show that proposed method is more efficient and stable than FDMPM-1P. Further, proposed method provides accurate predictions of 2D RBC under different boundary conditions and 3D turbulent RBC.

PA-071

Experimental calibration of a numerical scheme simulating the sediment transport problem in an open channel.

Angel Balaguer-Beser	Universitat Politècnica de València
Beatriz Nácher-Rodríguez	Universitat Politècnica de València
Francisco José Vallés Morán	Universitat Politècnica de València

Abstract: In this paper, a well-balanced finite volume scheme is used to solve the sediment transport equations in channels with irregular geometry. Several mathematical expressions have been evaluated to model the energy losses and sediment flow in the environment of bridge structures. The comparison with laboratory experiments, carried out in a sand bed open channel, has allowed an assessment of the accuracy of numerical results and the calibration of some parameters used in the mathematical model.

PA-072

Investigation of networks of exclusion processes with interactions.

Tripti Midha	Indian Institute of Technology Ropar
Arvind Kumar Gupta	IIT Ropar

Abstract: We investigate a network consisting of a vertex V from which several lattices converge and diverge together. Each of the lattice undergoes the totally asymmetric simple exclusion process with interactions. The model is motivated by the biological and vehicular transport processes. Using theoretical approaches and computer simulations, we find that the additional interaction energy increases the traffic flow while the extra outgoing segments smooth out the transport.

PA-073

Mathematical analysis and numerical methods for internal incompressible flows with inertial-dissipative inflow/outflow conditions.

Kamil Wołos	Warsaw University of Technology
Przemysław Kosewski	Warsaw University of Technology

Abstract: Boundary conditions play significant role in PDE system. Our aim is to analyse special type of boundary conditions created to simulate flows in cardiovascular and respiratory systems. Firstly, we will focus of mathematical correctness of proposed conditions. Next, we will describe method of discretisation of a Stokes system equipped with mentioned conditions. Finally we will show results of simulations and highlight effects following from assumed boundary conditions in comparison to standard open boundary conditions.

PA-074

Mathematical model for diversity of cell fate by canonical vs non-canonical dynamics of notch signaling

Kosuke Okuno	Hiroshima University
SEIRIN-LEE Sungrim	Hiroshima University

Abstract: Notch-Delta signaling is well-known cell-to-cell signaling pathway involved indetermination of cell fateand pattern formation during development. During the neurogenic phase of mouse brain development, only a part of neural precursor cells differentiates into neurons and the cell fate is regulated by some specific combination of notch and delta concentrations. In this study we introduce a mathematical model describing several dynamics of notch signaling pathway and finds how the dynamics can influence the cell fate.

PA-075

Mathematical model of active cochlear pressure

Fatima-Ezzahra Aboulkhouatem	Faculty of Sciences Ben M'sik
Fatiha Kouilily	Faculty of Sciences Ben M'sik
Naceur Achtaich	Faculty of Sciences Ben M'sik
Noura Yousfi	Faculty of Sciences Ben M'sik
Mohammed El Khasmi	Faculty of Sciences Ben M'sik

Abstract: In this paper, we developped a mathematical model in order to establish the relationship between the fluid pressure and the amplitude of displacement of the Basilar Membrane, including the feed-forward/feed-backward mechanisms of the outer hair cell force amplification. The results of this study can be useful for understanding cochlear dysfunction of the ear in active model and describe the cause of Hearing loss .

PA-076

Mathematical modelling of the cardiovascular system to study the effects of Respiratory Sinus Arrhythmia on cardiac output

Shumaila Noreen	Massey University
Alona Ben-Tal	Massey University
Maja Elstad	University of Oslo
Winston Sweatman	Massey University
Rohit Ramchandra	University of Auckland
Julian Paton	University of Auckland

Abstract: Respiratory sinus arrhythmia (RSA) is a phenomenon where heart-rate (HR) increases during inhalation and decreases during exhalation. A strong RSA indicates a healthy cardiac system but its physiological benefits are still debatable. We have developed a mathematical model for the cardiovascular system of a sheep that takes RSA into account. The model was used to study the effects of different sources of RSA on cardiac output.

PA-077

Modeling and Experimental verification of thermal properties of thermo skold painting

Frank Florez	Universidad Nacional de Colombia
Jose Luis Higón	Universitad Politecnica de Valencia
Alberto Conejero	Universitad Politecnica de Valencia
Pedro Fernandez De Cordoba	Universitad Politecnica de Valencia

Abstract: This research was developed in the frame of an agreement between the company G-cover and the Polytechnic University of Valencia. The first aim of the project was modeling and simulation of the effect of coating solution in a thermal zone, for achieve this goal were planted an experiment using three equals wood boxes, applying the painting on the exterior face, another on the inside face and leaving the third without paint for comparison.

PA-078

Numerical simulations of sediment transport based in shallow water equations

JUAN CARLOS GONZALEZ AGUIRRE	UNIVERSIDAD DE MALAGA
TOMAS MORALES DE LUNA	UNIVERSIDAD DE CORDOBA
MANUEL JESUS CASTRO DIAZ	UNIVERSIDAD DE MALAGA

Abstract: We carried out the study of sediment transport by analysing the system of balance laws consisting in the mass and momentum conservation equations for the water-sediment mixture, the mass-conservation equation for the suspended sediment and the Exner-equation for the morphological evolution. This system is solved using a two-step algorithm: first, an approximation for the system of conservation laws is computed by using a PVM method, then the source term is solved using a semi-implicit strategy.

PA-079

Numerical simulations of vortex interactions in the nonlinear Schrödinger equation under periodic boundary conditions

Teng Zhang	National University of Singapore

Abstract: The nonlinear Schrödinger equation (NLSE) is a fundamental equation to model quantum vortices in the superfluid. In this poster, we present the simulations on quantized vortex interactions in the 2D NLSE under periodic boundary conditions. We compare the results are compared with the reduced dynamical laws some interesting moving patterns are also shown.

PA-080

PARAMVALVE: In-silico prediction of aorta Wall Shear Stress from a geometric characterization

Pau Romero	Universitat de Valencia
Samuel Santos	Universitat de Valencia
Rafael Sebastian	Universitat de Valencia
Dolors Serra	Universitat de Valencia
Pilar Calvillo	Hospital Universitario y Politecnico La Fe
Alejandro Rodríguez	Hospital Universitario y Politecnico La Fe
Rebeca Maldonado Puig	Hospital Universitario y Politecnico La Fe
Luis Martí-Bonmatí	Hospital Universitario y Politecnico La Fe
Angel Alberich-Bayarri	IIS La Fe
Miguel Lozano	Universitat de Valencia
Ignacio García-Fernández	Universitat de Valencia

Abstract: This poster presents the development of a simulation workflow to assess the effect of aorta geometry on the Wall Shear Stress profile in the aorta flow. We describe the pre-processing step, that builds a model to characterize the aorta geometry, obtained from computed tomography, using differential geometry. The smooth reconstruction generated is used in a CFD solver to compute the wall shear stress profiles and try to predict the risk of certain diseases.

PA-081

Performance assessment of CHIRPS, PERSIANN-CCS and TMPA precipitation products across North-west Himalayas

Sourabh Garg	Indian Institute of Technology, Mandi
Sarita Azad	Indian Institute of Technology, Mandi

Abstract: Accurate estimates of precipitation at fine spatiotemporal resolution are vital for hydrometeorology, climatological application. The study assesses the performance of the latest versions of three multi-satellite precipitation products: CHIRPS, PERSIANN-CCS, TMPA across NWH using gauge-based observations over time 2014-2016. Results indicate that PERSIANN and TMPA are comparable to gauge-based precipitation estimates at fine-scales followed by CHIRPS. The systematic error in CHIRPS dominates the random error, which suggests a suitable bias correction for any application.

PA-082

Potential risks of dengue fever and international travels from high-risk countries

Hohyung Ryu	Kyung Hee University
Yeahwon Kim	Kyung Hee University
Sunmi Lee	Kyung Hee University

Abstract: The number of imported dengue cases in the Republic of Korea is increasing as global travels increase. In this study, we estimate the imported dengue cases by using the number of incoming travellers and local dengue cases from high-risk countries. Findings of this preliminary study can be used to assess estimating the potential risk of local transmission of dengue in the Republic of Korea.

PA-083

Pressure Boundary Conditions for SPH fluid simulations

Alba Peris	University of Valencia
Samuel Santos	University of Valencia
Pau Romero	University of Valencia
Dolors Serra	University of Valencia
Ignacio García	University of Valencia
Miguel Lozano	University of Valencia

Abstract: This work presents a new method to provide pressure boundary conditions to sph fluid simulations. The simulation scenario considered is a cylinder (r,h) with a constant inflow fluid rate at one side (inlet) and a pressure controller on the other one (outlet). This controller includes a sensor-membrane inside the cylinder to adjust the output flow (removing particles) according to the pressure differences between the internal membrane and the outlet (end of the cylinder).

PA-084

Role of interactions in non-conserving driven diffusive systems

Arvind Gupta	Indian Institute of Technology Ropar

Abstract: We explain the collective behavior of interacting particles on a lattice with thermodynamically consistent interactions. It is shown that even for weak interactions, theoretical predictions from simple mean-field approach deviate significantly from Monte Carlo simulation results. To overcome this issue, we proposed a new theoretical method namely correlated cluster mean-field theory that takes into account some correlations. The effect of interactions on stationary phase diagrams, particle currents and densities are explicitly evaluated.

PA-085

Sensitivity analysis of a novel microwave imaging device for endoscopic explorations

Judit Chamorro-Servent	Universitat Pompeu Fabra
Marta Gardiola	Universitat Pompeu Fabra
Miguel Angel Gonzalez Ballester	Universitat Pompeu Fabra
Roberto Sont	Universitat Politecnica de Catalun
Lluís Jofre Roca	Universitat Politecnica de Catalun
Gloria Fernandez-Esparrach	IDIBAPS, CIBERehd, Hospital Clínic, Universitat de Barcelona
Oscar Camara	Universitat Pompeu Fabra

Abstract: We present a finite difference time domain simulation of a novel microwave imaging device for endoscopic explorations and its use to detect colorectal cancer. The aim is to study the effect of the number of reception antennas and of the transmitted pulse frequency on the detemination of the resulting electromagnetic fields and images. The frequency to differentiate tumors depended on the device-tumor/colon wall distance, and an optimized number of reception antennas reduced degrees of freedom.

PA-086

Stability of traffic flow with forward looking effect: Modeling & Simulation

Sapna Sharma	Thapar Institute of Engineering & Technology

Abstract: We proposed a one-dimensional unidirectional lattice hydrodynamic traffic flow model by considering the information of traffic stream received from the forward sites. Theoretically, the model is tested via linear as well as nonlinear stability analysis. The model is further tested through simulation on a hypothetical test road under a periodic boundary condition. It is observed that the stable region will be enhanced with the consideration of the advanced information.

PA-087

Suppressing avian influenza A(H5N6) outbreak in the Philippines through isolation, vaccination, or periodic culling

Abel Lucido	De La Salle University
Angelyn Lao	De La Salle University

Abstract: Avian influenza A(H5N6) caused an outbreak in the Philippines which resulted to depopulation of 667,184 domestic birds. Through mathematical modelling, we investigate the effects of isolation with treatment, preventive vaccination and periodic culling against the transmission of A(H5N6) in the poultry population. Our simulation suggests that culling infected birds at least once a week together with culling of susceptible birds at most once every 60 days outperforms isolation and vaccination in controlling an A(H5N6) outbreak.

PA-088

The effect of basilar membrane stiffness on the michromechanics cochlear model

Fatiha Kouilily	Faculty of science Ben M'sik Hassan II University
Fatima-Ezzahra Aboulkhouatem	Faculty of science Ben M'sik Hassan II University
Noura Yousfi	Faculty of science Ben M'sik Hassan II University
Naceur Achtaich	Faculty of science Ben M'sik Hassan II University
Mohammed El Khasmi	Faculty of science Ben M'sik Hassan II University

Abstract: The micromechanics model of the cochlea has been analyzed to describe the displacement of cochlear partition by using finite difference method and Cramer's rule, then we have studied the effect of Basilar membrane stiffness on the responses of cochlear partition. As a result, the decrease of the maximum displacement of basilar and tectorial membranes was observed, these observations contribute to understand that the mechanism of hearing loss may be the result of altered cochlear micromechanics.

PA-089

Time-harmonic acoustic scattering from a non-locally perturbed trapezoidal surface

Wangtao Lu	Zhejiang University
Guanghui Hu	Beijing CSRC

Abstract: We consider acoustic scattering problem from a sound-soft trapezoidal surface, which can be regarded as a non-local perturbation of a straight line. We enforce that the scattered wave, post-subtracting reflected plane waves by the the two half lines in certain two regions respectively, satisfies an integral form of Sommerfeld radiation condition at infinity. We prove uniqueness and existence of weak solutions by a coupling scheme between finite element and integral equation methods.

PA-090

Traffic Jam: Cellular Automaton Modelling and a Dynamics inside a Queue of Vehicles

Akiyasu Tomoeda	Musashino University

Abstract: Cellular Automaton (CA) is one of the suitable ways to model Self-Driven Particle (SDP) systems, such as vehicular traffic and pedestrians' dynamics. The advantage of CA is that it can explicitly consider the exclusion principle of particles, thus we can investigate the dynamics inside a queue. In this talk, we start with CA modeling for 1D traffic flow and show some results about the dynamics inside a queue of vehicles.

PA-091

Validation of wall shear stress profiles from reconstructed aorta geometries

Samuel Santos	University of Valencia
Pau Romero	University of Valencia
Rafael Sebastián	University of Valencia
Dolors Serra	University of Valencia
Pilar Calvillo	Hospital Universitario y Politécnico La Fe
Alejandro Rodríguez	IIS La Fe
Rebeca Maldonado Puig	IIS La Fe
Luis Martí-Bonmatí	Hospital Universitario y Politécnico La Fe
Angel Alberich-Bayarri	IIS La Fe
Miguel Lozano	University of Valencia
Ignacio García-Fernández	University of Valencia

Abstract: Blood flow simulation can help predict cardiovascular diseases using patient-specific data. In this work we present the validation of a method to reconstruct the aorta geometry used for CFD simulations. The Finite Volume Method is used to solve the Navier-Stokes equations. We discuss the properties of the computational mesh and the boundary conditions used. We compare wall shear stress patterns that appear in the original geometry and in the reconstructed geometries.

PA-092

Walkability estimation on relief maps using Monte Carlo methods

Pablo Real Gómez	Universitat de València
Francisco Martinez-Gil	Universitat de València
Rafael J Martinez-Dura	Universitat de València
Ignacio García-Fernández	Universitat de València

Abstract: Generation of complex scenes including human derived elements can be a really time consuming task for artists. We propose a method to obtain walkability maps from complex surfaces by means of Monte Carlo method, obtaining multiple minimum cost paths on a graph with different metrics that emulate human traits. By using surface local geometric properties, we obtain habitability maps that determine probable location for buildings.

PA-093

A tool for the representation and visual analysis of multidimensional constructors.

Ismael Baeza-Sampere	University Of Valencia

Abstract: This work introduces a new form of representation of components of a whole where it is possible to represent multiple dimensions (discrete and / or continuous) of the data which allows a better visualization and understanding of their behavior. In this way it is possible to visually analyze a large set of information in an easy, simple and very intuitive way, also serving as a pedagogical tool.

PA-094

An extensive version of Chebyshev inequality employing Pathway fractional integrals

A. M. Mishra	Rajasthan Technical University, Kota
Dumitru Baleanu	Cankaya University, Ankara, Turkey
Sunil Dutt Purohit	Rajasthan Technical University, Kota

Abstract: An analogous version of Chebyshev inequality has been established by means of Pathway fractional integral operators. The result is a generalization of Chebyshev inequality in fractional integral operators. We deduce left sided Riemann Liouville version and Laplace version of the same identity. Our main deduction will breaks in noted results for a appropriate changes of Pathway fractional integral parameter and degree of fractional operator.

PA-095

Anticipative techniques on portfolio optimization

Mauricio Elizalde	Universidad Autonoma de Madrid
Carlos Escudero	Universidad Nacional de Educación a Distancia

Abstract: We show the usage of several anticipative techniques on portfolio optimization with tools such as Brownian Bridges, enlargement of filtrations and Hida-Malliavin calculus for insider trading, that is, when a trader has privileged information about the future of the stock or of the driving Brownian motion. To handle this, there exist stochastic integrals like the forward and Skorokhod integrals that work as generalizations of the Itô's one.

PA-096

Automated Chest X-Rays Screening Method using Framelet-embedded Deep Learning

SIYU SUN	Yonsei University

Abstract: This paper proposes a framelet-embedded deep learning method for screening chest X-rays automatically. The proposed method is designed to deel with the lack of supervised training data. We downscale X-rays images by framelet in 2 levels. Then we train the VGGNet-16, which is short but still powerful. The experimental results demonstrated that our model achieves comparable F1-score compared with the CheXNet algorithm.

PA-097

Estimation of subcutaneous fat thickness using a learning-based method with electrical impedance tomography

Ariungerel Jargal Yonsei University

Abstract: Abdominal obesity is one of the most important issues that to be harmful to human health. The electrical properties of human tissues are imaged by injecting low-frequency currents and measuring voltages. Using measured voltages, we can solve into a tomographic image by a reconstructing algorithm. In this work, we used a learning-based method for reconstruction. The performance of the method is confirmed by numerical simulations using 16-channel EIT system and a human-like abdomen domain.

PA-098

Evolution of a two-layer thin film over a heated vertical substrate

Geetanjali Chattopadhyay IIT Kanpur
Naveen Tiwari IIT Kanpur

Abstract: Evolution of the interfaces of two immiscible fluids flowing down a vertical plate is studied under the action of gravitational, viscous and thermocapillary forces. The system remains stable when the upper layer is less viscous otherwise it is unstable to short wavelength perturbations. Thermocapillary effects are induced by heating the vertical substrate and is found to primarily destabilize the long waves those were originally stable under the influence of viscous stratification at the interface.

PA-099

Mitigation of wave-induced forces on a floating bridge by vertical flexible porous barriers

Prakash Kar Indian Institute of Technology Kharagpur

Abstract: The roles of partial permeable flexible vertical barriers located at a finite distance from a floating bridge are analyzed for mitigating the wave-induced response of the structure. The model is based on the linearized theory of water waves the physical problem is handled for the solution using least square approximation method. Various hydrodynamic characteristics such as reflection and transmission coefficients and wave forces on the floating structure are analyzed for hydroelastic response mitigation.

PA-100

New series expansions of the p+1Fp function.

Pablo Palacios Herrero Universidad Pública de Navarra
Pedro Jesús Pagola Martínez Universidad Pública de Navarra
José Luis López García Universidad Pública de Navarra

Abstract: The power series of the hypergeometric functions p+1Fp(a;b1,...,bp;c1,...,cp;z) converge either inside the unit disk or outside it. There exist other expansions but none of them converge on the indented unit disk |z|<=1, z!=1. In this work, we use multi-point Taylor expansions to derive new expansions in terms of rational functions of z that converge in different regions, bounded or unbounded, of the complex plane containing in its interior the indented unit disk.

PA-101

Strategic dynamics analysis of smoking and smoking substitute through evolutionary game theory

Jae Hun Jung Pusan National University
Il Hyo Jung Pusan National University

Abstract: The number of people using smoking substitutes such as e-cigarettes and IQOS has increased and health-related problems are also emerging. Game dynamics model how individuals and populations change their strategies over time with payoffs comparisons, but what is considered is the fitness of the individual which depends on the strategy of others. Using the evolutionary game theory, we will construct a model of how people's smoking behaviors change by applying to smoke and smoking substitutes.

PA-102

The HyperBagGraph DataEdron: An Enriched Browsing Experience of Scientific Publications

Xavier OUVRARD University of Geneva & CERN
Jean-Marie LE GOFF CERN
Stéphane MARCHAND-MAILLET University of Geneva

Abstract: This poster complements the talk given in this conference: An enriched experience of exploring scientific publication landscape through HyperBagGraphs We showcase on this poster the main steps that allow us to build an interactive 2.5D visualisation interface for navigating data, formulating complex visual queries and performing contextual searches of co-occurence networks of online search outputs of scientific publication dataset and visualise the different dimensional perspectives of the information space as HyperBagGraphs. More information on http://www.infos-informatique.net.

PA-254

Two paradoxes of infinity

Lorena Segura Abad University of Alicante

Abstract: The concept of infinity has always been a source of much controversy, paradoxes, contradictions and myths in science, art, and literature. In this paper, the authors present two mathematical examples of how the human mind dizzy and confused with the unlimited and the unattainable concepts.

PB Session

Wednesday, July 17

PB-103

3d structure – 2d plate interaction model

Matko Ljulj University of Zagreb
Josip Tambača University of Zagreb

Abstract: In this paper we rigorously derive models for interaction of a linearized threedimensional elastic structure with a thin elastic layer and of possibly different material attached to it. Furthermore the thin material is assumed to have the elasticity coefficients of multiple orders, which gives five different models. Moreover a three-dimensional– two-dimensional model is proposed with the same asymptotics as the original problem, which is more convenient in applications.

PB-104

A case study on comparing images domains using the lens of automatic feature descriptor selection

Pierre F. Do Prado ICTS/UNESP
Iolanda C. S. Duarte UFSCAR
Antonio C. S. Martins ICTS/UNESP

Abstract: The availability of ground-level or overhead images is increasing fast and the potentialities of this fact regarding jointly usage of this images are still to be completely evaluated. This paper offers a methodology , based on an automatic selection of features descriptors, for the study of the similarities between images with potential jointly usage. The results obtained shows positive features including possible usage for educational tasks and similarities of BARKTEX and UCMERCED benchmarks.

PB-105

A dynamical study of the melting and transition to turbulence in a Phase Change Material heated from below

Jezabel Curbelo Universidad Autónoma de Madrid
Santiago Madruga Universidad Politécnica de Madrid

Abstract: We describe the evolving dynamic regimes and their scaling exponents occurring during the melting of the PCM n-octadecane heated from below: conductive, linear, coarsening and turbulent. The transition to turbulence happens after a secondary instability that forces the coarsening of the thermal plumes. Each one of the melting regimes creates a distinct solid/liquid front that characterizes the internal state of the melting process. Madruga and Curbelo (2018). Int. J. Heat Mass Transf., 126, 206–220.

PB-106

A non-intrusive reduced-order modeling using polynomial chaos expansion

Xiang Sun	Yonsei University
Jung-Il Choi	Yonsei University

Abstract: A non-intrusive reduced-order modeling based on proper orthogonal decomposition (POD) and polynomial chaos expansion (PCE) for stochastic representations in uncertainty quantification (UQ) analysis is proposed. The method extracts a set of reduced basis from the selected full-order snapshots via POD and employs PCE to approximate the coefficients of the reduced model. The proposed method provides a reliable and efficient tool for stochastic representations in UQ analysis, and its effectiveness is illustrated by benchmark numerical examples.

PB-107

Active and Passive Driving in Liquid Crystal Devices

Oliver Whitehead	University of Oxford
Ian Griffiths	University of Oxford
Apala Majumdar	University of Bath
Colin Please	University of Oxford

Abstract: Liquid crystal devices form a continually growing multi-billion-dollar industry which has garnered an increased level of academic interest in recent years. Several models for these devices have been well studied including the Ericksen-Leslie model for nematic liquid crystals. This work develops an extension to this model for more modern active-matrix liquid-crystal displays.

PB-108

An asymptotic approach to flow in pipes of triangular cross section

Laura M. Keane	University of Limerick
Iain R. Moyles	York University
Cameron L. Hall	University of Bristol

Abstract: Flow in pipes of triangular cross section have important applications in porous media where the sharp corners of the geometry allow for wetting and non-wetting surfaces. The flow profile in arbitrary triangles is difficult to analyse and many researchers instead use geometric simplifications. We present an asymptotic flow solution for a near-equilateral triangle which agrees favourably with numerical solutions. We compare and contrast our results to geometric models.

PB-109

An Overlapping Domain Decomposition Framework without Dual Formulation for Variational Imaging Problems

Jongho Park	KAIST

Abstract: We propose a novel domain decomposition method (DDM) that can be applied to various problems in variational imaging such as total variation minimization. Most recent DDMs for total variation minimization adopt the Fenchel--Rockafellar duality, whereas the proposed method is based on the primal formulation. Thus, the proposed method can be applied to those with complex dual problems such as higher order models and nonconvex problems. Numerical examples for various model problems are presented.

PB-110

Automatic 3D cephalometric annotation system using shadowed 2D image-based machine learning

Sung Min Lee	Yonsei University

Abstract: There has long been considerable demand for automated cephalometric landmarking, since manual landmarking requires considerable time and experience. Deep learning approaches to cephalometric landmarking seem highly promising, but there exist serious difficulties in handling high dimensional 3D CT data. To address this issue of dimensionality, this paper proposes a shadowed 2D image-based machine learning method which uses multiple shadowed 2D images with various lighting and view directions to capture 3D geometric cues.

PB-111

Automatic Landmark Localization for 3D Cephalometry

Hye Sun Yun	Yonsei University

Abstract: Landmarking takes a crucial role in cephalometric analysis, which is an important tool for orthodontic procedures. Automated system has been in high demand for this challenging task but applying machine learning techniques for three-dimensional (3D) cephalometry has its limitations due to dimensionality problem and data hungry issues. This paper deals with these problems by employing variational autoencoder.

PB-112

Automatic lumbar vertebrae detection and segmentation from X-ray images for fracture diagnosis by combining deep learning and level set methods

Cho Hyun Cheol	Yonsei University

Abstract: This paper proposed an automatic X-ray image segmentation, combining deep learning methods and level set, for lumbar vertebrae fracture diagnosis. The automatic segmentation in X-ray image is much tricker than that in CT and MRI images, because of overlapping shadows of various complex 3D structures including rib. To deal with these difficulties, we developed a structured hierarchical segmentation method that combine the advantages of the deep learning methods with conventional techniques including level set method.

PB-113

Construct quantum MDS codes from repeated-root constacyclic codes over finite fields and chain rings

Hai Q Dinh	Kent State University
Bac Trong Nguyen	Thai Nguyen University of Economics and Business Administration

Abstract: In this presentation, by using the structure of repeated-root constacyclic codes, we establish some maximum distance separable (MDS) codes over finite fields and chain rings. As an application, we construct some quantum MDS codes. Among others, some quantum MDS codes are new in the sense that their parameters are different from all the known ones.

PB-114

Crude oil and BRICS stock markets under extreme shocks: new evidence

LU WANG	SOUTHWEST JIAOTONG UNIVERSITY

Abstract: In this paper, we propose an extreme Granger causality analysis model to uncover the causal links between crude oil and BRICS stock markets. Instead of analyzing the average causal relationship, we first decompose the data into three cumulative components and investigate the causality between different combinations of extreme positive, extreme negative and normal shocks.

PB-115

Data generation for semi-supervised learning in medical imaging

MinGyu LEE	Yonsei University

Abstract: Recently, deep neural network(CNN) has been successful in computer vision. It needs lots of training data represented all data distribution. In medical imaging, however, there are several restrictions to get many data. This paper aims to overcome overfitting problem caused by small data set. We develop a semi-supervised learning using fake unlabeled data generated by Categorical Generative Adversarial Networks.

PB-116

Design of Folding Structures for Improving Energy-Absorbing Performance

Daigo Ito	Meiji University
Sachiko Ishida	Meiji University

Abstract: It is known that inversion, which is a plastic deformation that occurs on thin shell structures, is an effective buckling phenomenon to absorb energy. The purpose of this study is to design and evaluate the energy-absorbing performance of the folding structures that consist of core parts and folding parts in turn to generate this deformation stably. The performance of the folding structures with different design variables is revealed by static compression tests.

PB-117

Design of Vibration Isolator Using Foldable Structure and Air Spring

Kazuya Inamoto	Meiji University
Sachiko Ishida	Meiji University

Abstract: A new vibration isolator with air spring mechanism mounted on a foldable structure is designed and the mechanical characteristics are evaluated. The conventional isolator with zero spring stiffness was designed by adding a linear spring to the bistable cylindrical foldable structure. In this study, the new isolator is devised in consideration of the characteristics of air instead of the additional linear spring, and the spring characteristics of the new isolator are revealed by numerical simulation.

PB-118

Development and verification of a time-dependent nodal collocation approximation to PL equations

Mª Teresa Capilla Romá	Universidad Politécnica de Valencia
César F. Talavera Usano	Universidad Politécnica de Valencia
Damián Ginestar Peiró	Universidad Politécnica de Valencia
Gumersindo J. Verdú Martín	Universidad Politécnica de Valencia

Abstract: The time-dependent transport equation models the neutron population inside a nuclear reactor core. We develop a numerical discretization that predicts its behaviour in general conditions. The angular dependence of the transport equation is approximated by a finite spherical-harmonics expansion and the spatial dependence by a finite Legendre polynomials expansion. Advantages are: lower dimension and good characteristics of the algebraic problem. The time dependence is approximated using implicit methods. The accuracy is tested with benchmark problems.

PB-120

Digital image analysis for shrinkage evaluation in strawberries subjected to emerging processing technologies

Juliana Gamboa Santos	CIDCa
Laura Campañone	CIDCa

Abstract: Computer vision techniques and digital image analysis are an attractive and economical alternative to evaluate the appearance changes of foodstuffs during processing. Therefore, the present work aims the evaluation and correlation of morphological characteristics area (A), by digital image analysis techniques, and thickness (L) measured by caliber in strawberries subjected to combined treatments that include application of edible coatings (alginate-lactate), osmotic dehydration (sucrose, 60 ºB, 40 ºC, 4h) and microwave assisted drying (1,2 W/g).

PB-121

Efficient algorithms for generating mid-air haptic surfaces.

Salvador Catsis	Ultrahaptics
Jerzy Dziewierz	Ultrahaptics
Orestis Georgiou	Ultrahaptics
Benjamin Long	Ultrahaptics

Abstract: Ultrahaptics is developing mid-air, non-contact haptic feedback systems for AR/VR and Automotive human-machine-interfaces. The sense of touch is delivered through a localised tactile point by focusing high-intensity ultrasound from a phased array of transducers. Here, we expand the set of haptic generating algorithms to that of non-localised tactile surfaces by means of high-dimensional under-constrained optimisation problems. Further, we transpose this problem into an efficient GPU implementation format using techniques from Linear algebra and Fourier analysis.

PB-122

Fines Migration in Oil Reservoirs

Thomas Babb	University of Oxford
S. Jon Chapman	University of Oxford
Chris J. W. Breward	University of Oxford

Abstract: Fines are small particles of clay that reside in the pore-space of some oil reservoirs. These fines often block pores within the rock, causing a reduction in permeability which affects the ability of oil companies to recover oil. We attempt to build an understanding of the interaction between fines and permeability by developing a micro-scale model for the migration of fines and then using upscaling techniques, such as network-homogenisation, to derive a macro-scale model.

PB-123

GAN-based sinogram inpainting for metal artifact reduction in dental cone-beam CT

Taigyntuya Bayaraa	Yonsei University

Abstract: We proposed generative adversarial network based sinogram inpainting method to deal with some metal related artifacts in dental cone-beam CT. Existing MAR methods which are implemented for a 2D slice such as a sinogram may not be effective for CBCT projection data due to the lack of information. To overcome this issue, our method was modeled to use a additional z-axis context information of cone-beam projection to inpaint metal trace in sinogram.

PB-124

Hypersingular Integral Equation Technique to Study the Membrane-Wave Interaction

Santanu Koley	Birla Institute of Technology & Science - Pilani, Hyderabad Campus
Panduranga Kottala	Birla Institute of Technology & Science - Pilani, Hyderabad Campus
Dipak Kumar Satpathi	Birla Institute of Technology & Science - Pilani, Hyderabad Campus

Abstract: The present study deals with the hydroelastic analysis of a flexible membrane floating in ocean water under the action of gravity waves. By constructing an appropriate free surface Green's function, the associated boundary value problem is converted into hypersingular integral equations. These integral equations are solved numerically using Chebyshev polynomial approximation. Various physical results associated with membrane coupled gravity waves are obtained and analyzed for a wide range of wave and structural parameters.

PB-125

Interpretable Machine Learning in Ultrasound Image Segmentation

Bukweon Kim	Yonsei university

Abstract: Obstetricians mainly use ultrasound imaging for various purposes. However, many of such measurements are cumbersome. Hence, there is urgent need for automatic estimation. For automatic estimation in medical image, taking clinicians' decisions into account is very important. To do this, I tried to achieve the semantic segmentation from fetal ultrasound images. For this segmentation I applied layerwise relevance propagation and observed the result to understand why and how my algorithms are performing as such.

PB-126

Mathematical modelling of air drying and microwaves dehydration of Coffee

Jose Chaparro Reyes	CIDCA CONICET
Ricardo Duran Barón	Universidad Popular del Cesar
Ramiro Arballo	CIDCA
Laura Analia Campañone	CIDCA

Abstract: In this work, the drying of Parchment coffee was solved numerically (coffee genus, arabic species, castle variety) through the resolution of the microscopic balances of energy and mass. In the modeling, convective conditions that take into account the effect of the air flow in the 3D geometry of the coffee bean was considered. The validation was done, a good agreement was obtained between the experimental data and the simulations.

PB-127

MueLu: A Portable High Performance C++ Multigrid Preconditioning Library

Jonathan Hu	Sandia National Laboratories
Christopher Siefert	Sandia National Laboratories
Raymond Tuminaro	Sandia National Laboratories
Luc Berger-Vergiat	Sandia National Laboratories
Christian Glusa	Sandia National Laboratories

Abstract: MueLu is a high-performance C++ multigrid library in the Sandia Trilinos project. MueLu provides aggregation-based multigrid preconditioners that are used in a wide-variety of applications (low Mach CFD, PIC, MHD), as well as structured grid methods targeting hybrid structured/unstructured grids. A key focus is ensuring robust algorithmic performance on manycore CPUs and GPUs. We highlight key algorithmic kernel advances that ensure both performance portability and scalability, and provide results from a variety of applications.

PB-128

Numerical Evaluation on Flow Characteristic in a Folding Pipe

Kenta Mizutani	Meiji University
Sachiko Ishida	Meiji University
Yoshitsugu Naka	Meiji University

Abstract: We numerically evaluated the inner flow in the folding pipe with regular spiral fold lines that can be extended. Fluid transport in a turbulent flow causes a large energy loss and transport efficiency is significantly reduced. In this research, we aim to promote the relaminarization of the flow by the structural characterization of the pipe and the generation of the pulsing flow using pipe expansion to improve the efficiency of fluid transport.

PB-129

Optimal Portfolio in the Presence of Transaction Costs and Convex Risk Measure

Obonye Doctor	Botswana International University of Science and Technology
Elias Rabson Offen	University of Botswana
Edward Lungu	Botswana International University of Science and Technology

Abstract: We analyse optimal portfolio selection problem of maximizing the utility of an agent who invests in a stock and money market account in the presence of transaction costs. The preference of the investor is assumed to follow the Constant Relative Risk Aversion (CRRA). We further investigate the risk minimizing portfolio through a zero-sum stochastic differential game (SDG). To solve this two player SDG we use HJBI for general zero-sum SDG in a jump setting.

PB-130

Origami Engineering: Application of Paper-made Honeycomb Cores

Sachiko Ishida	Meiji University

Abstract: Honeycomb cores are well-known as lightweight structures having high rigidity, and widely used in aerospace industry for this reason. In this study, mathematical origami (i.e. paper-folding) approach is demonstrated to redesign the honeycomb cores with cylindrical configuration, and mechanical properties of the cores are clarified by numerical and experimental analyses. Finally, it is concluded that the cores made of even soft paper are relatively rigid and promising for practical usages such as rolling tires.

PB-131

Parameter identification for the Landau-Lifshitz-Gilbert equation in Magnetic Particle Imaging

Barbara Kaltenbacher	Alpen-Adria-Universität Klagenfurt
Tram Thi Ngoc Nguyen	Alpen-Adria-Universität Klagenfurt
Thomas Schuster	Saarland University
Anne Wald	Saarland University

Abstract: Magnetic particle imaging is a new imaging modality for medical applications. The technique takes advantage of the response of the nanoparticles to an oscillating magnetic field to construct their spatial-dependent concentration. Aiming at an accurate model for the system function to avoid the slow calibration, we use a model from micromagnetism governed by the Landau-Lifshitz-Gilbert equation and consider parameter identification in it. The problem is formulated in two settings: An all-at-once and a reduced version.

PB-132

Piecewise approximate implicitization with prescribed conditions using tensor-product B-splines

Andrea Raffo	SINTEF Digital and University of Oslo
Tor Dokken	SINTEF Digital

Abstract: Approximate implicitization is the process of determining an implicit form that matches a parametric representation as close as possible in some sense. Examples of applications include approximating simple CAD geometries for the purposes of visualization, segmentation and supporting intersection computations. The use of piecewise polynomials represents a natural generalization of implicit representations by a single polynomial, combining the benefits of their good approximation properties with fast evaluation and a higher flexibility.

PB-133

Reduced Basis Methods for Parametrized Optimal Control Problems with Non-Affine Source Terms

Zoi Tokoutsi	RWTH Aachen University and Philips Research
Martin Grepl	RWTH Aachen University
Karen Veroy	RWTH Aachen University
Marco Baragona	Philips Research
Ralph Maessen	Philips Research

Abstract: We employ the reduced basis method as a surrogate model for the solution of optimal control problems governed by parametrized partial differential equations with non-affine source terms. The proposed method constructs affine approximations of the non-affine parameter depend source terms by employing the empirical interpolation method (EIM). We develop online-efficient a posteriori error bounds for elliptic and parabolic problems and present numerical results motivated by the planning of thermal cancer treatments.

PB-134

Representing raw data with polynomial chaos

Emeline Gayrard	Université Clermont Auvergne
Cédric Chauvière	Université Clermont Auvergne
Hacène Djellout	Université Clermont Auvergne
Pierre Bonnet	Université Clermont Auvergne

Abstract: A new numerical method to model the distribution of a raw data sample will be presented. It consists in modelling a sample under the form of polynomial chaos. We set up a constrained optimization problem and we show that computing the first five coefficients of the polynomial is enough to get accurate results. This method is an alternative solution when no adequate distributions can be found to represent the sample.

PB-135

Skull CT Image Segmentation for 3D cephalometry?using Metal Artifact Reduction and Deep-learning

Tae Jun Jang	Yonsei University

Abstract: Accurate skull segmentation in the 3D CT data is required for 3D cephalometry. However, in the CT image, the presence of metallic object causes some streaking and shadow artifacts, making it difficult to segement skull. To overcome this issue, we propose skull segmentation method based on a deep-learning in 3D CT data. For more effective segmentation, CT images are pre-processed by metal artifact reduction (MAR).

PB-136

Stochastic Floyd-Steinberg dithering on GPU: image quality and processing time improved

Giorgia Franchini	University of Modena and Reggio Emilia
Roberto Cavicchioli	University of Modena and Reggio Emilia

Abstract: Error diffusion dithering is a technique that is used to convert grey-scale images for industrial printing. The method generates a conversion error, that is distributed to the neighboring pixels with different algorithm. These algorithms suffer two issues: quality artifacts and slowness. In order to avoid artifacts, we will use a stochastic version of the Floyd-Steinberg algorithm; then we describe a parallel version of it that will exploit GPU, drastically reducing the time spent.

PB-137

Tomographic reconstruction of elastic strain field from Energy Resolved Neutron imaging

Riya Aggarwal	University of Newcastle
Mike Meylan	University of Newcastle
Chris Wensrich	University of Newcastle
Bishnu Lamichhane	University of Newcastle

Abstract: The objective of this research is to develop a reconstruction algorithm for elastic strain tomography from energy resolved neutron imaging by using a pulsed neutron beam. This technique brings several advantages to those using monochromatic neutron beam from continuous sources, e.g., finer wavelength resolution. It involves the reconstruction from the collections of Bragg-edge transmission strain images as measured by pixelated time-of-flight neutron detectors at pulsed neutron sources.

PB-138

Using Iteration to Solve Matrix Wiener-Hopf Problems with Application to Bio-inspired Aeroacoustics

Matthew Priddin	University of Cambridge
Anastasia Kisil	University of Cambridge
Lorna Ayton	University of Cambridge

Abstract: The Wiener-Hopf technique is a useful tool for understanding the reduction of aerodynamic noise by, for instance, bio-inspired adaptations. Modelling practical implementations often yields matrix Wiener-Hopf problems for which straightforward and accurate solution methods generally do not exist. This work demonstrates the efficiacy of iteration to solve N by N matrix Wiener-Hopf problems, in particular those associated with wave scattering from many collinear plates and adding porous edges to finite rigid plates.

PB-139

Using Matlab´s wavelets tools to compare electric signals outputted by microbial fuel cells

Pierre F. Do Prado	ICTS/UNESP
Maria Del Angeles Mayen	UFSCAR
Iolanda C. S. Duarte	UFSCAR

Abstract: Microbial fuel cells (MFC) represents a wastewater treatment technology with potential for a relevant electric energy generation. The monitoring of the electric current outputted by MFC generates times series of data. Innovatively,according our best knowledge, this series was studied using power spectral density, multifractal and wavelet coherence analysis. Results is promising and indeed points out this approach as an under considered tool towards gaining knowledge on microbial fuel cell features.

PB-140

Industrial Mathematics at DRiV: a Success Story on Modeling an Active Suspension for Ride Comfort and Energy Efficiency.

Joan Vazquez Molina	Tenneco (DRiV)
Rafael Tavares	University of Agder
Monzer Al Sakka	Tenneco (DRiV)
Michael Ruderman	University of Agder
Miguel Dhaens	Tenneco (DRiV)

Abstract: DRiV (formerly part of Tenneco) is one of the world's leading designers, manufacturers and marketers of Ride Performance products. In collaboration with the University of Agder, an automotive active suspension based on a torsion bar has been modelled in Matlab/Simulink to assess its comfort improvement and energy harvesting potential. This is a Success Story from a H2020 MSCA Staff Exchange project on "robust control, state estimation and disturbance compensation for highly dynamic environmental mechatronic systems".

PB-141

Our challenges developing AI techniques to make our lives smarter.

Kohei Yasuda	Arithmer Inc.
Yoshihiro Ohta	Arithmer Inc.
Hiroki Yato	Arithmer Inc.
Chikashi Arita	Arithmer Inc.

Abstract: "Arithmer": we are a group of IT developers who have not only high-level arithmetic ability but also many different backgrounds like pure and applied mathematics, physics, chemistry, engineering, economics, etc. Arithmer Inc. is solving problems in the real society in order to make our lives smarter. We present human body image measurement, driving movie analysis, and AI-OCR that are parts of our innovative solutions including Still-Image-Analysis and Dynamic-Image-Analysis based on advanced mathematics.

PB-142

Truck shape recognition from mixed distance maps

Pablo Real Gómez	Órbita Ingeniería

Abstract: Precise truck placement is fundamental on ship loading processes. The desired placement depends on factors such as the operation and container type or truck model. In this poster we describe the workflow used by Órbita Ingeniería to mix information extracted from two scanners, to detect relevant truck points to precisely position the truck, regardless of operation and container type, by means of a ruleset to identify truck shape and direction.

PB-143

A Hopf-bifurcation interpretation of the dynamic effect of a sovereign spread shock on the business cycle of emerging economies

EDGARDO JOVERO	UNIVERSIDAD DE VIGO, SPAIN

Abstract: Proof is presented regarding the behavior of a small open-economy growth model facing an upward sloping supply curve for debt. It has been shown that there possibly exists a Hopf-bifurcation type of structural instability in a nonlinear dynamical model of the macroeconomy, whereby a mark-up pricing variable acting as sovereign risk premium may behave as a bifurcation parameter.

PB-144

A Machine Learning Approach to Triaging Patients with Congestive Heart Failure

Sumanth Swaminathan	ETHERA INC
James Morrill	University of Oxford
Klajdi Qirko	ETHERA INC
Anthony Gerber	National Jewish Health
Jacob Kelly	Alaska Heart

Abstract: Heart Failure (HF) patients are burdened with a daily risk of symptom flare-ups, which could be mitigated by effective, at-home digital decision support tools. We present a machine learning-based strategy for detection of exacerbations and subsequent triage using gradient boosted classifier models trained on statistically generated patient vignettes. The model is compared to physician consensus and indicates accuracy/safety performance surpassing all individual competing specialists in both identifying exacerbations and recommending the best responsive action.

PB-145

Developing an optimal route recommendation system for ships

SeungHeon Yi	Pusan National University
HyunMin Kim	Pusan National University
Sangil Kim	Pusan National University
YiCheng Hong	Yanbian University
GiPhil Cho	Pusan National University
TaeHyeong Kim	Pusan National University
GeunSoo Jang	Pusan National University

Abstract: In this study, we have been developed an optimal route recommendation algorithm for a ship given information on the starting and ending locations. The algorithm calculates optimal route considering various data such as marine climate and weather forecast from MyOcean and NOMADS during 1994 and 2017. We have been employed Space-Time Prism(STP) and Forward-Backward Approach(FBA) to develop this algorithm. We have been compared our numerical results with real data for verification model.

PB-146

Faults Detection in Induction Motors combining Higher and Second Order Statistics of Stray Flux Signals. Results from Bispectral and Covariance Functions.

Miguel Enrique Iglesias Martínez	University of Pinar del Río
J. Alberto Conejero	Instituto Universitario de Matemática Pura y Aplicada
Pedro Fernández De Córdoba	Instituto Universitario de Matemática Pura y Aplicada
Jose A. Antonino-Daviu	Instituto Tecnológico de la Energía

Abstract: The aim of this work is to find out through the analysis in the time and frequency domains significant differences that lead to obtain one or several variables that may result in an indicator that allows diagnosing the condition of the rotor in an induction motor from the processing of the stray flux signals. For this, the combination of higher and second order statistical analysis were used. The obtained results are satisfactory

PB-147

Identification of aerodynamic coefficients from free flight data using an asymptotic expansion of the Modified Point Mass ballistic model

Condaminet Vincent	Université de Caen Normandie
DELVARE Franck	Université de Caen Normandie
GRIGNON Christophe	DGA
Heddadj Settie	Nexter Munitions

Abstract: An identification method of the aerodynamic coefficients of a spin-stabilized projectile based on the Modified Point Mass (MPM) trajectory model is presented. The idea consists of an asymptotic expansion of the ballistic model with respect to a nodimensional parameter in order to obtain models derived from the MPM model where all terms have the same order of magnitude. This identification method is numerically implemented and tested with simulated data but also with real radar data.

PB-148

Shape prior beam hardening correction algorithm for industrial 3D cone-beam CT

Soomin Jeon	KAIST
Chang-Ock Lee	KAIST

Abstract: Beam hardening artifact is one of the most major factors that degrade the image quality of computed tomography (CT) and it causes misinterpretation in CT image analysis. We present a methodology to reduce the beam hardening artifact especially due to metallic objects for three dimensional industrial conbeam CT. In order to manage the three dimensional volume data efficiently we develop a registration technique. Through numerical experiments, we verify that the proposed algorithm performs successfully.

PB-149

Streamlining cardiac simulations, from images to predictions

Cristóbal Rodero	King's College London
Marina Strocchi	King's College London
Gernot Plank	Medical University of Graz
Christopher A. Rinaldi	King's College London
Pablo Lamata	King's College London
Steven A. Niederer	King's College London

Abstract: Patient-specific computational cardiac models combine patient data with encoded physiological and physics constraints. Personalising the model parameters to individual patients from clinical data remains a significant challenge in translating this technology into the clinic. Here we describe a workflow to estimate patient anatomy, fibre orientation, …. from the patient record to simulate cardiac electromechanics over a heartbeat.

PB-151

An Application of the Dynamic Mode Decomposition (DMD) to Laser Data

Hunter Rice	United States Naval Academy
Reza Malek-Madani	United States Naval Academy
Svetlana Avramov-Zamurovic	United States Naval Academy

Abstract: In this poster, we will present an analysis of laser data using the new technique of the Dynamic Mode Decomposition. The data has been collected through a set of maritime experiments performed at the Naval Academy where a laser beam is propagated through a complex medium. The goal of the analysis is to characterize the parameters of the turbulent medium by computing the modes of propagation from the snapshots of the data.

PB-152

Detection and quantification of tubers size in agricultural systems using Ground Penetrating Radar

Susanne Maciel	University of Brasilia
Guilherme Zakarewicz	University of Brasilia
Amanda Rocha	University of Brasilia

Abstract: The detection and quantification of the size and the biomass produced by tubers in agricultural systems are relevant to several agricultural studies. Ground-penetrating radar (GPR) provides a cheap and non-invasive method for underground root biomass investigation. Evaluation of GPR efficacy for tubers biomass estimation is done within a controlled GPR acquisition in a sandbox. Results show that the water content and total length of the tuber are leading factors for diameter imaging resolution.

PB-153

Innovative Teaching Education in Mathematics (ITEM): An Erasmus+ project focused on improve quality of teaching Mathematics on Computer Science and Electrical Engineering

Rodrigo Trujillo González	Universidad de La Laguna
Matías Camacho Machín	Universidad de La Laguna
Israel García Alonso	Universidad de La Laguna
Konstantinos Petridis	Technological Educational Institute of Crete
V. Makris	Technological Educational Institute of Crete
V. Kokkinos	Technological Educational Institute of Crete

Abstract: ITEM is an Erasmus+ project on the programme KA2 – Cooperation for innovation and the exchange of good practices: Capacity Building in the field of Higher Education (598587-EPP-1-2018-EL-EPPKA2-CBHE-JP-ENV2), conformed by 16 HEIs from 10 countries. The main goals of the projects are: - Improve students math level of first year Computer Science and Electrical Engineering. - Reduce failure rates on math courses. - Show the relevance of math by study of real industrial problems.

PC Session

Thursday, July 18
Friday, July 19

PC-028

Identification of some physical parameters in a shallow arch considering damping effect

Sudeok Shon Korea University of Technology and Education
Junhong Ha Korea University of Technology and Education
Seungjae Lee Korea University of Technology and Education

Abstract: In this paper we study the parameter identification problem for shallow arches considering damping effect. We discuss both symmetric and non-symmetric shapes and loads, and provide theoretical and numerical studies of the model behavior.

PC-154

An improved wavelet approach to defining geomagnetically quiet days

Odim Mendes National Institute for Space Research (INPE)
Margarete Domingues National Institute for Space Research (INPE)

Abstract: The Sun affects the Earth’s environment by electromagnetic radiation, high energetic particles and solar plasmas. Several indices have been structured to categorise and quantify the resultant geomagnetic disturbances in our planet. Dealing with a wavelet technique, we investigate the behaviour of magnetograms considering the five geomagnetically quieter days identified by the geomagnetic index Kp (from the GFZ, Potsdam). Our analysis obtains a novel improved classification and highlights the agents involved with the difference in classifications.

PC-155

Fast and Accurate Algorithms for Cosmic Microwave Background Radiation Data on HEALPix Points

Kathryn Drake Boise State University
Grady Wright Boise State University

Abstract: The Cosmic Microwave Background Radiation (CMBR) offers the strongest evidence for the Big Bang theory. While scientists have measured this using a Hierarchical Equal Area isoLatitude Pixelization scheme, these “HEALPix” points are not well suited for fast computations. By transforming the HEALPix grid to a uniform grid in a way that preserves crucial symmetry and periodicity, we develop faster algorithms for CMBR analysis. Results illustrating the effectiveness of this algorithm over current methods are presented.

PC-156

Analysis of a Coupled Reaction-diffusion Model for Tumour Induced Angiogenesis in Breast Cancer Tissue

Phebe Mawuena Afi Havor National Institute for Mathematical Sciences Ghana (Center for Scientific and Technical Computing)

Abstract: Tumour-induced angiogenesis links the relatively benign avascular phase to the prospective lethal vascular stage of growth. Endothelial cells in capillary vessels from nearby vessels form in response to secreted proteins in the hypoxic avascular solid tumour. A continuum mathematical model with coupled non-linear PDE is developed and analyzed to describe this migration process. Results show chemotaxis and haptotaxis affect the movement of the endothelial cells to the solid tumour.

PC-157

Climate Change and Mortality Rate of Anchovy Juveniles in the Southeastern Waters of Korea

Jin Yeong Kim Kyungpook National University
Byulnim Kim Kyungpook National University
Yongkuk Kim Kyungpook National University

Abstract: Anchovy, Engraulis japonicus, experiences high variation of recruitment and mortality in Korean waters. We analyzed the mortality of anchovy juveniles using the mixture model for catch data (1992-2016) and length composition of three stages. Climate regime shifts were identified by time series analysis of the sea temperature and prey abundance. The increasing trend of sea temperature, prey density and daily mortality during juvenile stage suggested the impact of climate change on anchovy population and fisheries.

PC-158

Constructing an Average Geometry and Diffusion Tensor Magnetic Resonance Field from Explanted Porcine Hearts

Mia Mojica Ontario Tech University
Maxime Sermesant INRIA
Mihaela Pop University of Toronto
Mehran Ebrahimi Ontario Tech University

Abstract: The structural remodeling of the myocardial fibers is a main determinant of the electro-mechanical function of the heart, which is often impaired in cardiovascular diseases (CVD). Fiber directions in healthy state can be determined via diffusion tensor MRI, and then integrated into morphological cardiac models and statistical atlases to help in diagnosis and treatment-planning of CVD. Here, we present a pipeline for constructing a statistical fiber atlas from eight ex-vivo DT images of porcine hearts.

PC-159

Control Strategies for pro-inflammatory and Anti-inflammatory Cytokines Model in an Autoimmune Disease

Anna Park Pusan National University
Il Hyo Jung Pusan National University

Abstract: An autoimmune disease is a chronic inflammatory disease and triggered by abnormal immune response. This is related to a break down in immune tolerance. Two impulsive models of immune tolerance control strategized are proposed, one with time-dependent impulsive effect and the other with state-dependent. We have main purpose about two impulsive each other. In cytokine model with time-dependent of impulsive effect, we find pro-inflammatory cytokine cut down solution of system and period T.

PC-160

Dynamics of Disease Models with Self Diffusion: Case Study on Cholera in Ghana

Phebe Mawuena Afi Havor National Institute for Mathematical Sciences, Ghana (Center for Scientific and Technical Computing)
Anas Musah National Institute for Mathematical Sciences, Ghana (Center for Scientific and Technical Computing)

Abstract: Cholera epidemiology has increased as its epidemics have become a worldwide health problem especially in Ghana. A reaction-diffusion SIR-B mathematical model of cholera epidemiology that incorporates an environmental reservoir of bacteria is formulated to capture the movement of human hosts and bacteria in a heterogeneous environment. Results show organism distribution and their interaction of spatially distributed populations with local diffusion indicating that diffusion has a great influence on the spread of the cholera epidemic.

PC-161

Exploring the emergence of abnormal oscillations in the basal ganglia during Parkinson’s Disease

Michael Caiola Emory University
Mark Holmes Rensselaer Polytechnic Institute
Thomas Wichmann Emory University

Abstract: As synaptic connections change in the basal ganglia changes during Parkinson’s disease (PD), motor symptoms worsen, firing rates change, and oscillations between nuclei become pronounced at specific frequencies (such as beta). The origin of these oscillations are not known, but using a population-level modeling structure we can analytically solve the weight spaces that generate these abnormal oscillations and highlight key connections to target for potential treatments of the disease.

PC-162

Forecast Modelling for Combination Disease Comorbidity

Rahil Sachak-Patwa	University of Oxford
Helen Byrne	University of Oxford
Robin Thompson	University of Oxford

Abstract: We consider an ordinary differential equation SEIR epidemic model which describes the dynamics of an infectious disease, validating the model using data from an influenza pandemic. We generate synthetic data from a heterogeneous 2-group model and ascertain how well a homogeneous 1-group model can describe the heterogeneous system. We consider how the time between epidemics can affect how well a homogeneous model describes an epidemic in a population consisting of naive and immune individuals.

PC-163

Fractal vascular structure optimization based on a multi-scale blood flow model

Ulin Nuha Abdul Qohar	University of Bergen
Antonella Zanna Munthe-Kaas	University of Bergen
Erik Andreas Hanson	University of Bergen
Jan Martin Nordbotten	University of Bergen

Abstract: In our knowledge, vascular system spread nutrients efficiently throughout the organ in optimal condition by minimizing energy. We propose vascular optimization based on multi-scale flow model and fractal structure generator to find mathematical models that satisfy this optimum system. Time of flight as an optimization condition represent nutrient transport time to capillaries in the organ. We obtain the result from numerical experiments and the optimized vascular structure model depend on the capillary domain.

PC-164

Group variable reduction procedure for complex high-dimensional survival data

Natasha Sahr	St. Jude Children's Research Hospital
Kwang Woo Ahn	Medical College of Wisconsin
Soyoung Kim	Medical College of Wisconsin

Abstract: We propose to a two-step screening procedure for clustered multivariate survival data with correlated candidate predictors. In this method, we: i) reduce the number of candidate predictors; and ii) select and estimate significant group variables and individual variables. We address complicated data structures with possibly overlapped predictors by allowing for flexible group assignments. This method, sure joint group screening, provides the optimal performance in simulation while maintaining theoretical properties.

PC-165

Interaction between effects of chemicals evidenced by combined in silico and ex vivo investigations

Tamas Erdei	University of Debrecen
Adrienn Monika Szabo	University of Debrecen
Gabor Viczjan	University of Debrecen
Judit Zsuga	University of Debrecen
Rudolf Gesztelyi	University of Debrecen

Abstract: Combination of a computer simulation study (using canonical and self-developed mathematical models of the receptor function) with ex vivo experiments (on isolated, working guinea pig atrium) yielded a hypothesis that FSCPX, known as a selective, irreversible A1 adenosine receptor antagonist, inhibits the effect of NBTI, a selective nucleoside transport blocker, on the interstitial concentration of endogenous adenosine, by inhibiting one (or more) enzyme(s) for the interstitial adenosine formation, an action not acknowledged yet.

PC-166

Mathematical model for analyzing the potential of the inhibition of S-phase kinase-associated protein 2 (SKP-2) in Osteosarcoma as treatment in established metastasis cases.

María Isabel Romero Rodríguez	Universidad Militar Nueva Granada
Jenny Paola Alfaro García	Universidad Militar Nueva Granada
Stephany Orjuela Suárez	Universidad Militar Nueva Granada

Abstract: Osteosarcoma is a potentially fatal disease, affecting the metaphyseal region in long bones of the body, highly aggressive with a percentage of patients developing metastases promoted by the SKP-2. Treatment is surgical with combined chemotherapy and has high survival rate in the absence of metastases. When they exist, survival is precarious. We present a mathematical model of the development of osteosarcoma for different stages through simulation based on data obtained from bibliography and SEER data.

PC-167

Mathematical Modeling of Choanoflagellates using Mixed Stokeslet & Stokeslet-segments Method

Nathan Richter	Trinity University
Hoa Nguyen	Trinity University

Abstract: Choanoflagellates are single cell organism that can form into multi-cell colonies. To explain whether colonies are more successful than single cells in feeding, a mixed Stokeslets & Stokeslet-segments method is implemented to speed up the computational time and reduce the number of discretized points on the choanoflagellate model. The simulations of a straight chain show that as the number of cells increases, the velocity of the chain decreases and the feeding flux increases.

PC-168

Pattern formation in Phagocytosis : a mathematical model of the underlying network of Rho GTPases and Phosphoinositides.

Marco Antonio Avila Ponce De Leon	University of Minnesota
Hans Othmer	University of Minnesota

Abstract: Phagocytosis is a remarkably complex process that is an essential component of the immune response, tissue homeostasis and development. It is defined as the recognition and ingestion of particles by myeloid cells into vacuoles known as phagosomes. The engulfment process is coordinated by a spatio-temporal activation and deactivation of Rho GTPases and metabolism of phosphoinositides. In this work, we write a mathematical model that properly describes the phagocytic process and fully captures the observed patterns.

PC-169

SEIR Epidemic Model where Incubation Period is Distributed by the Coxian Phase-Type Distribution

Sungchan Kim	Pusan National University
Jong Hyuk Byun	Pusan National University
Il Hyo Jung	Pusan National University

Abstract: We present reconstructed SEIR epidemic model, which is named the Coxian SEIR model, to incorporate empirical incubation period distribution based on the fact the Coxian distribution can approximate any distribution function arbitrarily closely. The basic reproduction number, was discussed. We also give an example how to use the Coxian SEIR model with empirical incubation period data and it was shown that the use of the model can be an alternative to solve the above phenomenon.

PC-170

Special matrices to analyze the evolution of an infectious disease in a population

Carmen Coll	Universitat Politècnica de València
Elena Sánchez	Universitat Politècnica de València

Abstract: Several mathematical models are used, both in continuous and discrete time, to analyze the evolution of some infectious diseases. We are interested in a disease developed by indirect transmission on a farm where individuals are organized in compartments. In this work, we explore some spectral properties of the nonnegative block tridiagonal matrices which are used in this modeling.

PC-171

Transient frequency preference in simple cell signaling motifs

Rocio Balderrama	Universidad de Buenos Aires-IMAS-FCEyN

Juliana Reves Smere	Universidad de Buenos Aires-IFIBYNE
Constanza Fernandez Sanchez De La Vega	Universidad de Buenos Aires-IMAS-FCEyN
Alejandra Ventura	Universidad de Buenos Aires-IFIBYNE

Abstract: In many biological contexts it is important to understand how the cell signaling systems responds to time-dependent inputs. When a pulsatile signal stimulates a signaling component a transient response is induced, later on a stationary behavior is achieved. Several works focus on the stationary response. In this work, by combined computational and theoretical approach, we identify conditions for which simple signaling topologies can optimize a given response in a time window within the transient phase.

PC-172

Modeling and Simulation Studies on Development of Solutions on TLC for Verifying the Evolution of Components Based on the Scanned-Image Analysis

Hiroshi Ijima	Wakayama University
Masanori Yamaguchi	Wakayama University

Abstract: Previously, we proposed a quantification method of the carbohydrate based on the scanned image analysis of results of the thin-layer chromatography and its efficacy was confirmed by experiments. On this method, the concentration was quantified by calculating the volume of the 2D Gaussian function as a component model. In this presentation, a dynamical model of the TLC is introduced based on advection-diffusion equation. Component model of the solutions are verified by numerical and experimental results.

PC-173

Quantification of Carbohydrate Based on Scan Image Analysis for TLC Technique Compensating Lack of Spot Overlaps: Some New Results

Masanori Yamaguchi	Wakayama University
Hiroshi Ijima	Wakayama University

Abstract: Currently, we are studying quantification of solutions of carbohydrates by using analysis of scanned image of the thin-layer chromatography. On this study, we previously proposed a quantification method such that the color density concerned with solutions were modeled by 2D Gaussian function for compensating lack of spot overlaps. Efficacy of proposed method was confirmed by experiments. In this presentation we report some new experimental results for some kinds of carbohydrate solutions applying proposed methods.

PC-174

Numerical approximation of Holditch curves

David Rochera	University of Valencia
Sergio López-Ureña	University of Valencia

Abstract: Given p,q⩾0, Holditch's theorem for a closed planar curve describes by a moving chord a new closed curve—its Holditch curve—such that the area between both curves is equal to πpq. An efficient algorithm to compute Holditch curves even for retrograde movements for the chord is given. Moreover, it is shown that nested applications of it can be used as a curve visual smoothing method, with an exact control on the approximation error.

PC-175

Some new results on groups of homeomorphisms and sets of equivariant non-expansive operators in topological data analysis.

Nicola Quercioli	University of Bologna
Mattia Bergomi	Champalimaud Center for the Unknown
Patrizio Frosini	University of Bologna
Daniela Giorgi	Institute of Information Science and Technologies "Alessandro Faedo"

Abstract: The theory of group equivariant non-expansive operators (GENEOs) is a new mathematical framework that links machine learning to topological data analysis. Some topological and geometrical questions naturally arise from this theoretical setting. In this poster we will illustrate some new methods to build GENEOs and discuss the relationship between equivariance topological groups of homeomorphisms and the corresponding GENEOs.

PC-176

Edge-Informed Image Zooming

Kamyar Nazeri	Ontario Tech University
Mehran Ebrahimi	Ontario Tech University

Abstract: Existing deep learning image zooming methods use convolutional network with a low-resolution image input and apply convolution with upsampling to estimate high-resolution image. This often leads to a blurry image as the model fails to reconstruct structures. We propose a new approach by reformulating the problem as an in-between pixels inpainting task conditioned on high-frequency edge information extracted from the low resolution image. Preliminary results will be presented.

PC-177

Quantum Algorithms for Optimization over Finite Fields and Applications in Cryptanalysis

Xiaoshan Gao	Academy of Mathematics and Systems Science, Chinese Academy of Sciences

Abstract: We present quantum algorithms for two fundamental computation problems: solving polynomial systems and optimization over finite fields. The complexity of the algorithms is polynomial in the size of the input and the condition number of certain matrix derived from the problem. We apply the quantum algorithm to the cryptanalysis and show that they are secure under quantum algebraic attack only if the condition numbers of the corresponding equation systems are large.

PC-178

Web Based Learning with intelligent tutoring system to learn and practice Linux Command Online

Serrhini Mohamed	Université Mohamed Premier

Abstract: Linux has gained big adoption, Linux power 90% of Internet servers, runs in 80% of the world's smartphones. Many Linux distributions are with a graphical user interface (GUI), but Linux has a command line interface (CLI). This paper present an innovative solution,Web Based Learning and Practicing environment that integrates an intelligent tutoring system to teach and assists student's learning by doing Linux scripting command in CLI within real Linux kernel executed in students browsers.

PC-179

A collision and avoidance problem using a navigation function

Sudeok Shon	Korea University of Technology and Education
Seungjae Lee	Korea University of Technology and Education
Donwoo Lee	Interdisciplinary Program in Creative Engineering, Korea University of Technology and Education
Hyeonju Ha	Korea University of Technology and Education

Abstract: In this paper, we study the collision avoidance and attraction problem for a moving vehicle by using the Lyapunov stability and a navigation function, and design the desirable controls to solve our problem as introducing the natural dynamical system.

PC-180

Frequency isolation for the hyperbolic quadratic eigenvalue problem

Julio Moro	Universidad Carlos III de Madrid
Fernando De Terán Vergara	Universidad Carlos III de Madrid
Ninoslav Truhar	University of Osijek
Suzana Miodragović	University of Osijek

Abstract: The solution of the forced system undergo large oscillations whenever some eigenvalue of the corresponding QEP $(\lambda^2 M +$

$\lambda C + K)x = 0$ is close to the frequency of the external force. One way to avoid resonance is to modify matrices M, C and K in such a way that the new system has no eigenvalues close to these frequencies. This frequency isolation problem is considered for the hyperbolic QEP.

PC-181

Optimal control of a nonsmooth perturbed sweeping process and its applications

Nguyen-Truc-Dao Nguyen	Wayne State University
Boris Mordukhovich	Wayne State University

Abstract: This talk addresses a new class of optimal control problems described by a controlled version of Moreau's sweeping process where measurable control actions enter additive nonsmooth perturbation in order to optimize the Mayer-type functional. To deal with the non-Lipschitzian of the unbounded differential inclusions with intrinsic state constraints, we develop a method of discrete approximations to derive the necessary optimality conditions of the Euler-Lagrange type for local minimizers. Application in robotic models will be considered.

PC-182

Optimal Control trajectories, Occupation Measures and Dirac Deltas

Hernán García	Universidad de los Andes
Mauricio Velasco	Universidad de los Andes

Abstract: An optimal control problem can be reformulated as an infinite dimensional linear problem where the variables are the moments of the "occupation measures" which encode optimal trajectories and controls. We propose hierarchies alternative to the Parrilo-Lasserre approach that allow us to compute the moments of these measures. Furthermore we show how to recover trajectories and controls from the moments by using some new polynomial approximations to Dirac deltas. The results are illustrated through computational simulations.

PC-183

Stabilization for nonlinear switched systems with slowly varying parameter

Wajdi Kallel	Faculty of applied sciences, university Umm Al-Qura
Amel Hatem	Faculty of applied sciences, university Umm Al-Qura

Abstract: we establish some conditions for the stabilization of switched systems with slowly varying parameters. Some necessary conditions are given for the stabilizability of switched homogeneous systems with varying parameter. This work may be viewed as extension of the CLF to the study of the switched systems with slowly varying parameter. Another objective is to give a controller which maintain the homogeneity of the closed loop switched homogeneous system under a necessary and sufficient stability condition.

PC-184

Divisibility patterns of numbers in the Pascal triangle on a complex network

JOSE ALBERTO CONEJERO CASARES	UPV
JUAN MIGUEL GARCIA GOMEZ	UPV
PEDRO ANTONIO SOLARES HERNANDEZ	UPV
FRANCISCO JAVIER PEREZ BENITO	UPV
FERNANDO MANZANO AYBAR	UNAPEC

Abstract: We consider a network based on the Pascal triangle, where nodes stand for numbers and two numbers are linked if they lay in the same diagonal of the triangle. We show that the degree distribution of the network satisfies a scale-free property, in the same way as it holds for the network of divisibility of natural numbers. We also study some other properties such as clustering, mean degree, and assortativity.

PC-185

Generalization of orthogonality that connected with invertibility of n-ary operations

Iryna Fryz	Vasyl' Stus Donetsk National University

Abstract: In coding theory, an n-ary quasigroup is a distance-2 MDS code. It is well known that repetition-free composition of quasigroups is a quasigroup. F.M. Sokhatsky and the author proved that constructing an n-ary quasigroup that is a repetition composition of two quasigroups is reduced to constructing a pair of perpendicular quasigroups. Note that perpendicularity is a special kind of n-ary orthogonality. To simplify construction of such quasigroups we study some properties of perpendicular operations.

PC-186

Optimal Harvesting Strategies for Hairtails, Trichiurus Lepturus in Korea Sea using Discrete Time Age-Structured Model with Nonlinear Recruitment

Yong Dam Jeong	Pusan National University
IL Hyo Jung	Pusan National University

Abstract: Hairtail has been occupying a large portion of catches in Korea for a long time as the second major fishery resource in Korea. However, since the 1980s, catches have fallen sharply, bringing the minimum catch in 2012. In order to produce maximum sustainable yield, we need the management of hairtail. Thus, in this study, we talk about the optimal harvesting strategies for hairtails by using the discrete time age-structured model.

PC-187

Girls in math: a study of how role models can affect performance in mathematics at secondary level.

Gustavo Braga Alcantara	Secretaria de Estado de Educação do Distrito Federal
Graziela D'e Lima Pereira Kalinowski	Secretaria de Estado de Educação do Distrito Federal
Kariza Dias Andrade Sant'Ana	Secretaria de Estado de Educação do Distrito Federal
Jose Cezario Mariano Junior	Agência Nacional de Mineração
Susanne Taina Ramalho Maciel	Universidade de Brasília, Campus Planaltina

Abstract: Although some progress is happening to reduce the gender gap over the last decades, women are still under-represented on STEM fields. One way to surpass this disparity is reducing the presence of culturally embedded beliefs about female inferiority and male superiority in mathematics at school. We developed a classroom goal orientation to female mathematician role models, such as Ada Lovelace, Florence Nightingale and Maryam Mirzakhani, for 362 students at a secondary level in Brasilia, Brazil.

PC-188

LEARNING EVALUATION: VISIÓN OF UNIVERSITY STUDENTS

María Luisa Vallejo	Universidad Nacional de Tucumán

Abstract: This work is part of a research on the evaluation of Mathematics in the Faculty of Agronomy and Zootechnics of the National University of Tucumán, Argentina. Thinking about the evaluation as an instrument to improve learning, it is considered important the opinion of the students on some aspects: difficulty and grades obtained. They are presented: context, theoretical framework, design and analysis of information. It is concluded that the answers obtained are significant, from a critical and reflexive teaching attitude.

PC-189

Methods and systems for supporting graphs in computer science

Elena Kasyanova	Institute of Informatics Systems
Victor Kasyanov	Institute of Informatics Systems

Abstract: In the paper, methods and systems being under development at Institute of Informatics Systems for supporting graph methods in computer science are considered. Wiki-dictionary WikiGRAPP on graphs in computer science, wiki-encyclopedia WEGA on graph algorithms for solving problems of informatics and programming and system Visual Graph for visualization of big amounts of complex information on the base of graph models are presented. This research is supported by the Russian Foundation for Basic Research (18-07-00024).

PC-190

Model for asset prices and valuation of financial derivatives based on randomly indexed branching processes

John Freddy Moreno Trujillo	Universidad Externado de Colombia

Abstract: A pure jump stochastic model is presented to describe the price of risky assets, based on randomly indexed branching processes, which is more appropriate to describe some of the characteristics observed in global financial markets. Expressions are also presented for the prices of financial options for purchase and sale agreed on these assets.

PC-191

Optimal Portfolios For An Investor Who Receives Stochastic Income

Kebareng Court	BIUST
Edward. M Lungu	BIUST

Abstract: We study an investor whose wealth is described by a Markovian process and who additionally receives a stochastic income. We consider a stochastic income with terminal amount, and we find an initial stochastic income using the BSDE through maximum principle. Our aim is to generate a unique Markov stochastic process that arguments the investor's new total wealth W'(t). We also show some unique solutions for the optimal portfolios of an investor.

PC-192

OPTION VALUATION USING FINITE DIFFERENCE METHODS

DEBORAH DORMAH KANUBALA	AFRICAN INSTITUTE FOR MATHEMATICAL SCIENCE

Abstract: This research examines the different options in finance and use finite difference methods for valuation while stating a few examples of how the PDE framework may be exploited in option pricing. The main focus is deriving the Black-Scholes PDE using Ito lemma and solving the PDE using Finite Difference Methods.

PC-193

An elegant and effective color image encryption algorithm using ARMAC in virtual planet domain

Manish Kumar	BITS Pilani

Abstract: In this work, an elegant and effective method of encrypting color images using ARMAC in the virtual planet domain is proposed. We have designed a highly secure algorithm wherein color images can be encrypted with varied computational cost depending on the user, enabling real-time image encryption. Computer simulation with standard examples and results have been provided to analyze the capability and robustness of the proposed approach. Further, comparison with current existing methods has been demonstrated.

PC-194

Discrete octonion Fourier transform and its applications in the analysis of discrete-time linear time-invariant systems

Łukasz Błaszczyk	Warsaw University of Technology

Abstract: Following earlier research on octonion Fourier transformations and their applications in 3-D system analysis, we develop the theory of discrete transformations, i.e. discrete-space octonion Fourier transform. We combine the theory of hypercomplex-valued functions, Fourier transforms and difference equations analysis, using previous research on algebra of quadruple-complex numbers. This hypercomplex generalization of DTFT provides a tool for the analysis of 3-D discrete LTI systems. The research was supported by National Science Centre (Poland) grant No. 2016/23/N/ST7/00131.

PC-195

Hiding Information in Images Distributed by QR Codes

Hsun-Wen Chang	Tatung University
Pei-Shin Chen	Tatung University
I-Tsai Chen	Tatung University

Abstract: Information hiding schemes imperceptibly conceal secret messages into cover images to prevent from eavesdropping and keep secret messages safe. On the other hand, QR (Quick Response) code is a popular barcode which conveniently leads to additional information or websites. In this paper, we make use of the open feature of QR code to distribute the cover image so that only those who know the information hiding mechanism in advance can further retrieve the secret messages.

PC-196

On Compressed Sensing Applied to Channel Parameters Estimation for Indoor Localization

Dolores Garcia	Imdea Networks,

Abstract: Indoor localization is a key enabler for a wide range of applications, including IoT and sensor networks. Also, indoor localization can be used for improved beamforming in wireless communications. In this poster we want to present an innovative approach to indoor positioning, using compressed sensing to estimate the parameters of the channel, angles of arrival and times of flight of the multipath environment, and postprocessing using machine learning to achieve precise indoor positioning.

PC-197

Parameter selection in non-local variational image denoising

Andrés Miniguano Trujillo	Research Center on Mathematical Modeling / Escuela Politécnica Nacional
Juan Carlos De Los Reyes	Research Center on Mathematical Modeling / Escuela Politécnica Nacional

Abstract: We consider (and compare) different modifications of the non-local means kernel for image denoising tasks. The resulting linear and total variation regularization models are applied to a data base of noisy unscaled images, alongside a scheme for selecting the Tikhonov penalty parameter in the objective function and the filtering parameter inside the kernel. As quality measure we consider the SSIM index.

PC-198

A stabilized semi-implicit Euler gauge-invariant method for the time-dependent Ginzburg-Landau equations

Huadong Gao	Huazhong University of Science and Technology

Abstract: we propose and analyze a stabilized semi-implicit Euler gauge-invariant method for time-dependent Ginzburg-Landau (TDGL) equations in the two-dimensional space.We prove that the proposed method unconditionally preserves the point-wise boundedness of the solution and is also energy-stable.The proposed method under the zero gauge is shown to be equivalent to a mass-lumped version of the lowest order rectangular edge element approximation. These indicate the method is also effective in solving the TDGL problems in non-convex domains.

PC-199

Nonlinear model in hyperelasticity.

José Carlos Bellido Guerrero	Universidad de Castilla-La Mancha
Javier Cueto García	Universidad de Castilla-La Mancha
Carlos Mora Corral	Universidad Autónoma de Madrid

Abstract: The aim of this work is to study a broader model for elastic deformations such that it also includes singularity phenomena such as fracture and cavitation. This task is carried out searching optimal deformations of a non-local functional associated with the energy of the system. In this process we remark the neccessity of a non-local Piola Identity. Additionally, we also consider the recovery of the classical model when the singularity vanishes.

PC-200

A multilevel domain decomposition solver and its combination with adaptive finite element method

Jakub Sistek	Institute of Mathematics of the Czech Academy of Sciences
Pavel Kus	Max Planck Computing and Data Facility

Abstract: We combine the adaptive mesh refinement (AMR) with a multilevel domain decomposition solver for finite element computations. Multilevel Balancing Domain Decomposition based on Constraints (BDDC) is considered. We discuss the effect of disconnected subdomains on the convergence and solution time of the BDDC method. Results for Poisson problems and linear elasticity are presented. The largest problem has over a billion unknowns and it is solved on 2048 CPU cores.

PC-201

A parallel Galerkin-based methodology versus data mining techniques for predicting the compressive of the concrete

Violeta Migallón	Universidad de Alicante
Francisco Navarro-González	Universidad de Alicante
José Penadés	Universidad de Alicante
Yolanda Villacampa	Universidad de Alicante

Abstract: A Galerkin-based methodology for modelling the compressive strength of the lightweight aggregate concrete is proposed. Taking into account both the memory requirements and the computational cost of this technique, as the complexity or the number of input variables increases, the execution of the algorithm becomes infeasible in a sequential mode. Consequently, a parallel algorithm has been designed, showing that the proposed methodology significantly outperforms other analyzed data mining techniques.

PC-202

Computational environment for Lie Algebras

Pilar Benito	Universidad de La Rioja
Jorge Roldán-López	Universidad de La Rioja

Abstract: Lie algebras arise naturally in Mathematics and Physics. The structural objects around this class of non-associative algebras are often large and complex to describe. The developement of algorithms for analizing the structure of a Lie algebra in the seventies opened up lots of possibilities in the research on this topic. In this poster, we give a computational environment with some algorithms related to metrics, authomorphisms, derivations and constructions on Lie algebras.

PC-203

CUR Decompositions and Subspace Clustering

Keaton Hamm	University of Arizona
Longxiu Huang	Vanderbilt University
Akram Aldroubi	Vanderbilt University
Ali Sekmen	Tennessee State University
Bugra Koku	Middle East Technical University

Abstract: We present randomized algorithms for determining exact CUR decompositions of low-rank matrices, which are generated by choosing a small subset of columns and rows from the original matrix. We show that this decomposition can be used to solve the Subspace Clustering Problem, and exhibit a practical algorithm which achieves the best performance to date on clustering motions of the Hopkins155 motion data set.

PC-204

Design of new multiresolution operators using Machine Learning techniques

Adrián Pérez-Suay	Universitat de València
Dionisio F. Yánez	Universitat de València
Francesc Aràndiga	Universitat de València

Abstract: Multiresolution techniques have been satisfactory used in signal and image processing. In last years, learning-based multiresolution operators have been designed and tested obtaining good results in compression tasks (see F.Aràndiga, A.Cohen, D.F.Yáñez, Learning based multiresolution schemes with application to compression of images, Signal Process). In this work, we introduce some Machine Learning techniques to construct new prediction functions. Experimental results over synthetic one dimensional signals and gray scale images are provided.

PC-205

Efficient algorithms for geodesic shooting in diffeomorphic image registration

Felix Huber	University of Stuttgart
Miriam Mehl	University of Stuttgart
Andreas Mang	University of Houston

Abstract: We present efficient algorithms for geodesic shooting in diffeomorphic image registration. Our contributions are the design of efficient algorithms, their analysis, and their application to imaging problems. In image registration, we seek a map that establishes a spatial correspondence between two images of the same scene. We use an optimal control formulation with initial value control. We discuss Newton-type algorithms for optimization. We showcase performance results and compare them to our prior work.

PC-206

Methods and system for cloud parallel programming

Victor Kasyanov	Institute of Informatics Systems
Elena Kasyanova	Institute of Informatics Systems

Abstract: In this paper, the CPPS project being under development at the Institute of Informatics Systems in Novosibirsk with support of the Russian Science Foundation (18-11-00118) is considered. The CPPS system is available on web via browser and includes interface, interpreter, graphic visualization/debugging subsystem, optimizing cross compiler, cluster runtime. It provides means to write and debug architecture-independent parallel Cloud-Sisal-programs on low cost devices and to translate and execute Cloud-Sisal-programs in clouds.

PC-207

Reservoir Computing with Complex Nonlinear System

Eonyoung Park	UNIST
JaeSung Choi	UNIST
Bongsoo Jang	UNIST

Abstract: In this work, we propose a new frame of Reservoir computing(RC) by using a Complex Nonlinear System. Due to the several properties of the nonlinear system, the proposed RC provides an excellent performance of the task for predicting and reconstructing several types of information such as time series, image. To improve the performance of RC, we investigate an appropriate train length as well as the method for constructing the Reservoir.

PC-208

Reversing the series of the reciprocal of Γ near negative integer argument

Ana Carolina Camargos Couto	Western University
Robert Corless	Western University
David Jeffrey	Western University

Abstract: Computing the functional inverse of the Γ function requires good starting guesses. For the principal branch, an approximation can be generated by reversing Stirling's original series. For other branches, it can be more difficult. This note shows how to find as many terms as one likes for series for the functional inverse of Γ by reversing the series for reciprocal Γ near negative integers. We also discuss the radius of convergence of the resulting series.

PC-209

SAFE ML: Surrogate Assisted Feature Extraction for Automated Model Training

Alicja Gosiewska	Warsaw University of Technology
Aleksandra Gacek	Warsaw University of Technology
Piotr Lubon	Warsaw University of Technology
Przemyslaw Biecek	University of Warsaw

Abstract: Interpretable Machine Learning received much attention recently. Complex predictive models may obtain high accuracy, but opacity causes problems such as instability or lack of trust. On the other hand, interpretable models require much effort in feature engineering. We introduce SAFE ML method to train interpretable and accurate models created on new features extracted from the surrogate complex model. The advantage of this approach is that we get an interpretable model without time-consuming feature engineering.

PC-210

Second-order accurate gas kinetic schemes for the relativistic flow simulations

Yaping Chen	Northwestern Polytechnical University
Yangyu Kuang	Peking University
Huazhong Tang	Peking University

Abstract: This paper presents second-order accurate gas kinetic schemes in the framework of finite volume method for the relativistic flows. The present schemes are derived from the analytical solution of the Anderson–Witting model, which is given for the first time and includes the “genuine” particle collisions in the gas transport process. The gas kinetic schemes are developed for ultra-relativistic fluid of both inviscid and viscous case. Besides, a simplified version is developed for the Synge gas.

PC-211

Simulation of Oldroyd-B viscoelastic flows using a free-energy-dissipative scheme.

Mokhtari Omar	IMFT
Latché Jean Claude	IRSN
Quintard Michel	IMFT
Davit Yohan	IMFT

Abstract: We present a prediction-correction scheme with a staggered finite volume discretization for the Oldroyd-B model of a viscoelastic fluid. Based on the work of Boyaval [ESSAIM, 2009], our scheme satisfies at the discrete level a stability criterion related to the free energy dissipation property of the model at the continuum level. Scheme performance is assessed on benchmark problems, with Weissenberg numbers beyond standard limitations, and results are compared to those obtained with the log-conformation formulation.

PC-212

Single Image Super-Resolution via Non-Local Normalized Graph Laplacian Regularization

Cory Falconer	Ontario Tech University
Sean Bohun	Ontario Tech University
Mehran Ebrahimi	Ontario Tech University

Abstract: The process of producing a high-resolution image given a single low-resolution noisy measurement is called single-frame image super-resolution. We apply a normalized graph Laplacian regularization scheme to solve this inverse problem. Promising results on resolution enhancement for a variety of digital images will be presented.

PC-213

A discrepancy principle for the Landweber iteration based on risk minimization

Cristina Campi	Università di Padova
Federico Benvenuto	Università di Genova

Abstract: We show the application of a criterion based on risk minimization to stop the Landweber algorithm. We provide an unbiased estimator of the risk and we use it for defining a variant of the classical discrepancy principle. We applied it to data coming from two signal formation models, and we show that the proposed method is numerically reliable and furnishes slightly better solutions than classical estimators based on the predictive risk.

PC-214

A new approach for analyzing Fourier approximations for differentiable periodic functions

Haiyong Wang	Huazhong University of Science and Technology

Abstract: Fourier expansion is a powerful approach to approximate periodic functions. Here we provide a new approach to analyze the approximation properties of Fourier expansion for differentiable periodic functions. In particular, we show that optimal estimates for the Fourier coefficients of differentiable periodic functions with noninteger powers, i.e., f(x) = |sin(x/2)|^(3/2), can be achieved.

PC-215

A NUMERICAL SOLUTION FOR VARIABLE ORDER INTEGRO-DIFFERENTIAL EQUATIONS

Hossein Jafari	University of South Africa
R. M. Ganji	University of Mazandaran

Abstract: In this paper, we use Taylor, Chebychev and Legendre polynomials to obtain numerical solution of variable order Integro-differential equations (VOIDEs). With the help the basis polynomials and collocation method, the VOIDEs reduce to a system of algebraic equations. Then, we solve the system and obtain the approximate solution. Two examples are given to verify the efficiency of the proposed method.

PC-216

A pressure-robust Hybrid High-Order method for the steady incompressible Navier-Stokes problem

Daniel Castanon Quiroz	University of Montpellier
Daniele A. Di Pietro	University of Montpellier

Abstract: We introduce and analyze a novel pressure-robust Hybrid High-Order method for the steady incompressible Navier-Stokes equations. The proposed method supports arbitrary approximation orders, and is (relatively) inexpensive thanks to the possibility of statically condensing a subset of the unknowns at each nonlinear iteration. For regular solutions and under a standard data smallness assumption, we prove a pressure-independent energy error estimate on the velocity of order (k+1). Numerical results are presented to support the theoretical analysis.

PC-217

A Type of Parallel Augmented Subspace Method for Eigenvalue Problems

Fei Xu	Beijing University of Technology
Hehu Xie	Chinese Academy of Science

Abstract: A type of parallel augmented subspace scheme for eigenvalue problems is proposed. In this scheme, eigenvalue problem is decomposed into boundary value problems and very low dimensional eigenvalue problems. The efficiency can be improved since there is no direct eigenvalue solving in the finest space. Furthermore, for different eigenvalues, the corresponding boundary value problem and low dimensional eigenvalue problem can be solved in the parallel way since they are independent of each other.

PC-218

An adaptive algorithm for solving differential problems via radial basis function collocation methods

Roberto Cavoretto	University of Turin
Alessandra De Rossi	University of Turin

Abstract: We propose an adaptive scheme designed to be applied with radial basis function (RBF) collocation methods. The algorithm is based on an adaptive superimposition technique, which is characterized by an error indicator that compares two approximate RBF collocation solutions computed on a coarser and a finer set of collocation points. The algorithm is tested on some differential problems of elliptic-type. Numerical results show the performance of our adaptive scheme.

PC-219

An efficient numerical approach for solving nonlinear two-point boundary value problems with a Caputo fractional derivatives

Junseo Lee	UNIST
Keonho Kim	UNC chapel hill
Hyunju Kim	North Greenville University
Bongsoo Jang	UNIST

Abstract: We propose an efficient numerical method to solve the nonlinear two-point boundary value problems of Caputo fractional derivative based on the nonlinear Shooting method. The two-point BVP is transformed into the system of IVP with an unknown guess. The initial guess is updated by solving Newton's and the Hally's method combined with another boundary condition. Each of the method have second and third order convergence, respectively. Numerical illustrations show the efficiency of the proposed method.

PC-220

Comparing Time Schemes for Chemotaxis Equations

Alba María Navarro Izquierdo	Universidad de Cádiz
José Rafael Rodríguez Galván	Universidad de Cádiz

Abstract: The movement of biological cells in response to chemical signals, called chemotaxis, was modelled by Keller-Segel in 1970. The classical mode, present some interesting challenges from the point of view of the Numerical Analysis. Some discrete in time linear sechemes are proposed here, wich decouple calculation of cells and chemical signal. The sechemes are compared from different points of view: energy-stability, order, positivity ability of estimation of blow up time.

PC-221

Computing Matrix Functions in Arbitrary Precision Arithmetic

Massimiliano Fasi	The University of Manchester
Nicholas J. Higham	The University of Manchester

Abstract: In some applications, results computed in IEEE double precision arithmetic are not sufficiently accurate and higher precision is needed, often due to ill conditioned or badly scaled problems. Yet in other situations, single or even half precision is sufficient. We present algorithms for computing the matrix logarithm and the matrix exponential in arithmetic of arbitrary precision. The algorithms adapt their underlying approximations to the working precision through the use of rigorous error bounds.

PC-222

Discontinuous kernels for reconstructing multidimensional piecewise continuous functions

Stefano De Marchi	Università degli Studi di Padova
Wolfgang Erb	Università degli Studi di Padova
Francesco Marchetti	Università degli Studi di Padova
Emma Perracchione	Università degli Studi di Padova
Milvia Rossini	Università di Milano-Bicocca

Abstract: Approximation and interpolation techniques for functions with discontinuities are relevant key tools in many applications. We present a RBF-type method for scattered data interpolation that incorporates discontinuities via a variably scaling function. We characterize the native spaces spanned by these kernel functions and study error bounds, which are then confirmed by numerical experiments. Information about the edges of the interpolated function is necessary and it can be achieved via machine learning classification algorithms.

PC-223

Diverse applications of the sigmoidal functions

Beong In Yun	Kunsan National University

Abstract: Sigmoidal functions are versatile non-linear maps over the real line. They have particular properties which are useful to various fields of applications. In this work we summarize and illustrate concisely the applications of the sigmoidal functions that have been verified to be available, for example, in numerical integration, Fourier analysis, root finding for non-linear equations, ad hoc approximation to special functions, and neural network approximation. The wider applications are also explored for further work.

PC-224

Efficient calculus of ENO-wavelet coefficients for orthonormal wavelets of any order.

José Jaime Noguera Noguera	UNED-Denia
Francesc Aràndiga Llaudes	Universitat de València
Rosa Maria Donat Beneíto	Universitat de València

Abstract: This poster presents a new way of calculating the coefficients of high and low frequencies of the ENO-Wavelet transform, proposed by Chan and Zhou in 2002. Unlike the original scheme, we use the inverse transform for the calculation of these coefficients, which allows us to make a more efficient calculation of them, as well as a simple generalization not only for the base DB2p but also for any orthogonal wavelet base.

PC-225

Efficient composition schemes for problems separable into three parts

Alejandro Escorihuela-Tomàs	Universitat Jaume I
Fernando Casas	Universitat Jaume I

Abstract: We construct efficient fourth-order numerical integrators by composing first-order schemes for systems of ODEs separable into three parts.Systems of this form appear frequently in applications, ranging from the motion of particles in electromagnetic fields to plasma physics and problems in astrodynamics. We illustrate our schemes in comparison with other published in the literature on the so-called disordered discrete nonlinear Schrödinger (DDNLS) model, describing anharmonic interactions between oscillators in disordered media.

PC-226

Fast computation of optimal damping parameters for linear vibrational system via eigendecomposition of a diagonal-plus-low-rank matrix

Nevena Jakovčević Stor	University of Split, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture
Ivan Slapničar	University of Split, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture
Zoran Tomljanović	University of Osijek, J. J. Strossmayer

Abstract: We consider determination of optimal damping for the linear vibrational system by formulating the quadratic eigenvalue problem underlying this mathematical model as an eigenvalue problem of a diagonal-plus-low-rank matrix A. The eigenvector matrix of A has Cauchy-like structure. We use fast multiplication of linked Cauchy-like matrices to compute the trace of the solution of the Lyapunov equation. The subsequent optimization is order of magnitude faster than in the standard approach.

PC-227

Fast spatial convergence for KdV like equations

Mirko Residori	University of Innsbruck
Alexander Ostermann	University of Innsbruck
Lukas Einkemmer	University of Innsbruck

Abstract: The aim of this work is to present a new approach for solving KdV (Korteweg--de Vries) like equations. It combines splitting methods in time and pseudo-spectral spatial discretization to achieve a superpolynomial spatial convergence. We impose the so-called transparent boundary conditions, which allow us to perform numerical simulations on a finite domain without appreciable reflections, which typically appear for Dirichler or Neumann boundary conditions.

PC-228

FCIRK integrators with Application to Solar System Simulations

Mikel Antoñana	UPV/EHU
Joseba Makazaga	UPV/EHU
Elisabete Alberdi	UPV/EHU
Ander Murua	UPV/EHU

Abstract: We propose a family of integration methods called flow-composed implicit Runge–Kutta (FCIRK) methods, consisting of the composition of flows of the unperturbed part alternated with one step of an implicit Runge–Kutta method applied to a transformed system. The resulting integration schemes are symplectic and admits mixed precision implementation that allows us to efficiently reduce the effect of round-off errors. We particularly focus on the potential application to long-term solar system simulations.

PC-229

Finding stability regions of approximate methods: a direct geometric approach

Asghar Ghorbani Ferdowsi University of Mashhad

Abstract: The stability region of a numerical method for solving nonlinear differential equations usually is difficult to characterize in general, except for some special cases. In this work, we suggest a practical geometric approach to directly discover the stability region. Some cases are considered to illustarate the efficiency of the proposed scheme.

PC-230

Fourth Order Orthogonal Spline Collocation Methods for Two-Point Boundary Value problems with Interfaces

Santosh Kumar Bhal BITS Pilani KK Birla Goa Campus
Danumjaya Palla BITS Pilani KK Birla Goa Campus
Graeme Fairweather AMS

Abstract:

Orthogonal Spline Collocations Methods (OSC) are used to solve two-point boundary value problems (BVPs) with interfaces. In particular, we consider the one dimensional Helmholtz equation with piecewise wave numbers solved using the standard OSC approach with piecewise Hermite cubic bases. For solution of self-adjoint two point BVPs with interfaces, we employ OSC with cubic monomial bases. Fourth-order accuracy in L
and superconvergence in the nodal error of the derivative of the OSC approximation is observed.

PC-231

High Accuracy Compact Difference Schemes for Differential Equations in Mathematical Sciences

Murli Gupta George Washington University

Abstract: We developed high order compact difference schemes in 1980's when we presented new discretizations for the convection-diffusion equations. This is now applied to complex fluid flow problems and has evolved into the streamfunction- velocity formulations for the Navier- Stokes equations. Here, we present some historical developments of the high order compact difference schemes and their evolution into the powerful computational techniques that are now used to solve fluid flow problems of important physical interest.

PC-232

Least-squares finite element method with dual system for nonlinear partial differential equations

Hyesun Na Yonsei University
Eunjung Lee Yonsei University

Abstract: Due to the unique approximation form of LL* method, it allows to construct a discontinuous approximation which makes the continuation of Newton's iteration be infeasible. In the papaer 'FOSLL* for nonlinear partial differential equations', several options were introduced how LL* can be used in Newton iteration. In this work, we propose to use LL*-approach as a preconditioner to balance the nonlinearity and produce a better initial guess for inexact Newton iteration.

PC-233

Method of the fundamental solution for Neumann problems of the modified Helmholtz equation in disk domain

Yoshitaro Tanaka Future University Hakodate
Hiroyuki Ochiai Kyushu University
Shin-Ichiro Ei Hokkaido University

Abstract: The method of the fundamental solutions (MFS) is to construct the approximate solution for the partial differential equation in bounded domains. It is based on combining the shifted fundamental solutions, and determining the coefficients of the linear sum to satisfy the boundary condition on the finite points of the boundary. We construct the approximate solution for Neumann boundary problems of the modified Helmhortz equation by the MFS, and show its convergence to the exact solution.

PC-234

Methods to find the accurate Stress Intensity Factors raised from domain singularity

Seokchan Kim Changwon National University

Abstract: We consider the Poisson equation on a polygonal domain with the domain singularity raised from the changed boundary conditions. The solution of the Poisson equation with such singularity can be written as a sum of a regular part and singular parts, whose coefficients are called as SIFs (Stress Intensity Factors). We talk about methods to find a more accurate estimate of SIF.

PC-235

Multilevel BDDC method for incompressible flow

Martin Hanek Czech Technical University in Prague
Jakub Šístek Institute of Mathematics of the CAS
Pavel Burda Czech Technical University in Prague

Abstract: We deal with numerical simulation of incompressible flows using multilevel Balancing Domain Decomposition based on Constraints (BDDC). We apply this method to non-symmetric problems arising from the linearized incompressible Navier-Stokes equations. Picard iteration is used for linearization, and linear system is solved by the BiCGstab method using one step of BDDC as a preconditioner. Multilevel BDDC method for benchmark problem of 3-D lid-driven cavity is presented.

PC-236

Multivariate polynomial root finding with tensor techniques

Patrick Kürschner KU Leuven

Abstract: We show how the root finding problem for systems of multivariate polynomials can solved in terms of tensor decompositions. One way is the reformulation of the polynomial system as linear system of equations where the solution vectors allow a representation as canonical polyadic decomposition of a tensor. Another approach is to use the Macaulay matrix, whose null space admits a representation as tensor decomposition which reveals the roots.

PC-237

Nonlinear semi-NMF based method for deep neural network computations and its improvements

Akira Imakura University of Tsukuba
Tetsuya Sakurai University of Tsukuba

Abstract: Deep neural networks (DNNs) have attracted a great deal of attention over the years for their high efficiency in various fields, such as image and signal recognition. Recently, we have proposed a novel nonlinear semi-NMF based method for full-connected DNN computations. This presentation introduces basic ideas of the nonlinear semi-NMF based method and proposes its improvement techniques.

PC-238

Numerical approach to the interface problem with general inclusion domain

Eunhye Hong Yonsei University

Abstract: In studying of interface problem, the effect on their confronting boundary is important. The potential theory is used in expressing the solution analytically. However, for a general shape inclusion, finding the explicit form of the solution is difficult. We use conformal mapping to find the solution numerically. It is based the Laplace’s equation is conformally invariant. To construct that mapping, we establish an optimal control problem that minimized the dissimilarity between transformed and reference image.

PC-239

Numerical Schemes for Classical Chemotaxis Equations.

J. Rafael Rodríguez Galván	Universidad de Cádiz
Alba María Navarro Izquierdo	Universidad de Cádiz
Daniel Acosta Soba	Universidad de Cádiz

Abstract: Movement of biological cells in response to chemical signals, called chemotaxis, was modeled by Keller-Segel in 1970. One of the more interesting challenges for the classical model is the development of numerical schemes which are energetically stable and conserve the positivity of the variables. We propose some schemes which decouple first the calculation of cells and chemical signal. Then we apply continuous and discontinuous space discretizations allowing techniques like local maximum principle preserving.

PC-240

Sharp uniform in time error estimate on a stochastic structure-preserving Lagrangian method and computation of effective diffusivity in 3D chaotic flows

Zhongjian Wang	The University of Hong Kong
Jack Xin	University of California at Irvine
Zhiwen Zhang	The University of Hong Kong

Abstract: There are two formulations to compute the effective diffusivity for divergence-free chaotic flows, Eulerian and Lagrangian. For large Peclet number, cell problem PDE in Eulerian is ill-posed. We used the Lagrangian approach, which is modeled by SDEs. A completely new and uniform in time error estimate for effective diffusivities is proposed to rid of the exponential growth factor in classic ones. We also investigate the diffusion-enhanced phenomenon in the Arnold-Beltrami-Childress flow and Kolmogorov flow.

PC-241

Solving parameter estimation problems using the all-at-once ansatz and domain decomposition

Richard Gootjes	TU Bergakademie Freiberg
Michael Eiermann	TU Bergakademie Freiberg

Abstract: The poster deals with reconstructing a 2D spatial thermal conductivity distribution from temperature observations. Therefore, a constraint least-squares optimization problem is formulated in terms of the Lagrange formalism (all-at-once ansatz) and solved by the Gauss-Newton approach. The underlying heat equation is discretized with P1 finite elements. The resulting sparse linear system is solved with FETI-DP, a domain decomposition algorithm. The introduced algorithm is applied on manufactured observations which are disturbed by Gaussian noise.

PC-242

Spectral interpolation in polar and spherical geometries

Wolfgang Erb	University of Padova

Abstract: Rhodonea curves or spherical Lissajous curves can be used as sampling trajectories to create novel nodes for spectral interpolation on the disk or the unit sphere. Based on a parity-modified double Fourier basis in the respective coordinate systems, we will generate interpolation spaces that allow unique spectral interpolation for these node sets. Important properties as continuity, convergence, robust numerical condition and simple implementation will be shown for the presented interpolation schemes.

PC-243

Stabilized continuous finite element schemes for problems in plasma physics

Sibusiso Mabuza	Sandia National Laboratories
John Shadid	Sandia National Laboratories
Eric Cyr	Sandia National Laboratories
Roger Pawlowski	Sandia National Laboratories
Dmitri Kuzmin	TU Dortmund University

Abstract: We present finite element schemes for simulating ionized and magnetized gases. We consider iterative, linearity preserving, nodal variation limiting strategies for the stabilization of hyperbolic systems such as the magnetohydrodynamics (MHD) equations and multifluid plasma equations. These equations, are discretized using piece-wise linear continuous finite elements. The stabilization of the scheme follows the flux corrected transport paradigm by introducing diffusion into the system, whose amount is regulated by solution dependent element and nodal limiters.

PC-244

Structured linearizations of some nonlinear eigenvalue problems

Vasilije Perovic	University of Rhode Island
D. Steven Mackey	Western Michigan University

Abstract: The nonlinear eigenproblem consists of finding scalars λ (eigenvalues) and nonzero vectors x (eigenvectors) satisfying N(λ)x=0, where N(λ) is a matrix-valued function. Eigenvalues of N(λ)'s arising in applications often exhibit symmetry which computed spectrum should reflect. We address this question for a T-even nonlinear eigenproblem arising from delay differential equations, i.e. N(-λ)=NT(λ), by approximating N(λ) by a T-even matrix polynomial P(λ) and constructing a T-even linearization of P(λ). Generalizations to other structured eigenproblems are discussed.

PC-245

The active flux scheme on Cartesian grids

Wasilij Barsukow	Zurich University
Jonathan Hohm	Wuerzburg University
Christian Klingenberg	Wuerzburg University
Philip L. Roe	University of Michigan

Abstract: The Active Flux scheme is a finite volume scheme with continuous reconstructions. The intercell flux is obtained using additional degrees of freedom distributed along the boundary. An implementation of this method on Cartesian grids is shown for linear acoustics. The time evolution of the point values employs an exact evolution operator, which naturally ensures the correct direction of information propagation and provides stability for explicit time integration. It is third order accurate.

PC-246

The finite element method for linear strain gradient elasticity

Hongliang Li	Microsystem and Terahertz Research Center
Pingbing Ming	Chinese Academy of Sciences

Abstract: We propos two finite element to approximate a boundary value problem arising from gradient elasticity, which is a high order perturbation of the linearized elastic system. Our elements are H2-conforming while H1-nonconforming. We show both elements conerge in the energy norm uniformly with respect to the perturbation parameter.

PC-247

The finite volume method on a Schwarzschild background

Shijie Dong	Sorbonne University
Philippe LeFloch	Sorbonne University

Abstract: We introduce a class of nonlinear hyperbolic conservation laws on a Schwarzschild black hole background. Next, we formulate a numerical approximation scheme which is based on the finite volume methodology and takes the curved geometry into account. We establish that this scheme converges to an entropy weak solution to the initial value problem and, in turn, our analysis also provides us with a theory of existence and stability for a new class of conservation laws.

PC-248

The radial part of non-standard orthogonal polynomials on the ball

Fátima Lizarte López	University of Granada
Teresa Encarnación Pérez Fernández	University of Granada
Miguel Ángel Piñar González	University of Granada

Abstract: We consider a Sobolev inner product on the d-ball, which involves the outward nomal derivatives. Using spherical-polar coordinates we construct explicitly a mutually orthogonal basis of polynomials, which are given in terms of spherical harmonics and a family of univariate Sobolev orthogonal polynomials in the radial part. The latter ones are studied and some algebraic and analytic properties are obtained. This is a joint work with Teresa E. Pérez and Miguel A. Piñar.

PC-249

Theory and computation of solution to the multidimensional option price equation in a regime switching market

KULDIP SINGH PATEL INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH PUNE
ANINDYA GOSWAMI INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH PUNE

Abstract: We produce a self-contained proof for the existence and uniqueness of the solution to a multidimensional system of parabolic partial differential equation (PDE) which naturally arises in the study of derivative pricing in a Markov modulated geometric Brownian motion (MMGBM) model. After truncating infinite domain to a bounded domain, far boundary error estimates are obtained for initial-boundary value problem. Moreover, Crank-Nicolson finite difference scheme is used for computing the option price numerically.

PC-250

Towards Isotropic Transport with Co-Meshes

Christina Paulin CEA
Antoine Llor CEA
Eric Heulhard De Montigny CEA

Abstract: Transport is the central ingredient of all numerical schemes for hyperbolic PDE and in particular for CFD applications. Transport has thus been extensively studied in many of its features and for numerous specific applications. A major artifact produced by numerical transport is mesh imprinting. Though mesh imprinting is inevitable, its anisotropy can be modulated and is thus amenable to significant improvements. The co-mesh strategy computes enlarged stencils through the modified equation to minimize anisotropy.

PC-251

Variational integrators for stochastic dissipative Hamiltonian systems

Michael Kraus Max Planck Institute for Plasma Physics
Tomasz Tyranowski Max Planck Institute for Plasma Physics

Abstract: Variational integrators are derived for structure-preserving simulation of stochastic forced Hamiltonian systems. The derivation is based on a generalization of the Lagrange-d'Alembert principle. The resulting integrators satisfy a discrete stochastic Lagrange-d'Alembert principle, and in the presence of symmetries, they also satisfy a discrete counterpart of stochastic forced Noether's theorem. Furthermore, mean-square and weak Lagrange-d'Alembert Runge-Kutta methods are proposed and tested numerically to demonstrate their superior long-time numerical stability and energy behavior compared to non-geometric methods.

PC-252

Generating models of densifiable sets

Juan Matías Sepulcre University of Alicante

Abstract: We will show the description of two models which have been implemented to generate curves densifying some representative densifiable sets. In particular, we will study some of such sets generated by means of functional equations whose analytic solutions are closely related to the partial sums of the Riemann zeta function. Some specific cases of such functional equations were proposed by other authors for modeling processes relative to the combustion of hydrogen in a car engine.

PC-253

Geometric aspects of Riemann's non-differentiable function.

Daniel Eceizabarrena BCAM - Basque Center for Applied Mathematics

Abstract: Riemann's non-differentiable function was the first example of a continuous function which is almost nowhere differentiable, and traditionally it has been studied from an analytic perspective. My objective is to show that it also has an intrinsic geometric nature coming from a problem of the Vortex Filament Equation and consequently to present my work on some geometric properties of its image in the complex plane and remark their interest.

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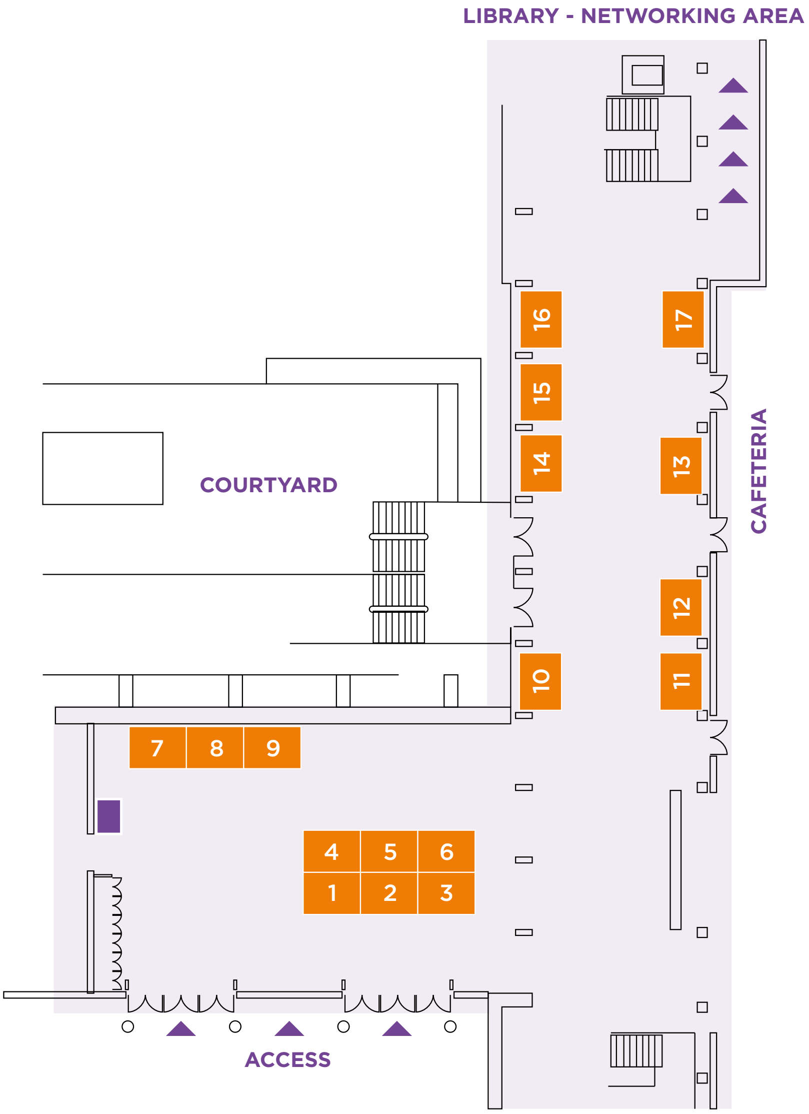
10. Speaker, Author and Organizer Index

10. Speaker, Author and Organizer Index

PS - FACULTAT DE PSICOLOGIA



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17	European Consortium for Mathematics in Industry (ECMI + EU-MATHS-IN)
🟪	Unstaffed tabletop: NIMS – National Institute for Mathematical Sciences / South Korea

SIAM (SOCIETY FOR INDUSTRIAL AND APPLIED MATHEMATICS)

PS Booths 1&2

The Society for Industrial and Applied Mathematics (SIAM) is an international community of over 14,500 individual and almost 500 institutional members. Through publications, research, and community SIAM fosters the application of mathematics and computational science to engineering, industry, science, and society. SIAM members enjoy access to publications and career and networking opportunities and discounts on books, conferences, journals, and more.

MATHWORKS

PS Booth 3

MATLAB and Simulink are fundamental computation tools used at more the 5,000 educational intuitions worldwide. MATLAB is one of the top 10 most popular programming languages and is used for teaching, research, and project-based learning. Add MATLAB and Simulink to the classroom to inspire critical thinking and innovation as well as prepare students for prominent careers in industry, where the tools are the de facto standard for R&D. Learn more at mathworks.com

ICIAM TOKIO 2023

PS Booth 4

This booth introduces information about ICIAM 2023 and is provided by the Tokyo Metropolitan Government.
The 10th ICIAM will be held in Tokyo, Japan in August 20-25, 2023. Besides information about ICIAM 2023, we also introduce the charms of Tokyo.

GERMAN RESEARCH FOUNDATION (DFG)

PS Booths 5 & 6

“Research in Germany” is a government-funded initiative that provides information on research and career opportunities in Germany. Whether you want to learn more about mathematical research in Germany in general, go to graduate school, do a postdoc, establish a research group, or spend a sabbatical, we have funding programs and information for all career stages. Stop by our booth and learn more.

AMERICAN MATHEMATICAL SOCIETY

PS Booths 7-9

The American Mathematical Society is dedicated to advancing research and connecting the diverse global mathematical community through our publications, meetings and conferences, MathSciNet®, professional services, advocacy, and awareness programs.

SPANISH COMMITTEE OF MATHEMATICS (CEMAT)

PS Booth 10

The Spanish Committee of Mathematics (CEMat) is the Spanish Adhering Organization to the International Mathematical Union (IMU). Our membership includes societies like RSME, SEMA, SCM, SEIO, FESPM, SEIEM, SEHCyT, as well as institutions like ICMAT, BCAM, CIMNE, CDM, RedIUM and RACEFN. Among its aims are to reinforce the international Spanish presence, to channel initiatives from IMU, CIMPA, ISC and other international organizations, as well as to advice the Spanish Ministries on the matters of our concern. Its web page: http://matematicas.uclm.es/cemat/en/presentation/

SPANISH SOCIETY FOR APPLIED MATHEMATICS (SEMA)

PS Booth 11

The Spanish Society of Applied Mathematics (SEMA) was created in 1991, as a milestone in the development of applied mathematics in Spain and motivated by the quantitative deep change occurred in the preceding decade in the application of the mathematical techniques and methodology, essentially due to the development of parallel and subsequently high performance computing. Today the activity of SEMA is based upon the consideration that mathematical modeling and analysis, numerical simulation and control techniques are essential tools to understand and solve the many challenging problems in physics, chemistry, engineering, biomedical sciences, geosciences, economy, finance, among others.

SOCIÉTÉ DE MATHÉMATIQUES APPLIQUÉES ET INDUSTRIELLES (SMAI)

PS Booth 12

It is a French scientific society aiming at promoting applied mathematics. SMAI was founded in 1983 to contribute to the development of applied mathematics for research, commercial applications, publications, teaching, and industrial training. As of 2009, the society has nearly 1300 members, including both individuals and institutions.

BCAM

PS Booth 13

BCAM is a world-class research center in the field of Applied Mathematics that was founded in 2008 as a Basque Excellence Research Center (BERC), with a focus on interdisciplinary research in Mathematics, as well as training and attracting talented scientists, and promoting scientific and technological advances worldwide. Embedded in a multicultural environment, with more than 90 people from over 25 nationalities working there, BCAM promotes the creation of international and interdisciplinary teams. The center has been awarded twice with the Severo Ochoa distinction that consolidates BCAM as one of the most relevant institutions of the field in Europe.

ORBITA

PS Booth 14

Willing to apply your mathematical knowledge in industrial projects worldwide? Orbita Ingenieria is a Company specialized in designing engineering solutions and automation systems for the most demanding industry sectors, such as Food and Beverage, Automotive, Pharma or Ports &Terminals. Come to discuss our poster and visit us in our stand at the Congress.

NUMERICAL ALGORITHMS GROUP (NAG)

PS Booth 15

The Numerical Algorithms Group (NAG) applies its unique expertise in numerical engineering to delivering high-quality computational software, consultancy and high performance computing services. For over 40 years NAG experts have worked closely with world-leading researchers in academia and industry to provide powerful, reliable and flexible software and solutions relied on by tens of thousands of individual users, as well as numerous independent software vendors. NAG is a not-for-profit organisation and serves its customers from offices in Oxford, Manchester, Chicago and Tokyo, through staff in France and Germany, as well as via a global network of distributors. Together with the globally renowned NAG Library, NAG experts assist others in many ways, whether that be by parallelizing serial codes so they optimally perform on HPC hardware to delivering in-depth technical training courses through developing bespoke algorithms.

www.nag.com

SPANISH FOUNDATION FOR SCIENCE AND TECHNOLOGY (FECYT)

PS Booth 16

The Spanish Foundation for Science and Technology (FECYT) is a public foundation dependent on the Spanish Ministry of Science, Innovation and Universities. Our Mission is to strengthen the link between science and society through actions promoting open and inclusive science, scientific culture and education, and responding to the needs and challenges of the science, technology and innovation system.

ECMI (EUROPEAN CONSORTIUM FOR MATHEMATICS IN INDUSTRY)

PS Booth 17

The European Consortium for Mathematics in Industry (ECMI) is a collaboration between academic institutions and industrial companies throughout Europe. ECMI aims to promote and support the use of mathematical modelling, simulation and optimization, in all activities of social or economic importance in Europe, as well as to further the education of industrial mathematicians to meet the growing demand for mathematical innovation and research.

EU-MATHS-IN (EUROPEAN SERVICE NETWORK OF MATHEMATICS FOR INDUSTRY AND INNOVATION)

PS Booth 17

EU-MATHS-IN aims to leverage the impact of Mathematical Sciences and Technologies on industrial innovations by enhanced communication and information exchange between and among the involved stakeholders on a European level. Together with its industrial core team it aims to coordinate and facilitate the required exchanges in the field of application-driven mathematical research and its exploitation for innovations in industry, science and enlarged society.

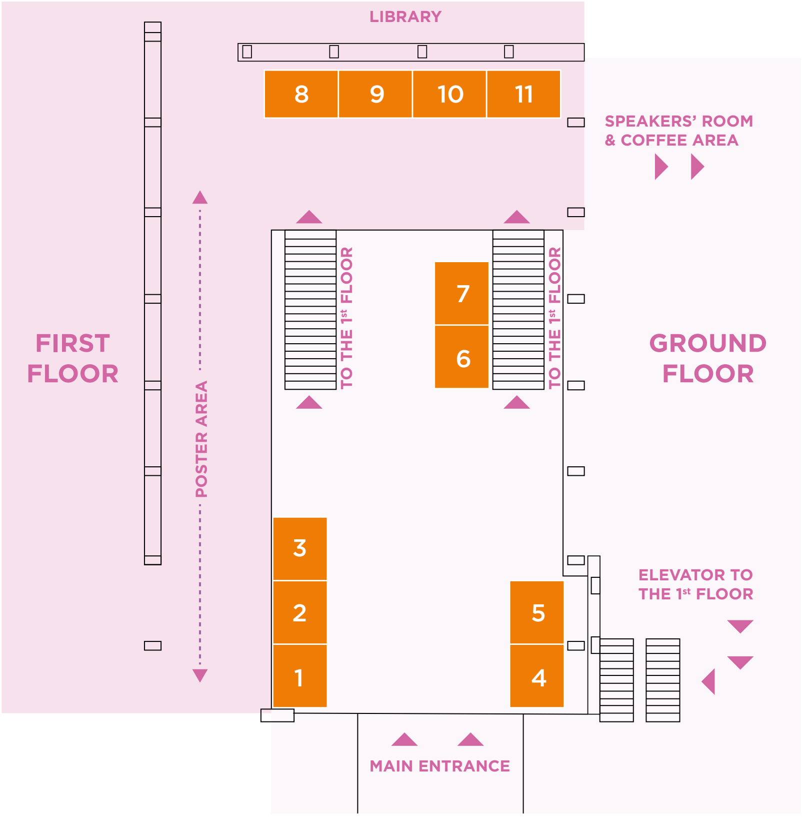
NATIONAL INSTITUTE FOR MATHEMATICAL SCIENCES

PS Unstaffed tabletop

National Institute of Mathematical Sciences is the only government-funded mathematical research institute founded in 2005.
Vision
 - The application of scientific technology and industrial use of mathematics contribute to the improvement of national competitiveness in mathematics.
Mission
 - To meet such national and social demands, NIMS places its goal of conducting strategic R & D, including industrial mathematics, finding and solving mathematical problems in industry and the public sector, and returning the results, and thereby we are trying to contribute to the world through mathematics.
 - NIMS actively pursues R&D partnerships with businesses to promote innovative ideas in mathematics and assist in the development of start-ups that have the potential to surprise the world over, and also aims to establish a problem-solving system and develop specialized programs for start-ups engaging in mathematics.
 - Medical mathematics, which is a new field of study combining medical field and mathematics, is responding to the increasing demands of mathematical solutions for the difficulties of the medical field and making efforts to contribute to the improvement of the health and quality of life.

ICIAM 2019 Exhibit Hall Maps

Facultat de Filosofía i Ciències de l' Educació



FE - FACULTAT DE FILOSOFÍA I CIÈNCIES DE L' EDUCACIÓ	
1 - 2	CAMBRIDGE University Press
3	PRINCETON University Press
4 - 5	SPRINGER
6	FRONTIERS
7	European Mathematical Society Publishing House
8	ELSEVIER
9	Royal Society Publishing
10	OXFORD University Press
11	TAYLOR AND FRANCIS

CAMBRIDGE UNIVERSITY PRESS

FE Booths 1&2

Cambridge University Press is a not-for-profit organization that advances learning, knowledge and research worldwide. It is an integral part of the University of Cambridge and for centuries has extended its research and teaching activities through an extensive range of academic books, journals and digital products.

PRINCETON UNIVERSITY PRESS

FE Booth 3

Princeton University Press was established in 1905, when Woodrow Wilson was President of Princeton University.
Since that time, we have grown from a small printer of scholarly books to a major academic press, publishing more than 250 new books per year. Princeton University Press was incorporated in 1910 as a non-profit company. It is governed by a Board of Trustees. Privately owned, the Press has throughout its history maintained a close relationship with Princeton University

SPRINGER NATURE

FE Booths 4 & 5

Springer Nature is one of the world's leading global research, educational and professional publishers, home to an array of respected and trusted brands providing quality content through a range of innovative products and services. Springer Nature is the world's largest academic book publisher and numbers almost 13,000 staff in over 50 countries. www.springernature.com

FRONTIERS

FE Booth 6

Frontiers is a leading Open Access Publisher and Open Science Platform.
Our journals are led and peer-reviewed by editorial boards of over 100,000 top researchers. Covering more than 600 academic disciplines, we are one of the largest and highest-cited publishers in the world. To date, our freely accessible research articles have received over 500 million views and downloads and 1 million citations.

EUROPEAN MATHEMATICAL SOCIETY PUBLISHING HOUSE

FE Booth 7

The EMS Publishing House is a not-for-profit organization dedicated to the publication of high-quality peer-reviewed journals and high-quality books, on all academic levels and in all fields of pure and applied mathematics. The proceeds from the sale of our publications will be spent in compliance with the purposes of the European Mathematical Society, particularly the furtherance, dissemination and popularization of mathematical knowledge, furtherance of exchange of ideas between mathematicians in Europe and between mathematicians in Europe and other mathematicians.

ELSEVIER

FE Booth 8

Elsevier publishes world-class mathematics content, from journals and books to online Solutions. Visit booth 3 to hear about our latest news, discover how you can enrich your article with our content innovation and to find out how we ensure content perpetuity.

THE ROYAL SOCIETY

FE Booth 9

The Royal Society journals offer rigorous, constructive peer review; open access options; promotion by a dedicated press office; and broad dissemination to an international audience. To find out more, please visit the Royal Society Publishing booth 9 where Bailey Fallon will be happy to answer your questions. Alternatively, visit our website at: http://royalsocietypublishing.org

OXFORD UNIVERSITY PRESS

FE Booth 10

Oxford University Press is a department of the University of Oxford. It furthers the University´s objective of excellence in research, scholarship, and education by publishing worldwide. OUP is the world´s largest university press with the widest global presence. It currently publishes more than 7.000 new publications a year and has offices in around fifty countries.

TYLOR & FRANCIS GROUP

FE Booth 11

Taylor & Francis Group/CRC Press is a premier global publisher of more than 2,600 journals and over 5,000 new books each year. Visit our booth to discover more about our mathematics products, including world-class references, handbooks and textbooks, and discuss with our team how we can best distribute your research as widely as possible.

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