The Activity Group on Analysis of Partial Differential Equations fosters activity in the analysis of partial differential equations (PDE) and enhances communication between analysts, computational scientists and the broad PDE community. Its goals are to provide a forum where theoretical and applied researchers in the area can meet, to be an intellectual home for researchers in the analysis of PDE, to increase conference activity in PDE, and to enhance connections between SIAM and the mathematics community.
Table of Contents

Program-at-a-Glance..... Fold out section .......................... 2
General Information.............................. 2
Get-togethers............................... 4
Invited Plenary Presentations .............. 5
Program Schedule............................... 11
Abstracts ............................................. 65
Speaker and Organizer Index ........... 153
Conference Budget .... Inside Back cover
Hotel Meeting Room Map .... Back cover

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- Wednesday, November 16
  7:30 AM – 4:00 PM
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- Welcome Reception

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**Table Top Displays**

SIAM

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**Get-togethers**

- Sunday, November 13
  Welcome Reception

- Wednesday, November 16
  SIAG/APDE Business Meeting (open to SIAG/APDE members)
  *Complimentary beer and wine will be served.*
Invited Plenary Speakers

** All Invited Plenary Presentations will take place in Salon DE**

Monday, November 14
8:00 AM – 8:45 AM
IP1 Nonconvex Hamilton-Jacobi Equations
Lawrence C. Evans, University of California, USA

8:45 AM – 9:30 AM
IP2 Title Not Available at Time of Publication
Jalal Shatah, Courant Institute of Mathematical Sciences, New York University, USA

Tuesday, November 15
8:00 AM – 8:45 AM
IP3 Nonlocal Evolution Equations
Peter Constantin, University of Chicago, USA

8:45 AM – 9:30 AM
IP4 Mathematical and Numerical Modelling of the Respiratory System
Celine Grandmont, INRIA, France

Wednesday, November 16
8:00 AM – 8:45 AM
IP5 Energetic Variational Approaches in Complex Fluids
Chun Liu, Pennsylvania State University, USA

8:45 AM – 9:30 AM
IP6 Rough Stochastic PDEs
Martin Hairer, University of Warwick, United Kingdom

2:00 PM - 2:45 PM
SIAG/Analysis of Partial Differential Equations Prize Award and Lecture
Recipient to be Announced
Invited Plenary Speakers

Thursday, November 17
8:00 AM – 8:45 AM
IP7 \textit{h-principle and Fluid Dynamics}
\textbf{Camillo De Lellis}, University of Zurich, Switzerland

1:15 PM – 2:00 PM
IP8 Landau Damping and Macroscopic Irreversibility for Plasmas and Galaxies
\textbf{Clément Mouhot}, University of Cambridge, United Kingdom
Minitutorials

** Both Minitutorial Presentations will take place in Salon DE **

Tuesday, November 15
8:00 PM – 10:00 PM

MT1 Models of Cell Colonies Self-organization and Mathematical Analysis

Benoit Perthame, Université Pierre et Marie Curie, France

Wednesday, November 16
8:00 PM – 10:00 PM

MT2 Gradient Flows, Energy Landscapes, and Scaling Laws

Felix Otto, University of Bonn, Germany
SIAM Activity Group on Analysis of Partial Differential Equations (SIAG/APDE)
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The Linear Sampling Method in Inverse Electromagnetic Scattering
Fioralba Cakoni, David Colton, and Peter Monk
The authors describe the linear sampling method for a variety of electromagnetic scattering problems, presenting uniqueness theorems and the derivation of various inequalities on the material properties of the scattering object from a knowledge of the far field pattern of the scattered wave.

Mark S. Gockenbach
This undergraduate textbook introduces students to the topic with a unique approach that emphasizes the modern finite element method alongside the classical method of Fourier analysis. Additional features of this new edition include broader coverage of PDE methods and applications.

Graph Algorithms in the Language of Linear Algebra
Edited by Jeremy Kepner and John Gilbert
This book addresses the challenges associated with the recent shift to parallel computing for executing graph algorithms by exploiting the well-known duality between a canonical representation of graphs as abstract collections of vertices and edges and a sparse adjacency matrix representation.

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Final Program

SIAM Conference on
Analysis of
Partial Differential Equations

November 14-17, 2011
San Diego Marriott Mission Valley
San Diego, California USA
Welcome Reception
6:00 PM-8:00 PM  
Room: Rio Vista Pavilion

Welcome Remarks
7:45 AM-8:00 AM  
Room: Salon DE

Monday, November 14

IP1  
Nonconvex Hamilton-Jacobi Equations
8:00 AM-8:45 AM  
Room: Salon DE

Chair: Edriss S. Titi, University of California, Irvine, USA and Weizmann Institute of Science, Israel

The Crandall–Lions theory of viscosity solutions provides existence and uniqueness theory for appropriate weak solutions Hamilton-Jacobi type PDE, but does not for nonconvex Hamiltonians directly provide much information about the structure of solutions, their possible singularities, etc. I will report on some recent work on nonconvex Hamilton–Jacobi equations, explaining how to apply geometric insights, compensated compactness tricks and game theoretic methods to such PDE. I will in particular revisit some examples from the great book of Isaacs on differential games.-

Lawrence C. Evans  
University of California, USA
Monday, November 14

MS1
Connections Between Dispersive PDE’s and Fluid Mechanics - Part I of II
10:00 AM-12:30 PM
Room: Salon A
For Part 2 see MS29
Nonlinear dispersive equations and fluid mechanic equations are intimately related from the beginning. But the view points of the researchers in either field have been often quite different. After decades of rapid progress in nonlinear dispersive equations, however, it is getting more and more realistic, from the technical points, to put those areas together as a vast but unified object in the study of PDEs. One can observe the beginning of this in several recent progresses, for example those by Lannes, by Wu, and by Germain, Masmoudi and Shatah. Topics include water wave, boundary layers for Navier-Stokes and Primitive equations.
Organizer: Slim Ibrahim
University of Victoria, Canada
Organizer: Makram Hamouda
Indiana University, USA
10:00-10:25 Well-posedness Issues for Degenerate Dispersive Equations
Doug Wright, Drexel University, USA
10:30-10:55 The Dynamics of Perturbations of Minimal Mass Solitons
Sarrah Raynor, Wake Forest University, USA
11:00-11:25 A Lower Bound on Blowup Rates for the 3D Incompressible Euler Equation and a Single Exponential Beale-Kato-Majda Estimate
Thomas Chen and Natasa Pavlovic,
University of Texas, Austin, USA
11:30-11:55 On the Global Well-posedness of the Euler Equation Forced by a Riesz Transform
Peter Constantin and Vlad C. Vicol,
University of Chicago, USA
12:00-12:25 Global Solutions of the Landau-Lifshitz equation
Stephen Gustafson, University of British Columbia, Canada; Eva Koo, University of British Columbia, Canada
Monday, November 14

**MS3**

**Analysis Issues in the Study of Liquid Crystals and Related Areas - Part I of IV**

10:00 AM-12:30 PM

*Room: Salon C*

*For Part 2 see MS31*

Liquid crystal materials have seen many important application in physical, engineering and biological sciences. The theories for various type of liquid crystals are also important to the studies of other materials, such as magnetohydrodynamics, electro rheological fluids, viscoelastic fluids, biological membranes. With the development of new mathematical techniques, in numerics and analysis, there have been increasing interest in these fields. The symposium will focus on analytical issues from the studies of liquid crystal materials and related areas. It brings together both senior and junior researchers in the fields. The topics include dynamics and configurations of defects, hydrodynamical theories, compressible liquid crystals, stability phenomena, free boundary problems. We hope the meeting will provide a survey of the field and foster new collaborations.

*Organizer: Chun Liu*

**Pennsylvania State University, USA**

*Organizer: Changyou Wang*

**University of Kentucky, USA**

10:00-10:25 Multiscale Coupling for Liquid Crystals

*Chun Liu, Pennsylvania State University, USA*

10:30-10:55 An Analysis of the Effect of Artificial Stress Diffusivity on the Flow Dynamics of Creeping Viscoelastic Flow

*Becca Thomases, University of California, Davis, USA*

11:00-11:25 Passage from Mean-field to the Continuum Landau-de Gennes Theory for Nematic Liquid Crystals

*Apala Majumdar and John Ball, University of Oxford, United Kingdom*

continued in next column

Monday, November 14

**MS4**

**Hyperbolic Conservation Laws and Related Topics - Part I of IV**

10:00 AM-12:30 PM

*Room: Salon D*

*For Part 2 see MS32*

The main purpose of this symposium is to bring researchers and young mathematicians together to exchange the new progress on the study of nonlinear hyperbolic conservation laws and related topics, with special emphasis on the structure of solutions, asymptotic behaviors of solutions, stability of nonlinear waves, and the related numerical computations.

*Organizer: Ming Mei*

**McGill University, Canada**

*Organizer: Ronghua Pan*

**Georgia Institute of Technology, USA**

*Organizer: Feimin Huang*

**Chinese Academy of Sciences, China**

10:00-10:25 Shock Diffraction Problems in Multidimensional Hyperbolic Conservation Laws

*Gui-Qiang G. Chen, University of Oxford, United Kingdom*

10:30-10:55 Existence of Algebraic Vortex Spirals

*Volker W. Elling, University of Michigan, USA*

11:00-11:25 Title Not Available at Time of Publication

*Hai-Liang Li, Capital Normal University, China*

11:30-11:55 Conservation Laws with Distributed Control

*Andrea Marson and Marco Corghi, University of Padova, Italy*

12:00-12:25 Conservation Laws on Networks

*Benedetto Piccoli, Rutgers University, USA*
In nature, groups of individuals organize globally using only local information. For instance, in a school of fish, there are no external forces to coordinate the group, no leader to guide them. Several mathematical models have been proposed to describe self-organization. In contrast to models coming from physics, typically no momentum or energy is conserved. As a result, self-organized dynamics is a great source of new challenges in dynamical systems and PDEs. This mini-symposium will focus on both the theoretical aspects of self-organized dynamics (analysis of PDE) and on the development of numerical methods.

Organizer: Sebastien Motsch
University of Maryland, USA

10:00-10:25 A New Model for Self-organized Dynamics and its Flocking Behavior
Eitan Tadmor, University of Maryland, USA
10:30-10:55 Mathematical Modeling of Collective Displacements: From Microscopic to Macroscopic Description
Sebastien Motsch, University of Maryland, USA
11:00-11:25 Phase Transition in a System of Self-propelled Particles
Amic Frouvelle, University of Toulouse, France
11:30-11:55 On Repulsion in Biological Aggregation Equations
Trygve Karper, University of Maryland, USA

Biomolecular interactions exhibit rich chemistry and physics spanning many length and time scales. A central challenge is to understand how such interactions determine the conformation, dynamics, and ultimately biological function of biomolecules. While traditional descriptions of these systems often use explicit molecular and solvent degrees of freedom, Partial Differential Equations and Stochastic Partial Differential Equations have been recently developed to allow for new approaches of analysis and computation to be employed. This minisymposium shall focus on such descriptions of some fundamental aspects of biomolecular interactions. These include the implicit solvation, electrostatic forces, anomalous diffusion, and ionic structures.

Organizer: Paul J. Atzberger
University of California, Santa Barbara, USA
Organizer: Bo Li
University of California, San Diego, USA

10:00-10:25 Effective Dielectric Boundary Forces in Variational Implicit Solvation
Bo Li, Hsiao-Bing Cheng, and Li-Tien Cheng, University of California, San Diego, USA; Xiao-Liang Cheng and Zhengfang Zhang, Zhejiang University, China
10:30-10:55 Efficient Algorithms for Biomolecular Electrostatics with Dielectric Discontinuities
Zheng Xu, Shanghai Jiaotong University, China

continued in next column
Monday, November 14

**MS7**

**Recent Development in Potential Theory, Harmonic Analysis and PDEs - Part I of II**

**10:00 AM-12:30 PM**

**Room: Salon G**

For Part 2 see MS35

Minisymposium reflects significant recent developments in analysis of PDEs and in related fields such as potential theory, harmonic analysis and geometric measure theory. The area and co-area formulas in metric spaces, Wiener test at infinity for elliptic and parabolic PDEs, harmonic analysis in stratified Lie groups, regularity of Riesz transforms for subelliptic operators, measure-theoretic analysis of fractal singularities, regularity of sets with quasiminimal surfaces are among the more specific topics covered in this minisymposium.

Organizer: Ugur G. Abdulla
Florida Institute of Technology, USA

Organizer: William Ziemer
Indiana University, USA

10:00-10:25 The Area and Co-area Formulas for Newtonian Functions Defined on Metric Spaces
William Ziemer, Indiana University, USA

10:30-10:55 Harmonic Characterization of Balls in Stratified Lie Groups.
Ermanno Lanconelli, Universita’ di Bologna, Italy

11:00-11:25 Regularity Properties of Sets with Quasiminimal Surfaces in the Metric Setting
Nageswari Shanmugalingam, University of Cincinnati, USA

11:30-11:55 Title Not Available at Time of Publication
David Swanson, University of Louisville, USA

12:00-12:25 On the Distributional Divergence of Vector Fields Vanishing at Infinity
Monica Torres, Purdue University, USA; Thierry De Pauw, Université Paris VII - Denis Diderot, France

Monday, November 14

**MS8**

**Nonlinear Wave Phenomena**

**10:00 AM-12:30 PM**

**Room: Salon H**

The minisymposium focus is on mathematical aspects of nonlinear wave phenomena. It includes, in particular, studies of an interplay between dispersive and nonlinear properties of propagating media, nonlinear spectral theory, solitonlike waves and nonlinear oscillatory processes.

Organizer: Alexander Figotin
University of California, Irvine, USA

Organizer: Anatoli Babin
University of California, Irvine, USA

10:00-10:25 The Invariant Measure of the Stochastic Navier-Stokes Equation
Bjorn Birnir, University of California, Santa Barbara, USA

10:30-10:55 Nonlinear Dirac Equations in One Spatial Dimension
Dmitry Pelinovsky, McMaster University, Canada

11:00-11:25 Carrier Shock Waves in Nonlinear and Nonlinear Media
Michael I. Weinstein, Columbia University, USA

11:30-11:55 Euler Equations on a Fast Rotating Sphere: Time-averages and Zonal Flows
Alex Mahalov and Bin Cheng, Arizona State University, USA

12:00-12:25 Title Not Available at Time of Publication
Anatoli Babin, University of California, Irvine, USA

Monday, November 14

**MS9**

**Topics in Higher Order Geometric PDEs - Part I of III**

**10:00 AM-12:00 PM**

**Room: Santa Fe 3**

For Part 2 see MS37

Many partial differential equations arising in the study of geometric problems are elliptic and parabolic PDEs of higher order. The analysis of such equations is challenging due to the failure of techniques effectively used in the second order case to carry over to the higher order setting. We aim to present some recent developments concerning existence and qualitative properties of solutions of such geometric PDEs, bringing together some new and some experienced researchers to discuss the ramifications of recent progress and possible future developments.

Organizer: Anna Dall’Acqua
Otto-von-Guericke-Universität Magdeburg, Germany

Organizer: Glen Wheeler
Otto-von-Guericke-Universität Magdeburg, Germany

10:00-10:25 The Affine Mean Curvature Flow of Convex Surfaces
Ben Andrews, Tsinghua University, China

10:30-10:55 Quantization Phenomena for Minimizing Sequences of the Willmore Functional
Yann L. Bernard, Albert-Ludwigs University, Germany

11:00-11:25 Euler Equations on a Fast Rotating Sphere: Time-averages and Zonal Flows
Alex Mahalov and Bin Cheng, Arizona State University, USA

11:30-11:55 Numerical Approximation of Anisotropic Willmore Flow
Paola Pozzi and Gerhard Dziuk, University of Freiburg, Germany

12:00-12:25 On the Helfrich Flow
Glen Wheeler, Otto-von-Guericke-Universität Magdeburg, Germany; James A. McCoy, University of Wollongong, Australia
Monday, November 14

**MS10**

**Nonlinear Hyperbolic Equations: Theoretical Advances and Applications - Part I of II**

10:00 AM - 11:30 PM

*Room: Santa Fe 4*

For Part 2, see MS38

In the large context of nonlinear evolution equations, we will focus on systems of PDEs which exhibit a hyperbolic or parabolic-hyperbolic structure. The topics of this minisymposium will revolve around qualitative and quantitative properties of solutions to these equations, such as existence, uniqueness, regularity of solutions, and long-time asymptotic behavior. Of special interest in our discussions are nonlinear interactions and the methods available to investigate them. We anticipate also to discuss specific problems that arise in applications such as nonlinear acoustics, traveling waves in elasticity and viscoelasticity, plasma dynamics, and semiconductors.

Organizer: Stephen Pankavich
United States Naval Academy, USA
Organizer: Petronela Radu
University of Nebraska, Lincoln, USA

10:00-10:25 Numerical Analysis of the Null Controllability of Thermoelastic Plate Dynamics
George Avalos, University of Nebraska, Lincoln, USA

10:30-10:55 Extremals of the Log Sobolev Inequality
Qi Zhang, University of California, Riverside, USA

11:00-11:25 Monotone Operator Theory and Applications to PDEs
Mohammed Rammaha, University of Nebraska, Lincoln, USA

**MS11**

**Modelling for Hot-plasma Physics, Simulations and Mathematical Analysis**

10:00 AM - 12:00 PM

*Room: Sierra 5*

In hot-plasma physics, a lot of different models are used, fluid or kinetic ones; and for each model, it is useful to check its well-posedness. We focus here on the mathematical analysis of some specific models related to non-linear wave propagation phenomena. For instance we consider the wave coupling problems with applications to laser-plasma interaction. Moreover, kinetic effects phenomena with electrostatic coupling will be also addressed and some magneto-hydrodynamics models with application to tokamaks plasma modelling.

Organizer: Remi Sentis
CEA, DAM, DIF-Bruyeres, France

10:00-10:25 Analysis of the Three-Wave Coupling System for Laser-Plasma Interaction.
Remi Sentis, CEA, DAM, DIF-Bruyeres, France

10:30-10:55 Reduced Resistive Models with Arbitrary Density for Mhd in Tokamaks
Bruno Despres, University of Paris VI, France

11:00-11:25 High-Order Numerical Simulation of Vlasov Systems for Laser Plasma Interaction
Jeffrey W. Banks and Richard L. Berger, Lawrence Livermore National Laboratory, USA; Stephan Brunner, École Polytechnique Fédérale de Lausanne, Switzerland; Bruce I. Cohen and Jeffrey A. F. Hitinger, Lawrence Livermore National Laboratory, USA

11:30-11:55 Nonlinear Landau Damping and Inviscid Damping
Zhifu Lin and Chongchun Zeng, Georgia Institute of Technology, USA

**MS12**

**Nonlinear Analysis and Simulations of PDE Models**

10:00 AM - 12:30 PM

*Room: Sierra 6*

The aim of the special session is to address analytic and computational aspects of nonlinear systems of PDEs arising particularly in mechanics and physics (such as Burgers-KdV-type equations). The session will focus on recent advances in mathematical analysis of partial differential equations and evolution equations with applications to propagating phenomena, formation of patterns and other physical contexts. The special session will bring together both specialists in mathematical analysis of nonlinear PDEs and applied researchers with interests in numerical computations and simulations.

Organizer: Zhaosheng Feng
University of Texas - Pan American, USA

10:00-10:25 Proper Solutions to the Burgers-Huxley Equations
Zhaosheng Feng, University of Texas - Pan American, USA

10:30-10:55 Mathematical Analysis of the Dimensional Scaling Technique for the Schrodinger Equation with Power-Law Potentials
Zhonghai Ding, University of Nevada, Las Vegas, USA

11:00-11:25 Bursting and Two-parameter Bifurcation in the Chay Neuronal Model
Lixia Duan, North China University of Technology, China

11:30-11:55 Nonlinear Duffing-van der Pol Oscillator System
Guangyue Gao, Virginia Polytechnic Institute & State University, USA

12:00-12:25 Optimal Regularity for A-Harmonic Type Equations under the Natural Growth
Shenzhou Zheng, Beijing Jiaotong University, China
Monday, November 14

**MS13**

**Analysis of Partial Differential Equations Arising in Fluid Dynamics - Part I of IV**

10:00 AM - 12:30 PM

Room: Cabrillo 1

For Part 2 see MS41

This minisymposium is focused on recent developments in the field of fluid dynamics, with emphasis on the Navier-Stokes equations, Euler equations, and related models. The issues to be discussed range from well-posedness theory, regularity, and stability issues, to the theory of turbulence.

Organizer: Alexey Cheskidov  
*University of Illinois, Chicago, USA*

Organizer: Roman Shvydkoy  
*University of Illinois, Chicago, USA*

Organizer: Vlad C. Vicol  
*University of Chicago, USA*

10:00-10:25  Convection-diffusion Equations with Small Viscosity in a Circle  
Roger M. Temam, Indiana University, USA

10:30-10:55  Leonardo vs. Kolmogorov; 3D Enstrophy Cascade  
Zoran Grujic, University of Virginia, USA; Radu Dascaliuc, Oregon State University, USA

11:00-11:25  Local Existence and Uniqueness of the Solutions to the Free Boundary Value Problem for the Ocean  
Mihaela Ignatova, University of California, Riverside, USA; Igor Kukavica and Mohammed B. Ziane, University of Southern California, USA

11:30-11:55  Boundary Layer Analysis of the Navier-Stokes Equations with Generalized Navier Boundary Conditions  
James Kelliher and Gung-Min Gie, University of California, Riverside, USA

Lunch Break

12:30 PM - 2:00 PM

Attendees on their own

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Monday, November 14

**MS14**

**Numerical Analysis for Nonlinear Evolution Equations**

10:00 AM - 12:00 PM

Room: Cabrillo 2

Solutions of nonlinear evolution equations may lose smoothness spontaneously. Or, if they do not, they may display chaotic and strange behavior. Numerical methods therefore are important to understand them. The four speakers have worked for mathematical aspect of numerical analysis and will report the latest results for nonlinear PDEs related to fluid mechanical, blow-up, and mean curvature flow. Our aim is to report not only what we have done but also what we could not solve.

Organizer: Hisashi Okamoto  
*Kyoto University, Japan*

10:00-10:25  Finite Difference Methods for Blow-up Problems  
Hisashi Okamoto, Kyoto University, Japan

10:30-10:55  L1 Analysis of the Finite Volume Method for Nonlinear Degenerate Diffusion Problems  
Norikazu Saito, University of Tokyo, Japan

11:00-11:25  A Pressure-stabilized Characteristics Finite Element Scheme for the Navier-Stokes Equations and Its Application to a Thermal Convection Problem  
Hirofumi Notsu and Masahisa Tabata, Waseda University, Japan

11:30-11:55  Mean Curvature Flow with Volume Constraint  
Karel Svadlenka and Elliott Ginder, Kanazawa University, Japan

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Monday, November 14

**MS15**

**Calculus of Variations and Applications - Part I of III**

2:00 PM - 4:00 PM

Room: Salon A

For Part 2 see MS43

The calculus of variations has been an active field of research for nearly 300 years. Today it plays a central role in partial differential equations (in particular, of nonlinear type). The main object of the proposed mini-symposium is the applications of the calculus of variations to various fields in science and engineering. We intend to bring together some experts who work on different applications, including superconductivity, image processing, optimal mass transportation, chemotaxis and others, who apply different tools from the calculus of variations. Such a meeting will hopefully lead to a fruitful exchange of ideas and methods.

Organizer: Gershon Wolansky  
*Technion IIT, Haifa, Israel*

Organizer: Itai Shafrir  
*Technion Israel Institute of Technology, Israel*

2:00-2:25  Reversible Description of Coagulation and Fragmentation  
Gershon Wolansky, Technion IIT, Haifa, Israel

2:30-2:55  Hybrid Methods for Keller-Segel-Pattak Type of Equations  
David Kinderlehrer, Carnegie Mellon University, USA

3:00-3:25  On the Ramified Optimal Allocation Problem  
Qinglan Xia, University of California, Davis, USA

3:30-3:55  Variational Methods in Image Processing  
Irene Fonseca, Carnegie Mellon University, USA
Monday, November 14

**MS16**

**Exploiting Geometry in the Development of Numerical Methods of Partial Differential Equations - Part I of II**

2:00 PM-4:00 PM

*Room: Salon B*

**For Part 2 see MS44**

The role of geometry in the development and analysis of numerical methods for partial differential equations has grown dramatically over the last two decades. Surface finite element methods have emerged to require a more sophisticated geometric analysis than provided by the Strang Lemmas, and mixed finite elements have been found to have deep connections with the calculus of exterior differential forms, de Rham cohomology and Hodge theory, culminating in the development of finite element exterior calculus. In this minisymposium, we will examine the recent convergence of these ideas, and look ahead at some exciting new developments on the horizon.

Organizer: Michael J. Holst  
*University of California, San Diego, USA*

Organizer: Ryan Szypowski  
*University of California, San Diego, USA*

Organizer: Alan Demlow  
*University of Kentucky, USA*

2:00-2:25 **Adaptive Boundary Element Methods with Convergence Rates**  
Gantumur Tsogtgerel, McGill University, Canada

2:30-2:55 **Finite Element Clifford Algebra: A New Toolkit for Evolution Problems**  
Andrew Gillette, University of California, San Diego, USA

3:00-3:25 **A Priori Estimates and Adaptive Methods for Geometric Partial Differential Equations**  
Yanrong Zhu, Michael J. Holst, and Ryan Szypowski, University of California, San Diego, USA

3:30-3:55 **Geometric Variational Crimes: Hilbert Complexes, Finite Element Exterior Calculus, and Problems on Hypersurfaces**  
Ari Stern and Michael J. Holst, University of California, San Diego, USA

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Monday, November 14

**MS17**

**Fluid-Structure and Flow-Structure Interactions: Modeling, Analysis and Control - Part I of III**

2:00 PM-4:30 PM

*Room: Salon C*

**For Part 2 see MS45**

This Minisymposium will focus on the PDEs which govern fluids/flows interacting with elastic structures. Such phenomena are constantly observed in the natural and man-made world: e.g., vascular blood flow immersing cellular bodies; submarines coursing through a sea; large flexible structures subjected to windstorm turbulence. The Minisymposium participants will have research interests and expertise in the Navier-Stokes Equations, mathematical control and numerical analysis of PDE dynamics (particularly those of hyperbolic or “composite” characteristics), and in modeling of complex physical processes. Questions such as well-posedness, control and stabilization of the coupled PDEs governing such interactions will constitute the focus of the symposium.

Organizer: Lorena Bociu  
*North Carolina State University, USA*

Organizer: Irena M. Lasiecka  
*University of Virginia, USA*

Organizer: George Avalos  
*University of Nebraska, Lincoln, USA*

2:00-2:25 **Longtime Behavior of Fluid-structure PDE Dynamics**  
George Avalos, University of Nebraska, Lincoln, USA

2:30-2:55 **Non-aircraft Applications of Aeroelastic Flutter**  
A.V. Balakrishnan, University of California, Los Angeles, USA

3:00-3:25 **Controllability of the Foppl-von Karman Elastic Shells with Residual Strain**  
Marta Lewicka, University of Pittsburgh, USA

3:30-3:55 **Surface Waves for Hyperbolic Systems of PDE**  
Matthias Eller, Georgetown University, USA

4:00-4:25 **Controllability of a Membrane or Plate Enclosing a Potential Fluid**  
Scott Hansen, Iowa State University, USA

continued in next column
Monday, November 14

**MS18**

**Multidimensional Conservation Laws and Related Applications - Part I of III**

2:00 PM-4:30 PM

Room: Salon D

For Part 2 see MS46

Multidimensional conservation laws are mathematical models for fundamental processes in physics and engineering, such as high-speed flows and supersonic jets. Interesting open problems including mixed (hyperbolic-elliptic) types and free boundaries arising from multidimensional conservation laws have been studied by many researchers. Yet many problems are still remaining open and needed to be investigated further. This session will bring together analytical and numerical experts to discuss the current development in multidimensional conservation laws and related applications. The session will cover broad ranges of topics including mathematical problems for conservation laws, mixed-type problems, and various applications.

Organizer: Eun Heui Kim
California State University, Long Beach, USA

Organizer: Chung-Min Lee
California State University, Long Beach, USA

**2:00-2:25 Particle Behaviors in Strained Turbulence**

Armann Gylfason, Reykjavik University, Iceland; Chung-Min Lee, California State University, Long Beach, USA; Prasad Perlekar and Federico Toschi, Eindhoven University of Technology, Netherlands

2:30-2:55 Title Not Available at Time of Publication

Shuxing Chen, Fudan University, China

3:00-3:25 On the \( L^1 \)-Stability and Instability of the Boltzmann and Vlasov-Poisson Equations

Seung-Young Hsu and Sun-Ho Choi, Seoul National University, Korea

3:30-3:55 Weak Shock Diffraction

John Hunter, University of California, Davis, USA; Allen Tesdall, City University of New York, Staten Island, USA

4:00-4:25 Shock Formation in the Plane

Barbara Lee Keyfitz, Ohio State University, USA

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Monday, November 14

**MS19**

**Models for Evolutionary Biology - Part I of II**

2:00 PM-4:00 PM

Room: Salon E

For Part 2 see MS47

Evolutionary biology aims at explaining the appearance and evolution of species (from viruses to mamals). Theoretical models, and in particular structured population models, play an significant role in this field. The nonlocal PDE models that appear in this context lead to challenging mathematical problems: convergence to singular measures, constrained Hamilton-Jacobi equations, front propagation... An increasing number of mathematicians are interested by those problems, and this minisymposium will be an occasion to discuss the studies ongoing on this topic.

Organizer: Gael Raoul
University of Cambridge, United Kingdom

2:00-2:25 Populations Structured by a Phenotypic Trait and a Space Variable

Gael Raoul, University of Cambridge, United Kingdom

2:30-2:55 Eco-evolutionary Dynamics: Advances and Challenges

Régis Ferrière, University of Arizona, USA and Ecole Normale Supérieure, France

3:00-3:25 Selection-mutation Dynamics

Pierre-Emmanuel Jabin, University of Maryland, USA

3:30-3:55 Dirac Mass Dynamics in Parabolic Equations

Alexander Lorz, University of Cambridge, United Kingdom; Sepideh Mirrahimi, Ecole Polytechnique, France; Benoît Perthame, Université Pierre et Marie Curie, France

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Monday, November 14

**MS20**

**Mixed-Type and Free Boundary Problems - Part I of IV**

2:00 PM-4:00 PM

Room: Salon F

For Part 2 see MS48

This minisymposium is in the area of analysis of solutions to typical boundary-value problems for hyperbolic, mixed and composite type PDEs from continuum mechanics. The emphasis is on the problems involving interfaces such as shocks, moving boundaries, interfaces where equations change their type and interfaces between different phases of a continuum. The discussions will address questions of the dynamics and the geometry of interfaces as well as regularity issues. The aim of this minisymposium is to give an opportunity for researchers from the international PDE community working in this field to get together for discussions, collaboration and dissemination of research.

Organizer: Mikhail Perepelitsa
University of Houston, USA

Organizer: Suncica Canic
University of Houston, USA

Organizer: Chen Gui-Qiang
University of Oxford, United Kingdom

2:00-2:25 Shock Reflection and Free Boundary Problems

Gui-Qiang G. Chen, University of Oxford, United Kingdom; Mikhail Feldman, University of Wisconsin, Madison, USA

2:30-2:55 Dynamics of a Density Discontinuity in Compressible, Viscous Fluid Flows

Mikhail Perepelitsa, University of Houston, USA; David Hoff, Indiana University, USA

3:00-3:25 Isometric Embedding and BV Weak Solutions

Cleopatra Christoforou, University of Cyprus, Cyprus

3:30-3:55 Instability Theory of Navier-Stokes-Poisson System

Juhi Jung, University of California, Riverside, USA
Monday, November 14

**MS21**

**Recent Progress on Dispersive Partial Differential Equations - Part I of III**

**2:00 PM-4:30 PM**

*Room: Salon G*

**For Part 2 see MS49**

The session will contain talks on a wide range of topics in the theory of dispersive partial differential equations. These topics include, but will not necessarily be restricted to, the following: existence of global-in-time solutions, regularity and smoothing effects, soliton and blow-up dynamics, existence of wave and scattering operators, and linear dispersive estimates on various manifolds.

Organizer: Nikolaos Tzirakis

*University of Illinois at Urbana-Champaign, USA*

Organizer: Burak Erdogan

*University of Illinois at Urbana-Champaign, USA*

**2:00-2:25 Strichartz Estimates in Polygonal Domains**

*Matthew Blair, University of New Mexico, USA*

**2:30-2:55 Wave Propagation on Square Lattices**

*Vita Borovyk and Michael Goldberg, University of Cincinnati, USA*

**3:00-3:25 Phase-driven Interaction of Widely Separated Nonlinear Schroedinger Solitons**

*Justin Holmer and Quanhui Lin, Brown University, USA*

**3:30-3:55 Bounds on the Growth of High Sobolev Norms of Solutions to Nonlinear Schroedinger Equations**

*Vedran Sohinger, University of Pennsylvania, USA*

**4:00-4:25 Title Not Available at Time of Publication**

*Jacob Sterbenz, University of California, San Diego, USA*

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**MS22**

**Fluids, Boundaries and Free Interfaces**

**2:00 PM-4:00 PM**

*Room: Salon H*

This minisymposium is concerned with the evolution of interfaces between two fluids or with the interaction of fluids subject to fixed boundaries. Of special interest are the free boundary value problems describing the spin-coating process for Newtonian or non-Newtonian fluids, the Muskat problem, as well as stochastic stability results for Ekman boundary layers and results on non-decaying data.

Organizer: Matthias Hieber

*TU Darmstadt, Germany*

**2:00-2:25 Analysis of the Spin-coating Process**

*Mathias Hieber, TU Darmstadt, Germany*

**2:30-2:55 A Generalized Rayleigh-Taylor Condition for the Two Phase Muskat Problem**

*Joachim Escher, Leibniz University Hannover, Germany*

**3:00-3:25 Stochastic Stability of the Ekman Spiral**

*Wilhelm Stannat, TU Darmstadt, Germany*

**3:30-3:55 On the Navier-Stokes Problem in Exterior Domains with Non-decaying Initial Data**

*Giovanni Galdi, University of Pittsburgh, USA*

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**MS23**

**Calculus of Variations in $L^\infty$ and Aronsson Equations - Part I of III**

**2:00 PM-4:00 PM**

*Room: Santa Fe 3*

For Part 2 see MS51

Recent developments in the emerging area of Calculus of Variations in $L^\infty$ have been motivated by a broad range of applications to problems where one seeks to minimize functionals represented as an essential supremum (worst case analysis) rather than the average cost. Minimization problems for supremal functionals and of the associated Aronsson equations also has extensive connections with other areas of mathematics, including optimal control, random-turn games, optimal transport, weak KAM theory, differential geometry, and degenerate elliptic PDEs associated with level set convexity. The aim of this minisymposium is to facilitate the exchange of ideas on the latest developments.

Organizer: Emmanuel Barron

*Loyola University Chicago, USA*

Organizer: Marian Bocea

*Loyola University Chicago, USA*

Organizer: Rafal Goebel

*Loyola University Chicago, USA*

Organizer: Robert Jensen

*Loyola University Chicago, USA*

**2:00-2:25 Homogenization of $L^\infty$ Variational Problems in Random Media**

*Scott Armstrong, University of Chicago, USA*

**2:30-2:55 Calibration Method for Infinity Harmonic Functions**

*Changyou Wang, University of Kentucky, USA*

**3:00-3:25 American Option Tug-of-War and the Infinity Laplacian; A Free Boundary Problem**

*Stephanie Somersille, University of Texas at Austin, USA*

**3:30-3:55 Existence and Duality for $L^\infty$ Optimal Transport**

*Luigi DePascale, University of Pisa, Italy*
Monday, November 14

**MS24**
Nonlocal Equations: Perspectives from Probability and PDEs - Part I of III
2:00 PM-4:00 PM
Room: Santa Fe 4

For Part 2 see MS25
Integro-differential equations and jump processes have seen increased activity in recent years both in the probability and PDE communities with a long list of applications arising from models in e.g. kinetic theory, hydraulic fracturing, stochastic control, image processing, etc... The increasing abundance of these nonlocal equations arising from science provides many mathematical challenges deserving attention. We believe it will be fruitful to bring together analysts and probabilists working on very similar topics in this area for discussion and exposure of the vast amounts of recent work on the two different sides of this one coin -- integro-differential equations.

Organizer: Nestor Guillen
University of California, Los Angeles, USA

2:00-2:25 On Aleksandrov-Bakelman-Pucci Type Estimates for Integro-Differential Equations (comparison theorems with measurable ingredients)
Russell Schwab, Carnegie Mellon University, USA

2:30-2:55 Global Solutions to a Nonlocal Diffusion Equation with Quadratic Non-linearity
Robert Strain, University of Pennsylvania, USA

3:00-3:25 Magnetic Interaction
Morawetz Estimates and Applications
Maqda Czubak, Binghamton University, USA; James Colliander, University of Toronto, Canada; Jeonghun Lee, University of Minnesota, USA

3:30-3:55 A Factorization Method for a Non-symmetric Linear Operator: Enlargement of the Functional Space while Preserving Hypo-coercivity
Maria Gualdani, University of Texas, Austin, USA

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**MS25**
The Many Aspects of Fluids and Harmonic Analysis - Part I of V
2:00 PM-4:00 PM
Room: Sierra 5

For Part 2 see MS26
This minisymposium will be dedicated to the behaviour of solutions to fluid models such as Navier-Stokes equations, Magneto-Hydrodynamics, and liquid crystals. We will look into theoretical and applied questions. We have invited a very diverse group of researchers and we expect that this will allow for exchange of research and hopefully new collaborations.

Organizer: Maria E. Schonbek
University of California, Santa Cruz, USA
Organizer: Marco Cannone
Université Paris-Est Marne-la-Vallée, France

2:00-2:25 The Vortex-Wave Equation as the Limit of the Euler Equation
Clayton Bjorland, University of Texas, USA

2:30-2:55 Self-similar Asymptotics of Solutions to Navier-Stokes System in Two Dimensional Exterior Domain
Grzegorz Karch, Uniwersytet Wroclawski, Poland

3:00-3:25 Weak Solutions to the Vortex-Wave System
Milton C. Lopes Filho, UNICAMP, Brazil; Evelyne Miot, Universite de Paris VI, France; Helena Nussenzveig Lopes, IMECC - UniCamp, Brazil

3:30-3:55 Vortex Layers of Small Thickness
Marco Sammartino, Universita degli Studi Di Palermo, Italy

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**MS26**
Mathematical Foundations of Turbulent Flows and Its Application to Geophysics - Part I of III
2:00 PM-4:30 PM
Room: Sierra 6

For Part 2 see MS27
This mini-symposium aims to cover recent important developments in the mathematics of turbulent flows, new advances in reduced dynamical modeling for flows in geophysics, and the latest techniques in numerical computation for these flows. The talks include an up-to-date overview of the basic problems in the analytical and computational studies of turbulent flows in connection to geophysical fluid dynamics, magnetohydrodynamics, and convection. Our goal is to have a better understanding of the mathematics of turbulent flows and the various physical processes that underlie them. In addition, we aim to encourage connections and communication between related areas of this research, ranging from novel analytical methods, to the latest techniques in efficient numerical simulations.

Organizer: Evelyn Lunasin
University of Michigan, USA
Organizer: Adam Larios
Texas A&M University, USA

2:00-2:25 A New Blow-up Criterion for the 2D Boussinesq and 3D Euler Equations: Analytical and Numerical Results
Adam Larios, Texas A&M University, USA

2:30-2:55 Global well-posedness for the 2D Boussinesq System without Heat Diffusion with Anisotropic Viscosity
Adam Larios, Texas A&M University, USA; Evelyn Lunasin, University of Michigan, USA; Edriss S. Titi, University of California, Irvine, USA and Weizmann Institute of Science, Israel

continued on next page
Monday, November 14

**MS26**

Mathematical Foundations of Turbulent Flows and Its Application to Geophysics - Part I of III

continued

3:00-3:25 Improving Accuracy in Alpha Models of Incompressible Flows via Adaptive Nonlinear Filtering

Abigail Bowers, Clemson University, USA; William Layton, University of Pittsburgh, USA; Leo Rebholz, Clemson University, USA; Catalin Trenchea, University of Pittsburgh, USA

3:30-3:55 On a Critical Leray-alpha Model of Turbulence: Regularity and Singularity Issues

Hani Ali, Institute of Mathematical Research of Rennes, France

4:00-4:25 Partial Regularity Results for Generalized Alpha Models of Turbulence

Gantumur Tsogtgerel, McGill University, Canada; Michael J. Holst, University of California, San Diego, USA; Evelyn Lunasin, University of Michigan, USA

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Monday, November 14

**MS27**

Mathematical Models of Biological Aggregations - Part I of II

2:00 PM-4:00 PM

Room:Cabrillo 1

For Part 2 see MS55

Collective behaviour of biological aggregations (such as fish schools, bird flocks, insect swarms and bacterial colonies) has received a great deal of interest in recent years. Various mathematical models have been suggested in the literature, ranging from individual (Lagrangian) based models to continuum (Eulerian) descriptions. The speakers in the minisymposium will address challenging mathematical issues raised by some of these models. We mention in particular the asymptotic behavior of solutions, which is very important in applications.

Organizer: Razvan Fetecau
Simon Fraser University, Canada

Organizer: Theodore Kolokolnikov
Dalhousie University, Canada

2:00-2:25 Swarm Dynamics and Equilibria for a Nonlocal Aggregation Model

Razvan Fetecau, and Yanghong Huang, Simon Fraser University, Canada; Theodore Kolokolnikov, Dalhousie University, Canada

2:30-2:55 A Primer of Swarm Equilibria

Andrew J. Bernoff, Harvey Mudd College, USA; Chad M. Topaz, Macalester College, USA

3:00-3:25 Mathematical Models for Phototaxis

Doron Levy, University of Maryland, USA

3:30-3:55 Limiting PDEs of a Vicsek-type Flocking Model

Alethea Barbaro, University of California, Los Angeles, USA

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Monday, November 14

**MS28**

Interface Dynamics and Regularity Issues Arising in Fluid Mechanics - Part I of III

2:00 PM-3:30 PM

Room:Cabrillo 2

For Part 2 see MS56

Two sessions are focused on the study of free boundary equations that evolve with an incompressible flow such as Euler equations, Darcy’s law, Magnetohydrodynamics, etc... The third session is devoted to regularity issues arising in Boltzmann, beta-model, Euler and porous media equations. Recently there has been an extensive study, related to these problems, on uniqueness, well-posedness, global existence, stability and formation of singularities through several quite different approaches, including modern PDE methods, harmonic analysis techniques and numerical computations.

Organizer: David Lannes
Ecole Nationale Superieure, France

Organizer: Diego Cordoba
Institute de Ciencias Matematicas-CSIC, Spain

2:00-2:25 Stability Issues for Interfacial Flows

David Lannes, Ecole Nationale Superieure, France

2:30-2:55 Pressure Beneath a Periodic Traveling Water Wave

Adrian Constantin, University of Vienna, Austria

3:00-3:25 Singularity Formations for a Surface Wave Model

Angel Castro, CSIC, Madrid, Spain

Coffee Break

4:30 PM-5:00 PM

Room:Foyer
Monday, November 14

**CP1**
Computational Analysis for Physical Problems I
5:00 PM-6:40 PM
Room: Salon A
Chair: Sunnie Joshi, Texas A&M University, USA

5:00-5:15 Iterative Schemes for Bump Solutions in a Neural Field Model
Arcady Ponosov, Anna Oleynik, and John Wyller, Norwegian University of Life Sciences, Norway

5:20-5:35 A Fast Mixed-Precision Strategy for Iterative GPU-Based Solution of the Laplace Equation
Stefan L. Glimberg and Allan P. Engsig-Karup, Technical University of Denmark, Denmark

5:40-5:55 A Finite Element Algorithm for Inverse Sturm-Liouville Problems Using Least Squares Formulation
Sunnie Joshi, Texas A&M University, USA; Abner J. Salgado, University of Maryland, USA

6:00-6:15 A Numerical Routine for Solving an Eigenvalue Problem on a Disk
Charlotta E. Coetzee, Tshwane University of Technology, South Africa

Eric Avila-Vales, Universidad Autónoma de Yucatán, Mexico

Monday, November 14

**CP2**
Computational Analysis for Physical Problems II
5:00 PM-6:40 PM
Room: Salon B
Chair: Ronald M. Caplan, San Diego State University, USA

5:00-5:15 Implementing the Finite Volume Method on a Rectangular Collocated Grid
Tanay M. Deshpande and Shibu Clement, BITS Pilani, India

5:20-5:35 NLSEmagic: A High-Order Multidimensional GPU-Accelerated Code Package for Simulating the Nonlinear Schrödinger Equation
Ronald M. Caplan and Ricardo Carretero, San Diego State University, USA

5:40-5:55 Alternating Direction Implicit Finite Difference Method for the 3-D Wave Equation: P-SV Vectorial Case
Ursula Iturraran-Viveros, Universidad Nacional Autonoma de Mexico, Mexico

6:00-6:15 Computational Analysis of Invisibility Cloaking Using Nurbs
Scott M. Little, Northcentral University, USA

6:20-6:35 The von Karman Theory for Incompressible Elastic Shells
Hui Li, University of Minnesota, USA; Marta Lewicka, University of Pittsburgh, USA

Monday, November 14

**CP3**
Computational Analysis for Physical Problems III
5:00 PM-6:40 PM
Room: Salon C
Chair: Chanwoo Kim, University of Cambridge, United Kingdom

5:00-5:15 Boltzmann Equation with Specular Reflection in 2D Domains
Chanwoo Kim, University of Cambridge, United Kingdom

5:20-5:35 Convergence of a Particle Method and Global Weak Solutions for a Family of Evolutionary Pdes
Alina Chertock, North Carolina State University, USA; Jian-Guo Liu, Duke University, USA; Terrance Pendleton, North Carolina State University, USA

5:40-5:55 One Field Formulation and Simple Stable Explicit Schemes for Fluid Structure Interaction
Jie Liu, National University of Singapore, Republic of Singapore

6:00-6:15 Research of Difference Schemes for Hyperbolic Heat Conduction Equation in Sobolev Space
Isom Jurayev, Unaffiliated

6:20-6:35 Variational Schemes in Nonlinear Elastodynamics, the Positivity of Determinants, Convergence and Relative Entropy Method
Alexey Miroshnikov, University of Maryland, College Park, USA; Athanasios Tzavaras, University of Crete, Greece
Monday, November 14

**CP4**

**Reaction-diffusion Equations**  
5:00 PM-6:20 PM

*Room: Salon D*

*Chair: Mutlu Akar, Yildiz Technical University, Turkey*

5:00-5:15 An Algebraic Procedure to Construct Exact Solutions of Nonlinear Evolution Equations  
*Mutlu Akar and Adem Cevikel, Yildiz Technical University, Turkey; Ahmet Bekir and Sait San, Eskisehir Osmangazi University, Turkey*

5:20-5:35 An Approximate Solution for a Fractional Advection Diffusion Equation  
*Ercilia Sousa, Coimbra University, Portugal*

5:40-5:55 Modern Traffic Flow Models  
*Alexander Kurganov, Tulane University, USA*

6:00-6:15 Linear Quadratic Mean Field Games  
*Phillip S. Yam, Chinese University of Hong Kong, Hong Kong; Alain Bensoussan, University of Texas at Dallas, USA and the Hong Kong Polytechnic University, Hong Kong; K. C. J. Sung and S. P. Yung, University of Hong Kong, China*

Monday, November 14

**CP5**

**Elasticity and Analysis**  
5:00 PM-6:40 PM

*Room: Salon E*

*Chair: Justin Webster, University of Virginia, USA*

5:00-5:15 An Isoperimetric Problem With Long-Range Interactions on the Two-Sphere  
*Ihsan A. Topaloglu, Indiana University, USA*

5:20-5:35 Linear elasticity as Gamma-limit of finite elasticity under weak coerciveness conditions  
*Virginia Agostiniani, SISSA, Italy; Gianni Dal Maso and Antonio DeSimone, SISSA/Trieste, Italy*

5:40-5:55 Modern Traffic Flow Models  
*Alexander Kurganov, Tulane University, USA*

6:00-6:15 Pseudo-Differential Operator Involving Fractional Fourier Transform  
*Manish Kumar and Akhilesh Prasad, Indian School of Mines, India*

6:20-6:35 Semigroup Approach to Nonlinear Flow-Structure Interactions  
*Justin Webster, University of Virginia, USA*

Monday, November 14

**CP6**

**Turbulence and Wave Equations**  
5:00 PM-6:40 PM

*Room: Salon F*

*Chair: Yu-Yu Liu, University of California, Irvine, USA*

5:00-5:15 Turbulent Flame Speeds for G-Equations  
*Yu-Yu Liu, University of California, Irvine, USA*

5:20-5:35 Well-Posedness for Some Kinetic Models of Collective Behavior  
*Jesus Rosado, University of California, Los Angeles, USA; José Alfredo Cañizo and José Antonio Carrillo, Universitat Autònoma de Barcelona, Spain*

*Denys Dutykh, Universite de Savoie, France; Dimitrios Mitsotakis, University of Minnesota, USA; Xavier Gardeil, Universite de Savoie, France; Paul Christodoulides, Cyprus University of Technology, Cyprus; Frédéric Dias, University College Dublin, Ireland and Ecole Normale Supérieure de Cachan, France*

6:00-6:15 Bounds on the Growth of High Sobolev Norms of Solutions to Nonlinear Schrödinger Equations  
*Vedran Sohinger, University of Pennsylvania, USA*

6:20-6:35 Time Decay for the Solutions of a Coupled Nonlinear Schrödinger Equations  
*Jeng-Eng Lin, George Mason University, USA*
Monday, November 14

**CP7**

**Navier-Stokes Equations for Incompressible Fluids**

*5:00 PM-6:20 PM*

*Room: Salon G*

**Chair:** Jacob Glenn-Levin, University of Texas at Austin, USA

*5:00-5:15 Some Results on Statistical Solutions of the Navier-Stokes Equations for an Extended Class of External Forces*

*Cecilia F. Mondaini, Anne Bronzi, and* Ricardo Rosa, Universidade Federal do Rio De Janeiro, Brazil

*5:20-5:35 Incompressible Boussinesq Equations and Spaces of Borderline Besov Type*

*Jacob Glenn-Levin, University of Texas at Austin, USA*

*5:40-5:55 On the Convergence of Statistical Solutions of the 3D Navier-Stokes-\(\alpha\) Model as \(\alpha \to 0\)*

*Anne C. Bronzi and Ricardo Rosa, Universidade Federal do Rio De Janeiro, Brazil*

*6:00-6:15 Inertial Waves in a Rapidly Rotating Cylinder*

*Juan Lopez, Arizona State University, USA*

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Monday, November 14

**CP8**

**Thin Films**

*5:00 PM-6:20 PM*

*Room: Salon H*

**Chair:** To Be Determined

*5:00-5:15 Evolution of Elastic Thin Films with Curvature Regularization Via Minimizing Movements*

*Paolo Piovano, Carnegie Mellon University, USA*

*5:20-5:35 Formation of High-Temp/low-Viscosity Fingers Within Lava Flow*

*Serina Diniega, Jet Propulsion Laboratory, California Institute of Technology, USA*

*5:40-5:55 Global Solutions to Bubble Growth in Porous Media*

*Lavi Karp, ORT Braude College, Israel*

*6:00-6:15 Shape Selection in Hyperbolic Non-Euclidean Plates*

*John A. Gemmer and Shankar C. Venkataramani, University of Arizona, USA*

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Monday, November 14

**CP9**

**Phase Transitions in Material Sciences**

*5:00 PM-6:40 PM*

*Room: Santa Fe 3*

**Chair:** Adam Boucher, University of New Hampshire, USA

*5:00-5:15 Domain and Trajectory Bundles for Fluid Structure Interaction*

*Adam Boucher, University of New Hampshire, USA*

*5:20-5:35 Incompatibility and Hysteresis in Shape Memory Alloys*

*Barbara Zwicknagl, Carnegie Mellon University, USA*

*5:40-5:55 Power-Law Asymptotics and Growth of Heterogeneous Sandpiles*

*Marian Bocea, Loyola University Chicago, USA*

*6:00-6:15 The 2D Selective Withdrawal Transition: Analogies with Microelectromechanical Systems*

*Stuart Kent and Shankar C. Venkataramani, University of Arizona, USA*

*6:20-6:35 Borehole Heat Exchanger Modeling Validation*

*Georgios Florides, Paul Christodoulides, and Panayiotis Pouloupatis, Cyprus University of Technology, Cyprus*
Monday, November 14

**CP10**

**Modeling in Mathematical Biology**

5:00 PM-6:40 PM

Room: Santa Fe 4

Chair: Joyce Lin, University of Utah, USA

5:00-5:15 A New Electrical Model of Cardiac Cells

Joyce Lin, University of Utah, USA

5:20-5:35 Analysis of a Mathematical Model For Erythropoiesis

Susana Serna, Universitat Autònoma de Barcelona, Spain; Jasmine Nirody, New York Medical College, USA; Miklos Racz, University of California, Berkeley, USA

5:40-5:55 Global Stability for the N-Species Lotka-Volterra Tree Systems of Reaction-Diffusion Equations

Xinhua Ji, Institute of Mathematics, AMSS, Chinese Academy of Sciences, China

6:00-6:15 Local Existence and Finite Time Blowup in a Class of Stochastic Nonlinear Wave Equations

Rana D. Parshad and belkacem said-houari, King Abdullah University of Science & Technology (KAUST), Saudi Arabia

6:20-6:35 Stretch-Dependent Proliferation in a One-Dimensional Elastic Continuum Model of Cell Layer Migration

Tracy L. Stepien and David Swigon, University of Pittsburgh, USA

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Monday, November 14

**CP11**

**Homogenization and Stability**

5:00 PM-6:20 PM

Room: Sierra 5

Chair: Max Melnikov, Cumberland University, USA

5:00-5:15 Effect of Non-Newtonian Pulsatile Flow on Convective Diffusion in Annulus

Binil Sebastian, The University of the West Indies, Jamaica; Nagarani Ponakala, University of the West Indies, Jamaica

5:20-5:35 Periodic Unfolding and Oscillating Test Functions for the Homogenization in a Periodically Perforated Domain

Rachad Zaki, Khalifa University of Science, Technology and Research, United Arab Emirates

5:40-5:55 To the Construction of Green’s Functions of Terminal-Boundary-Value Problems for the Black-Scholes Equation

Max Melnikov, Cumberland University, USA

6:00-6:15 Bifurcation Analysis for the Lugiato-Lefever Equation in Two Space Dimensions

Tomoyuki Miyaji, Kyoto University, Japan; Isamu Ominishi, Hiroshima University, Japan; Yoshio Tsutsumi, Kyoto University, Japan

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Monday, November 14

**CP12**

CANCELLED

5:00 PM-6:40 PM

Room: Cabrillo 2

**CP13**

CANCELLED

5:00 PM-6:40 PM

Room: Cabrillo 1
Monday, November 14

**CP14**

**Nonlinear Wave Equations**
5:00 PM-6:20 PM
Room: Sierra 6
Chair: Jameson Graber, University of Virginia, USA

5:00-5:15 Blow-Up and Global Existence for a General Class of Nonlocal Nonlinear Coupled Wave Equations
Husnu A. Erbay, Ozyegin University, Turkey; Nilay Duruk and Albert Erkip, Sabanci University, Turkey

5:20-5:35 The Cauchy Problem for a Two-Dimensional Nonlocal Nonlinear Wave Equation
Saadet Erbay, Isik University, Turkey; Husnu A. Erbay, Ozyegin University, Turkey; Albert Erkip, Sabanci University, Turkey

5:40-5:55 Uniform Boundary Stabilization of a Wave Equation with Nonlinear Acoustic Boundary Conditions and Nonlinear Boundary Damping
Jameson Graber, University of Virginia, USA

6:00-6:15 Weak Solutions for a Class of Semilinear Elliptic Bvps in Unbounded Domains
Rasmita Kar, IIT Kanpur, India

Tuesday, November 15

**IP3**

**Nonlocal Evolution Equations**
8:00 AM-8:45 AM
Room: Salon DE
Chair: Suncica Canic, University of Houston, USA

Nonlocal evolution equations have been around for a long time, but in recent years there have been some nice new developments. The presence of nonlocal terms might originate from modeling physical, biological or social phenomena (incompressibility, Ekman pumping, chemotaxis, micro-micro interactions in complex fluids, collective behavior in social aggregation) or simply from inverting local operators in the analysis of systems of PDE. I will present some regularity results for hydrodynamic models with singular constitutive laws. I will also present a nonlinear maximum principle for linear nonlocal dissipative operators and some applications.
Peter Constantin
University of Chicago, USA

Tuesday, November 15

**IP4**

**Mathematical and Numerical Modeling of the Respiratory System**
8:45 AM-9:30 AM
Room: Balboa 1
Chair: Suncica Canic, University of Houston, USA

The respiratory system is a complex multiphysics and multiscale system. Indeed, breathing involves gas transport through the respiratory tract: the inhaled air is convected in the “fractal” bronchial tree which ends in the alveoli embedded in a viscoelastic tissue, made of blood capillaries, and where gaseous exchange occurs. Inhaled air contains dust and debris or curative aerosols. In this talk we present some mathematical and numerical modelling issues related to this system. Many questions may be addressed, such as the wellposedness of the problems, the design of accurate numerical algorithms, the performing of efficient computational simulations as well as the validation of the model by comparison to experimental results or clinical data
Celine Grandmont
INRIA, France

Coffee Break
9:30 AM-10:00 AM
Room: Foyer
Tuesday, November 15  
**MS29**  
Connections Between Dispersive PDE's and Fluid Mechanics - Part II of II  
10:00 AM-12:30 PM  
Room: Salon A  
For Part 1 see MS1  
Nonlinear dispersive equations and fluid mechanic equations are intimately related from the beginning. But the view points of the researchers in either field have been often quite different. After decades of rapid progress in nonlinear dispersive equations, however, it is getting more and more realistic, from the technical points, to put those areas together as a vast but unified object in the study of PDEs. One can observe the beginning of this in several recent progresses, for example those by Lannes, by Wu, and by Germain, Masmoudi and Shatah. Topics include water wave, boundary layers for Navier-Stokes and Primitive equations.  
Organizer: Slim Ibrahim  
University of Victoria, Canada  
Organizer: Makram Hamouda  
Indiana University, USA  

10:00-10:25 Initial and Boundary Value Problems for Some Equations from Geophysical Fluid Mechanics  
Roger M. Temam, Indiana University, USA  

10:30-10:55 Examples of Boundary Layers Associated with the Incompressible Navier-Stokes Equations  
Xiaoming Wang, Florida State University, USA  

11:00-11:25 Asymptotic Analysis of the Navier-Stokes Equations in a General Bounded Domain with Non-characteristic Boundaries  
Gung-Min Gie, University of California, Riverside, USA; Makram Hamouda, and Roger M. Temam, Indiana University, USA  

11:30-11:55 Boundary Layer Correctors for Curved Boundaries  
Jim Kelliher, University of California, Riverside, USA  

12:00-12:25 Global Existence for the Dissipative Critical Surface Quasi-geostrophic Equation  
Omar Lazar, Université Paris-Est, France  

**MS30**  
Singularities in Physical Systems and the Calculus of Variations - Part II of III  
10:00 AM-12:00 PM  
Room: Salon B  
For Part 1 see MS2  
For Part 3 see MS58  
Singularities are present in many physical systems, from domain walls in micromagnets to vortex lines in superconductors or liquid crystals to domain structures in co-polymers. These can often be expressed as singular limits of variational problems and lead to challenging analytical and geometrical problems. In this minisymposium, we will focus on energy minimizing configurations and their associated gradient flows arising as singular perturbations problems in the calculus of variations, and their associated PDEs. Applications to problems coming from diverse areas of physics and materials science will be presented.  
Organizer: Lia Bronsard  
McMaster University, Canada  
Organizer: Vincent Millot  
Université Paris VII, France  

10:00-10:25 Singular Perturbation Models in Phase Transitions for Second Order Materials  
Giovanni Leoni, Carnegie Mellon University, USA  

10:30-10:55 The Effect of Small Inclusion is Sometimes Not Small  
Hoai-Minh Nguyen, Courant Institute of Mathematical Sciences, New York University, USA  

11:00-11:25 Vortex Density Models for 3d Superconductors and Superfluids  
Sisto Baldo, University of Verona, Italy; Robert Jerrard, University of Toronto, Canada; Giandomenico Orlandi, University of Verona, Italy; H. Mete Soner, ETH Zürich, Switzerland  

11:30-11:55 Ginzburg-Landau Vortex Dynamics with Pinning and Strong Currents  
Ian Tice, Brown University, USA; Sylvia Serfaty, UPMC Paris 6, France, and Courant Institute of Mathematical Sciences, New York University, USA  

**MS31**  
Analysis Issues in the Study of Liquid Crystals and Related Areas - Part II of IV  
10:00 AM-12:30 PM  
Room: Salon C  
For Part 1 see MS3  
For Part 3 see MS59  
Liquid crystal materials have seemed many important application in physical, engineering and biological sciences. The theories for various type of liquid crystals are also important to the studies of other materials, such as magnetohydrodynamics, electrorheological fluids, viscoelastic fluids, biological membranes. With the development of new mathematical techniques, in numerics and analysis, there have been increasing interest in these fields. The symposium will focus on analytical issues from the studies of liquid crystal materials and related areas. It brings together both senior and junior researchers in the fields. The topics include dynamics and configurations of defects, hydrodynamical theories, compressible liquid crystals, stability phenomena, free boundary problems. We hope the meeting will provide a survey of the field and foster new collaborations.  
Organizer: Changyou Wang  
University of Kentucky, USA  
Organizer: Chun Liu  
Pennsylvania State University, USA  

Xiang Xu, Pennsylvania State University, USA; Hao Wu, Fudan University, China; Chun Liu, Pennsylvania State University, USA  

10:30-10:55 Some Results of the Incompressible Magnetohydrodynamic Flow  
Xin-peng Hu, New York University, USA  

continued on next page
Tuesday, November 15

**MS31**
Analysis Issues in the Study of Liquid Crystals and Related Areas - Part II of IV
10:00 AM-12:30 PM
continued

11:00-11:25 Numerical Analysis of the Equations of Liquid Crystal Elastomers
Maria-Carme Calderer, University of Minnesota, USA

11:30-11:55 Second Order Unconditionally Stable Schemes for Models of Thin Film Epitaxy
Xiaoming Wang, Florida State University, USA

12:00-12:25 Blow Up Criterion for Compressible Nematic Liquid Crystal Flows in Dimension Three
Changyou Wang and Tao Huang, University of Kentucky, USA; Huanyao Wen, South China Normal University, China

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Tuesday, November 15

**MS32**
Hyperbolic Conservation Laws and Related Topics - Part II of IV
10:00 AM-12:30 PM
Room: Salon D
For Part 1 see MS4
For Part 3 see MS60
The main purpose of this symposium is to bring researchers and young mathematicians together to exchange the new progress on the study of nonlinear hyperbolic conservation laws and related topics, with special emphasis on the structure of solutions, asymptotic behaviors of solutions, stability of nonlinear waves, and the related numerical computations.
Organizer: Ming Mei
McGill University, Canada
Organizer: Ronghua Pan
Georgia Institute of Technology, USA
Organizer: Feimin Huang
Chinese Academy of Sciences, China

10:00-10:25 Some Local Well-posedness Results Related to Multi-fluid System
Didier Bresch, Universite de Savoie, France

10:30-10:55 Dynamics of Shock Fronts for Some Hyperbolic Systems
Tao Luo, Georgetown University, USA

11:00-11:25 Vanishing Viscosity Limit for Isentropic Navier-Stokes Equations
Mikhail Perepelitsa, University of Houston, USA

11:30-11:55 On Global Solutions to the Three-dimensional Magnetohydrodynamics
Dehua Wang, University of Pittsburgh, USA

12:00-12:25 Traveling Waves in Capillary Fluids
Sylvie Benzoni-Gavage, University of Lyon 1, France

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Tuesday, November 15

**MS33**
Analysis of Fragmentation Equations and Applications to Models in Biology
10:00 AM-12:00 PM
Room: Salon E
This session is devoted to recent results in the mathematical theory of equations involving fragmentation. These often arise in models for cell division and growth, polymerization, and related situations in Biology and Physics where breakage phenomena are involved.
In particular, results dealing with the asymptotic behavior of the equation using entropy methods will be treated.
An application to a model describing the accumulation of prion proteins which cause spongiform encephalopathies is also discussed in one of the talks.
Exposition will be aimed at researchers in the field of partial differential equations, not necessarily familiar with fragmentation equations.
Organizer: Jose A. Cañizo
Universitat Autònoma de Barcelona, Spain

10:00-10:25 Rate of Convergence to Self-similarity for the Fragmentation Equation
Stephane Mischler, Université Paris Dauphine, France

10:30-10:55 Asymptotic Behavior of Fragmentation-drift Equations with Variable Drift Rates
Daniel Balagué and José A. Cañizo, Universitat Autònoma de Barcelona, Spain; Pierre Gabriel, UPMC, France

11:00-11:25 Optimization of the Fragmentation for a Prion Proliferation Model
Pierre Gabriel, UPMC, France; Vincent Calvez, Ecole Normale Superieure de Lyon, France

11:30-11:55 Entropy Methods for Fragmentation Equations
Maria J. Cáceres, Universidad de Granada, Spain; Jose Alfredo Cañizo, Universitat Autònoma de Barcelona, Spain; Stéphane Mischler, Université Paris Dauphine, France
### MS34

Partial Differential Equations for Biomolecular Interactions: Electrostatics, Hydrodynamics, and Fluctuations - Part II of III  
10:00 AM-12:00 PM  
Room: Salon F  
For Part 1 see MS6  
For Part 3 see MS62

Biomolecular interactions exhibit rich chemistry and physics spanning many length and time scales. A central challenge is to understand how such interactions determine the conformation, dynamics, and ultimately biological function of biomolecules. While traditional descriptions of these systems often use explicit molecular and solvent degrees of freedom, Partial Differential Equations and Stochastic Partial Differential Equations have been recently developed to allow for new approaches of analysis and computation to be employed. This minisymposium shall focus on such descriptions of some fundamental aspects of biomolecular interactions. These include the implicit solvation, electrostatic forces, anomalous diffusion, and ionic structures.

Organizer: Bo Li  
University of California, San Diego, USA
Organizer: Paul J. Atzberger  
University of California, Santa Barbara, USA

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<th>Time</th>
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<tbody>
<tr>
<td>10:00-10:25</td>
<td>Energetic Variational Approaches and Related Issues for Ionic Fluids and Ion Channels</td>
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<td>Chun Liu, Pennsylvania State University, USA</td>
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<td>10:30-10:55</td>
<td>Mean-Filed Description of Ionic Size Effects with Non-Uniform Ionic Sizes: A Numerical Approach</td>
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<td>Shenggao Zhou, Zhejiang University, China; Zhongming Wang and Bo Li, University of California, San Diego, USA</td>
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### MS35

Recent Development in Potential Theory, Harmonic Analysis and PDEs - Part II of II  
10:00 AM-12:30 PM  
Room: Salon G  
For Part 1 see MS7

Minisymposium reflects significant recent developments in analysis of PDEs and in related fields such as potential theory, harmonic analysis and geometric measure theory. The area and co-area formulas in metric spaces, Wiener test at infinity for elliptic and parabolic PDEs, harmonic analysis in stratified Lie groups, regularity of Riesz transforms for subelliptic operators, measure-theoretic analysis of fractal singularities, regularity of sets with quasimimal surfaces are among the more specific topics covered in this minisymposium.

Organizer: Ugur G. Abdulla  
Florida Institute of Technology, USA
Organizer: William Ziemer  
Indiana University, USA

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<th>Time</th>
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<tr>
<td>10:00-10:25</td>
<td>Wiener Test for the Regularity of Infinity for Elliptic Equations with Measurable Coefficients and its Consequences</td>
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<td>Ugur G. Abdulla, Florida Institute of Technology, USA</td>
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<td>10:30-10:55</td>
<td>The $L^p$ continuity of the Riesz Transforms Associated with a Subelliptic Operator on a Smooth Manifold</td>
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<td>Nicola Garofalo, Purdue University, USA</td>
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<td>11:00-11:25</td>
<td>Elliptic Operators and Fractal Singularities</td>
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<td>Umberto Mosco, Worcester Polytechnic Institute, USA</td>
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<td>11:30-11:55</td>
<td>A Finite Difference Approach to the Infinity Laplace Equation</td>
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<td>Scott Armstrong, University of Chicago, USA; Charles Smart, Massachusetts Institute of Technology, USA</td>
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<td>12:00-12:25</td>
<td>On the Inverse Stefan Problem</td>
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<td>Ugur G. Abdulla and Ogugua Onyejekwe, Florida Institute of Technology, USA</td>
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Tuesday, November 15

**MS36**
Dissipative PDEs and Exponential Attractors - Part I of II
10:00 AM-12:00 PM
Room: Salon H
For Part 2 see MS64
It is known that the long-time behavior of solutions of dissipative PDEs can be described in terms of global attractors. However, the concept of a global attractor possesses two essential drawbacks: the rate of convergence to it may be slow and it is sensitive to perturbations. The exponential attractor, which is an intermediate object between the global attractors and inertial manifolds, overcomes these drawbacks and looks more suitable from both theoretical and applied points of view. The scope of the minisymposium is to discuss the recent progress in the theory of global and exponential attractors as well as to present a number of new applications to equations of mathematical physics.

**Organizer:** Sergey Zelik

*University of Surrey, United Kingdom*

**10:00-10:25 On Inertially Equivalent Dynamical Systems**
Alp Eden, Bogazici University, Turkey

**10:30-10:55 Counterexamples in the Attractors Theory**
Sergey Zelik, University of Surrey, United Kingdom

**11:00-11:25 Long Time Behavior of Solutions to Flow-Structure Interactions Arising in Modeling of Subsonic Ows of Gas**
Irena M. Lasiecka, University of Virginia, USA

**11:30-11:55 A Cahn-Hilliard Model with Dynamic Boundary Conditions**
Alain Miranville, University of Poitiers, France

Tuesday, November 15

**MS37**
Topics in Higher Order Geometric PDEs - Part II of III
10:00 AM-12:00 PM
Room: Sante Fe 3
For Part 1 see MS9
For Part 3 see MS65
Many partial differential equations arising in the study of geometric problems are elliptic and parabolic PDEs of higher order. The analysis of such equations is challenging due to the failure of techniques effectively used in the second order case to carry over to the higher order setting. We aim to present some recent developments concerning existence and qualitative properties of solutions of such geometric PDEs, bringing together some new and some experienced researchers to discuss the ramifications of recent progress and possible future developments.

**Organizer:** Anna Dall’Acqua

*Otto-von-Guericke-Universität Magdeburg, Germany*

**10:00-10:25 Compactness and Stability Issues for Fourth Order Elliptic PDEs**
Olivier Druet, Ecole Normale Superieure de Lyon, France

**10:30-10:55 Maximal Time Estimate for Fourth Order Geometric Flows**
James A. McCoy, University of Wollongong, Australia; Glen Wheeler, Otto-von-Guericke-Universität Magdeburg, Germany; Min-Chun Hong, University of Queensland, Australia

**11:00-11:25 Time-like Willmore Surfaces in Minkowski Space**
Matthias Bergner, Leibniz University Hannover, Germany

**11:30-11:55 On Equilibria and Stability of the Axisymmetric Surface Diffusion Flow**
Jeremy LeCrone and Gieri Simonett, Vanderbilt University, USA

Tuesday, November 15

**MS38**
Nonlinear Hyperbolic Equations: Theoretical Advances and Applications - Part II of II
10:00 AM-12:00 PM
Room: Sante Fe 4
For Part 1 see MS10
In the large context of nonlinear evolution equations we will focus on systems of PDEs which exhibit a hyperbolic or parabolic-hyperbolic structure. The topics of this minisymposium will revolve around qualitative and quantitative properties of solutions to these equations, such as existence and uniqueness, regularity of solutions, and long time asymptotic behavior. Of special interest in our discussions are nonlinear interactions and the methods available to investigate them. We anticipate also to discuss specific problems that arise in applications such as nonlinear acoustics, traveling waves in elasticity and viscoelasticity, plasma dynamics, and semiconductors.

**Organizer:** Stephen Pankavich

*United States Naval Academy, USA*

**10:00-10:25 On Inertially Equivalent Dynamical Systems**
Alp Eden, Bogazici University, Turkey

**10:30-10:55 Counterexamples in the Attractors Theory**
Sergey Zelik, University of Surrey, United Kingdom

**11:00-11:25 Long Time Behavior of Solutions to Flow-Structure Interactions Arising in Modeling of Subsonic Ows of Gas**
Irena M. Lasiecka, University of Virginia, USA

**11:30-11:55 A Cahn-Hilliard Model with Dynamic Boundary Conditions**
Alain Miranville, University of Poitiers, France

**10:00-10:25 Existence and Stability of Viscous Profiles in a Nonlinear System of Viscoelasticity**
Marta Lewicka, University of Pittsburgh, USA

**10:30-10:55 Wellposedness for Some Nonlinear Wave Equations**
Petrosel Radu, University of Nebraska, Lincoln, USA

**11:00-11:25 Existence of Ground States for Fourth-order Wave Equations**
Paschalis Karageorgis, Trinity College, Ireland; Joseph McKenna, University of Connecticut, USA

**11:30-11:55 Existence and Regularity for a Coupled Kinetic-hyperbolic Model of Plasma Dynamics**
Stephen Pankavich, United States Naval Academy, USA
Tuesday, November 15

**MS39**  
**Fluid Dynamics: Deterministic and Stochastic Perspectives - Part I of II**

10:00 AM-12:30 PM  
Room: Sierra 5

For Part 2 see MS67

Fluid dynamics is a rich field of both classical and modern scientific investigation. It has numerous applications to important applications to engineering, meteorology and various other fields. Though the underlying equations are usually deterministic, a stochastic component naturally arises through intrinsic sources of noise, and turbulent instabilities. The aim of the mini-symposium is to bring together researchers working on deterministic, and stochastic PDEs with applications to fluid dynamics. The main focus is to get a better understanding of the behavior of turbulent flows and their coherent structures.

Organizer: Hakima Bessaih  
University of Wyoming, USA

Organizer: Gautam Iyer  
Carnegie Mellon University, USA

10:00-10:25 Potential Feedback and Regularization in Complex Fluid Models  
Peter Constantin and Weiran Sun, University of Chicago, USA

10:30-10:55 Well-Posedness Results for the Stochastic Primitive Equations of the Oceans and Atmosphere  
Nathan Glatt-Holtz, Indiana University, USA

11:00-11:25 Ergodic Properties of the Burgers Equation in the Noncompact Setting  
Yuri Bakhtin, Georgia Institute of Technology, USA

11:30-11:55 Burgers Turbulence and Complete Integrability  
Ravi Srinivasan, University of Texas at Austin, USA

12:00-12:25 Stochastic Burgers Equation with Random Initial Conditions  
Salah A. Mohammed, Southern Illinois University, Carbondale, USA

**MS40**  
**Self-organization Phenomena and Geometric Structures of Concentration in PDEs - Part I of III**

10:00 AM-12:30 PM  
Room: Sierra 6

For Part 2 see MS68

Geometric patterns arise in many physical and biological systems as orderly outcomes of self-organization principles. Examples are morphological phases in block copolymers, morphogene patterns in cell development, animal coats, and skin pigmentation. This three part mini-symposium is devoted to the study of various geometric structures observed as singular limits from solutions of partial differential equations. Known objects on which solutions of PDEs concentrate include spikes, spots, vortices, minimal and constant mean curvature surfaces, toroidal rings, etc.

Organizer: Xiaofeng Ren  
George Washington University, USA

Organizer: Theodore Kolokolnikov  
Dalhousie University, Canada

Organizer: Yoshihito Oshita  
Okayama University, Japan

10:00-10:25 Results for a Nonlocal Isoperimetric Problem Related to Diblock Copolymers  
Peter Sternberg, Indiana University, USA

10:30-10:55 Stability of Steady States and Asymptotic Behavior of Mean-field Models for Micro Phase Separation  
Yoshihito Oshita, Okayama University, Japan

11:00-11:25 Dynamics in Phase Field Models for Dilute Mixtures: A Gradient Flow Approach  
Rustum Choksi, McGill University, Canada

11:30-11:55 Worm-like States in Pattern Forming Systems  
Karl Glasner, University of Arizona, USA

12:00-12:25 Population Adaptive Evolution and Concentration Dynamics  
Benoît Perthame, Université Pierre et Marie Curie, France
Tuesday, November 15

**MS42**

Fundamental Equations for Fluid Dynamics and Related Models
10:00 AM-12:00 PM
Room: Cabrillo 2
The theory of fluid dynamics underlies developments in physics and engineering and gives a lot of advances which have influenced modern scientific society. Moreover, governing equations of fluid mechanics has long been a source of important and challenging mathematical problems. The objectives of this mini-symposium are to discuss on these governing equations and related mathematical models appearing in applied sciences. In particular, we study the compressible Navier-Stokes equations, the compressible Euler equation and so on to attempt to answer fundamental questions such as the global well-posedness and the asymptotic structure of the solutions.
Organizer: Shinya Nishibata
Tokyo Institute of Technology, Japan
10:00-10:25 Stationary Wave to the Symmetric Hyperbolic-parabolic System in Half Space
Tohru Nakamura, Kyushu University, Japan
10:30-10:55 Stability of Planar Shock Fronts for Multi-d Systems of Relaxation Equations
Bongsuk Kwon, Texas A&M University, USA
11:00-11:25 Decay Structure of Regularity-loss Type for Symmetric Hyperbolic Systems with Relaxation
Yoshihiro Ueda, Kobe University, Japan
11:30-11:55 Asymptotic Structure of Solutions to the Euler-Poisson Equations Arising in Plasma Physics
Masahiro Suzuki, Tokyo Institute of Technology, Japan

**Lunch Break**
12:30 PM-2:00 PM
Attendees on their own

Tuesday, November 15

**MS43**

Calculus of Variations and Applications - Part II of III
2:00 PM-4:00 PM
Room: Salon A
For Part 1 see MS15
For Part 3 see MS71
The calculus of variations has been an active field of research for nearly 300 years. Today it plays a central role in partial differential equations (in particular, of nonlinear type). The main object of the proposed mini-symposium is the applications of the calculus of variations to various fields in science and engineering. We intend to bring together some experts who work on different applications, including superconductivity, image processing, optimal mass transportation, chemotaxis and others, who apply different tools from the calculus of variations. Such a meeting will hopefully lead to a fruitful exchange of ideas and methods.
Organizer: Gershon Wolansky
Technion IIT, Haifa, Israel

Room: Salon B
2:00 PM-4:00 PM
The role of geometry in the development and analysis of numerical methods for partial differential equations has grown dramatically over the last two decades. Surface finite element methods have emerged to require a more sophisticated geometric analysis than provided by the Strang Lemmas, and mixed finite elements have been found to have deep connections with the calculus of exterior differential forms, de Rham cohomology and Hodge theory, culminating in the development of finite element exterior calculus. In this minisymposium, we will examine the recent convergence of these ideas, and look ahead at some exciting new developments on the horizon.
Organizer: Michael J. Holst
University of California, San Diego, USA
2:00-2:25 Pinning by Holes of Multiple Vortices and Homogenization for Ginzburg-Landau Problems
Leonid Berlyand, Pennsylvania State University, USA
2:30-2:55 Bubbling at the Boundary for Ginzburg-Landau equations
Etienne Sandier, Université Paris-Est Créteil Val de Marne, France
2:00-2:25 Level-Set Flow for Capturing Unstable Geodesics on Surfaces
Li-Tien Cheng, University of California, San Diego, USA
2:30-2:55 Application of the Finite Element Exterior Calculus to the Equations of Linear Elasticity
Richard S. Falk, Rutgers University, USA; Douglas N. Arnold, University of Minnesota, USA; Ragnar Winther, University of Oslo, Norway

continued on next page
MS44

Exploiting Geometry in the Development of Numerical Methods of Partial Differential Equations - Part II of II

continued

3:00-3:25 Multisymplectic Hamilton--Jacobi Theory and their Applications to Geometric Integration of Lagrangian Field Theories

Melvin Leok, University of California, San Diego, USA; Cuicui Liao, Harbin Institute of Technology, China; Joris Vankerschaver, University of California, San Diego, USA

3:30-3:55 A Posteriori Error Estimates for a Surface FEM Based on an Outer Triangulation

Alan Demlow, University of Kentucky, USA

MS45

Fluid-Structure and Flow-Structure Interactions: Modeling, Analysis and Control - Part II of III

2:00 PM-4:30 PM

Room: Salon C

For Part 1 see MS17
For Part 3 see MS73

This Minisymposium will focus on the PDEs which govern fluids/flows interacting with elastic structures. Such phenomena are constantly observed in the natural and man-made world: e.g., vascular blood flow immersing cellular bodies; submarines coursing through a sea; large flexible structures subjected to windstorm turbulence.

The Minisymposium participants will have research interests and expertise in the Navier-Stokes Equations, mathematical control and numerical analysis of PDE dynamics (particularly those of hyperbolic or “composite” characteristics), and in modeling of complex physical processes. Questions such as well-posedness, control and stabilization of the coupled PDEs governing such interactions will constitute the focus of the symposium.

Organizer: Lorena Bociu
North Carolina State University, USA

Organizer: Irena M. Lasiecka
University of Virginia, USA

Organizer: George Avalos
University of Nebraska, Lincoln, USA

2:00-2:25 Incompressible Fluid Coupled with Nonlinear Elasticity

Lorena Bociu, North Carolina State University, USA; Jean-Paul Zolesio, INRIA Sophia Antipolis, France

2:30-2:55 Moving-boundary Problems of Mixed Type Arising in Modeling Blood Flow

Suncica Canic, University of Houston, USA

continued in next column
Tuesday, November 15
MS46
Multidimensional Conservation Laws and Related Applications - Part II of III
2:00 PM-4:30 PM
Room: Salon D
For Part 1 see MS18
For Part 3 see MS74
Multidimensional conservation laws are mathematical models for fundamental processes in physics and engineering, such as high-speed flows and supersonic jets. Interesting open problems including mixed (hyperbolic-elliptic) types and free boundaries arising from multidimensional conservation laws have been studied by many researchers. Yet many problems are still remaining open and needed to be investigated further. This session will bring together analytical and numerical experts to discuss the current development in multidimensional conservation laws and related applications. The session will cover broad ranges of topics including mathematical problems for conservation laws, mixed-type problems, and various applications.
Organizer: Eun Heui Kim
California State University, Long Beach, USA
Organizer: Chung-Min Lee
California State University, Long Beach, USA
2:00-2:25 Boundary Regularity of Degenerate Elliptic Equations without Boundary Conditions
Gary Lieberman, Iowa State University, USA
2:30-2:55 Global solutions to the Navier-Stokes-Vlasov-Fokker-Planck equations
Jihoon Lee, Sungkyunkwan University, Korea; Kyungkeun Kang, Yonsei University, South Korea; Myeongju Chae, Hankyong National University, South Korea
3:00-3:25 Thermosolutal Convection at Infinite Prandtl Number with or without Rotation: Bifurcation and Stability in Physical Space
Jungho Park, New York Institute of Technology, USA
3:30-3:55 Semi-hyperbolic Patches of Two Dimensional Riemann Problems
Kyungwoo Song, KyungHee University, South Korea
4:00-4:25 The Sonic Line As a Free Boundary
Barbara Keyfitz, Ohio State University, USA; Allen Tesdall, City University of New York, Staten Island, USA; Kevin Payne, University of Milan, Italy; Nedyu Popivanov, University of Sofia, Bulgaria

Tuesday, November 15
MS47
Models for Evolutionary Biology - Part II of II
2:00 PM-3:30 PM
Room: Salon E
For Part 1 see MS19
Evolutionary biology aims at explaining the appearance and evolution of species (from viruses to mamals). Theoretical models, and in particular structured population models, play an significant role in this field. The nonlocal PDE models that appear in this context lead to challenging mathematical problems: convergence to singular measures, constrained Hamilton-Jacobi equations, front propagation... An increasing number of mathematicians are interested by those problems, and this minisymposium will be an occasion to discuss the studies ongoing on this topic.
Organizer: Gael Raoul
University of Cambridge, United Kingdom
2:00-2:25 Some New Results for Reaction Cross-diffusion Equations
Laurent Desvillettes, Ecole Normale Superieur de Cachan, France
2:30-2:55 P-gp Transfer and Acquired Multi-drug Resistance in Tumors Cells
Pierre Magal, University of Bordeaux, France
3:00-3:25 Evolution of Species Trait Through Resource Competition
Sepideh Mirrahimi, Ecole Polytechnique, France; Benoît Perthame, Université Pierre et Marie Curie, France; Joe Yuichiro Wakano, Meiji Institute for Advanced Study for Mathematical Sciences, Japan
Tuesday, November 15  
**MS48**  
**Mixed-Type and Free Boundary Problems - Part II of IV**  
2:00 PM-4:00 PM  
Room: Salon F  
For Part 1 see MS20  
For Part 3 see MS76  
This mini-symposium is in the area of analysis of solutions to typical boundary-value problems for hyperbolic, mixed and composite type PDEs from continuum mechanics. The emphasis is on the problems involving interfaces such as shocks, moving boundaries, interfaces where equations change their type and interfaces between different phases of a continuum. The discussions will address questions of the dynamics and the geometry of interfaces as well as regularity issues. The aim of this mini-symposium is to give an opportunity for researchers from the international PDE community working in this field to get together for discussions, collaboration and dissemination of research.  
Organizer: Mikhail Perepelitsa  
University of Houston, USA  
Organizer: Suncica Canic  
University of Houston, USA  
Organizer: Chen Gui-Qiang  
University of Oxford, United Kingdom  
2:00-2:25 Well-posedness of the 3-D Compressible Euler Equations with Moving Physical Vacuum Boundary  
Steve Shkoller, University of California, Davis, USA  
2:30-2:55 Some Mixed Type Problems in Gas Dynamics and Geometry  
Dehua Wang, University of Pittsburgh, USA  
3:00-3:25 On the Structure of Solutions of Nonlinear Hyperbolic Systems of Conservation Laws  
Monica Torres, Purdue University, USA;  
Gui-Qiang G. Chen, University of Oxford, United Kingdom  
3:30-3:55 Well-posedness of the Cauchy Problem for a Class of Multidimensional Nonlinear Stochastic Balance Laws  
Ding Qian, Northwestern University, USA;  
Gui-Qiang G. Chen, University of Oxford, United Kingdom; Kenneth Karlsen, University of Oslo, Norway  

Tuesday, November 15  
**MS49**  
**Recent Progress on Dispersive Partial Differential Equations - Part II of III**  
2:00 PM-4:30 PM  
Room: Salon G  
For Part 1 see MS21  
For Part 3 see MS77  
The session will contain talks on a wide range of topics in the theory of dispersive partial differential equations. These topics include, but will not necessarily be restricted to, the following: existence of global-in-time solutions, regularity and smoothing effects, soliton and blow-up dynamics, existence of wave and scattering operators, and linear dispersive estimates on various manifolds.  
Organizer: Nikolaos Tzirakis  
University of Illinois at Urbana-Champaign, USA  
Organizer: Burak Erdogan  
University of Illinois at Urbana-Champaign, USA  
2:00-2:25 Recent Results on the Gross-Pitaevskii Hierarchy  
Thomas Chen and Natasa Pavlovic, University of Texas, Austin, USA  
2:30-2:55 Wave Operators and Applications  
Marius Beceanu, Rutgers University, USA  
3:00-3:25 The Radial Defocusing Energy-supercritical Cubic Nonlinear Wave Equation in $R^{1+5}$  
Aynur Bulut, University of Texas, USA  
3:30-3:55 Global Smoothing for the Periodic KdV Evolution  
Burak Erdogan and Nikos Tzirakis, University of Illinois at Urbana-Champaign, USA  
4:00-4:25 Long Time Dynamics for Forced and Weakly Damped KdV on the Torus  
Nikolaos Tzirakis and Burak Erdogan, University of Illinois at Urbana-Champaign, USA  

Tuesday, November 15  
**MS50**  
**Asymptotic Methods for Heterogeneous Media - Part I of II**  
2:00 PM-4:00 PM  
Room: Salon H  
For Part 2 see MS78  
The minisymposium will assess the use of asymptotic methods in analysis of models arising in composite and other heterogeneous media. In particular, issues that will be addressed but not limited to are asymptotic analysis for singular fields, geometric aspects of averaging, inverse problems, and computational tools for complex inhomogeneous media. The purpose of this session is to enable contact between researchers working on asymptotic analysis for partial differential equations with an update on recent progress in this field.  
Organizer: Yuliya Gorb  
University of Houston, USA  
Organizer: Alexei Novikov  
Pennsylvania State University, USA  
2:00-2:25 Adhesion of Heterogeneous Media  
Kaushik Bhattacharya, California Institute of Technology, USA  
2:30-2:55 Some Properties of Large Deviations for Mean Field Models of Phase Transitions  
George C. Papanicolaou, Stanford University, USA  
3:00-3:25 From Homogenization to Averaging in Cellular Flows  
Gautam Iyer, Carnegie Mellon University, USA  
3:30-3:55 Fluctuation Theories Beyond Homogenization in Random Media  
Guillaume Bal, Columbia University, USA
Calculus of Variations in $L^\infty$ and Aronsson Equations - Part II of III
2:00 PM-4:00 PM
Room:Sante Fe 3
For Part 1 see MS23
For Part 3 see MS79
Recent developments in the emerging area of Calculus of Variations in $L^\infty$ have been motivated by a broad range of applications to problems where one seeks to minimize functionals represented as an essential supremum (worst case analysis) rather than the average cost. Minimization problems for supremal functionals and of the associated Aronsson equations also has extensive connections with other areas of mathematics, including optimal control, random-turn games, optimal transport, weak KAM theory, differential geometry, and degenerate elliptic PDEs associated with level set convexity.

The aim of this minisymposium is to facilitate the exchange of ideas on the latest developments.
Organizer: Emmanuel Barron
Loyola University Chicago, USA
Organizer: Marian Bocea
Loyola University Chicago, USA
Organizer: Rafal Goebel
Loyola University Chicago, USA
Organizer: Robert Jensen
Loyola University Chicago, USA
2:00-2:25 The $p$-Laplacian on Graphs
Juan J. Manfredi, University of Pittsburgh, USA
2:30-2:55 Interior Regularity for a Minimal Principal Curvature Operator
Robert Jensen, Loyola University Chicago, USA
3:00-3:25 Vector-valued Optimal Lipschitz Extensions
Charles Smart, Massachusetts Institute of Technology, USA
3:30-3:55 Contact Solutions for Fully Nonlinear Systems and the Aronsson System of PDEs
Nikolaos I. Katzourakis, Basque Center for Applied Mathematics, Spain
3:30-3:55 Harnack Inequalities and Regularity Estimates for Discontinuous Processes
Mohammad Foondun, Loughborough University, United Kingdom

Nonlocal Equations: Perspectives from Probability and PDEs - Part II of III
2:00 PM-4:00 PM
Room:Santa Fe 4
For Part 1 see MS24
For Part 3 see MS80
Integro-differential equations and jump processes have seen increased activity in recent years both in the probability and PDE communities with a long list of applications arising from models in e.g. kinetic theory, hydraulic fracturing, stochastic control, image processing, etc. The increasing abundance of these nonlocal equations arising from science provides many mathematical challenges deserving attention. We believe it will be fruitful to bring together analysts and probabilists working on very similar topics in this area for discussion and exposure of the vast amounts of recent work on the two different sides of this one coin- integro-differential equations.
Organizer: Nestor Guillen
University of California, Los Angeles, USA
Organizer: Schwab Russell
Carnegie Mellon University, USA
2:00-2:25 Harnack's Inequality: A New Formulation and Applications
Moritz Kassmann, Universität Bielefeld, Germany
2:30-2:55 Levy Processes and Fourier Multipliers
Rodrigo Bañuelos, Purdue University, USA
3:00-3:25 The Harnack Inequality and Littlewood-Paley Functions for Symmetric Stable Processes
Deniz Karli, University of British Columbia, Canada
3:30-3:55 Harnack Inequalities and Regularity Estimates for Discontinuous Processes
Mohammad Foondun, Loughborough University, United Kingdom

The Many Aspects of Fluids and Harmonic Analysis - Part II of V
2:00 PM-4:30 PM
Room:Sierra 5
For Part 1 see MS25
For Part 3 see MS81
This minisymposium will be dedicated to the behaviour of solutions to fluid models such as Navier-Stokes equations, Magneto-Hydrodynamics, and liquid crystals. We will look into theoretical and applied questions. We have invited a very diverse group of researchers and we expect that this will allow for exchange of research and hopefully new collaborations.
Organizer: Maria E. Schonbek
University of California, Santa Cruz, USA
Organizer: Marco Cannone
Université Paris-Est Marne-la-Vallée, France
2:00-2:25 Regularity Results for the Prandtl-Reuss Law
Maria Specovius-Neugebauer, University of Kassel, Germany; Jens Frehse, University of Bonn, Germany
2:30-2:55 Asymptotic Behaviour of Infinite Energy Solutions to Navier-Stokes Equations
Cesar Niche, Universidade Federal do Rio De Janeiro, Brazil
3:00-3:25 Asymptotic Stability of Landau Solutions to Navier-Stokes System
Dominika Pilarczyk and Grzegorz Karch, University of Wroclaw, Poland
3:30-3:55 An Alternative Approach to Regularity for the Navier-Stokes Equations in Critical Spaces
Gabriel S. Koch, University of Sussex, United Kingdom
4:00-4:25 An Active Scalar Equation for the Geodynamo
Susan Friedlander, University of Southern California, USA; Vlad C. Vicol, University of Chicago, USA
Mathematical Foundations of Turbulent Flows and Its Application to Geophysics - Part II of III

2:00 PM-4:30 PM
Room: Sierra 6
For Part 1 see MS26
For Part 3 see MS82
This minisymposium aims to cover recent important developments in the mathematics of turbulent flows, new advances in reduced dynamical modeling for flows in geophysics, and the latest techniques in numerical computation for these flows. The talks include an up-to-date overview of the basic problems in the analytical and computational studies of turbulent flows in connection to geophysical fluid dynamics, magnetohydrodynamics, and convection. Our goal is to have a better understanding of the mathematics of turbulent flows and the various physical processes that underlie them. In addition, we aim to encourage connections and communication between related areas of this research, ranging from novel analytical methods, to the latest techniques in efficient numerical simulations.

Organizer: Evelyn Lunasin
University of Michigan, USA
Organizer: Adam Larios
Texas A&M University, USA

2:00-2:25 The Baroclinic Instability and Turbulence Parameterizations in Ocean Models
Mark R. Petersen and Matthew Hecht, Los Alamos National Laboratory, USA; Darryl D. Holm, Imperial College London, United Kingdom; Beth Wingate, Los Alamos National Laboratory, USA

2:30-2:55 Approximate Deconvolution Large Eddy Simulation of a Barotropic Ocean Circulation Model
Traian Iliescu, Omer San, Anne Staples, and Zhu Wang, Virginia Polytechnic Institute & State University, USA

3:00-3:25 Aspect-ratio Effects in Boussinesq Flows with Rotation and Stratification
Susan Kurien, Los Alamos National Laboratory, USA

3:30-3:55 Separation of Scales in Strongly Rotating Flows with Weak Stratification
Beth Wingate, Los Alamos National Laboratory, USA

4:00-4:25 Pseudospectral Reduction of Incompressible Two-Dimensional Turbulence.
John C. Bowman, University of Alberta, Canada

Collective behaviour of biological aggregations (such as fish schools, bird flocks, insect swarms and bacterial colonies) has received a great deal of interest in recent years. Various mathematical models have been suggested in the literature, ranging from individual (Lagrangian) based models to continuum (Eulerian) descriptions. The speakers in the minisymposium will address challenging mathematical issues raised by some of these models. We mention in particular the asymptotic behavior of solutions, which is very important in applications.

Organizer: Razvan Fetecau
Simon Fraser University, Canada
Organizer: Theodore Kolokolnikov
Dalhousie University, Canada

2:00-2:25 Particle Interaction Models of Biological Aggregation
Theodore Kolokolnikov, Dalhousie University, Canada; Hui Sun, David Uminsky, and Andrea L. Bertozzi, University of California, Los Angeles, USA

2:30-2:55 Steady States of Nonlocal Interaction Equations with Repulsively-attractive Potential
Thomas Laurent, University of California, Riverside, USA

3:00-3:25 Stability and the Inverse Statistical Mechanics Problem for Aggregating Particles
David T. Uminsky and James von Brecht, University of California, Los Angeles, USA; Theodore Kolokolnikov, Dalhousie University, Canada; Andrea L. Bertozzi, University of California, Los Angeles, USA

continued on next page
Tuesday, November 15

MS55
Mathematical Models of Biological Aggregations - Part II of II
2:00 PM-4:30 PM
continued

3:30-3:55 Interfacial Behavior in Biological Aggregation
Andrea L. Bertozzi, University of California, Los Angeles, USA; Russell Schwab and Dejan Slepcev, Carnegie Mellon University, USA

4:00-4:25 Nonlocal Aggregation Equations and Concentration Phenomena
Gael Raoul, University of Cambridge, United Kingdom

MS56
Interface Dynamics and Regularity Issues Arising in Fluid Mechanics - Part II of III
2:00 PM-4:00 PM
Room: Cabrillo 2

For Part 1 see MS28
For Part 3 see MS84

Two sessions are focused on the study of free boundary equations that evolve with an incompressible flow such as Euler equations, Darcy’s law, Magneto-hydrodynamics, etc… The third session is devoted to regularity issues arising in Boltzmann, beta-model, Euler and porous media equations. Recently there has been an extensive study, related to these problems, on uniqueness, well-posedness, global existence, stability and formation of singularities through several quite different approaches, including modern PDE methods, harmonic analysis techniques and numerical computations.

Organizer: Diego Cordoba
Institute de Ciencias Matematicas-CSIC, Spain

Organizer: David Lannes
Ecole Nationale Superieure, France

2:00-2:25 Turning Waves and Breakdown for Muskat
Diego Cordoba, Institute de Ciencias Matematicas-CSIC, Spain

2:30-2:55 Splash Singularity for Water Waves
Charles Fefferman, Princeton University, USA

3:00-3:25 The Spine of an SQG Almost-sharp Front
Garving Kevin Luli, Yale University, USA

3:30-3:55 Knots and Links in Fluid Mechanics
Alberto Enciso and Daniel Peralta-Salas, CSIC, Madrid, Spain

Coffee Break
4:30 PM-5:00 PM
Room: Foyer

Tuesday, November 15

Forward Looking Session
5:00 PM-6:00 PM
Room: Salon DE

Dinner Break
6:00 PM-8:00 PM
Attendees on their own
Cell colonies can exhibit remarkable patterns which result from complex and poorly understood mechanisms that allow them to communicate, respond to signals and finally move collectively. The term ‘sociomicrobiology’ has been coined for this field of biology. The question of explaining these patterns is old and many PDE models have been proposed in this field. It is one of the very few examples in biology where the validity of the PDEs is largely accepted because experiments and models fit at least qualitatively but also quantitatively in a few cases.

Three classes of PDE models are remarkable:
- Fokker-Planck equations as the famous Patlak-Keller-Segel model for chemotaxis
- Kinetic models at the cell size scale
- Semilinear parabolic system for the cell population density and the nutrient

The various questions that we will address are as follows:
- The Keller-Segel model: chemoattraction and blow-up
- Branching instabilities as results of short range attraction long range repulsion,
- Kinetic models of chemotaxis
- The Flux Limited Keller-Segel equation in the diffusion limit
- Traveling bands and the Adler experiment

This talk is based on collaborations with mathematicians and experimentalists: A. Blanchet, J. Dolbeault, with V. Calvez, N. Bournaveas, A. Buguin, J. Saragosti, P. Silberzan and with Ch. Schmeiser, M. Tang, N. Vauchelet.

Benoît Perthame
Université Pierre et Marie Curie, France
Wednesday, November 16

**MS57**
Partial Differential Equations for Non-linear Processes in Porous Media - Part I of II
10:00 AM-12:30 PM
Room: Salon A

For Part 2 see MS85
This session is dedicated to analysis of the problems raised by recent advances in engineering and industry related to hydrodynamic and bio-geo-chemical processes in porous media. These processes usually exhibit non-linear properties such as specific long-time asymptotic and regularity, traveling waves, blow-up, dead zones, etc, which can be modeled by using machinery of PDEs. The goal of the mini-symposium is to discuss new results and methods for analyses of the solution of non-linear PDEs with direct or potential applications to porous media.

Organizer: Malgorzata Peszynska
Oregon State University, USA
Organizer: Akif Ibragimov
Texas Tech University, USA
Organizer: Luan Hoang
Texas Tech University, USA

10:00-10:25 New Class of Constitutive Models Giving Rise to Challenges to PDE
Kumbakonam Rajagopal, Texas A&M University, USA; Josef Malek, Charles University, Prague, Czech Republic

10:30-10:55 Liouville-Type Theorems for a Class of Degenerate and Singular Parabolic Equations
Emmanuele DiBenedetto, Vanderbilt University, USA

11:00-11:25 Mixed Formulations of Coupled Systems of Mechanics and Diffusion
Ralph Showalter, Oregon State University, USA

Xiaoming Wang, Florida State University, USA

12:00-12:25 Well-Posenedness Theory for an Aggregation Equations and Patlak-Keller-Segel Models with Degenerate Diffusion
Nancy Rodriguez, University of California, Los Angeles, USA

Wednesday, November 16

**MS58**
Singularities in Physical systems and the Calculus of Variations - Part III of III
10:00 AM-12:00 PM
Room: Salon B

For Part 2 see MS30
Singularities are present in many physical systems, from domain walls in micromagnets to vortex lines in superconductors or liquid crystals to domain structures in co-polymers. These can often be expressed as singular limits of variational problems and lead to challenging analytical and geometrical problems. In this minisymposium, we will focus on energy minimizing configurations and their associated gradient flows arising as singular perturbations problems in the calculus of variations, and their associated PDEs. Applications to problems coming from diverse areas of physics and materials science will be presented.

Organizer: Lia Bronsard
McMaster University, Canada
Organizer: Vincent Millot
Université Paris VII, France

10:00-10:25 Epitaxially Strained Thin Films: Regularity of Quantum Dots and Motion by Anisotropic Surface Diffusion
Irene Fonseca and Giovanni Leoni, Carnegie Mellon University, USA; Massimiliano Morini, Universita degli Studi di Parma, Italy; Nicola Fusco, University of Naples, Italy

10:30-10:55 Multiscale Gamma Convergence for Point Interactions in 2D
Etienne Sandier, Université Paris-Est Créteil Val de Marne, France; Sylvia Serfaty, UPMC Paris 6, France, and Courant Institute of Mathematical Sciences, New York University, USA

11:00-11:25 On Minimizers of the Doubly-Constrained Helfrich Functional
Rustum Choksi, McGill University, Canada

11:30-11:55 Thin Films for Ginzburg Landau in the London Limit
Bernardo Galvao-Sousa, University of Toronto, Canada; Stan Alama and Lia Bronsard, McMaster University, Canada

Wednesday, November 16

**MS59**
Analysis Issues in the Study of Liquid Crystals and Related Areas - Part III of IV
10:00 AM-12:30 PM
Room: Salon C

For Part 2 see MS31
For Part 4 see MS87
Liquid crystal materials have seen many important application in physical, engineering and biological sciences. The theories for various type of liquid crystals are also important to the studies of other materials, such as magnetohydrodyanamics, electrorheological fluids, viscoelastic fluids, biological membranes. With the development of new mathematical techniques, in numerics and analysis, there have been increasing interest in these fields. The symposium will focus on analytical issues from the studies of liquid crystal materials and related areas. It brings together both senior and junior researchers in the fields. The topics include dynamics and configurations of defects, hydrodynamical theories, compressible liquid crystals, stability phenomena, free boundary problems. We hope the meeting will provide a survey of the field and foster new collaborations.

Organizer: Changyou Wang
University of Kentucky, USA
Organizer: Chun Liu
Pennsylvania State University, USA

10:00-10:25 Defects in Thin Smectic Liquid Crystal Films
Daniel Phillips and Sean Colbert-Kelly, Purdue University, USA

10:30-10:55 Well-posedness for the 3-D Compressible MHD Equations with Moving Vacuum Boundary
Steve Shkoller, University of California, Davis, USA

continued in next column
Wednesday, November 16

MS59
Analysis Issues in the Study of Liquid Crystals and Related Areas - Part III of IV
10:00 AM-12:30 PM
continued

11:00-11:25 Specific Tensorial Features in the Modelling of Nematic Liquid Crystals
Arghir Zarnescu, University of Sussex, United Kingdom
11:30-11:55 Analysis of Nematic Liquid Crystals with Disclination Lines
Patricia Bauman and Daniel Phillips, Purdue University, USA; Jinhae Park, Seoul National University, Korea
12:00-12:25 Numerical Approximation of the Ericksen Leslie Equations
Noel J. Walkington, Carnegie Mellon University, USA

Wednesday, November 16

MS60
Hyperbolic Conservation Laws and Related Topics - Part III of IV
10:00 AM-12:30 PM

11:00-11:25 The Hyperbolic Keller-Segel Model and Branching Instabilities
Benoit Perthame, Université Pierre et Marie Curie, France
11:30-12:55 On a Chemotaxis Model
Tong Li, University of Iowa, USA
12:00-12:25 Lagrangian Solutions of a Semigeostrophic System
Mikhail Feldman, University of Wisconsin, Madison, USA

Wednesday, November 16

MS61
Modulation Equations in Nonlinear Waves - Part 1 of II
10:00 AM-12:30 PM
Room: Salon E
For Part 2 see MS89

Many problems of physical interest are on such large scales that direct numerical simulation is not possible. Modulation equations are often derived in such situations to reduce the problem to a computationally reasonable scale. Some notable examples include the Nonlinear Schrödinger (NLS) equation which describes slow modulations in time and space of an underlying carrier wave in fiber optics, or the Korteweg-de Vries (KdV) equation describing water waves in the long wave limit. It is the goal of this minisymposium to explore the most recent advances in the derivation, validity and application of modulation equations describing the evolution of nonlinear waves.

Organizer: Martina Chirilus-Bruckner
Boston University, USA
Organizer: Christopher Chong
University of Massachusetts, Amherst, USA

10:00-10:25 On the Validity of the NLS Equation in Systems with Quadratic Resonances
Christopher Chong, University of Massachusetts, Amherst, USA; Guido Schneider, University of Stuttgart, Germany
10:30-10:55 Stability of Solitary waves in the KdV Limit for Fluid and Lattice Models
Robert Pego, Carnegie Mellon University, USA
11:00-11:25 Justification of the NLS Approximation for a Quasi-linear Water Wave Model
C. Eugene Wayne, Boston University, USA; Guido Schneider, University of Stuttgart, Germany

continued on next page
Wednesday, November 16

**MS61**

**Modulation Equations in Nonlinear Waves - Part I of II**
10:00 AM-12:30 PM
continued

11:30-11:55 Approximation Theorems for the Water Wave Problem in the Arc Length Formulation
*Wolf-Patrick Düll, University of Stuttgart, Germany*

12:00-12:25 A Rigorous Justification of the Modulation Approximation to the 2D Full Water Wave Problem
*Nathan Totz, Duke University, USA*

For Part 2 see MS34

Biomolecular interactions exhibit rich chemistry and physics spanning many length and time scales. A central challenge is to understand how such interactions determine the conformation, dynamics, and ultimately biological function of biomolecules. While traditional descriptions of these systems often use explicit molecular and solvent degrees of freedom, Partial Differential Equations and Stochastic Partial Differential Equations have been recently developed to allow for new approaches of analysis and computation to be employed. This minisymposium shall focus on such descriptions of some fundamental aspects of biomolecular interactions. These include the implicit solvation, electrostatic forces, anomalous diffusion, and ionic structures.

Organizer: Bo Li
*University of California, San Diego, USA*

Organizer: Paul J. Atzberger
*University of California, Santa Barbara, USA*

11:00-11:25 Composition Dynamics in Multicomponent Lipid Bilayer Membranes
*Brian A. Camley and Frank Brown, University of California, Santa Barbara, USA*

11:30-11:55 Anomalous Diffusion through Protective Biological Fluid Layers
*M. Gregory Forest, University of North Carolina at Chapel Hill, USA; Scott McKinley, University of Florida, USA; Lingxing Yao, University of Utah, USA; David Hill, University of North Carolina at Chapel Hill, USA*
### Wednesday, November 16

#### MS63

**Wave Propagation and Imaging in Complex Media - Part I of II**

*10:00 AM-12:00 PM*

*Room: Salon G*

*For Part 2 see MS91*

Wave propagation and imaging in complex media is an emerging interdisciplinary area in applied mathematics, with roots in hyperbolic partial differential equations, probability theory, statistics, optimization, and numerical analysis. This minisymposium will present some of the latest advances in this area including wave propagation with time-dependent perturbations, source and reflector imaging in random media with arrays, imaging with cross correlation techniques, and imaging methods based on spectral decompositions of the scattering operator.

**Organizer:** Knut Solna  
*University of California, Irvine, USA*

10:00-10:25 **Stability and Resolution Analysis for a Topological-derivative-based Imaging Functional in Random Media**  
Habib Ammari, Ecole Normale Superieure, France; Josselin Garnier, Université Paris VII, France; Vincent Jugnon, Ecole Polytechnique, France; Hyeonbae Kang, Inha University, Korea

10:30-10:55 **Wave Propagation in Time Dependent Randomly Layered Media**  
Liliana Borcea, Rice University, USA; Knut Solna, University of California, Irvine, USA

11:00-11:25 **Inverse Source Problem in Random Media**  
Vincent Jugnon, Ecole Normale Superieure, France

11:30-11:55 **Shock Profiles in Random Media**  
Georg Papanicolaou, Stanford University, USA; Josselin Garnier, Université Paris VII, France; Tzu-wei Yang, Stanford University, USA

#### MS64

**Dissipative PDEs and Exponential Attractors - Part II of II**

*10:00 AM-11:30 PM*

*Room: Salon H*

*For Part 1 see MS36*

It is known that the long-time behavior of solutions of dissipative PDEs can be described in terms of global attractors. However, the concept of a global attractor possesses two essential drawbacks: the rate of convergence to it may be slow and it is sensitive to perturbations. The exponential attractor, which is an intermediate object between the global attractors and inertial manifolds, overcomes these drawbacks and looks more suitable from both theoretical and applied points of view. The scope of the minisymposium is to discuss the recent progress in the theory of global and exponential attractors as well as to present a number of new applications to equations of mathematical physics.

**Organizer:** Sergey Zelik  
*University of Surrey, United Kingdom*

10:00-10:25 **Nonlinear Wave Equations with Strong Damping and Nonlinear Damping Terms**  
Varga Kalantarov, Koc University, Turkey

10:30-10:55 **Cahn–Hilliard Equations with Memory and Dynamic Boundary Conditions**  
Ciprian G. Gal, University of Missouri, USA; Cecilia Cavaterra, University of Milano, Italy; Maurizio Grasselli, Politecnico di Milano, Italy

11:00-11:25 **Long time Behavior of the Caginalp System with Singular Potentials and Dynamic Boundary Conditions**  
Laurence Cherfils, Université de la Rochelle, France; Stefania Gatti, Universita di Modena e Reggio Emilia, Italy; Alain Miranville, University of Poitiers, France

#### MS65

**Topics in Higher Order Geometric PDEs - Part III of III**

*10:00 AM-12:00 PM*

*Room: Santa Fe 3*

*For Part 2 see MS37*

Many partial differential equations arising in the study of geometric problems are elliptic and parabolic PDEs of higher order. The analysis of such equations is challenging due to the failure of techniques effectively used in the second order case to carry over to the higher order setting. We aim to present some recent developments concerning existence and qualitative properties of solutions of such geometric PDEs, bringing together some new and some experienced researchers to discuss the ramifications of recent progress and possible future developments.

**Organizer:** Anna Dall’Acqua  
*Otto-von-Guericke-Universität Magdeburg, Germany*

**Organizer:** Glen Wheeler  
*Otto-von-Guericke-Universität Magdeburg, Germany*

10:00-10:25 **Very Weakly Biharmonic Maps into Homogeneous Spaces**  
Roger Moser and Peter Hornung, University of Bath, United Kingdom

10:30-10:55 **The Gradient Flow of the L^2 Norm of the Riemannian Curvature Tensor**  
Jeff Streets, Princeton University, USA

11:00-11:25 **Area Constrained Willmore Surfaces in Riemannian Manifolds**  
Jan Metzger, Universität Potsdam, Germany

11:30-11:55 **Uniqueness for the Homogeneous Willmore Dirichlet Boundary Value Problem**  
Anna Dall’Acqua, Otto-von-Guericke-Universität Magdeburg, Germany
Wednesday, November 16

**MS66**
Analysis and Numerics for the Euler Water Wave Equations - Part I of II
10:00 AM-12:00 PM
Room: Santa Fe 4

*For Part 2 see MS94*

The Euler equations for surface water waves have been studied for well over a century. To this day, progress continues to be made, using both numerical and analytical approaches. In this session, researchers from different communities are brought together to discuss recent advances on different aspects of the water wave problem.

Organizer: Vishal Vasan
*University of Washington, USA*

Organizer: Bernard Deconinck
*University of Washington, USA*

10:00-10:25 The Water Wave Problem via Conformal Mappings
Vera Mikyoung Hur, University of Illinois at Urbana-Champaign, USA

10:30-10:55 Rotational Steady Periodic Water Waves with Stagnation Points
Walter Strauss, Brown University, USA

11:00-11:25 Regularity of Rotational Travelling Water Waves
Joachim Escher, Leibniz University Hannover, Germany

11:30-11:55 Instability of Periodic Water Waves
Zhijun Lin, Georgia Institute of Technology, USA

**MS67**
Fluid Dynamics: Deterministic and Stochastic Perspectives - Part II of II
10:00 AM-12:00 PM
Room: Sierra 5

*For Part 1 see MS39*

Fluid dynamics is a rich field of both classical and modern scientific investigation. It has numerous applications to important applications to engineering, meteorology and various other fields. Though the underlying equations are usually deterministic, a stochastic component naturally arises through intrinsic sources of noise, and turbulent instabilities. The aim of the mini-symposium is to bring together researchers working on deterministic, and stochastic PDEs with applications to fluid dynamics. The main focus is to get a better understanding of the behavior of turbulent flows and their coherent structures.

Organizer: Hakima Bessaih
*University of Wyoming, USA*

Organizer: Gautam Iyer
*Carnegie Mellon University, USA*

10:00-10:25 Boundary Effect and Turbulence
Claude Bardos, Université Pierre et Marie Curie, France

10:30-10:55 The incompressible Euler Equations as a Limit of Euler-α Models
A. Valentina Busuioc and Dragos Iftimie, Université de Lyon, France; Milton C. Lopes Filho, UNICAMP, Brazil; Helena Lopes, Universidade Estadual de Campinas, Brazil

11:00-11:25 Large Time Behavior for Vorticity Formulation of a 2-D Incompressible Flow Model
Jin Feng, University of Kansas, USA

11:30-11:55 Riesz Transforms and the Helmholtz-Hodge Decomposition -- Probabilistic Methods with Applications to the Equations of Fluid Mechanics
Enrique A. Thomann, Oregon State University, USA

**MS68**
Self-organization Phenomena and Geometric Structures of Concentration in PDEs - Part II of III
10:00 AM-12:00 PM
Room: Sierra 6

*For Part 1 see MS40*

*For Part 3 see MS96*

Geometric patterns arise in many physical and biological systems as orderly outcomes of self-organization principles. Examples are morphological phases in block copolymers, morphogeneous patterns in cell development, animal coats, and skin pigmentation. This three part mini-symposium is devoted to the study of various geometric structures observed as singular limits from solutions of partial differential equations. Known objects on which solutions of PDEs concentrate include spikes, spots, vortices, minimal and constant mean curvature surfaces, toroidal rings, etc.

Organizer: Xiaofeng Ren
*George Washington University, USA*

Organizer: Theodore Kolokolnikov
*Dalhousie University, Canada*

Organizer: Yoshihito Oshita
*Okayama University, Japan*

10:00-10:25 Concentration Behavior in Fourth Order Nonlinear Eigenvalue Problems of MEMS
Michael Ward, University of British Columbia, Canada; Alan E. Lindsay, University of Arizona, USA

10:30-10:55 Dynamics and Hopf Bifurcation in the Gierer-Meinhardt System
Kota Ikeda, Meijo University, Japan

11:00-11:25 Competition and Oscillation Instabilities in the Near-shadow Limit of Certain Reaction-diffusion Systems
Theodore Kolokolnikov, Dalhousie University, Canada

11:30-11:55 Trapped Vortices in the Large-density (Thomas-Fermi) Limit
Dmitry Pelinovsky, McMaster University, Canada
Wednesday, November 16

**MS69**

Analysis of Partial Differential Equations Arising in Fluid Dynamics - Part III of IV  
10:00 AM-12:30 PM  
Room:Cabrillo 1  
For Part 2 see MS41  
For Part 4 see MS97  
This minisymposium is focused on recent developments in the field of fluid dynamics, with emphasis on the Navier-Stokes equations, Euler equations, and related models. The issues to be discussed range from well-posedness theory, regularity, and stability issues, to the theory of turbulence.  
Organizer: Alexey Cheskidov  
University of Illinois, Chicago, USA  
Organizer: Roman Shvydkoy  
University of Illinois, Chicago, USA  
Organizer: Vlad C. Vicol  
University of Chicago, USA  
10:00-10:25 A Parabolic Approximation of Incompressible Fluid Equations  
Walter Rusin, University of Southern California, USA  
10:30-10:55 Asymptotic Behavior of a Determining Form for the 2D Navier-Stokes Equations  
Mike Jolly, Indiana University, USA  
11:00-11:25 Boundary Layer Analysis and Vanishing Viscosity Limit for Pipe Flows  
Anna Mazzucato, Pennsylvania State University, USA; Dongjuan Niu, Capital Normal University, China; Xiaoming Wang, Florida State University, USA  
11:30-11:55 Complexity of Solutions for Parabolic Equations with Gevrey Coefficients  
Igor Kukavica, University of Southern California, USA  
12:00-12:25 On Some Properties of the Navier-Stokes Equation on the Hyperbolic Space  
Chi Hin Chan, Chinese University of Hong Kong, Hong Kong; Magdalena Czubak, University of Toronto, Canada; Pawel Konieczny, University of Iowa, USA

**MS70**

Geometric Approaches for Eigenvalue and Stability Problems - Part I of II  
10:00 AM-12:00 PM  
Room:Cabrillo 2  
For Part 2 see MS98  
This session includes talks on a variety of stability and eigenvalue problems associated to structures in applied problems of linear and nonlinear partial differential equations. Applications include stability of solitary waves and related structures, periodic problems, geometric methods for stability and Evans function analysis, etc.  
Organizer: Jared Bronski  
University of Illinois at Urbana-Champaign, USA  
Organizer: Keith Promislow  
Michigan State University, USA  
10:00-10:25 Stability of Coupled Oscillators on a Graph  
Jared Bronski, University of Illinois at Urbana-Champaign, USA; R.E.L. Deville and Moon Jip Park, University of Illinois, USA  
10:30-10:55 On the Natural Frequencies of a Free/free Goupillard-type Elastic Strip  
Ani P. Velo, University of San Diego, USA; George A Gazonas, Army Research Laboratory, USA  
11:00-11:25 Title Not Available at Time of Publication  
Igor Kukavica, University of Southern California, USA  
11:30-11:55 Complexity of Solutions for Parabolic Equations with Gevrey Coefficients  
Igor Kukavica, University of Southern California, USA  
12:00-12:25 On Some Properties of the Navier-Stokes Equation on the Hyperbolic Space  
Chi Hin Chan, Chinese University of Hong Kong, Hong Kong; Magdalena Czubak, University of Toronto, Canada; Pawel Konieczny, University of Iowa, USA

**Coffee Break**  
2:45 PM-3:15 PM  
Room:Foyer

**Lunch Break**  
12:30 PM-2:00 PM  
Attendees on their own
Wednesday, November 16

**MS71**

**Calculus of Variations and Applications - Part III of III**

3:15 PM-4:45 PM

*Room: Salon A*

*For Part 2 see MS43*

The calculus of variations has been an active field of research for nearly 300 years. Today it plays a central role in partial differential equations (in particular, of nonlinear type). The main object of the proposed mini-symposium is the applications of the calculus of variations to various fields in science and engineering. We intend to bring together some experts who work on different applications, including superconductivity, image processing, optimal mass transportation, chemotaxis and others, who apply different tools from the calculus of variations. Such a meeting will hopefully lead to a fruitful exchange of ideas and methods.

**Organizer:** Gershon Wolansky  
*Technion IIT, Haifa, Israel*

**Organizer:** Itai Shafrir  
*Technion Israel Institute of Technology, Israel*

**3:15-3:40 Behavior of Ginzburg-Landau Vortices on a Surface**  
*Peter Sternberg, Indiana University, USA*

**3:45-4:10 Global Minimizers for a p-Ginzburg-Landau Energy When p goes to Infinity**  
*Itai Shafrir, Technion Israel Institute of Technology, Israel*

**4:15-4:40 A Rigorous Proof of the Maxwell-Clausius-Mossotti Formula**  
*Yaniv Almog, Louisiana State University, USA*

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**Wednesday, November 16**

**MS72**

**Singular Solutions and Phase Transitions in PDE - Part I of II**

3:15 PM-5:15 PM

*Room: Salon B*

*For Part 2 see MS99*

The mini-symposium will bring together scientists working on analytical and numerical questions arising from the modeling of condensed matter systems. The talks will focus on the study of nonlinear PDE in soft matter systems (such as chiral smectic liquid crystals and polar gels) and in superconductivity. The resolution of the theoretical challenges in this area requires a high degree of mathematical sophistication, as well as the use of formal asymptotic analysis and numerical simulations. The participants will be talented mathematicians at different stages of their careers, who will be given an opportunity to share similarities and distinctions between the various physical systems, and to compare the analytical tools available, different perspectives and methods.

**Organizer:** Tiziana Giorgi  
*New Mexico State University, USA*

**Organizer:** Lia Bronsard  
*McMaster University, Canada*

**3:15-3:40 Analysis of Chevron Patterns in Liquid Crystals by Way of Gamma Convergence**  
*Daniel Phillips and Lei Zhang, Purdue University, USA*

**3:45-4:10 Phase Separation in Diblock Copolymers**  
*Carlos Garcia-Cervera, University of California, Santa Barbara, USA*

**4:15-4:40 Dynamical Problems Arising in the Modeling of Polyelectrolyte Gels**  
*Maria-Carme Calderer, University of Minnesota, USA*

**4:45-5:10 Regularity for a Strongly Anisotropic Free Boundary Problem**  
*Vincent Millot, Université Paris VII, France*

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**Wednesday, November 16**

**MS73**

**Fluid-Structure and Flow-Structure Interactions: Modeling, Analysis and Control - Part III of III**

3:15 PM-5:45 PM

*Room: Salon C*

*For Part 2 see MS45*

This Minisymposium will focus on the PDEs which govern fluids/flows interacting with elastic structures. Such phenomena are constantly observed in the natural and man-made world: e.g., vascular blood flow immersing cellular bodies; submarines coursing through a sea; large flexible structures subjected to windstorm turbulence. The Minisymposium participants will have research interests and expertise in the Navier-Stokes Equations, mathematical control and numerical analysis of PDE dynamics (particularly those of hyperbolic or “composite” characteristics), and in modeling of complex physical processes. Questions such as well-posedness, control and stabilization of the coupled PDEs governing such interactions will constitute the focus of the symposium.

**Organizer:** Lorena Bociu  
*North Carolina State University, USA*

**Organizer:** Irena M. Lasiecka  
*University of Virginia, USA*

**Organizer:** George Avalos  
*University of Nebraska, Lincoln, USA*

**3:15-3:40 Model Development and Uncertainty Quantification for Systems with Nonlinear and Hysteretic Actuators**  
*Ralph C. Smith, North Carolina State University, USA*

**3:45-4:10 Attractor for a Non-dissipative von Karman Plate with damping in Free Boundary Conditions**  
*Daniel Toundykov, University of Nebraska-Lincoln, USA; Lorena Bociu, North Carolina State University, USA*

*continued on next page*
Wednesday, November 16

**MS73**

4:15-4:40 A Third Order PDE arising in High-Intensity Ultrasound: Structural Decomposition, Spectral Analysis, and Exponential Stability

*Roberto Triggiani*, University of Virginia, USA; *Richard Marchand*, Slippery Rock University, USA; *Timothy McDevitt*, Elizabethtown College, USA

4:45-5:10 Strong Well-posedness and Long-time Behavior of the Two-phase Navier-Stokes Equations with Surface Tension

*Mathias Wilke*, University of Halle, Germany

5:15-5:40 Arterial Blood Flow Modeling: Analysis, Computations and Applications

*Giovanna Guidoboni*, Indiana University - Purdue University Indianapolis, USA

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**MS74**
Multidimensional Conservation Laws and Related Applications - Part III of III

3:15 PM-5:15 PM

*Room: Salon D*

For Part 2 see MS46

Multidimensional conservation laws are mathematical models for fundamental processes in physics and engineering, such as high-speed flows and supersonic jets. Interesting open problems including mixed (hyperbolic-elliptic) types and free boundaries arising from multidimensional conservation laws have been studied by many researchers. Yet many problems are still remaining open and needed to be investigated further. This session will bring together analytical and numerical experts to discuss the current development in multidimensional conservation laws and related applications. The session will cover broad ranges of topics including mathematical problems for conservation laws, mixed-type problems, and various applications.

Organizer: *Eun Heui Kim*

*California State University, Long Beach, USA*

Organizer: *Chung-Min Lee*

*California State University, Long Beach, USA*

3:15-3:40 Balance Laws: Existence, Asymptotics & Singular Limits

*Konstantina Trivisa*, University of Maryland, USA

3:45-4:10 Riemann Problems for Two Dimensional Euler Systems

*Yuxi Zheng*, Yeshiva University, USA

4:15-4:40 Title Not Available at Time of Publication

*Yung-Sze Choi*, University of Connecticut, USA

4:45-5:10 Global Solutions for Transonic Self-similar Two-dimensional Riemann Problems

*Eun Heui Kim*, California State University, Long Beach, USA

3:15-3:40 Title Not Available at Time of Publication

*John Lowengrub*, University of California, Irvine, USA

3:45-4:10 Virtual Melanoma: When, Where and How Much to Cut

*Yang Kuang*, Arizona State University, USA

4:15-4:40 A Mathematical Model of Glioma Invasion

*Yangjin Kim*, University of Michigan, USA; *Avner Friedman*, Ohio State University, USA; *Sean Lawler*, University of Leeds, United Kingdom

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**MS75**
New Perspectives in Nonlinear PDEs from Mathematical Biology - Part I of II

3:15 PM-5:15 PM

*Room: Salon E*

For Part 2 see MS102

Partial differential equation is an extremely effective and powerful tool in mathematical biology. The use of partial differential equations provides deep insights into the complex nature of biology that would otherwise be difficult to capture experimentally or in a clinical setting. Active research areas in mathematical biology involving partial differential equations include, but not limited to, modeling of human vascular system, chemotaxis, wound healing, population dynamics, cancer modeling and solid tumor growth. Speakers in this mini-symposium will discuss current research progress on the modeling, analysis and numerical simulation of partial differential equations in such areas.

Organizer: *Kun Zhao*

*University of Iowa, USA*

Organizer: *Shu Dai*

*Ohio State University, USA*

3:15-3:40 Title Not Available at Time of Publication

3:45-4:10 Global Solutions for Transonic Self-similar Two-dimensional Riemann Problems

*Eun Heui Kim*, California State University, Long Beach, USA
Wednesday, November 16

**MS76**

**Mixed-Type and Free Boundary Problems - Part III of IV**

**3:15 PM-5:45 PM**

*Room:* Salon F

*For Part 2 see MS48*

*For Part 4 see MS103*

This mini-symposium is in the area of analysis of solutions to typical boundary-value problems for hyperbolic, mixed and composite type PDEs from continuum mechanics. The emphasis is on the problems involving interfaces such as shocks, moving boundaries, interfaces where equations change their type and interfaces between different phases of a continuum. The discussions will address questions of the dynamics and the geometry of interfaces as well as regularity issues. The aim of this mini-symposium is to give an opportunity for researchers from the international PDE community working in this field to get together for discussions, collaboration and dissemination of research.

**Organizer:** Mikhail Perepelitsa  
*University of Houston, USA*

**Organizer:** Suncica Canic  
*University of Houston, USA*

**Organizer:** Chen Gui-Qiang  
*University of Oxford, United Kingdom*

*3:15-3:40 Title Not Available at Time of Publication*

Emmanuele DiBenedetto, Vanderbilt University, USA

*3:45-4:10 The Two-phase Stefan Problem: Regularization near Initial Lipschitz Data*

Inwon Kim, University of California, Los Angeles, USA; Sunhi Choi, University of Arizona, USA

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**4:15-4:40 Degenerate Convection Diffusion Equations: Decay Rate and Global Regularity**

Christian Klingenberg and Ujjwal Koley, Würzburg University, Germany; Yun-Guang Lu, University of Science and Technology of China, China

*4:45-5:10 A Liouville Theorem for the Axially-symmetric Navier-Stokes Equations*

Zhen Lei, Fundan University, China; Qi Zhang, University of California, Riverside, USA

*5:15-5:40 Title Not Available at Time of Publication*

Suncica Canic, University of Houston, USA

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**Wednesday, November 16**

**MS77**

**Recent Progress on Dispersive Partial Differential Equations - Part III of III**

**3:15 PM-5:45 PM**

*Room:* Salon G

*For Part 2 see MS49*

The session will contain talks on a wide range of topics in the theory of dispersive partial differential equations. These topics include, but will not necessarily be restricted to, the following: existence of global-in-time solutions, regularity and smoothing effects, soliton and blow-up dynamics, existence of wave and scattering operators, and linear dispersive estimates on various manifolds.

**Organizer:** Nikolaos Tzirakis  
*University of Illinois at Urbana-Champaign, USA*

**Organizer:** Burak Erdogan  
*University of Illinois at Urbana-Champaign, USA*

*3:15-3:40 Nonlinear Bound States on Manifolds*

Jeremy L. Marzuola, University of North Carolina, Chapel Hill, USA

*3:45-4:10 Decay for Wave Equations on Black Hole Backgrounds*

Jason Metcalfe, University of North Carolina, Chapel Hill, USA

*4:15-4:40 Title Not Available at Time of Publication*

Xiaoyi Zhang, University of Iowa, USA

*4:45-5:10 Dynamics of Blow up Solutions to the NLS Equation*

Svetlana Roudenko, George Washington University, USA

*5:15-5:40 Scattering for the Mass-critical Nonlinear Schroedinger Equations*

Benjamin Dodson, University of California, Berkeley, USA
Wednesday, November 16
MS78
Asymptotic Methods for Heterogeneous Media - Part II of II
3:15 PM-5:15 PM
Room: Salon H
For Part 1 see MS50
The minisymposium will assess the use of asymptotic methods in analysis of models arising in composite and other heterogeneous media. In particular, issues that will be addressed but not limited to are: asymptotic analysis for singular fields, geometric aspects of averaging, inverse problems, and computational tools for complex inhomogeneous media. The purpose of this section is to enable contact between researchers working on asymptotic analysis for partial differential equations with an update on recent progress in this field.
Organizer: Yuliya Gorb
University of Houston, USA
Organizer: Alexei Novikov
Pennsylvania State University, USA
3:15-3:40 Resistor Network Approaches to the Inverse Problem of Electrical Impedance Tomography
Liliana Borcea, Rice University, USA
3:45-4:10 An Integral Equation Approach for Media with Close or Touching Inclusions
Eric Bonnetier and Faouzi Triki, Universite Joseph Fourier, France
4:15-4:40 Analysis of Some Numerical Methods in Stochastic Homogenization
Antoine Gloria, INRIA Lille-Nord Europe, France
4:45-5:10 Asymptotics of Solutions of the Random Schroedinger Equation
Lenya Ryzhik, Stanford University, USA

Wednesday, November 16
MS79
Calculus of Variations in $L^\infty$ and Aronsson Equations - Part III of III
3:15 PM-5:15 PM
Room: Santa Fe 3
For Part 2 see MS51
Recent developments in the emerging area of Calculus of Variations in $L^\infty$ have been motivated by a broad range of applications to problems where one seeks to minimize functionals represented as an essential supremum (worst case analysis) rather than the average cost. Minimization problems for supremal functionals and of the associated Aronsson equations also have extensive connections with other areas of mathematics, including optimal control, random-turn games, optimal transport, weak KAM theory, differential geometry, and degenerate elliptic PDEs associated with level set convexity. The aim of this minisymposium is to facilitate the exchange of ideas on the latest developments.
Organizer: Emmanuel Barron
Loyola University Chicago, USA
Organizer: Marian Bocea
Loyola University Chicago, USA
Organizer: Rafal Goebel
Loyola University Chicago, USA
Organizer: Robert Jensen
Loyola University Chicago, USA
3:15-3:40 Several Things Related to the Regularity of Infinity Harmonic Functions
Yifeng Yu, University of California, Irvine, USA
3:45-4:10 Fast Numerical Solvers for the Infinity Laplace Equation and Methods for Minimal Distortion Mappings in the Plane
Adam Oberman, Simon Fraser University, Canada
continued in next column
Wednesday, November 16

MS80
Nonlocal Equations: Perspectives from Probability and PDEs - Part III of III
3:15 PM-5:15 PM
Room: Santa Fe 4
For Part 2 see MS52
Integro-differential equations and jump processes have seen increased activity in recent years both in the probability and PDE communities with a long list of applications arising from models in e.g. kinetic theory, hydraulic fracturing, stochastic control, image processing, etc... The increasing abundance of these nonlocal equations arising from science provides many mathematical challenges deserving attention. We believe it will be fruitful to bring together analysts and probabilists working on very similar topics in this area for discussion and exposure of the vast amounts of recent work on the two different sides of this coin - integro-differential equations.
Organizer: Nestor Guillen
University of California, Los Angeles, USA
3:15-3:40 On the Supercritical SQG Equation
Michael G. Dabkowski, University of Toronto, Canada
3:45-4:10 Lp and Schauder Estimates for a Class of Nonlocal Elliptic Operators
Hongjie Dong, Brown University, USA; Doyoon Kim, KyungHee University, South Korea
4:15-4:40 Regularity Theory for Solutions of Fully Nonlinear Integro-differential Parabolic Equations
Hector Chang, University of Texas at Austin, USA; Gonzalo Davila, University of Texas, USA
4:45-5:10 A Rigidity Theorem for Nonlocal Mean Curvature
Nestor Guillen, University of California, Los Angeles, USA; Luis Silvestre, University of Chicago, USA

Wednesday, November 16

MS81
The Many Aspects of Fluids and Harmonic Analysis - Part III of V
3:15 PM-5:45 PM
Room: Santa Fe 4
For Part 2 see MS53
For Part 4 see MS95
This minisymposium will be dedicated to the behaviour of solutions to fluid models such as Navier-Stokes equations, Magneto-Hydrodynamics, and liquid crystals. We will look into theoretical and applied questions. We have invited a very diverse group of researchers and we expect that this will allow for exchange of research and hopefully new collaborations.
Organizer: Maria E. Schonbek
University of California, Santa Cruz, USA
Organizer: Marco Cannone
Université Paris-Est Marne-la-Vallée, France
3:15-3:40 On Local Strong Solvability of the Navier-Stokes Equation
Werner Varnhorn, University of Kassel, Germany; Reinhard Farwig, TU Darmstadt, Germany; Hermann Sohr, Universität Paderborn, Germany
3:45-4:10 Convergence to Self-similarity for the Boltzmann Equation for Strongly Inelastic Maxwell Molecules
Elide Terraneo, Università di Milano, Italy; Giulia Furioli, Universita’ degli Studi di Bergamo, Italy; Ada Pulvirenti, Università di Pavia, Italy; Giuseppe Toscani, University of Pavia, Italy
4:15-4:40 Gevrey Regularity and Decay of Sobolev Norms of the Navier-Stokes Equations
Hantaek Bae, University of Maryland, USA; Animikh Biswas, University of North Carolina, Charlotte, USA
4:45-5:10 Stokes Pressure and a Navier-Stokes Approximation
Gautam Iyer, Carnegie Mellon University, USA; Bob Pego, Carnegie Mellon University, USA; Arghir Zarnescu, University of Sussex, United Kingdom
5:15-5:40 Inverse Problems for some Structured Population Models
Jorge Zubelli, Instituto de Matemática Pura E Aplicada, Brazil

Wednesday, November 16

MS82
Mathematical Foundations of Turbulent Flows and Its Application to Geophysics - Part III of III
3:15 PM-5:45 PM
Room: Sierra 5
For Part 2 see MS54
This mini-symposium aims to cover recent important developments in the mathematics of turbulent flows, new advances in reduced dynamical modeling for flows in geophysics, and the latest techniques in numerical computation for these flows. The talks include an up-to-date overview of the basic problems in the analytical and computational studies of turbulent flows in connection to geophysical fluid dynamics, magnetohydrodynamics, and convection. Our goal is to have a better understanding of the mathematics of turbulent flows and the various physical processes that underlie them. In addition, we aim to encourage connections and communication between related areas of this research, ranging from novel analytical methods, to the latest techniques in efficient numerical simulations.
Organizer: Evelyn Lunasin
University of Michigan, USA
Organizer: Adam Larios
Texas A&M University, USA
3:15-3:40 On The Exact Laws of MHD Turbulence
Xinwei Yu, University of Alberta, Canada
3:45-4:10 Finite-Dimensional Models for Porous-Medium Convection Using a Priori Adapted Bases from Upper-Bound Theory.
NavidDiaami, and Charles R. Doering, University of Michigan, Ann Arbor, USA; Gregory Chini, University of New Hampshire, USA; Evelyn Lunasin, University of Michigan, USA; Baole Wen, University of New Hampshire, USA
continued on next page
Wednesday, November 16

**MS82**

Mathematical Foundations of Turbulent Flows and Its Application to Geophysics - Part III of III

4:15-4:40 Numerical Investigations of Infinite Prandtl Number Convection
Brandon Cloutier, University of Michigan, USA; Hans Johnston, University of Massachusetts, Amherst, USA; Peter van Keek, Benson K. Muite, Paul Rigge, and Jared Whitehead, University of Michigan, USA

4:45-5:10 Long-time Behavior of a Geostrophic Two-layer Model for Zonal Jets
Aseel Farhat, University of California, Irvine, USA; R. Lee Panetta, Texas A&M University, USA; Edriss S. Titi, University of California, Irvine, USA and Weizmann Institute of Science, Israel; Mohammed Ziane, University of Southern California, USA

5:15-5:40 A New Local Well-posedness Framework for the Prandtl Boundary Layer Equations
Vlad C. Vicol, University of Chicago, USA; Igor Kukavica, University of Southern California, USA

**Intermission**

5:45 PM-6:00 PM
MS85
Partial Differential Equations for Non-linear Processes in Porous Media - Part II of II
9:15 AM-11:45 AM
Room: Salon A
For Part 1 see MS57
This session is dedicated to analysis of the problems raised by recent advances in engineering and industry related to hydrodynamic and bio-geo-chemical processes in porous media. These processes usually exhibit non-linear properties such as specific long-time asymptotic and regularity, traveling waves, blow-up, dead zones, etc, which can be modeled by using machinery of PDEs. The goal of the mini-symposium is to discuss new results and methods for analyses of the solution of non-linear PDEs with direct or potential applications to porous media.
Organizer: Luan Hoang
Texas Tech University, USA
Organizer: Malgorzata Peszynska
Oregon State University, USA
Organizer: Akif Ibragimov
Texas Tech University, USA
9:15-9:40 Evolution Under Constraints: Fate of Methane in Subsurface
Malgorzata Peszynska, Oregon State University, USA
9:45-10:10 Stability of Fluid Structure Interaction Problem
Eugenio Aulisa, Yasemen Kaya, and Akif Ibragimov, Texas Tech University, USA
10:15-10:40 Multiscale Finite Element Methods for Fluid-structure Interaction Problems
Yuliya Gorb, University of Houston, USA
continued on next page
Thursday, November 17

**MS85**

Partial Differential Equations for Non-linear Processes in Porous Media - Part II of II

10:45-11:10 Qualitative Properties of Nonlinear Parabolic Equations: Regularity and Stabilization
Mikhail Surnachev, Moscow State University, Russia

Akif Ibragimov, Luan Hoang, Eugenio Aulisa, and Thinh Kieu, Texas Tech University, USA

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Thursday, November 17

**MS86**

Free Boundary Problems in Mathematical Fluid Dynamics

9:15 AM-11:45 AM

Room: Salon B

A free boundary problem of the Navier-Stokes equations and related equations is one of the most interesting and important topics in mathematical fluid dynamics. The progress of a theory of maximal $L^p$ regularity in recent decades enables us to treat free boundary problems not only $L^2$ setting but also $L^p$ setting. Local solvability, global solvability, asymptotic behavior, stability or instability will be discussed.

Organizer: Senjo Shimizu
Shizuoka University, Japan

9:15-9:40 On the Suitable Distance to Control a Perturbed Flow in a Domain with Free Boundary
Mariarosaria Padula, University of Ferrara, Italy

9:45-10:10 Bifurcation Theorems for Free Surface Problems
Yoshiaki Teramoto, Setsunan University, Japan

10:15-10:40 Well-posedness for the Two-phase Navier-Stokes Equations with Surface Tension and Surface Viscosity
Stefan Meyer, University of Halle, Germany

10:45-11:10 Motion of a Vortex Filament with Axial Flow in the Half Space
Masashi Aiki and Tatsuo Iguchi, Keio University, Japan

11:15-11:40 Loss of Control of Motions from Initial Data for Pending Capillary Liquid
Umberto Massari and Mariarosaria Padula, University of Ferrara, Italy; Senjo Shimizu, Shizuoka University, Japan

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Thursday, November 17

**MS87**

Analysis Issues in the Study of Liquid Crystals and Related Areas - Part IV of IV

9:15 AM-11:45 AM

Room: Salon C

For Part 3 see MS59

Liquid crystal materials have seen many important application in physical, engineering and biological sciences. The theories for various type of liquid crystals are also important to the studies of other materials, such as magnetohydrodynamics, electrorheological fluids, viscoelastic fluids, biological membranes. With the development of new mathematical techniques, in numerics and analysis, there have been increasing interest in these fields. The symposium will focus on analytical issues from the studies of liquid crystal materials and related areas. It brings together both senior and junior researchers in the fields. The topics include dynamics and configurations of defects, hydrodynamical theories, compressible liquid crystals, stability phenomena, free boundary problems. We hope the meeting will provide a survey of the field and foster new collaborations.

Organizer: Changyou Wang
University of Kentucky, USA

Organizer: Chun Liu
Pennsylvania State University, USA

9:15-9:40 Poisson-Nernst-Planck (PNP) Equations for Ion Transport
Tai-Chia Lin, National Taiwan University, Taiwan

9:45-10:10 Existence of Globally Weak Solutions to the Flow of Compressible Liquid Crystals System
Xiangao Liu, Fudan University, China

continued on next page
Thursday, November 17

**MS87**

Analysis Issues in the Study of Liquid Crystals and Related Areas - Part IV of IV

9:15 AM-11:45 AM

continued

10:15-10:40 Strong Solution of Compressible Nematic Liquid Crystal Flows
Tao Huang and Changyou Wang, University of Kentucky, USA; Huanyao Wen, South China Normal University, China

10:45-11:10 Motion of vortices in the Landau-Lifschitz-Gilbert equation
Daniel Spirn, University of Minnesota, USA; Matthias Kurzke, University of Bonn, Germany; Christof Melcher, RWTH Aachen University, Germany; Roger Moser, University of Bath, United Kingdom

11:15-11:40 On Global Solutions to Flows of Liquid Crystals
Dehua Wang, University of Pittsburgh, USA

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Thursday, November 17

**MS88**

Hyperbolic Conservation Laws and Related Topics - Part IV of IV

9:15 AM-11:15 AM

Room: Salon D

For Part 3 see MS60

The main purpose of this symposium is to bring researchers and young mathematicians together to exchange the new progress on the study of nonlinear hyperbolic conservation laws and related topics, with special emphasis on the structure of solutions, asymptotic behaviors of solutions, stability of nonlinear waves, and the related numerical computations.

Organizer: Ming Mei
McGill University, Canada

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Thursday, November 17

**MS89**

Modulation Equations in Nonlinear Waves - Part II of II

9:15 AM-11:15 AM

Room: Salon E

For Part 1 see MS61

Many problems of physical interest are on such large scales that direct numerical simulation is not possible. Modulation equations are often derived in such situations to reduce the problem to a computationally reasonable scale. Some notable examples include the Nonlinear Schrödinger (NLS) equation which describes slow modulations in time and space of an underlying carrier wave in fiber optics, or the Korteweg-de Vries (KdV) equation describing water waves in the long wave limit. It is the goal of this minisymposium to explore the most recent advances in the derivation, validity and application of modulation equations describing the evolution of nonlinear waves.

Organizer: Martina Chirilus-Bruckner
Boston University, USA

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For MS87, MS88, and MS89, the full details and abstracts of each talk are provided, including the names of the presenters and their affiliations. The focus is on the study of liquid crystals, hyperbolic conservation laws, and modulation equations in nonlinear waves, with an emphasis on the latest research and developments in these areas.
Thursday, November 17

**MS90**

**Front Propagation in Heterogeneous and Random Media**

9:15 AM-11:15 AM

Room: Salon F

Front propagation and the associated free boundary problems play an important role in many physical processes like phase transformations or combustion. This minisymposium addresses the underlying partial differential equations modeling propagation, pinning, and mixing phenomena in such systems. Both in fully deterministic models and in heterogeneous media with randomness, many fundamental mathematical questions are unresolved despite substantial interest in the macroscopic behavior of the physical systems. The speakers will present recent theoretical results on homogenization and existence and stability of standing or traveling waves. Mathematical tools used in the proofs include variational, functional-analytic, and dynamical systems techniques, as well as probability theory.

Organizer: Patrick W. Dondl

*Durham University, United Kingdom*

**For Part I see MS63**

**Cyrill B. Muratov**

*New Jersey Institute of Technology, USA*

**9:15-9:40 Front Propagation in Stratified Media: A Variational Approach**

*Cyrill B. Muratov*, New Jersey Institute of Technology, USA; *Matteo Novaga*, University of Padova, Italy

9:45-10:10 A Result on Homogenization of Fronts in Highly Heterogeneous Media

Guy Barles, University of Tours, France; *Annalisa Cesaroni* and *Matteo Novaga*, University of Padova, Italy

10:15-10:40 Stochastic Allen-Cahn Equation and Mean Curvature Flow

*Hendrik Weber*, University of Warwick, United Kingdom; *Matthias Rüger*, TU Dortmund, Germany

10:45-11:10 Pinning and Depinning of Interfaces in Random Media

*Patrick W. Dondl*, Durham University, United Kingdom; *Michael Scheutzow*, Technical University Berlin, Germany; *Nicolas Dirr*, Cardiff University, United Kingdom

**MS91**

**Wave Propagation and Imaging in Complex Media - Part II of II**

9:15 AM-11:15 AM

Room: Salon G

For Part I see MS63

Wave propagation and imaging in complex media is an emerging interdisciplinary area in applied mathematics, with roots in hyperbolic partial differential equations, probability theory, statistics, optimization, and numerical analysis. This minisymposium will present some of the latest advances in this area including wave propagation with time-dependent perturbations, source and reflector imaging in random media with arrays, imaging with cross correlation techniques, and imaging methods based on spectral decompositions of the scattering operator.

Organizer: *Knut Solna*

*University of California, Irvine, USA*

Organizer: *Josselin Garnier*

*Université Paris VII, France*

9:15-9:40 Scattering and Estimation from Cross Correlations

*Knut Solna*, University of California, Irvine, USA; *Josselin Garnier*, Université Paris VII, France; *Maarten de Hoop*, Purdue University, USA

9:45-10:10 Title Not Available at Time of Publication

*Maarten de Hoop*, Purdue University, USA

10:15-10:40 Passive Sensor Imaging using Cross-correlations of Noisy Signals

*Chrysoula Tsogka* and *Adrien Semin*, University of Crete, Greece; *George Papanicolaou*, Stanford University, USA; *Josselin Garnier*, Université Paris VII, France

10:45-11:10 Thermoacoustic and Photoacoustic Tomography

*Guenterer Uhlmann*, University of Washington, USA

**MS92**

**Non-standard Modeling of Incompressible Flows via Navier-Stokes Equations**

9:15 AM-11:15 AM

Room: Salon H

Simulation of incompressible flows for industrial or environmental applications is a major challenge because of the lack of knowledge about the models deduced from the Navier-Stokes equations and mathematical tools to study them. The topic was intensively studied for many decades, through either functional or numerical analysis. This symposium aims to consider those both aspects. We bring material in numerical analysis, especially in studying finite element methods applied to fluid motion in various situations, and we consider some flow models, for which we prove existence and uniqueness of solution and we make some asymptotic analysis.

Organizer: *Roger Lewandowski*

*Université Rennes 1, France*

9:15-9:40 Finite Element Discretization of the Navier-Stokes Equations with Mixed Boundary Conditions

*Christine Bernardi*, Université Paris VI, France

9:45-10:10 Stabilized Finite Element Solvers of Incompressible Flow Equations: Modeling of Stabilization Coefficients via Kinetic Energy

*Tomas L. Chacon Rebollo*, University of Sevilla, Spain

10:15-10:40 Asymptotic Analysis of the Approximate Deconvolution Models to the Mean Navier Stokes Equations

*Roger Lewandowski*, Université Rennes 1, France; *Luigi C. Berselli*, Universita di Pisa, Italy

10:45-11:10 On Large Data Analysis of Kolmogorov’s Two Equation Model of Turbulence

*Josef Malek*, Charles University, Prague, Czech Republic
**Thursday, November 17**

**MS93**

**High Order Mimetic Differential Operators**

9:15 AM-11:15 AM  
Room: Santa Fe 3

We will present advancements on the theory and application of High Order Mimetic Difference Operators. The main goal of this research is to construct local high order difference approximations of differential operators on nonuniform grids that mimic the properties of the continuum operators. Partial differential equations solved with these mimetic difference approximations often automatically satisfy discrete versions of conservation laws and analogies to stoke’s theorem that are true in the continuum and as a consequence are more likely to produce physically faithful results.

Organizer: José E. Castillo  
San Diego State University, USA

9:15-9:40 A Mimetic Scheme to Solve Poisson’s Equation in a 3-d Curvilinear Mesh  
Mohammad Abouali, San Diego State University, USA

9:45-10:10 A Numerical Study of a Mimetic Scheme for the Unsteady Heat Equation  
Yamilet Quintana, Universidad Simon Bolivar, Venezuela; Juan Guevara and Iliana Mannarino, Universidad Central de Venezuela, Venezuela

10:15-10:40 A Mimetic Difference Method for Maxwell Equations on a Non-uniform Logically Rectangular Mesh  
Antonio Nicola Di Teodoro, Universidad Simon Bolivar, Venezuela

10:45-11:10 A Distributed Mimetic Approach to Simulating Water-rock Interaction Following CO2 Injection in Sedimentary Basins  
Eduardo Sanchez and Chris Paolini, San Diego State University, USA; Anthony Park, Sienna Geodynamics and Consulting, Inc, USA; José E. Castillo, San Diego State University, USA

**Thursday, November 17**

**MS94**

**Analysis and Numerics for the Euler Water Wave Equations - Part II of II**

9:15 AM-11:15 AM  
Room: Santa Fe 4

For Part 1 see MS66

The Euler equations for surface water waves have been studied for well over a century. To this day, progress continues to be made, using both numerical and analytical approaches. In this session, researchers from different communities are brought together to discuss recent advances on different aspects of the water wave problem.

Organizer: Vishal Vasan  
University of Washington, USA

Organizer: Bernard Deconinck  
University of Washington, USA

9:15-9:40 Inverse Problems in the Theory of Water Waves  
Vishal Vasan, University of Washington, USA

9:45-10:10 Experiments on Water Waves in Finite, Variable Depth  
Diane Henderson, Pennsylvania State University, USA; Saziye Bayram, SUNY College at Buffalo, USA

David P. Nicholls and Ben Akers, University of Illinois, Chicago, USA

10:45-11:10 Water Waves: Reconstructing the Surface Elevation from Pressure Data  
Katie Oliveras, Seattle University, USA

11:15-11:40 Bifurcation and Resonance in Standing Water Waves  
Jon Wilkening, University of California, Berkeley, USA; Chris Rycroft, Lawrence Berkeley National Laboratory, USA

**Thursday, November 17**

**MS95**

**The Many Aspects of Fluids and Harmonic Analysis - Part IV of V**

9:15 AM-11:15 AM  
Room: Sierra 5

For Part 3 see MS81  
For Part 5 see MS107

This minisymposium will be dedicated to the behaviour of solutions to fluid models such as Navier-Stokes equations, Magneto-Hydrodynamics, and liquid crystals. We will look into theoretical and applied questions. We have invited a very diverse group of researchers and we expect that this will allow for exchange of research and hopefully new collaborations.

Organizer: Maria E. Schonbek  
University of California, Santa Cruz, USA

Organizer: Marco Cannone  
Université Paris-Est Marne-la-Vallée, France

9:15-9:40 Asymptotic Behavior for the Aggregation Equation with Diffusion  
Jose A. Cañizo and José Carrillo, Universitat Autònoma de Barcelona, Spain; Maria E. Schonbek, University of California, Santa Cruz, USA

9:45-10:10 Construction of Almost Sharp Fronts for the Surface Quasi-geostrophic Equation  
Jose Luis Rodrigo, Warwick University, United Kingdom
Thursday, November 17
MS96
Self-organization Phenomena and Geometric Structures of Concentration in PDEs - Part III of III
9:15 AM-11:45 AM
Room:Sierra 6
For Part 2 see MS68
Geometric patterns arise in many physical and biological systems as orderly outcomes of self-organization principles. Examples are morphological phases in block copolymers, morphogeneous patterns in cell development, animal coats, and skin pigmentation. This three part mini-symposium is devoted to the study of various geometric structures observed as singular limits from solutions of partial differential equations. Known objects on which solutions of PDEs concentrate include spikes, spots, vortices, minimal and constant mean curvature surfaces, toroidal rings, etc.
Organizer: Xiaofeng Ren
George Washington University, USA
Organizer: Theodore Kolokolnikov
Dalhousie University, Canada
Organizer: Yoshihito Oshita
Okayama University, Japan
9:15-9:40 Existence of Multiple Spike Stationary Patterns in a Chemotaxis Model with Weak Saturation
Kazuhiro Kurata, Tokyo Metropolitan University, Japan
9:45-10:10 Delay Gierer-Meinhard Systems in the Self-organisation of Cells
S. Seirin Lee, RIKEN, Japan; Eamonn Gaffney, University of Oxford, United Kingdom
10:15-10:40 Singularly Perturbed Nonlinear Neumann Problems under Optimal Conditions for the Nonlinearity
Youngae Lee and Jaeyoung Byeon, POSTECH, Korea
continued in next column

Thursday, November 17
MS97
Analysis of Partial Differential Equations Arising in Fluid Dynamics - Part IV of IV
9:15 AM-11:45 AM
Room:Cabrillo 1
For Part 3 see MS69
This minisymposium is focused on recent developments in the field of fluid dynamics, with emphasis on the Navier-Stokes equations, Euler equations, and related models. The issues to be discussed range from well-posedness theory, regularity, and stability issues, to the theory of turbulence.
Organizer: Alexey Cheskidov
University of Illinois, Chicago, USA
Organizer: Roman Shvydkoy
University of Illinois, Chicago, USA
Organizer: Vlad C. Vicol
University of Chicago, USA
9:15-9:40 Nonlinear Maximum Principles for Linear Nonlocal Operators and Applications
Peter Constantin and Vlad C. Vicol, University of Chicago, USA
9:45-10:10 Optimal Stirring for Passive Scalar Mixing
Charles R. Doering, University of Michigan, Ann Arbor, USA
10:15-10:40 Geodesic Equations on the Contactomorphism Group
Stephen Preston, University of Colorado at Boulder, USA; David Ebin, Stony Brook University, USA
10:45-11:10 Bounds on Heat Transport for Fixed Flux Thermal Boundary Conditions at Infinite Prandtl Number
Jared Whitehead, and Charles R. Doering, University of Michigan, Ann Arbor, USA
11:15-11:40 Oscillations of Solutions to the Navier-Stokes Equations
Mohammed Ziane, University of Southern California, USA
Thursday, November 17

**MS98**

**Geometric Approaches for Eigenvalue and Stability Problems - Part II of II**

9:15 AM - 11:45 AM

Room: Cabrillo 2

For Part 1 see MS70

This session includes talks on a variety of stability and eigenvalue problems associated to structures in applied problems of linear and nonlinear partial differential equations. Applications include stability of solitary waves and related structures, periodic problems, geometric methods for stability and Evans function analysis, etc.

Organizer: Jared Bronski, University of Illinois at Urbana-Champaign, USA

Organizer: Keith Promislow, Michigan State University, USA

9:15 - 9:40 The Stability of Pulses in Singularly Perturbed Reaction-Diffusion Equations

Arjen Doelman, Leiden University, Netherlands

9:45 - 10:10 Nonlinear Modulational Stability of Periodic Traveling Waves in a Generalized Kuramoto-Sivashinsky Equation

Mat Johnson, University of Kansas, USA

10:15 - 10:40 Structured Interfaces and Network Formation in the Functionalized Cahn-Hilliard Equation

Keith Promislow, Michigan State University, USA

10:45 - 11:10 Homoclinic Solutions as Critical Points of Functionalized Energies

Yang Li, Michigan State University, USA

11:15 - 11:40 On the Modulational Instability for the Benjamin-Ono Equation

Vera Hur, University of Illinois, USA

**Coffee Break**

2:00 PM - 2:30 PM

Room: Foyer

Lunch Break

11:45 AM - 1:15 PM

Attendees on their own

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**IP8**

**Landau Damping and Macroscopic Irreversibility for Plasmas and Galaxies**

1:15 PM - 2:00 PM

Room: Salon DE

Chair: Konstantina Trivisa, University of Maryland, USA

Landau damping is a fundamental collisionless stability phenomenon in plasma physics, as well as in galactic dynamics. Roughly speaking, it says that spatial waves are damped in time (very rapidly) by purely conservative mechanisms, on a time scale much lower than the effect of collisions. These evolution systems are described mathematically by the Vlasov-Poisson equations. These nonlinear partial differential equations are reversible in time; they describe the transport of particles through their mean-field interactions. We shall present a joint work with C. Villani which provides the first positive mathematical result for this damping effect in the nonlinear regime. We shall also discuss a general overview of this question and comment on its link with microscopic reversibility, macroscopic irreversibility and entropy.

Clément Mouhot, University of Cambridge, United Kingdom

**MS99**

**Singular Solutions and Phase Transitions in PDE - Part II of II**

2:30 PM - 4:30 PM

Room: Salon B

For Part 1 see MS72

The mini-symposium will bring together scientists working on analytical and numerical questions arising from the modeling of condensed matter systems. The talks will focus on the study of nonlinear PDE in soft matter systems (such as chiral smectic liquid crystals and polar gels) and in superconductivity. The resolution of the theoretical challenges in this area requires a high degree of mathematical sophistication, as well as the use of formal asymptotic analysis and numerical simulations. The participants will be talented mathematicians at different stages of their careers, who will be given an opportunity to share similarities and distinctions between the various physical systems, and to compare the analytical tools available, different perspectives and methods.

Organizer: Tiziana Giorgi, New Mexico State University, USA

Organizer: Lia Bronsard, McMaster University, Canada

2:30 - 2:55 Gamma Convergence of Lawrence-Doniach Energies

Patricia Baum and Chunyan Yuan, Purdue University, USA

3:00 - 3:25 Decay Rates in the Cahn-Hilliard Equation

Maria G. Westdickenberg, Georgia Institute of Technology, USA

3:30 - 3:55 Critical Phenomena in Keller-Segel Equations for Chemotaxis and Related Particle Models

Ibrahim Fatkullin, University of Arizona, USA

4:00 - 4:25 Bifurcation Theory of Layer Undulations in Smectic A Liquid Crystals

Sookyung Joo, Old Dominion University, USA
Thursday, November 17

**MS100**

**Wrinkling of Elastic Thin Films**

2:30 PM-4:30 PM

*Room: Salon A*

This symposium will bring together researchers from both the math and physics community interested in wrinkling of thin elastic films. There are many examples of thin sheets developing a fine scale structure (e.g., wrinkles) caused by specific boundary conditions or prescribed non-Euclidean metric. The main goal is to understand this behavior and show some properties of solutions.

Organizer: Peter Bella  
New York University, USA

Organizer: Robert V. Kohn  
Courant Institute of Mathematical Sciences, New York University, USA

2:30-2:55 Wrinkles as a Relaxation of Compressive Stresses in Annular Thin Films  
Peter Bella, New York University, USA; Robert V. Kohn, Courant Institute of Mathematical Sciences, New York University, USA

3:00-3:25 The Matching Property of Infinitesimal Isometries for Developable Shells  
Marta Lewicka, University of Pittsburgh, USA

3:30-3:55 Wrinkling of a Floating Elastic Thin Film  
Hoai-Minh Nguyen, Courant Institute of Mathematical Sciences, New York University, USA

4:00-4:25 The Lamé Problem: A Prototypical Model for Wrinkling of Thin Sheets  
Benny Davidovitch, University of Massachusetts, Amherst, USA

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Thursday, November 17

**MS101**

**Structured Population Dynamics in Life Sciences**

2:30 PM-4:30 PM

*Room: Salon D*

Structured population dynamics models allow important and relevant enrichment of simple population models. Instead of being represented by a number, the population is represented by a density $n(t,x)$, where $x$ is the structuring variable that drives the dynamics (e.g., age, size, ...). Ordinary differential equations are the turned into partial differential equations, with possibly (often) integral terms. We present here a few recent contributions to this very rich field, dedicated to applications in life sciences. A specific attention is devoted to asymptotic behaviour.

Organizer: Thomas Lepoutre  
INRIA, France

2:30-2:55 Age-structured Division Equations: Unexpected Asymptotics  
Thomas Lepoutre, INRIA, France

3:00-3:25 Structured Population Models of Cell Differentiation and Tissue Regeneration  
Anna Marciniak-Czochra, University of Heidelberg, Germany

3:30-3:55 Size-Structured Populations with Distributed States at Birth  
Peter Hinow, University of Wisconsin, Milwaukee, USA

4:00-4:25 Long-Time Behavior for Nonlinear Size-Structured Population Models  
Pierre Gabriel, UPMC, France; Vincent Calvez, Ecole Normale Superieure de Lyon, France; Marie Douamic, INRIA Rocquencourt, France

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Thursday, November 17

**MS102**

**New Perspectives in Nonlinear PDEs from Mathematical Biology - Part II of II**

2:30 PM-4:30 PM

*Room: Salon E*

For Part 1 see MS75

Partial differential equation is an extremely effective and powerful tool in mathematical biology. The use of partial differential equations provides deep insights into the complex nature of biology that would otherwise be difficult to capture experimentally or in a clinical setting. Active research areas in mathematical biology involving partial differential equations include, but not limited to, modeling of human vascular system, chemotaxis, wound healing, population dynamics, cancer modeling and solid tumor growth. Speakers in this mini-symposium will discuss current research progress on the modeling, analysis and numerical simulation of partial differential equations in such areas.

Organizer: Kun Zhao  
University of Iowa, USA

Organizer: Shu Dai  
Ohio State University, USA

2:30-2:55 Spiky and Transition Layer Steady States of Chemotaxis Systems via Global Bifurcation and Helly’s Compactness Theorem  
Xuefeng Wang, Tulane University, USA

3:00-3:25 Folds, Canards and Shocks in Advection-reaction-diffusion Models  
Martin Wechselberger, University of Sydney, Australia; Graeme Pettet, Queensland University of Technology, Australia

3:30-3:55 Dynamics of the Visual Cortex -- The Challenges Facing Population-dynamics Models  
Aadipta Rangan, Courant Institute of Mathematical Sciences, New York University, USA

4:00-4:25 Dynamics in a Modulation Equation for Alternans in a Cardiac Fiber  
Shu Dai, Ohio State University, USA; David G. Schaeffer, Duke University, USA
Thursday, November 17

**MS103**

Mixed-Type and Free Boundary Problems - Part IV of IV

2:30 PM-4:30 PM

*Room: Salon F*

For Part 3 see MS76
This mini-symposium is in the area of analysis of solutions to typical boundary-value problems for hyperbolic, mixed and composite type PDEs from continuum mechanics. The emphasis is on the problems involving interfaces such as shocks, moving boundaries, interfaces where equations change their type and interfaces between different phases of a continuum. The discussions will address questions of the dynamics and the geometry of interfaces as well as regularity issues. The aim of this mini-symposium is to give an opportunity for researchers from the international PDE community working in this field to get together for discussions, collaboration and dissemination of research.

Organizer: Mikhail Perepelitsa
*University of Houston, USA*

Organizer: Suncica Canic
*University of Houston, USA*

Organizer: Chen Gui-Qiang
*University of Oxford, United Kingdom*

2:30-2:55 Global Low Regularity Solutions of Quasi-linear Wave Equations
Yi Zhou, Fundan University, China

3:00-3:25 Incompressible Euler Equation from a Lagrangian Point of View and Unstable Manifolds
Chongchun Zeng, Georgia Institute of Technology, USA

3:30-3:55 Time-Periodic Solutions for the Euler Equations
Robin Young, University of Massachusetts, Amherst, USA

4:00-4:25 Well-posedness for Two-dimensional Steady Supersonic Euler Flows Past Lipschitz Walls
Vaibhav Kukreja, Northwestern University, USA

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**Thursday, November 17**

**MS104**

Well-posedness of the Navier-Stokes Equations

2:30 PM-4:00 PM

*Room: Salon G*

The problem on both well and ill-posedness of the Navier-Stokes equations is discussed from a viewpoint of techniques of functional and harmonic analysis. The $H^s$ calculus has been intensively developed to analyze the linearized equations, while it turns out that the various spaces such as Besov, Triebel-Lizorkin and Modulation spaces play an essential role in investigating ill-posedness.

Organizer: Hideo Kozono
*Tohoku University, Japan*

2:30-2:55 Global and Almost Global Solutions for the Navier-Stokes Equations in Besov Spaces and Triebel-Lizorkin
Tsukasa Iwabuchi, Tohoku University, Japan

3:00-3:25 Weak Neumann Implies Stokes
Matthias Geissert, TU Darmstadt, Germany

3:30-3:55 Long time Solvability of Equations in Geophysical Fluid Dynamics
Tsuyoshi Yoneda, Hokkaido University, Japan

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**Thursday, November 17**

**MS105**

Inverse Problems for Density Estimation and Medical Imaging

2:30 PM-4:30 PM

*Room: Salon H*

Inverse problems related to density estimation and medical imaging have important practical applications. One of the main tasks typically consists in obtaining relevant “real” information about an image starting with imperfect collected data. This can take the form of inferring a “true” density distribution from the given data or of extracting relevant and interesting features from medical images. The minisymposium will showcase the ability of variational and PDE based methods to perform such tasks and provide analytical insight into their inner workings.

Organizer: Yunho Kim
*University of California, Irvine, USA*

Organizer: Patrick Guidotti
*University of California, Irvine, USA*

2:30-2:55 Image Enhancement via Forward-backward Diffusion
Yunho Kim and Patrick Guidotti, University of California, Irvine, USA

3:00-3:25 Variational and Wavelet Frame Based Models for Medical Imaging and Image Analysis
Bin Dong, University of Arizona, USA

3:30-3:55 A Ridge and Corner Preserving Model for Surface Restoration
Rongjie Lai, University of Southern California, USA; Xue-Cheng Tai, University of Bergen, Norway; Tony Chan, Hong Kong University of Science and Technology, Hong Kong

4:00-4:25 Combining Event Data and Spatial Images in Variational Approaches to Density Estimation
Laura M. Smith, Matthew Keegan, and Todd Wittman, University of California, Los Angeles, USA; George Mohler, Santa Clara University, USA; Andrea L. Bertozzi, University of California, Los Angeles, USA
Thursday, November 17

**MS106**

**Integrable Quadratic Systems**

2:30 PM-5:00 PM

**Room:** Santa Fe 3

Recently several nonautonomous (with time-dependent coefficients) and inhomogeneous (with space-dependent coefficients) nonlinear Schrödinger equations have been discussed as (possible) new integrable systems. They arise in the theory of Bose--Einstein condensation, fiber optics and plasma physics. These systems can be reduced by a set of transformations to the standard autonomous nonlinear Schrödinger equation, which explains their integrability properties because this equation is a well-known complete integrable system with Lax-Zakhrov-Shabat pair, conservation laws and N-soliton solutions, solvable through the inverse scattering method. Our goal is to discuss these and related linear systems and some of their applications.

Organizer: Sergei K. Suslov

*Arizona State University, USA*

**2:30-2:55** On Integrability of Nonautonomous Nonlinear Schrödinger Equations

Sergei K. Suslov, *Arizona State University, USA*

**3:00-3:25** Soliton-like Solutions for Nonlinear Schrödinger Equation with Variable Quadratic Hamiltonians

Erwin Suazo, *University of Puerto Rico, Mayaguez, Puerto Rico*

**3:30-3:55** Exact Wave Functions for Generalized Harmonic Oscillators

Raquel Lopez, *Arizona State University, USA*

**4:00-4:25** The Riccati System and Diffusion-type Equations

Jose M. Vega-Guzman, *Arizona State University, USA*

**4:30-4:55** Quadratic systems and Airy functions

Nathan Lanfear, *Arizona State University, USA*

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**MS107**

**The Many Aspects of Fluids and Harmonic Analysis - Part V of V**

2:30 PM-4:00 PM

**Room:** Sierra 6

For Part 4 see MS95

This minisymposium will be dedicated to the behaviour of solutions to fluid models such as Navier-Stokes equations, Magneto-Hydrodynamics, liquid crystals. We will look into theoretical and applied questions. We have invited a very diverse group of researchers and we expect that this will allow for exchange of research and hopefully new collaborations.

Organizer: Maria E. Schonbek

*University of California, Santa Cruz, USA*

**2:30-2:55 Title Not Available at Time of Publication**

Tomas Schonbek, *Florida Atlantic University, USA*

**3:00-3:25** The Grazing Collision Limit of the Inelastic Kac Model

Giulia Furioli, Universita’ degli Studi di Bergamo, Italy; Ada Pulvirenti, Università di Pavia, Italy; Elide Terraneo, Universita di Milano, Italy; Giuseppe Toscani, University of Pavia, Italy

**3:30-3:55** On the Doi Model for the Suspension of Rod-Like Molecules

Konstantina Trivisa and Hantaek Bae, *University of Maryland, USA*

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**MS108**

**Advances in Geophysical Flows**

2:30 PM-4:30 PM

**Room:** Sierra 6

The purpose of the minisymposium is to present recent advances in the mathematical analysis and simulation of flows in the earth, the ocean, and the atmosphere. In particular, the minisymposium will concentrate on the primitive equations for the ocean, the surface quasi-geostrophic equation, modeling the evolution of surface potential temperature in quasi-geostrophic models, data assimilation in weather forecasting, in particular bred vectors, and the equations for slightly compressible fluids in porous media.

Organizer: Anna Mazzucato

*Pennsylvania State University, USA*

Organizer: George Sell

*University of Minnesota, USA*

Organizer: Nusret Balci

*University of Minnesota, USA*

**2:30-2:55** The EBV algorithm: Now, Deal with Uncertainty!

Nusret Balci, *University of Minnesota, USA*

**3:00-3:25** Deterministic and Stochastic Dynamics of the Primitive Equations

Mohammed Ziane, *University of Southern California, USA*

**3:30-3:55** Navier--Stokes Equations in Thin Two-layer Domains with Non-flat Boundaries

Luan Hoang, *Texas Tech University, USA*

**4:00-4:25** Global Well-posedness of a 3D Stratified Reduced Rayleigh--Bénard Convection Model

Chongsheng Cao, *Florida International University, USA*; Aseel Farhat and Edriss S. Titi, *University of California, Irvine, USA*
### Thursday, November 17

#### MS109
**Turbulence and Statistical Solutions in Incompressible Flows - Part II of II**

*2:30 PM-4:30 PM*

*Room: Cabrillo 1*

**For Part 1 see MS83**

This minisymposium is expected to cover the mathematical aspects of turbulent flows in general, the analysis of weak and strong solutions of the Navier-Stokes and other fluid flow equations in view of their connection to turbulence, and theoretical and applied properties of statistical solutions of fluid flow equations.

**Organizer:** Ricardo Rosa  
*Universidade Federal do Rio De Janeiro, Brazil*

**Organizer:** Animikh Biswas  
*University of North Carolina, Charlotte, USA*

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<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
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<tbody>
<tr>
<td>2:30-2:55</td>
<td>Analyticity and Turbulence in Fluids</td>
<td>Animikh Biswas</td>
<td>University of North Carolina, Charlotte, USA</td>
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<tr>
<td>3:00-3:25</td>
<td>Casimir Cascades in Two-Dimensional Turbulence</td>
<td>John C. Bowman</td>
<td>University of Alberta, Canada</td>
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<tr>
<td>3:30-3:55</td>
<td>Ultimate State of Two-Dimensional Rayleigh-Bénard Convection Between Free-Slip Fixed-Temperature Boundaries</td>
<td>Charles R. Doering</td>
<td>University of Michigan, Ann Arbor, USA; Jared Whitehead, University of Michigan, USA</td>
</tr>
<tr>
<td>4:00-4:25</td>
<td>An Efficient 2nd Order Scheme for Long Time Statistical Properties of the 2D NSE</td>
<td>Xiaoming Wang</td>
<td>Florida State University, USA</td>
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#### MS110
**Stability and Qualitative Properties of Viscous Flows**

*2:30 PM-4:30 PM*

*Room: Cabrillo 2*

This minisymposium addresses questions related to stability and qualitative properties of viscous incompressible flows in some unbounded domains. Specifically, domains exterior to translating/rotating obstacles and domains with unbounded boundaries such as aperture domains are important in applications. Asymptotic structure at infinity of the flow is of particular interest since it could depend on the motion of the obstacles and on the geometry of the boundaries.

**Organizer:** Toshiaki Hishida  
*Nagoya University, Japan*

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<tr>
<td>2:30-2:55</td>
<td>Stability and Asymptotic Structure of Steady Navier-Stokes Flows in Exterior and Aperture Domains</td>
<td>Toshiaki Hishida</td>
<td>Nagoya University, Japan</td>
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<tr>
<td>3:00-3:25</td>
<td>Asymptotic Structure of Steady Navier-Stokes Flows Past and Around a Rotating Body</td>
<td>Mads Kyed</td>
<td>TU Darmstadt, Germany</td>
</tr>
<tr>
<td>3:30-3:55</td>
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<td>Florida State University, USA</td>
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Abstracts are printed as submitted by the author.
IP1

Nonconvex Hamilton-Jacobi Equations

The Crandall–Lions theory of viscosity solutions provides existence and uniqueness theory for appropriate weak solutions Hamilton–Jacobi type PDE, but does not for nonconvex Hamiltonians directly provide much information about the structure of solutions, their possible singularities, etc. I will report on some recent work on nonconvex Hamilton–Jacobi equations, explaining how to apply geometric insights, compensated compactness tricks and game theoretic methods to such PDE. I will in particular revisit some examples from the great book of Isaacs on differential games.

Celine Grandmont
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IP2

Title Not Available at Time of Publication

Abstract not available at time of publication.

Jalal Shatah
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IP3

Nonlocal Evolution Equations

Nonlocal evolution equations have been around for a long time, but in recent years there have been some nice new developments. The presence of nonlocal terms might originate from modeling physical, biological or social phenomena (incompressibility, Ekman pumping, chemotaxis, micro-micro interactions in complex fluids, collective behavior in social aggregation) or simply from inverting local operators in the analysis of systems of PDE. I will present some regularity results for hydrodynamic models with singular constitutive laws. I will also present a nonlinear maximum principle for linear nonlocal dissipative operators and some applications.

Peter Constantin
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IP4

Mathematical and Numerical Modelling of the Respiratory System

The respiratory system is a complex multiphysics and multiscale system. Indeed, breathing involves gas transport through the respiratory tract: the inhaled air is convected in the fractal bronchial tree which ends in the alveoli embedded in a viscoelastic tissue, made of blood capillaries, and where gaseous exchange occurs. Inhaled air contains dust and debris or curative aerosols. In this talk we present some mathematical and numerical modeling issues related to this system. Many questions may be addressed, such as the wellposedness of the problems, the design of accurate numerical algorithms, the performing of efficient computational simulations as well as the validation of the model by comparison to experimental results or clinical data.

Celine Grandmont

IP5

Energetic Variational Approaches in Complex Fluids

In the spirit of the seminal works of Rayleigh and Onsager, we employ a general framework involving various energetic variational approaches, in particular, the least action principle (LAP) and the maximum dissipation principle (MDP), to study a wide class of different complex fluids. The framework focus on the couplings between different parts of the system that are the consequences of different physics from different scales. I will illustrate the approaches with polymeric fluids and ionic fluids. I will present our recent results as well as difficulties in modeling, numerical simulations and analysis related to the study of these materials.

Chun Liu
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IP6

Rough Stochastic PDEs

There are several natural situations giving raise to stochastic PDEs with solutions that are so “rough” that their nonlinearity cannot be defined classically. However, in some typical cases, the situation is very close to “borderline”. One classical example of such a “borderline” situation is the case of ordinary stochastic differential equations. There, the stochastic integral is “almost well-posed” in the sense that, if Brownian motion had sample paths that are α-Hölder continuous for every α > 1/2, one could use classical Riemann-Stieltjes integration and there would be little need for a stochastic calculus. Unfortunately, Brownian motion is only α-Hölder continuous for every α < 1/2. We will explore two examples of stochastic PDEs where a similar situation arises, but due this time to the lack of spatial regularity. In particular, we will provide a solution theory that still allows to make sense of solutions to these equations and to obtain sharp regularity result.

Martin Hairer
The University of Warwick
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IP7

h-principle and Fluid Dynamics

There are nontrivial solutions of the incompressible Euler equations which are compactly supported in space and time. If they were to model the motion of a real fluid, we would see it suddenly start moving after staying at rest for a while, without any action by an external force. There are C^1 isometric embeddings of a fixed flat rectangle in arbitrarily small balls of the threedimensional space. You should therefore be able to put a fairly large piece of paper in a pocket of your jacket without folding it or crumpling it. I will discuss the corresponding mathematical theorems, point out some surprising relations and give evidences that, maybe, they are not merely a mathematical game.

Camillo De Lellis
Institut für Mathematik
Universität Zurich, Switzerland
Based Solution of the Laplace Equation

Our work is concerned with the development of a generic high-performance library for scientific computing. The library is targeted for assembling flexible-order finite-difference solvers for PDEs. Our goal is to enable fast solution of large PDE systems, fully exploiting the massively parallel architecture of Graphics Processing Units. We will detail a strategy for an iterative mixed-precision p-multigrid solver of the Laplace equation, which appears as a computational bottleneck in applications in coastal and offshore engineering.

Stefan L. Glimberg, Allan P. Engsig-Karup
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CP1
A Finite Element Algorithm for Inverse Sturm-Liouville Problems Using Least Squares Formulation

Inverse problems arise in many areas of science and mathematics, including geophysics, astronomy, tomography and medical biology. Inverse Sturm-Liouville problems (SLP) is a branch of inverse problems that has applications in most of these areas, and our motivation for studying such problems comes from an application in biomechanics, particularly in estimating material parameters for soft tissues. We propose a constructive numerical algorithm based on finite element methods to recover the potential of a SLP using least squares formulation.

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Abner J. Salgado
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CP1
Iterative Schemes for Bump Solutions in a Neural Field Model

We develop two iteration schemes for construction of localized stationary solutions (bumps) of a one-population Wilson-Cowan model with a smoothed Heaviside firing rate function. The first scheme is based on the fixed point formulation of the stationary Wilson-Cowan model. The second one is formulated in terms of the excitation width of a bump. Using the theory of monotone operators in ordered Banach spaces we justify convergence of both iteration schemes.

Arcady Ponomov, Anna Oleynik, John Wyller
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CP2
NLSEmagic: A High-Order Multidimensional GPU-Accelerated Code Package for Simulating the Nonlinear Schrödinger Equation

We present a powerful, simple to use, package named NLSEmagic to integrate nonlinear Schrödinger equations
in multiple dimensions. NLSEmagic relies on high-order compact finite-difference schemes implemented for graphic processing unit (GPU) parallel architectures. These freely distributable codes are many times faster than their serial counterparts, and are much cheaper than standard parallel clusters. With usability and portability in mind, the GPU-enabled C codes are implemented to directly interface with MATLAB.

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CP2
Implementing the Finite Volume Method on a Rectangular Collocated Grid

We formulate an algorithm to solve steady-state, laminar and incompressible fluid flow on a collocated rectangular grid. The chief aim is to considerably simplify existing FVM techniques such as the Semi Implicit Method for Pressure Linked Equations (Patankar, 1972), while simultaneously accounting for contributions of neighbouring cells pressure correction errors. Taking driven-cavity flow as an instance, the central differencing scheme, the divergence theorem and the TDMA two-pass solver are invoked to discretize the Navier-Stokes equations.

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Shibu Clement
Associate Professor, Mechanical Engineering, BITS-Pilani Goa
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CP2
Alternating Direction Implicit Finite Difference Method for the 3-D Wave Equation: P-SV Vectorial Case

Partial differential equations are the base of many physical models. Therefore it is essential to approximate their solution numerically. Following the pioneering ideas first presented in (Douglas & Peaceman, 1955) and (Peaceman & Rachford 1959) we develop a new second-order direction implicit (ADI) scheme, based on the idea of the operator splitting where 3-D problems are solved by a succession of 1-D tridiagonal systems. This new scheme for the 3-D wave equation is applied to model elastic wave propagation in heterogenous media for the P-SV vectorial case. The advantage of this approach over the traditional explicit schemes is that it is unconditionally stable and there is no limitation regarding the size of the time step.

Ursula Iturraran-Viveros
Instituto Mexicano del Petroleo
ursula.iturraran@gmail.com

CP2
The von Karman Theory for Incompressible Elastic Shells

Starting from the 3d nonlinear elasticity, we rigorously derive the von Karman thin film theory for incompressible materials. In case of thin plates, the Euler-Lagrange equations of the limiting energy functional give the incompressible version of the classical von Karman equations, obtained formally in the limit of Poisson’s ratio $\nu \to 1/2$. Our analysis applies as well to more general case of shells, i.e. thin films with midsurface of arbitrary geometry, as long as they satisfy the following approximation property: $C^3$ first order infinitesimal isometries are dense in the space of all $W^{2,2}$ infinitesimal isometries. The class of surfaces with this property includes: subsets of $R^2$, convex surfaces, developable surfaces and rotationally invariant surfaces. Our analysis relies on the modern methods of calculus of variations and analysis.

Hui Li
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Marta Lewicka
University of Pittsburgh
School of Arts and Sciences
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CP2
Computational Analysis of Invisibility Cloaking Using Nurbs

The purpose of this research is to develop a Non-Uniform Rational B-Spline (NURBs) method to accurately measure and graphically represent actions of electromagnetic cloaking specifically defined by the parameters of the Helmholtz Equation. Using singular transformation optics, the shape representation is that of an electromagnetic wave in topological space. Additional applications include not only invisibility cloaks but other aspects of stealth technology.

Scott M. Little
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CP3
Convergence of a Particle Method and Global Weak Solutions for a Family of Evolutionary Pdes

We provide global existence and uniqueness results for a family of fluid transport equations by establishing convergence results for the particle method applied to these equations. The considered family of PDEs is a collection of strongly nonlinear equations which yield traveling wave solutions and can be used to model a variety of fluid dynamics. The equations are characterized by a bifurcation parameter $b$, which provides a balance for the nonlinear solution behavior, and a kernel $G(x)$, which determines the shape of the traveling wave and the length scale. For some special cases of $b$ and $G(x)$, the equations are completely integrable and admit solutions that are nonlinear superpositions of traveling waves that have a discontinuity in the first derivative at their peaks and therefore are called peakons.

We apply a particle method to the considered evolutionary equations and provide a new self-contained method for proving its convergence. The latter is accomplished by using the concept of space-time bounded variation and the associated compactness properties. From this result, we
prove the existence of a unique global weak solution to the family of fluid transport equations for \( b > 1 \) and a particular choice of \( G(x) \) and obtain stronger regularity properties of the solution than previously established.

**CP3**

**Research of Difference Schemes for Hyperbolic Heat Conduction Equation in Sobolev Space**

A characteristic feature of hyperbolic heat conduction equation is that the coefficient of the highest time derivative is a small parameter. In the numerical solution of such problems, except stability and accuracy, the question of uniformity on the small parameter accuracy estimates is also fundamentally important. This paper is devoted to construction and justification of difference schemes for hyperbolic heat conduction equation in the Sobolev space. The stability and accuracy of these schemes are investigated. Uniform on small parameter of their accuracy estimates are generated. Two new a priori estimates are obtained for the three-layer operator - difference schemes. The theoretical findings are confirmed by computational experiment conducted on the basis of IDE Borland Turbo C++ Explorer for Windows.

**Igor Jurayev**

Unemployed
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**CP3**

**Boltzmann Equation with Specular Reflection in 2D Domains**

We consider the initial-boundary value problem of Boltzmann equation with specular reflection boundary condition in 2 dimensional smooth convex domain and analytic non-convex domain. In this talk the global existence and exponential decay in the \( L^\infty \) norm for cut-off hard potentials near an absolute Maxwellian are established.

**Chanwoo Kim**

University of Cambridge
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**CP3**

**One Field Formulation and Simple Stable Explicit Schemes for Fluid Structure Interaction**

We develop a one field formulation for the fluid structure (FS) interaction problem. It uses Arbitrary Lagrangian Eulerian (ALE) description for the fluid and Lagrangian description for the solid. We present a fully discrete explicit (in terms of how to determine the interface) scheme that uses conservative ALE description and allows any time step as long as it will not make the FS interface collides with itself or other fixed boundaries. Like in the continuous case, the stability bound is independent of the fluid mesh velocity. To prove the stability, we assume the flow is incompressible Navier-Stokes and the solid has convex strain energy (e.g. linear elastic). Perhaps unexpected, the proof will not work for Stokes flow and hence it shows the advantage of Navier-Stokes over Stokes in terms of stability. As the nonlinear convection term in the fluid part is treated semi-implicitly, in each time step, we only need to solve a linear system if the solid is linear elastic. Two numerical tests including the benchmark test of Navier-Stokes flow past a Saint Venant-Kirchhoff elastic bar are performed to show the power of this one field formulation.

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**Jian-Guo Liu**

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**Terrance Pendleton**

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**CP3**

**Variational Schemes in Nonlinear Elastodynamics, the Positivity of Determinants, Convergence and Relative Entropy Method**

We study radial elastodynamics for isotropic elastic materials; these form a system of non-homogeneous conservation laws. We construct a variational scheme that decreases the total mechanical energy and also leads to physically realizable motions that avoid interpenetration of matter. In addition, with the aid of the relative entropy method, we establish convergence of time-continuous interpolates obtained via three-dimensional variational schemes (studied by S. Demoulini, D. Stuart, A. Tzavaras) to a smooth solution of the elastodynamics.

**Alexey Miroshnikov**

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**Athanasios Tzavaras**

University of Crete
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**CP4**

**An Algebraic Procedure to Construct Exact Solutions of Nonlinear Evolution Equations**

In this paper, we implemented the functional variable method for the exact solutions of the Zakharov Kuznetsov-Modified Equal-Width, the modified Benjamin-Bona-Mahony and the modified KdV-Kadomtsev-Petviashvili equations. By using this scheme, we found some exact solutions of the above-mentioned equations. The obtained solutions include solitary wave solutions, periodic wave solutions and combined formal solutions. The functional variable method presents a wider applicability for handling nonlinear wave equations.

**Mutlu Akar, Adem Cevikel**

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**Ahmet Bekir, Sait San**

Eskişehir Osmangazi University
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**CP4**

**Application of Hes Variational Approach Method**
for Single Degree of Freedom Problems in Nonlinear Vibration

This paper, Hes Variational Approach Method is used to obtain the exact solution of nonlinear problems in nonlinear vibration. The governing equation is obtained by using Lagrange method and it is solved analytically by Hes Variational Approach Method. In the VAM, just one iteration takes one to high exactness of the solutions, counter to the different methods. Some patterns are given to demonstrate the impressiveness and serviceableness of the method.

Mahmoud Bayat, Iman Pakar
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CP4
An Approximate Solution for a Fractional Advection Diffusion Equation

Recently, many transport problems, involving diffusion, have been formulated on fractional differential equations where the fractional derivatives are used to model the anomalous diffusion phenomenon. A one dimensional fractional advection diffusion model is considered, where the usual second-order derivative gives place to a fractional operator. To compute the approximate solution, we propose an explicit difference method which is second order accurate. Consistency and stability of the method are examined and numerical tests are presented.

Ercilia Sousa
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CP4
Linear Quadratic Mean Field Games

The theory of Mean Field Games has grown rapidly after the pioneering paper by Lasry and Lions (2007). For the recent development and its applications, one can refer to, for example, the survey (Gueant et al. 2011) and the references therein. In this talk, I shall introduce a class of Mean Field Games in which both the pay-off function and cost functional are quadratic in state variable, control variable together with the mean field term; besides, the controlled dynamics is linear and also consists of a mean field term. We shall also briefly discuss about the existence and uniqueness of both the value function and the optimal control of each of these Mean Field Games; indeed, we can establish them by using a method that combines adjoint equation approach and the theory of backward stochastic differential equations.

Phillip S. Yam
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The Chinese University of Hong Kong
phillip.yam@gmail.com

Alain Bensoussan
University of Texas at Dallas
and the Hong Kong Polytechnic University, Hong Kong
alain.bensoussan@utdallas.edu

CP5
Linear elasticity as Gamma-limit of finite elasticity under weak coerciveness conditions

The energy functional of linear elasticity is obtained as Gamma-limit of suitable rescalings of the energies of finite elasticity. The quadratic control from below of the energy density $W(\nabla v)$ for large values of the deformation gradient $\nabla v$ is replaced here by the weaker condition $W(\nabla v) \geq |\nabla v|^p$, for some $p > 1$. Energies of this type are commonly used in the study of a large class of compressible rubber-like materials.

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CP5
Pseudo-Differential Operator Involving Fractional Fourier Transform

Pseudo-differential operator involving fractional Fourier transform associated with symbol $a(x, y)$ is defined. An integral representation of pseudo-differential operator and a Sobolev space boundedness result is obtained.

Manish Kumar
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Akhilesh Prasad
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CP5
Modern Traffic Flow Models

I will talk about several models of vehicular traffic. I will first describe microscopic cellular automata models and show how the vehicle interaction can be modeled through the look-ahead interaction potential, which leads to slow down due to heavy traffic conditions. I will then proceed with the derivation of the semi-discrete mesoscopic and continuous PDE-based macroscopic models. The resulting (systems of) PDEs are hyperbolic (systems of) PDEs with global fluxes, which make it very challenging from both analytical and numerical perspectives. The last part of my talk will be devoted to numerical methods for hyperbolic systems with global fluxes.

Alexander Kurganov
Tulane University
Department of Mathematics
kurganov@math.tulane.edu

CP5
An Isoperimetric Problem With Long-Range Inter-
actions on the Two-Sphere

There is currently much interest on the mathematical analysis of phase separation of block copolymers and their sharp interface limit leading to a nonlocal isoperimetric problem (NLIP). In this talk I will analyze the NLIP on the two-sphere and characterize the global minimizer when the parameter controlling the influence of the nonlocality is small. Furthermore, I will demonstrate stability/instability results of certain critical points depending on where in the parameter regime one looks.

Ihsan A. Topaloglu
Indiana University
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CP5
Semigroup Approach to Nonlinear Flow-Structure Interactions

We consider a subsonic flow-structure interaction between a perturbed wave equation and a second order nonlinear plate with a rotational parameter. A suitable inner product on the finite-energy space allows the application of monotone operator theory which leads to weak and strong well-posedness for several classes of nonlinear dynamics. We show that well-posedness is preserved with nonlinear boundary damping, and discuss asymptotic properties of the corresponding nonlinear semigroups as the rotational term degenerates.

Justin Webster
University of Virginia
jtw3k@virginia.edu

CP6
Construction of Dynamic Co-Seismic Sea Bed Displacements for Tsunami Generation Problems

We study tsunami wave generation and we present a new method for the construction of dynamic co-seismic sea bed displacements. This method relies on the finite fault solution (see slip distribution) and dynamic sea bed deformation scenarios (see rupture dynamics). The bottom motion is reconstructed and waves induced on the oceans free surface are studied. The 2006 Java tsunami generation case is computed with three different models. A comparison between them gives good agreement.

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Frédéric Dias
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CP6
Time Decay for the Solutions of a Coupled Nonlinear Schrödinger Equations

Using Morawetz Radial Identity, we show that the local solutions of a coupled nonlinear Schrodinger equations decay in time.

Jeng-Eng Lin
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CP6
Turbulent Flame Speeds for G-Equations

Joint work with Jack Xin and Yifeng Yu. In combustion theory various models have been proposed in modeling of the flame propagation. By level curve formulation, G-equation describes the motion of the flame front by a constant normal velocity (called laminar flame speed) and the advection of the fluid. If the initial flame is planar in some direction, the front will be wrinkled by the advection and becomes very complicated in time. Eventually the front will evolve into an asymptotic state propagating at a constant speed (called turbulent flame speed.) Consider the G-equation with 2D cellular flow. We are interested in the turbulent flame speed parameterized by the intensity of the cellular flow. For the basic G-equation model, the turbulent flame speed is enhanced by the cellular flow with marginally linear growth rate. If a dissipation term is added into G-equation, however, the growth rate will be drastically altered and become uniformly bounded. Correction terms may be also added to laminar flame speed to take account of the effects of the curvature of the level curve and the strain of the advection. We will discuss numerical methods in computing the turbulent flame speed. The numerical results support the laboratory observation that flame front may be quenched by the turbulence.

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CP6
Well-Posedness for Some Kinetic Models of Collective Behavior

The aim of this work is to give a well-posedness theory for general models of collective behavior of large groups of individuals which include a variety of effects: interaction through a potential, velocity-averaging, self-propulsion effects... We develop our theory in a space of measures, using mass transportation distances, and as consequence of it we show also the convergence of particle systems to their corresponding kinetic equations.

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CP6
Bounds on the Growth of High Sobolev Norms of Solutions to Nonlinear Schrödinger Equations

In this talk, we study the growth of Sobolev norms of solutions to Nonlinear Schrodinger Equations which we cant bound from above by energy conservation. The growth of such norms gives a quantitative estimate of the low-to-high frequency cascade. We present a frequency decomposition method which allows us to obtain polynomial bounds in the case of the 1D Hartree equation with sufficiently regular convolution potential, and which allows us to bound the growth of fractional Sobolev norms of the Cubic NLS on the real line. We will also present some 2D and 3D results.

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CP7
On the Convergence of Statistical Solutions of the 3D Navier-Stokes-α Model as α → 0

In this talk we consider statistical solutions of the 3D Navier-Stokes-α model with periodic boundary condition. We prove that under certain conditions statistical solutions of the 3D Navier-Stokes-α model converge to statistical solutions of the exact 3D Navier-Stokes equations as α → 0. The statistical solutions that we consider here arise from measures in suitable trajectory spaces, in a sense akin to that considered by Vishik and Fursikov.

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CP7
Incompressible Boussinesq Equations and Spaces of Borderline Besov Type

We prove local-in-time existence and uniqueness of an inviscid Boussinesq-type system. We assume the density equation contains nonzero diffusion and that our initial vorticity and density belong to a space of borderline Besov type.

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CP7
Inertial Waves in a Rapidly Rotating Cylinder

Rapidly rotating flows can support waves with peculiar properties. In the inviscid limit, the equations for infinitesimal disturbances about solid-body rotation reduce to a hyperbolic problem for disturbance frequencies less than twice the background rotation rate, the characteristics of which represent discontinuities in the velocity or its gradient. In real life, these are regularized by viscosity, resulting in the observed inertial waves. We explore numerically the consequences of finite viscosity and nonlinearity on such flows.

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CP7
Some Results on Statistical Solutions of the Navier-Stokes Equations for an Extended Class of External Forces

The study of statistical solutions of the Navier-Stokes equations has been considered mostly for forcing terms with values in the phase space H of square-integrable, divergence-free vector fields with the appropriate boundary conditions. In this talk, we discuss the existence of statistical solutions for forcing terms which are square-integrable in time and with values in the natural dual space V∗, where V is the subspace of H of functions with square-integrable derivative, with the corresponding boundary conditions. First, we prove the existence of statistical solutions which satisfy the so-called strengthened mean energy inequality. Then, we also show that for certain classes of forcing terms with values in V∗, any statistical solution must satisfy this strengthened mean energy inequality. This last result is based on the extension to more general forces of a result of equivalence between the energy inequality and the strengthened energy inequality for individual weak solutions.

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CP8
Formation of High-Temp/low-Viscosity Fingers Within Lava Flow

As lava viscosity can change 1-2 orders of magnitude due to small changes in temperature, several studies have predicted the formation of low-viscosity/high-speed fingers (similar to a Saffman-Taylor type instability). We examine the onset and evolution of such fingers within a Hele-shaw-type flow. In particular, we attempt to identify steady-state laminar solutions that would provide pahoehoe lava flows with a natural mechanism for the formation of lava channels/tubes within an initially uniform sheet flow.

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CP8
Shape Selection in Hyperbolic Non-Euclidean Plates

Non-Euclidean plates are thin elastic sheets in which the preferred intrinsic geometry of the mid-surface corresponds...
to a surface with nonzero Gaussian curvature. These sheets model the complex geometries generated by the differential growth of soft tissue such as the rippling in leaves and sea slugs. We present a study of free non-Euclidean discs with a constant negative Gaussian curvature. The equilibrium configuration taken by these sheets are solutions to a Föppl-Von Kármán type coupled system of equations in which configurations free of any in plane stretching correspond to isometric immersions of the hyperbolic plane.

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CP8  
Global Solutions to Bubble Growth in Porous Media

A model of an injected fluid into another viscous fluid leads to a moving boundary problem. We present solutions to the free boundary problem in terms of time-derivative of generalized Newtonian potentials, and show that the bubble occupies the entire space as the time tends to infinity if and only if the internal potential of the initial bubble is a quadratic polynomial. This classification relies on the quadratic growth of solutions to certain free boundary problems.

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CP8  
Evolution of Elastic Thin Films with Curvature Regularization Via Minimizing Movements

We consider the evolution equation with curvature regularization that models the motion of a two-dimensional elastic thin film on a rigid substrate. The mismatch between the material lattices forces the film to be strained. We prove short time existence, uniqueness and regularity of the solution, using De Giorgi’s minimizing movements to exploit the $L^2$-gradient flow structure of the equation. This seems to be the first analytical result in the case of elasticity without surface diffusion.

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CP9  
Domain and Trajectory Bundles for Fluid Structure Interaction

We present a new methodology for the study and analysis of the solvability of fluid structure interaction problems. We introduce definitions of domain bundles and trajectory bundles which are instances of Banach bundles that may be used for establishing the existence of strong and classical solutions for fluid structure interaction problems. Rather than the more common method of lifting the interaction problem to a fixed reference domain, we develop the existence theory in a modular fashion and show how classical existence results can be adapted to these vector bundles and then coupled to iterative mappings for the structural displacements in order to establish the existence of fixed points which solve the fluid-structure interaction problems by construction. We demonstrate these techniques on a variety of different example problems, including the self-propelling problem for a shape changing body in three spatial dimensions.

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CP9  
Borehole Heat Exchanger Modeling Validation

We present the development and validation of a numerical model for the simulation of energy flows and temperature changes in and around a borehole heat exchanger when a fluid circulates through a U-tube. The FlexPDE software is used to solve the model of a heat exchanger. The validated model (through comparisons with experiments) is used to study how various parameters (ground thermal conductivity etc.) affect the temperature of the inlet and outlet fluid.

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CP9  
The 2D Selective Withdrawal Transition: Analogies with Microelectromechanical Systems

Free boundaries in selective withdrawal systems have been observed undergoing topological transitions through apparently-singular steady states as the withdrawal rate is increased. We transfer the study of this transition to a simpler class of problems that are analogous to those found in the study of MEMS. By first considering a restricted family of one dimensional boundaries related to two-parameter conformal maps, we aim to identify the mechanisms that control the boundary breakdown in two dimensions.

Stuart Kent
CP10
Global Stability for the N-Species Lotka-Volterra Tree Systems of Reaction-Diffusion Equations

We consider system of reaction-diffusion equations

\[(u_i)_t - D \Delta u_i = u_i \left( b_i - \sum_{j=1}^n a_{ij} u_j \right), \quad 1 \leq i \leq n, \quad (1)\]

where \(u_i = u_i(t,x), (t,x) \in [0,\infty) \times R^n_+\), \(D = \text{diag}(D_1, \ldots, D_n)\), \(D_i > 0\). For case of graph \(G((a_{ij})_{n \times n})\) being a tree, applying invariant region method and with the aid of Volterra multiplier we obtain a set of sufficient conditions for the globally asymptotic stability for Cauchy problem of the system. The criteria are in explicit forms of the parameters, and are easily verifiable to competition model, cooperation model, as well as to predator-prey model.

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CP10
Analysis of a Mathematical Model for Erythropoiesis

We consider a mathematical model for the regulation of erythropoiesis, the process where new blood cells are created from precursor cells in the bone marrow at a rate proportional to the amount of the hormone erythropoietin present in the body. These cells age over a period of months through abrasion in the capillaries, eventually losing all ability to transport oxygen, at which point they are destroyed by phage cells. Mature red blood cells carry hemoglobin the concentration of which is fairly constant among the population of red blood cells and therefore a good measure of red blood cells levels. Erythropoietin and hemoglobin are involved in a negative feedback loop. We analyze the system of partial differential equations describing the mathematical model and reduce it to a pair of threshold-type delay differential equations to perform a stability analysis. We perform a complete parameter study and several numerical tests.

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CP10
Incompatibility and Hysteresis in Shape Memory Alloys

For certain martensitic phase transformations, one observes a close relation between the width of the thermal hysteresis and the compatibility of two phases. The latter is in the context of geometrically non-linear elasticity measured by the deviation of the middle eigenvalue of the transformation stretch matrix from one. This observation forms the basis of a theory of hysteresis that assigns an important role to the energy of the transition layer (Zhang, James, M"uller, Acta mat. 57(15), 4332–4352, 2009). Following this ansatz, we study the energy barriers leading to hysteresis, and analyze the shapes of energetically optimal transition layers for low hysteresis alloys.

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CP10
A New Electrical Model of Cardiac Cells

Action potential propagation in cardiac tissue has been classically understood to occur through gap junctions. However, recent experimental studies have shown that ephaptic coupling, or field effects, may be another method of communication between cardiac cells. Here we present and discuss results from a new model for the electrical activity in cardiac cells with simplifications that afford more efficient numerical simulation, yet captures complex cellular geometry and spatial inhomogeneities that are critical to ephaptic coupling.

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Model of Cell Layer Migration

A recently developed mathematical model of cell layer migration based on an assumption of elastic deformation of the cell layer leads to a generalized Stefan problem. The model is extended to incorporate stretch-dependent proliferation, and the resulting PDE system is analyzed for self-similar solutions. The efficiency and accuracy of adaptive finite difference and MOL schemes for numerical solution are compared. We find a large class of assumptions about the dependence of proliferation on stretch that lead to traveling wave solutions.

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CP11
To the Construction of Greens Functions of Terminal-Boundary-Value Problems for the Black-Scholes Equation

A number of Greens functions has earlier been constructed for a variety of problems posed for the Black-Scholes equation that finds numerous applications. An approach that appears efficient for such construction is based on a combination of the integral Laplace transform with the method of variation of parameters. Further analysis shows that the number of problem settings, for which the approach could be productive, can be extended. One of such extensions is analyzed in detail.

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CP11
Bifurcation Analysis for the Lugiato-Lefever Equation in Two Space Dimensions

We consider a nonlinear Schrödinger equation with cubic nonlinearity, damping, detuning and external force in two space dimensions. It is a model equation for pattern formation in nonlinear optics. Because of the damping term, it defines a weak dissipative system. We study the steady-state bifurcation of spatially homogeneous equilibrium point for the equation on square and hexagonal lattices within the space of periodic functions with respect to the lattice.

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CP11
Effect of Non-Newtonian Pulsatile Flow on Convective Diffusion in Annulus

This paper presents an exact analysis of the dispersion of a solute in Casson fluid flow through an annulus between two coaxial cylinders under the influence of periodic pressure gradient. Using the generalized dispersion model which is valid for all time after the injection of a solute, the entire process is expressed in terms of two dispersion coefficients i.e. convection and diffusion coefficients. This model analyses how the spreading of tracer is influenced by the non-Newtonian nature and periodic pulsation of the fluid. The results of the study are of great importance in understanding the dispersion process in cardiovascular flows in particular in catheterized arteries.

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CP11
Periodic Unfolding and Oscillating Test Functions for the Homogenization in a Periodically Perforated Domain

We study the homogenization of the Laplace equation with nonhomogeneous Robin boundary conditions in a periodically perforated domain. First we prove the main convergence results using the method of oscillating test functions of Tartar, then we treat the same problem by applying the periodic unfolding method. We show that the auxiliary functions introduced in the first method are not needed in the second one for proving the homogenization results.

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CP14
Blow-Up and Global Existence for a General Class of Nonlocal Nonlinear Coupled Wave Equations

We study the initial-value problem for a general class of nonlinear nonlocal coupled wave equations:

\[
\begin{align*}
  u_{1tt} &= (\beta_1 * (u_1 + g_1(u_1, u_2)))_{xx}, & x \in R, & t > 0 \\
  u_{2tt} &= (\beta_2 * (u_2 + g_2(u_1, u_2)))_{xx}, & x \in R, & t > 0 \\
  u_1(x, 0) &= \varphi_1(x), & u_{1t}(x, 0) &= \psi_1(x) \\
  u_2(x, 0) &= \varphi_2(x), & u_{2t}(x, 0) &= \psi_2(x).
\end{align*}
\]

The problem involves convolution operators with kernel functions whose Fourier transforms are nonnegative. Some well-known examples of nonlinear wave equations, such as coupled Boussinesq-type equations arising in elasticity and in quasi-continuum approximation of dense lattices, follow from the present model for suitable choices of the kernel functions. We establish local existence and sufficient conditions for finite time blow-up and as well as global existence of solutions of the problem.

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CP14
The Cauchy Problem for a Two-Dimensional Nonlocal Nonlinear Wave Equation

We study the Cauchy problem of a general class of two-dimensional nonlinear nonlocal wave equations:

\[ \begin{align*}
    w_{tt} &= \left( \beta \ast \frac{\partial F}{\partial w_x} \right)_x + \left( \beta \ast \frac{\partial F}{\partial w_y} \right)_y, \\
    w(x, y, 0) &= \varphi(x, y), \\
    w_t(x, y, 0) &= \psi(x, y).
\end{align*} \]

The above partial differential equation governs anti-plane shear motions in nonlocal elasticity. The nonlocal nature of the problem is reflected by a convolution integral in the space variables. The Fourier transform of the convolution kernel is nonnegative and satisfies a certain growth condition at infinity. For initial data in \( L^2 \) Sobolev spaces, conditions for global existence or finite time blow-up of the solutions of the Cauchy problem are established.

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CP14
Uniform Boundary Stabilization of a Wave Equation with Nonlinear Acoustic Boundary Conditions and Nonlinear Boundary Damping

We consider a wave equation with nonlinear acoustic boundary conditions. This is a coupled system of hyperbolic equations modeling an acoustic/structure interaction, where the coupling is \( \beta \ast \text{nonlinear} \), rather than linear. Using the methods of Lasiecka and Tataru, we demonstrate well-posedness and uniform decay rates for finite energy solutions. Special attention is given to the relationship between (i) the mass of the structure, (ii) the nonlinear coupling term, and (iii) the size of the nonlinear damping.

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CP14
Weak Solutions for a Class of Semilinear Elliptic Bvps in Unbounded Domains

In this study, we prove the existence of a weak solution for degenerate semilinear elliptic Dirichlet boundary-value problem

\[ \begin{align*}
    Lu(x) + \alpha \sum_{i=1}^{n} g_i(x) h_i(u(x)) D_i u(x) &= f(x) \quad \text{in } \Omega, \\
    u(x) &= 0 \quad \text{on } \partial \Omega,
\end{align*} \]

in a suitable weighted Sobolev space, where \( \Omega \subset \mathbb{R}^n, 1 \leq n \leq 3 \), is not necessarily bounded.

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MS1
A Lower Bound on Blowup Rates for the 3D Incompressible Euler Equation and a Single Exponential Beale-Kato-Majda Estimate

We prove a Beale-Kato-Majda criterion for the loss of regularity for solutions of the incompressible Euler equations in \( H^s(\mathbb{R}^3) \), for \( s > \frac{5}{2} \). Instead of double exponential estimates of Beale-Kato-Majda type, we obtain a single exponential bound on \( \| u(t) \|_{H^s} \) involving a length parameter previously introduced by P. Constantin. In particular, we derive lower bounds on the blowup rate of such solutions.

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MS1
Global Solutions of the Landau-Lifshitz equation

The Landau-Lifshitz equation (which includes as a special case the Schrödinger map equation) is a nonlinear Schrödinger-type equation of geometric and physical origin (ferromagnetism). I will describe some results on global regularity and asymptotic behaviour in the energy-critical 2D setting, from joint work with Eva Koo, and with Kenji Nakanishi and Tai-Peng Tsai.

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MS1
The Dynamics of Perturbations of Minimal Mass Solitons

We study soliton solutions to several nonlinear dispersive equations with saturated nonlinearities. We consider a small perturbation of a minimal mass soliton and identify a system of ODEs extending the work of Comech and Pelinovsky and of Comech Cuccagna and Pelinovsky, which model the behavior of the perturbation for short times. For the nonlinear Schrodinger equation (NLS), we provide numerical evidence that under this system of ODEs there are two possible dynamical outcomes, in accord with the conclusions of Pelinovsky, Afanasjev and Kivshar. Generically, initial data which supports a soliton structure appears to oscillate, with oscillations centered on a stable soliton. For initial data which is expected to disperse, the finite dimensional dynamics initially follow the unstable portion of the soliton curve. For the generalized Korteweg-deVries equation with saturated nonlinearity, we provide initial evidence that the dynamics of a small perturbation of the minimal mass soliton are governed by a simple two-dimensional system of ODEs. Analysis of the phase plane indicates that the solution either disperses or eventually approaches a nearby stable soliton, without oscillation.

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MS1
On the Global Well-posedness of the Euler Equation Forced by a Riesz Transform

I will address the issue of global well-posedness of smooth solutions $u$ of a dispersively forced Euler equation, in the two dimensional case. That is, the forcing equals to $Ru$, where $R$ is a singular integral operator.

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MS2
Well-posedness Issues for Degenerate Dispersive Equations

Linear dispersion plays a fundamental role in the study of a large number of physical scenarios and has been the subject of intense theoretical development in recent years. Consequently there has been an explosion of results concerning nonlinear dispersive equations. Nevertheless there are situations in which the mechanism which creates dispersion is itself nonlinear and degenerate. Examples can be found in the study of sedimentation, magma dynamics, granular media, numerical analysis and elasticity. Little is understood about general well-posedness issues for such equations. In this talk we will discuss some recent results which show that degenerate dispersive effects can result in catastrophic instability akin to a backwards heat equation.

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Vortices for a Two-component Ginzburg-Landau Model

We study vortices in a Ginzburg-Landau model for a pair of complex-valued order parameters. Multi-component functionals have been introduced in the context of unconventional p-wave superconductors and spinor Bose-Einstein condensates to include spin coupling effects. As in the classical Ginzburg-Landau model, minimizers will exhibit quantized vortices in response to boundary conditions or applied fields. However, we show that the interaction between the two components allows for vortices with a more exotic core structure. Our results are based on a combination of variational and PDE methods, blowing up around the vortex core and studying the resulting system and its local minimizers.

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MS2
A Zigzag Pattern in Micromagnetics

We study a simplified model for the micromagnetic energy functional in a specific asymptotic regime. The analysis includes a construction of domain walls with an internal zigzag pattern and a lower bound for the energy of a domain wall. Under certain conditions, the two results combined match into a Gamma-convergence result. This is a joint work with Roger Moser (University of Bath, UK).

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On Some Variational Problems Related to Fractional Phase Transitions

In this talk I will present some variational problems involving energies of ”fractional order” and related to phase transitions. I will specially focus on fractional isoperimetric inequalities and their quantitative versions. This is a joint work with N. Fusco and M. Morini.

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Energy Estimates and Cavity Interaction for a Simple Cavitation Model

In joint work with Duvan Henao we study a toy model for cavitation with critical power. Using ball-construction methods, we provide energy lower bounds in terms of the shapes and locations of the cavities, and energy upper bounds via constructions.

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Vortex Liquids and the Ginzburg-Landau Equations

I will discuss vortex dynamics for the time-dependent Ginzburg-Landau equations with asymptotically large numbers of vortices. For dilute vortex liquids it is shown that sequences of solutions converge to the hydrodynamic limit.

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MS3
Incompressible Limit of the Compressible Hydrodynamic Flow of Liquid Crystals

This talk is concerned with the incompressible limit of the compressible hydrodynamic flow of liquid crystals with periodic boundary conditions in $\mathbb{R}^3 (N = 2, 3)$. The derivation of the compressible model is given by least action principle and variations. The uniform (in $\lambda$ (Mach Number)) local existence of strong solutions to the compressible is obtained. The limit behavior including the convergence rate from the compressible model to the incompressible model is proved. Therefore, the global existence of strong solutions to the incompressible model under small conditions is also given.

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MS3
Multiscale Coupling for Liquid Crystals

Abstract: In this talk, we will focus on the multiscale-multiphysics coupling in the modeling of liquid crystal flows. The focus will be on the relation between different kinematic rules and the induced macroscopic elastic stresses. We will also discuss the roles of Eleslie conditions and the Parodi’s condition in the dynamical properties of the flow system.

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MS3
Passage from Mean-field to the Continuum Landau-de Gennes Theory for Nematic Liquid Crystals

We propose a new continuum energy functional for nematic liquid crystals derived from mean-field principles. It is well-known that the continuum Landau-de Gennes predictions fail to be physically realistic in the low-temperature regime. Of key importance in our analysis is the definition of a new bulk potential that blow-ups or diverges whenever the macroscopic $Q$-tensor order parameter takes values outside the physical domain predicted by mean-field theory. The proposed model can account for uniaxiality, biaxiality and spatial inhomogeneities in a three-dimensional context. For spatially inhomogeneous systems, we prove that the Landau-de Gennes theory is ill-posed in the presence of a cubic term in the elastic energy density and we make important mathematical distinctions between the isotropic one-constant elastic energy density and more general quadratic elastic energy densities.

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MS3
An Analysis of the Effect of Artificial Stress Diffusivity on the Flow Dynamics of Creeping Viscoelastic Flow

The effect of stress diffusivity is examined in both the Oldroyd-B and FENE-P models of a viscoelastic fluid in the low Reynolds (Stokes) limit for a 2D periodic time-dependent flow. A local analytic solution can be obtained when assuming a viscous flow of the form $u = Wi^{-1}(x, -y)$, where $Wi$ is the Weissenberg number. In this case the width of the birefringent strand of the polymer stress scales with the added viscosity as $\nu^{1/2}$, and is independent of the Weissenberg number. Also, the maximum extension of the polymer coils remains finite with any stress diffusion and scales as $Wi/\nu^{1/2}$. These predictions closely match the full simulations. When a FENE-P penalization term is included the percent of extension can be predicted based on $Wi, \nu$, and $b$, the maximum extensibility parameter.

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MS3
Models for Active Liquid Crystal Materials and Their Application to Biomaterials Modeling

Active liquid crystals are liquid crystalline materials whose large molecules are mobile. Flows of active liquid crystals have been observed in mesoscopic biological systems like cytoskeletal regions of a live cell. Various efforts have been made to derive suitable hydrodynamic theories for the intriguing flowing materials. In this talk, I will give an overview of the latest development in modeling and simulation of active liquid crystal materials. I will discuss the application of the models in studying cell motility and oscillation.

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MS4
Shock Diffraction Problems in Multidimensional Hyperbolic Conservation Laws

We will discuss some recent efforts in the rigorous mathematical analysis of shock diffraction problems for multidimensional hyperbolic conservation laws. We will focus mainly on the shock diffraction by two-dimensional convex corner wedges in compressible fluid flow determined by the nonlinear wave system. This shock diffraction problem can be formulated as a boundary value problem for second-order nonlinear partial differential equations of mixed elliptic-hyperbolic type in an unbounded domain. It can be further reformulated as a free boundary problem for nonlinear degenerate elliptic equations of second order. We will present a global theory of existence and regularity for this shock diffraction problem, as well as several new mathematical ideas/techniques motivated by the earlier work by Feldman and myself. Further results, perspectives, and open problems on this topic will be also addressed.

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MS4
Existence of Algebraic Vortex Spirals
Abstract not available at time of publication.
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MS4
Conservation Laws with Distributed Control
We consider a balance law in one space variable \( u_t + f(u)x = z(t,x) \), with \( f \) strictly convex. We regard the source term \( z \) as a bounded control, and characterize the set of attainable profiles \( u(T,\cdot) \) at a fixed time \( T \) in two cases
1. whenever \( z \) is defined on a strip \([0,T] \times \);
2. whenever \( z(t,\cdot) \) is compactly supported in an interval \([a,b]\), independent on \( t \in [0,T] \).
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MS4
Conservation Laws on Networks
Abstract not available at time of publication.
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MS5
Phase Transition in a System of Self-propelled Particles
Abstract not available at time of publication.
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MS5
On Repulsion in Biological Aggregation Equations
Abstract not available at time of publication.
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MS5
Mathematical Modeling of Collective Displacements: From Microscopic to Macroscopic Description
Abstract not available at time of publication.
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MS5
A New Model for Self-organized Dynamics and its Flocking Behavior
Self-organized dynamics is driven by ‘rules of engagement’, which describe how each agent interacts with its ‘neighbors’. They consist of long-term attraction, mid-range alignment and short-range repulsion. Many self-propelled models are driven by the balance between these three forces, which yield emerging structures of interest. Here, we introduce a new particle-based model driven by self-alignment, which addresses several drawbacks of existing models for self-organized dynamics. We will explain the emerging behavior of flocking in our proposed model, when the non-symmetric pairwise interactions between its agents decays sufficiently slow. The methodology presented here is based on the new notion of active sets, which carries over from particle to kinetic and hydrodynamic descriptions.
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MS6
Effective Dielectric Boundary Forces in Variational Implicit Solvation
The competition of electrostatic and entropic interactions influences crucially biomolecular conformations. In the variational implicit-solvent modeling (VISM), the dielectric boundary force is the key in the description of electrostatic interactions. Such forces are defined and their analytic formulas are derived based on the Coulomb-field, Yukawa-field, and Poisson-Boltzmann approximations of electrostatic free energies. The notion of shape derivatives is employed. The implementation of the resulting theory in the context of the level-set VISM is discussed.
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MS6
New Poisson-Boltzmann Type Equations
Continuing our previous work for ionic solutions with two ion species of opposite charges [Nonlinearity, 24 (2011) 431–458], we study a new Poisson-Boltzmann type (PBn) equation which describes the equilibrium of electrolytes with multiple types of ionic species. Under Robin type boundary conditions with various material coefficients, we give the rigorous proof of the asymptotic behavior of the solutions of PBn equations in one spatial dimension.
cases, as the parameter approaches zero. When the global electro-neutrality holds, we find different asymptotic behaviors between PB, and the standard Poisson-Boltzmann (PB) equations. For finite size effects, we may introduce another PB equation having same asymptotic behavior as Andelman’s results (1997).

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MS6
Fast Solvers for Nonlocal Continuum Electrostatic Models

The nonlocal continuum electrostatic model is an important extension of the classical Poisson dielectric model, but very costly to be solved in general. In this talk, we introduce one commonly-used nonlocal continuum dielectric model of water and a modified nonlocal model for protein in water. We then show that both models can be transformed equivalently from their original integro-differential equations into systems of partial differential equations. In this way, the complexity of the nonlocal model is simplified sharply. We also describe our finite element program package for solving the nonlocal model, and report the analytical solutions of three nonlocal ionic Born models that we obtained recently. Moreover, we demonstrate that a nonlocal continuum electrostatic model is a much better predictor of the solvation free energy of ions than the classical Poisson dielectric model. This project is a joined work with Prof. L. Ridgway Scott at the University of Chicago. It is supported in part by NSF grant #DMS-0921004.

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MS6
Efficient Algorithms for Biomolecular Electrostatics with Dielectric Discontinuities

In this talk, we will discuss some recent results on efficient electrostatic algorithms of surface polarization charges in the presence of dielectric discontinuities, in both salt-free and ionic solvents, including the method of images and the generalized Born method. These algorithms are useful in molecular simulations of biological and soft matter systems when the polarization effects play a role. We will report the applications of these algorithms into two nano-scale systems. The first one is the spherical colloidal system. We will present our insight on electric double layer with Monte Carlo simulations by systematically investigating the effects of image charges, ionic sizes, and discrete surface charges. The second system is an ion channel model. We have developed a new generalized Born algorithm to account for the polarization effect of membrane bilayer, which is incorporated in Monte Carlo program to provide an efficient tool for the study of ion transport in nanoscale channels.

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MS7
Harmonic Characterization of Balls in Stratified Lie Groups.

We extend, to the sub-Laplacians setting, a theorem by Aharonov, Schiffer and Zalcman regarding an inverse property for harmonic functions. As a byproduct, a harmonic characterization of the gauge balls is proved, thus extending a Kuran’s theorem related to the Euclidean balls.

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MS7
Regularity Properties of Sets with Quasiminimal Surfaces in the Metric Setting

Abstract not available at time of publication.

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MS7
Title Not Available at Time of Publication

Abstract not available at time of publication.

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MS7
On the Distributional Divergence of Vector Fields Vanishing at Infinity

In this talk we present results concerning the solvability of the equation \( \nabla v = F \) in various spaces of functions for the vector field \( v \). We find necessary and sufficient conditions on the right hand side \( F \) that guarantees the existence of solutions \( v \). We show that the equation \( \nabla v = F \) has a solution \( v \) in the space of continuous vector fields vanishing at infinity if and only if \( F \) belongs to a closed subspace of the dual of \( BV_{loc}(\mathbb{R}^m) \) (where the latter is the space of functions in \( L^{\frac{m}{m-1}}(\mathbb{R}^m) \) whose distributional gradient is a vector valued measure). In particular we show that, even though \( \nabla (\nabla u) = \Delta u = f \in L^m \) need not have a
solution \( u \in C^1 \), to each \( f \in L^m(\mathbb{R}^m) \) there corresponds a continuous vector field \( v \) vanishing at infinity such that \( \text{div} \ v = f \).

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MS7  
The Area and Co-area Formulas for Newtonian Functions Defined on Metric Spaces

Abstract not available at time of publication.

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MS8  
The Invariant Measure of the Stochastic Navier-Stokes Equation

The mathematical proof of Kolmogorov’s (1962) statistical theory of turbulence consists of proving the existence of the invariant measure of the Navier-Stokes equation, on which the statistical theory is based. In this talk we discuss how the laminar solution of the Navier-Stokes equation becomes unstable for large Reynolds number and the stable solution is the solution of the stochastic Navier-Stokes equation. This is the unique solution that describes fully-developed turbulence. In order to compare with experiments and simulations, we solve the stochastic Hopf equation for the invariant measure. The Feynmann-Kac formula produces log-Poisson processes from the stochastic Navier-Stokes equation. These processes, first found by She, Leveque, Waymire and Dubrulle give the intermittency corrections to the structure functions of turbulence. The probability density function of the two-point statistics that can be compared to experiments and simulations turn out to be similar to the generalized hyperbolic distributions first suggested by Barndorff-Nilsen.

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MS8  
Euler Equations on a Fast Rotating Sphere: Time-averages and Zonal Flows

Motivated by geophysical and planetary sciences, we investigate the barotropic, incompressible Euler equations on a fast rotating sphere \( S^2 \). We prove that the finite-time-average of the solution stays close to a subspace of longitude-independent zonal flows. The initial data can be arbitrarily far away from this subspace. Meridional variation of the Coriolis parameter underlies this phenomenon. Our proofs use Riemannian geometric tools, in particular the Hodge Theory.

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MS8  
Nonlinear Dirac Equations in One Spatial Dimension

We consider the nonlinear Dirac equations in one dimension and review various results on global existence of solutions in \( H^1 \) and \( L^2 \). Depending on the character of the nonlinear terms, the large-norm solutions may exist for all times or may blow up in a finite time. We show that the small-norm solutions exist globally for the nonlinear Dirac equations with cubic and higher-order nonlinear terms. We also explain details of asymptotic stability of gap solitons in nonlinear Dirac equations with quintic and higher-order nonlinear terms.

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MS8  
Carrier Shocks Waves in Nonlinear and Nonlinear Media

Abstract not available at time of publication.

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MS9  
The Affine Mean Curvature Flow of Convex Surfaces

Abstract not available at time of publication.

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MS9  
Quantization Phenomena for Minimizing Sequences of the Willmore Functional

We consider a minimizing sequence of conformal immersions for the Willmore energy functional. We show that a quantization phenomenon arises. The sequence converges towards a Willmore immersion except at finitely many branch points, where the energy concentrates (by increments of \( 4\pi \), according to the order of the branch). No energy is lost in the neck regions.

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MS9  
Numerical Approximation of Anisotropic Willmore
Flow

Lately the analytical and numerical study of the Willmore functional

\[ \mathcal{W}(\cdot) = \int \frac{1}{\varepsilon} \mathcal{H}^\varepsilon \]

has received a lot of attention. In this work we provide a geometrically consistent definition of anisotropic Willmore functional and an appropriate FE-discretization for its flow. Our aim is to discover interesting (numerical) anisotropic Willmore surfaces.

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MS9
On the Helfrich Flow

The Helfrich flow is the steepest descent gradient flow in \( L^2 \) for the Helfrich functional, which for a closed immersed surface is a linear combination of the Willmore energy, surface area, and enclosed volume. In this talk we consider the global behaviour of the flow under an assumption of small initial Helfrich energy. We classify critical points of the functional and prove that the flow becomes asymptotic to a round point in finite time.

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MS10
Numerical Analysis of the Null Controllability of Thermoelastic Plate Dynamics

Semidiscrete finite difference and finite element approximation schemes are presented for the null controllability of those evolution equations which can be abstractly described by generators of analytic semigroups. The key feature here is that the null controllers being explicitly constructed exhibit the asymptotics of the associated minimal energy function. We focus here upon both "spectral" and "nonspectral" cases. Explicit PDE examples include fourth-order elastic equations subjected to either thermal and "nonspectral" cases. Explicit PDE examples include fourth-order elastic equations subjected to either thermal or structural damping.

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MS10
Monotone Operator Theory and Applications to PDEs

In this talk, I will focus on the treatment of hyperbolic PDE’s under the influence of supercritical interior and boundary sources. The local solvability of such problems is hopeless via standard fixed point theorems or Galerkin approximations, due to the lack of compactness. Also, it is well known that most solutions to such PDE’s blow up in finite time. Therefore, from the viewpoint of stability, the presence of such sources necessitates the introduction of interior and/or boundary damping. On the other hand, it is well known that nonlinear dissipation in hyperbolic dynamics has been a source of many technical difficulties, especially when both interior and boundary feedback are present.

I will describe a general strategy that can handle the local solvability of most monotone problems by using nonlinear semi-groups (Kato’s Theorem). However, nonlinear semi-groups can only accommodate a globally Lipschitz perturbation of a monotone problem. Thus, going from globally Lipschitz sources to the full generality of supercritical sources will require a great effort. In addition, I will discuss some recent results on convex integrals on Sobolev spaces which are essential to this strategy.

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MS10
Extremals of the Log Sobolev Inequality

The main purpose of the talk is to describe a counter example to the old question on existence of extremal of a standard Log Sobolev inequality (or its recent reincarnation in the form of Perelman’s W entropy) on noncompact manifolds with bounded geometry. We also prove existence of extremal under an extra condition.

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MS11
High-Order Numerical Simulation of Vlasov Systems for Laser Plasma Interaction

We will report on our development of high-order algorithms for Vlasov systems for simulating laser-plasma interactions. Our approach is based on an explicit, high-order, nonlinear, finite-volume discretization that is discretely conservative, controls oscillations, and can explicitly enforce positivity. Adaptive mesh refinement will also be discussed. Results of physical significance will be presented in 1+1 and 2+2 dimensions and will include an analysis of the dynamics of externally driven plasma waves in two space dimensions.

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MS11
Reduced Resistive Models with Arbitrary Density

Reduced Resistive Models with Arbitrary Density

Reduced Resistive Models with Arbitrary Density
for Mhd in Tokamaks

Reduced resistive MHD models are useful to study MHD equilibrium in Tokamaks. I will discussed a new model with arbitrary density: this model is a extension of previous models. The so-called Current Hole instability will serve as an illustration. This work has been done with many colleagues: in particular Remy Sart and Shiva Malapaka.

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MS11
Nonlinear Landau Damping and Inviscid Damping

Consider electrostatic plasmas described by 1D Vlasov-Poisson system with a fixed ion background. In 1946, Landau discovered the linear decay of electric field near a stable homogeneous state. The nonlinear Landau damping was recently proved for analytic perturbations by Villani and Mouhot, and for general perturbations it is still largely open. With Chongchun Zeng, we construct nontrivial traveling waves (BGK waves) with any spatial period which are arbitrarily near any homogeneous state in $H^s(s < \frac{3}{2})$ Sobolev norm of the distribution function. Therefore, the nonlinear Landau damping is NOT true in $H^s(s < \frac{3}{2})$ spaces. We also showed that in small $H^s(s > \frac{3}{2})$ neighborhoods of linearly stable homogeneous states, there exist no nontrivial invariant structures. This suggests that the long time dynamics near stable homogeneous states in $H^s(s > \frac{3}{2})$ spaces might be much simpler. These results also hold true in 2D and 3D for a weighted Sobolev space. Besides, we obtained similar results for the problem of nonlinear inviscid damping of Couette flow, for which the linear decay was first observed by Orr in 1907.

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MS11
Analysis of the Three-Wave Coupling System for Laser-Plasma Interaction.

In the framework of Laser-Plasma interaction problems, one addresses the coupling between two electromagnetic waves (the transmitted and Brillouin backscattered ones) and an ion hydrodynamic wave. The characteristic speed of this last one is of course very small compared to the speed of light. We give new mathematical results on this non-linear hyperbolic system which is used for forty years by physicists. Moreover we propose a numerical scheme and numerical illustrations.

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MS12
Power-Law Potentials

The dimensional scaling (D-scaling) technique is an innovative asymptotic expansion approach to study multi-particle systems in chemical physics. It enables the calculation of ground and excited state energies of quantum systems without having to solve the Schrodinger equation. In this talk, the mathematical analysis of the D-scaling technique for the Schrodinger equation with power-law potentials is presented. By casting the D-scaling technique in an appropriate variational setting and studying the corresponding minimization problem, the D-scaling technique is justified rigorously.

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MS12
Bursting and Two-parameter Bifurcation in the Chay Neuronal Model

In this paper, we study and classify the firing patterns in the Chay neuronal model by the fast/slow decomposition and the two-parameter bifurcations analysis. We show that the Chay neuronal model can display complex bursting oscillations, including the “fold/fold” bursting, the “Hopf/Hopf” bursting and the “Hopf/homoclinic” bursting. Furthermore, dynamical properties of different firing activities of a neuron are closely related to the bifurcation structures of the fast subsystem. Our results indicate that the codimension-2 bifurcation points and the related codimension-1 bifurcation curves of the fast-subsystem can provide crucial information to predict the existence and types of bursting with changes of parameters.

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MS12
Proper Solutions to the Burgers-Huxley Equations

Many nonlinear partial equations arise in physical, chemical and biological contexts. Finding innovative methods to solve and analyze these equations has been an interesting subject in the field of partial equations and dynamical systems. In this talk, we are concerned with the Burgers-Huxley equations. Under certain conditions, we apply the higher terms in the Taylor series and the center manifold method to obtain the local behavior around a non-hyperbolic point of codimension one in the phase plane. Applying the Lie symmetry method we obtain some properties for proper solutions.

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MS12
Nonlinear Duffing-van der Pol Oscillator System

The nonlinear Duffing-van der Pol oscillator system is studied by means of the Lie symmetry reduction method and the Preller-Singer method. With the particular case of coefficients, this system has physical relevance as a simple model in certain flow-induced structural vibration prob-
lems. Under certain parametric conditions, we are concerned with the first integrals of the Duffing-van der Pol oscillator system. After making a series of variable transformations, we apply the Preller-Singer method and the Lie symmetry reduction method to obtain the first integrals of the simplified equations without complicated calculations.

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**MS12**

Optimal Regularity for A-Harmonic Type Equations under the Natural Growth

In this talk, we show that each bounded weak solution of A-harmonic type equations under the natural growth belongs to locally Hölder continuity based on a density lemma and Moser-Nash’s argument. Then we show that its weak solution is of optimal regularity with the Hölder exponent for any $\gamma$: $0 \leq \gamma < \kappa$, where $\kappa$ is the same as the Hölder’s index for homogeneous A-harmonic equations.

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**MS13**

Partial Regularity for Higher Dimensional Navier-Stokes Equations

I will discuss some recent results about partial regularity and a regularity criterion for higher dimensional Navier-Stokes equations. The talk is based on joint work with Dapeng Du and Robert Strain.

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**MS13**

Leonardo vs. Kolmogorov; 3D Enstrophy Cascade

Existence of 2D enstrophy cascade in a suitable mathematical setting – and under suitable conditions compatible with 2D turbulence phenomenology – is known both in the Fourier and in the physical scales. The goal of this talk is to show that the same geometric condition preventing the formation of singularities (Hölder coherence of the vorticity direction), coupled with a 2D-like condition for the enstrophy cascade, and under a certain modulation assumption on evolution of the vorticity, leads to existence of 3D enstrophy cascade in physical scales of the flow.

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**MS13**

Local Existence and Uniqueness of the Solutions to the Free Boundary Value Problem for the Ocean

In this talk, we consider the free boundary value problem for the primitive equations of the atmosphere and the ocean model, which has been proposed by Lions, Temam, and Wang. We establish that the initial value problem is well-posed in the space of real analytic functions. Namely, we prove the local existence of a unique real analytic solution. This is a joint work with Igor Kukavica and Mohammed Ziane.

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**MS13**

Boundary Layer Analysis of the Navier-Stokes Equations with Generalized Navier Boundary Conditions

Using generalized Navier boundary conditions, in which the friction parameter is replaced by a tensor on the boundary, we obtain a boundary layer expansion for solutions to the Navier-Stokes equations for small viscosity in a 3D bounded domain. As a result, we obtain convergence in the energy norm and uniformly in time and space, with bounds on the convergence rate, for solutions of the Navier-Stokes equations to a solution to the Euler equations.

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**MS13**

Convection-diffusion Equations with Small Viscosity in a Circle

In this talk we will discuss singular perturbation problems for convection-diffusion equations in a circle when the viscosity is small. Highly singular behaviors can occur at the characteristic points which render the analysis difficult. A detailed analysis of these singularities has been conducted, and the corresponding boundary layers have been made explicit. This simplified model shows how singular and involved the behaviors can be in incompressible fluid mechanics when the viscosity is small.

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**MS14**

A Pressure-stabilized Characteristics Finite Element Scheme for the Navier-Stokes Equations and Its Application to a Thermal Convection Problem

Recently, we have developed a combined finite element scheme with the method of characteristics and a pressure stabilization for the Navier-Stokes equations. The scheme has such advantages that the coefficient matrix of the sys-
FVM is a suitable discretization method for the equation related equations, where approximation for a parabolic blow-up problem, Cho, S. Hamada, and H. Okamoto, On the finite difference blow-up phenomena. We generalize some results in C.-H. Indut. Appl. Math. Hisashi Okamoto

Continuous function satisfying let boundary condition. Here, 0 in a bounded domain Ω with the homogeneous Dirichlet boundary condition. We are concerned with a question as to how a finite difference scheme can reproduce the blow-up phenomena. We generalize some results in C.-H. Cho, S. Hamada, and H. Okamoto, On the finite difference approximation for a parabolic blow-up problem, Japan J. Indut. Appl. Math., 24 (2007), 131–160.

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MS14
Finite Difference Methods for Blow-up Problems
We consider a scalar semi-linear parabolic partial differential equation u_t = u_{xx} + f(u) (0 ≤ t, 0 ≤ x ≤ 1) and related equations, where f : R → R is a smooth function.

It is known that a solution with a large initial data may blow up in finite time, if an appropriate growth condition on f as u → ∞ is imposed. We are concerned with a question as to how a finite difference scheme can reproduce the blow-up phenomena. We generalize some results in C.-H. Cho, S. Hamada, and H. Okamoto, On the finite difference approximation for a parabolic blow-up problem, Japan J. Indut. Appl. Math., 24 (2007), 131–160.

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MS14
L^1 Analysis of the Finite Volume Method for Nonlinear Degenerate Diffusion Problems
We consider a degenerate parabolic equation u_t − Δf(u) = 0 in a bounded domain Ω with the homogeneous Dirichlet boundary condition. Here, f denotes a non-decreasing continuous function satisfying f(0) = 0. We shall see that FVM is a suitable discretization method for the equation in the sense that the discrete version of the L^1 theory of Brezis and Strauss can be applied. This is totally new approach to study FVM for degenerate parabolic problems.

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MS14
Mean Curvature Flow with Volume Constraint
An approximation for the volume-constrained multiphase mean curvature flow will be presented. A thresholding method based on the idea of the MBO algorithm is used and theoretical and computational aspects of the global constraint are discussed. The ultimate goal is to simulate the motion of bubbles or droplets touching each other and/or a rigid boundary and to analyze the corresponding evolutionary free-boundary problem.

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MS15
Variational Methods in Image Processing
Deblurring, denoising, inpainting and recolorization of images are fundamental problems in image processing and have given rise in the past few years to a vast variety of techniques and methods touching different fields of mathematics. Among them, variational methods based on the minimization of certain energy functionals have been successfully employed to treat a fairly general class of image restoration problems. The underlying theoretical challenges are common to the variational formulation of problems in other areas. Here first order RGB variational problems for recolorization will be analyzed, and the use of second order variational problems to eliminate the staircasing effect will be validated.

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MS15
Hybrid Methods for Keller-Segel-Patlak Type of Equations
We describe an implicit scheme to approximate the solution of the Keller-Segel-Patlak system. There are several issues related to the convergence of this scheme whose status we discuss.

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MS15
Reversible Description of Coagulation and Fragmentation
The process of coagulation is associated with scalar conservation laws, where the adhesion particle dynamics results from shock waves. Conversely, the fragmentation of a massive particle is associated with rarefaction waves. It is shown that both coagulation and fragmentation may coexist for a reversible solution, under a natural generalization of the system of conservation law. This is done by the introduction of an action principle which includes an internal energy.

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MS15
On the Ramified Optimal Allocation Problem
We propose an optimal allocation problem with ramified transport technology in a spatial economy. Ramified transportation is used to model the transport economy of scale in group transportation observed widely in both nature and efficiently designed transport systems of branching structures. The ramified allocation problem aims at finding an optimal allocation plan as well as an associated optimal allocation path to minimize overall cost of transporting commodity from factories to households. We develop methods of marginal transportation analysis and projectional analysis to study properties of optimal assignment maps. These properties are then related to the search for an optimal allocation path to minimize overall cost of transporting commodity from factories to households.
signment map in the context of state matrix. A joint work with Shaofeng Xu.

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MS16
Finite Element Clifford Algebra: A New Toolkit for Evolution Problems

This talk will introduce a new toolkit for the design of stable finite element methods for evolution equations using the geometric theory provided by Clifford algebras. Building on the viewpoint from Arnold, Falk and Winther’s finite element exterior calculus, I will show how the broader theory of geometric calculus (a type of Clifford algebra) can be used to coherently describe and discretize time-like dimensions in evolutionary problems. Applications of this perspective to specific problems from molecular biology will be discussed.

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MS16
Geometric Variational Crimes: Hilbert Complexes, Finite Element Exterior Calculus, and Problems on Hypersurfaces

The success of mixed finite element methods is deeply connected with differential geometry and algebraic topology—particularly with the exterior calculus of differential forms. The notion of ‘Hilbert complex,’ rather than ‘Hilbert space,’ provides the appropriate functional-analytic setting for these methods. This talk will present recent results that analyze ‘variational crimes’ (a la Strang) on Hilbert complexes; as a corollary, this work also generalizes several key results on ‘surface finite elements’ for elliptic PDEs on hypersurfaces.

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MS16
Adaptive Boundary Element Methods with Convergence Rates

Boundary element methods (BEM) are a way to numerically solve elliptic boundary value problems by reformulating them as singular integral equations on the boundary of the domain, and by applying finite element (FEM) type methods to the resulting integral equations. This is very convenient and leads to potentially efficient computational schemes since now the unknown function lives on a manifold with dimension one less than that of the original domain. However, in order to arrive at an efficient working computer code that is backed up by a sound mathematical theory, one has to overcome some major algorithmic and analytic hurdles, in addition to the problems encountered in the corresponding FEM setting. Although most of these hurdles have been successfully attacked so that the whole situation is about as satisfactory as with FEM, there still remain a few glaring exceptions including the convergence theory of adaptive BEM. The difficulties are related to the non locality of the involved integral operators and fractional order Sobolev norms. For instance, geometric error reduction for adaptive BEM has been rigorously established so far only under the so-called saturation assumption, whereas the first such proof without saturation assumption for an adaptive FEM in 2D was published in 1996. This contribution is an attempt to fill this gap by developing a set of techniques that is able to prove geometric error reduction and quasi-optimal convergence rates for adaptive BEM, without relying on saturation type assumptions. The main ingredients of the proof are some new results on local a posteriori error estimates for boundary element methods, and inverse-type inequality involving boundary integral operators on locally refined finite element spaces.

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MS16
A Priori Estimates and Adaptive Methods for Geometric Partial Differential Equations

In this talk, we present an approximation theory framework the use of adaptive finite element approximation techniques for the constraints arising in the Einstein equations in general relativity. We first summarize recent work on a priori max-norm estimates, sub- and super-solutions, and existence theory for this system of elliptic equations. We then develop a discrete analogue of the existence argument and a priori estimates for the Petrov-Galerkin discretization. Based on this approximation theory framework, we develop a nonlinear approximation algorithm based on error indicator-driven refinement of simplex triangulations of the domain. We show that the adaptive algorithm converges for the Hamiltonian constraint, and establish that the overall algorithm has optimal (linear) complexity in the number of degrees of freedom.

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MS17
Longtime Behavior of Fluid-structure PDE Dynamics

In this talk we shall derive certain delicate decay rates for a partial differential equation (PDE) systems which comprise couplings of parabolic with hyperbolic dynamics. The ap-
pearances of such coupled PDE models in the literature are well-established, inasmuch as they mathematically govern many physical phenomena; e.g., structural acoustic flow fields, or the immersion of an elastic structure within a fluid. The coupling between the distinct hyperbolic and parabolic dynamics typically occurs at the boundary interface between the media. In previous work, we have established semigroup well-posedness for such dynamics, in part through a nonstandard elimination of the associated pressure variable. For this PDE model, we provide a uniform rational decay estimate for solutions corresponding to smooth initial data; viz., for initial data in the domain of the semigroup generator. The attainment of this result depends upon the appropriate use of a recently derived operator semigroup result of A. Borichev and Y. Tomilov.

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MS17  
Non-aircraft Applications of Aeroelastic Flutter

We report on our recent experimental work on a low-speed wind-tunnel on non-aircraft applications of Aeroelastic Flutter: Optimizing Piezoelectric Power generation from ambient wind.

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MS17  
Surface Waves for Hyperbolic Systems of PDE

Hyperbolic systems with conservative boundary conditions in a half space are considered. Usually, these boundary problems do not satisfy the Kreiss-Sakamoto condition (uniform Lopatinskii condition); hence, there may exist non-trivial solutions to the homogeneous boundary problem. These solutions can be described as surface waves of either finite energy or of infinite energy. Elementary properties of surface waves will be discussed. The most important example is the Rayleigh wave in elastodynamics.

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MS17  
Controllability of a Membrane or Plate Enclosing a Potential Fluid

We consider a fluid-filled container with a rigid portion and an elastic portion of the boundary. We assume a simple potential fluid model, with linearized coupling to the membrane at the equilibrium configuration. We show that if the fluid density is sufficiently small, then exact controllability results similar to the results for the completely uncoupled system hold. For example, in the case of a two-dimensional membrane enclosing a three-dimensional fluid, it is enough to control a sufficiently large portion of the (one-dimensional) boundary of the flexible membrane. This result however, is not a simple perturbation result since even in the case of a zero fluid density, there remain nonlocal constraints imposed on the elastic system. We also discuss some related controllability results for a 2-dimensional cochlea model consists of a one-dimensional elastic structure (modeling the basilar membrane) surrounded by an incompressible 2-dimensional fluid.

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MS17  
Controllability of the Foppl-von Karman Elastic Shells with Residual Strain

The prestrained von-Karman system is a version of the von-Karman equations of nonlinear elasticity, proposed by Mahadevan and Liang as a description of morphogenesis of naturally growing thin tissues (leaves, flowers) at a specific regime of the magnitude of internal strain. The same system has been then rigorously derived, starting from the 3d nonlinear non-Euclidean elasticity, by Lewicka, Mahadevan and Pakzad. We discuss questions related to controllability and stability of this system.

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MS18  
Title Not Available at Time of Publication

Abstract not available at time of publication.

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MS18  
On the $L^1$-Stability and Instability of the Boltzmann and Vlasov-Poisson Equations

In this talk, I will present a recent progress on the uniform $L^1$-stability and instability of the two prototype kinetic equations (the Boltzmann and Vlasov-Poisson(V-P) system). For the V-P system in high dimensions ($d \geq 4$), the small amplitude decaying solutions are uniformly $L^1$-stable due to the strong dispersion property of the corresponding linearized equation, while for three dimensions, such an uniform $L^1$-stability estimate for the V-P system is still not known even for small solutions. I will report two negative results on the non-existence of $L^1$-asymptotic completeness and instability of compacton solution for the V-P system in three dimensions, which might suggest the possible scenario for the $L^1$-instability of the Vlasov-Poisson system in three dimensions. This is a joint work with Sun-Ho Choi (SNU).

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MS18  
Weak Shock Diffraction

We study an asymptotic problem that describes the diffraction-
tion of a weak, self-similar shock near a point where its shock strength approaches zero and the shock turns continuously into an expansion wavefront. An example arises in the reflection of a weak shock off a semi-infinite screen. The asymptotic problem consists of the unsteady transonic small disturbance equation with suitable matching conditions. We obtain numerical solutions of this problem, which show that the shock diffracts nonlinearly into the expansion region. We also solve numerically a related half-space problem with a “soft” boundary, which shows a complex reflection pattern similar to one that occurs in the Guderley Mach reflection of weak shocks.

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MS18
Shock Formation in the Plane

In classical pictures of steady transonic flow (for example, a compression wave over an airfoil), it appears that the shock forms exactly on the sonic line. However, careful numerical simulations on this and on a corresponding situation in unsteady two-dimensional flows reveal that the shock actually forms at a point where the underlying system (steady or self-similar) is strictly hyperbolic. What is in fact the case? I will talk about joint work with Allen Tesdall that shows (by means of a simple example) that a transonic shock can indeed be created on the sonic line. However, the set-up appears to be structurally unstable, and a small perturbation will displace it into the hyperbolic region. This explains both the appearance of such shocks and the fact that under sufficient numerical resolution they appear to move off the sonic line.

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MS18
Particle Behaviors in Strained Turbulence

Our work discusses the effect of straining on particles in turbulence. Turbulent flows are simulated with the Direct Numerical Simulation method, and the Rogallo algorithm is applied to deal with domain variations from strain over time. We study the behaviors of inertial particles by simulating movements of particles with inertia. Distributions and probability density functions of velocities and accelerations of particles with different Stokes numbers under different strain rates will be presented.

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MS19
Eco-evolutionary Dynamics: Advances and Challenges

The ecological dynamics of populations and evolutionary dynamics of species have traditionally been modeled on different timescales and with different classes of equations. Realizing that this was an artificial distinction with no solid biological justification had led the development over the last decade of new eco-evolutionary dynamics models in which evolutionary processes shape ecological systems and ecological dynamics feedback on evolution. Here we will review the state of the art about how to construct eco-evolutionary dynamics models from microscopic processes taking place at the level of individuals. We will outline some major biological advances made possible, and challenges raised, by the mathematical and numerical analysis of eco-evolutionary dynamics models.

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MS19
Selection-mutation Dynamics

We consider an integro-diiffential nonlinear model that describes the evolution of a population structured by a quantitative trait. The interactions between traits occur from competition for resources whose concentrations depend on the current state of the population. Corrections from competition for resources whose concentrations depend on the current state of the population. Corrections taking the effects of small populations are also introduced. We study a concentration phenomenon arising in the limit of strong selection and small mutations.

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MS19
Dirac Mass Dynamics in Parabolic Equations

Nonlocal Lotka-Volterra models have the property that solutions concentrate as Dirac masses in the limit of small diffusion. Is it possible to describe the dynamics of the concentration points and of the mass of the Dirac? We will explain how this relates to the so-called ‘constrained Hamilton-Jacobi equation’ and how numerical simulations can exhibit unexpected dynamics well explained by this equation. Our motivation comes from ‘population adaptive evolution’ a branch of mathematical ecology which models the darwinian evolution.

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MS19
Populations Structured by a Phenotypic Trait and a Space Variable

Together with Sepideh Mirrahimi, I investigated a structured population model where the population is structured by both a phenotypic trait and a space variable. The population endures a classical mutation-selection effect locally, and diffuses in space. From this kinetic model, we are able to derive a PDE model introduced by N. Barton and M. Kirkpatrick (and thus enlight the conditions necessary for this model to apply). Finally, we analyse further this model.

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MS20
Isometric Embedding and BV Weak Solutions

The isometric immersion problem for surfaces embedded into $\mathbb{R}^3$ is studied via a fluid dynamic formulation as a system of balance laws. Local and global existence results are established for weak solutions of small bounded variation to the Gauss–Codazzi system for negatively curved surfaces that admit equilibrium configurations. As an application, the case of catenoidal shell of revolution is provided.

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MS20
Shock Profiles in Radiative Hydrodynamics: Formation of Zeldovich Spikes

We shall present some results on the existence of shock profiles for a model of radiative hydrodynamics that couples the compressible Euler equations with an elliptic equation for the radiation energy density. When the shock amplitude is small, previous works have shown the existence and stability of smooth and monotone traveling waves. Here we present an existence result in the case of large amplitude shock waves. In particular we give a rigorous justification to the formation of so-called Zeldovich spikes, meaning that the temperature profile exhibits an overshoot behind the shock. This is a joint work with T. Goudon, P. Lafitte and C. Lin.

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MS20
Shock Reflection and Free Boundary Problems

Shocks in gas or compressible fluid arise in various physical situations, and often exhibit complex structures, which present fundamental multidimensional phenomena in hyperbolic conservation laws. One example is reflection of shock by a wedge. Experimental and computational works have shown that various patterns of reflected shocks may occur, including regular and Mach reflection. In this talk we discuss some results on existence, regularity and geometric properties of regular reflection solutions for potential flow equation. The approach is to reduce the shock reflection problem to a free boundary problem for a nonlinear equation of mixed elliptic-hyperbolic type. Open problems will also be discussed.

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MS20
Instability Theory of Navier-Stokes-Poisson System

We establish a linear and a nonlinear instability for the Lane-Emden solutions of the Navier-Stokes-Poisson system for $6/5 < \gamma < 4/3$ in the spherically symmetric motion. This is a joint work with Ian Tice.

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MS20
Dynamics of a Density Discontinuity in Compressible, Viscous Fluid Flows

In this talk we will discuss some geometric properties of an interface of jump discontinuity of the density of a fluid flow in the model of the Navier-Stokes equations. We show that at the points where the interface meets the boundary, where the flow is subjected to Navier boundary conditions, the velocity field has a weak singularity that instantaneously changes the type of the tangency from transversal to tangent.

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MS21
Strichartz Estimates in Polygonal Domains

Strichartz inequalities are a family of space time $L^p$ estimates for the wave equation in that rely on the decay properties of solutions. They are of interest due to their applications to nonlinear equations. These estimates are best understood when the equation is posed over all of Euclidean space. However, the situation is more intricate when one starts to consider boundary value problems. This is due to the fact that boundary conditions affect the flow of energy. When the equation is posed on a polygonal domain, diffractive effects coming from interaction with the corners further complicate matters. Nonetheless, we will see that such inequalities are valid in this context. This is a joint work with G.A. Ford and J. Marzuola.

Matthew Blair
MS21  
Wave Propagation on Square Lattices

We study dispersive estimates for the wave equation on a square lattice with non-isotropic coupling between nodes. Areas of minimal dispersion occur at critical values of the velocity function for plane waves, with the time-decay exponent determined by the type of degeneracy present at the critical value. For the two-dimensional lattice, there exists a unique critical velocity (up to mirror symmetries) along which wavefronts propagate with amplitude $|t|^{-3/4}$.

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MS21  
Phase-driven Interaction of Widely Separated Nonlinear Schrödinger Solitons

We show that, for the 1d cubic NLS equation, widely separated equal amplitude in-phase solitons attract and opposite-phase solitons repel. Our result gives an exact description of the evolution of the two solitons valid until the solitons have moved a distance comparable to the logarithm of the initial separation. Our method does not use the inverse scattering theory and should be applicable to nonintegrable equations with local nonlinearities that support solitons with exponentially decaying tails. The result is presented as a special case of a general framework which also addresses, for example, the dynamics of single solitons subject to external forces.

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MS21  
Bounds on the Growth of High Sobolev Norms of Solutions to Nonlinear Schrödinger Equations

Abstract not available at time of publication.

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MS22  
A Generalized Rayleigh-Taylor Condition for the Two Phase Muskat Problem

The evolution of two fluid phases in a porous medium is studied. Two free interfaces which evolve in time separate the fluids from each other and the wetting phase from the air, respectively. The full problem is reduced to an abstract evolution equation for the interfaces. A generalised Rayleigh-Taylor condition characterizes the parabolicity regime of the problem and allows to establish a general well-posedness result and to study stability properties of flat steady-states. When considering surface tension effects at the interface between the fluids and when the less dense fluid lies beneath, bifurcating finger-shaped equilibria are shown to exist which are however all unstable.

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MS22  
On the Navier-Stokes Problem in Exterior Domains with Non-decaying Initial Data

We study the existence and uniqueness of regular solutions to the Navier-Stokes initial-boundary value problem with non-decaying bounded initial data, in a smooth exterior domain of $\mathbb{R}^n$, $n \geq 3$. The pressure field, $p$, associated to these solutions may grow, for large $|x|$, as $O(|x|^{n/2})$, for some $\gamma \in (0,1)$. Our class of existence is sharp for well posedness, in that we show that uniqueness fails if $p$ has a linear growth at infinity. We also provide a sufficient condition on the spatial growth of $\nabla p$ for the boundedness of $v$, at all times. Also this latter result is shown to be sharp.

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MS22  
Analysis of the Spin-coating Process

In this talk we investigate analytically the evolution of a small drop of liquid which is placed on the center of a rotating disc. Considering the above problem as a one- or two-phase free boundary value problem for Newtonian or generalized Newtonian fluids subject to surface tension and rotational forces, we prove that $T > 0$ there exists a unique, strong solution to this problem on $(0,T)$ provided the data are small enough is suitable norms.

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MS22  
Stochastic Stability of the Ekman Spiral

We consider the Navier-Stokes equations with Coriolis term with periodic boundary conditions perturbed by a cylindrical Wiener process. Weak and stationary martingale solutions to the associated stochastic evolution equation are constructed. The time-invariant distribution of the stationary martingale solution can be interpreted as the long-time statistics of random fluctuations of the stochastic evolution around the Ekman spiral, which is an explicit stationary solution of the Navier-Stokes equations with Coriolis term.

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MS23  
Homogenization of $L^{\infty}$ Variational Problems in Random Media

In joint work with Souganidis, we introduce a new compari-
son principle for Eikonal equations in exterior domains. As a consequence, we are able to homogenize $L^\infty$ variational problems (and in particular the Aronsson equation) in self-averaging (i.e., periodic, almost periodic, and stationary ergodic) environments.

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MS23
Existence and Duality for $L^\infty$ Optimal Transport

I will discuss an existence result (obtained in collaboration with Thierry Champion and Petri Juutinen) for the optimal transportation problem in which the cost is given by the essential sup instead of an integral. I will point at some evidence that, although the problem is not convex, there must be some kind of hidden duality. I will propose some recent development in this direction.

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MS23
American Option Tug-of-War and the Infinity Laplacian; A Free Boundary Problem

We consider American option tug-of-war and its application to the problem of proving the existence of extensions of boundary functions satisfying the infinity Laplacian equation which are constrained to lie above an obstacle. We consider the usual two player tug-of-war game played in $\mathbb{R}^n$ with the added constraint that one player may end the game at any time and collect the value of the obstacle function. We prove that the limit as $\varepsilon\to 0$ satisfies the infinity Laplacian equation.

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MS23
Calibration Method for Infinity Harmonic Functions

In this talk, I will describe a calibration scheme corresponding to infinity harmonic functions and illustrate an application to the removable isolated singularity of infinity harmonic functions. This is a joint work with Thierry De Pauw.

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MS24
Magnetic Interaction Morawetz Estimates and Applications

We establish an interaction Morawetz estimate for the magnetic Schrödinger equation under certain smallness conditions on the gauge potentials. We discuss applications to wellposedness and scattering.

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MS24
A Factorization Method for a Non-symmetric Linear Operator: Enlargement of the Functional Space while Preserving Hypo-coercivity.

We present a factorization method for non-symmetric linear operators: the method allows to enlarge functional spaces while preserving spectral properties for the considered operators. In particular, spectral gap and related convergence towards equilibrium follow easily by hypo-coercivity and resolvent estimates. Applications of this theory to several kinetic equations will be presented.

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MS24
On Aleksandrov-Bakelman-Pucci Type Estimates for Integro-Differential Equations (comparison theorems with measurable ingredients)

Despite much recent (and not so recent) attention to solutions of integro-differential equations of elliptic type, it is surprising that a fundamental result such as a comparison theorem which can deal with only measure theoretic norms of the right hand side of the equation ($L^n$ and $L^\infty$) has gone unexplored. For the case of second order equations this result is known as the Aleksandrov-Bakelman-Pucci estimate (and dates back to circa 1960s), which says that for supersolutions of uniformly elliptic equation $Lu=f$, the supremum of $u$ is controlled by the $L^n$ norm of $f$ ($n$ being the underlying dimension of the domain). We discuss extensions of this estimate to fully nonlinear integro-differential equations and present a recent result in this direction. (Joint with Nestor Guillen, available at arXiv:1101.0279v [math.AP])

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MS24
Global Solutions to a Non-local Diffusion Equation with Quadratic Non-linearity

In this talk we will present our recent proof of the global in time well-posedness of the following non-local diffusion equation with $\alpha \in [0, 2/3)$:

$$\partial_t u = \left((\Delta)^{-1}u\right) \Delta u + \alpha u^2,$$

The initial condition is positive, radial, and non-increasing; these conditions are propagated by the equation. There is however no size restriction on the initial data. This model
problem is of interest due to its structural similarity with Landau’s equation from plasma physics, and moreover its radically different behavior from the semi-linear Heat equation with quadratic non-linearity. This is a joint work with Joachim Krieger.

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MS25
The Vortex-Wave Equation as the Limit of the Euler Equation

The Wave-Vortex system was introduced by Marchioro and Pulvirenti to model point vortex motion in an inviscid fluid. It consists of a PDE describing the vorticity of the inviscid fluid coupled to ODEs that describe the point vortex motion. In this talk we will discuss the physical justification for such a model. In particular, we will discuss how a sequence of solutions for the Euler equation in the plane converges to a solution of the Vortex-Wave equation.

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MS25
Self-similar Asymptotics of Solutions to Navier-Stokes System in Two Dimensional Exterior Domain

We show how to construct a family of initial velocities such that the large time behavior of corresponding solutions to the initial-boundary value problem for Navier-Stokes equations in a two dimensional exterior domain is described by the Lamb-Oseen vortex. The later is the well-known explicit self-similar solution to the Navier-Stokes system in the whole space $\mathbb{R}^3$.

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MS25
Weak Solutions to the Vortex-Wave System

The vortex-wave system is the coupling of the 2D vorticity equation with the point vortex system. In 2009, Lacave and Miot proved uniqueness of weak solutions to this system for initial configurations where the continuous part of the vorticity is constant near the initial position of the point vortices. There have been several developments following Lacave and Miot’s work, which include existence of weak solution for initial vorticity in $L^p$ and convergence of approximations coming from the vortex blob method, by C. Bjorland. In this talk, we report on two new results: convergence of approximations coming from the Euler-α system, joint work with E. de Moura, and existence of particle trajectories for the $L^p$ weak solutions.

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MS25
Vortex Layers of Small Thickness

In this talk we shall treat the case of a planar inviscid flow with initial datum of vortex layer-type: vorticity of $O(\epsilon^{-1})$ is concentrated on a layer of thickness $\epsilon$ in such a way that, in the limit $\epsilon \to 0$, the vorticity distribution converges to a $\delta$-function concentrated on a curve. In an analytic functional setting we shall prove that the Euler equation are well-posed for a time that does not depend on the thickness of the layer. This is a generalization of the result of D.Benedetto and M.Pulvirenti, SIAM J. Appl. Math. 52 (1992), where the authors considered the case of vortex layers of uniform vorticity. We shall also discuss the possibility of using our result as a step toward the justification of the Birkhoff-Rott equation starting from the Navier-Stokes equations.

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MS26
On a Critical Leray-alpha Model of Turbulence: Regularity and Singularity Issues

In this talk, we prove the existence of a unique weak solution to turbulent flows governed by the Leray-alpha model with critical regularization. When alpha tends to zero, we prove that the Leray alpha solution, with critical regularization, gives rise to a suitable solution to the Navier Stokes equations. We consider also the subcritical case where we establish the upper estimate of the Hausdorff dimension of the possible times at which the singularity can occur.

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MS26
A New Blow-up Criterion for the 2D Boussinesq and 3D Euler Equations: Analytical and Numerical Results

Recently, the Voigt-regularization–related to the alpha-models of turbulent flows–has been investigated as a regularization of various fluid models. It overcomes many of the problems present in other alpha-models. Moreover, in studying the limit as the regularization parameter tends to zero, a new criterion for the finite-time blow-up of the original equations arises. I will discuss recent analytical and numerical work on the Voigt-regularization in the context of the 3D Euler and 2D Boussinesq equations.

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MS26
Global well-posedness for the 2D Boussinesq System without Heat Diffusion with Anisotropic Vis-
Models of Turbulence

This talk is on an extension of the analysis of Katz and Pavlović on partial regularity of hyper-dissipative Navier-Stokes equations, to include cases where the nonlinear term is suitably regularized. This family captures most of the specific regularized alpha-type models that have been proposed and analyzed in the literature, including the the Navier-Stokes-alpha model, the Leray-alpha model, the modified Leray-alpha model, and certain MHD-alpha models, etc. The bounds are functions of the spatial dimension and of the three parameters characterizing the principal smoothing operators, and we recover the Katz-Pavlović results in 3 dimension and for one specific combination of the three remaining parameters.

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MS27
Limiting PDEs of a Vicsek-type Flocking Model

Interacting particle models have been widely applied in recent years, particularly for simulating the collective dynamics of many cooperative organisms. These models present interesting mathematical challenges, since the number of interacting organism is often quite large. As the system becomes larger, it becomes more expensive to use interacting particles and so the question lies in how to describe the complex dynamics at a macroscopic level without losing important microscopic effects. Here, we will formally derive limiting PDEs for a model that has been used to study fish schooling and other flocking dynamics.

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MS27
A Primer of Swarm Equilibria

We study equilibrium configurations of swarming biological organisms subject to exogenous and pairwise endogenous forces. Beginning with a discrete dynamical model, we derive a variational description of the continuum population density. Equilibrium solutions are extrema of an energy functional, and satisfy a Fredholm integral equation. We find conditions for the extrema to be local minimizers, global minimizers, and minimizers with respect to infinitesimal Lagrangian displacements of mass. In one spatial dimension, for a variety of exogenous forces, endogenous forces, and domain configurations, we find exact analytical expressions for the equilibria. These agree closely with numerical simulations of the underlying discrete model. The exact solutions provide a sampling of the wide variety of equilibrium configurations possible within our general swarm modeling framework. The equilibria typically are compactly supported and may contain δ-concentrations or...
jump discontinuities at the edge of the support. We apply our methods to a model of locust swarms, which are observed in nature to consist of a concentrated population on the ground separated from an airborne group. Our model can reproduce this configuration; quasi-two-dimensionality of the model plays a critical role.

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MS27
Swarm Dynamics and Equilibria for a Nonlocal Aggregation Model

We consider the aggregation equation \( \rho_t - \nabla \cdot (\nabla K * \rho) = 0 \) in \( \mathbb{R}^n \), where the interaction potential \( K \) models short-range repulsion and long-range attraction. We study a family of interaction potentials for which the equilibria are of finite density and compact support. We show global well-posedness of solutions and investigate analytically and numerically the equilibria and their global stability. In particular, we consider a potential for which the corresponding equilibrium solutions are of uniform density inside a ball of \( \mathbb{R}^n \) and zero outside. For such a potential, various explicit calculations can be carried out in detail. In one dimension we fully solve the temporal dynamics, and in two or higher dimensions we show the global stability of this steady state within the class of radially symmetric solutions.

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MS27
Mathematical Models for Phototaxis

Certain organisms undergo phototaxis, that is they migrate toward light. In this talk we will discuss our recent results on modeling phototaxis in order to understand the functionality of the cell and how the motion of individual cells is translated into emerging patterns on macroscopic scales. This is a joint work with Amanda Galante, Susanne Wisen, Tiago Requeijo, and Devaki Bhaya.

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MS28
Singularity Formations for a Surface Wave Model

In this talk we discuss the Burgers equation with a Hilbert transform. This system has been considered as a quadratic approximation for the dynamics of a free boundary of a vortex patch. We prove blow-up in finite time for a large class of initial data with finite energy.

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MS28
Pressure Beneath a Periodic Traveling Water Wave

Consider periodic two-dimensional gravity water waves propagating in irrotational flow at constant speed at the surface of water with a flat bed. Then the pressure in the fluid strictly decreases horizontally away from the crest line and strictly increases with depth. Moreover, along each streamline the horizontal velocity strictly decreases away from the crest line. These results have been obtained as joint work with Walter Strauss.

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MS28
Stability of Current Vortex Sheets in Incompressible Magnetohydrodynamics

We consider the free boundary problem for current-vortex sheets in ideal incompressible magneto-hydrodynamics. It is known that current-vortex sheets may be at most weakly (neutrally) stable due to the existence of surface waves solutions to the linearized equations. The existence of such waves may yield a loss of derivatives in the energy estimate of the solution with respect to the source terms. However, under a suitable stability condition satisfied at each point of the initial discontinuity and a flatness condition on the initial front, we prove an a priori estimate in Sobolev spaces for smooth solutions with no loss of derivatives. The result of this paper gives some hope for proving the local existence of smooth current-vortex sheets without resorting to a Nash-Moser iteration. Such result would be a rigorous confirmation of the stabilizing effect of the magnetic field on Kelvin-Helmholtz instabilities, which is well known in astrophysics.

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MS28
Stability Issues for Interfacial Flows

We analyze various mechanisms of the propagation of interfacial waves (such as Kelvin-Helmholtz instabilities) and show how these mechanisms allow us to explain various physical phenomena, and in particular internal waves in the ocean.

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MS29
Asymptotic Analysis of the Navier-Stokes Equations in a General Bounded Domain with Non-characteristic Boundaries

We consider the Navier-Stokes equations of an incompress-
ible fluid, when the viscosity is small, in a three-dimensional curved domain with permeable walls. Thanks to the curvilinear coordinate system, adapted to the boundary, we construct corrector functions which allow us to obtain asymptotic expansions of the Navier-Stokes solutions. Then, using the asymptotic expansions, we prove that the Navier-Stokes solutions converge, as the viscosity parameter tends to zero, to the corresponding Euler solution in the natural energy norm.

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MS29  
Boundary Layer Correctors for Curved Boundaries

I discuss the use of principal curvature coordinates in the construction of boundary layer correctors, discussing, as a specific example, the corrector for the Navier-Stokes Equations with generalized Navier boundary conditions.

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MS29  
Global Existence for the Dissipative Critical Surface Quasi-geostrophic Equation

In this talk, we study the critical dissipative (SGQ) equation. We show the global existence for large initial data in a space close to the space of uniformly locally square integrable functions. The proof is based on an energy inequality verified by the truncated and regularized equation.

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MS29  
Initial and Boundary Value Problems for Some Equations from Geophysical Fluid Mechanics

In this lecture we present some existence and uniqueness results for initial and boundary value problems for the linearized two-dimensional inviscid shallow water equations in a rectangle. We will also give some indications on the nonlinear equation in space dimension one.

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MS29  
Examples of Boundary Layers Associated with the Incompressible Navier-Stokes Equations

Boundary layer associated with slightly viscous fluid is one of the most challenging problem in applied analysis and fluid mechanics. We survey a few examples of boundary layers for which the Prandtl boundary layer theory can be rigorously validated. All of them are associated with the incompressible Navier-Stokes equations for Newtonian fluids equipped with various Dirichlet boundary conditions (specified velocity). These examples include a family of (nonlinear 3D) plane parallel flows, a family of (nonlinear) parallel pipe flows, as well as flows with uniform injection and suction at the boundary. We also identify a key ingredient in establishing the validity of the Prandtl type theory, i.e., a spectral constraint on the approximate solution to the Navier-Stokes system constructed by combining the inviscid solution and the solution to the Prandtl type system. This is an additional difficulty besides the well-known issue related to the well-posedness of the Prandtl type system. It seems that the main obstruction to the verification of the spectral constraint condition is the possible separation of boundary layers. A common theme of these examples is the inhibition of separation of boundary layers either via suppressing the velocity normal to the boundary or by injection and suction at the boundary so that the spectral constraint can be verified. A meta theorem is then presented which covers all the cases considered here.

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MS30  
Vortex Density Models for 3d Superconductors and Superfluids

I will discuss a class of models that describe the distribution of vortex lines in 3d superconductors and superfluids in certain asymptotic limits. These models give rise to associated variational problems that can be viewed as nonlocal, vector-valued generalizations of the classical obstacle problem.

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MS30  
Singular Perturbation Models in Phase Transitions for Second Order Materials

In this talk we discuss a variational model proposed in the physics literature to describe the onset of pattern formation in two-component bilayer membranes and amphiphilic monolayers. This leads to the analysis of a Ginzburg-
Landau type energy, precisely,
\[ u \mapsto \int_{\Omega} \left[ W(u) - q |\nabla u|^2 + |\nabla^2 u|^2 \right] \, dx. \]

When the stiffness coefficient \(-q\) is negative, one expects curvature instabilities of the membrane and, in turn, these instabilities generate a pattern of domains that differ both in composition and in local curvature. Scaling arguments motivate the study of the family of singular perturbed energies
\[ u \mapsto F_\varepsilon(u, \Omega) := \int_{\Omega} \left[ \frac{1}{\varepsilon} W(u) - q \varepsilon |\nabla u|^2 + \varepsilon^3 |\nabla^2 u|^2 \right] \, dx. \]

Here, the asymptotic behavior of \( \{ F_\varepsilon \} \) is studied using \( \Gamma \)-convergence techniques. In particular, compactness results and an integral representation of the limit energy are obtained.

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MS30
The Effect of Small Inclusion is Sometimes Not Small

In this talk, we discuss the phenomena of resonance in cloaking for the Helmholtz equation where the effect of small inclusions is sometimes not small and the energy of the solution can go to infinity. Consequently, cloaking is not achieved and the energy of the solution is not finite in some cases. This is unexpected in the literature.

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MS30
Ginzburg-Landau Vortex Dynamics with Pinning and Strong Currents

We study a mixed heat and Schrödinger Ginzburg-Landau evolution equation that is meant to model a superconductor containing impurities and subjected to an applied electric current and electromagnetic field. Such a current is expected to set the vortices in motion, while the pinning term drives them toward minima of the pinning potential and “pins” them there. We derive the limiting dynamics of a finite number of vortices in the limit of a large Ginzburg-Landau parameter, or \( \varepsilon \to 0 \), when the intensity of the electric current and applied magnetic field on the boundary scale like \( |\log \varepsilon| \). We show that the limiting velocity of the vortices is the sum of a Lorentz force, due to the current, and a pinning force. Comparing the two then allows us to identify the “critical depinning current.”

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MS31
Numerical Analysis of the Equations of Liquid Crystal Elastomers

We present a finite element analysis of the partial differential equations modeling the static behavior of liquid crystal elastomers. These equations are critical points of the energy that couples the Blundon-Terentjev-Warner elastic free energy of the elastomer with the Landau-deGennes model of liquid crystals. We apply the equations for the compressible elastomer to model phase transitions in actin filament systems.

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MS31
Some Results of the Incompressible Magnetohydrodynamic Flow

Abstract not available at time of publication.

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MS31
Second Order Unconditionally Stable Schemes for Models of Thin Film Epitaxy

Abstract not available at time of publication

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MS31
Blow Up Criterion for Compressible Nematic Liquid Crystal Flows in Dimension Three

We consider the short time strong solution to a simplified hydrodynamic flow modeling the compressible, nematic liquid crystal materials in dimension three. We establish a criterion for possible breakdown of such solutions at finite time in terms of the temporal integral of both the maximum norm of the deformation tensor of velocity gradient and the square of maximum norm of gradient of liquid crystal director field.

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MS31

In this paper we investigate the interplay between certain physical relations—namely, Leslie’s relations and, more imp-
portantly, Parodi’s relation—and the wellposedness of the general Ericksen-Leslis system modeling nematic liquid crystal flow. We prove the existence of global classical solutions under assumption of large viscosity and show that Parodi’s relation is not a necessary condition in this case. Then we study the near equilibrium case, and reveal that Parodi’s relation serves as a stability condition for the liquid crystal system.

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MS32  
Traveling Waves in Capillary Fluids

We are interested in compressible, inviscid fluids whose energy depends not only on their density but also on their density gradient. The main purpose of the talk is to investigate the correspondence between traveling waves in Eulerian coordinates and those in Lagrangian coordinates, from both the existence and stability points of view. Under most general assumptions on the energy law, three types of waves will be considered, namely, heteroclinic, homoclinic, and periodic ones.

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MS32  
Some Local Well-posedness Results Related to Multi-fluid System

In this talk, we will present some recent mathematical features around multi-fluid models. Such systems may be encountered for instance to model internal waves, violent aerated flows, oil-and-gas mixtures. Depending on the context, the models used for simulation may greatly differ. However averaged models share the same structure. Here, we address the question whether available mathematical results in the case of a single fluid governed by compressible equations for single flow may be extended to multi-phase models. This is based on joint works with B. Desjardins, J.-M. Ghidaglia, E. Grenier and M. Renardy.

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MS32  
Dynamics of Shock Fronts for Some Hyperbolic Systems

Abstract not available at time of publication.

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MS32  
Vanishing Viscosity Limit for Isentropic Navier-Stokes Equations

Abstract not available at time of publication.

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MS32  
On Global Solutions to the Three-dimensional Magnetohydrodynamics

The three-dimensional compressible and incompressible magnetohydrodynamics (MHD) will be considered. Global weak solution, strong solutions, and incompressible limits will be discussed.

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MS32  
Asymptotic Behavior of Fragmentation-drift Equations with Variable Drift Rates

We will describe the asymptotic behavior of solutions to the growth-fragmentation equations with variable drift rates. For this, we give detailed estimates of the steady state and of the solution to the associated dual problem which gives the weight in the conserved quantity of the system. Convergence of solutions to a steady state is investigated through the study of an entropy functional.

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MS33  
Entropy Methods for Fragmentation Equations

We show how entropy-entropy dissipation inequalities may be used in the study of the speed of convergence to equilibrium for some equations involving a fragmentation term.

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**MS33**

**Optimization of the Fragmentation for a Prion Proliferation Model**

The prion proteins cause transmissible spongiform encephalopathies when they aggregate under their abnormal form. The in vitro amplification of prion proteins is a key point for diagnosis purposes. This problem is modeled by a growth-fragmentation equation with a control parameter in front of the fragmentation operator. The optimization problem is to find the control which maximizes the growth of the quantity of proteins. To this end, we first compare constant controls with periodic controls.

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**MS33**

**$L^1$ Rate of Convergence to Self-similarity for the Fragmentation Equation**

We present a general “factorization” method which makes possible to enlarge the functional space of decay estimates on a semigroup from a “small” Hilbert space to a “larger” Banach space. This method applies to a class of PDE operators writing as a “regularizing” part plus a dissipative part. Next, we explain how we may apply that result to the case of the fragmentation equation and deduce a $L^1$ rate of convergence to self-similarity for the solutions to the fragmentation equation.

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**MS34**

**Energetic Variational Approaches and Related Issues for Ionic Fluids and Ion Channels**

In this talk, we will discuss some specific issues arising from the energetic variational approaches in modeling the ionic fluids and ion channels. We will emphasize on the analytical issues, such as the existence, stability and specific boundary conditions to these problems.

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**MS34**

**Numerical Approximation of the Euler-Poisson-Boltzmann Model in the Quasineutral Limit**

This work analyzes various schemes for the Euler-Poisson-Boltzmann (EPB) model of plasma physics. This model consists of the pressureless gas dynamics equations coupled with the Poisson equation and where the Boltzmann relation relates the potential to the electron density. If the quasi-neutral assumption is made, the Poisson equation is replaced by the constraint of zero local charge and the model reduces to the Isothermal Compressible Euler (ICE) model. We compare a numerical strategy based on the EPB model to a strategy using a reformulation (called REPB formulation). The REPB scheme captures the quasi-neutral limit more accurately. This is a joint work with P. Degond, D. Savelief and M-H. Vignal.

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**MS34**

**A Three-Dimensional Model of Electrodiffusion and Osmosis in Cells and Tissues**

We introduce a system of PDEs model that describes that seamlessly couples electrodiffusion and osmosis and in the presence of deforming membranes. A salient feature of this model is that it satisfies a natural free energy identity. We discuss how this free energy identity has led to the resolution of a longstanding question on the stability of steady states of pump-leak models of cell volume control.

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**MS34**

**Mean-Filed Description of Ionic Size Effects with Non-Uniform Ionic Sizes: A Numerical Approach**

This work begins with a variational formulation of electrostatic free energy that includes ionic size effects and develops numerical methods for the resulting optimization problems. Numerical tests demonstrate that the model and method capture many interesting phenomena, such as the stratification of multivalent counterions near a charged surface, that are not well described by the classical or size-modified Poisson–Boltzmann theory.

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**MS35**

**Wiener Test for the Regularity of Infinity for Elliptic Equations with Measurable Coefficients and its Consequences**

We introduce a notion of regularity (or irregularity) of the point at infinity ($\infty$) for the unbounded open set $\Omega \subset \mathbb{R}^N$ concerning second order uniformly elliptic equations with bounded and measurable coefficients, according as whether the $A$-harmonic measure of $\infty$ is zero (or positive). A necessary and sufficient condition for the existence of a unique bounded solution to the Dirichlet problem in an arbitrary
open set of $\mathbb{R}^n$, $N \geq 3$ is established in terms of the Wiener test for the regularity of $\infty$. It coincides with the Wiener test for the regularity of $\infty$ in the case of Laplace equation. From the topological point of view, the Wiener test at $\infty$ presents thinness criteria of sets near $\infty$ in fine topology. Precisely, the open set is a deleted neighborhood of $\infty$ in fine topology if and only if $\infty$ is irregular.

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**MS35**  
**On the Inverse Stefan Problem**

We develop a new variational formulation of the inverse Stefan problem, where information on the heat flux on the fixed boundary is missing and must be found along with temperature and free boundary. We formulate the inverse Stefan problem as an optimal control problem which takes into account the inaccuracy of the phase transition temperature. We prove well-posedness, Frechet differentiability and convergence of discrete optimal control problems to the original problem in functional and in control.

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**MS35**  
**The $L^p$ continuity of the Riesz Transforms Associated with a Subelliptic Operator on a Smooth Manifold**

Abstract not available at time of publication.

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**MS35**  
**Elliptic Operators and Fractal Singularities**

Sub-elliptic and fractal operators, as to their metric and spectral properties, display kind of opposite non-Euclidean behavior. Elliptic operators may develop fractal singularities and in the process geometry undergoes wild changes while spectral measures converge. In our talk we show with examples that non-Euclidean features can be clarified within a common framework from abstract harmonic analysis, potential theory and Dirichlet forms, and the occurrence of fractal singularities can be regulated by asymptotic singular homogenization. This study is done in the perspective of applications to boundary value problems in small domains and large boundaries and is partly supported by NSF Grant DMS-0807840.

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**MS35**  
**A Finite Difference Approach to the Infinity Laplace Equation**

Abstract not available at time of publication.

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**MS36**  
**On Inertially Equivalent Dynamical Systems**

In the absence of an inertial manifold, a way of realizing an equivalent finite dimensional dynamical system was suggested in (1). The result ofFoias and Olson (2) on the existence of Holder continuous inverse for the Mane's projection has allowed the realization of this program. In (1), this approach was mainly considered for parabolic type PDE's. It was later extended to hyperbolic type of PDE's in (3). In fact, this general approach is adaptable to a variety of dynamical systems that arises from PDE's. Here we will consider its adaptation to a class of hyperbolic PDE's with operator coefficients that enjoy exponential attractors. This class was first considered in (4) where existence of an exponential attractor was established using alpha-contractions (see also (5)). This is joint work with V. Kalantarov. References. 1) A. Eden, C. Foias, B. Nicolaenko and R. Temam, Exponential Attractors for dissipative Evolution Equations, 1994, Paris, Masson Publications. 2) C. Foias, and E.J. Olson, "Finite fractal dimensions and Holder-Lipschitz parametrization", Indiana Univ. Math. J. 45 (1996) 603-616. 3) A. Eden, "Finite Dimensional Dynamics on the Attractors", in Proceedings of the Third International Palestinian Conference in Mathematics and Mathematics Education, editors: S. Elaydi, E.S.Titi, M. Saleh, S.K. Jain and R. Abu-Saris, World Scientific, 90-97, 2002. 4) A. Eden and V. Kalantarov, "Finite dimensional attractors for a class of semilinear wave equations", Turkish Journal of Mathematics, 20 (1996) 3, 425-450. 5) A. Eden, C. Foias and V. Kalantarov "A remark on two constructions of exponential attractors for -contractions", Journal of Dynamics and Differential Equations, 10 (1998) 1, 37-45.

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**MS36**  
**Long Time Behavior of Solutions to Flow-Structure Interactions Arising in Modeling of Subsonic Owls of Gas**

We shall consider a model of ow-structure interaction which consists of perturbed wave equation coupled with a nonlinear plate. The interaction between two media takes place on the edge of the plate with the dissipation occurring in a small layer near the edge of the plate. We shall consider both subsonic and supersonic case. It is known that in the latter case the static problem loses ellipticity. Questions such as existence and uniqueness of finite energy solutions will be addressed first. The final goal is to determine ge-
ometric conditions for the configuration which would lead to existence of global attractors capturing solutions near the structure (wing of the airplane). The proofs rely on weighted energy methods with suitably constructed geometric multipliers combined with microlocal analysis. This is joint talk with Justin Webster, University of Virginia.

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MS36
A Cahn-Hilliard Model with Dynamic Boundary Conditions

Our aim in this talk is to discuss the dynamical system associated with the Cahn-Hilliard equation with dynamic boundary conditions. Such boundary conditions take into account the interactions with the walls for confined systems. We are in particular interested in a model which accounts for the conservation of mass, both in the bulk and on the walls.

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MS36
Counterexamples in the Attractors Theory

A number of known and new examples/counterexamples related with global/exponential attractors and inertial manifolds will be discussed. These examples indicate the limitations of the theory and show the sharpness of the results previously obtained. In particular, in the class of abstract semilinear equations, we present an example of a global attractor which cannot be embedded in any finite-dimensional Lipschitz or log-Lipschitz manifold. In addition, in the class of abstract semilinear damped wave equation, we give an example of a regular (exponential) attractor whose Hausdorff dimension equals two and the fractal (box-counting) dimension is greater than two and is not the same in different Sobolev spaces.

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MS37
Time-like Willmore Surfaces in Minkowski Space

Willmore surfaces $X$ arise as critical points of the so-called Willmore energy $W(X) = \int H^2 \, dA$ and they satisfy the fourth order Euler-Lagrange equation $\Delta H + 2H(H^2 - K) = 0$. Here, $H$ and $K$ are mean and Gaussian curvature of $X$ and $\Delta$ is the Laplace-Betrami operator. In case of time-like surfaces in Minkowski space $R^{2,1}$, this Laplace-Betrami operator is of hyperbolic type. By replacing fourth order Euler-Lagrange equation by an equivalent second order, quasilinear, hyperbolic system, we prove existence and uniqueness of time-like Willmore surfaces subject to geometric Cauchy initial conditions. The uniqueness part will also be used to deduce symmetry properties of the solution, assuming corresponding symmetry conditions on the initial data.

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MS37
Compactness and Stability Issues for Fourth Order Elliptic PDEs

I will discuss the notion of stability for elliptic PDEs. This notion of stability is rather new and concerns the sets of all solutions of a PDE and of perturbations of it. I will focus on results for second order equations and raise some questions for fourth-order equations.

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MS37
On Equilibria and Stability of the Axisymmetric Surface Diffusion Flow

Surface Diffusion is a geometric evolution law which dictates that the normal velocity on a surface is equal to the surface laplacian acting on the mean curvature. We consider the case of axisymmetric surfaces, with periodic boundary conditions, evolving according to the surface diffusion flow. We discuss well-posedness and stability/instability of cylinders, which are equilibria in this setting.

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MS37
Maximal Time Estimate for Fourth Order Geometric Flows

We consider closed immersed surfaces evolving by a class of fourth order surface diffusion type flows. Our result, similar to earlier results for the Willmore flow and constrained surface diffusion flows gives both a positive lower bound on the maximal existence time and a total curvature bound during this time. This is joint work with Glen Wheeler and Min-Chun Hong.

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MS38
Existence of Ground States for Fourth-order Wave Equations

Focusing on the fourth-order wave equation $u_{tt} + \Delta^2 u + f(u) = 0$, we prove the existence of ground state solutions $u = u(x + ct)$ for an optimal range of speeds $c \in R^n$ and a
MS38
Existence and Stability of Viscous Profiles in a Nonlinear System of Viscoelasticity

We investigate existence and stability of viscoelastic shock profiles for a class of planar models including the incompressible shear case studied by Antman and Malek-Madani. We establish that the resulting equations fall into the class of symmetrizable hyperbolic-parabolic systems, hence spectral stability implies linearized and nonlinear stability with sharp rates of decay. The new contributions are treatment of the compressible case, formulation of a rigorous nonlinear stability theory, including verification of stability of small-amplitude Lax shocks, and the systematic incorporation in our investigations of numerical Evans function computations determining stability of large-amplitude and or nonclassical type shock profiles. This is a joint work with Blake Baker and Kevin Zumbrun.

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MS38
Existence and Regularity for a Coupled Kinetic-hyperbolic Model of Plasma Dynamics

The fundamental description of a collisionless plasma is given by the Vlasov-Maxwell (VM) equations. When relativistic velocity effects are absent in the model, the existence and regularity of classical solutions to this system of nonlinear hyperbolic PDEs is still unknown, even for the lowest dimensional formulation. In this vein, we consider the one-dimensional problem with a coupled transport field equation which displays the identical difficulties as (VM) and present results concerning the regularity and behavior of solutions.

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MS38
Wellposedness for Some Nonlinear Wave Equations

New approaches have been recently developed to study existence of weak and strong solutions for semilinear wave equations. In this talk I will discuss a larger class of equations for which these methods could be implemented. In particular, an emphasis will be placed on the characteristics that are needed in order to ensure the solvability of the problems through these methods. These features include the existence of some conservation law (i.e. the existence of some nonincreasing, energy-type quantity) and a type of finite speed of propagation.

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MS39
Ergodic Properties of the Burgers Equation in the Noncompact Setting

Burgers equation is a basic hydrodynamic model. The ergodic theory of randomly forced Burgers equation is well-developed in the periodic setting, but understanding the ergodic properties of the Burgers equation in unbounded domains is a challenge. In this talk, I will describe the main ergodic component of the dynamics driven by Poissonian noise of finite total intensity.

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MS39
Potential Feedback and Regularization in Complex Fluid Models

Kinetic formulations of complex fluids can provide non-dissipative regularizing mechanisms that have natural physical interpretations. I will describe recent results in which global existence for arbitrary smooth admissible data follows from such regularization mechanisms.

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MS39
Well-Posedness Results for the Stochastic Primitive Equations of the Oceans and Atmosphere

The primitive equations are widely regarded as a fundamental description of geophysical scale fluid flows and forms the core of the most advanced numerical general circulation models (GCMs). This system may be derived from the compressible Navier-Stokes equations with a combination of empirical observation and scale analysis. In view of the wide progress made in computation the need has appeared to better understand and model some of the uncertainties which are contained in these GCMs. In this context stochastic modeling has appeared as one of the major modes in the contemporary evolution of the field. While the mathematical theory for the deterministic primitive equations is now on a firm ground it seems that very little has been done so far on its stochastic counterpart. For this and other nonlinear SPDE’s the issue of compactness remains a challenging problem especially for the case of nonlinear multiplicative noise. Moreover, notwithstanding the very recent global existence results in the 3D case, the PEs are technically more involved than the Navier-Stokes equations and thus present novel challenges in the stochastic setting. In this talk we discuss some recent work on the global existence and uniqueness of solutions of the primitive equations in both 2 and 3 spatial dimensions. This talk represents joint work with A. Debussche, R. Temam, and M. Ziane.

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MS39
Stochastic Burgers Equation with Random Initial Conditions

We prove a new existence theorem for solutions of Burgers equation on the unit interval with random initial conditions and driven by affine (additive + linear) noise. Our approach uses Malliavin calculus techniques. The existence theorem provides a dynamic characterization of solutions of the stochastic Burgers equation on its unstable invariant manifolds. Furthermore, as a corollary of the existence theorem, we show that random equilibrium points on the energy space correspond to (possibly non-ergodic) stationary solutions for the stochastic Burgers equation.

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MS39
Burgers Turbulence and Complete Integrability

A remarkable model of stochastic coalescence arises from considering shock statistics in scalar conservation laws with random initial data. While originally rooted in the study of Burgers turbulence, the model has deep connections to statistics, kinetic theory, random matrices, and completely integrable systems. The evolution takes the form of a Lax pair which, in addition to yielding interesting conserved quantities, admits some rather intriguing exact solutions. We discuss several distinct derivations for the evolution equation and properties of the corresponding kinetic system. This is joint work with Govind Menon (Brown University).

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MS40
Dynamics in Phase Field Models for Dilute Mixtures: A Gradient Flow Approach

It is well-known (heuristically) that motion by the Mullins-Sekerka free boundary problem converges to the solutions of the finite-dimensional Lifshitz-Slyozov-Wagner (LSW) system of ODEs in the dilute regime. Alikakos and Fusco have used direct PDE methods to prove examples of this convergence. Under certain assumptions, we prove a similar convergence result with purely energetic arguments. We exploit both the gradient flow structure of the dynamics as well as a Gamma-convergence result of Peletier and myself for the associated energies in the limit of small volume fraction. The two are bridged following the recent approach of Sandier and Serfaty. This is joint work with Nam Le (Columbia) and Mark Peletier (TU Eindhoven).

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MS40
Worm-like States in Pattern Forming Systems

This talk concerns long, narrow two dimensional domains which arise from one dimensional localized patterns. There are a rich set of associated dynamics, such as curve lengthening, buckling, and (infrequently) side-branching. Two examples are discussed. The first is the subcritical Ohta-Kawasaki energy which describes diblock copolymer mixtures. Rigorous scaling limits of the functional reveal that energy concentrates on lower dimensional sets, specifically curves. The asymptotic energy of the curves can be formally shown to consist of a negative line energy and a small elastic-type correction. The second example is the generic (variational) Swift-Hohenberg equation. The emergence of worm-like states can be tied to the existence and stability properties of one-dimensional localized patterns which have received considerable attention in recent years. Criteria are derived for the stability of quasi-one dimensional structures, and dynamics are analyzed in the limit of weak bending.

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MS40
Stability of Steady States and Asymptotic Behavior of Mean-field Models for Micro Phase Separation

We study the mean-field models for diblock copolymer melts, describing the evolution of distributions of particle radii obtained by taking the small volume fraction limit of the free boundary problem where micro phase separation results in an ensemble of small balls of one component. In the dilute case, we identify all the steady states and show the convergence of solutions.

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MS40
Population Adaptive Evolution and Concentration Dynamics

Living systems are subject to constant evolution through the three processes of population growth, selection and mutations, a principle established by C. Darwin. In a very simple, general and idealized description, their environment can be considered as a nutrient shared by all the population. This allows certain individuals, characterized by a ‘phenotypical trait’, to expand faster because they are better adapted to use the environment. This leads to select the ‘fittest trait’ in the population (singular point of the system). On the other hand, the new-born individuals undergo small variations of the trait under the effect of genetic mutations. In these circumstances, is it possible to describe the dynamical evolution of the current trait?

We will give a self-contained mathematical model of such dynamics, based on parabolic equations, and show that an asymptotic method allows us to formalize precisely the concepts of monomorphic or polymorphic population. Then, we can describe the evolution of the ‘fittest trait’ and eventually to compute various forms of branching points which represent the cohabitation of two different populations.

The concepts are based on the asymptotic analysis of the above mentioned parabolic equations once appropriately rescaled. This leads to concentrations of the solutions and
the difficulty is to evaluate the weight and position of the moving Dirac masses that describes the population. We will show that a new type of Hamilton-Jacobi equation, with constraints, naturally describes this asymptotic. Some additional theoretical questions as uniqueness for the limiting Hamilton-Jacobi equation will also be addressed.

This talk is based on collaborations with G. Barles, J. Carrillo, S. Cuadrado, O. Diekmann, M. Gauduchon, S. Genieys, P.-E. Jabin, S. Mirrahimi, S. Mischler and P. E. Souganidis.

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MS40
Results for a Nonlocal Isoperimetric Problem Related to Diblock Copolymers

I will discuss work with Ihsan Topaloglu on a nonlocal isoperimetric problem arising as the Gamma-limit of the Ohta-Kawasaki model for diblock co-polymers. Focus here is on identifying the global minimizer of the problem posed on the two-torus and on the two-sphere in the regime where the nonlocality is sufficiently small.

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MS41
On Dissipation Anomaly and Energy Cascades in 3D Incompressible Flows

We show, using a general setting for the study of energy cascade in physical scales of 3D incompressible flows recently introduced by the authors, that the anomalous dissipation is indeed capable of triggering the cascade which then continues ad infinitum, confirming Onsager’s predictions. We also use these settings to present mathematical evidence of dissipation anomaly in 3D turbulent flows.

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MS41
Ill-Posedness for the Magneto-geostrophic Equations

The magneto-geostrophic equation is an active scalar equation with a very singular drift velocity. We have proved that the "critical" equation is globally well-posed. In contrast, the non-diffusive and even a fractionally diffusive version of the equation is ill-posed in the sense of Hadamard. This is joint work with Vlad Vicol.

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MS41
Local and Global Existence of Smooth Solutions for the Stochastic Euler Equations on a Bounded Domain

We prove the local existence of pathwise solutions for the stochastic Euler equations in a three-dimensional bounded domain, with a general nonlinear multiplicative noise and slip boundary conditions. In the two-dimensional case we obtain the global existence of these solutions with additive or linear-multiplicative noise. Lastly, we show that linear multiplicative noise provides a regularizing effect in the sense that the global existence of solutions occurs with high probability if the initial data is sufficiently small or if the noise coefficient is sufficiently large.

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MS41
Linear Instability for Euler’s Equation - Two Classes of Perturbations

In this talk we will consider 2- and 3-dimensional Euler’s equation linearized at steady-state solutions and examine the growth of high frequency perturbations in two separate classes: those that preserve circulation and the corresponding factor space. Instability criteria for each type of perturbation will be established in the form of lower bounds for the essential spectral radius of the linear evolution operator restricted to each class.

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MS42
Stability of Planar Shock Fronts for Multi-d Systems of Relaxation Equations

We study stability of multidimensional planar shock profiles of a general hyperbolic relaxation system whose equilibrium model is a system, under the necessary assumption of spectral stability and a standard set of structural conditions that are known to hold for many physical systems. Our main result is to establish the bounds on the Green’s function for the linearized equation and obtain nonlinear $L^2$ asymptotic behavior/sharp decay rate of perturbed weak shock profiles. To establish Green’s function bounds, we use the semigroup approach in the low frequency regime, and use the energy method for the high frequency bounds, separately.

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**MS42**  
*Stationary Wave to the Symmetric Hyperbolic-parabolic System in Half Space*

In this talk, we consider the large-time behavior of solutions to the symmetric hyperbolic-parabolic system in the half space. For this system, we assume that all of characteristics are non-positive. We show the existence and asymptotic stability of the stationary solution (boundary layer solution) under the smallness assumption on the initial perturbation and the strength of the stationary solution. The key to proof is to derive the uniform a priori estimates by using the energy method under the stability condition of Shizuta–Kawashima type. The present talk is based on the joint research with Professor Shinya Nishibata at Tokyo Institute of Technology.

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**MS42**  
*Asymptotic Structure of Solutions to the Euler-Poisson Equations Arising in Plasma Physics*

The main concern of this talk is to analyze a phenomena that a boundary layer, called a sheath, occurs on the surface of materials with which plasma contacts. For a formation of the sheath, the Bohm criterion in plasma physics requires the ion velocity must be faster than a certain constant. We show that the Bohm criterion is a sufficient condition for the existence and the stability of the stationary solution to the Euler-Poisson equations.

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**MS42**  
*Decay Structure of Regularity-loss Type for Symmetric Hyperbolic Systems with Relaxation*

In this talk, we consider the initial value problem for symmetric hyperbolic systems with relaxation. When the systems satisfy the Shizuta-Kawashima condition, we can obtain the asymptotic stability result and the explicit rate of convergence. There are, however, some physical models which do not satisfy the Shizuta-Kawashima condition (cf. Timoshenko system, Euler-Maxwell system). Moreover, it had already known that the dissipative structure of these systems is weaker than the standard type. Our purpose of this talk is to construct a new condition which include the Shizuta-Kawashima condition, and to analyze the weak dissipative structure.

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**MS43**  
*On the Asymptotic Behavior of Variational Inequalities set in Cylinders*

We would like to study the asymptotic behaviour in \( \ell \) of the solution to elliptic variational inequalities set in generalised cylinders of the type \( \ell \omega_1 \times \omega_2 \) where \( \omega_1, \omega_2 \) are bounded open subsets of \( \mathbb{R}^{p}, \mathbb{R}^{n-p} \) respectively.

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**MS43**  
*A Ginzburg-Landau-type Model for Crystalline Lattice*

The structure of a Ginzburg-Landau (GL) model originally introduced to model superconductivity can be extended to describe a variety of other physical phenomena that involve ordered systems. The GL theory is particularly useful for understanding the behavior of structural defects - the regions of disorder that appear, e.g., for topological reasons. In my talk, I will discuss a macroscopic level GL-type model that arises in modeling of dislocations in a crystalline solid. The focus will be on establishing a connection between the coarse-grained model and it’s atomistic counterpart.

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**MS43**  
*Bubbling at the Boundary for Ginzburg-Landau equations*

In this talk we analyze Palais Smale sequences for the Ginzburg-Landau equations with semi-stiff boundary conditions and derive existence results for these equations. This is joint work with Leonid Berlyand and P.Mironescu.

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**MS44**

**Level-Set Flow for Capturing Unstable Geodesics on Surfaces**

The level-set method has been successfully applied to interface deformation problems in a variety of settings due to several inherent advantages it has in handling the motions of curves and surfaces. In this talk, we consider the classic problem in geometry of determining the geodesics of a given surface. For this purpose, we introduce a flow involving mean curvature and the Gauss-Bonnet formula for capturing a surface’s geodesics, notably the ones that are unstable. We apply the closest-point representation to handle complex surface geometries and the level-set representation to handle complex curve dynamics for the numerical calculation of these geodesics. We then conduct numerical experiments to verify that even unstable geodesics can be accurately found under our approach.

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**MS44**

**A Posteriori Error Estimates for a Surface FEM Based on an Outer Triangulation**

In this talk we describe a adaptive surface finite element method in which the surface mesh is obtained essentially by intersecting the continuous surface with an outer volume (bulk) mesh. Reliability and efficiency properties of the estimator are detailed. This is joint work with Maxim Olshanskii of Moscow State University.

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**MS44**

**Application of the Finite Element Exterior Calculus to the Equations of Linear Elasticity**

In this talk, we present an overview of how ideas from the finite element exterior calculus and the link between the de Rham complex and various forms of the elasticity complex can be used to obtain stable mixed finite element approximation schemes for the equations of linear elasticity. These include both schemes in which the stress tensor is symmetric and those in which the symmetry condition is only satisfied weakly. In recent years, a number of new methods have been proposed and analyzed by the authors and other researchers. The emphasis will be on the common framework used to develop these methods.

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**MS44**

**Multisymplectic Hamilton–Jacobi Theory and their Applications to Geometric Integration of Lagrangian Field Theories**

We present a derivation of the De Donder–Weyl Hamilton–Jacobi theory by considering a multisymplectic analogue of Jacobi’s solution. This is given by the action integral over a region of space-time, for a section of the configuration bundle which satisfies the Euler–Lagrange equations with prescribed fiber boundary conditions. This plays the role of the exact discrete Lagrangian in discrete Lagrangian mechanics, and can be viewed as a generating function of a multisymplectic relation. We demonstrate how this naturally leads to internal boundary conditions that allow piecewise solutions of the Euler–Lagrange field equations to be patched together in a multisymplectic fashion. In turn, this yields a framework for constructing geometric integration algorithms for Lagrangian field theories that can be implemented in a parallel and distributed fashion.

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**MS45**

**Incompressible Fluid Coupled with Nonlinear Elasticity**

The problem under consideration is the nonlinear coupling of Navier-Stokes and elasticity. I will present a completely new linearization, derived in view of the stability analysis. The linearization reveals the presence of the curvature on the common interface, which demonstrates that the free boundary plays a key role in the analysis of the coupled system and its influence can not be neglected.

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Jean-Paul Zolesio  
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Moving-boundary Problems of Mixed Type Arising in Modeling Blood Flow

We give a variational solution for the following MHD problem:

\[ (\zeta = \zeta^2, V) \in L^1(0, 1, H^r(D)) \times L^1(0, 1, L^1(D, R^3)) \]

Such that

\[ \frac{\partial}{\partial t}(\zeta V) + D(\zeta) V + \nabla p = E \times \text{curl} V + \mathcal{H}_r \nabla \zeta \]

\[ \text{div} V = 0, \quad \frac{\partial}{\partial t} \zeta + \nabla \zeta V = 0 \]

Where \( 0 < r < 1/2 \) and \( \mathcal{H}_r \) is the new Sobolev curvature introduced in [1] and based of the property of bounded perimeter sets whose characteristic function \( \zeta \in H^r(D), \forall r, 0 < r < 1/2 \). This new mean curvature turns to be the shape gradient of the shape differentiable sobolev perimeter. [1] Shape Morphic Metric, Operator Theory: Advances and Applications, Vol. 216, 343367, 2011 Springer Basel AG

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Global solutions to the Navier-Stokes-Vlasov-Fokker-Planck equations

In this talk, we consider the particle-spray model in combustion theory. The model is described by the Navier-Stokes-Vlasov equations and the coupled Fokker-Planck equation. At first, we consider the global-in-time existence of the weak solution for this model in two or three dimensions. And then we consider two dimensional Navier-Stokes-Vlasov-Fokker-Planck equations. For the equations, we can show that the global-in-time existence of the smooth solution. Also we consider three dimensional Vlasov-Stokes equations. This is the joint work with Myeongju Chae and Kyungkeun Kang.

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Boundary Regularity of Degenerate Elliptic Equations without Boundary Conditions

In this talk, we discuss a class of degenerate elliptic equations with a unique smooth solution (in any suitably smooth domain) without prescription of boundary condition. (In fact the equation degenerates on the entire boundary.) The results are similar to those for certain ordinary differential equations with regular singular points but the method of proof is very different.

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Thermosolutal Convection at Infinite Prandtl Number with or without Rotation: Bifurcation and Stability in Physical Space

We examine the nature of the thermosolutal convection with or without rotation in the infinite Prandtl number regime, which is applicable to magma chambers. The onset of bifurcation and the structure of the bifurcated solutions in this double diffusion problem are analyzed. The stress-free boundary condition is imposed at the top and bottom plates confining the fluid. For the rotation free case, 2-dimensional Boussinesq equations are considered and we prove that there are bifurcating solutions from the
basic solution and that the bifurcated solutions consist of only one cycle of steady state solutions that are homeomorphic to $S^1$. By thoroughly investigating the structure and transitions of the solutions of the thermosolutal convection problem in physical space, we confirm that the bifurcated solutions are indeed structurally stable. In the presence of rotation, we consider 3-dimensional Boussinesq equations and we can get similar results as of the rotation free case. We also see how intensively the rotation inhibits the onset of convective motion. In turn, this will corroborate and justify the suggested results with the physical findings about the presence of roll structure.

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MS46
Semi-hyperbolic Patches of Two Dimensional Riemann Problems

We study semi-hyperbolic patches of two dimensional Riemann problems. These patches are essential parts in understanding some configurations formed by the interaction of elementary waves like the interaction of 2 forward rarefaction waves and 2 backward rarefaction waves.

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MS46
The Sonic Line As a Free Boundary

We consider the steady transonic small disturbance equations on a domain and with data that lead to a solution that depends on a single variable. After writing down the solution, we show that it can also be found by using a hodograph transformation followed by a partial Fourier transform. This motivates considering perturbed problems that can be solved with the same technique. We identify a class of such problems.

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MS47
Some New Results for Reaction Cross-diffusion Equations

We introduce new results based on entropy methods and duality methods for systems of PDEs involving cross diffusion and reaction terms. Those equations model situations occurring in population dynamics when the diffusion rate of one species depends on the concentration of another species. The existence theory and the approximation by standard reaction-diffusion equations are revisited.

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MS47
P-gp Transfer and Acquired Multi-drug Resistance in Tumors Cells

Multi-Drug resistance for cancer cells as been a serious issue since several decades. In the past, many models have been proposed to describe this problem. These models use a discrete structured for the cancer cell population, and they may include some class of resistant, non resistant, and acquired resistant cells. Recently, this problem has received a more detailed biological description, and it turns out that the resistance to treatments is due in 40% of cancers to a protein called P-glycoprotein (P-gp). Moreover some new biological experiments show that transfers can occur by the mean of Tunneling nanoTubes built in between cells (direct transfers). But transfers can also occur through microparticles (containing P-pg) released by over expressing cells into the liquid surrounding these cells. These microparticles can then diffuses and can be recaptured by the cells (indirect transfers). This transfers turn to be responsible for the acquired resistance of sensitive cells. The goal of this talk is to introduce this problem, and to present a cell population dynamic model with continuous P-gp structure.

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MS47
Evolution of Species Trait Through Resource Competition

We study a chemostat-type model where species consume resource that are constantly supplied. Continuous traits in both consumer species and resource are incorporated. Consumers utilize resource whose trait values are similar with their own. This model is more mechanistic than the so-called direct-competition model, studied widely in the literature, because the competitive interaction of species occurs not directly but through competition for resource. We prove that self-organized generation of distinct species occurs. We also prove global convergence to the evolutionarily stable distribution.

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MS48
Well-posedness of the Cauchy Problem for a Class of Multidimensional Nonlinear Stochastic Balance Laws

We are interested in the well-posedness and continuous dependence for a class of multidimensional nonlinear stochastic balance laws. The vanishing viscosity method is employed to establish the existence of entropy solutions. One of our main observations is the uniform BV bounds in the space-variables of stochastic viscous solutions. Based on the uniform BV bounds, we establish the equicontinuity of the viscous solutions in the time-variable, uniform in the viscosity coefficient. With these uniform estimates, we then establish the existence of stochastic entropy solutions in BV as the vanishing viscosity limits, when the initial data functions are in BV. We further establish the continuous dependence of BV stochastic entropy solutions on the flux functions and the coefficient functions in the random source terms. This leads to the well-posedness theory in $L^p$ for the class of multidimensional nonlinear stochastic balance laws. Various further generalizations of the results are also discussed.

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MS48
Well-posedness of the 3-D Compressible Euler Equations with Moving Physical Vacuum Boundary

We establish the well-posedness of the 3-D compressible Euler equations with "physical" vacuum boundary, wherein the sound speed must vanish as the square-root of the distance function to the vacuum. This is a degenerate and characteristic hyperbolic moving free-boundary system of multi-D conservation laws, wherein the regularity of the geometry of the free-surface is coupled to regularity of the velocity and density at leading order. This is joint work with D. Coutand.

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MS49
Wave Operators and Applications

Abstract not available at time of publication.

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MS49
The Radial Defocusing Energy-supercritical Cubic Nonlinear Wave Equation in $\mathbb{R}^{1+5}$

In this talk, we will discuss the energy-supercritical defocusing cubic nonlinear wave equation in dimension d=5 for radially symmetric initial data. We prove that an a priori bound in the critical homogeneous Sobolev space implies global well-posedness and scattering. The main tool that we use is a frequency localized version of the classical Morawetz inequality, inspired by recent developments in the study of the mass and energy critical nonlinear Schrödinger equation.

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MS49
Global Smoothing for the Periodic KdV Evolution

The KdV equation with periodic boundary conditions is considered. It is shown that for $H^s$ initial data, $s > -1/2$, and for $a < \min(2s + 1, 1)$, the difference of the nonlinear and linear evolutions is in $H^{s+a}$ for all times, with at most polynomially growing norm. This and a theorem of Oskolkov for the Airy evolution imply that for continuous and bounded variation initial data, the solution is a continuous function of space and time.

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MS49
Recent Results on the Gross-Pitaevskii Hierarchy

The Gross-Pitaevskii (GP) hierarchy is an infinite system of coupled linear non-homogeneous PDEs, which appear in the derivation of the nonlinear Schrödinger equation (NLS). Inspired by the PDE techniques that have turned out to be useful on the level of the NLS, we realized that, in some instances we can introduce analogous techniques at the level of the GP. In this talk we will discuss some of those techniques which we use to study well-posedness for GP hierarchies.

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MS50
From Homogenization to Averaging in Cellular Flows

We consider an elliptic eigenvalue problem in the presence of a fast cellular flow in a two-dimensional domain. It is well known that when the amplitude, A, is fixed, and the number of cells, \( L^2 \), increases to infinity, the solution ‘homogenizes’ – that is, can be approximated by the solution of an effective (homogeneous) problem. On the other hand, if the number of cells, \( L^2 \), is fixed and the amplitude A increases to infinity, the solution ‘averages’. In this case, the solution equilibrates along stream lines, and it’s behaviour across stream lines is given by an averaged equation. In this talk we study what happens if we simultaneously send both the amplitude A, and the number of cells \( L^2 \) to infinity. It turns out that if \( A \ll L^4 \), the problem homogenizes, and if \( A \gg L^4 \), the problem averages. The transition at \( A \approx L^4 \) can quickly be predicted by matching the effective diffusivity of the homogenized problem, to that of the averaged problem. However a rigorous proof is much harder, in part because the effective diffusion matrix is unbounded. This is joint work with T. Komorowski, A. Novikov and L. Ryzhik.

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MS51
Interior Regularity for a Minimal Principal Curvature Operator

In this talk I will present a proof of the continuity of solutions to certain degenerate elliptic operators, connected to the curvature of the level sets (of the solution). An example of such an operator in 2 dimensions is \( \Delta - \Delta_\infty \).

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MS51
Contact Solutions for Fully Nonlinear Systems and the Aronsson System of PDEs

We will present some rudiments of a recently proposed theory of non-differentiable solutions which applies to fully nonlinear systems of PDEs and extends the theory of Viscosity Solutions of Crandall-Ishii-Lions to the general vector case. The main contribution is the discovery of an Extremality notion for vector functions which extends the...
scalar extrema and is characterized by a Maximum Principle type calculus applying to vector functions. This leads to a PDE theory which enables the analysis of non-differentiable solutions of systems like the Infinity-Laplace and the general Aronsson system can be rigorously interpreted, while, most importantly, the theory supports flexibility under limit operations, preserving the working philosophy and the main features of the scalar viscosity counterpart. In the context of this new framework, we will discuss some recent applications to the Aronsson system of PDEs and Calculus of Variations in $L^\infty$.

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MS51
The $p$-Laplacian on Graphs

We study a version of the $p$-Laplace operator in non-divergence from on graphs which are the discrete version of the $p$-harmonic functions that appear as value functions of tug-of-war games with noise. This is joint work with Alexander Sviridov and Adam Oberman.

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MS51
Vector-valued Optimal Lipschitz Extensions

I will discuss joint work with Scott Sheffield extending the theory of absolutely minimizing Lipschitz extensions to the vector-valued case.

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MS52
Levy Processes and Fourier Multipliers

We investigate the $L^p$-norms of certain Fourier multipliers which arise from Levy processes. These operators have connections to several classical singular integrals in harmonic analysis.

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MS52
Harnack Inequalities and Regularity Estimates for Discontinuous Processes

The aim of this talk is to present some Harnack inequalities and regularity estimates for Harmonic function associated with operators of discontinuous processes. These operators are in general integro-differential operators. Our approach will be mainly probabilistic.

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MS52
The Harnack Inequality and Littlewood-Paley Functions for Symmetric Stable Processes

In recent years, there has been an increasing interest in jump processes and their applications. In this talk, we consider $\alpha$-harmonic functions which are defined with respect to the product of a one dimensional Brownian motion and a $d$-dimensional symmetric stable process. We discuss Harnack inequality from a probabilistic approach and then we show some properties and regularity of $\alpha$-harmonic functions. In the last part, we talk about Littlewood-Paley functions obtained by means of the harmonic extension of a function on $R^d$ which is considered as the boundary of the half-space $R^d \times R^+$. 

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MS52
Harnack’s Inequality: A New Formulation and Applications

We present a formulation of Harnack’s inequality which is applicable to local and nonlocal operators at the same time. We show that this version of Harnack’s inequality implies regularity estimates for solutions to several integro-differential operators. We apply the method to some nonlocal symmetric Dirichlet forms and to generators of jump processes. We discuss how this approach extends known results significantly. The talk is based on three works: [K. 2010], [K.-Mimica 2011] and [Dyda-K. 2011]

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MS53
An Active Scalar Equation for the Geodynamo

We discuss an active scalar equation proposed by Moffatt as a model for the geodynamo. We prove that this equation is globally well posed. We illustrate strong dynamo action by proving that a particular example is nonlinearly unstable.

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MS53
An Alternative Approach to Regularity for the Navier-Stokes Equations in Critical Spaces

We use the dispersive method of “critical elements” established by Kenig and Merle to give an alternative proof of a well-known Navier-Stokes regularity criterion due to Escauriaza, Seregin and Sverak, namely that 3-d solutions whose spatial $L^3$-norm remain bounded in time cannot develop a singularity. The key tool is a decomposition into “profiles” of bounded sequences in critical spaces (e.g., $L^3$). As a byproduct, we also generalize a recent result of Rusin and Sverak on “minimal blow-up data” for Navier-Stokes.
We will also discuss generalizations of the Escauriaza-Seregin-Sverak criterion. This is joint work with Isabelle Gallagher and Fabrice Planchon.

**MS53**

**Asymptotic Behaviour of Infinite Energy Solutions to Navier-Stokes Equations**

We study the asymptotic behaviour of solutions to the 2D Navier-Stokes equations with initial data in some "infinite energy spaces", namely some homogeneous scale-invariant Besov spaces. We use the results obtained to understand the long time behaviour of solutions with vortex-sheet-like initial data. This is joint work with Clayton Bjorland (Univ. of Texas - Austin).

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**MS53**

**Asymptotic Stability of Landau Solutions to Navier–Stokes System**

It is known that the three dimensional Navier-Stokes system for an incompressible fluid in the whole space has a one parameter family of explicit stationary solutions, which are axisymmetric and homogeneous of degree $-1$. We show that these solutions are asymptotically stable under any $L^2$-perturbation.

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**MS53**

**Regularity Results for the Prandtl-Reuss Law**

We consider regularity aspects for solutions to variational inequalities which describe the deformations of elastic plastic bodies, thereby starting with the Prandtl-Reuss problem. Using difference quotients and Fourier analysis together with canonical assumptions for the data we show fractional time-differentiability of the stress velocity. With suitable modifications the method can also applied to the cases of isotropic or kinematic hardening.

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**MS54**

**Pseudospectral Reduction of Incompressible Two-Dimensional Turbulence.**

Spectral reduction was originally formulated entirely in the wavenumber domain as a bin-averaged wavenumber convolution in which bins of modes interact with enhanced coupling coefficients. A Liouville theorem leads to inviscid equipartition solutions when each bin contain the same number of modes. We describe a pseudospectral implementation of spectral reduction which enjoys the efficiency of the fast Fourier transform. The model compares well with full pseudospectral simulations of the two-dimensional forced-dissipative energy and enstrophy cascades.

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**MS54**

**Approximate Deconvolution Large Eddy Simulation of a Barotropic Ocean Circulation Model**

This talk introduces a new large eddy simulation closure modeling strategy for two-dimensional turbulent geophysical flows. This closure modeling approach utilizes approximate deconvolution, which is based solely on mathematical approximations and does not employ phenomenological arguments, such as the concept of energy cascade. The new approximate deconvolution model is tested in the numerical simulation of the wind-driven circulation in a shallow ocean basin, a standard prototype of more realistic ocean dynamics. The model employs the barotropic vorticity equation driven by a symmetric double-gyre wind forcing, which yields a four-gyre circulation in the time mean. The approximate deconvolution model yields the correct four-gyre circulation structure predicted by a direct numerical simulation, on a much coarser mesh and at a fraction of the computational cost. This first step in the numerical assessment of the new model shows that approximate deconvolution represents a promising approach for the large eddy simulation of more realistic turbulent geophysical flows.

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**MS54**

**Aspect-ratio Effects in Boussinesq Flows with Rotation and Stratification**

I will present numerical evidence from high-resolution simulations performed on Blue Gene/Petascale resources using
32K cores or more, which reveal novel small-scale (sub-forcing scale) features in small aspect ratio rotating and stratified Boussinesq flows. I will discuss our attempts to disentangle the effects of small aspect-ratio from those of rotation and stratification.

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MS54
The Baroclinic Instability and Turbulence Parameterizations in Ocean Models

The baroclinic instability, where the potential energy of tilted isopycnals in the ocean is converted to kinetic energy, is challenging for ocean models because the eddies must be resolved to properly capture this process. We present a channel test problem where the isopycnals remain tilted at low resolution, while at higher resolution eddies form and isopycnals flatten out. It is the job of parameterizations to capture such important physical effects at lower resolution. How well do various ocean model parameterizations perform in this baroclinic instability test? Simulations using the Lagrangian-averaged Navier Stokes-alpha (LANS-alpha) turbulence parameterization in the POP ocean model resemble higher resolution simulations of standard POP in statistics like kinetic energy, eddy kinetic energy, and potential temperature fields. The LANS-alpha model accomplishes this improvement through an additional nonlinear term and a smoothed advecting velocity. I also show comparisons between the LANS-alpha model and Gent-McWilliams (GM) model. The alpha model is shown to make superior predictions of eddy kinetic energy equivalent to that produced at twice the resolution with no model, while the GM model excels at description of the tracers but suppresses eddy kinetic energy.

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MS54
Separation of Scales in Strongly Rotating Flows with Weak Stratification

Motivated by gaining fundamental understanding of ocean dynamics at high latitudes my collaborators and I have derived new equations, based on the method of multiple scales presented in Embid and Majda (1996,1998) that address the scale separation between slow- and fast-time dynamics in the limit of fast rotation and weak stratification. The slow dynamics describes a regime we call Taylor-Proudman flows. We also show numerical simulations that support the theory.

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MS55
Particle Interaction Models of Biological Aggregation

Animal groups often form striking aggregation patterns. Examples include from schools of fish to locust swarms, to patterns in bacterial cultures. In this talk, we discuss a very simple model of swarming based on pairwise particle interactions with short-range attraction and long-range repulsion, which can lead to very complex and intriguing patterns in two or three dimensions. Depending on the relative strengths of attraction and repulsion, a multitude of various patterns are observed, from nearly-constant density swarms to annular solutions, to complex N-fold symmetry patterns. We show that many of these patterns can be understood as a result of a bifurcation of a ring-type pattern. Turing-type analysis of a ring reveals a wealth of possible instabilities which often lead to complicated and beautiful patterns. Using weakly nonlinear analysis, we also classify two-ring, annular and triangular patterns which arise when the ring becomes unstable.

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MS55
Steady States of Nonlocal Interaction Equations with Repulsive-attractive Potential

We consider radially symmetric solutions of nonlocal interaction equations with repulsive attractive potential. We prove various results about convergence of solutions toward steady state. This is a joint work with Balague, Carrillo and Raoul.

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MS55
Nonlocal Aggregation Equations and Concentration Phenomena

Nonlocal aggregation equation appear in various fields of physics and biology. In many situations, the interaction potential presents a singularity at the origin. This singularity, which can be either attractive or repulsive, has a significant impact on the qualitative properties of solutions. In this talk, I will present a qualitative study of those qualitative properties in one and in several dimensions (although most questions remain open in the latter case). This work has been done in collaboration with Klemens Fellne, Daniel
Balague, Jose Carrillo and Thomas Laurent.

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**MS55**
**Interfacial Behavior in Biological Aggregation**

Individuals, described by the model of biological aggregation studied by Topaz, Bertozzi and Lewis, experience long range attraction, but also avoid overcrowding due to a short-range repulsion. In the continuum model the attraction is described via a nonlocal operator, while the repulsion is modeled by a differential operator. We show that the density profile develops interfaces between a near-constant-density aggregate state and the empty space. The interfaces evolve under surface-tension-like “forces”. More precisely, we demonstrate that the sharp-interface limit for the interfacial motion is the Hele-Shaw flow.

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**MS55**
**Stability and the Inverse Statistical Mechanics Problem for Aggregating Particles**

Pairwise particle interactions arise in diverse physical systems ranging from insect swarms and bacterial distributions, to self-assembly of nanoparticles. In the presence long-range attraction and short-range repulsion, such systems may exhibit rich patterns in there bound states. In this talk we present a theory to classify the morphology of various patterns in $N$ dimensions from a given confining potential. We also present a method to solve the inverse statistical mechanics problem: Given an observed pattern, can we construct a confining interaction potential which exhibits that pattern.

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**MS56**
**Turning Waves and Breakdown for Muskat**

We consider the dynamics of an interface given by two incompressible fluids with different densities satisfying Darcy’s law. This scenario is known as the Muskat problem. In this talk we show the existence of initial data that evolves from a stable regime to an unstable regime in finite time for which the Rayleigh-Taylor changes sign and the solution breaks down. Joint work with A. Castro, C.Fefferman, F.Gancedo and M. Lpez-Fernndez.

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**MS56**
**Splash Singularity for Water Waves**

We exhibit smooth initial data for the 2D water wave equation, for which we prove that smoothness of the interface breaks down in finite time. Joint work with A. Castro, D. Cordoba, F.Gancedo and J. Gomez.

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**MS56**
**The Spine of an SQG Almost-sharp Front**

Consider solutions to the surface quasi-geostrophic equation (SQG) that take the values 1 and -1 outside a delta-neighborhood of an evolving curve – they are called the almost sharp fronts for the SQG. Cordoba-Fefferman-Rodrigo (2004) showed that any curve that describes an almost sharp front (up to an error of order $\delta$) satisfies an evolution equation up to an error of order $\delta \log |\delta|$. I will describe recent work with Fefferman and Rodrigo on improving the error to $\delta - \text{squared} - \log |\delta|$ by introducing a special class of curves (which we call the spines).

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**MS66**
**Knots and Links in Fluid Mechanics**

In 1965 V.I. Arnold classified the steady solutions of the Euler equation, implying in particular that the topological structure of the stream (or vortex) lines of a fluid is quite restricted except for the so called Beltrami fields. Arnold’s work and the phenomena of frozeness of vorticity and magnetic relaxation gave rise to the conjecture in topological hydrodynamics that any knot and link can be realized as a set of stream (or vortex) lines of a steady solution of the Euler equation. The importance of this conjecture is that it tests the topological and geometrical complexity of steady fluid flows. The goal of this talk is to review the strategy which has recently led to the proof of this conjecture for Beltrami fields in $\mathbb{R}^3$ (to appear in Ann. of Math. 2011), as well as some interesting applications as the solution to the Etnyre-Ghrist problem: there exists a steady solution of the Euler equation containing all knot and link types.

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MS57
Liouville-Type Theorems for a Class of Degenerate and Singular Parabolic Equations

Relying on recent results on Harnack inequalities for equations of \( p \)-Laplacian type, and porous medium type, we prove Liouville-type estimates for solutions to these equations, both in the degenerate (\( p > 2, m > 1 \)), and in the singular (\( 1 < p < 2, 0 < m < 1 \)) range.

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MS57
New Class of Constitutive Models Giving Rise to Challenges to PDE

The implicit constitutive theory expands the repertoire of continuum models that can be used to describe complicated response of complex materials, yet keeping the number of involved quantities and boundary conditions unchanged. The framework includes the classical explicit models where the thermodynamical fluxes such as the Cauchy stress and the heat flux are nonlinear functions of thermodynamical affinities. More importantly, the framework includes a new class of explicit models in which the thermodynamical affinities are nonlinear functions of thermodynamical fluxes. We in particular focus on models related to flows through porous media. Some preliminary mathematical results concerning generalized Darcy-Forchheimer equations with pressure dependent coefficient will be also presented.

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MS57
Well-Posedness Theory for an Aggregation Equations and Patlak-Keller-Segel Models with Degenerate Diffusion

Recently, there has been much interest in modeling the competition between a species desire to aggregate and the desire for personal space, referred to as dispersal. Two mathematical systems which model this competition are aggregation diffusion equations and Patlak-Keller-Segel models, originally developed to model chemotaxis. Although the research of these two models have evolved separately they model the same phenomena. Classically, in the PKS equation, aggregation is modeled via convolution with the Newtonian or Bessel potential. On the other hand, the aggregation equation has been studied with more regular kernels. Our work focuses on unifying and extending the well-posedness theory of these equations. In particular, we study the well-posedness of an aggregation equation with degenerate diffusion, to model over-crowding effects, where the aggregation is modeled via the convolution with potentials as singular as the Newtonian potential. We generalize the notion of criticality seen in the PKS model with power-law diffusion and we observe a similar critical mass phenomenon. In this talk I will discuss the local and global well-posedness results from this work with an emphasis on the continuation theorem which connects the local and global theory.

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MS57
Mixed Formulations of Coupled Systems of Mechanics and Diffusion

Nonlinear coupled Darcy, Stokes, and Biot systems describe flow through deformable porous media and internal fractures or adjacent regions of free fluid. Such systems will be developed as examples of nonlinear degenerate evolution equations in mixed formulation, and their dynamics is determined by nonlinear semigroups.

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MS57
Well-posedness and Long Time Behavior of the Hele-Shaw-Cahn-Hilliard System

We discuss the well-posedness and long time behavior of the Hele-Shaw-Cahn-Hilliard system modeling binary fluid flow in porous media with arbitrary viscosity contrast but matched density between the components. Well-posedness that is global in time in the two dimensional case and local in time in the three dimensional case will be presented. Several blow-up criterions in the three dimensional case are provided as well. Long time behavior in terms of eventual regularity and convergence to steady states will be presented. Formal link to the sharp interface problem will be discussed as well.

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MS57
On Minimizers of the Doubly-Constrained Helfrich Functional

Since the pioneering paper of Helfrich in 1973, variational formulations involving curvature-dependent functionals have proven useful for shape analysis of biomembranes. We present an existence result for doubly-constrained global minimizers of a functional containing a spontaneous (preferred) curvature. The functional is minimized over axisymmetric surfaces with fixed area and enclosing a fixed volume. This is joint work with Marco Veneroni (McGill).

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MS58
Epitaxially Strained Thin Films: Regularity of Quantum Dots and Motion by Anisotropic Surface Diffusion

Short time existence, uniqueness, and regularity for a sur-
face diffusion evolution equation with curvature regularization are proved in the context of epitaxially strained two-dimensional films. This is achieved by using the $H^{-1}$ gradient flow structure of the evolution law, via De Giorgi's minimizing movements. This seems to be the first short time existence result for a surface diffusion type geometric evolution equation in the presence of elasticity.

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MS58
Thin Films for Ginzburg Landau in the London Limit

I will present recent results in collaboration with Stan Alama and Lia Bronsard on thin film London limits of the Ginzburg-Landau model for a superconductor in an applied magnetic field oriented obliquely to the film surface. We obtain $\Gamma$-convergence results for the first and second critical fields under particular asymptotic ratios between the magnitude of the parallel applied magnetic field and the thickness of the film. For the first critical field, we study the optimal density of vortices via an obstacle problem for some examples to illustrate how the geometry of the domain will affect the position of vortices.

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MS58
Multiscale Gamma Convergence for Point Interactions in 2D

We derive energies governing the blow-up limits of $N$ coulombian charges interacting at the scale $\sqrt{1/N}$, with consequences for superconducting vortices and/or random matrices.

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MS59
Analysis of Nematic Liquid Crystals with Disclination Lines

We investigate the structure of nematic liquid crystal thin films described by the Landau-de Gennes tensor-valued parameter with Dirichlet boundary conditions of nonzero degree. We prove that as the elasticity constant goes to zero, a limiting uniaxial texture forms with disclination lines corresponding to a finite number of defects, all of degree $\frac{1}{2}$ or all of degree $-\frac{1}{2}$. We also analyze the limiting behavior of the defects.

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MS59
Defects in Thin Smectic Liquid Crystal Films

We analyze a model for the elastic energy of planer c-director patterns in a smectic film. Because of boundary conditions and polar fields topological defects form in these patterns. We use a Ginzburg Landau model that allows the director field to have variable length and to vanish at the defect cores. We prove that if the model’s G-L parameter is small then low energy states develop degree ($\pm$) one defects that tend to a minimal energy configuration with a limiting far-field texture. Our main contribution is that we are able to treat the case of unequal splay and bend elasticity constants. Earlier analytic work for the G-L functional had been limited to the equal constant case.

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MS59
Well-posedness for the 3-D Compressible MHD Equations with Moving Vacuum Boundary

We establish well-posedness for the 3-D compressible MHD equations with moving physical vacuum boundary. The physical vacuum boundary permits the plasma to accelerate, and requires the sound speed and the magnetic field to degenerate like the square-root of the distance function to the moving boundary. As such, the MHD equations form a multi-D system of conservation laws which are both characteristic and degenerate. This is joint work with Joseph Grimm.

Steve Shkoller
MS59
Numerical Approximation of the Ericksen Leslie Equations

The Ericksen Leslie equations model the motion of nematic liquid crystalline fluids. The equations comprise the linear and angular momentum equations with non-convex constraints on the kinematic variables. These equations possess a Hamiltonian structure which reveals the subtle coupling of the two equations, and a delicate balance between inertia, transport, and dissipation. While a complete theory for the full nonlinear system is not yet available, many interesting sub-cases have been analyzed. This talk will focus on the development and analysis of numerical schemes which inherit the Hamiltonian structure, and hence stability, of the continuous problem. In certain situations compactness properties of the discrete solutions can be established which guarantee convergence of schemes.

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MS59
Specific Tensorial Features in the Modelling of Nematic Liquid Crystals

Nematic liquid crystals are modelled mathematically using either: unit-length vectors in the Oseen-Frank theory (2 degrees of freedom), scalars and unit-length vectors in Ericksen theory (3 degrees of freedom) or symmetric and traceless 3x3 matrices in Landau-de Gennes theory (5 degrees of freedom). We will look into specific features of nematics that require a tensorial description, with an emphasis on the interpretation of defects in various theories.

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MS60
Lagrangian Solutions of Semigeostrophic System

Semigeostrophic system is a model of large-scale atmospheric/ocean flows. I will discuss some results on existence and properties of weak Lagrangian solutions in physical space. Open problems will be also discussed.

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MS60
On a Chemotaxis Model

We investigate local/global existence, blowup criterion and long time behavior of classical solutions for a hyperbolic-parabolic system derived from the Keller-Segel model describing chemotaxis. Moreover, we establish the existence and the nonlinear stability of large-amplitude traveling wave solutions to the system of nonlinear conservation laws derived from KS model.

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MS60
The Hyperbolic Keller-Segel Model and Branching Instabilities

A remarkable feature of cell colonies are their ability to invade surfaces with dendritic patterns expressing an evolved strategy to look for the best conditions for growth. There are very few PDE models undergoing such branching instability. Among those, one of the most famous is known as Mimura’s model. It describes the growth of a cell population under the effect of a nutrient which is locally depleted by the colony and thus cells that are in advance have an advantage for multiplication. Discussions with biologists running experiments on very rich media motivated us to search for another possible mechanism. We consider a model which is based on a conservative parabolic system and that undergoes branching instabilities. The swarmer cells are modeled by a Fokker-Planck type equation à la Keller-Segel, coupled with two fields describing attraction and repulsion. It also includes the ‘quorum sensing’ limitation proposed by Dolak and Schmeiser. Extended models are more realistic and reduced systems are analytically tractable. They explain stability and unstability of plateau type traveling wave solutions. This lecture is based on collaborations with F. Cerreti, Ch. Schmeiser, M. Tang and N. Vauchelet.

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MS60
Global Dynamics of a Diffuse Interface Model for Solid Tumor Growth

In this talk I will report recent progress on a diffuse interface model (referred as the Cahn-Hilliard-Hele-Shaw system) which arises in modeling of spinodal decomposition in binary fluid in a Hele-Shaw cell, tumor growth and cell sorting, and two phase flows in porous media. Previous numerical simulations showed that the model is capable of modeling all the stages of a solid tumor growth - avascular, vascular and metastasis. In this work, wellposedness, regularity and long-time asymptotic behavior of solutions to an initial-boundary value problem of the model are rigorously justified.

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**MS61**  
On the Validity of the NLS Equation in Systems with Quadratic Resonances

For a nonlinear wave equation possessing quadratic resonances, we address the validity question concerning the approximation obtained via a formally derived nonlinear Schrödinger (NLS) equation. In analyzing the resonances one arrives at a three-wave interaction (TWI) system. We make connections between the validity of the NLS approximation and the stability of the TWI system associated to the resonance. Numerical simulations illustrate the results and offer insight to situations where the analysis is unclear.

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**MS61**  
Approximation Theorems for the Water Wave Problem in the Arc Length Formulation

There are several proofs that long–wavelength solutions to the two–dimensional water wave problem with finite depth can be approximated by solutions of the Korteweg–de Vries equation or the Kawahara equation. We provide a new proof, which is simpler, more elementary and shorter. Moreover, the justification of the KdV approximation can be given for the cases with and without surface tension together by one proof. In our proof, we parametrize the free surface by arc length.

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**MS61**  
Stability of Solitary waves in the KdV Limit for Fluid and Lattice Models

I will describe recent work with Shu-Ming Sun on asymptotic linear stability (a linearized scattering result) for small-amplitude solitary water waves with no surface tension over a flat bottom, and related nonlinear stability results for model equations for lattices and fluids. A significant feature of the analysis is the effective use of known stability properties of solvable models such as KdV and Toda lattice equations.

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**MS61**  
A Rigorous Justification of the Modulation Approximation to the 2D Full Water Wave Problem

We consider the 2D inviscid incompressible irrotational infinite depth water wave problem neglecting surface tension. Given wave packet initial data of the form $\alpha + \epsilon B(\alpha)e^{ik_0}$ for $k > 0$, we show that the modulation of the solution is a profile traveling at group velocity and governed by a focusing cubic nonlinear Schrödinger equation, with rigorous error estimates in Sobolev spaces. As a consequence, we establish existence of solutions of the water wave problem in Sobolev spaces for times of order $O(\epsilon^{-2})$ provided the initial data differs from the wave packet by at most $O(\epsilon^{3/2})$ in Sobolev spaces. These results are obtained by directly applying modulational analysis to the evolution equation with no quadratic nonlinearity constructed in the paper of S. Wu (2009) and by the energy method.

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**MS61**  
Justification of the NLS Approximation for a Quasi-linear Water Wave Model

I will show how for a quasilinear water wave model the NLS approximation can be justified. The model presents several new difficulties due to the quadratic terms which have to be eliminated by a normal-form transformation. Due to the quasilinearity of the problem there is some loss of regularity associated with the normal-form transformation and there is a nontrivial resonance present in the problem. The loss of regularity is dealt with by using a Cauchy–Kowaleskaya-like method to treat the initial value problem and the nontrivial resonance is dealt with via a rescaling argument.

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**MS62**  
Numerical Methods for SPDEs based on Fluctuation-Dissipation Balance: Applications to Implicit Solvent Models with Fluctuating Hydrodynamics

Many challenges arise in the numerical approximation of Stochastic Partial Differential Equations (SPDEs). This includes the need to approximate solutions that are often highly irregular (non-differentiable in space and time), the need to discretize and to generate stochastic driving fields that yield accurate dynamics, and the need to resolve stochastic dynamics often exhibiting significant stiffness. To cope with these issues spectral numerical methods are often used. However, such methods require in practice often rather simple domain geometries and fast transforms. We discuss alternative approaches based on finite difference discretizations and on ideas from statistical mechanics. For a class of SPDEs of parabolic type we develop discretizations for stochastic driving fields by formulating...
a fluctuation-dissipation principle for the control of numerical truncation errors. We demonstrate how this approach can be used to develop discretizations for spatially adaptive meshes and for domains having complex geometries with imposed Neumann or Dirichlet boundary conditions. We present evidence that these methods converge weakly for this class of SPDEs. As a specific application of these approaches we show how stochastic hydrodynamics can be incorporated into implicit solvent models for the study of molecular systems. In particular, we discuss a dynamic implicit solvent model for lipid bilayer membranes with protein inclusions which involve SPDEs that capture consistently the hydrodynamics, elastic mechanics, and thermal fluctuations.

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MS62
Composition Dynamics in Multicomponent Lipid Bilayer Membranes
We develop a stochastic phase-field model for multicomponent lipid bilayers that includes the quasi-two-dimensional hydrodynamics appropriate to a membrane surrounded by a viscous fluid, simulating ten micron systems for tens of seconds. We compare directly to fluorescence microscopy experiments on multicomponent vesicles, and use theory motivated by these simulations to probe membrane viscoelastic parameters. The dynamics of domain coarsening and diffusion of membrane-embedded objects are also discussed.

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MS62
Stochastic Models of Nucleation and Aggregation in Confined Spaces
The classic problem of homogeneous nucleation is examined within a finite-sized, stochastic framework. We derive a high-dimensional stochastic Master Equation describing the evolution of the concentrations of homogeneously nucleating clusters. Through careful enumeration of steady-state cluster configurations, we find recursion relations for determining quenched cluster configurations as well as exact analytical formulae for the equilibrium mean cluster size distribution. Our analysis of the full stochastic problem yields mean cluster size distributions that are qualitatively different from those derived from the corresponding mean-field, mass-action Becker-Döring equations. Not only do the final equilibrium mean cluster size distribution differ dramatically, but coarsening behavior often seen in mass-action models of nucleation largely disappears. The magnitude of these differences depends primarily on the divisibility of the total monomer mass by the maximum cluster size, and the remainder. Thus, strong finite-size and stochastic effects arise even when both total mass and maximum cluster sizes are unbounded, provided their ratio is finite. Our results indicate limits of validity of the classic mass-action Becker-Döring equations and were all verified using extensive kinetic Monte-Carlo simulations.

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MS62
Anomalous Diffusion through Protective Biological Fluid Layers
I will survey the Generalized Langevin Equation and alternative models for a field known as passive microbead rheology. The idea is classical: to measure fluctuations of a probe particle to infer dissipative properties. In this case, the idea is to expand fluctuation-dissipation to viscoelastic fluids, and soft biological materials in particular. I will survey progress by our group in modeling, semi-analytical, and simulation tools for inference from experimental data and direct simulations of paths, mean-squared displacement statistics, and first passage times.

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MS63
Wave Propagation in Time Dependent Randomly Layered Media
I will describe the cumulative scattering effects on wave front propagation in time dependent randomly layered media. It is well known that the wave front has a deterministic characterization in time independent media, aside from a small random shift in the travel time. That is, the pulse shape is stable, but faded and smeared as described mathematically by a convolution kernel determined by the second order statistics of the random fluctuations of the wave speed. I will describe the extension of the pulse stabilization results to time dependent randomly layered media.

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MS63
Stability and Resolution Analysis for a Topological-derivative-based Imaging Functional in Random
Media

In this talk we introduce and study a topological-derivative-based anomaly detection algorithm. We investigate its stability when the medium is random as well as its resolution. A postprocessing of the data set is introduced and shown to be essential in order to obtain an efficient topological-derivative-based imaging functional, both in terms of resolution and stability.

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MS63
Inverse Source Problem in Random Media

Abstract not available at time of publication.

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MS63
Shock Profiles in Random Media

I will introduce and discuss some large deviation problems for conservation laws as they arise in a number of applications in flow and combustion. I will then discuss the form of the rate function for the large deviations and analyze some of its properties for shock profiles.

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MS64
Cahn-Hilliard Equations with Memory and Dynamic Boundary Conditions

We consider a Cahn-Hilliard equation where the velocity of the order parameter depends on the past history of the Laplacian of the chemical potential. This dependence is expressed through a time convolution integral characterized by a smooth non-negative exponentially decreasing memory kernel. The chemical potential is subject to the no-flux condition, while the order parameter satisfies a (nonlinear) dynamic boundary condition. The latter accounts for possible interactions with the container walls. We illustrate the results we have obtained in the viscous case, namely, well-posedness, existence of a smooth global attractor, existence of exponential attractors. In the non-viscous case, the existence of a trajectory attractor is also established.

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MS64
Long time Behavior of the Caginalp System with Singular Potentials and Dynamic Boundary Conditions

This talk is devoted to the well-posedness and the long time behavior of the Caginalp phase-field model with singular potentials and dynamic boundary conditions. Thanks to a suitable definition of solutions, coinciding with the strong ones under proper assumptions on the bulk and surface potentials, we are able to get dissipative estimates, leading to the existence of the global attractor with finite fractal dimension, as well as of an exponential attractor.

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MS64
Nonlinear Wave Equations with Strong Damping and Nonlinear Damping Terms

We study initial boundary value problems for nonlinear wave equations with strong damping and nonlinear damping terms. The problems of global existence and uniqueness, regularity and blow up of solutions, existence of global attractors of dynamical systems generated by problems under consideration will be discussed. This is a joint work with S.Zelik.

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MS65
Uniqueness for the Homogeneous Willmore Dirich-
let Boundary Value Problem

The Willmore functional associates to a surface the integral over the surface of its mean curvature squared. This functional is conformally invariant. The corresponding Euler-Lagrange equation (the Willmore equation) is a fourth order non-linear elliptic equation. The study of this equation together with boundary conditions is challenging. In this talk we present a uniqueness result for the homogeneous Willmore Dirichlet boundary value problem for graphs over strictly star-shaped domains.

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MS65
Area Constrained Willmore Surfaces in Riemannian Manifolds

Abstract not available at time of publication.

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MS65
Very Weakly Biharmonic Maps into Homogeneous Spaces

Intrinsic biharmonic maps are the critical points of a functional involving second derivatives for maps between Riemannian manifolds. Formal calculations give an Euler-Lagrange equation for this problem of fourth order. But this equation has a meaningful interpretation only in a Sobolev space that is smaller than the natural space for the variational problem. If the target manifold is a homogeneous space, then it is possible to rewrite the equation and close the gap between the variational problem and the PDE. We can then also prove conditional regularity results under very weak initial assumptions of the solutions.

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MS65
The Gradient Flow of the $L^2$ Norm of the Riemannian Curvature Tensor

The $L^2$ norm of the Riemannian curvature tensor is a natural analogue of the Yang-Mills energy. Critical metrics of this functional include natural generalizations of Einstein metrics. The gradient flow of this functional is a natural approach to understanding the structure of the space of metrics and the existence of critical points. I will discuss some long time existence results in subcritical dimensions, as well as in “low energy” cases in the critical dimension 4, and discuss the main obstruction to extending these results further.

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MS66
Regularity of Rotational Travelling Water Waves

Several recent results on the regularity of streamlines beneath a rotational travelling wave, along with the wave profile itself will be discussed. The topic includes the classical wave problem in both finite and infinite depth, capillary waves, and solitary waves as well. A common assumption in all models to be discussed is the absence of stagnation points.

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MS66
The Water Wave Problem via Conformal Mappings

I will speak on functional analytic properties of small-amplitude solitary waves on the free surface of a two-dimensional steady flow of water over a finite bed, acted upon by gravity as well as surface tension. I will begin by formulating the water wave problem by combining Zakharov’s Hamiltonian and conformal mappings; its steady wave problem reduces to a nonlocal nonlinear equation, analogous to Babenko’s equation for Stokes waves. I will show how the Korteweg-de Vries equation arises as the leading-order approximation in a certain weakly-nonlinear long-wave regime. I will then discuss the existence of solitary-wave solutions as an application of the implicit function theorem and implications for their linear stability.

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MS66
Instability of Periodic Water Waves

Periodic traveling waves exist in 2D water waves and many dispersive wave models, such as Stokes waves of deep water (Stokes, 1847) and Cnoidal waves of KDV equation. I will discuss an approach to find stability criteria for periodic waves of water waves and many dispersive wave models, under perturbations of the same period. The results include a sharp instability criterion for KDV and BBM type models, and a proof of the existence of unstable Stokes waves under some natural assumptions. The perturbations with different periods will also be briefly discussed.

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MS66
Rotational Steady Periodic Water Waves with Stagnation Points

Consider inviscid 2D water waves of finite depth under the influence of gravity. We assume they have constant vorticity $\gamma$, travel at speed $c$, and have horizontal period $L$. The water waves may have stagnation points. Let $h$ be the conformal depth. Then for any values of $\gamma$, $c$, $L$ and $h$, there exists a global curve $K$ of such water waves with the following properties. (i) They have a single crest and trough per period and are monotone in between. (ii) At one end, the curve bifurcates from a laminar flow. (iii) At
the other end, either the curve approaches stagnation at the crest, or it approaches the vertical somewhere on the free surface. This is joint work with A. Constantin and E. Varvaruca.

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MS67  
Boundary Effect and Turbulence  
The most common criteria for turbulence, in statistical theory of turbulence, in numerical simulations and in experiments is the existence of anomalous: the fact that with Reynolds number going to $\infty$ the entropy dissipation does not converges to 0 or with $\nu = \frac{1}{\alpha}$

$$\lim_{\nu \to \infty} \nu \int |\nabla u_\nu|^2 \, dx \to \epsilon > 0$$

It is in presence of boundary effect that a mathematical formulation can be provided. This relies on a simple but very clever theorem of Kato. I will show how this depends on the nature of the boundary effect and exhibit similarity between Navier-Stokes and Boltzmann limit.

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MS67  
Large Time Behavior for Vorticity Formulation of a 2-D Incompressible Flow Model  
The vorticity formulation of 2-D incompressible Navier-Stokes equation can be viewed as mean-field limit of stochastic interacting point vortices. In such model context, the action functional for probabilistic large deviation principle (large particle number limit) characterizes Boltzmann entropy for the stochastic system in path space, in any finite time. It characterizes fluctuation around incompressible Euler equation. By studying a large time and inviscid limit of such functional as a variational/optimization control problem in space of measures, we give a scheme under which large time coherent structure for the associated complex flows can be justified. We will use the tools of large deviation, Hamilton-Jacobi equation in space of measures and optimal mass transportation theory to explain the procedure. The talk is based on joint work with a number of coauthors.

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MS67  
The incompressible Euler Equations as a Limit of Euler-$\alpha$ Models  
The Lagrangian-averaged Euler equations or Euler-$\alpha$ equations, introduced by D. Holm, J. Marsden and T. Ratiu in 1998, are a desingularization of the incompressible Euler equations. Convergence of Euler-$\alpha$ to the Euler equations, as $\alpha \to 0$, has been studied in domains without boundary. In this talk we discuss recent results on convergence in the presence of boundaries. Motivated by the second grade model for complex fluids, we consider zero tangential “stress” at the boundary and we relate this to the well-known Newtonian Navier free slip boundary condition, which we use as boundary condition for Euler-$\alpha$. We prove convergence to solutions of the incompressible Euler equations in a bounded domain with free slip boundary conditions, under the hypothesis that there exists a uniform time of existence for the approximations, independent of $\alpha$. This additional hypothesis is not necessary in 2D, where global existence is known, and for axisymmetric flows without swirl, for which we prove global existence. In summary, we obtain strong convergence in $L^2$, as $\alpha \to 0$, to a solution of the incompressible Euler equations, assuming smooth initial data.

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MS67  
Riesz Transforms and the Helmholtz-Hodge Decomposition – Probabilistic Methods with Applications to the Equations of Fluid Mechanics  
I will survey recent and ongoing work with HoeWoon Kim and Ed Waymire on the use of probabilistic methods in the representation of solutions of the equations of Fluid Mechanics in domains with boundaries. In particular, we use a recently developed probabilistic representation of the iterated Riesz transforms in connection with the Helmholtz-Hodge decomposition in $\mathbb{R}^3$. This work is based in part in HoeWoon Kim PhD thesis.

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MS68  
Dynamics and Hopf Bifurcation in the Gierer-Meinhardt System  
Some reaction-diffusion systems like the Gierer-Meinhardt system exhibit spot patterns. Actually, multiple spots must be unstable and only a single spot is observed in the shadow system, which is a limiting system as a diffusion coefficient goes to infinity. Hence we can simplify the system which describes the dynamics of spots and show that Hopf bifurcation of a single spot. We clarify how parameters in the system influence the bifurcation by this reduced system.

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MS68

Competition and Oscillation Instabilities in the Near-shadow Limit of Certain Reaction-diffusion Systems

We consider a well-known two-component RD system of the form $u_t = \varepsilon^2 u_{xx} + f(u,v)$, $v_t = D v_{xx} + g(u,v)$ in the limit of small $\varepsilon$ and large $D$. Under certain generic conditions on the nonlinearities, such system admits solutions consisting of $2K$ interfaces that are known to be stable for large but finite $D$. On the other hand, it is also well known that in the limit $D = \infty$, only a single interface solution can be stable. We show that the transition to instability occurs when $D$ is exponentially large in $\varepsilon$, and we explicitly compute the instability thresholds. Another type of instability is possible when $\tau = O(D/\varepsilon)$. In this case, the interfaces canoscillate. We show that this is a result of a supercritical Hopf bifurcation and we explicitly compute the amplitude of the oscillations, even far from the Hopf bifurcation point. Joint works with Rebecca McKay.

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MS68

Trapped Vortices in the Large-density (Thomas-Fermi) Limit

The Gross-Pitaevskii equation with a harmonic potential and repulsive nonlinear interactions is considered in the large-density limit, also known as the Thomas-Fermi limit. In the space of two dimensions, we employ the Rayleigh-Ritz method to obtain variational approximations of single vortices, dipole pairs, and quadrupoles trapped in the harmonic potential. In particular, we compute the eigenfrequency of the single vortex precession about the center of symmetry of the harmonic potential, as well as the eigenfrequencies of the oscillations of the dipole and quadrupole vortex configurations. The asymptotic results are illustrated by the numerical computations. This is a joint work with P. Kevrekidis (University of Massachussets).

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MS68

Concentration Behavior in Fourth Order Nonlinear Eigenvalue Problems of MEMS

Using formal asymptotic and numerical methods we construct the global bifurcation diagram of radially symmetric solutions in the unit disk in 2-D for a nonlinear Biharmonic eigenvalue problem. This problem models the steady-state deflection of an elastic membrane associated with a MEMS capacitor under a constant applied voltage in a narrow-gap limit. For $\delta > 0$, the steady-state deflection $u(|x|)$, with $0 < |x| < 1$, satisfies $-\delta \Delta^2 u + \Delta u = \lambda (1 + u)^2$ with $u = u_0 = 0$ on $|x| = 1$, where $\lambda$ is the bifurcation parameter. When $\delta = 0$, it is well-known that the limiting second-order nonlinear eigenvalue problem has an infinite fold-point structure. For $\delta > 0$, we show that this infinite fold-point structure is destroyed and that there is a maximal solution branch for which $\lambda \to 0$ as $\varepsilon \equiv 1 - \|u\|_{\infty} \to 0^+$. A precise asymptotic description of this concentration behavior is obtained, and the results are favorably compared with full numerical results.

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MS69

On Some Properties of the Navier-Stokes Equation on the Hyperbolic Space

Finite energy and finite dissipation solutions to the Navier-Stokes equation on a two dimensional hyperbolic space are nonunique. We discuss possible ways to arrive at uniqueness of solutions in the hyperbolic setting.

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MS69

Asymptotic Behavior of a Determining Form for the 2D Navier-Stokes Equations

Recently we have developed a determining form, which is an ordinary differential equation in the Banach space of time-dependent functions taking values in the determining low modes of the Navier-Stokes equations (NSE). If the initial condition for the ODE is the low-mode projection of a solution on the global attractor of the NSE, the solution of the determining form evolves as a traveling wave. In fact these are the only traveling waves for the determining form. In this talk we discuss how an arbitrary initial trajectory evolves under the flow of the determining form toward a solution of the NSE.

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MS69

Complexity of Solutions for Parabolic Equations with Gevrey Coefficients

We provide a quantitative estimate of unique continuation for high order parabolic equations (including the Navier-Stokes equations) with non-analytic Gevrey coefficients. We also provide a new upper bound for the number of spatial oscillations with polynomial dependence of coefficients. This is joint work with Mihaela Ignatova.

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MS69
Boundary Layer Analysis and Vanishing Viscosity Limit for Pipe Flows

I will present recent work on the analysis of the boundary layer and the limit of vanishing viscosity for certain incompressible, Newtonian flows in circular pipes.

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MS69
A Parabolic Approximation of Incompressible Fluid Equations

We consider the Cauchy problem for a nonlinear parabolic system $u_t - u + u \cdot \nabla u + \frac{1}{2}u \text{div} u - \frac{1}{\epsilon} \text{div} u = 0$ in $\mathbb{R}^3$ with initial data in Lebesgue spaces $L^2(\mathbb{R}^3)$ or $L^3(\mathbb{R}^3)$. We analyze the convergence of its solutions to a solution of the incompressible Navier-Stokes system as $\epsilon$ goes to zero and the questions of partial regularity.

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MS70
Stability of Coupled Oscillators on a Graph

There are a number of models of physical and biological interest which take the form of a (usually large) number of oscillators coupled weakly together. In situations where the system is stochastically forced one is interested not only in stable solutions but in solutions with one unstable direction, as these represent stationary paths connecting local minima. We establish some index results counting unstable directions for these problems. We use these results to prove some rigorous estimates on the probability of synchronisation when the oscillator frequencies are chosen randomly according to a Gaussian distribution.

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MS70
On the Natural Frequencies of a Free/free Goupillard-type Elastic Strip

We consider a layered Goupillaud-type elastic medium (equal wave travel time for each layer). The natural frequencies of a free/free Goupillaud-type strip are described analytically using two different approaches: 1) Solving the frequency equation after applying a transformation of the spatial variable. 2) Converting the resonance frequency results obtained when a discrete forcing function that varies harmonically with time is applied at one end of the strip, while the other end is free.

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MS71
A Rigorous Proof of the Maxwell-Claussius-Mossotti Formula

We consider a large number of identical inclusions (say spherical), in a bounded domain, with conductivity different than that of the matrix. In the dilute limit, with some mild assumption on the first few marginal probability distribution (no periodicity or stationarity are assumed), we prove convergence in $H^1$ norm of the expectation of the solution of the steady state heat equation, to the solution of an effective medium problem which for spherical inclusions is obtained through the Maxwell-Clausius-Mossotti formula. Error estimates are provided as well.

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MS71
Global Minimizers for a p-Ginzburg-Landau Energy When p goes to Infinity

We consider the minimization problem of the energy functional

$$E_p(u) = \int_{\mathbb{R}^2} |\nabla u|^p + (1 - |u|^2)^2$$

of the gradient flow of (FCH) to the sharp interface evolution is presented.

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MS70
Title Not Available at Time of Publication

Abstract not available at time of publication.

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MS71
Global Minimizers for a p-Ginzburg-Landau Energy When p goes to Infinity

We consider the minimization problem of the energy functional

$$E_p(u) = \int_{\mathbb{R}^2} |\nabla u|^p + (1 - |u|^2)^2$$
for $p > 2$ over the space of maps in $W^{1,p}_{W_0} (R^2, R^2)$ whose degree along circles of large radii is 1. We first review previous works where: (i) we proved existence of a minimizer for any $p > 2$, (ii) we obtained some properties of the minimizers over the class of radially symmetric maps. We then report on some recent results on the limit of the minimizers $u_p$ when $p$ tends to infinity. This is a joint work with Y. Almog, L. Berlyand and D. Golovaty.

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Way of Gamma Convergence
We investigate the structure of a smectic C liquid crystal body trapped between two parallel plates. This is modeled using the Chen-Lubensky energy that couples a second order energy that accounts for smectic layer formation and the first order nematic Frank energy. In the smectic C phase the smectic layers meet the plates at an acute angle. In order for this to happen the layers’ profiles should form a zig-zag or chevron pattern. We prove that these patterns occur in minimizers for this model, for the case that the layer bending constant is small. We do this using gamma convergence.

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MS71
Behavior of Ginzburg-Landau Vortices on a Surface
I will discuss some recent results regarding existence/nonexistence of stable vortex solutions to Ginzburg-Landau posed on a manifold. Time permitting, results will be discussed for critical points, solutions of the GL heat flow and solutions of the dispersive Gross-Pitaevskii dynamics in this context.

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MS72
Dynamical Problems Arising in the Modeling of Polyelectrolyte Gels
Abstract not available at time of publication.

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MS72
Phase Separation in Diblock Copolymers
Abstract not available at time of publication.

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MS72
Regularity for a Strongly Anisotropic Free Boundary Problem
We will present a variational free boundary problem involving 2D linear elasticity and highly anisotropic surface energy. We will be mainly concerned with the regularity of the free boundary for minimal configurations in the crystalline and strictly convex cases. This is a joint work with I. Fonseca, N. Fusco, and G. Leoni.

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MS72
Analysis of Chevron Patterns in Liquid Crystals by

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MS73
Arterial Blood Flow Modeling: Analysis, Computations and Applications
We will present some new ideas related to the mathematical and numerical modeling of arterial blood flow. We will discuss the design of stable loosely-coupled numerical algorithms, where the original problem is split in a sequence of simpler sub-problems. We will show how stability can be achieved by exploiting the mixed hyperbolic/parabolic features of the problem.

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MS73
Model Development and Uncertainty Quantification for Systems with Nonlinear and Hysteretic Actuators
Smart material actuators and sensors provide unique control capabilities for a range of applications involving fluid-structure and flow-structure interactions. These include PZT-based macrofiber composites which are being considered for flow control and shape memory alloys which are being tested for use as catheters employed for laser treatment of atrial fibrillation. In this presentation, we will discuss the development of a modeling framework for these systems that facilitates subsequent design, uncertainty quantification, and real-time control implementation for transducers operating in highly nonlinear and hysteretic regimes.

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MS73
Attractor for a Non-dissipative von Karman Plate with damping in Free Boundary Conditions
I will discuss a plate equation suggested by certain flow-structure interaction models: a von Karman plate with a first order non-dissipative term in the interior. Because of
this perturbation the resulting dynamical system is of a non-gradient type. Moreover, the dissipative velocity feedback is applied through the free boundary conditions only. It will be shown that despite the lack of monotonicity and absence of interior damping this flow can converge to a global compact attractor.

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MS73
A Third Order PDE arising in High-Intensity Ultrasound: Structural Decomposition, Spectral Analysis, and Exponential Stability

This presentation describes an abstract third-order equation motivated by the Moore–Gibson–Thompson Equation arising in high-intensity ultrasound. In its simplest form, the equation (with unbounded free dynamical operator) is not well-posed. However, a suitable change of variables permits one to show that it has a special structural decomposition, with a precise, hyperbolic-dominated part. Significant dynamical properties of the system, including spectral analysis and sharp stability estimates, will be presented and corroborated by numerical simulations.

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MS73
Strong Well-posedness and Long-time Behavior of the Two-phase Navier-Stokes Equations with Surface Tension

In this talk I present results on local well-posedness and qualitative behavior of solutions to the two-phase incompressible Navier-Stokes equations with surface tension. In particular, the equilibria are stable and each solution which is initially close to an equilibrium exists for all times and it converges to an equilibrium at an exponential rate. This is joint work with M. Köhne and J. Prüss.

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MS74
Global Solutions for Transonic Self-similar Two-dimensional Riemann Problems

We discuss the global self-similar solutions for transonic Riemann problems.

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MS74
Balance Laws: Existence, Asymptotics and Singular Limits

Results on models arising in continuum physics will be discussed. Issues of existence and asymptotic behavior will be analyzed.

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MS74
Riemann Problems for Two Dimensional Euler Systems

We present solutions to Riemann problems for the Euler system in two space dimensions in some special cases.

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MS75
A Mathematical Model of Glioma Invasion

Glioblastoma is a highly invasive brain tumor. This invasive behavior of tumor cells is responsible for low survival rate and microenvironment plays an important role in the active migration. A thorough understanding of the microenvironment would provide a foundation to generate new strategies in therapeutic drug development. We developed a mathematical model to better understand the role of microenvironment in creating different invasion patterns. We analyze the migration patterns of glioma cells from the main tumor, and show that the various patterns observed in experiments can be obtained by a model’s simulations, by choosing appropriate values of the key model parameters of the PDE model. These includes chemotactic sensitivity, haptotactic strength, and cell-cell adhesion. Cancer is a complex, multiscale process, in which genetic mutations occurring at a sub-cellular level manifest themselves as functional changes at the cellular and tissue scale. A hybrid model will also be discussed in order to get more detailed information on cell migration and growth under the influence of a particular microRNA (miR451).

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Sean Lawler
MS75
Virtual Melanoma: When, Where and How Much to Cut

Through our spatiotemporal model of melanoma, we observe that immune cells can destroy tumors and also at times induce tumorigenic expansion through the production of angiogenic factors. We observe that small metastatic lesions distal to the primary tumor mass can be held to a minimal size via the immune interaction with the larger primary tumor and satellite lesions can become aggressively tumorigenic upon removal of the primary tumor and its associated immune tissue.

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MS75
Title Not Available at Time of Publication

Abstract not available at time of publication.

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MS76
Degenerate Convection Diffusion Equations: Decay Rate and Global Regularity

We consider degenerate convection-diffusion equations. We are concerned with the regularity estimate of solutions of general convection diffusion equation and we obtain a regular estimate under certain assumptions on the degeneracy of the diffusion coefficients. Next we study the time-decay rate of solutions of the same equations. We obtain a new decay rate under certain conditions: the L-infinity norm of the solution decays like time to the power minus alpha, where alpha lies between zero and one half. The analysis depends on a Lax Oleinik type estimate.

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MS76
A Liouville Theorem for the Axially-symmetric Navier-Stokes Equations

Let \( v(x,t) = v^r e_r + v^\theta e_\theta + v^z e_z \) be a solution to the three-dimensional incompressible axially-symmetric Navier-Stokes equations. Denote by \( b = v^r e_r + v^\theta e_\theta \) the radial-axial vector field. Under a general scaling invariant condition on \( b \), we prove that the quantity \( \Gamma = r v^\theta \) is H"older continuous at \( r = 0, t = 0 \). As an application, we prove that bounded ancient weak solutions of axis symmetric Navier-Stokes equations are zero provided that \( b \in L^\infty([0,T],BMO^{-1}) \). As another application, we prove that if \( b \in L^\infty([0,T],BMO^{-1}) \), then \( v \) is regular.

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MS77
Scattering for the Mass-critical Nonlinear
Schroedinger Equations

Abstract not available at time of publication.

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MS77
Nonlinear Bound States on Manifolds

We will discuss the results of several joint projects (with subsets of collaborators Pierre Albin, Hans Christianson, Jason Metcalfe, Michael Taylor and Laurent Thomann), which explore the existence, stability and dynamics of nonlinear bound states and quasimodes on manifolds of both positive and negative curvature with various symmetry properties.

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MS77
Decay for Wave Equations on Black Hole Backgrounds

Abstract not available at time of publication.

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MS77
Dynamics of Blow up Solutions to the NLS Equation

We discuss dynamics of blow-up solutions to the focusing NLS equations in the \( L^2 \)-critical and \( L^2 \)-supercritical cases. In particular, we show that the log-log blow-up solutions to the \( L^2 \)-critical equation, studied by Merle-Raphael, remain regular in the energy space away from the blow-up point. This implies, for example, that there exist \( H^1 \) radial blow-up solutions on a sphere for the 3d quintic (energy-critical) NLS equation, thus, improving the result of Raphael-Szeftel (2008).

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MS78
An Integral Equation Approach for Media with Close or Touching Inclusions

We consider a system of integral equations for the potential in a 2D composite conductive medium, that contains close to touching inclusions. When the inclusions are disks, we relate the spectral properties of the integral operator to pointwise bounds on the potential gradients, in terms of the conductivity contrast and inter-inclusion distance.

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MS78
Resistor Network Approaches to the Inverse Problem of Electrical Impedance Tomography

Abstract not available at time of publication.

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MS78
Analysis of Some Numerical Methods in Stochastic Homogenization

In this talk I’ll focus on the simplest possible setting for stochastic homogenization: a discrete elliptic equation on \( \mathbb{Z}^d \) with i.i.d. conductivities. I’ll present and quantitatively analyze three different methods to compute the homogenized coefficients: approximations using the corrector equation regularized by a zero-order term, approximation by periodization, and simulation of the random walk in the random environment by a Monte-Carlo method. This talk is based on joint works with J.-C. Mourrat (EPFL), S. Neukamm (MPI Leipzig), and F. Otto (MPI Leipzig).

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MS78
Asymptotics of Solutions of the Random Schroedinger Equation

Abstract not available at time of publication.

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MS79
Fast Numerical Solvers for the Infinity Laplace Equation and Methods for Minimal Distortion Mappings in the Plane

We build discretizations and semi-implicit solvers for the \( \infty \)-Laplacian and the game theoretical \( p \)-Laplacian, which interpolates between the \( \infty \)-Laplacian and the Laplacian. We prove convergence of the solution of the Wide Stencil finite difference schemes to the unique viscosity solution of the underlying equation. We build a semi-implicit solver, which is faster than explicit solution methods. In particular, the convergence rate is independent of the problem size. Joint with Selim Esedoglu.

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MS79
Existence of Absolute Minimizers for Noncoercive
Hamiltonians and Viscosity Solutions of Aronsson Equation

I will discuss the notion of absolute minimizers and the corresponding Aronsson equation for a noncoercive Hamiltonian. We can extend the definition of absolutely minimizing functions (in a viscosity sense) for the minimization of the $L^\infty$ norm of a Hamiltonian, within a class of locally Lipschitz continuous functions with respect to possibly noneuclidean metrics. The metric structure is naturally associated to the Hamiltonian and it is related to the a-priori regularity of the family of subsolutions of the Hamilton-Jacobi equation. A special but relevant case contained in our framework is that of Hamiltonians with a Carnot-Carathéodory metric structure determined by a family of vector fields, in particular the eikonal Hamiltonian and the corresponding anisotropic infinity-Laplace equation. In this case, the definition of absolute minimizer can be written in an almost classical way, by the theory of Sobolev spaces in a Carnot-Carathéodory setting. In general open domains and with a prescribed continuous Dirichlet boundary condition, we prove the existence of an absolute minimizer and derive the Aronsson equation as a viscosity solution for such a minimizer. The proof is based on Perron’s method and relies on a-priori continuity estimates for absolute minimizers.

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MS79
Remarks on the Large Time Behavior of Viscosity Solutions of Quasi-monotone Weakly Coupled Systems of Hamilton–Jacobi Equations

We investigate the large-time behavior of viscosity solutions of quasi-monotone weakly coupled systems of Hamilton-Jacobi equations on the n-dimensional torus. We establish a convergence result to asymptotic solutions as time goes to infinity under rather restricted assumptions. Joint work with H. Mitake.

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MS79
Several Things Related to the Regularity of Infinity Harmonic Functions

I will discuss several things related to the regularity of infinity harmonic functions, such as the failure of the usual flatness argument, another way to derive the Crandall-Evans’s blow-up result, etc.

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MS80
Regularity Theory for Solutions of Fully Nonlinear Integro-differential Parabolic Equations

We study the regularity of solutions of parabolic fully nonlinear nonlocal equations. We prove first Hölder regularity in space and time which allows us to prove Hölder regularity for the first derivative when the equation is translation invariant and under a special assumption on the kernels. The proof relies on a weak parabolic ABP that we obtain by covering the contact set with rectangles where the function doesn’t separates too much from its convex (parabolic) envelope in a given fraction of the covering. Finally we use some ideas from L. Wang, ”On the Regularity Theory of Fully Nonlinear Parabolic Equations: I” to get a point estimate which implies the diminish of oscillation lemma. Same as in the previous work by L. Caffarelli and L. Silvestre, our intention is to present results that remain uniform as the order of the equation goes to 2, giving some unification between the non local and the classical theory.

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MS80
On the Supercritical SQG Equation

We will show that smooth solutions to the supercritical dissipative surface quasi-geostrophic equation eventually become smooth by uniformly bounding the Holder $C^{3}$ norm of the solution. We will do this by considering how the dynamics of the equation alter a class of functions dual to $C^{3}$.

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MS80
$L_p$ and Schauder Estimates for a Class of Nonlocal Elliptic Operators

I will discuss some recent results about $L_p$ and Schauder estimates for a class of non-local elliptic equations. Compared to previous known results, the novelty of our results is that the kernels of the operators are not necessarily to be homogeneous, regular, or symmetric.

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MS80
A Rigidity Theorem for Nonlocal Mean Curvature

We show how one can extend the celebrated moving plane method of Aleksandrov to show that the only compact hypersurfaces with constant non-local mean curvature are spheres. An interesting outcome of our proof is a kind of Hopf Maximum principle for non-local mean curvature.

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MS81
Gevrey Regularity and Decay of Sobolev Norms of the Navier-Stokes Equations

In this talk, I will show various decay estimates of Sobolev norms of the solutions to the Navier-Stokes. The main idea is to show that mild solutions of the Navier-Stokes equations are in Gevrey classes, which imply the time decay of Sobolev norms of weak solutions immediately. This is a joint work with Professor Biswas at the University of North Carolina at Charlotte.

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MS81
Convergence to Self-similarity for the Boltzmann Equation for Strongly Inelastic Maxwell Molecules

We present a result of propagation of the regularity, uniformly in time, for the scaled solutions of the inelastic Maxwell model for any value of the coefficient of restitution. The result follows from the uniform in time control of the tails of the Fourier transform of the solution, normalized in order to have constant energy. In the case of weak inelasticity, similar results have been established by Carlen, Carrillo and Carvalho (2009).

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MS81
On Local Strong Solvability of the Navier-Stokes Equation

Let \([0, T)\) with \(0 < T \leq \infty\) be a time interval and \(\Omega \subseteq \mathbb{R}^3\) a smoothly bounded domain. Consider in \([0, T) \times \Omega\) the non-stationary nonlinear Navier-Stokes equations with prescribed initial value \(u_0 \in L^2(\Omega)\) and external force \(f = F\) with \(F \in L^2(0, T; L^q(\Omega))\). It is well-known that there exists at least one weak solution of the Navier-Stokes system in \([0, T) \times \Omega\) in the sense of Leray-Hopf. Since we do not know if these solutions are unique it is an important problem to investigate conditions on the data \(u_0\) and \(f\) - as weak as possible - to guarantee the existence of a unique strong solution \(u \in L^s(0, T; L^q(\Omega))\) satisfying Serrin's condition \(\frac{2}{s} + \frac{3}{q} = 1\) with \(2 < s < \infty, 3 < q < \infty\), at least for \(T > 0\) sufficiently small. During the last years several sufficient conditions have been given, yielding step by step a larger class of corresponding local strong solutions. These conditions, however, need not to be necessary, in contrast to our result which is optimal in a certain sense and yields the largest possible class of such local strong solutions.

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MS81
Stokes Pressure and a Navier-Stokes Approximation

An important issue in solving numerically the incompressible Navier-Stokes equations is related to the presence of the pressure, particularly in bounded domains with no-slip boundary conditions. An extension of the Navier-Stokes equations was proposed a few years ago by Bob Pego and collaborators in order to address the specific numerical issues related to the presence of the pressure. This extension reduces to the usual Navier-Stokes when the initial data is divergence free, and for non divergence-free initial data the solution evolves (formally) exponentially toward a Navier-Stokes solution. A specific aspect of the extension is the presence of the so-called Stokes pressure generated by the commutator of the Laplacian with the Helmholtz projection onto divergence-free fields. The Stokes pressure is the main obstacle toward the well-posedness of the extended system, which is the issue we address in this talk.

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MS81
Inverse Problems for some Structured Population Models

Structured population models in biology lead to integro-differential equations that describe the evolution in time of the population density taking into account a given feature such as the age, the size, or the volume. These models possess interesting analytic properties and have been used extensively in a number of areas. After giving an introduction to this subject, we will discuss the inverse problem. In this part, we consider a size-structured model for cell division and address the question of determining the division (birth) rate from the measured stable size distribution of
the population. We formulate such question as an inverse problem for an integro-differential equation posed on the half line. We develop firstly a regular dependency theory for the solution in terms of the coefficients and, secondly, a regularization technique for tackling this inverse problem which takes into account the specific nature of the equation. Our results rely also on generalized relative entropy estimates and related Poincare inequalities. This second part is joint work with Benoit Perthame (UPMC, Paris) and Marie Doumic (ENS and INRIA, Paris).

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MS82
Finite-Dimensional Models for Porous-Medium Convection Using a Priori Adapted Bases from Upper-Bound Theory.

We will present a new method for the construction of finite-dimensional dynamical systems approximating the Rayleigh-Benard convection in a fluid-saturated porous medium. The method relies on the derivation of a priori bases specifically tailored to the problem, inspired by energy stability arguments and upper-bound theory. We show that the bases demonstrate dynamically favorable properties, and we present numerical results regarding the convective heat transport, i.e., the Nusselt number, obtained from the dynamical systems.

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MS82
Long-time Behavior of a Geostrophic Two-layer Model for Zonal Jets

In geophysics, multilayer models are derived under the assumption that the fluid consists of a finite number of homogeneous layers of distinct densities. Our model is a two-layer model that was derived to study the perturbation about a zonal jet shear flow. We show that the model is linearly unstable, however the solutions of the nonlinear model are bounded in time. We prove the existence of finite dimensional compact attractor and derive upper bounds on its fractal and Hausdorff dimensions.

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MS82
Numerical Investigations of Infinite Prandtl Number Convection

We describe results of high resolution computations of infinite Prandtl number convection and compute scaling laws for the Nusselt number as a function of the Rayleigh number for free slip boundary conditions in two dimensions. In addition we compare the effect of aspect ratio on flow dynamics and heat transfer rates. Some of this work was performed on Teragrid resources supported by award TG-CTS110010

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MS82
A New Local Well-posedness Framework for the Prandtl Boundary Layer Equations

We address the local well-posedness of the Prandtl boundary layer equations. Using a new change of variables we allow for more general data than previously considered, that is, we require the matching at the top of the boundary layer to be at a polynomial rather than exponential rate. The proof is direct, via analytic energy estimates in
the tangential variables.

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MS82
On The Exact Laws of MHD Turbulence

Exact laws are important properties of turbulent fluids. For MHD turbulence, such laws have been derived by various authors from the statistical point of view. In this talk, we show that these laws hold for weak solutions of the MHD equations, in a distributional sense. As a corollary, we give a simplified proof of the sufficient condition of energy conservation for MHD weak solutions.

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MS83
Invariant Gibbs Measures of the Energy for 3D Models of Turbulence

Gaussian measures of Gibbsian type are associated with some shell model of 3D turbulence; they are constructed by means of the energy, a conserved quantity for the 3D inviscid and unforced shell model. We prove the existence of a unique global flow for a stochastic viscous shell model and of a global flow for the deterministic inviscid shell model, with the property that these Gibbs measures are invariant for these flows. Some results on the 2D case will be discussed.

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MS83
On Energy and Enstrophy Cascades in Physical Scales of the 2D Navier-Stokes Equations

Local analysis of the two dimensional Navier-Stokes equations is used to obtain estimates on the energy and enstrophy fluxes involving Taylor and Kraichnan length scales and the size of the domain. In the framework of zero driving force and non-increasing global energy, these bounds produce sufficient conditions for existence of the direct enstrophy and inverse energy cascades. Several manifestations of locality of the fluxes under these conditions are obtained. All the scales involved are actual physical scales in $\mathbb{R}^2$ and no homogeneity assumptions are made.

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MS83
Stationary Solutions of a Determining Form for the 2D Navier-Stokes Equations

In a 2005 paper with R. Dascaliuc we showed that the global attractor of the 2D Navier-Stokes equations (NSE) achieves a sharp upper bound in the energy, enstrophy-plane if and only if the force is an eigenvalue of the Stokes operator. Recently we have developed a determining form, which is an ordinary differential equation in the Banach space of trajectories in the determining modes for the NSE. The solutions on the global attractor of the NSE are identified as traveling wave solutions of the determining form. In this talk we discuss an extremal property for stationary solutions of the determining form which is analogous to that in the 2005 paper.

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MS83
A Modified Formulation of Statistical Solutions of the Navier-Stokes Equations in Trajectory Space

Great part of the classical theory of turbulence relies on heuristic arguments and empirical information to obtain relations between mean quantities of the flow. The statistical theory of turbulence aims towards a rigorous foundation for the classical theory in the framework of Leray-Hopf weak solutions, in regards to mean quantities based on ensemble averages. The aim in this talk is to introduce a new formulation of the concept of statistical solution based on the definition given by Vishik and Fursikov.

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MS84
T4 Configurations in Fluid Mechanics

In this talk we consider weak solutions of the incompressible 2-D porous media equation. By using the approach of De Lellis-Szekelyhidi we show non-uniqueness for solutions in $L^\infty$ in space and time.

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MS84
Global-in-time Properties of the Muskat Problem

The Muskat problem models the dynamics of the interface between two incompressible immiscible fluids with different constant densities. In this talk we discuss three global-in-time results. First we prove an $L^2$ maximum principle, in
the form of a new “log” conservation law which is satisfied by the equation for the interface. Our second result is a proof of global existence for unique strong solutions if the initial data is smaller than an explicitly computable constant, for instance \( |f_0|_1 \leq 1/5 \). Lastly, we prove a global existence result for Lipschitz continuous solutions with initial data that satisfy \( |f_0|_{L^\infty} < \infty \) and \( \| \partial_x f_0 \|_{L^\infty} < 1 \). We take advantage of the fact that the bound \( \| \partial_x f_0 \|_{L^\infty} < 1 \) is propagated by solutions, which grants strong compactness properties in comparison to the log conservation law.

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**MS84**

**Analytical Treatment of the Beta-model for Intermittent Energy Cascade**

The classical beta-model for intermittent energy cascade is based on the idea that the collection of active eddies at a given dyadic scale fills only a fraction of the volume occupied by active eddies of preceding generation. The Hausdorff dimension of the set where energy dissipates is then determined by the exponential rate of decay of the volumes and relies on an incidence argument. In this talk we will give an analytical interpretation of this so far largely phenomenological argument. Our basic tool is a new formula that measures the active volumes, and active regions are found with the use of atomic decompositions. We introduce precisely the energy dissipation set as the limsup of those active regions and rigorously estimate its Hausdorff dimension.

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**MS84**

**Optimal Large-time Decay Rates for Collisinal Kinetic Equations in the Whole Space**

In this talk we explain several recent results surrounding the problem of determining the large time behavior of the Boltzmann equation and several related physical kinetic models on the full space \((R_+^d)\). Specifically, in collaboration with R. J. Duan, we introduce new methods which involve a combination of Fourier analytic techniques (in the spirit of Kawashima’s work) and the derivation of suitable systems of reduced kinetic equations. These methods enable us to prove the optimal large time decay rates to Maxwellian for several physical models such as the one species Vlasov-Poisson-Boltzmann system and the two-species Vlasov-Maxwell-Boltzmann system. Generalizations to other systems can be expected. Furthermore, since the work of Ukai-Asano in 1982 for cut-off moderately soft potentials, it has been a longstanding open problem to determine the optimal large time decay rates for the soft potential Boltzmann equation in the whole space, with or without the angular cut-off assumption. For perturbative initial data, we prove that solutions converge to the global Maxwellian with the optimal large-time decay rate of \( O(t^{-\frac{d}{2} + 1}) \) in the \( L^2_t(L^r_x) \)-norm for any \( 2 \leq r \leq \infty \) in \( n \)-dimensions. The proof of existence of global in time unique classical solutions to this system was a joint work with P. Gressman.

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**MS85**

**Stability of Fluid Structure Interaction Problem**

In this work we consider the dynamical response of a nonlinear plate interacting with non-linear gradient flow for slightly compressible fluid. The plate part is modeled using a non-linear system of momentum equations for all three components of the vector of the displacement. The fluid flow part is subjected to the generalized Forchheimer equation. Non-standard coupling conditions on the fluid structure interaction surface have been introduced. In particular we show that for a class of boundary conditions and for a specific constraint in the compressibility coefficient, there exists an appropriate energy norm which is bounded by the incoming flow velocity and pressure on the boundary of the liquid region.

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**MS85**

**Multiscale Finite Element Methods for Fluid-structure Interaction Problems**

A multiscale framework for fluid-structure interaction problems in inelastic media will be presented. Stokes flow is assumed at the pore scale with a general nonlinear elastic model for deformations. Due to complexity of pore-level interaction an iterative macroscopic model, that consists of nonlinear Darcy equations and upscaled elasticity equations modeled via an iterative procedure, is proposed. Numerical results for the case of linear elastic solid skeleton are presented for a number of model problems.

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**MS85**

**Stability of the Generalised Forchheimer Flow in Porus Media**

We study generalized Forchheimer equations for slightly compressible fluids in porous media subjected to the total flux condition on the boundary. We derive estimates for the pressure, its gradient and time derivative in terms of the time-dependent boundary data. For the stability, we establish the continuous dependence of the pressure and pressure gradient on the boundary total flux. In particular, we show the asymptotic dependence of the shifted solution on the asymptotic behavior of the boundary data. In order to improve estimates of various types, we prove and utilize suitable Poincare-Sobolev and nonlinear Gronwall inequal-
Motion of a Vortex Filament with Axial Flow in the Half Space

We are concerned with a model equation describing the motion of a vortex filament with axial flow immersed in three-dimensional, incompressible, and inviscid fluid. The model equation is a nonlinear third order dispersive system and we prove the time-local unique solvability of an initial-boundary value problem. Since a standard parabolic regularization will not suffice to solve our problem, we propose a new regularization method for a linear dispersive system.

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MS86
Well-posedness for the Two-phase Navier-Stokes Equations with Surface Tension and Surface Viscosity

A rigorous analysis of a sharp-interface model for the flow of two incompressible fluids in a bounded domain is presented. The motion of the moving interface between both fluids is governed by a stress condition which includes both surface tension and surface viscosity according to the Boussinesq-Scriven law. In order to prove local-in-time well-posedness of the model, the following techniques are used: A transformation to a configuration with fixed interface, a localization procedure, the theory of maximal $L_p$-regularity and the contraction principle.

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MS86
On the Suitable Distance to Control a Perturbed Flow in a Domain with Free Boundary

In the study of stability of steady laminar flows with free boundary, several different linearizations of the unsteady problem have been proposed, in particular the rigorous nonlinear stability theory is still entirely missing. Scope of this note is to begin the study of nonlinear stability of steady laminar flows with free boundary.

Specifically we succeed in the control of a particular distance between the steady $\Gamma_\nu$ and unsteady $\Gamma_t$ surfaces say $\Gamma_t - \Gamma_\nu$. Such a quantity becomes a distance if $\Gamma_t$ is the minimum surface. In such a case $\Gamma_t - \Gamma_\nu > 0$ is always positive. If $\Gamma_t$ is given as the graph $x_N = \eta(x',t)$, with $\eta \in C^m$, $m \geq 1$, setting $\varphi(x,t) = -x_N + \eta(x',t)$ yields the upward unit normal

$$n(x,t) = -\frac{(-\nabla' \eta(x',t),1)}{\sqrt{1+|\nabla' \eta(x',t)|^2}}$$

In this case $\Gamma_t - \Gamma_\nu$ with $\Gamma_\nu$ a plane $x_N = 0$ can be represented in the more explicit form

$$\Gamma_t - \Gamma_\nu = ||\eta||_X := \left(\int_{\Sigma} \frac{|\nabla \eta|^2}{\sqrt{1+|\nabla \eta|^2}} dx'\right)^{1/2} < \infty,$$

where $X$ denotes the subspace of functions $\eta \in H^1(\Sigma)$ satisfying $||\eta||_X < \infty$. In our nonlinear stability we control
for all time the $L^2$ norm of the velocity and the quantity $||\eta||_X$.

The goal is achieved by using a definition of perturbation different from the one usually adopted that has been recently proposed by ourselves.

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MS86
Loss of Control of Motions from Initial Data for Pending Capillary Liquid

We consider a horizontal layer of heavy viscous fluid bounded above by a rigid surface and below by a free surface. We reduce the study of nonlinear instability into the sign of initial energy of perturbations. In nonlinear phenomena, a solution may lose its control from initial data for large data, even though a linearly stable state. We construct a solution such that though linearly stable, it is not controlled by initial data when these data are larger than an computable constant. It is a joint work with U. Massari (Ferrara, Italy) and M. Padula (Ferrara, Italy).

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MS86
Bifurcation Theorems for Free Surface Problems

Abstract not available at time of publication.

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MS87
Strong Solution of Compressible Nematic Liquid Crystal Flows

We prove local existence of unique strong solutions of compressible nematic liquid crystal flows in a domain of $\mathbb{R}^3$, provided that an initial vacuum may exist. We then prove a blow-up criterion for the local strong solution at finite time in terms of $||\rho||_{L^\infty_t L^\infty_x}$ and $||\nabla d||_{L^3_t L^\infty_x}$. We also establish a blow-up criterion in terms of the temporal integral of both the maximum norm of the deformation tensor of velocity gradient and the square of $||\nabla d||_{L^\infty_x}$.

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MS87
Poisson-Nernst-Planck (PNP) Equations for Ion Transport

Understanding ion transport is crucial in the study of many physical and biological problems, such as semiconductors, electro-kinetic fluids, transport of electrochemical systems and ion channels in cell membranes. One of the fundamental models for the ionic transport is the time dependent coupled diffusion-convection equations, the Poisson-Nernst-Planck (PNP) system. The PNP system consists of the electro-static Poisson and Nernst-Planck equations describing electro-diffusion and electrophoresis. In this lecture, I will introduce our recent results on the equilibrium of the PNP system and the linear stability problem.

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MS87
Existence of Globally Weak Solutions to the Flow of Compressible Liquid Crystals System

We study a simplified system for the compressible fluid of Nematic Liquid Crystals in a bounded domain in three Euclidean space and prove the global existence of the finite energy weak solutions.

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MS87
Motion of vortices in the Landau-Lifschitz-Gilbert equation

A simplified model for the energy of the magnetization of a thin ferromagnetic film gives rise to a version of the theory of Ginzburg-Landau vortices for sphere-valued maps. In particular we have the development of vortices as a certain parameter tends to 0. The dynamics of the magnetization is ruled by the Landau-Lifschitz-Gilbert equation, which combines characteristic properties of a nonlinear Schrödinger equation and a gradient flow. I will discuss the motion of the vortex centers under this evolution equation.

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On Global Solutions to Flows of Liquid Crystals

The three-dimensional equations for the incompressible and compressible flows of liquid crystals are considered. The existence, large-time behavior, and incompressible limit of global strong and weak solution are discussed.

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Two Phase Flow in Porous Media: the Saffman-Taylor Instability Revisited

Plane waves for two phase flow in a porous medium are modeled by the one-dimensional Buckley-Leverett equation, a scalar conservation law. We analyze linearized stability of sharp planar interfaces to two-dimensional perturbations, which involves a system of PDE. Numerical simulations of the full nonlinear system, including dissipation, illustrate the analytical results. We also discuss a modified Buckley-Leverett equation, in which the capillary pressure is rate-dependent, thereby adding a BBM-type dispersive term. This equation sustains undercompressive planar waves, but they are all unstable to two-dimensional perturbations.

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Rate of Convergence for Vanishing Viscosity Approximations to Hyperbolic Balance Laws

Results on the rate of convergence for vanishing viscosity approximations to hyperbolic balance laws are presented. The systems under consideration are strictly hyperbolic and genuinely nonlinear with a source term satisfying a special mechanism that induces dissipation. The proof relies on error estimates that measure the interaction of waves. Shock waves are treated by monitoring the evolution of suitable Lyapunov functionals, whereas interactions involving rarefaction waves are accommodated by employing a sharp decay estimate.

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Global Solutions to Variational Nonlinear Wave Systems Modelling Nematic Liquid Crystals

Abstract not available at time of publication.

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An Envelope Approximation of Out-of-Plane Gap Solitons in 2D Photonic Crystals

We consider the nonlinear Maxwell equations for 2D Kerr nonlinear photonic crystals for fields propagating out of the plane of periodicity, cf e.g. photonic crystal fibers. Similarly to [Dohnal, Uecker, arXiv:0810.4499] we show that gap solitons in the vicinity of gap edges are approximated via modulation equations, so called coupled mode equations (CMEs), the coefficients of which are determined by the linear band structure of the Maxwell system. We numerically compute the band structure and the CME coefficients for a cylindrical photonic crystal geometry with a hexagonal Wigner-Seitz cell.

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Modulation Equations for Two Gravity Water-waves of Finite Depth

We consider the 3D gravity water-wave problem of finite depth, derive the leading and next-to-leading order macroscopic equations of hyperbolic scaling for small amplitudes of the surface elevation for a system of two arbitrary carrier waves, and discuss their rigorous justification.

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MS89
Nearly Finite-Dimensional Dynamics in Optical Waveguides

We investigate the dynamics of small-amplitude solutions to NLS with a potential supporting three eigenfunctions whose initial conditions are a superposition of the eigenmodes. We demonstrate that solutions are well-approximated by an ODE derived using a Galerkin truncation, and that the finite-dimensional dynamics are interesting. The ODE has standing waves, relative periodic orbits, heteroclinic connections, and apparent chaos. Its normal form remains poorly understood. We discuss proposed physical experiments in an optical waveguide.

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MS89
Linearized Backlund Transform as a tool to prove stability

Recently, the linearized backlund transform has been used to prove stability of solitons and multi-soliton solutions in several completely integrable systems. We will discuss this method for the Toda lattice and the Sine-Gordon equation.

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MS90
A Result on Homogenization of Fronts in Highly Heterogeneous Media

I will consider the evolution by mean curvature in a heterogeneous medium, modeled by a periodic forcing term. I will discuss two related problems: the existence of a homogenization limit, when the dimension of the periodicity cell tends to zero, and the long time behaviour of the evolution, in particular the existence of travelling waves solutions.

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MS90
Pinning and Depinning of Interfaces in Random Media

We consider a parabolic model for the evolution of an interface in random medium. The local velocity of the interface is governed by line tension and a competition between a constant external driving force \( F > 0 \) and a heterogeneous random field \( f(x, y, \omega) \), which describes the interaction of the interface with its environment. To be precise, let \((\Omega, F, P)\) be a probability space, \( \omega \in \Omega \). We consider the evolution equation

\[
\partial_t u(x, t, \omega) = \Delta u(x, t, \omega) - f(x, u(x, t, \omega), \omega) + F
\]

with zero initial condition. The random field \( f > 0 \) has the form of localized smooth obstacles of random strength. In particular, we are interested in the macroscopic, homogenized behavior of solutions to the evolution equation and their dependence on \( F \). We prove that, under some assumptions on \( f \), we have existence of a non-negative stationary solution for \( F \) small enough. This means that all solutions to the evolution equation become stuck if the driving force is not sufficiently large. The proof relies on a percolation argument. Given stronger assumptions on \( f \), but still without a uniform bound on the obstacle strength, we also show that for large enough \( F \) the interface will propagate with a finite velocity. The two results combined show the emergence of a rate-independent hysteresis in systems subject to a viscous microscopic evolution law through the interaction with a random environment.

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MS90
Front Propagation in Stratified Media: A Variational Approach

We prove, under generic assumptions, that the special variational traveling wave that minimizes the exponentially weighted Ginzburg-Landau functional associated with scalar reaction-diffusion equations in infinite cylinders is the long-time attractor for the solutions of the initial value problems with front-like initial data. The convergence to this traveling wave is exponentially fast. The obtained result is mainly a consequence of the gradient flow structure of the considered equation in the exponentially weighted spaces and does not depend on the precise details of the problem. It strengthens our earlier generic propagation and selection result for “pushed” fronts.

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MS90
Stochastic Allen-Cahn Equation and Mean Curvature Flow

In this talk we review some recent results on perturbation of the Allen-Cahn equation by a random forcing. It is
well known that the deterministic Allen-Cahn equation approximates an evolution of phase indicator functions. The phase boundaries perform a motion by mean curvature. We investigate if this behaviour is stable under random perturbations. To be more precise, we want to know if it is true that a stochastically perturbed Allen-Cahn equation converges to a stochastically perturbed mean curvature flow. We show that this is true - at least for short times - in the simplest possible case, where the forcing is the approximation of a one-dimensional time dependent white noise. Then we study a more complicated forcing by a stochastic transport-type term. We obtain compactness and regularity results. The limiting evolution will also be discussed.

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MS91
Scattering and Estimation from Cross Correlations

We will analyze the waves transmitted and reflected by a random medium in the case in which the medium has rapid random fluctuations. This involves deriving a white noise approximation for the wave field. We will show how the second-order statistics of the wave can be determined by this white noise approximation in the paraxial regime and be used for imaging.

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MS91
Passive Sensor Imaging using Cross-correlations of Noisy Signals

We consider here the problem of imaging using passive incoherent recordings due to ambient noise sources. The first step towards imaging in this configuration is the computation of the cross-correlations of the recorded signals. These cross-correlations are computed between pairs of sensors (receivers) and contain very important information about the background medium. They can be used, for example, to compute the travel time between sensors or even the Green’s function from one sensor to the other. Our aim is to use these cross-correlations in order to image reflectors embedded in clutter. To do so we will use coherent imaging methods, such as travel time migration and coherent interferometry (CINT).

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MS91
Thermoacoustic and Photoacoustic Tomography

Abstract not available at time of publication.

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MS92
Finite Element Discretization of the Navier-Stokes Equations with Mixed Boundary Conditions

We consider a variational formulation of the three-dimensional Navier-Stokes equations with mixed boundary conditions and prove that the variational problem admits a solution provided that the domain satisfies a suitable regularity assumption. Next, we propose a finite element discretization relying on the Galerkin method and establish a priori and a posteriori error estimates.

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MS92
Finite Element Discretization of the Navier-Stokes Equations with Mixed Boundary Conditions

We consider a variational formulation of the three-dimensional Navier-Stokes equations with mixed boundary conditions and prove that the variational problem admits a solution provided that the domain satisfies a suitable regularity assumption. Next, we propose a finite element discretization relying on the Galerkin method and establish a priori and a posteriori error estimates.

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MS92
Stabilized Finite Element Solvers of Incompressible Flow Equations: Modeling of Stabilization Coefficients via Kinetic Energy

The turbulent kinetic energy (TKE) plays a major role in standard turbulence models. In particular, Variational Multi-scale (VMS) models may be used as turbulence models. This includes on one hand two-grids models, that include modeling of eddy diffusion that acts on the equation of the small resolved scales. On another hand it includes Orthogonal Sub-grid Scale methods, that provide a with full modeling of large-small scale interactions, without the need of eddy diffusion modeling. All these models require stabilization parameters. This talk analyzes whether the use of TKE may improve VMS models. We derive a modeling of stabilization parameters depending of the TKE. The
TKE is obtained as the solution of a modeled equation. We prove that this equation is well posed in \( W^{1,q} \) norm, for \( 1 < q < d' \) (\( d \) is the space dimension), and that it tends to zero in this norm as the turbulent perturbation tends to zero in \( H^1 \) norm. In this sense we are considering LES models. We present some numerical tests that fully confirm these results, and also seem to indicate that the TKE equation is not well posed in \( H^1 \) norm. We finally present some results for lid-driven cavity flow that support the basic modeling hypothesis, that gives a functional structure for the perturbation in terms of the residual associated to the large resolved scales. We also show that TKE may be used as a good error indicator.

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MS92  
Asymptotic Analysis of the Approximate Deconvolution Models to the Mean Navier Stokes Equations

We consider a 3D Approximate Deconvolution Model (ADM) which belongs to the class of Large Eddy Simulation (LES) models. We aim at proving that the solution of the ADM converges towards a dissipative solution of the mean Navier-Stokes Equations, for periodic boundary conditions. The convolution filter we first consider is the Helmholtz filter. We next consider generalized convolution filters for which the convergence property still holds.

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MS92  
On Large Data Analysis of Kolmogorov’s Two Equation Model of Turbulence

Kolmogorov seems to be the first who recognized (in 1941) that a two equation model of turbulence might be appropriate to turbulent flow prediction. We present the results (joint work with M. Bulicek concerning long-time and large-data existence of weak solution to three-dimensional flows described by this Kolmogorov’s two equation model of turbulence. Similar results (joint work with M. Bulicek and R. Lewandowski associated with one equation model of turbulence (for turbulence kinetic energy) will be presented as well.

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MS93  
A Mimetic Scheme to Solve Poisson’s Equation in a 3-d Curvilinear Mesh

The performance and accuracy of the Castillo-Grone Mimetic has already been shown in many fields. There have been a number of studies in both one-dimensional and two-dimensional mostly in a uniform mesh; however, there are some publication showing the same performance in a non-uniform mesh. In this talk, we will discuss the performance of a scheme based on the Castillo-Grone mimetic operators in a 3-D fully curvilinear mesh by solving a Poissons equation. Poissons equation arises in many fields including non-hydrostatic simulation of Navier-Stokes equations. Solving Poissons equation in a 3-D fully curvilinear coordinate system is a vital step in these types of simulations. We will discuss both the accuracy and the performance of a difference scheme based on the Castillo-Grone mimetic operators in solving the Poissons equation in a fully 3-D curvilinear mesh

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MS93  
A Mimetic Difference Method for Maxwell Equations on a Non-uniform Logically Rectangular Mesh

A Mimetic formulation of Maxwell equations and their properties in two and three dimensional on non-uniform structured grids are developed. This formulation is an extension of the Castillo-Grone mimetic operators, for the 2-D curl operator on a uniform mesh. This mimetic numerical method produces approximations of fourth order both at the grid boundary and in the grid’s interior.

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MS93  
A Distributed Mimetic Approach to Simulating Water-rock Interaction Following CO2 Injection in Sedimentary Basins

Risk estimation of short- and long-term geologic storage of CO2 can only be addressed through numerical modeling and simulation. In this paper we employ a novel mimetic numerical method to model the short-term (10-100 year) effects of CO2 injection in a sandstone formation modeled after the Oligocene Frio Formation, a regional brine reservoir along the U.S. Gulf Coast. Mimetic numerical methods solve a discrete analog of a continuum problem. Applied to geologic carbon sequestration, we employ a finite-difference mimetic method to solve an elemental conservation of solute species mass equation that governs solute transport in deep brine water residing in a permeable sandstone formation, subjected to the injection of supercritical phase CO2. Our novel implementation has been developed for use on many-core clusters and uses the distributed SuperLU library developed at Lawrence Berkeley National Laboratory for solving large sparse nonsymmetric systems constructed to compute solute activities during each time step. We demonstrate that a mimetic approach to the numerical modeling of water-rock interaction yields solutions that achieve a comparably higher order approximation at, or near, the boundary of a defined reservoir.

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MS93
A Numerical Study of a Mimetic Scheme for the Unsteady Heat Equation

A new mimetic scheme for the unsteady heat equation is presented. It combines the Castillo-Grone mimetic discretizations for gradient and divergence operators in space with a Crank-Nicolson approximation in time. A comparative numerical study against standard finite difference shows that the proposed scheme achieves higher convergence rates, better approximations, and it does not require ghost points in its formulation.

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MS94
Experiments on Water Waves in Finite, Variable Depth

We report on experiments on surface-gravity waves on water of finite and variable depth using the Davey-Stewartson equation in one propagation direction as a mathematical framework.

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MS94
Spectral Stability of Water Waves: Stable, High-Order Computation in the Presence of Resonance

The water wave equations govern the movement of a large body of water (e.g., the ocean), and among the many motions permitted, the traveling wave solutions are of great interest due to their ability to transport energy and momentum over great distances in the ocean. Of course not all of these traveling waveforms are dynamically stable and it is of crucial importance to identify those that are as these will be the only ones observed in practice. In a recent publication the author endeavored upon a study of the spectral stability of periodic traveling water waves on a two-dimensional (one vertical and one horizontal) fluid. The author used the fact that traveling waves come in analytic branches to show that, in the case of simple eigenvalues, the spectral data can also be parametrized analytically. With this point of view, the author followed the “motion” of the spectrum in the complex plane as a wave height/steepeess parameter was increased, deducing (weak) spectral stability provided the parameter was sufficiently small (e.g., up to divergence of the expansions). In this talk we expand these results to eigenvalues of higher multiplicity (resonance), in particular the important case of multiplicity two where, again, we can deduce weak spectral stability. Time permitting, we will present numerical results and the details of eigenvalues of multiplicity three (e.g. Benjamin-Feir) and higher.

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MS94
Water Waves: Reconstructing the Surface Elevation from Pressure Data

A new method is proposed to recover the water-wave surface elevation from pressure data obtained at any depth below the fluid surface. The new method requires the numerical solution of a nonlocal nonlinear equation relating the pressure and the surface elevation which is obtained from the Euler formulation of the water-wave problem without approximation. This new approach is compared with other approaches currently used in field observations.

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MS94
Inverse Problems in the Theory of Water Waves

The problem of surface water waves has been formulated in several different but equivalent ways, e.g. Zakharov’s Hamiltonian formulation, the Dirichlet-to-Neumann operator formulation of Craig and Sulem and the recent Ablowitz-Fokas-Musslimani formulation. In this talk I shall describe how certain inverse problems in water waves may be approached by combining results from the various formulations.

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MS94
Bifurcation and Resonance in Standing Water Waves

We develop a trust-region shooting algorithm for solving two-point boundary value problems governed by nonlinear PDE. We use our method to compute families of time-periodic solutions of the gravity-driven water wave in two and three dimensions, focusing on questions of stability, resonance and the effect of small divisors. We also an-
swer negatively a long-standing conjecture of Penney and Price about the existence of a limiting standing wave of maximum amplitude that forms a sharp, 90 degree interior crest angle each time the fluid comes to rest.

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MS95
Asymptotic Behavior for the Aggregation Equation with Diffusion

We consider the equation $\partial_t \rho = \nabla \cdot (\nabla W \ast \rho) + \Delta \rho$, a diffusive equation with a nonlinear and nonlocal term given by a self-interaction through a potential $W$. We will give well-posedness results and study its asymptotic behavior. If $W$ satisfies some suitable bounds, one can prove that the behavior is dominated by diffusion, this is, solutions behave for large times essentially like those of the heat equation. Precise estimates on rates of convergence to the fundamental solution to the heat equation can be given by using entropy methods.

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MS95
Regularity of Solutions to the Liquid Crystals Systems in $\mathbb{R}^2$ and $\mathbb{R}^3$

We study the regularity and uniqueness of solutions to systems of nematic liquid crystals with non-constant density. We establish that, in $\mathbb{R}^2$, the global regularity with general data; in $\mathbb{R}^3$, the global regularity with small initial data and a local (short time) regularity with large data. In addition, with more smoothness assumption on initial data, we obtain the uniqueness both for dimension 2 and 3 cases.

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MS95
Vortex Sheets in Exterior Domains and Kelvin’s Circulation Theorem

We consider incompressible ideal 2D flow in the exterior of $N$ obstacles with vortex sheet regularity, i.e., the vorticity is assumed to be a bounded Radon measure in $H^{-1}$. We assume that the vorticity is of distinguished sign. We are concerned with the conservation of circulation around individual boundary components, which holds for smooth flows. We establish an analogue of this conservation law for weak solutions with vortex sheet regularity.

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MS95
Construction of Almost Sharp Fronts for the Surface Quasi-geostrophic Equation

I will describe recent work with Charles Fefferman on a construction of families of analytic almost-sharp fronts for SQG. These are special solutions of SQG which have a very sharp transition in a very thin layer. One of the main difficulties of the construction is the fact that there is no formal limit for the family of equations. I will show how to overcome this difficulty, linking the result to joint work with C. Fefferman and Kevin Luli on the existence of a "spine" for almost-sharp fronts. This is a curve, defined for every time slice by a measure-theoretic construction, that describes the evolution of the almost-sharp front.

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MS96
The Pattern of Multiple Rings from Morphogenesis in Development

Under certain conditions the problem of morphogenesis in development and the problem of morphology in block copolymers may be reduced to one geometric problem. In two dimensions two new types of solutions are found. The first type of solution is a disconnected set of many components, each of which is close to a ring. The sizes and locations of the rings are precisely determined from the parameters and the domain shape of the problem. The solution of the second type has a coexistence pattern. Each
component of the solution is either close to a ring or to
a round disc. The first-type solutions are stable for cer-
tain parameter values but unstable for other values; the
second-type solutions are always unstable. In both cases
one establishes the equal area condition: the components
in a solution all have asymptotically the same area.

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MS96
Existence of Multiple Spike Stationary Patterns in
a Chemotaxis Model with Weak Saturation

We are concerned with a multiple boundary spike solu-
tion to the steady-state problem of a chemotaxis system:
\( P_t = \nabla \cdot (P \nabla (\log \left( \frac{P}{W} \right))) \), \( W_t = \varepsilon^2 \Delta W + F(P,W) \), in
\( \Omega \times (0,\infty) \), under the homogeneous Neumann boundary
condition, where \( \Omega \subset \mathbb{R}^N \) is a bounded domain with
smooth boundary, \( P(x,t) \) is a population density, \( W(x,t) \)
is a density of chemotaxis substance. We assume that
\( \Phi(W) = W^p, p > 1 \), and we are interested in the cases
of \( F(P,W) = F_1(P,W) = -W + \frac{P W^q}{\alpha + \gamma W^k} \) and \( F(P,W) =
F_2(P,W) = -W + \frac{P}{\alpha + \gamma W^k} \) with \( q > 0, \alpha, \gamma, k \geq 0 \),
which has a saturating growth. In this talk, we assume that
\( \Omega \) is symmetric with respect to each hyperplane \( \{x_1 =
0\}, \ldots, \{x_{N-1} = 0\} \). For two classes of \( F(P,W) \) above with
saturation effect, we show the existence of multiple bound-
ary spike stationary patterns on \( \Omega \) under a weak saturation
effect on parameters \( \alpha, \gamma \) and \( k \). This talk is based on a
joint work with Dr. K. Morimoto.

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MS96
Delay Gierer-Meinhardt Systems in the Self-
organisation of Cells

Modelling investigations of cellular systems typically ne-
eglect the influence of gene expression on such dynamics,
even though transcription and translation are observed to
be important in morphogenetic systems. We formulate
and explore two mathematical models of extracellular mor-
phogen dynamics based on Gierer-Meinhardt systems, in
which gene expression time delays are incorporated by the
direct application of the mass action law via sub-cellular
dynamics.

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MS96
Singularly Perturbed Nonlinear Neumann Problems
under Optimal Conditions for the Nonlinearity

Let \( \Omega \) be a bounded domain in \( \mathbb{R}^N \) with the boundary
\( \partial \Omega \in C^3 \). We consider the following singularly perturbed
nonlinear elliptic problem on \( \Omega \),
\[
\varepsilon^2 \Delta v - v + f(v) = 0, \quad v > 0 \text{ on } \Omega, \quad \frac{\partial v}{\partial \nu} = 0 \text{ on } \partial \Omega,
\]
where \( v \) is the exterior normal to \( \partial \Omega \) and the nonlinearity
\( f \) is of subcritical growth. Under Berestycki and Lions
conditions for \( f \in C^1(\mathbb{R}) \), which turns out to be rather
strong regularity, it has been known that there exists a
solution \( v_\varepsilon \) of the above problem which exhibits a spike
layer near a local maximum point of the mean curvature \( H \)
on \( \partial \Omega \) as \( \varepsilon \to 0 \) for \( N \geq 3 \). In this paper, we extend to the result
under Berestycki and Lions conditions for \( f \in C^0(\mathbb{R}) \)
(almost optimal condition) for \( N \geq 2 \).

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MS96
Toroidal Solutions to a Pattern Formation Problem
of Mean Curvature and Newtonian Potential

Pattern formation problems arise in many physical and bio-
logical systems as orderly outcomes of self-organization
principles. Examples include animal coats, skin pigmenta-
tion, and morphological phases in block copolymers. Re-
cent advances in singular perturbation theory and asym-
ptotic analysis have made it possible to study these problems
rigorously. In this talk I will discuss a successful approach
in the construction of various patterns as solutions to some
well known PDE and geometric problems: how a single
piece of structure built on the entire space can be used as an
ansatz to produce a near periodic pattern on a bounded do-
main. We start with the simple disc ansatz to show how
the spot pattern in morphogenesis and the cylindrical phase
in diblock copolymers can be mathematically explained, and
end with the toroidal ansatz for the toroidal supramolecule
assemblies recently discovered in block copolymers.

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MS97
Nonlinear Maximum Principles for Linear Nlocal
Oerators and Aplications

Nonlocal dissipative operators have "shape-dependent"
maximum principles. I will explain these and provide ideas
of proofs. These maximum principles are nonlinear, robust
and rather useful. I will give some examples of applications.

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MS97
Optimal Stirring for Passive Scalar Mixing
We address the challenge of optimal incompressible stirring to mix an initially inhomogeneous distribution of passive tracers. As a measure for mixing we adopt the $H^{-1}$ norm of the scalar fluctuation field. This ‘mix-norm’ is equivalent to (the square root of) the variance of a low-pass filtered image of the tracer concentration field, and is a useful gauge even in the absence of molecular diffusion. This mix-norm’s vanishing as time progresses is evidence of the stirring flow’s mixing property in the sense of ergodic theory. For the case of a periodic spatial domain with a prescribed instantaneous energy or power budget for the stirring, we determine the flow field that instantaneously maximizes the decay of the mix-norm, i.e., the instantaneous optimal stirring — when such a flow exists. When no such ‘steepest descent’ stirring exists, we determine the flow that maximizes that rate of increase of the rate of decrease of the norm. This local-in-time stirring strategy is implemented computationally on a benchmark problem and compared to an optimal control approach utilizing a restricted set of flows. This is joint work with Zhi Lin, Evelyn Lunasin, and Jean-Luc Thiffeault.

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MS97
Geodesic Equations on the Contactomorphism Group
A contact form on a Riemannian manifold of dimension $2n + 1$ is a 1-form $\alpha$ such that $\alpha \wedge (d\alpha)^n$ is nowhere zero; the basic example is a left-invariant 1-form on the group of unit quaternions which is closely related to the Hopf fibration of $S^3$ over $S^2$. Contact forms are generally viewed as the odd-dimensional analogue of symplectic forms. Given a contact form we can consider the groups of diffeomorphisms either preserving the contact form exactly (the group of strict contactomorphisms or quantomorphisms), or preserving the contact form up to a nowhere zero function (the contactomorphism group). It is a well-known result of Arnold that the geodesic equation of the $L^2$ metric on the group of volume-preserving diffeomorphisms is the Euler equation of ideal fluid mechanics. We discuss the geodesic equation arising on both of the contactomorphism groups, including smoothness, local and global existence, and stability properties. The geodesic equation for strict contactomorphisms is related to the Euler equation with symmetry (e.g., the axisymmetric Euler equation without swirl), while the geodesic equation for non-strict contactomorphisms has many properties in common with the Camassa-Holm equation (and reduces to it when $n = 0$).

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MS97
Bounds on Heat Transport for Fixed Flux Thermal Boundary Conditions at Infinite Prandtl Number
Convection enhances the transport of heat in a fluid layer. In Rayleigh-Benard convection this enhancement is measured by the Nusselt number $Nu$. Of intense interest is the functional dependence of the Nusselt number on the material parameters of the system; the ratio of viscosity to thermal diffusivity given by the Prandtl number $Pr$, the geometry usually indicated by an aspect ratio, and the driving force as described by the dimensionless Rayleigh number $Ra$. When $Ra \to \infty$ (in the presence of turbulence), it is generally agreed that $Nu \sim Ra^{\gamma}$. The dependence of $\gamma$ on the velocity boundary conditions for the flow (i.e., stress-free or no-slip) and the temperature boundary conditions (i.e., fixed temperature or fixed flux) is of particular interest. The focus of most prior work (experimental, numerical simulations, and analytic bounds) has been on fixed temperature, no-slip boundaries. It has been pointed out that experimentally, fixed temperature boundaries are difficult to realize. Even so, recent numerical simulations and rigorous variational bounds have indicated that changes in the thermal boundary condition do not affect $\gamma$. To complete this investigation of varying thermal boundaries, we consider the reduced infinite $Pr$ system, and use a series of Hardy-Rellich type estimates to show that, $Nu \leq C\log(Ra)^{2/3}Ra^{1/3}$ for no-slip, fixed flux boundary conditions.

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MS97
Oscillations of Solutions to the Navier-Stokes Equations
Abstract not available at time of publication.

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MS98
The Stability of Pulses in Singularly Perturbed Reaction-diffusion Equations
In recent years, methods have been developed to study the existence and stability of pulses in singularly perturbed reaction-diffusion equations in one space dimension, in the context of a number of model problems such as the Gray-Scott and the Gierer-Meinhardt equations. Although these methods are in principle of a general nature, their applicability relies strongly on the characteristics of these models. For instance, the slow reduced spatial problem is linear in the models considered in the literature. This property is an essential ingredient of the spectral stability analysis. In this talk, we present a significantly extended method by which the Evans function associated to the general spectral problem can be decomposed into a fast and a slow component. Both components can be constructed explicitly, so that the spectrum can be determined analytically.

Arjen Doelman
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MS98
On the Modulational Instability for the Benjamin-Ono Equation

I will discuss the modulational stability and instability for a class of nonlinear dispersive equations, possibly involving nonlocal dispersion operators, such as the Benjamin-Ono equation and the intermediate long wave equation. In case the equation is equipped with Hamiltonian structure and thus periodic traveling-wave solutions arise as critical points of a constrained Hamiltonian, I will explain how the traditional Evans function based approach can be related to direct Bloch wave expansions. This is joint work with Jared Bronski.

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MS98
Nonlinear Modulational Stability of Periodic Traveling Waves in a Generalized Kuramoto-Sivashinsky Equation

In this talk, we consider the stability of periodic traveling wave solutions of a generalized Kuramoto-Sivashinsky equation. In special cases it has been known since 1976 that, when subject to small localized perturbations, spectrally stable solutions of this form exist. Although numerical time-evolution studies indicate that these waves should also be nonlinearly stable to such perturbations, an analytical verification of this result has only recently been provided. Here, I will discuss this result and, if time allows, I will briefly discuss the stability of such waves to small nonlocalized perturbations asymptotic to constant shifts in phase.

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MS98
Homoclinic Solutions as Critical Points of Functionalized Energies

Abstract not available at time of publication.

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MS98
Structured Interfaces and Network Formation in the Functionalized Cahn-Hilliard Equation

We show that a binary mixture of solvent and charged polymer, as modeled by the Functionalized Cahn-Hilliard energy, generates competing families of bilayer, pore, and micelle networks. In a mass preserving gradient flow we examine the competition between between these structures which leads to the hysteresis observed in polymer electrolyte membrane hydration. In particular we examine the influence of the volume fraction of the competing structures on the their curvature driven flow.

Keith Promislow

MS99
Gamma Convergence of Lawrence-Doniach Energies

We consider the Lawrence-Doniach energy functional for layered superconductors and a three-dimensional anisotropic Ginzburg-Landau energy functional. Both models have been used to describe high-temperature superconductors. We prove that as the interlayer spacing in the Lawrence-Doniach model tends to zero, the Lawrence-Doniach energy (with appropriate Josephson coefficients) Γ-converges to the three-dimensional anisotropic Ginzburg-Landau energy. We also prove compactness results which ensure that local minimizers of the Lawrence-Doniach energy converge to local minimizers of the anisotropic Ginzburg-Landau energy.

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MS99
Critical Phenomena in Keller-Segel Equations for Chemotaxis and Related Particle Models

The Keller-Segel PDEs describe chemotaxis, a phenomenon characterized by the bias of the bacterial motion according to concentration of some chemical. These equations exhibit blow-ups, a mathematical manifestation of the bacteria concentrating at the finest spatial scales. Studying these blow-ups is a challenging problem, both analytically and numerically. I will discuss some associated stochastic particle models and numerical methods which allow us to study this interesting phenomenon.

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MS99
Bifurcation Theory of Layer Undulations in Smectic A Liquid Crystals

We study the Landau-de Gennes free energy to describe the undulations instability in smectic A liquid crystals subjected to magnetic fields. If a magnetic field is applied in the direction parallel to the smectic layers, an instability occurs above a threshold magnetic field. When the magnetic field reaches this critical threshold, periodic layer undulations are observed. We study this phenomenon analytically by considering the minimizer of the second variation according to concentration of some chemical. These equations exhibit blow-ups, a mathematical manifestation of the bacteria concentrating at the finest spatial scales. Studying these blow-ups is a challenging problem, both analytically and numerically. I will discuss some associated stochastic particle models and numerical methods which allow us to study this interesting phenomenon.

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MS100

Wrinkles as a Relaxation of Compressive Stresses in Annular Thin Films

It is well known that elastic sheets loaded in tension will wrinkle, with the length scale of wrinkles tending to zero with vanishing thickness of the sheet [Cerdà and Mahadevan, Phys. Rev. Lett. 90, 074302 (2003)]. We give the first mathematically rigorous analysis of such a problem. Since our methods require an explicit understanding of the underlying (convex) relaxed problem, we focus on the wrinkling of an annular sheet loaded in the radial direction [Davidovitch et al., arxiv 2010]. While our analysis is for that particular problem, our variational viewpoint should be useful more generally. Our main achievement is identification of the scaling law of the minimum energy as the thickness of the sheet tends to zero. This requires proving an upper bound and a lower bound that scale the same way. We prove both bounds first in a simplified Kirchhoff-Love setting and then in the nonlinear three-dimensional setting. To obtain the optimal upper bound, we need to adjust a naive construction (one family of wrinkles superimposed on the planar deformation) by introducing cascades of wrinkles. The lower bound is more subtle, since it must be ansatz-free.

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MS100

The Lame’ Problem: A Prototypical Model for Wrinkling of Thin Sheets

Wrinkling patterns are often assumed to reflect a (super-critical) instability of a symmetric state of thin compressed sheets. The subtlety of this interpretation will be demonstrated through the Lamé geometry: annular sheet under axisymmetric tension. This elementary, yet nontrivial extension of Euler buckling, exhibits wrinkling patterns that vary markedly away from threshold. Focusing on the near-threshold and far-from-threshold limits, I will show how they emanate from distinct asymptotic expansions of Föppl-von Kármán equations.

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MS100

The Matching Property of Infinitesimal Isometries for Developable Shells

We study regularity, rigidity, density and matching properties for first order Sobolev-regular infinitesimal isometries on developable surfaces without flat regions. We prove that given enough regularity of the surface, any first order infinitesimal isometry can be matched to a higher order isometry. Our study is motivated by its applications to thin shells.

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MS101

Long-Time Behavior for Nonlinear Size-Structured Population Models

The evolution of a size-structured population in which individuals grow and split can be modeled by the growth-fragmentation equation. We present nonlinear versions of this equation which take into account some saturation effects of the total population on the growth or/and the death rate. The long-time behavior of the solutions is investigated by using the eigenvalues of the linear growth-fragmentation operator and their dependence on parameters.

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MS101

Size-Structured Populations with Distributed States at Birth

In contrast to age-structured models in population dynamics where every individual is born at the same age 0, size-structured models allow to take into account different, i.e. distributed birth sizes. This introduces an operator that takes values in an infinite-dimensional Banach space and complicates greatly the analysis of questions such as asymptotic growth, existence and stability of steady states.
etc. In this survey, we will describe some examples of models that we recently investigated in a series of joint papers with Jozsef Farkas (University of Stirling, United Kingdom).

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MS101
Age-structured Division Equations: Unexpected Asymptotics

We present here a recent joint work with Stéphane Gaubert. The very simple age-structured division equation,

\[
\frac{\partial n}{\partial t} + \frac{\partial n}{\partial x} + K(t, x)n(t, x) = 0,
\]

\[
\begin{align*}
\frac{\partial n}{\partial x}
+ n(t, x = 0) &= 2 \int_0^\infty K(t, x)n(t, x)dx,
\end{align*}
\]

that models the division of a cell of age \(x\) into two cells of age 0 at rate \(K\) can show unexpected complexity once we allow dependence both in age and time for this division rate. We interest ourselves especially to the effect of \(K\) on the Malthus rate \(\lambda\) that describes the exponential growth of the system. Link with discrete system is established when we allow this rate to take infinite values.

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MS101
Structured Population Models of Cell Differentiation and Tissue Regeneration

We introduce and analyze a general class of structured population models describing the dynamics of cell population based on cell differentiation process. The models are based on a nonlinear transport equation coupled with ordinary differential equations. Comparing the model to its discrete counterpart we address the question of the choice of the right class of models, for example discrete compartments with maturation punctuated by division events versus continuous maturation. We show that the models may exhibit different dynamics. Interestingly, the structure of steady states varies and the discrete compartmental model admits semi-trivial steady states, which do not exist in the continuous differentiation model. Finally, we present how to unify the discrete and continuous dynamics in the framework of measure-valued solutions. To obtain ODE-type quasi-stationary node points we exploit the idea of non-Lipschitz zeroes in the velocity. Since the analysis has biological motivations, we provide examples of its application in hematopoiesis and neurogenesis.

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MS102
Dynamics of the Visual Cortex – The Challenges Facing Population-dynamics Models

Can classical population-dynamics methods capture the dynamics of the visual cortex? The mammalian primary visual cortex (V1) is a relatively well studied area of the brain. Many experimental phenomena, such as orientation, surround suppression and background fluctuations can be rationalized by appealing to firing-rate models or standard population-dynamics models. However, after investigating a simple network model of V1 which exhibits many experimentally observed phenomena including those mentioned above, we found that the dynamic regime of this model exhibits many causally connected transiently correlated sub-populations of neurons. We have reason to believe that these strong transient correlations within our network are (i) biologically reasonable and consistent with recent experiments, and (ii) difficult, if not impossible, to capture by examining the ensemble-averaged dynamics of any subnetwork within our system. These investigations have led us to question the utility of most population-dynamics frameworks which are built on an ensemble- or network-averaged representation of the underlying network dynamics.

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MS102
Spiky and Transition Layer Steady States of Chemotaxis Systems via Global Bifurcation and Helly’s Compactness Theorem

The most important phenomenon about chemotaxis is the aggregation of "cells", for which we use spiky or transition layer steady states to model. We use the recent general results of Shi and Wang on global bifurcation theory to analyze several variants of the Keller-Segel model, showing that positive steady states exist if the chemotaxis coefficient is large enough; then we use Helly’s compactness theorem to obtain the asymptotics of these steady states as the chemotaxis coefficient tends to infinity, showing that they are spiky or have the shape of transition layers. Compared to other methods, this one is much softer and simpler; however at this moment, the method works only in the case of 1D spatial domains.

Xuefeng Wang
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MS102
Folds, Canards and Shocks in Advection-reaction-diffusion Models

In this talk, we will explore nonlinear advection-reaction-diffusion (ARD) models from a dynamical systems point of view. We consider diffusion as a viscous small perturbation in the ARD model. We then identify the underlying geometry of these models which leads to the existence of travelling waves and shocks (sharp interfaces) and show how this geometric structure relates to the viscous limit of the ARD model. In particular, we will show that folded invariant manifolds and canards play an essential role in the creation and form of traveling wave patterns in ARD models. Sharp interfaces in the wave form of tactically-driven cell migration is one important area of application for our results.

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MS103
Well-posedness for Two-dimensional Steady Supersonic Euler Flows Past Lipschitz Walls

We study the $L^1$ well-posedness for two-dimensional steady supersonic Euler flows past two Lipschitz walls whose boundary slope function has small total variation, when the total variation of the incoming flow is small. We have obtained the existence of solutions in BV when the incoming flow has small total variation by the wave front tracking method and then established the $L^1$ stability of the solutions with respect to the incoming flows. To do this, we have carefully incorporated the nonlinear waves generated by the wall boundaries to develop a Lyapunov functional between two solutions containing strong vortex sheets and prove that the functional decreases in the flow direction, establishing the $L^1$ stability and the uniqueness of solutions by the wave front tracking method. The uniqueness of solutions in a broader class, the class of viscosity solutions, is also obtained. This is joint work with Gui-Qiang G. Chen.

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MS103
Time-Periodic Solutions for the Euler Equations

I will report on recent progress Blake Temple and I have made towards proving the existence of time-periodic shock-free solutions of the compressible Euler equations. I shall briefly recall our discovery of the simplest possible structure of such solutions, and the corresponding linearized solutions. I shall then focus on the perturbation of these linearized solutions to the fully nonlinear problem in the resonant case. We give a complete and explicit description of the kernel of the linearized operator, which has a beautiful and unexpected resonant structure. We then analyze a generic perturbation of the linearized operator, and show that genuine nonlinearity breaks the resonances. Finally, we discuss a Nash-Moser iteration which we expect will complete the proof that our linearized periodic solutions perurb to the fully nonlinear Euler equations.

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MS103
Incompressible Euler Equation from a Lagrangian Point of View and Unstable Manifolds

We outline the framework of the Euler equation as Lagrangian systems on infinite dimensional manifolds for both the fixed and free boundary cases. In particular in the former case, we prove that exponentially unstable steady states admit smooth local unstable manifolds. This in turn shows the nonlinear instability in the sense that small $H^k$ perturbations can lead to $L^2$ derivation of the solutions.

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MS104
Weak Neumann implies Stokes

Let $\Omega$ be a domain with sufficiently smooth boundary. We show that the Stokes operator generates an analytic semigroup on $L^p(\Omega)$ provided the Helmholtz decomposition exists. In this case, the Stokes operator also satisfies maximal regularity estimates. Co-authors: Horst Heck, Matthias Hieber, Okihiro Sawada

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MS104
Global and Almost Global Solutions for the Navier-Stokes Equations in Besov Spaces and Triebel-Lizorkin

We consider the existence of the global and almost global solutions for the Navier-Stokes equations in the spaces which have scaling invariant properties to the equations, where almost global solutions are solutions which existence time is bounded below by the exponential order of the
norms of initial data. On the global solutions, we study in the space of all functions of bounded mean oscillation using the Triebel-Lizorkin spaces. The existence of the almost global solutions are also studied in the larger function spaces than those for the global solutions.

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MS104
Long time Solvability of Equations in Geophysical Fluid Dynamics

In the talk, we investigate large time existence of solutions of the Navier-Stokes equations with Coriolis and/or stratification effects. We also mention an incompressible forced two-dimensional flow on a beta plane. In 1996, Kimura and Herring examined numerical simulations to show a stabilizing effect due to the stratification. They observed scattered two-dimensional pancake-shaped vortex patches lying almost in the horizontal plane. One of our result is a mathematical justification of the presence of such two-dimensional pancakes.

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MS105
Variational and Wavelet Frame Based Models for Medical Imaging and Image Analysis

In this talk, I will start with a short review of some variational models and wavelet frame based models for image restoration problems. Then I will discuss connections between one of the wavelet frame based model and a general variational model. In a nutshell, we show that when image resolution goes to infinite, the energy functional of the wavelet frame based model Gamma-converges to that of the variational model. Such connection not only grants geometric interpretations to the wavelet frame based model, but also extends the scope of applications of wavelet frames. In the final part of the talk, I will focus on the applications of variational and wavelet frame based models in x-ray based CT image reconstruction, including 3D/4D cone beam CT reconstruction, CT reconstruction with Radon domain inpainting, and color CT reconstruction and tissue classifications.

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MS105
Image Enhancement via Forward-backward Diffusion

We propose a naive PDE model of Perona-Malik type for image restoration, applicable for both image denoising and deblurring. Our proposed model uses the notion of Young measure valued solutions, which turns out to be well-posed and does great work for image denoising and deblurring. We can control the diffusivity in the solutions which will smooth out noise and then sharpen the edges for better recovery.

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MS105
A Ridge and Corner Preserving Model for Surface Restoration

One challenge in surface restoration is to design a surface diffusion preserving ridges and sharp corners. In this talk, I will present a new surface restoration model based on the observation that the surface implicit representations are continuous functions with discontinuities of the first order derivatives at ridges and sharp corners. The proposed model of vectorial total variation on the derivatives is a fourth order and convex problem. We further utilize the augmented Lagrangian method to efficiently compute the optimizer. Moreover, we also include the theoretical convergence analysis. To demonstrate the efficiency and robustness of the proposed method, we illustrate our experimental results on several different examples and also conduct comparison with mean curvature flow method and nonlocal mean method.

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Tony Chan
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MS105
Combining Event Data and Spatial Images in Variational Approaches to Density Estimation

We wish to produce a probability density estimate from discrete event data to model the relative probability of events occurring in a region. Common methods do not incorporate geographical information and could have non-negligible portions of the density’s support in unrealistic locations. We propose Maximum Penalized Likelihood Estimation methods based on TV and $H^1$ regularizers that use spatial data to obtain more geographically accurate density estimates. We apply this method to residential burglary data.

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Todd Wittman
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George Mohler
Santa Clara University
MS106

**Quadratic systems and Airy functions**

We construct exact wave functions for the most general variable quadratic Hamiltonians in terms of solutions of certain Ermakov and Riccati-type systems. Applications to a macroscopic oscillator in Bose-Einstein condensation are discussed. We solve a Schrödinger equation in terms of Airy functions and use it to solve a quantum parametric oscillator. We consider a soliton-like solution to the equation

\[
\frac{\partial \psi}{\partial t} + \frac{1}{4} \frac{\partial^2 \psi}{\partial x^2} + tx^2 \psi = h(t)|\psi|^2 \psi
\]  

(2)

http://arxiv.org/abs/1102.5119
http://arxiv.org/abs/0903.3608

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MS106

**Exact Wave Functions for Generalized Harmonic Oscillators**

We construct exact wave functions for the most general variable quadratic Hamiltonians in terms of solutions of certain Ermakov and Riccati-type systems. Applications to a macroscopic oscillator in Bose-Einstein condensation are discussed. For more information, see: http://arxiv.org/abs/1102.5119

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MS106

**Soliton-like Solutions for Nonlinear Schrödinger Equation with Variable Quadratic Hamiltonians**

We will discuss applications of separation of variables in the study of linear and nonlinear Schrödinger equations with quadratic time-dependent Hamiltonians. In the latter we construct soliton-like solutions for certain choices of the coefficients, including important examples such as bright and dark solitons and Jacobi elliptic and second Painlevé transcendental solutions, which are important for current research in nonlinear optics and Bose–Einstein condensation. Also we show an example of existence of \( L^p \) finite time blowup for subcritical NLS. In the linear case we are able to construct the fundamental solution explicitly. We will give several examples inspired from solvable cases of the Riccati equation and emphasize an example involving Airy functions. A large part of the results presented have been done in joint work with Sergei K. Suslov.

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MS106

**On Integrability of Nonautonomous Nonlinear Schrödinger Equations**

We show, in general, how to transform the nonautonomous nonlinear Schrödinger equation with quadratic Hamiltonians into the standard autonomous form that is completely integrable by the familiar inverse scattering method in nonlinear science. Derivation of the corresponding equivalent nonisospectral Lax pair is outlined. A few simple integrable systems are discussed. http://arxiv.org/abs/1012.3661

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MS106

**The Riccati System and Diffusion-type Equations**

We discuss a method of constructing solution of the initial value problem for diffusion-type equations in terms of solutions of certain Riccati-type systems. A nonautonomous Burgers-type equation is also considered. Examples include the Fokker-Planck equation in physics, the Black-Scholes equation and the Hull-White model in finance.

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MS107

**The Grazing Collision Limit of the Inelastic Kac Model**

This talk is devoted to the grazing collision limit of the inelastic Kac model introduced in [Pulvirenti-Toscani, Asymptotic properties of the inelastic Kac model, J. Statist. Phys. 2004] when the equilibrium distribution function is a heavy-tailed Levy-type distribution with infinite variance. We prove that solutions in an appropriate domain of attraction of the equilibrium distribution converge to solutions of a Fokker-Planck equation with a fractional diffusion operator.

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Giuseppe Toscani
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On the Doi Model for the Suspension of Rod-Like Molecules

The Doi model for the suspensions of rod-like molecules in a dilute regime describes the interaction between the orientation of rod-like polymer molecules on the microscopic scale and the macroscopic properties of the fluid in which these molecules are contained (cf. Doi and Edwards [10]). The orientation distribution of the rods on the microscopic level is described by a Fokker-Planck-type equation on the sphere, while the fluid flow is given by the Navier-Stokes equations, which are now enhanced by an additional macroscopic stress reflecting the orientation of the rods on the molecular level. Prescribing arbitrarily the initial velocity and the initial orientation distribution in suitable spaces we establish the global-in-time existence of a weak solution to our model defined on a bounded domain in the three dimensional space. The proof relies on a quasi-compressible approximation of the pressure, the construction of a sequence of approximate solutions and the establishment of compactness.

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The EBV algorithm: Now, Deal with Uncertainty!

We propose a variant of the Bred Vector (BV) algorithm, originally introduced by Z. Toth and E. Kalnay (Bulletin of the American Meteorological Society 74:2317 2330, 1993). The algorithm can be used to assess the sensitivity of the model output to various sources of uncertainty. The new algorithm, which we call the Ensemble Bred Vector or EBV, is based on the collective dynamics of perturbations to classical trajectories in an essential way. It was conceived for applications to geophysical flows, as are the other similar algorithms. As such, it features some distinctive dynamical qualities compared to its brethren. I will outline the underlying mathematical ideas, and discuss some applications. Fun pictures will be on the menu, too! The talk is based on the joint work with A. L. Mazzucato, J. M. Restrepo, and G. R. Sell.

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Global Well-posedness of a 3D Stratified Reduced Rayleigh-Bénard Convection Model

The 3D Hasegawa-Mima equation arises in the study of plasma turbulence. In geophysical fluid dynamics, the equation appears as a simplified model inspired by the Rayleigh-Bénard convection model. The model is simpler than the 3D Euler equations, but the question of global existence and uniqueness of solutions is still open. Inspired by these models, we introduce and study a model of nicer mathematical structure and establish a global well-posedness result in an appropriate mathematical space.

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MS109
Analyticity and Turbulence in Fluids

It is well known regular solutions of the Navier-Stokes equations (NSE) are in fact analytic in both space and time variables. The space analyticity radius is an important physical object: at this length scale, the viscous effects and the (nonlinear) inertial effects are roughly comparable. Foias and Temam introduced an effective approach to estimate space analyticity radius via the use of gevrey norms which avoids recursive estimation of higher order derivatives. Using this technique, we study the maximal space analyticity radius of solutions as a function of time via an additional ODE connected to the NSE. We show that this ODE can be solved on a maximal domain; the boundary of this domain is given by a function (of time) that is precisely the maximal analyticity radius. We then discuss some connection between the topology of the boundary of this domain and energy cascades.

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MS109
Casimir Cascades in Two-Dimensional Turbulence

The nonlinear terms of the 2D incompressible Navier-Stokes equation are well-known to conserve energy and enstrophy. In addition, they also conserve the global integral of any continuously differentiable function of the scalar vorticity field. However, the phenomenological role of these additional inviscid invariants remains unclear: Polyakov’s minimal conformal field theory model indicates that high-order Casimir invariants cascade to large scales, while Eyink suggests that they might instead cascade to small scales. Numerical investigations of this problem are hampered by the fact that pseudospectral simulations, which necessarily truncate the wavenumber domain, do not exactly conserve global integrals of arbitrary powers of the vorticity. Nevertheless, well-resolved numerical simulations can be used to demonstrate that the fourth power of the vorticity cascades to small scales. Inertial-range pumping of this quantity by the large-scale forcing, as discussed by Falkovich and Lebedev, is also examined.

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MS109
Ultimate State of Two-Dimensional Rayleigh-Bénard Convection Between Free-Slip Fixed-Temperature Boundaries

Rigorous upper limits on the vertical heat transport in two dimensional Rayleigh-Bénard convection between stress-free isothermal boundaries are derived from the Boussinesq approximation of the Navier-Stokes equations. The Nusselt number Nu is bounded in terms of the Rayleigh number Ra according to $\nu \leq 0.2891 R_a^{5/12}$ uniformly in the Prandtl number Pr. This Nusselt number scaling challenges some theoretical arguments regarding the asymptotic high Rayleigh number heat transport by turbulent convection.

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Jared Whitehead
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MS109
An Efficient 2nd Order Scheme for Long Time Statistical Properties of the 2D NSE

We present and analyze an efficient 2nd order in time numerical scheme for the two dimensional Navier-Stokes equations in a periodic box. We demonstrate that the long time statistical properties of the scheme converge to those of the 2D NSE at vanishing time-step. Fully discrete schemes with both Galerkin FOUrier and collocation Fourier will also be discussed.

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MS110
Stability and Asymptotic Structure of Steady Navier-Stokes Flows in Exterior and Aperture Domains

Viscous flows around a translating/rotating rigid body and those through an aperture are discussed. Our interest is focused on the leading profile as well as decay at infinity of the steady flow, which is related to its stability. The results depend on the motion of the body and on the compactness of the boundary. The talk will be expository and be an introduction to the following three lectures in this session.

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MS110
Stability Theorem for the Stationary Solution to Navier-Stokes Equations in Half-space

We consider stability theorem for the stationary solution to Navier-Stokes equations in half-space. More precisely, we consider the stationary solution which has the property: $(1 + x_n) u_n \in L^\infty$ and we prove its stability theorem. We will report its stability theorem.

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MS110
Asymptotic Structure of Steady Navier-Stokes Flows Past and Around a Rotating Body

We consider a rigid body moving with a constant velocity and rotating with a non-zero constant angular velocity in a three-dimensional Navier-Stokes liquid. We analyze the asymptotic structure of a weak solution to the corresponding stationary equations of motion written in a frame attached to the body. In particular, we identify the leading
term in the asymptotic expansion of the solution.

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MS110
Navier-Stokes Flows Around a Rigid Body: Steady States with Finite Kinetic Energy and Long-time Behavior of Transient States

We consider an incompressible, three-dimensional Navier-Stokes flow, around a moving rigid body. The equations of motion are written with respect to a reference frame attached to the body, where the domain becomes time-independent, but such a change of frame produces new terms in the equations, related with the rotation, which difficult the analysis in exterior domains. We begin by presenting a result on existence and uniqueness of steady solutions with finite kinetic energy to this problem. The square integrability of the velocity field is shown without resorting to methods based on the (complicated) fundamental solution of the underlying linear operator. Then, we show the global existence of a transient solution which converges, when time goes to infinity, to the steady solution with finite kinetic energy.

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SIAM Conference on
Analysis of
Partial Differential Equations

November 14-17, 2011
San Diego Marriott Mission Valley
San Diego, California USA
A

Abdulla, Ugur G., MS7, 10:00 Mon
Abdulla, Ugur G., MS35, 10:00 Tue
Abdulla, Ugur G., MS35, 12:00 Tue
Abouali, Mohammad, MS93, 9:15 Thu
Agostiniani, Virginia, CP5, 5:20 Mon
Aiki, Masashi, MS86, 10:45 Thu
Akar, Mutlu, MS35, 12:00 Tue
Aboali, Mohammad, MS93, 9:15 Thu
Agostiniani, Virginia, CP5, 5:20 Mon
Aiki, Masashi, MS86, 10:45 Thu
Akar, Mutlu, MS35, 12:00 Tue

B

Babin, Anatoli, MS8, 10:00 Mon
Babin, Anatoli, MS8, 12:00 Mon
Bae, Hantaek, MS81, 4:15 Wed
Bakhtin, Yuri, MS93, 9:45 Thu
Bakhtin, Yuri, MS93, 9:45 Thu
Balagué, Daniel, MS33, 12:00 Tue
Balagué, Daniel, MS33, 12:00 Tue
Balanrkhman, A.V., MS17, 2:00 Mon
Balci, Nusret, MS108, 2:30 Thu
Balci, Nusret, MS108, 2:30 Thu
Banks, Jeffrey W., MS11, 11:00 Mon
Bañuelos, Rodrigo, MS52, 2:30 Thu
Barbaro, Alethea, MS27, 3:30 Mon
Bardos, Claude, MS67, 10:00 Wed

Barron, Emmanuel, MS23, 2:00 Mon
Barron, Emmanuel, MS51, 2:00 Tue

Barron, Emmanuel, MS79, 3:15 Wed
Bauman, Patricia, MS99, 2:30 Thu
Bauman, Patricia, MS59, 11:30 Wed
Bayat, Mahmoud, CP4, 5:40 Mon
Beceau, Marius, MS49, 2:30 Tue
Bella, Peter, MS100, 2:30 Thu
Bella, Peter, MS100, 2:30 Thu
Benzoni-Gavage, Sylvie, MS32, 12:00 Tue
Bergner, Matthias, MS37, 11:00 Tue
Berlyand, Leonid, MS43, 2:00 Tue
Berrone, Andrew J., MS27, 2:30 Mon
Bessaai, Hakima, MS39, 10:00 Tue
Bessaai, Hakima, MS67, 10:00 Wed
Bessaai, Hakima, MS83, 3:45 Wed
Bhattacharya, Kaushik, MS50, 2:00 Tue
Birnir, Bjorn, MS8, 10:00 Mon
Biswas, Animikh, MS83, 3:15 Wed
Biswas, Animikh, MS109, 2:30 Thu
Biswas, Animikh, MS109, 2:30 Thu
Bjorland, Clayton, MS25, 2:00 Mon
Blair, Matthew, MS21, 2:00 Mon
Bocea, Marian, MS23, 2:00 Mon
Bocea, Marian, CP9, 5:40 Mon
Bocea, Marian, MS51, 2:00 Tue
Bocea, Marian, MS79, 3:15 Wed
Bocicu, Lorena, MS17, 2:00 Mon
Bocicu, Lorena, MS45, 2:00 Tue
Bocicu, Lorena, MS45, 2:00 Tue
Bocicu, Lorena, MS73, 3:15 Wed
Bonnietier, Eric, MS78, 3:45 Wed
Borcea, Liliana, MS63, 10:30 Wed
Borcea, Liliana, MS78, 3:15 Wed
Boucher, Adam, CP9, 5:00 Mon
Bowman, John C., MS54, 4:00 Tue
Bowman, John C., MS109, 3:00 Thu
Bresch, Didier, MS32, 10:00 Tue
Bronsard, Lia, MS2, 10:00 Mon
Bronsard, Lia, MS30, 10:00 Tue
Bronsard, Lia, MS58, 10:00 Wed
Bronsard, Lia, MS72, 3:15 Wed
Bronsard, Lia, MS99, 2:30 Thu
Bronsard, Lia, MS100, 10:00 Mon
Bronsard, Lia, MS100, 10:00 Mon
Bronsard, Lia, MS100, 10:00 Mon
Bronsard, Lia, MS100, 10:00 Mon
Bronski, Jared, MS70, 10:00 Wed
Bronski, Jared, MS98, 9:15 Thu
Bronzi, Anne C., CP7, 5:40 Mon
Bulut, Aynur, MS49, 3:00 Tue

C

Calderer, Maria-Carme, MS31, 11:00 Tue
Calderer, Maria-Carme, MS72, 4:15 Wed
Camley, Brian A., MS62, 11:00 Wed
Canic, Suncica, MS20, 2:00 Mon
Canic, Suncica, MS48, 2:00 Tue
Canic, Suncica, MS45, 2:30 Tue
Canic, Suncica, MS76, 3:15 Wed
Canic, Suncica, MS76, 5:15 Wed
Canic, Suncica, MS88, 10:45 Thu
Canic, Suncica, MS103, 2:30 Thu
Cañizo, Jose A., MS33, 10:00 Tue
Cañizo, Jose A., MS95, 9:15 Thu
Cañizo, Jose Alfredo, MS33, 11:30 Tue
Cannone, Marco, MS25, 2:00 Mon
Cannone, Marco, MS53, 2:00 Tue
Cannone, Marco, MS81, 3:15 Wed
Cannone, Marco, MS95, 9:15 Thu
Cannone, Marco, MS107, 2:30 Thu
Caplan, Ronald M., CP2, 5:20 Mon
Castillo, Jose E., MS93, 9:15 Thu
Castro, Angel, MS28, 3:00 Mon
Cesaroni, Annalisa, MS90, 9:45 Thu
Chacon Rebollo, Tomas L., MS92, 9:45 Thu
Chang, Hector, MS80, 4:15 Wed
Chen, Gui-Qiang G., MS4, 10:00 Mon
Chen, Shuxing, MS18, 2:30 Mon
Chen, Thomas, MS1, 11:00 Mon
Cheng, Bin, MS8, 11:30 Mon
Gal, Ciprian G., MS64, 10:30 Wed
Galdi, Giovanni, MS22, 3:30 Mon
Galvao-Sousa, Bernardo, MS58, 11:30 Wed
Gancedo, Francisco, MS84, 3:15 Wed
Gao, Guangyue, MS12, 11:30 Mon
Garcia-Cervera, Carlos, MS72, 3:45 Wed
Garnier, Josselin, MS63, 10:00 Wed
Garnier, Josselin, MS63, 10:00 Wed
Garnier, Josselin, MS91, 9:15 Thu
Garofalo, Nicola, MS35, 10:30 Tue
Gatti, Stefania, MS64, 11:00 Wed
Geissert, Matthias, MS104, 3:00 Thu
Gemmer, John A., CP8, 6:00 Mon
Giannoulis, Yannis, MS89, 10:45 Thu
Gie, Gung-Min, MS29, 11:00 Tue
Gillette, Andrew, MS16, 2:30 Mon
Giorgi, Tiziana, MS72, 3:15 Wed
Glasner, Karl, MS40, 11:30 Tue
Glatt-Holtz, Nathan, MS39, 10:30 Tue
Glatt-Holtz, Nathan, MS41, 12:00 Tue
Glenn-Levin, Jacob, CP7, 5:20 Mon
Glimberg, Stefan L., CP1, 5:20 Mon
Gloria, Antoine, MS78, 4:15 Wed
Goebel, Rafal, MS23, 2:00 Mon
Goebel, Rafal, MS51, 2:00 Tue
Goldberg, Michael, MS21, 2:30 Mon
Golovaty, Dmitry, MS43, 3:00 Tue
Goodman, Roy H., MS89, 9:15 Thu
Gorb, Yuliya, MS50, 2:00 Tue
Gorb, Yuliya, MS78, 3:15 Wed
Gorb, Yuliya, MS85, 10:15 Thu
Grabr, Jameson, CP14, 5:40 Mon
Grandmont, Celine, IP4, 8:45 Tue
Grujic, Zoran, MS13, 10:30 Mon
Gualdani, Maria, MS24, 3:30 Mon
Guidoboni, Giovanna, MS73, 5:15 Wed
Guidotti, Patrick, MS105, 2:30 Thu
Guillen, Nestor, MS24, 2:00 Mon
Guillen, Nestor, MS52, 2:00 Tue
Guillen, Nestor, MS80, 3:15 Wed
Guillen, Nestor, MS80, 4:45 Wed
Gui-Qiang, Chen, MS20, 2:00 Mon
Gui-Qiang, Chen, MS48, 2:00 Tue
Gui-Qiang, Chen, MS76, 3:15 Wed
Gui-Qiang, Chen, MS103, 3:30 Thu
Gustafson, Stephen, MS1, 12:00 Mon
H
Ha, Seung-Yeal, MS18, 3:00 Mon
Hairer, Martin, IP6, 8:45 Wed
Hamouda, Makram, MS1, 10:00 Mon
Hamouda, Makram, MS29, 10:00 Tue
Hansen, Scott, MS17, 4:00 Mon
Hayrapetyan, Gurgun, MS70, 11:30 Wed
Henderson, Diane, MS94, 9:45 Thu
Hieber, Matthias, MS22, 2:00 Mon
Hieber, Matthias, MS22, 2:00 Mon
Hinow, Peter, MS101, 3:30 Thu
Hishida, Toshiaki, MS110, 2:30 Thu
Hishida, Toshiaki, MS110, 2:30 Thu
Hoang, Luan, MS57, 10:00 Wed
Hoang, Luan, MS85, 9:15 Thu
Hoang, Luan, MS108, 3:30 Thu
Hoffman, Aaron, MS89, 9:45 Thu
Holmer, Justin, MS21, 3:00 Mon
Holst, Michael J., MS16, 2:00 Mon
Holst, Michael J., MS44, 2:00 Tue
Hu, Xianpeng, MS31, 10:30 Thu
Huang, Feimin, MS4, 10:00 Mon
Huang, Feimin, MS32, 10:00 Tue
Huang, Feimin, MS60, 10:00 Wed
Huang, Feimin, MS88, 9:15 Thu
Huang, Tao, MS87, 10:15 Thu
Hunter, John, MS18, 3:30 Mon
Hur, Vera, MS98, 11:15 Thu
Hur, Vera Mikyoung, MS66, 10:00 Wed
I
Ibragimov, Akif, MS57, 10:00 Wed
Ibragimov, Akif, MS85, 9:15 Thu
Ibragimov, Akif, MS85, 11:15 Thu
Ibrahim, Slim, MS1, 10:00 Mon
Ibrahim, Slim, MS29, 10:00 Tue
Ignat, Radu, MS2, 11:00 Mon
Ignatova, Mihaela, MS13, 11:00 Mon
Ikeda, Kota, MS68, 10:30 Wed
Iliescu, Traian, MS54, 2:30 Tue
Iturraran-Viveros, Ursula, CP2, 5:40 Mon
Iwabuchi, Tsukasa, MS104, 2:30 Thu
Iyer, Gautam, MS39, 10:00 Tue
Iyer, Gautam, MS50, 3:00 Tue
Iyer, Gautam, MS67, 10:00 Wed
J
Jabin, Pierre-Emmanuel, MS19, 3:00 Mon
Jang, Juhi, MS20, 3:30 Mon
Jensen, Robert, MS23, 2:00 Mon
Jensen, Robert, MS51, 2:30 Tue
Jensen, Robert, MS79, 3:15 Wed
Jerrard, Robert, MS30, 11:00 Tue
Ji, Xinhua, CP10, 5:40 Mon
Jiu, Quansen, MS60, 11:30 Wed
Johnson, Mat, MS98, 9:45 Thu
Jolly, Michael S., MS83, 4:45 Wed
Jolly, Mike, MS69, 10:30 Wed
Joo, Sookyoung, MS99, 4:00 Thu
Joshi, Sunnie, CP1, 5:40 Mon
Jugnon, Vincent, MS63, 11:00 Wed
Jurayev, Isom, CP3, 6:00 Mon
K
Kalantarov, Varga, MS64, 10:00 Wed
Kang, Xiaosong, MS96, 11:15 Thu
Kar, Rasmita, CP14, 6:00 Mon
Karageorgis, Paschalis, MS38, 11:00 Tue
Karch, Grzegorz, MS25, 2:30 Mon
Karli, Deniz, MS52, 3:00 Tue
<table>
<thead>
<tr>
<th>Speaker</th>
<th>Session Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karp, Lavi</td>
<td>CP8, 5:40 Mon</td>
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<tr>
<td>Karper, Trygve</td>
<td>MS5, 11:30 Mon</td>
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<tr>
<td>Kassmann, Moritz</td>
<td>MS52, 2:00 Tue</td>
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<td>Katzourakis, Nikolaos I.</td>
<td>MS51, 3:30 Tue</td>
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<td>Kelliher, James</td>
<td>MS13, 11:30 Mon</td>
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<td>MS29, 11:30 Tue</td>
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<td>Kent, Stuart</td>
<td>CP9, 6:00 Mon</td>
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<td>Keyfitz, Barbara Lee</td>
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<td>Kim, Chanwoo</td>
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<td>Kim, Eun Heui</td>
<td>MS18, 2:00 Mon</td>
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<td>MS46, 2:00 Tue</td>
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<td>MS74, 3:15 Wed</td>
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<td>MS76, 3:45 Wed</td>
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<td>Kim, Yangjin</td>
<td>MS75, 4:15 Wed</td>
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<td>Kim, Yunho</td>
<td>MS105, 2:30 Thu</td>
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<td>Killioner, David</td>
<td>MS15, 2:30 Mon</td>
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<td>MS76, 4:15 Wed</td>
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<td>Koch, Gabriel S.</td>
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<td>Kohn, Robert V.</td>
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<td>Kolokolnikov, Theodore</td>
<td>MS27, 2:00 Mon</td>
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<td>MS32, 10:30 Tue</td>
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Lyng, Greg, MS70, 11:00 Wed

M
Magal, Pierre, MS47, 2:30 Tue
Majumdar, Apala, MS3, 11:00 Mon
Malek, Josef, MS57, 10:00 Wed
Malek, Josef, MS92, 10:45 Thu
Manfredi, Juan J., MS51, 2:00 Tue
Marciniak-Czochra, Anna, MS101, 3:00 Thu
Marson, Andrea, MS4, 11:30 Mon
Marzuola, Jeremy L., MS77, 3:15 Wed
Mazzucato, Anna, MS69, 11:00 Wed
Mazzucato, Anna, MS108, 2:30 Thu
McCoy, James A., MS37, 10:30 Tue
Mei, Ming, MS4, 10:00 Mon
Mei, Ming, MS32, 10:00 Tue
Mei, Ming, MS60, 10:00 Wed
Mei, Ming, MS88, 9:15 Thu
Melnikov, Max, CP11, 5:40 Mon
Metcalfe, Jason, MS77, 3:45 Wed
Metzger, Jan, MS65, 11:00 Wed
Meyer, Stefan, MS86, 10:15 Thu
Millot, Vincent, MS2, 10:00 Mon
Millot, Vincent, MS2, 11:30 Mon
Millot, Vincent, MS30, 10:00 Tue
Millot, Vincent, MS58, 10:00 Wed
Millot, Vincent, MS72, 4:45 Wed
Miranville, Alain, MS36, 11:30 Tue
Miroshnikov, Alexey, CP3, 6:20 Mon
Mirrahimi, Sepideh, MS47, 3:00 Tue
Mischler, Stephane, MS33, 10:00 Tue
Misiolek, Gerard, MS41, 10:00 Tue
Miyaji, Tomoyuki, CP11, 6:00 Mon
Mohammed, Salah. A, MS39, 12:00 Tue
Mondaini, Cecilia F., CP7, 5:00 Mon
Mori, Yoichiro, MS34, 11:30 Tue
Mosco, Umberto, MS35, 11:00 Tue
Moser, Roger, MS65, 10:00 Wed
Motsch, Sebastien, MS55, 10:00 Mon
Motsch, Sebastien, MS55, 10:30 Mon
Mouhot, Clement, IP8, 1:15 Thu
Muïte, Benson K., MS82, 4:15 Wed
Muratov, Cyrill B., MS90, 9:15 Thu
Muratov, Cyrill B., MS90, 9:15 Thu

N
Nakamura, Tohru, MS42, 10:00 Tue
Nguyen, Hoai-Minh, MS30, 10:30 Tue
Nguyen, Hoai-Minh, MS100, 3:30 Thu
Niche, Cesar, MS53, 2:30 Tue
Nicholls, David P., MS94, 10:15 Thu
Nicola Di Teodoro, Antonio, MS93, 10:15 Thu
Nishibata, Shinya, MS42, 10:00 Tue
Notsu, Hirofumi, MS14, 11:00 Mon
Novikov, Alexei, MS50, 2:00 Tue
Novikov, Alexei, MS78, 3:15 Wed
Nussenzveig Lopes, Helena, MS95, 10:15 Thu

O
Oberman, Adam, MS79, 3:45 Wed
Okamoto, Hisashi, MS14, 10:00 Mon
Okamoto, Hisashi, MS14, 10:00 Mon
Oliveras, Katie, MS94, 10:45 Thu
Oshita, Yoshihito, MS40, 10:00 Tue
Oshita, Yoshihito, MS40, 10:30 Tue
Oshita, Yoshihito, MS68, 10:00 Wed
Oshita, Yoshihito, MS96, 9:15 Thu
Otto, Felix, MT2, 8:00 Wed

P
Padula, Mariarosaria, MS86, 9:15 Thu
Pan, Ronghua, MS4, 10:00 Mon
Pan, Ronghua, MS32, 10:00 Tue
Pan, Ronghua, MS60, 10:00 Wed
Pan, Ronghua, MS88, 9:15 Thu
Pankovich, Stephen, MS10, 10:00 Mon
Pankovich, Stephen, MS38, 10:00 Tue
Pankovich, Stephen, MS38, 11:30 Tue
Paolini, Chris, MS93, 10:45 Thu
Papanicolaou, Georg, MS63, 11:30 Wed
Papanicolaou, George C., MS50, 2:30 Tue
Park, Jungho, MS46, 3:00 Thu
Parshad, Rana D., CP10, 6:00 Mon
Pavlovic, Natasa, MS49, 2:00 Tue
Phillips, Daniel, MS59, 10:00 Wed
Phillips, Daniel, MS72, 3:15 Wed
Piccoli, Benedetto, MS4, 12:00 Mon
Pilecki, Dominika, MS53, 3:00 Tue
Piovano, Paolo, CP8, 5:00 Mon
Ponosov, Arcady, CP1, 5:00 Mon
Pozzi, Paola, MS9, 11:00 Mon
Preston, Stephen, MS97, 10:15 Thu
Promislow, Keith, MS70, 10:00 Wed
Promislow, Keith, MS98, 9:15 Thu
Promislow, Keith, MS98, 10:15 Thu
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Time</th>
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<tbody>
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<td>MS48</td>
<td>3:30 Tue</td>
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<td>9:45 Thu</td>
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Zabelli, Jorge, MS81, 5:15 Wed
Zwicknagl, Barbara, CP9, 5:20 Mon
# PDE11 Budget

Conference Budget  
November 14-17, 2011  
San Diego, CA

Expected Paid Attendance 375

## Revenue

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## Direct Expenses

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## Support Services: *

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## Total Expenses:  

**$160,035**

* Support services includes customer service (who handle registration), accounting, computer support, shipping, marketing and other SIAM support staff. It also includes a share of the computer systems and general items (building expenses in the SIAM HQ).
Meeting & Event Facilities

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