The Activity Group on Nonlinear Waves & Coherent Structures (NWCS) fosters collaborations among applied mathematicians, physicists, fluid dynamicists, engineers, and biologists in those areas of research related to the theory, development, and use of nonlinear waves and coherent structures. It promotes and facilitates nonlinear waves and coherent structures as an academic discipline; brokers partnerships between academia, industry, and government laboratories; and works with other professional societies to promote NWCS.

The activity group organizes the biennial SIAM Conference on Nonlinear Waves & Coherent Structures; awards The Martin Kruskal Lecture every two years to recognize a notable body of mathematics and contributions in the field of nonlinear waves and coherent structures; and maintains a website, a member directory, and an electronic mailing list.
Table of Contents

Program-at-a-Glance...... Fold out section
General Information.................. 2
Get-togethers........................ 4
Invited Plenary Presentations ......... 8
Minitutorial .......................... 5
Poster Session ....................... 26
Prize Lecture ........................ 7
Program Schedule .................... 9
Abstracts ............................. 41
Speaker and Organizer Index ........ 95
Conference Budget ................... 100
University Floor Plans...... Inside Back Cover
Campus Map .......................... Back Cover

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Important Notice to Poster Presenters
The poster session is scheduled for Thursday, June 14 from 4:30 PM – 6:30 PM. Poster presenters are requested to set up their poster material on the provided 4’ x 6’ or 4’ x 8’ poster boards in Mary Gates Hall 135 between the hours of 10:00 AM and 4:30 PM on Thursday, June 14. All materials must be posted by Thursday, June 14th at 4:30 PM, the official start time of the session. Posters will remain on display through 6:30 PM on Thursday, June 14. Poster displays must be removed by 7:30 PM. Posters remaining after this time will be discarded. SIAM is not responsible for discarded posters.

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Display copies of books and complimentary copies of journals are available onsite. SIAM books are available at a discounted price during the conference. Completed order forms and payment (credit cards only) may be taken to the SIAM Registration Desk or mailed to SIAM using the order form on the display table. Additionally, online orders may be placed at www.siam.org/catalog using the coupon code provided on the form.

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Get-togethers
• Reception and Poster Session
  Thursday, June 14
  4:30 PM – 6:30 PM
• Business Meeting
  (open to SIAG/NWCS members)
  Friday, June 15
  5:00 PM - 6:00 PM
  Complimentary beer and wine will be served.

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Friday, June 15

**MT1**

**A New Transform Method for Boundary Value Problems**

*12:30 PM - 2:30 PM*

Room: Mary Gates Hall 241

I will outline a powerful integral transform method for the analysis and solution of boundary value problems for integrable PDEs. PDEs in this class include linear constant coefficient PDEs (heat, Stokes, Helmholtz equations) and nonlinear integrable PDEs. The method has its origin in the inverse scattering transform approach, and shares with it the basic tenet that the transform variable be complex. This is a crucial difference from the classical Fourier transform approaches, for which the spectral variable is real.

I will illustrate the method for the linear case, and will indicate how the ideas generalizes to the integrable nonlinear case.

Organizer and Speaker:

Beatrice Pelloni, University of Reading, United Kingdom
SIAM Activity Group on Nonlinear Waves and Coherent Structures (SIAG/NWCS)
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**Prize Lecture**

**The Prize Lecture will take place in Guggenheim Hall 220 **

**Wednesday, June 13**

**Martin D. Kruskal Lecture - Pattern Quarks and Leptons**  
5:00 PM - 6:00 PM  
Chair: Nathan Kutz, University of Washington, USA

Martin Kruskal was one of a kind, a pure scientist who followed roads less travelled by and whose new discoveries made all the difference in so many ways. Once a question intrigued and gripped him, he never let go. The discovery of solitons and the uncovering of whole new classes of integrable systems have led to major advances in the worlds of Hamiltonian partial differential equations, in exactly integrable models in statistical physics, and to the fascinating and more recently discovered properties of random matrices. And there may be yet many more windfalls to come. In this Kruskal lecture, I will give a brief overview of some of the early days, of how Martin took on the Fermi, Pasta, Ulam conundrum which had defied explanation by some of the best minds of the time and, with the help of colleagues Zabusky, Miura, Gardner and Greene, turned it into one of the most important discoveries of the last half of the 20th century. As for my own contributions to today’s lecture, I have no illusions that the story I shall tell will have any of the same impact but hope that it will reflect some of the same pioneering spirit that Martin displayed in pursuing the unconventional. What I plan to do is sketch some ideas I have been mulling in connection with the Standard Model and show that quark and lepton like objects with different masses and all the invariants associated with spin (+/-1/2) and charge (+/-1/3,+/-2/3,+/-1) can occur naturally as the result of phase transitions in far from equilibrium, pattern forming systems. In contrast to the Standard Model, they arise without any a priori introduction of the SU(2) and SU(3) symmetries into the governing free energy. The invariants can each be connected to the condensation of mean and Gaussian curvature of the constant phase surfaces along certain defect cores.

Alan Newell, University of Arizona, USA
Invited Plenary Speakers

**All Invited Plenary Presentations will take place in Guggenheim Hall 220**

Wednesday, June 13
8:45 AM - 9:30 AM
IP1 Stability and Synchrony in the Kuramoto Model
Jared Bronski, University of Illinois at Urbana-Champaign, USA

Thursday, June 14
8:45 AM - 9:30 AM
IP2 Kramers’ Law - Validity and Generalizations
Barbara Gentz, University of Bielefeld, Germany

Friday, June 15
8:45 AM - 9:30 AM
IP3 Fluid Ratchets and Biocomotion
Jun Zhang, Courant Institute of Mathematical Sciences, New York University, USA

Saturday, June 16
8:45 AM - 9:30 AM
IP4 Semiclassical Computation of High Frequency Waves in Heterogeneous Media
Shi Jin, University of Wisconsin, Madison, USA
SIAM Conference on Nonlinear Waves and Coherent Structures

June 13-16, 2012
The University of Washington
Seattle, Washington, USA
Wednesday, June 13
Opening Remarks
8:30 AM-8:45 AM
Room: Guggenheim Hall 220

IP1
Stability and Synchrony in the Kuramoto Model
8:45 AM-9:30 AM
Room: Guggenheim Hall 220
Chair: Keith Promislow, Michigan State University, USA

The phenomenon of the synchronization of weakly coupled oscillators is an old one, first described by Huygens in his “Horoloquium Oscilatorium.”

Some other examples from science and engineering include the cardiac pacemaker, the instability in the Millenium Bridge, and the synchronous flashing of fireflies. A canonical model is the Kuramoto model.

\[ \frac{d\theta_i}{dt} = w_i + \gamma \sum_j \sin(\theta_i - \theta_j) \]

We describe the fully synchronized states of this model together with the dimensions of their unstable manifolds. Along the way we will encounter a high dimensional polytope, a Coxeter group, and a curious combinatorial identity. This leads to a proof of the existence of a phase transition in the case where the frequencies are chosen from an iid Gaussian distribution.

Jared Bronski
University of Illinois at Urbana-Champaign, USA

Coffee Break
9:30 AM-10:00 AM
Room: Mary Gates Hall 135

Wednesday, June 13
MS1
Hamiltonian and Symplectic Methods in the Theory of Nonlinear Waves - Part I of III
10:00 AM-12:30 PM
Room: Mary Gates Hall 241

For Part 2 see MS9

Hamiltonian structures have played a central role in the theory of nonlinear waves. The subject is ever expanding, and the purpose of this minisymposium is to present a snapshot of recent developments. Topics include Hamiltonian structures of nonlinear dispersive wave equations, theory of Hamiltonian PDEs, Krein signature, the Maslov index, wave interactions, stability of solitary waves (Evans function, the energy-momentum method), modulation of waves, multi-symplectic structures, Whitham modulation theory, as well as numerical methods for all of the above, and applications to the theory of water waves.

Organizer: Tom J. Bridges
University of Surrey, United Kingdom
Organizer: Frederic Chardard
ENS Lyon, France

10:00-10:25 On the Stability of Some Periodic Waves Arising in the Kawahara Equation
Frederic Chardard, ENS Lyon, France

10:30-10:55 Viscosity-induced Instability for Euler and Averaged Euler Equations in a Circular Domain
Gianne Derks, University of Surrey, United Kingdom

11:00-11:25 Relaxed Variational Principle for Water Wave Modeling
Denys Dutykh, Université de Savoie, France

11:30-11:55 Geometric Integration for Damped Hamiltonian PDEs
Brian E. Moore, University of Central Florida, USA

12:00-12:25 A New Model of Roll Waves: Comparison with Brock’s Experiments
Sergey Gavrilyuk, and Gaël Richard, Aix-Marseille Université, France
Wednesday, June 13  
**MS2**  
**Nonlinear Wave Phenomena in Periodic Structures - Part I of II**  
**10:00 AM - 12:30 PM**  
Room: Mary Gates Hall 228  
For Part 2 see MS10  
Nonlinear wave dynamics in periodic and quasi-periodic media is currently one of the research frontiers in applied mathematics, optics and Bose-Einstein condensation. The novel interplay between nonlinearity and the underlying periodic media creates very rich and novel phenomena which have no counterpart in homogeneous media. Experimental advances in optics and Bose-Einstein condensates are strongly pushing this field forward. Recently, novel analytical techniques have also been developed for solitary waves in periodic media, and the resulting analytical results significantly deepen our understanding of these wave phenomena. This minisymposium will survey the current state of knowledge on nonlinear waves in periodic and quasi-periodic media, both in theory and in experiments.  
Organizer: Jianke Yang  
University of Vermont, USA  
10:00-10:25 Asymptotic Methods for Multi-scale Solitary Waves in Periodic Media  
Triantaphyllos R. Akylas, Massachusetts Institute of Technology, USA  
10:30-10:55 Light Localization in Specially Designed Photonic Lattices  
Zhigang Chen, San Francisco State University, USA  
11:00-11:25 Multivortex Discrete Solitons in Coupled Nonlinear Waveguides and Photonic Lattices  
Daniel Leykam and Anton S. Desyatnikov, Australian National University, Australia  
11:30-11:55 Nonlinear Modes in Finite-dimensional PT-symmetric Systems  
Vladimir V. Konotop and Dmitry Zezyulin, Universidade de Lisboa, Portugal  
12:00-12:25 Stability Analysis of Solitons in PT Symmetric Lattices  
Sean Nixon, Lijuan Ge, and Jianke Yang, University of Vermont, USA

Wednesday, June 13  
**MS3**  
**Wave Turbulence: Experiments and Theory**  
**10:00 AM - 12:30 PM**  
Room: Mary Gates Hall 231  
“Weak Turbulence Theory” (WTT) has been shown to be a powerful method for studying the long-time evolution of nonlinear dispersive wave systems presenting random fluctuations. WTT is based on the asymptotic closure of the moments of the random waves in the weakly nonlinear regime and it has been applied to surface gravity waves, capillary waves, plasma waves, elastic waves and nonlinear optics for instance. After a first introductory talk presenting an overview of WTT and its applications, other speakers will present new results in various fields with a special emphasis given about comparison between experiments and theory.  
Organizer: Pierre Suret  
Université de Lille 1, France  
10:00-10:25 Wave Turbulence: A Story Far From Over  
Alan Newell, University of Arizona, USA  
10:30-10:55 Can One Hear a Kolmogorov Spectra? Wave Turbulence on a Thin Elastic Plate  
Sergio Rica, Universidad Adolfo Ibanez, Chile  
11:00-11:25 Non Linear Dynamics of Flexural Wave Turbance  
Benoit Miquel, Ecole Normale Superieure, France; Nicolas Mordant, Universite Joseph Fourier, France  
11:30-11:55 Wave Turbulence in Nonlinear Fiber Optics: Experiments and Theory  
Pierre Suret, Universite de Lille 1, France; A. Picozzi, Universite de Bourgogne, France; Stephane Randoux, Universite de Lille 1, France  
12:00-12:25 Space-time Statistics of Capillary Wave Turbulence  
Claudio Falcon and Andres Franco, Universidad de Chile, Chile

Wednesday, June 13  
**MS4**  
**Computational High Frequency Waves - Part I of II**  
**10:00 AM - 12:30 PM**  
Room: Mary Gates Hall 234  
For Part 2 see MS12  
Propagation of high frequency waves is an old but still hot research subject of applied mathematics. It can find applications in various disciplines such as seismology, quantum physics and/or chemistry, geometrical optics, electromagnetics and medical imaging. High frequency waves present a great numerical challenge, since from the simulation point of view, one generally cannot afford to resolve the wavefield with grid points. This minisymposium intends to explore the recent progress on this subject, with more emphasis on its numerical aspect. It will bring together scientists from mathematics, applications and computational science, and provide a forum for exchanging ideas between these different communities.  
Organizer: Shi Jin  
Shanghai Jiao Tong University, China, and the University of Wisconsin-Madison, USA  
10:00-10:25 Global Geometrical Optics Method  
Chunxiong Zheng, Tsinghua University, China  
10:30-10:55 Dispersionless Time-domain PDE Solvers for High-frequency Problems and General Spatial Geometries  
Oscar P. Bruno, California Institute of Technology, USA  
11:00-11:25 Frozen Gaussian Approximation for High Frequency Wave Propagation  
Xu Yang, Courant Institute of Mathematical Sciences, New York University, USA  
continued on next page
11:30-11:55 A Fast and Accurate Absorbing Boundary Condition for the Helmholtz Equation
Rosalie Belanger-Rioux and Laurent Demanet, Massachusetts Institute of Technology, USA

12:00-12:25 The Gaussian Beam Method for the Dirac Equation in the Semi-classical Regime
Zhongyi Huang and Hao Wu, Tsinghua University, China; Shi Jin, Shanghai Jiao Tong University, China, and the University of Wisconsin-Madison, USA; Dongsheng Yin, Tsinghua University, China

Wednesday, June 13

MS5
Mixing and Coherent Structures in Fluid Flows
10:00 AM-12:30 PM
Room: Mary Gates Hall 287

Even the most complex flow fields in nature and technology tend to show coherent patterns. Such patterns guide or inhibit mixing, and form the skeleton of observed tracer distributions in the ocean, the atmosphere and even human crowds. While asymptotic mixing patterns have been well understood for flows with simple time dependence, little has been known about patterns emerging in complex, temporally aperiodic flows. This minisymposium surveys recent mathematical advances in understanding mixing and coherence in complex flows, and reviews relevant applications to geophysical flow problems.

Organizer: Sanjeeva Balasuriya
Connecticut College, USA

Organizer: George Haller
McGill University, Canada

10:00-10:25 Coherent Structures, Transport and Invariant Manifolds in Unsteady Flows
Sanjeeva Balasuriya, Connecticut College, USA

10:30-10:55 Lagrangian Coherent Structures and Eddy Diffusion
Wenbo Tang, Arizona State University, USA

11:00-11:25 Topological Detection of Coherent Structures
Jean-Luc Thiffeault, University of Wisconsin, Madison, USA; Michael Allshouse, Massachusetts Institute of Technology, USA

11:30-11:55 Data Mining Remotely Sensed Image Sequences and Transport Analysis of Spatiotemporal Dynamical Systems
Erik Boltt, Clarkson University, USA

12:00-12:25 A Global Theory of Transport Barriers
George Haller, McGill University, Canada

MS7
Geometric Methods in the Dynamics and Stability Analysis of Nonlinear Waves
10:00 AM-12:30 PM
Room: Mary Gates Hall 238

This minisymposium will feature speakers using geometric approaches to stability calculations, as well as those using geometric techniques in the analysis and numerical calculation of dynamics within nonlinear wave problems. Among the topics covered will be Grassmanian and Schubert varietal calculations for Evans functions, Index Theorems and eigenvalue counting, Geometric Based Numerical Methods: Continuous orthogonalization and Stiefel manifold methods, and Whitham Theory and long-wavelength techniques, Maslov index techniques in Hamiltonian systems, as well as higher dimensional analogs of the Evans function and Maslov index.

Organizer: Robert Marangell
University of Sydney, Australia

Organizer: Christopher Jones
University of North Carolina at Chapel Hill, USA & University of Warwick, United Kingdom

10:00-10:25 Nonlinear Eigenvalues, Keldysh’s Theorem, and the Evans Function
Yuri Latushkin, University of Missouri, Columbia, USA; Wolf-Jergen Beyn and Jens Rottmann-Matthes, University of Bielefeld, Germany

10:30-10:55 Horseshoes and Hand Grenades: On Standing Waves in a Gross-Pitaevskii Equation
Russell Jackson, US Naval Academy, USA

11:00-11:25 Fredholm Determinants and Computing the Stability of Travelling Waves
Simon Mallam, Heriot-Watt University, United Kingdom

continued on next page
Wednesday, June 13

**MS7**

Geometric Methods in the Dynamics and Stability Analysis of Nonlinear Waves

**MS8**

Nonlinear Waves in Nonlocal Media

10:00 AM-12:30 PM

Room: Mary Gates Hall 242

**MS19**

Solitons in Semiclassical Dispersive Fluids - Part I of II

10:00 AM-12:30 PM

For Part 2 see MS26

**continued**

11:30-11:55 Stability of Solitons Traveling on Vortex Filaments

Stephane Lafontaine and Annalisa M. Calini, College of Charleston, USA

12:00-12:25 Spectral Stability of Shock Layers in Compressible Fluid Flow

Jeffrey Humpherys, Brigham Young University, USA; Blake Barker, Indiana University, USA; Gregory Lyng, University of Wyoming, USA; Kevin Zumbrun, Indiana University, USA

10:00-10:25 Existence, Stability and Dynamics of Solitary Waves in Local and Nonlocal Discrete Nonlinear Schrodinger and Klein-Gordon Lattices

Panayotis Kevrekidis, University of Massachusetts, Amherst, USA

10:30-10:55 The Cauchy Problem and Traveling Waves for a Nonlocal Gross-Pitaevskii Equation

Andre de Laire, Université Pierre et Marie Curie, France

11:00-11:25 Dark Solitons and Soliton Complexes in Nonlocal Dissipative Systems

Maxim Molchan, University of Cape Town, South Africa

11:30-11:55 Loops of Energy Bands for Bloch Waves in Optical Lattices

Matt Coles, University of British Columbia, Canada

12:00-12:25 Stability of Solutions to a Non-local Gross-Pitaevskii Equation with Applications to Bose-Einstein Condensates

Chris Curtis, University of Colorado at Boulder, USA

There is growing experimental and theoretical interest in the small-dispersion (semiclassical) fluid dynamics of nonlinear waves in various materials and structures. Examples include light propagation in photonics, cold atom superfluids, and supercritical flow in water waves. Mathematically, many of these systems can be modeled using the KdV, KP, and NLS equations, which give rise to solitary wave solutions. Subjects of current interest include multi-component fluids, multi-dimensional solitons, and dispersive shock waves. This minisymposium will foster an exchange of ideas between the applied mathematicians and experimentalists who are working on such problems.

Organizer: Mark A. Hoefer
North Carolina State University, USA

Organizer: Boaz Ilan
University of California, Merced, USA

10:00-10:25 Dispersive Dam Breaks and Lock Exchanges in a Two-layer Fluid

Gavin Esler, University College London, United Kingdom

10:30-10:55 Interactions and Asymptotics of Dispersive Shock Waves

Douglas Baldwin, University of Colorado at Boulder, USA

11:00-11:25 Quantum Hydrodynamics and Turbulence in Bose-Einstein Condensates

Makoto Tsubota, Osaka University, Japan

11:30-11:55 From Superfluid Counterflow to Novel Types of Solitons: Quantum Hydrodynamics with Dilute-gas Bose-Einstein Condensates

Peter Engels, Washington State University, USA

12:00-12:25 Hydrodynamic Solitons and Vortices in Polariton Condensates

Alberto Amo, CNRS, France
Wednesday, June 13
Lunch Break
12:30 PM-2:00 PM
Attendees on their own

MS9
Hamiltonian and Symplectic Methods in the Theory of Nonlinear Waves - Part II of III
2:00 PM-4:30 PM
Room: Mary Gates Hall 241
For Part 1 see MS1
For Part 3 see MS16
Hamiltonian structures have played a central role in the theory of nonlinear waves. The subject is ever expanding, and the purpose of this minisymposium is to present a snapshot of recent developments. Topics include Hamiltonian structures of nonlinear dispersive wave equations, theory of Hamiltonian PDEs, Krein signature, the Maslov index, wave interactions, stability of solitary waves (Evans function, the energy-momentum method), modulation of waves, multi-symplectic structures, Whitham modulation theory, as well as numerical methods for all of the above, and applications to the theory of water waves.

Organizer: Tom J. Bridges
University of Surrey, United Kingdom
Organizer: Frederic Chardard
ENS Lyon, France

2:00-2:25 The Reduced Ostrovsky Equation: Integrability and Breaking
Roger Grimshaw, University of Loughborough, United Kingdom; Karl Helfrich, Woods Hole Oceanographic Institute, USA

2:30-2:55 Transverse Spectral Stability of Periodic Waves
Mariana Haragus, Universite de Franche-Comte, France

3:00-3:25 Generalized Multi-symplectic Integrators for a Class of Hamiltonian Nonlinear Wave PDEs
Weipeng Hu and Zichen Deng, Northwestern Polytechnical University, China

3:30-3:55 The Morse and Maslov Indices for Periodic Problems
Chris Jones, University of North Carolina, USA; Yuri Latushkin, University of Missouri, Columbia, USA; Robby Marangell, University of Sydney, Australia

4:00-4:25 Statics and Dynamics of Atomic Dark-bright Solitons in the Presence of Localized Impurities
Vassilios Rothos, Aristotle University of Thessaloniki, Greece; Vassos Achilleos and Dimitri Frantzeskakis, University of Athens, Greece; Panayotis Kevrekidis, University of Massachusetts, Amherst, USA

continued in next column

Wednesday, June 13
MS10
Nonlinear Wave Phenomena in Periodic Structures - Part II of II
2:00 PM-4:30 PM
Room: Mary Gates Hall 228
For Part 1 see MS2
Nonlinear wave dynamics in periodic and quasi-periodic media is currently one of the research frontiers in applied mathematics, optics and Bose-Einstein condensation. The novel interplay between nonlinearity and the underlying periodic media creates very rich and novel phenomena which have no counterpart in homogeneous media. Experimental advances in optics and Bose-Einstein condensates are strongly pushing this field forward. Recently, novel analytical techniques have also been developed for solitary waves in periodic media, and the resulting analytical results significantly deepen our understanding of these wave phenomena. This minisymposium will survey the current state of knowledge on nonlinear waves in periodic and quasi-periodic media, both in theory and in experiments.

Organizer: Jianke Yang
University of Vermont, USA

2:00-2:25 Multi-site Breathers in Klein--Gordon Lattices: Stability, Resonances, and Bifurcations
Anton Sakovich, McMaster University, Canada

2:30-2:55 Nonlinear Diffraction and Interband Transitions in Photonic Graphene
Yi Zhu, Tsinghua University, China; Mark Ablowitz, University of Colorado, USA

3:00-3:25 Linear and Nonlinear Properties of Strained Photonic Crystals
Mikael Rechtsman, Technion - Israel Institute of Technology, Israel; Alexander Szameit, Friedrich Schiller Universität Jena, Germany; Mordechai Segev, Technion, Israel

continued on next page
Wednesday, June 13  

**MS10**  
**Nonlinear Wave Phenomena in Periodic Structures - Part II of II**  
2:00 PM-4:30 PM  

continued  

3:30-3:55 Stability Analysis of Solitary Waves Near Bifurcation Points in Generalized Nonlinear Schroedinger Equations  
Jianke Yang, University of Vermont, USA  

4:00-4:25 Stabilizing 1D Solitons Against the Critical Collapse by Quintic Nonlinear Lattices  
Boris Malomed, Tel Aviv University, Israel; Jianhua Zeng, Tsinghua University, China  

**MS11**  
**Strongly Nonlinear Lattices and Granular Crystals - Part I of II**  
2:00 PM-4:00 PM  

Room: Mary Gates Hall 231  
For Part 2 see MS29  

Equations possessing strongly nonlinear terms (or perhaps absent of linear terms) are useful in modeling several phenomena. One notable example is in the description of granular crystals, which are defined as ordered aggregates of elastically interacting particles. These crystals can be assembled as homogeneous, heterogeneous, one-dimensional or even higher dimensional structures, and can be tailored to have responses tunable from linear to strongly nonlinear. This minisymposium aims to bring together researchers looking at state of the art problems in this area from different perspectives: from the point of view of experimental observations and engineering applications, but also from that of physical principles and mathematical analysis of strongly nonlinear lattice equations.  

Organizer: Christopher Chong  
University of Massachusetts, Amherst, USA  
Organizer: Georgios Theocharis  
California Institute of Technology, USA  

2:00-2:25 Analytical Study of the Interaction of Solitary Waves with Defects in Granular Crystals  
Yuli Starosvetsky, Technion - Israel Institute of Technology, Israel  

2:30-2:55 Highly Nonlinear Stress Waves in 2D Granular Crystals  
Andrea Leonard, California Institute of Technology, USA  

3:00-3:25 Equipartition of Energy in Uncompressed Granular Crystals  
Ivan Szelengowicz, California Institute of Technology, USA  

3:30-3:55 Periodic Travelling Waves in Dimer Granular Chains  
Matthew Betti and Dmitry Pelinovsky, McMaster University, Canada  

**MS12**  
**Computational High Frequency Waves - Part II of II**  
2:00 PM-4:30 PM  

Room: Mary Gates Hall 234  
For Part 1 see MS4  

Propagation of high frequency waves is an old but still hot research subject of applied mathematics. It can find applications in various disciplines such as seismology, quantum physics and/or chemistry, geometrical optics, electromagnetics and medical imaging. High frequency waves present a great numerical challenge, since from the simulation point of view, one generally cannot afford to resolve the wavefield with grid points. This minisymposium intends to explore the recent progress on this subject, with more emphasis on its numerical aspect. It will bring together scientists from mathematics, applications and computational science, and provide a forum for exchanging ideas between these different communities.  

Organizer: Shi Jin  
Shanghai Jiao Tong University, China, and the University of Wisconsin-Madison, USA  
Organizer: Chunxiong Zheng  
Tsinghua University, China  

2:00-2:25 Semiclassical Models for the Schroedinger Equation with Periodic Potentials and Band-crossings  
Shi Jin, Shanghai Jiao Tong University, China, and the University of Wisconsin-Madison, USA  

2:30-2:55 Error Estimates for Gaussian Beam Superpositions  
Olof Runborg, KTH Stockholm, Sweden  

3:00-3:25 High Frequency Approximation in Molecular Quantum Dynamics  
Caroline Lasser, Technische Universität München, Germany  

3:30-3:55 Multipathing Problem in Seismic Imaging and a Numerical Solution of Escape Equations  
Sergey Fomel and Vladimir Bashkardin, University of Texas at Austin, USA  

4:00-4:25 Large Time-step and Asymptotic-preserving Schemes for Hyperbolic Systems with Sources and their Parabolic Limits  
Christophe Chalons, Université Paris VII, France
Interaction between light and active optical media is one of the most fruitful areas in applied physics and provides the basic mechanism underlying devices such as lasers and optical amplifiers. Due to the great variety of physical phenomena it exhibits, light interaction with active media has also given rise to a broad range of mathematical descriptions of their dynamics, ranging from chaotic and turbulent to completely integrable, exhibited by the corresponding Maxwell-Bloch equations. The minisymposium will showcase recent work ranging from integrable/stochastics polarization dynamics, to light stopping, and pulse propagation in metamaterials doped with active atoms.

Organizer: Gregor Kovacic
Rensselaer Polytechnic Institute, USA

Organizer: Alexander O. Korotkevich
University of New Mexico, USA

2:00-2:25 Integrable/Stochastic Polarization Dynamics in Active Media
Gregor Kovacic, Rensselaer Polytechnic Institute, USA; Ethan Akins, University of California, Berkeley, USA; Peter R. Kramer, Rensselaer Polytechnic Institute, USA; Ildar R. Gabitov, University of Arizona, USA

2:30-2:55 Monte-Carlo Simulations of a Stochastic Maxwell-Bloch System
Katherine Newhall, Courant Institute of Mathematical Sciences, New York University, USA

continued in next column
Wednesday, June 13

**MS26**

**Solitons in Semiclassical Dispersive Fluids - Part II of II**

2:00 PM-4:30 PM

Room: Mary Gates Hall 254

For Part I see MS19

There is growing experimental and theoretical interest in the small-dispersion (semiclassical) fluid dynamics of nonlinear waves in various materials and structures. Examples include light propagation in photonics, cold atom superfluids, and supercritical flow in water waves. Mathematically, many of these systems can be modeled using the KdV, KP, and NLS equations, which give rise to solitary wave solutions. Subjects of current interest include multi-component fluids, multi-dimensional solitons, and dispersive shock waves. This minisymposium will foster an exchange of ideas between the applied mathematicians and experimentalists who are working on such problems.

Organizer: Mark A. Hoefer, North Carolina State University, USA

Organizer: Boaz Ilan, University of California, Merced, USA

2:00-2:25 Dispersive Shock Wave Propagation in Weakly Non-Uniform Media

Gennady El, Loughborough University, United Kingdom

2:30-2:55 The Semiclassical Modified Nonlinear Schrödinger Equation

Peter D. Miller, University of Michigan, Ann Arbor, USA

3:00-3:25 Semiclassical Dynamics and Rogue Waves Formation in Quasi 1D Attractive Bose-Einstein Condensates: The Riemann-Hilbert Problem Approach

Alexander Tovbis, University of Central Florida, USA

3:30-3:55 Thermodynamic Phase Transitions and Shock Singularities

Antonio Moro, SISSA, Italy

4:00-4:25 Dark Solitons, Dispersive Shock Waves and their Transverse Instabilities

Boaz Ilan, University of California, Merced, USA; Mark A. Hoefer, North Carolina State University, USA

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Wednesday, June 13

**CP1**

**Optics**

2:00 PM-4:20 PM

Room: Mary Gates Hall 242

Chair: Roy Goodman, New Jersey Institute of Technology, USA

2:00-2:15 Crosstalk Dynamics of Optical Solitons in Broadband Optical Waveguide Systems

Avner Peleg, State University of New York, Buffalo, USA; Quan Nguyen, Vietnam National University at Ho Chi Minh City, Vietnam; Yeojin Chung, Southern Methodist University, USA

2:20-2:35 Disordered Beam Propagation in a Focusing Nonlinear Medium

Stanislav A. Derevyanko, Aston University, United Kingdom

2:40-2:55 Josephson Oscillations in Dissipative Optical Systems

Alexey Yulin and Vladimir V. Konotop, Universidade de Lisboa, Portugal

3:00-3:15 Nonlinear Refraction Versus Solitonic Fission in Optical Lattices

Yaroslav Prylepskiy and Stanislav A. Derevyanko, Aston University, United Kingdom; Sergei Gredeskul, Ben Gurion University Negev, Israel

3:20-3:35 Nonlinear Dynamics and Normal Forms in the Time Dependent Nonlinear Schrodinger/Gross Pitaevskii Equations

Roy Goodman, New Jersey Institute of Technology, USA

3:40-3:55 Chaos Control in a Transmission Line Model

Ioana A. Triandaf, Naval Research Laboratory, USA

4:00-4:15 Adaptive Construction of Surrogates for Parameter Inference in Nonlinear Wave Equations

Jinglai Li, Massachusetts Institute of Technology, USA

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Coffee Break

4:30 PM-5:00 PM

Room: Mary Gates Hall 135

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Wednesday, June 13

**Martin D. Kruskal Lecture**

**Pattern Quarks and Leptons**

5:15 PM-6:00 PM

Room: Guggenheim Hall 220

Chair: Nathan Katz, University of Washington, USA

Martin Kruskal was one of a kind, a pure scientist who followed roads less travelled by and whose new discoveries made all the difference in so many ways. Once a question intrigued and gripped him, he never let go. The discovery of solitons and the uncovering of whole new classes of integrable systems have led to major advances in the worlds of Hamiltonian partial differential equations, in exactly integrable models in statistical physics, and to the fascinating and more recently discovered properties of random matrices. And there may be yet many more windfalls to come. In this Kruskal lecture, I will give a brief overview of some of the early days, of how Martin took on the Fermi, Pasta, Ulam conundrum which had defied explanation by some of the best minds of the time and, with the help of colleagues Zabusky, Miura, Gardner and Greene, turned it into one of the most important discoveries of the last half of the 20th century. As for my own contributions to today's lecture, I have no illusions that the story I shall tell will have any of the same impact but hope that it will reflect some of the same pioneering spirit that Martin displayed in pursuing the unconventional. What I plan to do is sketch some ideas I have been mulling in connection with the Standard Model and show that quark and lepton like objects with different masses and all the invariants associated with spin

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(+/-1/2) and charge (+/-1/3,+/-2/3,+/-1) can occur naturally as the result of phase transitions in far from equilibrium, pattern forming systems. In contrast to the Standard Model, they arise without any a priori introduction of the SU(2) and SU(3) symmetries into the governing free energy. The invariants can each be connected to the condensation of mean and Gaussian curvature of the constant phase surfaces along certain defect cores.

Alan Newell
University of Arizona, USA

Thursday, June 14

MS6
Dynamics of Coagulation-Fragmentation Processes - Part I of II
10:00 AM-12:30 PM
Room: Mary Gates Hall 228
For Part 2 see MS14
Various natural phenomena as aggregation, nucleation, micellization, coalescence, or biopolymer length maintenance appearing in material sciences or biology can be modeled by coagulation-fragmentation models. Mathematically, these problems, discrete or continuous (mean-field), lead to systems of ordinary or partial differential equations describing dynamics of distribution of various cluster sizes. Asymptotic analysis relates the area to nonlinear waves as one can often study convergence to self-similar solutions or a collapse (gelation). The aim of this minisymposium is to overview recent development in mathematical modeling and in mathematical analysis of coagulation-fragmentation processes including well-known Smoluchowski and Becker-Doring equations.

Organizer: Richard Kollar
Comenius University, Bratislava, Slovakia
Organizer: Robert Pego
Carnegie Mellon University, USA

10:00-10:25 Symmetry-breaking in Crystallisation
Jonathan Wattis, University of Nottingham, United Kingdom

10:30-10:55 Aggregation and Growth of Clusters During a Thermal Quench
Yossi Farjoun, Universidad Carlos III de Madrid, Spain

11:00-11:25 Coagulation Equations with Nonhomogeneous Kernels
Henry van Roessel, University of Alberta, Canada

11:30-11:55 Branching Processes and Coagulation: Asymptotic Self-similarity for a Generalized Smoluchowski Equation
Nicholas Leger, Gautam Iyer, and Robert Pego, Carnegie Mellon University, USA

12:00-12:25 Coagulation Dynamics Driven by Uniform Growth
Robert Pego, Carnegie Mellon University, USA

IP2
Kramers’ Law - Validity and Generalizations
8:45 AM-9:30 AM
Room: Guggenheim Hall 220
Chair: Margaret Beck, Boston University, USA
Consider the overdamped motion of a Brownian particle in a multiwell potential. Kramers’ Law describes the small-noise limit of the particle’s mean transition time between local minima. We will outline several approaches to the problem of describing such noise-induced transitions, discuss recent generalizations of Kramers’ Law to potentials with nonquadratic saddles and stochastic partial differential equations as well as the limitations of the law such as the cycling effect. Generalizations and refined results on cycling are joint work with Nils Berglund (Orleans).

Barbara Gentz
University of Bielefeld, Germany

Coffee Break
9:30 AM-10:00 AM
Room: Mary Gates Hall 135
Thursday, June 14

**MS16**

**Hamiltonian and Symplectic Methods in the Theory of Nonlinear Waves - Part III of III**

10:00 AM-12:30 PM

Room: Mary Gates Hall 241

For Part 2 see MS9

Hamiltonian structures have played a central role in the theory of nonlinear waves. The subject is ever expanding, and the purpose of this minisymposium is to present a snapshot of recent developments. Topics include Hamiltonian structures of nonlinear dispersive wave equations, theory of Hamiltonian PDEs, Krein signature, the Maslov index, wave interactions, stability of solitary waves (Evans function, the energy-momentum method), modulation of waves, multi-symplectic structures, Whitham modulation theory, as well as numerical methods for all of the above, and applications to the theory of water waves.

Organizer: Tom J. Bridges
University of Surrey, United Kingdom

Organizer: Frederic Chardard
ENS Lyon, France

10:00-10:25 Weakly Nonlinear Solution of Initial Value Problem for Boussinesq-type Equations

Kieron Moore and Karima Khusnutdinova, Loughborough University, United Kingdom

10:30-10:55 Whitham Modulation Equations for Korteweg-de Vries/Kuramoto-Sivashinsky Equations

Pascal Noble, Universite Lyon, France; Luis Miguel Rodrigues, University of Lyon 1, France

11:00-11:25 Stability of Homoclinic Orbits of the Nonlinear Schrodinger Equation

Constance Schober, University of Central Florida, USA

**11:30-11:55 A Dimension-breaking Phenomenon for Steady Water Waves with Weak Surface Tension**

Erik Wahlen, Lund University, Sweden; Mark D. Groves, Universitat des Saarlandes, Germany; Shu-Ming Sun, Virginia Polytechnic Institute and State University, USA

12:00-12:25 Emergence of Unsteady Dark Solitary Waves from Large-amplitude Periodic Patterns

Tom J. Bridges, University of Surrey, United Kingdom

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Thursday, June 14

**MS17**

Nonlinear Propagation and Collapse

10:00 AM-12:30 PM

Room: Mary Gates Hall 231

This minisymposium will focus on recent advances in the theory of nonlinear waves. The talks will cover collapse phenomena and propagation of solitary waves, in deterministic and stochastic settings, using rigorous analysis, asymptotic analysis, and numerical simulations.

Organizer: Gadi Fibich
Tel Aviv University, Israel

10:00-10:25 Continuations of NLS Solutions Beyond the Singularity

Gadi Fibich, and Moran Klein, Tel Aviv University, Israel

10:30-10:55 Nonlinear Optics in Periodic, PT-symmetric Systems

Alejandro Aceves, Southern Methodist University, USA

11:00-11:25 Logarithmic Corrections in Formation of Singularities in 2D Radially Symmetric Reduced Keller-Segel Model

Pavel M. Lushnikov, Sergey Dyachenko, and Natalia Vladimirova, University of New Mexico, USA

11:30-11:55 Waves in Microstructures

Michael I. Weinstein, Columbia University, USA

continued in next column
Thursday, June 14

**MS18**

**Internal Waves in Stratified Fluids**

10:00 AM-12:00 PM

Room: Mary Gates Hall 254

The idea of this minisymposium is to bring together people who study waves in stratified flows from slightly different angles, and we hope to have a dynamical exchange of ideas and synergy of the group. Talks will look at waves stratified flows from theoretical, numerical, observational and experimental prospective, and will include flows in the ocean, and laboratory. More specifically, we will consider internal waves in the ocean, reduced highly nonlinear models of stratified flows and two layer fluids.

Organizer: Yuri V. Lvov
Rensselaer Polytechnic Institute, USA

10:00-10:25 Internal Waves in the Ocean Seen from Spectral Perspective
Yuri V. Lvov, Rensselaer Polytechnic Institute, USA

10:30-10:55 On Stochastic Closures for Finite Amplitude Internal Waves
Kurt Polzin, Woods Hole Oceanographic Institute, USA

11:00-11:25 Reduced Models of Stratified Internal Waves
Roberto Camassa, University of North Carolina at Chapel Hill, USA

11:30-11:55 Asymptotic Models for Large Amplitude Internal Waves in Weakly Stratified Fluids
Wooyoung Choi, New Jersey Institute of Technology, USA

Thursday, June 14

**MS20**

**Riemann-Hilbert Problems: Analysis and Computation - Part I of II**

10:00 AM-12:00 PM

Room: Mary Gates Hall 238

For Part 2 see MS27

Riemann-Hilbert problems arise in a wide range of applications. They can be used to extract asymptotic formulae, derive new solution expressions and perform accurate numerical computations. In this symposium we discuss recent developments of techniques and ideas in all of these areas.

Organizer: Thomas D. Trogdon
University of Washington, USA

Organizer: Sheehan Olver
Oxford University, United Kingdom

10:00-10:25 Toeplitz-like Structure of Riemann–Hilbert Problems
Sheehan Olver, Oxford University, United Kingdom

10:30-10:55 On the Elliptic Sine-Gordon Equation
Beatrice Pelloni, University of Reading, United Kingdom; Athanassios Fokas, University of Cambridge, United Kingdom; Jonatan Lenells, Baylor University, USA

11:00-11:25 Asymptotics for a Fredholm Determinant Involving the Second Painleve Transcendent
Thomas J. Bothner, Indiana University and Purdue University, USA

11:30-11:55 Automatic Contour Deformation
Georg Wechslberger, Technical University of Munich, Germany

Thursday, June 14

**MS21**

**Coherent Structures in Continuous and Discrete Systems: Applications in Optics and Fluids - Part I of II**

10:00 AM-12:00 PM

Room: Mary Gates Hall 234

For Part 2 see MS28

Long term dynamics in partial differential equations and systems of ordinary differential equations is an important issue in many problems in fluid mechanics, in climate, in nonlinear optics, and in molecular dynamics. Coherent structures are often the main observed features of the corresponding physical systems. In this minisymposium we will highlight work on discrete systems or in reduced models that are obtained through asymptotics, averaging or variational procedures. We will examine the existence, the symmetry properties, and the stability of coherent, spatially localized states as well as the role they play in wave turbulence in a wide range of physical problems.

Organizer: Panayotis Panayotaros
IIMAS-UNAM, Mexico

Organizer: Alejandro Aceves
Southern Methodist University, USA

Organizer: Jean-Guy Caputo
Universite de Rouen, France

10:00-10:25 Resonant Dynamics of Fourier Modes
Jean-Guy Caputo, Universite de Rouen, France

10:30-10:55 Singular Structure of Wave Modes in Rotating Shallow Water
David J. Muraki, Simon Fraser University, Canada

11:00-11:25 Wave Train Defocusing over a Highly Disordered Bathymetry
Andre Nachbin, Institute of Pure and Applied Mathematics, Brazil; Ana Maria Luz, Universidade Federal Fluminense, Brazil

11:30-11:55 Spontaneous Breaking of the Spatial Homogeneity Symmetry in Wave Turbulence and the Emergence of Coherent Structures
Benno Rumpf, Southern Methodist University, USA
Thursday, June 14

**MS22:** CANCELLED

10:00 AM-12:30 PM

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**CP2**

Dissipative Effects

10:00 AM-12:00 PM

Room: Mary Gates Hall 242

Chair: Mark A. Hoefer, North Carolina State University, USA

10:00-10:15 Envelope Quasi-Solitons in Dissipative Systems with Cross-Diffusion

Vadim N. Biktashev, University of Liverpool, United Kingdom; Mikhail Tsyganov, Russian Academy of Sciences, Russia

10:20-10:35 Evolution of Spiral and Scroll Waves of Excitation in a Mathematical Model of Ischaemic Border Zone

Irina Biktasheva and Vadim Biktashev, University of Liverpool, United Kingdom; Narine Sarvazyan, George Washington University, USA

10:40-10:55 Impact of Randomness on Solitary Wave Propagation in Granular Systems

Mohith Manjunath, Amnaya P. Awasthi, and Philippe H. Geubelle, University of Illinois at Urbana-Champaign, USA

11:00-11:15 Target Detection in Non-Uniform Slowness Fields Using Time-Reversed Nonlinear Solitary Waves

Subhashini Chitta and John Steinhoff, University of Tennessee Space Institute, USA

11:20-11:35 Perturbed Magnetic Droplet Solitons

Mark A. Hoefer, North Carolina State University, USA; Matteo Sommacal, Northumbria University, United Kingdom

11:40-11:55 Amplification of Synaptic Inputs by Dendritic Spines

William Kath, Northwestern University, USA

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**Lunch Break**

12:30 PM-2:00 PM

Attendees on their own

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Thursday, June 14

**MS14**

Dynamics of Coagulation-Fragmentation Processes - Part II of II

2:00 PM-4:00 PM

Room: Mary Gates Hall 228

For Part I see MS6

Various natural phenomena as aggregation, nucleation, micellization, coalescence, or biopolymer length maintenance appearing in material sciences or biology can be modeled by coagulation-fragmentation models. Mathematically, these problems, discrete or continuous (mean-field), lead to systems of ordinary or partial differential equations describing dynamics of distribution of various cluster sizes. Asymptotic analysis relates the area to nonlinear waves as one can often study convergence to self-similar solutions or a collapse (gelation). The aim of this minisymposium is to overview recent development in mathematical modeling and in mathematical analysis of coagulation-fragmentation processes including well-known Smoluchowski and Becker-Doring equations.

Organizer: Richard Kollar
Comenius University, Bratislava, Slovakia

Organizer: Robert Pego
Carnegie Mellon University, USA

2:00-2:25 Coagulation-Fragmentation in Alternative Telomere Length Maintenance

Katarina Bodova, Richard Kollar, Lubomir Tomaska, and Jozef Nosek, Comenius University, Bratislava, Slovakia

2:30-2:55 Convergence to Equilibrium for the Coagulation-fragmentation Equations with Detailed Balance and a Finite Critical Mass

Jose A. Cañizo, University of Cambridge, United Kingdom; Bertrand Lods, Università degli Studi di Torino, Italy

continued on next page
Thursday, June 14

**MS23**

**Traveling Water Waves and their Stability**

2:00 PM-4:30 PM

*Room: Mary Gates Hall 241*

The water wave equations arise in a wide array of engineering applications. Traveling wave solutions are of great interest due to their ability to transport energy and momentum over great distances. It is of crucial importance to identify those solutions which are stable as these will be the only ones observed in practice. The object of this session is to communicate the state-of-the-art in the stability theory of water waves.

Organizer: Benjamin Akers

*Air Force Institute of Technology, USA*

Organizer: David P. Nicholls

*University of Illinois, Chicago, USA*

2:00-2:25 **Modulational Instability of Weakly Nonlinear Gravity Waves on a Current of Uniform Vorticity in Arbitrary Depth**

Christian Kharif and Roland Thomas, Institut de Recherche sur les Phénomènes Hors Équilibre, Marseille, France

2:30-2:55 **Stability of Traveling Wave Solutions to Euler’s Equations**

Katie Oliveras, Seattle University, USA; Vishal Vasan, University of Washington, USA

3:00-3:25 **On the Evolution of Ocean Swell Over Long Distances**

Harvey Segur, University of Colorado, USA

3:30-3:55 **Numerical and Experimental Investigation for Spectral Evolution of Nonlinear Ocean Surface Waves and their Stability**

Matt Milewski, U.S. Army Engineer Research and Development Center, USA; Wooyoung Choi, New Jersey Institute of Technology, USA

4:00-4:25 **Time Dependent Hydro-Elastic Waves**

Paul A. Milewski, University of Bath, United Kingdom

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Thursday, June 14

**MS24**

**Optical Wave Attraction and Turbulence**

2:00 PM-4:30 PM

*Room: Mary Gates Hall 287*

Polarization attraction and optical turbulence are two emerging areas of research involving complementary aspects of the statistical description of wave self-organization in nonlinear optics. The former involves the phenomenon of the nonlinear repolarization/depolarization of a initially depolarized wave by means of its interaction with an initially fully polarized/depolarized pump wave. On the other hand the concept and methods of wave turbulence are important for properly describing and optimizing the operation of fiber lasers and optical devices. Presentations will cover the derivation of the basic equations, their stability analysis, numerical simulations and experimental demonstrations.

Organizer: Stefan Wabnitz

*University of Brescia, Italy*

2:00-2:25 **Theory of Polarization Attraction in Randomly Birefringent Nonlinear Optical Fibers**

Stefan Wabnitz, Victor V. Kozlov, and Massimiliano Guasoni, University of Brescia, Italy

2:30-2:55 **Hamiltonian Relaxation Phenomena and Applications to Nonlinear Optics**

A. Picozzi, Université de Bourgogne, France; Elie Assémat, Dominique Sugny, and Hans Jauslin, Laboratoire Interdisciplinaire Carnot de Bourgogne, France

3:00-3:25 **Four-wave-mixing and Optical Wave Turbulence in Fiber Lasers**

Dmitry Churkin, Aston University, United Kingdom

3:30-3:55 **Collapses in Optical Turbulence**

Natalia Vladimirova and Pavel M. Lushnikov, University of New Mexico, USA
Internal waves are thought to play an essential role in ocean mixing and global climate patterns. Past internal wave research has focused on fluids with constant buoyancy frequency (linear stratification). However, naturally occurring stratifications are nonlinear, with buoyancy frequencies varying by more than two orders of magnitude in the ocean. The propagation and generation of internal waves in nonlinear stratifications will be the focus of this symposium with specific emphasis on: large amplitude waves, models of the deep ocean and ocean topography, generation and propagation of solitary waves and the effects of rotation in a model thermocline.

Organizer: Matthew S. Paoletti
University of Texas at Austin, USA

2:00-2:25 The Effects of Rotation on Internal Solitary Waves
Karl Helfrich, Woods Hole Oceanographic Institute, USA; Roger Grimshaw, University of Loughborough, United Kingdom

Matthew S. Paoletti and Harry Swinney, University of Texas at Austin, USA

3:00-3:25 Transient Interfacial Waves - Nonlinear Calculations in Three Dimensions
John Grue, University of Oslo, Norway

continued in next column
Thursday, June 14

MS28
Coherent Structures in Continuous and Discrete Systems: Applications in Optics and Fluids - Part II of II
2:00 PM-4:30 PM
Room: Mary Gates Hall 234
For Part 1 see MS21

Long term dynamics in partial differential equations and systems of ordinary differential equations is an important issue in many problems in fluid mechanics, in climate, in nonlinear optics, and in molecular dynamics. Coherent structures are often the main observed features of the corresponding physical systems. In this minisymposium we will highlight work on discrete systems or in reduced models that are obtained through asymptotics, averaging or variational procedures. We will examine the existence, the symmetry properties, and the stability of coherent, spatially localized states as well as the role they play in wave turbulence in a wide range of physical problems.

Organizer: Panayotis Panayotaros
IIMAS-UNAM, Mexico
Organizer: Alejandro Aceves
Southern Methodist University, USA
Organizer: Jean-Guy Caputo
Universite de Rouen, France

2:00-2:25 Light Propagation in Two Dimensional Plasmonic Arrays
Danhua Wang and Alejandro Aceves,
Southern Methodist University, USA

2:30-2:55 Wave Propagation in Anharmonic Discrete Systems
Luis A Cisneros-Ake, Instituto Politécnico Nacional, Mexico

3:00-3:25 Instabilities of Breathers in a Discrete NLS
Panayotis Panayotaros, IIMAS-UNAM, Mexico

continued in next column

3:30-3:55 Stable, Conservative Solution Methods for Large, Stiff Hamiltonian Systems Modeling Coherent Phenomena in Nonlinear Optics and Biophysics
Brenton J. LeMesurier, College of Charleston, USA

4:00-4:25 Second Harmonic Generation in Negative Index Materials
Alejandro Aceves, Southern Methodist University, USA; Zhaxylyk Kudyshev, Al-Farabi Kazakh National University, Kazakhstan; Il’dar Gabitov and Alyssa Pampell, Southern Methodist University, USA

Thursday, June 14

MS29
Strongly Nonlinear Lattices and Granular Crystals - Part II of II
2:00 PM-4:00 PM
Room: Mary Gates Hall 231
For Part 1 see MS11

Equations possessing strongly nonlinear terms (or perhaps absent of linear terms) are useful in modeling several phenomena. One notable example is in the description of granular crystals, which are defined as ordered aggregates of elastically interacting particles. These crystals can be assembled as homogeneous, heterogeneous, one-dimensional or even higher dimensional structures, and can be tailored to have responses tunable from linear to strongly nonlinear. This minisymposium aims to bring together researchers looking at state of the art problems in this area from different perspectives: from the point of view of experimental observations and engineering applications, but also from that of physical principles and mathematical analysis of strongly nonlinear lattice equations.

Organizer: Christopher Chong
University of Massachusetts, Amherst, USA
Organizer: Georgios Theocharis
California Institute of Technology, USA

2:00-2:25 Resonances, Solitary Waves, and Passive Wave Redirection in Granular Media
Alexander Vakakis, National Technical University of Athens, Greece; Yuli Starostvsky, University of Illinois at Urbana-Champaign, USA; KR Jayaprakash and Md. Arif Hasan, University of Illinois, USA

2:30-2:55 From Newton’s Cradle to the p-Schrödinger Equation
Gaëlle James, Université de Grenoble and CNRS, France; Panayotis Kevrekidis, University of Massachusetts, USA; Jesus Cuevas, Universidad de Sevilla, Spain

3:00-3:25 Dispersion Estimation for Weakly and Strongly Nonlinear Periodic Systems
Massimo Ruzzene, Georgia Institute of Technology, USA

3:30-3:55 Nonlinear Frequency Conversion Through Driven Granular Media
Joseph Lydon, California Institute of Technology, USA
Thursday, June 14

CP3
Complex Fluids
2:00 PM-4:20 PM
Room: Mary Gates Hall 242
Chair: Mark Deinert, University of Texas at Austin, USA

2:00-2:15 A Characterization of Dispersive Shock Waves in the Magma Equation
Nicholas Lowman and Mark A. Hoefer, North Carolina State University, USA

2:20-2:35 On Seismic Wave in Magnetoelastic Low Velocity Crustal Layer
Sanjeev A. Sahu and Amares Chattopadhyay, Indian School of Mines, India

2:40-2:55 Steady Structures and Rheology of Active Complex Fluids
Zhenlu Cui, Fayetteville State University, USA

3:00-3:15 Rogue Waves in Plasmas
Ioannis Kourakis, Vikrant Saxena, and Sharmin Sultana, Queen’s University, Belfast, United Kingdom; Jafar Borhanian, University of Mohaghegh Ardabili, Iran

3:20-3:35 Propagation of a Constant Velocity Fission Wave
Mark Deinert, University of Texas at Austin, USA

3:40-3:55 Radiation by Superfluid Vortices in the Lighthill Regime
Hayder Salman, University of East Anglia, United Kingdom

4:00-4:15 Solitons in Dipolar Bose-Einstein Condensates with Trap and Barrier Potential
Fatkhulla Abdullaev, Uzbek Academy of Sciences, Uzbekistan; Valeriy Brazhnyi, Universidade do Porto, Portugal

Thursday, June 14

PP1
Reception and Poster Session
4:30 PM-6:30 PM
Room: Mary Gates Hall 135

Some Exact Solutions Of Two 5th Order KdV-Type Nonlinear Evolution Equations
Tania Akter, World University, Canada; Abdus Sattar Mia, Brock University, Canada

Compressed Sensing in Retinal Image Processing
Victor Barranca and Gregor Kovacic, Rensselaer Polytechnic Institute, USA; David Cai, Shanghai Jiao Tong University, China and Courant Institute of Mathematical Sciences, New York University, USA

Computational Reductions and Dynamics of Neuronal Models with Adaptation Current
Victor Barranca and Gregor Kovacic, Rensselaer Polytechnic Institute, USA; David Cai, Shanghai Jiao Tong University, China and Courant Institute of Mathematical Sciences, New York University, USA

Simultaneous Frequency Conversion, Regeneration and Reshaping of Optical Signals
Daniel Cargill, New Jersey Institute of Technology, USA

Fifth Order Evolution Equation for Long Wave Dissipative Solitons
Cristina Depassier and Juvenal Letelier, Universidad Catolica de Chile, Chile

Feigenbaum Universality, Lyapunov Exponents and Fractal Dimensions in Two Dimensional Chaotic Models
Tarini K. Dutta, Gauhati University, India

Confinement of the Eigenvalues of the Ablowitz-Ladik Eigenvalue Problem
J. Adrian Espinola-Rocha, University of Arizona, USA; Patrick Shipman, Colorado State University, USA

On the Nonlinear Schrodinger Equation with Embedded Eigenvalues
Emily Fagerstrom, and Gino Biondini, State University of New York, Buffalo, USA

Travelling Waves of a Reaction-Diffusion Model for the Acidic Nitrate-Ferrin Reaction
Sheng-Chen Fu, National Chengchi University, Taiwan; Je-Chiang Tsai, National Chung Cheng University, Taiwan

Random and Regular Dynamics of Stochastically Driven Neuronal Networks
Pamela B. Fuller, Rensselaer Polytechnic Institute, USA

Vaccinating Against HPV in Dynamic Network
Pamela B. Fuller, Toni Wagner, Mark Yuhas, and Peter R. Kramer, Rensselaer Polytechnic Institute, USA

A Hamiltonian Water Wave Model with Horizontally Sheared Currents
Elena Gagarina, University of Twente, Netherlands

Many-Body Interaction in Fast Collisions of Nls Solitons
Avner Peleg, State University of New York, Buffalo, USA; Yeojin Chung, Southern Methodist University, USA; Paul Glenn, State University of New York, Buffalo, USA; Quan Nguyen, Vietnam National University at Ho Chi Minh City, Vietnam

Dynamics of a Mean Field Cortex Model
Kevin R. Green, University of Ontario Institute of Technology, Canada

Pattern Competition in Spatially-Forced Systems
Aric Hagberg, Los Alamos National Laboratory, USA; Yair Mau and Ehud Meron, Ben-Gurion University, Israel

A Slow Pushed Front in a Lotka-Volterra Competition Model
Matt Holzer and Arnd Scheel, University of Minnesota, USA

Stability and Dynamics of Solitary Waves in Bec Spinor Lattices
Rudy L. Horne, Florida State University, USA; Hadi Susanto, University of Nottingham, United Kingdom; Nathan Whitaker, University of Massachusetts, Amherst, USA; Panos Kevrekidis, University of Massachusetts, USA

Weakly Subcritical Stationary Patterns: Eckhaus Instability and Homoclinic Snaking
Hsien-Ching Kao and Edgar Knobloch, University of California, Berkeley, USA

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continued on next page
Localized Structures in Rotating Convection
Edgar Knobloch, University of California, Berkeley, USA

Gain-Controlled Soliton Routing in Dispersive Lattices
Yannis Komini, National Technical University of Athens and University of Patras, Greece; Sotiris Droulias, Panagiotis Papagiannis, and Kyriakos Hizanidis, National Technical University of Athens, Greece

Mutual Interactions Between Electromagnetic Solitons in Plasmas
Ioannis Koutrakis and Vikrant Saxena, Queen’s University, Belfast, United Kingdom; Amita Das, Abhijit Sen, and Pradimanta Kaw, Institute for Plasma Research, India

Synchronous and Asynchronous Dynamics of Complex Neuronal Networks
Gregor Kovacic, Rensselaer Polytechnic Institute, USA

Spatiotemporal Dynamics in Three Species Model Systems with Self-Diffusion
Nitu Kumari, Indian Institute of Technology Mandi, India

Localized Patterns on the Surface of a Magnetic Fluid
David Lloyd, University of Surrey, United Kingdom

Transition Between Slow and Fast Wavefronts from the Point of View of Speed Selection
Peter McLarman, Miami University, USA; Anna Ghazaryan, Miami University and University of Kansas, USA; Christopher Jones, University of North Carolina at Chapel Hill, USA & University of Warwick, United Kingdom

Oscillons Near Forced Hopf Bifurcations
Kelly McQuighan and Bjorn Sandstede, Brown University, USA

Bistable Fronts in Discrete Inhomogeneous Media
Brian E. Moore, University of Central Florida, USA; Tony R. Humphries, McGill University, Canada; Erik Van Vleck, University of Kansas, USA

Numerical Simulation of Internal Wave Generation from a Collapsing Mixed Region in Stratified Fluid
Nikolay Moshkin, Suranaree University of Technology, Thailand; Gennadii Chernykh and Andrey Zudin, Institute of Computational Technologies, Novosibirsk, Russia

A Numerical Method For Solving Nonlinear Schrödinger Equation
Weizhong Dai and Frederick Moxley, Louisiana Technical University, USA

Synchrony in Stochastic Pulse-Coupled Neuronal Network Models
Katherine Newhall, and Aadiyta Rangan, Courant Institute of Mathematical Sciences, New York University, USA

An Improved Local Well-Posedness Result for the Periodic “Good” Boussinesq Equation
Seungly Oh and Atanas Stefanov, University of Kansas, USA

Effects of Stochastic Perturbations on the Atlantic Thermohaline Circulation
Alejandro Aceves and Alyssa Pampell, Southern Methodist University, USA

Complex Soliton Dynamics in Lattices with Longitudinal Modulation
Panagiotis Papagiannis, National Technical University of Athens, Greece; Yannis Komini, National Technical University of Athens and University of Patras, Greece; Kyriakos Hizanidis and Sotiris Droulias, National Technical University of Athens, Greece

Point Vortex Equilibria and Calogero-Sutherland Equation
Ronald Perline, Drexel University, USA

Snakes and Ladders: Stability of Fronts and Pulses
Bjorn Sandstede, Brown University, USA

On the Spectral Stability of Soliton Solutions of the Vector Nonlinear Schrödinger Equation
Natalie Sheils, and Bernard Deconinck, University of Washington, USA; Nghiem Nguyen and Rushun Tian, Utah State University, USA

On Model of Short Pulse Type in Continuous Media
Yannan Shen, University of Massachusetts, Amherst, USA; Nikolaos Tsitsas, National Technical University of Athens, Greece; Dimitri Frantzeskakis, University of Athens, Greece; Floyd Williams, University of Massachusetts, Amherst, USA; Avadh Saxena, Los Alamos National Laboratory, USA; Atanas Stefanov, University of Kansas, USA; Theodoros Horikis, University of Ioannina, Greece; Nathaniel Whitaker, University of Massachusetts, Amherst, USA; Panos Kevrekidis, University of Massachusetts, USA

Global Existence for a System of Schrödinger Equations with Power-Type Nonlinearities
Rushun Tian and Nghiem Nguyen, Utah State University, USA; Bernard Deconinck, and Natalie Sheils, University of Washington, USA

A Single Equation Describing Free Surface Water Waves
Olga Trichtchenko, and Bernard Deconinck, University of Washington, USA

Numerical Inverse Scattering: Uniform Approximation of Solutions of Integrable Pdes
Thomas D. Trogdon, University of Washington, USA; Sheehan Olver, Oxford University, United Kingdom; Bernard Deconinck, University of Washington, USA

Traveling Waves in a Simplified Model of Calcium Dynamics
Je-Chiang Tsai, National Chung Cheng University, Taiwan; Wenjun Zhang and Vivien Kirk, University of Auckland, New Zealand

Behaviour of Torsional Surface Wave in a Homogeneous Substratum over a Dissipative Half Space
Sumit K. Vishwakarma and Shishir Gupta, Indian School of Mines, India

Propagation Failure in Discrete Periodic Media
Chin-Chin Wu and Shih-Gang Liao, National Chung-Hsing University, Taiwan

Grain Boundaries in Swift-Hohenberg Equations
Qiliang Wu, University of Mississippi, USA; Arnd Scheel, University of Minnesota, USA

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Friday, June 15

**MS30**

Water Wave Bifurcations: Theory and Numerics - Part I of II
10:00 AM-12:30 PM
Room: Mary Gates Hall 231
For Part 2 see MS37

Water waves are well known to be a rich source of complex dynamics. This minisymposium brings together mathematicians, engineers, and oceanographers with a focus on the bifurcation structure of nonlinear water waves, specifically Euler’s Equations for surface water waves. Researchers will present theoretical and numerical techniques to investigate different aspects of this problem.

Organizer: Vishal Vasan
University of Washington, USA
Organizer: Katie Oliveras
Seattle University, USA

10:00-10:25 Traveling Water Waves in Three Dimensions
Vishal Vasan, University of Washington, USA; Katie Oliveras, Seattle University, USA

10:30-10:55 Breakdown of Self-similarity at the Crests of Large-amplitude Standing Water Waves
Jon Wilkening, University of California, Berkeley, USA

11:00-11:25 Small Divisors Made Visible
John Neu, University of California, Berkeley, USA

11:30-11:55 Global Continuation for Solitary Waves with Vorticity
Miles Wheeler, Brown University, USA

12:00-12:25 Variational Methods for Solitary Water Waves
Vera Mikyoung Hur, University of Illinois at Urbana-Champaign, USA

**IP3**

Fluid Ratchets and Biolocomotion
8:45 AM-9:30 AM
Room: Guggenheim Hall 220
Chair: Diane Henderson, Pennsylvania State University, USA

In this talk, I will discuss a few laboratory experiments where moving structures freely interact with the surrounding fluid. These moving structures, or boundaries, behave in asymmetric ways - either because of their anisotropic construction or by the spontaneous breaking of symmetry in their response to the fluid. When subjected to reciprocal forcing, their motion might be described as a ratcheting behavior. In one case, a fluid is forced through a corrugated channel that is under shaking. In another, a solid body hovers stably in an oscillatory airflow, mimicking a hovering insect. Lastly, a symmetric wing leaps into a forward flight when flapped up and down, following a symmetry breaking bifurcation. These phenomena can be viewed as the starting points for understanding the effect of increasing biological realism.

Jun Zhang
Courant Institute of Mathematical Sciences, New York University, USA

Coffee Break
9:30 AM-10:00 AM
Room: Mary Gates Hall 135
Friday, June 15

**MS31**

**Modeling and Dynamics of Mode-Locked Lasers - Part I of III**

10:00 AM-12:30 PM

*Room: Mary Gates Hall 287*

*For Part 2 see MS38*

Mode-locked lasers operation has experienced rapid progress in terms of characteristics such as pulse width, peak power, wavelength, phase and timing jitter, and stability. This three-part minisymposium will highlight recent advances in the modeling of mode-locked fiber lasers, and feature recent experimental developments with special emphasis on high-repetition-rate and carrier-envelope-phase-locked lasers with applications to supercontinuum generation and frequency combs. The exchange of ideas facilitated should further the goals of more accurate experimental characterization of these lasers, corresponding qualitative and quantitative improvements in the models, a complete understanding of the fundamental limits of operation, and new approaches to optimize their design.

**Organizer:** Omri Gat  
*Hebrew University of Jerusalem, Israel*

10:00-10:25 **Applications of Carrier-Envelope Phase-Locked Lasers**  
Nathan Newbury and Ian Coddington, National Institute of Standards and Technology, USA

10:30-10:55 **Ultralow Noise Mode-Locked Semiconductor Diode Based Fiber Lasers**  
Peter Delfyett, University of Central Florida, USA

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11:00-11:25 **Coherent Combs: Optimized Supercontinuum Generation for Carrier-envelope Phase-locked Lasers**  
*John Dudley, Universite de Franche-Comte, France*

11:30-11:55 **Carrier-envelope Phase Locking of Multi-pulse Lasers**  
*Mark Shtaif, Tel Aviv University, Israel; Curtis R. Menyuk, University of Maryland, Baltimore County, USA*

12:00-12:25 **Chip-Based Parametric Frequency Combs**  
*Alexander Gaeta, Cornell University, USA*

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**MS32**

**Recent Experiments in Fluids and Complex Systems - Part I of II**

10:00 AM-12:30 PM

*Room: Mary Gates Hall 228*

*For Part 2 see MS39*

In recent years, many mathematics departments across the country have initiated and maintained some element of experimental research. Such effort ensures the crucial connection between theory and experiment, allowing mathematical modeling and computational simulations to evolve side-by-side with experimental research. This minisymposium brings together a selection of new experimental results, with topics ranging from fluid dynamics to biological locomotion, geophysical fluids, and fluidic computation. The diverse group of experimentalists will share their findings in an informal setting, which encourages future collaborations and might inspire experiments that can be performed in primarily theoretical research groups.

**Organizer:** Jun Zhang  
*Courant Institute of Mathematical Sciences, New York University, USA*

10:00-10:25 **Applications of Carrier-Envelope Phase-Locked Lasers**  
*Nathan Newbury and Ian Coddington, National Institute of Standards and Technology, USA*

10:30-10:55 **Ultralow Noise Mode-Locked Semiconductor Diode Based Fiber Lasers**  
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11:00-11:25 **Coherent Combs: Optimized Supercontinuum Generation for Carrier-envelope Phase-locked Lasers**  
*John Dudley, Universite de Franche-Comte, France*

11:30-11:55 **Carrier-envelope Phase Locking of Multi-pulse Lasers**  
*Mark Shtaif, Tel Aviv University, Israel; Curtis R. Menyuk, University of Maryland, Baltimore County, USA*

12:00-12:25 **Chip-Based Parametric Frequency Combs**  
*Alexander Gaeta, Cornell University, USA*
Friday, June 15

**MS33**

Non-Self-Adjoint Spectral Problems - Part I of III

10:00 AM-12:30 PM

Room: Mary Gates Hall 241

For Part 2 see MS40

Non-self-adjoint spectral problems are ubiquitous in mathematics. They appear in hydrodynamic stability, stability of nonlinear waves, in inverse scattering, and also in a specialized field devoted to nonlinear eigenvalue problems. Despite the variety of applications and formalisms, the tools and methods used to study these problems are very similar. Nevertheless, it often takes years for important results to be rediscovered within a different mathematical field. The goal of this minisymposium is to bring together researchers across various mathematical communities to showcase the current state of the art in various fields and discuss particular recent advances in the study of non-self-adjoint spectral problems.

Organizer: Richard Kollar
Comenius University, Bratislava, Slovakia

Organizer: Peter D. Miller
University of Michigan, Ann Arbor, USA

10:00-10:25 (In)stability of Traveling Waves for the Sine-Gordon Equation: How Bands Balloon

Christopher Jones, University of North Carolina at Chapel Hill, USA & University of Warwick, United Kingdom; Robert Marangell, University of Sydney, Australia; Peter D. Miller, University of Michigan, Ann Arbor, USA; Ramon G. Plaza, National University of Mexico, Mexico

10:30-10:55 On the Spectral Stability of Nonlinear Waves in Continuum Mechanics

Ramon G. Plaza, National University of Mexico, Mexico

11:00-11:25 Breather Stability in Klein-Gordon Equations

Zoi Rapti, University of Illinois at Urbana-Champaign, USA

continued in next column

11:30-11:55 Stability of Periodic Traveling Waves in a KdV/Kuramoto-Sivashinsky Equation

Mat Johnson, University of Kansas, USA

12:00-12:25 A Numerical Study of Stability of Periodic Kuramoto-Sivashinsky Waves

Blake Barker, Indiana University, USA; Mathew Johnson, University of Kansas, USA; Pascal Noble, Universite Lyon, France; Miguel Rodrigues, University of Lyon 1, France; Kevin Zumbrun, Indiana University, USA

Friday, June 15

**MS34**

Geometric Methods for Advection-reaction-diffusion Systems - Part I of II

10:00 AM-12:30 PM

Room: Mary Gates Hall 234

For Part 2 see MS41

This minisymposium brings together researchers utilizing geometric methods to study the emergence and interaction of patterned states in advection-reaction-diffusion equations. Geometric methods, among them singular perturbation theory and spatial dynamics, have proven a reliable tool for the analysis of many different coherent structures. Fundamental properties of these solutions are also amenable to a geometric line of analysis, including their stability, bifurcation structure and the manner in which different patterns interact. Topics to be covered include traveling waves, interaction of localized structures, snaking and phase transitions. Presentations will span the theoretical, numerical, and applied points of view.

Organizer: Peter van Heijster
Boston University, USA

Organizer: Matt Holzer
University of Minnesota, USA

Organizer: Martin Wechselberger
University of Sydney, Australia

10:00-10:25 Interacting Invasion Fronts

Matt Holzer and Arnd Scheel, University of Minnesota, USA

10:30-10:55 Colliding Convectons

Edgar Knobloch, University of California, Berkeley, USA; Isabel Mercader, Oriol Batiste, and Arantxa Alonso, Universitat Politècnica de Catalunya, Spain

11:00-11:25 Localized Oscillations in a Nonvariational Swift - Hohenberg Equation

John Burke, Boston University, USA

11:30-11:55 Heterogeneity-induced Spot Dynamics in Dissipative Systems

Takashi Teramoto, Chitose Institute of Science and Technology, Japan; Yasumasa Nishiura, Hokkaido University, Japan

12:00-12:25 Gluing Localized Structures in Reaction-diffusion Systems

Scott McCalla, University of California, Los Angeles, USA
Friday, June 15

**MS35**

**Novel Symbolic Methods to Investigate (Integrable) Nonlinear Differential Equations**

10:00 AM-12:30 PM

*Room: Mary Gates Hall 254*

This minisymposium covers novel methods and symbolic software to compute symmetries, conservation laws, Lax pairs, and traveling wave solutions of nonlinear PDEs. The methods will be illustrated with PDEs that model wave propagation in fluids, gases, plasmas, optical fibers, and nonlinear media. An algorithm for the symbolic computation of perturbation-iteration solutions of nonlinear ODEs will also be presented and applied to a Bratu type initial value problem. A challenging application involves the computation of traveling wave solutions and conservation laws for complex mKdV equations, which requires solving large systems of differential-algebraic equations with CRACK (available within Reduce).

**Organizer:** Willy A. Hereman  
*Colorado School of Mines, USA*

**Organizer:** Thomas Wolf  
*Brock University, Canada*

10:00-10:25 **Symbolic Computation of Scaling Invariant Lax Pairs in Operator Form for Integrable Systems**  
Willy A. Hereman, Colorado School of Mines, USA; Mark Hickman, University of Canterbury, New Zealand; Unal Goktas, Turgut Ozal University, Ankara, Turkey; Jennifer Larue, Colorado School of Mines, USA

10:30-10:55 **Construction of Lax Pairs in Matrix Form and the Drinfel’d-Sokolov Method for Conservation Laws**  
Jacob Rezac and Willy A. Hereman, Colorado School of Mines, USA

11:00-11:25 **Traveling Waves and Conservation Laws for Complex mKdV-type Equations**  
Thomas Wolf, Stephen Anco, and Mohammad Mohiuddin, Brock University, Canada

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Friday, June 15

**MS36**

**Diffusion-Driven Pattern Formation in Biological Model Systems**

10:00 AM-12:30 PM

*Room: Mary Gates Hall 238*

This minisymposium deals with spatio-temporal pattern formation by a variety of diffusion-type mechanisms for five contemporary biological model systems: Namely, two ecological ones (Turing patterning of vegetation and of young mussel beds); two developmental biological ones (growth of filamentous protein bundles and row formation of Lepidopteran-wing scale cells); and a behavioral one (occurrence of urban criminal-activity hot spots). Here the primary emphasis is on the origin of the appropriate diffusion mechanism for each of these model systems (e.g., motility, dispersion, migration) and on the comparison of the resulting pattern with those produced from similar model systems as well as with relevant observational or experimental evidence.

**Organizer:** David J. Wollkind  
*Washington State University, USA*

**Organizer:** Bonni Kealy  
*Washington State University, USA*

10:00-10:25 **Symbolic Computation of Perturbation-Iteration Solutions for Nonlinear Differential Equations**  
Unal Goktas, Turgut Ozal University, Ankara, Turkey

12:00-12:25 **Symbolic Computation of Point Symmetries of an Infinite Family of Multi-point Correlation Equations in Turbulence Theory**  
Alexei F. Cheviakov, University of Saskatchewan, Canada

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**continued in next column**
Friday, June 15

**MS36**
Diffusion-Driven Pattern Formation in Biological Model Systems
10:00 AM-12:30 PM
continued

11:30-11:55 The Brownian Rachet Revisited: Multiple Filamentous Bundle Growth
Christine L. Cole and Hong Qian, University of Washington, USA

12:00-12:25 Mussel Pattern Formation Model Systems: Comparison of Turing Diffusive and Differential Flow Instabilities
David J. Wollkind and Richard Cangelosi, Washington State University, USA

Friday, June 15

**CP4**
Numerical Approaches
10:00 AM-12:00 PM
Room: Mary Gates Hall 242
Chair: Braxton Osting, University of California, Los Angeles, USA

10:00-10:15 A Coupled Boundary-Integral/Level-Set Method for Eigenvalue Optimization Problems
Braxton Osting, University of California, Los Angeles, USA; Chiu-Yen Kao, Ohio State University, USA

10:20-10:35 A Discontinuous-Galerkin Spectral Wave Model
Jessica D. Meixner, Casey Dietrich, and Clint Dawson, University of Texas at Austin, USA

10:40-10:55 Compatible Numerical Scheme for the Linear Inertial Waves
Shavarsh Nurijanyan, University of Twente, Netherlands

11:00-11:15 Local Absorbing Boundary Conditions for Nonlinear Wave Equation on Unbounded Domain
Hongwei Li, Hong Kong Baptist University, Hong Kong

11:20-11:35 Numerical Modeling of Internal Waves Generated by Turbulent Wakes Behind Towed Bodies in Stratified Media
Nikolay Moshkin, Suranaree University of Technology, Thailand; Gennadii Cherykh, Institute of Computational Technologies, Novosibirsk, Russia

Pablo U. Suarez, Delaware State University, USA

Friday, June 15

Lunch Break and Minitutorial
12:30 PM-2:30 PM
Bagged lunches will be available for purchase.

**MT1**
A New Transform Method for Boundary Value Problems
12:30 PM-2:30 PM
Room: Mary Gates Hall 241
I will outline a powerful integral transform method for the analysis and solution of boundary value problems for integrable PDEs. PDEs in this class include linear constant coefficient PDEs (heat, Stokes, Helmholtz equations) and nonlinear integrable PDEs. The method has its origin in the inverse scattering transform approach, and shares with it the basic tenet that the transform variable be complex. This is a crucial difference from the classical Fourier transform approaches, for which the spectral variable is real. I will illustrate the method for the linear case, and will indicate how the ideas generalizes to the integrable nonlinear case.

Organizer and Speaker:
Beatrice Pelloni, University of Reading, United Kingdom
Friday, June 15

**MS37**

**Water Wave Bifurcations: Theory and Numerics - Part II of II**

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

**Room:** Mary Gates Hall 231

For Part 1 see MS30

Water waves are well known to be a rich source of complex dynamics. This minisymposium brings together mathematicians, engineers, and oceanographers with a focus on the bifurcation structure of nonlinear water waves, specifically Euler’s Equations for surface water waves. Researchers will present theoretical and numerical techniques to investigate different aspects of this problem.

Organizer: Vishal Vasan
University of Washington, USA

Organizer: Katie Oliveras
Seattle University, USA

2:30-2:55 **Stability of Gravity Waves with Surface Tension**

*Olga Trichtchenko*, and *Bernard Deconinck*,
University of Washington, USA; *Katie Oliveras*, Seattle University, USA

3:00-3:25 **Wilton Ripples in Weakly Nonlinear Models**

*Benjamin Akers*, Air Force Institute of Technology, USA

3:30-3:55 **Time-periodic Vortex Sheets with Surface Tension**

*David Ambrose*, Drexel University, USA

4:00-4:25 **On the Existence and Stability of Solitary-wave Solutions to a Class of Evolution Equations of Whitham Type**

*Mark D. Groves*, Universität des Saarlandes, Germany

continued in next column
### MS39
**Recent Experiments in Fluids and Complex Systems - Part II of II**
2:30 PM-5:00 PM
Room: Mary Gates Hall 228

For Part 1 see MS32

In recent years, many mathematics departments across the country have initiated and maintained some element of experimental research. Such effort ensures the crucial connection between theory and experiment, allowing mathematical modeling and computational simulations to evolve side-by-side with experimental research. This minisymposium brings together a selection of new experimental results, with topics ranging from fluid dynamics to biological locomotion, geophysical fluids, and fluidic computation. The diverse group of experimentalists will share their findings in an informal setting, which encourages future collaborations and might inspire experiments that can be performed in primarily theoretical research groups.

**Organizer:** Jun Zhang  
Courant Institute of Mathematical Sciences, New York University, USA

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<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speakers</th>
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<tbody>
<tr>
<td>2:30-2:55</td>
<td>Swimming &amp; Propulsion in Complex Fluids</td>
<td>Paulo E. Arratia, University of Pennsylvania, USA</td>
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<tr>
<td>3:00-3:25</td>
<td>Fluidic Computation: Dynamics of Drops and Bubbles in Geometrical Fluid Networks</td>
<td>Manu Prakash, Stanford University, USA</td>
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<td>3:30-3:55</td>
<td>Microbial Flow Fields, Noise, and Cell-cell Interactions</td>
<td>Knut Drescher, Princeton University, USA</td>
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<td>4:00-4:25</td>
<td>Dynamics of Passive Flexible Wings</td>
<td>Daniel Tam and John Bush, Massachusetts Institute of Technology, USA</td>
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<tr>
<td>4:30-4:55</td>
<td>Title Not Available at Time of Publication</td>
<td>William Irvine, University of Chicago, USA</td>
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### MS40
**Non-Self-Adjoint Spectral Problems - Part II of III**
2:30 PM-5:00 PM
Room: Mary Gates Hall 241

For Part 1 see MS33  
For Part 3 see MS46

Non-self-adjoint spectral problems are ubiquitous in mathematics. They appear in hydrodynamic stability, stability of nonlinear waves, in inverse scattering, and also in a specialized field devoted to nonlinear eigenvalue problems. Despite the variety of applications and formalisms, the tools and methods used to study these problems are very similar. Nevertheless, it often takes years for important results to be rediscovered within a different mathematical field. The goal of this minisymposium is to bring together researchers across various mathematical communities to showcase the current state of the art in various fields and discuss particular recent advances in the study of non-self-adjoint spectral problems.

**Organizer:** Richard Kollar  
Comenius University, Bratislava, Slovakia

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<tr>
<td>2:30-2:55</td>
<td>Evans-Krein Function and Eigenvalue Counts</td>
<td>Richard Kollar, Comenius University, Bratislava, Slovakia; Peter D. Miller, University of Michigan, Ann Arbor, USA</td>
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<tr>
<td>3:00-3:25</td>
<td>Index Theorems for Quadratic Pencils with Applications</td>
<td>Todd Kapitula, Calvin College, USA</td>
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<tr>
<td>3:30-3:55</td>
<td>Two Parameter Methods for Symmetrizable Non-self-adjoint Eigenproblems</td>
<td>Paul Binding, University of Calgary, Canada</td>
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### MS41
**Geometric Methods for Advection-reaction-diffusion systems - Part II of II**
2:30 PM-4:30 PM
Room: Mary Gates Hall 234

For Part 1 see MS34

This minisymposium brings together researchers utilizing geometric methods to study the emergence and interaction of patterned states in advection-reaction-diffusion equations. Geometric methods, among them singular perturbation theory and spatial dynamics, have proven a reliable tool for the analysis of many different coherent structures. Fundamental properties of these solutions are also amenable to a geometric line of analysis, including their stability, bifurcation structure and the manner in which different patterns interact. Topics to be covered include traveling waves, interaction of localized structures, snaking and phase transitions. Presentations will span the theoretical, numerical, and applied points of view.

**Organizer:** Peter van Heijster  
Boston University, USA

**Organizer:** Matt Holzer  
University of Minnesota, USA

**Organizer:** Martin Wechselberger  
University of Sydney, Australia

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### MS42
**Advection-reaction-diffusion systems - Part II of II**
2:30 PM-4:30 PM
Room: Mary Gates Hall 234

For Part 1 see MS34

This minisymposium brings together researchers utilizing geometric methods to study the emergence and interaction of patterned states in advection-reaction-diffusion equations. Geometric methods, among them singular perturbation theory and spatial dynamics, have proven a reliable tool for the analysis of many different coherent structures. Fundamental properties of these solutions are also amenable to a geometric line of analysis, including their stability, bifurcation structure and the manner in which different patterns interact. Topics to be covered include traveling waves, interaction of localized structures, snaking and phase transitions. Presentations will span the theoretical, numerical, and applied points of view.

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### MS43
**Advection-reaction-diffusion systems - Part II of II**
2:30 PM-4:30 PM
Room: Mary Gates Hall 234

For Part 1 see MS34

This minisymposium brings together researchers utilizing geometric methods to study the emergence and interaction of patterned states in advection-reaction-diffusion equations. Geometric methods, among them singular perturbation theory and spatial dynamics, have proven a reliable tool for the analysis of many different coherent structures. Fundamental properties of these solutions are also amenable to a geometric line of analysis, including their stability, bifurcation structure and the manner in which different patterns interact. Topics to be covered include traveling waves, interaction of localized structures, snaking and phase transitions. Presentations will span the theoretical, numerical, and applied points of view.

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Friday, June 15

**CP5**

**Analytical Approaches**

*2:30 PM - 4:50 PM*

*Room: Mary Gates Hall 242*

*Chair: Nghiem Nguyen, Utah State University, USA*

2:30-2:45 *Stability of Solitons in PT-Symmetric Nonlinear Potentials*  
*Dmitry Zezyulin* and Fatkhulla Abdullaev, Universidade de Lisboa, Portugal;  
*Yaroslav Kartashov* and *Vladimir V. Konotop*, Universidade de Lisboa, Portugal

2:50-3:05 *Stability of Traveling Waves for Systems of Nonlinear Integral Recursions in Spatial Population Biology*  
*Judith R. Miller*, Georgetown University, USA;  
*Haihui Zeng*, Tsinghua University, China

3:10-3:25 *Interaction Properties Of Complex Solitons For The Hirota MKdV Equation*  
*Abdus Sattar Mia* and *Stephen Anco*, Brock University, Canada;  
*Mark Willoughby*, University of British Columbia, Canada

3:30-3:45 *Semicommutative Operators Associated with Dirac Operator and Darboux Transformation*  
*Mayumi Ohmiya* and *Masatomo Matsushima*, Doshisha University, Japan

3:50-4:05 *Fractional Partial Differential Equations Driven by Fractional Gaussian Noise*  
*Mahmoud M. El-Borai* and *Khairia E. El-Nadi*, Alexandria University, Egypt

*Yaobin Ou*, University of Electronic Science and Technology of China, China;  
*Peicheng Zhu*, University of Basque Country, Spain

4:30-4:45 *Stability of Solitary Waves for the Vector Nonlinear Schroedinger Equation in Higher-Order Sobolev Spaces*  
*Nghiem Nguyen*, Utah State University, USA

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**CP6**

**Water Waves**

*2:30 PM - 3:10 PM*

*Room: Mary Gates Hall 238*

*Chair: Juan Lopez, Arizona State University, USA*

2:30-2:45 *Have You Seen Our Water Waves?*  
*Philippe H. Trinh*, Princeton University, USA;  
*Jonathan Chapman*, University of Oxford, United Kingdom

2:50-3:05 *Inertial Waves in a Rapidly Rotating Cylinder*  
*Juan M. Lopez*, Arizona State University, USA

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**SIAG/NWCS Business Meeting**

*5:15 PM - 6:00 PM*

*Room: Guggenheim Hall 220*

*Complimentary wine and beer will be served.*
Friday, June 15

PD1
Forward Looking Panel Discussion
6:00 PM-7:00 PM
Room: Guggenheim Hall 220
Chair: Gino Biondini, State University of New York, Buffalo, USA
This will be an open-ended discussion about the future of research in nonlinear waves and coherent structures. What are the big open problems, interesting new research directions, opportunities for collaboration, etc? After brief introductory remarks from the panelists, the chair will open the floor for questions from the audience.

Panelists:
Jared Bronski
University of Illinois at Urbana-Champaign, USA
Shi Jin
Shanghai Jiao Tong University, China, and the University of Wisconsin-Madison, USA
Christopher Jones
University of North Carolina at Chapel Hill and University of Warwick, United Kingdom
Alan Newell
University of Arizona, USA
Jun Zhang
Department of Physics and Courant Institute of Mathematical Sciences, New York University, USA

Saturday, June 16

Registration
8:15 AM-10:30 AM
Room: Mary Gates Foyer

Closing Remarks
8:40 AM-8:45 AM
Room: Guggenheim Hall 220

IP4
Semiclassical Computation of High Frequency Waves in Heterogeneous Media
8:45 AM-9:30 AM
Room: Guggenheim Hall 220
Chair: David Cai, Shanghai Jiao Tong University, China and Courant Institute of Mathematical Sciences, New York University, USA
We introduce semiclassical Eulerian methods that are efficient in computing high frequency waves through heterogeneous media. The method is based on the classical Liouville equation in phase space, with discontinuous Hamiltonians due to the barriers or material interfaces. We provide physically relevant interface conditions consistent with the correct transmissions and reflections, and then build the interface conditions into the numerical fluxes. This method allows the resolution of high frequency waves without numerically resolving the small wave lengths, and capture the correct transmissions and reflections at the interface. This method can also be extended to deal with diffraction and quantum barriers. We will also discuss Eulerian Gaussian beam formulation which can compute caustics more accurately.
Shi Jin
Shanghai Jiao Tong University, China, and the University of Wisconsin-Madison, USA

Saturday, June 16

Coffee Break
9:30 AM-10:00 AM
Room: Mary Gates Hall 135
Saturday, June 16

**MS43**

**Tsunami Modeling – Recent Approaches to Some of the Most Challenging Aspects**

10:00 AM-12:30 PM

*Room: Mary Gates Hall 231*

This minisymposium will focus on some of the novel approaches being applied to the most challenging aspects of tsunami modeling, with an emphasis on tsunami forecasting and hazard assessment. We solicit papers related to advances in inversion techniques to constrain tsunami initial conditions, presentations addressing modeling aspects of land-slide generated tsunamis, nonlinear tsunami interaction with tidal fluctuations, the use of novel techniques to identify coherent structures in tsunami wave fields, and tsunami hazard assessment. The minisymposium is intended to provide an overview of the different approaches the scientific community is taking to address some of the most controversial topics in tsunami research.

**Organizer:** Diego Arcas  
*National Oceanic and Atmospheric Administration, USA*

10:00-10:25 **Detecting Standing Waves in Modeled Tsunami Wave-Fields**

_Elena Tolkova, JISAO / NOAA Center for Tsunami Research, USA; William L. Power, GNS Science, New Zealand*

10:30-10:55 **A Probabilistic Tsunami Hazard Assessment Study of Crescent City, Ca**

_Frank I. Gonzalez, Randall LeVeque, and Jonathan Varkovitzky, University of Washington, USA*

11:00-11:25 **Modeling Landslides and Landslide-generated Tsunamis**

_David George, USGS Cascade Volcano Observatory, USA*

11:30-11:55 **Three-dimensional Tsunami Runup with GPUSPH**

_Robert Weiss, Virginia Polytechnic Institute & State University, USA*

[continued in next column]

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12:00-12:25 **Simulation of Landslide-Generated Tsunamis with the Hysea Platform: the Lituya Bay 1958 Event**

_Jose Manuel Gonzalez-Vida, M. De La Asunció, and M. J. Castro, University of Malaga, Spain; E. D. Fernández-Nieto, University of Seville, Spain; J. Macías, University of Malaga, Spain; T. Morales, Universidad de Cordoba, Argentina; C. Parés and C. Sánchez-Linares, University of Malaga, Spain*

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Saturday, June 16

**MS44**

**Modeling and Dynamics of Mode-Locked Lasers - Part III of III**

10:00 AM-12:00 PM

*Room: Mary Gates Hall 287*

For Part 2 see MS38

Mode-locked lasers operation has experienced rapid progress in terms of characteristics such as pulse width, peak power, wavelength, phase and timing jitter, and stability. This three-part minisymposium will highlight recent advances in the modeling of mode-locked fiber lasers, and feature recent experimental developments with special emphasis on high-repetition-rate and carrier-envelope-phase-locked lasers with applications to supercontinuum generation and frequency combs. The exchange of ideas facilitated should further the goals of more accurate experimental characterization of these lasers, corresponding qualitative and quantitative improvements in the models, a complete understanding of the fundamental limits of operation, and new approaches to optimize their design.

**Organizer:** Omri Gat  
*Hebrew University of Jerusalem, Israel*

10:00-10:25 **The Sinusoidal Ginzburg-Landau Equation for High-Energy Mode-Locking**

_J. Nathan Kutz, University of Washington, USA*

10:30-10:55 **Laser Light Condensation Phenomena**

_Baruch Fischer, Technion Israel Institute of Technology, Israel*

11:00-11:25 **Phase-coherent Repetition Rate Multiplication of a Mode-Locked Laser by Injection Locking**

_David Kiepinski, Griffith University, Brisbane, Australia*

11:30-11:55 **Ultra-short Pulse Dynamics Towards Modeling Atto-second Physics**

_J. Nathan Kutz, University of Washington, USA*
Saturday, June 16

**MS45**

**Solitary Wave Applications**

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

**Room:** Mary Gates Hall 228

This minisymposium is mainly focused on solitary wave applications, but is not restricted to this class of waves. The applications include surface and internal solitary waves in the ocean, as well as waves in river locks and basins. This minisymposium will foster interaction among researchers with interest in applications in water waves, stimulating the exchange of ideas on reduced modeling, stability analysis and computations, among other techniques.

**Organizer:** Ricardo Barros

**IMPA, Brazil**

**Organizer:** Andre Nachbin

**Institute of Pure and Applied Mathematics, Brazil**

**10:00-10:25 Modeling Three Dimensional Gravity-capillary Waves in Deep Water**

Zhan Wang, University of Wisconsin, Madison, USA

**10:30-10:55 Stable Solitary Waves in Two-layer Flows**

Anakewit Boonkasame, University of Wisconsin, Madison, USA

**11:00-11:25 Exact Solution of Linear Wave Motion Over Periodic Topography of Large Amplitude and Arbitrary Shape**

Jie Yu, North Carolina State University, USA

**11:30-11:55 Two-dimensional Nonlinear Internal Waves**

Ricardo Barros, IMPA, Brazil; Arnaud Goullet, New Jersey Institute of Technology, USA; Wooyoung Choi, New Jersey Institute of Technology, USA

**12:00-12:25 Strongly Nonlinear Interaction of Crossing Large Amplitude Internal Waves**

Arnaud Goullet, New Jersey Institute of Technology, USA

**Saturday, June 16**

**MS46**

**Non-Self-Adjoint Spectral Problems - Part III of III**

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

**Room:** Mary Gates Hall 241

For Part 2 see MS40

Non-self-adjoint spectral problems are ubiquitous in mathematics. They appear in hydrodynamic stability, stability of nonlinear waves, in inverse scattering, and also in a specialized field devoted to nonlinear eigenvalue problems. Despite the variety of applications and formalisms, the tools and methods used to study these problems are very similar. Nevertheless, it often takes years for important results to be rediscovered within a different mathematical field. The goal of this minisymposium is to bring together researchers across various mathematical communities to showcase the current state of the art in various fields and discuss particular recent advances in the study of non-self-adjoint spectral problems.

**Organizer:** Richard Kollár

**Comenius University, Bratislava, Slovakia**

**Organizer:** Peter D. Miller

**University of Michigan, Ann Arbor, USA**

**10:00-10:25 Asymptotic Stability of Semi-Strong Interactions in Weakly Damped Systems: Attack of the Point Spectrum**

Keith Promislov, Michigan State University, USA; Tom Bellsky, Arizona State University, USA

**10:30-10:55 Stability and Bifurcations of Rotating Vortices in the Gross-Pitaevskii Equation with a Harmonic Potential**

Dmitry Pelinovsky, McMaster University, Canada

**11:00-11:25 Modulational Stability for a General Class of Dispersive Waves**

Jared Bronski, University of Illinois at Urbana-Champaign, USA; Vera Hur and Nanjundamurthy Venkataramu, University of Illinois, USA


David P. Nicholls, University of Illinois, Chicago, USA

**Saturday, June 16**

**MS47**

**Stability of Localised Structures and the Possible Scenarios after Destabilisation**

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

**Room:** Mary Gates Hall 254

Localized structures are ubiquitous in nature, occurring in a multitude of systems in chemistry, physics and biology. The stability properties of these structures describe their persistence in the presence of perturbations. In case a structure is unstable, an important question that arises is how it develops after this destabilisation. This minisymposium will highlight recent developments regarding the possible scenarios after destabilisation takes place. Also, bifurcations that arise will be considered. Each of the talks in this minisymposium takes a different approach to the problem.

**Organizer:** Vivi Rottschäfer

**Leiden University, Netherlands**

**10:00-10:25 Blowup of Solitary Waves of the Generalised Korteweg-de Vries Equation**

Vivi Rottschäfer, Leiden University, Netherlands

**10:30-10:55 Pulse Stability in a Gierer-Meinhardt System with a Slow Nonlinearity**

Frits Veerman, Leiden University, Netherlands

**11:00-11:25 Bifurcations of Front Solutions for a Three-component Reaction Diffusion System**

Martina Chirilus-Bruckner, Boston University, USA

**11:30-11:55 Destabilizing of Stationary Spots in a Planar Three-component FitzHugh-Nagumo Equation**

Peter van Heijster, and Bjorn Sandstede, Brown University, USA

**12:00-12:25 Localized Spot Patterns for the Brusselator Model on the Surface of the Sphere**

Ignacio Rozada, University of British Columbia, Canada
Saturday, June 16

**MS48**

**Effects of Degeneracy in Dispersive LDE and PDE**

10:00 AM-12:00 PM

**Room:** Mary Gates Hall 238

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, more problematically, degenerate. Examples can be found in the study of sedimentation, magma dynamics, numerical analysis, elasticity and, most commonly, granular media. In this minisymposium we bring together researchers to discuss the theory and applications of degenerate dispersive equation in both the discrete (e.g., Hertzian chains) and continuous (e.g., Rosenau-Hyman compacton equations) settings.

Organizer: J. Douglas Wright  
*Drexel University, USA*

Organizer: David Ambrose  
*Drexel University, USA*

**10:00-10:25** Ill-Posedness Due to Degenerate Dispersion  
*Dennis Guang Yang, Drexel University, USA*

**10:30-10:55** Topological and Spectral Features of Nonlinear Wave Motion in Periodic Chains  
*Stefano Gonella and Ganesh Ramakrishnan, University of Minnesota, USA*

**11:00-11:25** Ill-posedness of a Linearized Compacton Equation  
*Daniel Jordan, Drexel University, USA*

**11:30-11:55** Dark Breathers in Granular Crystals  
*Christopher Chong, University of Massachusetts, Amherst, USA*

Saturday, June 16

**MS49**

**Social Modeling, Game Theory, and the Continuum**

10:00 AM-12:00 PM

**Room:** Mary Gates Hall 234

Social systems are comprised of many distinct actors behaving in a fairly unpredictable fashion. The underlying dynamics are usually best understood in terms of random walks, game theory, and other probabilistic, discrete models. However, these systems may at times be well approximated by continuous limits. For example, partial differential equations (PDEs) have been used to understand traffic flow, crime, and disease spread. In this minisymposium, we will explore many of the recently developed techniques being applied to the study of social phenomena.

Organizer: Scott McCalla  
*University of California, Los Angeles, USA*

Organizer: Martin Short  
*University of California, Los Angeles, USA*

**10:00-10:25** Social Interactions on Networks: Self-excitation, Third-party inhibition, and the Link with Game Theory  
*Martin Short, University of California, Los Angeles, USA*

**10:30-10:55** An Adversarial Evolutionary Game for Criminal Behavior  
*Maria Rita D’Orsogna, California State University, Northridge, USA*

**11:00-11:25** Threshold Models and Abrupt Change in Social Norms in Complex Social Networks  
*Andrei Akhmetzhanov, McMaster University, Canada; Lee Worden, University of California, Berkeley, USA; Jonathan Dushoff, McMaster University, Canada*

**11:30-11:55** Towards Simulating Societies: Simple Models with Complex Dynamics  
*Dirk Helbing, ETH Zürich, Switzerland*
Abstracts are printed as submitted by the author.
IP0
Martin D. Kruskal Lecture - Pattern Quarks and Leptons

Martin Kruskal was one of a kind, a pure scientist who followed roads less travelled by and whose new discoveries made all the difference in so many ways. Once a question intrigued and gripped him, he never let go. The discovery of solitons and the uncovering of whole new classes of integrable systems have led to major advances in the worlds of Hamiltonian partial differential equations, in exactly integrable models in statistical physics, and to the fascinating and more recently discovered properties of random matrices. And there may be yet many more windfalls to come.

In this Kruskal lecture, I will give a brief overview of some of the early days, of how Martin took on the Fermi, Pasta, Ulam conundrum which had defied explanation by some of the best minds of the time and, with the help of colleagues Zabusky, Miura, Gardner and Greene, turned it into one of the most important discoveries of the last half of the 20th century. As for my own contributions to today’s lecture, I have no illusions that the story I shall tell will have any of the same impact but hope that it will reflect some of the same pioneering spirit that Martin displayed in pursuing the unconventional. What I plan to do is sketch some ideas I have been mulling in connection with the Standard Model and show that quark and lepton like objects with different masses and all the invariants associated with spin (+/-1/2) and charge (+/-1/3,+/-2/3,+/-1) can occur naturally as the result of phase transitions in far from equilibrium, pattern forming systems. In contrast to the Standard Model, they arise without any a priori introduction of the SU(2) and SU(3) symmetries into the governing free energy. The invariants can each be connected to the condensation of mean and Gaussian curvature of the constant phase surfaces along certain defect cores.

Alan Newell
University of Arizona
anewell@math.arizona.edu

IP1
Stability and Synchrony in the Kuramoto Model

The phenomenon of the synchronization of weakly coupled oscillators is a old one, first been described by Huygens in his ‘Horoloquium Oscilatorium.’ Some other examples from science and engineering include the cardiac pacemaker, the instability in the Millenium Bridge, and the synchronous flashing of fireflies. A canonical model is the Kuramoto model

$$\frac{d\theta_i}{dt} = \omega_i + \gamma \sum_j \sin(\theta_j - \theta_i)$$

We describe the fully synchronized states of this model together with the dimensions of their unstable manifolds. Along the way we will encounter a high dimensional polytope, a Coxeter group, and a curious combinatorial identity. This leads to a proof of the existence of a phase transition in the case where the frequencies are chosen from an iid Gaussian distribution.

Jared Bronski
University of Illinois Urbana-Champaign
Department of Mathematics
jared@math.uiuc.edu

IP2
Kramers’ Law - Validity and Generalizations

Consider the overdamped motion of a Brownian particle in a multiwell potential. Kramers’ Law describes the small-noise limit of the particle’s mean transition time between local minima. We will outline several approaches to the problem of describing such noise-induced transitions, discuss recent generalizations of Kramers’ Law to potentials with nonquadratic saddles and stochastic partial differential equations as well as the limitations of the law such as the cycling effect. Generalizations and refined results on cycling are joint work with Nils Berghlund (Orleans).

Barbara Gentz
University of Bielefeld
Bielefeld, Germany
gentz@math.uni-bielefeld.de

IP3
Fluid Ratchets and Biolocomotion

In this talk, I will discuss a few laboratory experiments where moving structures freely interact with the surrounding fluid. These moving structures, or boundaries, behave in asymmetric ways - either because of their anisotropic construction or by the spontaneous breaking of symmetry in their response to the fluid. When subjected to reciprocal forcing, their motion might be described as a ratcheting behavior. In one case, a fluid is forced through a corrugated channel that is under shaking. In another, a solid body hovers stably in an oscillatory airflow, mimicking a hovering insect. Lastly, a symmetric wing leaps into a forward flight when flapped up and down, following a symmetry breaking bifurcation. These phenomena can be viewed as the starting points for understanding the effect of increasing biological realism.

Jun Zhang
Courant Institute
jun@CIMS.nyu.edu

IP4
Semiclassical Computation of High Frequency Waves in Heterogeneous Media

We introduce semiclassical Eulerian methods that are efficient in computing high frequency waves through heterogeneous media. The method is based on the classical Liouville equation in phase space, with discontinuous Hamiltonians due to the barriers or material interfaces. We provide physically relevant interface conditions consistent with the correct transmissions and reflections, and then build the interface conditions into the numerical fluxes. This method allows the resolution of high frequency waves without numerically resolving the small wave lengths, and capture the correct transmissions and reflections at the interface. This method can also be extended to deal with diffraction and quantum barriers. We will also discuss Eulerian Gaussian beam formulation which can compute caustics more accurately.

Shi Jin
Shanghai Jiao Tong University, China and the University of Wisconsin-Madison
jin@math.wisc.edu
CP1
Disordered Beam Propagation in a Focusing Nonlinear Medium

We calculate both analytically and numerically the probability distribution for the intensity of a disordered optical beam propagating in a focusing media within the framework of the 1+1 Nonlinear Schrodinger equation. The far field intensity pattern is formed by a random number of interfering optical solitons with random parameters. We obtain the statistics of these parameters (and hence the field intensity distribution) via the disordered Zakharov-Shabat eigenvalue problem.

Stanislav A. Derevyanko
Aston University, Birmingham, United Kingdom
s.derevyanko@aston.ac.uk

CP1
Nonlinear Dynamics and Normal Forms in the Time Dependent Nonlinear Schrodinger/Gross Pitaevskii Equations

We consider the nonlinear dynamics of solutions to the NLS/GP equations with potential supporting three or four linear bound states. We compute and prove the existence of previously-unreported periodic orbits and routes to chaos in an ODE model problem. Normal forms are computed using Lie transforms, and the finite-dimensional solutions are shown to be shadowed by solutions to NLS/GP. Comparisons are made to NLS trimer and tetramer problems.

Roy Goodman
New Jersey Institute of Technology
roy.goodman@njit.edu

CP1
Adaptive Construction of Surrogates for Parameter Inference in Nonlinear Wave Equations

Surrogate models are often used to accelerate Bayesian inference in computationally intensive systems. Yet the construction of globally accurate surrogates can be prohibitive and in a sense unnecessary, as the posterior distribution typically concentrates on a small fraction of the prior support. We present a new adaptive approach that uses stochastic optimization (the cross-entropy method) to construct surrogates that are accurate over the support of the posterior distribution. The method is then applied to parameter inference in nonlinear wave equations.

Jinglai Li
Massachusetts Institute of Technology
jinglai@mit.edu

CP1
Crosstalk Dynamics of Optical Solitons in Broadband Optical Waveguide Systems

We investigate the dynamics of soliton parameters in broadband optical waveguide systems, induced by energy and momentum exchange (crosstalk) in pulse collisions. Using single-collision analysis along with collision rate calculations, we show that dynamics of soliton amplitudes in N-channel waveguide systems can be described by N-dimensional Lotka-Volterra models. By finding the equilibrium states of these models and analyzing their stability, we are able to obtain ways for achieving stable transmission with equal nonzero amplitudes in all channels.

Avner Peleg
State University of New York at Buffalo
apeleg@buffalo.edu

Quan Nguyen
Vietnam National University at Ho Chi Minh City
nmquanta@gmail.com

Yeojin Chung
Southern Methodist University
ychung@mail.smu.edu

CP1
Nonlinear Refraction Versus Solitonic Fission in Optical Lattices

Within the nonlinear Shrödinger equation we consider the soliton beam passing through the periodic or random optical lattice. We address how the lattice shape and geometry affect the refraction of the soliton. It is shown that the soliton-wave interference can play an important role in determining the refraction type. Then we demonstrate that the interplay between the beam refraction and reflection can bring about the splitting of a single coherent state into two ones.

Yaroslav Prylepskiy
Nonlinearity and Complexity Research Group
Aston University
Y.PRYLEPSKIY1@aston.ac.uk

Stanislav A. Derevyanko
Aston University, Birmingham, United Kingdom
s.derevyanko@aston.ac.uk

Sergei Gredeskul
Department of Physics
Ben Gurion University of Negev, Beer Sheva, Israel
sergey.gredeskul@gmail.com

CP1
Chaos Control in a Transmission Line Model

We present a model of an electromagnetic system consisting of a transmission line oscillator coupled to terminating nonlinear electrical boundary components. Using the method of characteristics spatio-temporal chaos is observed. A chaos control method is presented, that uses small parameter perturbations to adjust the resistance at one of the boundaries. The control is based on a Poincare section technique that does not require a fully developed simulation in time.

Ioana A. Triandaf
Naval Research Laboratory
Plasma Physics Division
triandaf@russel.nrl.navy.mil

CP1
Josephson Oscillations in Dissipative Optical Systems

We have studied Josephson oscillations in an active fully optical system with defocusing Kerr nonlinearity. The considered system consists of a lasing cavity emitting photons into a waveguiding structure having strong but narrow
variation of the refractive index. It has been shown that Josephson-like oscillations appear in the system when the flux through the barrier exceeds the threshold value. Different regimes of the oscillations have been studied thoroughly.

Alexey Yulin
Centro de Física Teórica e Computacional, Universidade de Lisboa
ayulin@cii.fc.ul.pt

Vladimir V. Konotop
Universidade de Lisboa, Portugal
konotop@cii.fc.ul.pt

CP2
Envelope Quasi-Solitons in Dissipative Systems with Cross-Diffusion

We consider two-component nonlinear dissipative spatially extended systems of reaction-cross-diffusion type. Previously, such systems were shown to support ‘quasi-soliton’ pulses, which have fixed stable structure but can reflect from boundaries and penetrate each other. Presently we demonstrate a different type of quasi-solitons, with a phenomenology resembling that of the envelope solitons in Nonlinear Schroedinger equation: spatiotemporal oscillations with a smooth envelope, with the velocity of the oscillations different from the velocity of the envelope.

Vadim N. Biktashev
Dept of Mathematical Sciences
University of Liverpool
V.N.Biktashev@liverpool.ac.uk

Mikhail Tsyganov
Institute of Theoretical and Experimental Biophysics
Pushchino Research Centre, Russian Academy of Science
miktsyg@rambler.ru

CP2
Evolution of Spiral and Scroll Waves of Excitation in a Mathematical Model of Ischaemic Border Zone

We use asymptotics based on response functions to predict dynamics of re-entrant excitation waves in a moving boundary of a recovering ischaemic cardiac tissue, due to gradients of cell excitability and cell-to-cell coupling, and heterogeneity of individual cells. In three spatial dimensions, theory predicts conditions for scrolls to escape into the recovered tissue, where they are either collapse or develop fibrillation-like state, depending on filament tension. We confirm these predictions by direct simulations.

Irina Biktasheva
University of Liverpool
ivb@liv.ac.uk

Vadim Biktashev
University of Liverpool
Department of Mathematical Sciences
vnb@liv.ac.uk

Narine Sarvazyan
George Washington University
phynas@gmail.com

CP2
Perturbed Magnetic Droplet Solitons

The Landau-Lifshitz equation with uniaxial anisotropy in one and two spatial dimensions admits a two-parameter family of solitary wave solutions called magnetic droplets. Physically relevant perturbations due to weak damping, a slowly varying external magnetic field, and spin torque are considered in the context of soliton perturbation theory. A dynamical systems analysis of the modulation system and direct numerical simulations of the governing PDE demonstrate that physical droplets can be nucleated, accelerated, and controlled.

Mark A. Hoefer
North Carolina State University
mahoefer@ncsu.edu

Matteo Sommacal
Northumbria University, Newcastle, UK
matteo.sommacal@gmail.com

CP2
Amplification of Synaptic Inputs by Dendritic Spines

Dendritic spines are the site of contact for the majority of excitatory synapses in the mammalian brain, and as a result are the first step in the signaling between dendritic inputs and neuronal actional potential output. In this combined theoretical and experimental study, it is demonstrated that spines provide a uniformly high impedance compartment across the dendritic arbor that amplifies local depolarization. This spine amplification increases nonlinear voltage-dependent conductance activation and promotes electrical interaction among coactive inputs, enhancing neuronal response.

William Kath
Northwestern University
Engineering Sciences and Applied Mathematics
kath@northwestern.edu

CP2
Impact of Randomness on Solitary Wave Propagation in Granular Systems

We study the effect of randomness on the propagation of solitary waves in granular media composed of spherical particles. Randomness in grain properties and size is considered. The study shows the presence of two regimes of decay in peak force and kinetic energy, and a gradual transfer from potential to kinetic energy of the system. In 2D square packed systems, we also investigate the anisotropy of the randomness induced decay.

Mohith Manjunath, Amnaya P. Awasthi, PHILIPPE H. Geubelle
University of Illinois at Urbana-Champaign
manjuna2@illinois.edu, amnaya@illinois.edu, geubelle@illinois.edu

CP2
Target Detection in Non-Uniform Slowness Fields Using Time-Reversed Nonlinear Solitary Waves

Radar problems include propagation of short waves with large scale realistic effects, such as refraction by complex
slowness fields. Our approach is based on dissipative nonlinear solitary waves centered on wave centroid surfaces, which propagate on characteristics. This approach allows efficient propagation both forward in time, and backward in time (for target and source detection). Unlike ray tracing in complex domains, there do not appear to be any multiparticle chaotic effects.

Subhashini Chitta
UTSI
subha@flowanalysis.com

John Steinhoff
University of Tennessee Space Inst.
Goethert Pkwy
jsteinho@utsi.edu

CP3
Solitons in Dipolar Bose-Einstein Condensates with Trap and Barrier Potential

The propagation of solitons in dipolar BEC in trap potential with a barrier potential is investigated. The regimes of soliton transmission, reflection and splitting in dependence on the ratio between the local and dipolar nonlocal interactions are analyzed analytically and numerically. The conditions for a fusion of splitted solitons are found. In addition the delocalization transition governed by strength of the nonlocal dipolar interaction is presented.

Fatkhulla Abdullaev
Uzbek Academy of Sciences
Uzbekistan
fatkh@physic.uzsci.net

Valeriy Brazhnyi
Faculdade de Ciencias, Universidade de Porto, Portugal
brazhnyy@gmail.com

CP3
Steady Structures and Rheology of Active Complex Fluids

Bacteria suspensions, active gels and assemblies of motors and filaments are active complex fluids which differ from their passive counterparts in that particles absorb energy and generate motion. They are interesting from a more fundamental perspective as their dynamic phenomenons are both physically fascinating and potentially of great biological significance. In this talk, I will present a continuum model for such systems. Hydrodynamics, stability and rheology will be discussed.

Zhenlu Cui
Department of Mathematics and Computer Science
Fayetteville State University
zcui@uncfsu.edu

CP3
Propagation of a Constant Velocity Fission Wave

The mechanism for the formation of a fission wave is simple: a large cylinder of fertile material is subjected to a neutron source at one end. The neutrons transmute material downstream and produce plutonium, which itself undergoes fission and produces neutrons. If the conditions are right, a self-sustaining reaction wave would form. Numerical studies have shown that waves of this type are possible. We have now derived an exact solution for the propagation velocity of these waves and show that these waves fall into a class of traveling wave phenomena encountered in other systems. The results are confirmed numerically.

Mark Deinert
The University of Texas at Austin
mdeinert@mail.utexas.edu

CP3
Rogue Waves in Plasmas

Rogue waves (freak waves) are space- and time-localized extreme events, recently arising as a paradigm in various fields. The occurrence of such excitations in charged matter (plasmas) is investigated, from first principles. A multiscale technique for the derivation of a nonlinear Schrödinger (NLS) model for plasma waves is adopted, and the result is analyzed, in terms on intrinsic plasma parameters. A set of exact solutions of the NLS equation has been argued to provide a plausible model for rogue waves in the ocean. These include rational solutions, the Ma breather, the Akhmediev breather and the Peregrine soliton. We review the properties of these solutions, and investigate their occurrence and relevance in plasmas. Our research covers both electrostatic and electromagnetic modes, and provides a self-contained framework for future investigations of the dependence of such modes on intrinsic plasma properties.

Ioannis Kourakis
Queen’s University Belfast
Centre for Plasma Physics (CPP)
IoannisKourakisSci@gmail.com

Vikrant Saxena, Sharmin Sultana
Centre for Plasma Physics (CPP)
Queen’s University Belfast, UK
v.saxena@qub.ac.uk, ssultana02@qub.ac.uk

Jafar Borhanian
Department of Physics, Faculty of Science
University of Mohaghegh Ardabili, Iran
borhanian.sci@gmail.com

CP3
A Characterization of Dispersive Shock Waves in the Magma Equation

In 1-D and under reasonable simplifications and assumptions, the full governing equations of subterranean vertical magma transport reduce to a degenerate nonlinear dispersive partial differential equation for the porosity \( \phi \) of the form: 
\[
\phi_t + (\phi^n)_z - (\phi^m (\phi^{-m} \phi_t)_z) = 0,
\]
where \( n, m \) are physically derived parameters. For an arbitrary initial step and physical parameter values, the properties of magma dispersive shock waves (speeds, leading amplitude) are constructed asymptotically. Results are corroborated by comparisons with an accurate pseudospectral numerical code for long-time integration.

Nicholas Lowman
Department of Mathematics
North Carolina State University
nklowman@ncsu.edu

Mark A. Hoefer
North Carolina State University
mahoefer@ncsu.edu
CP3
On Seismic Wave in Magnetoelastic Low Velocity Crustal Layer

We aim to study the propagation pattern of shear type waves or G-type waves in magnetoelastic crustal layer which is highly anisotropic in nature. The layer has been taken self-reinforced which is lying over a heterogeneous semi-infinite medium. B. Gutenberg investigated this special class of waves in low velocity zone between the Earth crust and upper mantle. Along with the period equation Condition for a large amount of energy to be confined near the surface has been obtained. We observed that a portion of energy can flow along the interface for horizontally polarized shear waves with group velocity lower than the shear wave velocity in the upper mantle. Effects of reinforcement, magnetoelastic coupling parameter and inhomogeneity on the phase velocity of shear wave have been obtained separately and depicted by means of graphs. The surface plot of group velocity is drawn for wave number and depth parameter.

Sanjeev A. Sahu
Indian School of Mines, Dhanbad, India
ism.sanjeev@gmail.com

Amarees Chattopadhyay
Indian School of Mines, Dhanbad-826004, India
amarees.c@gmail.com

CP3
Radiation by Superfluid Vortices in the Lighthill Regime

On hydrodynamic length scales, quantized superfluid vortices are commonly modeled as a system of coreless point vortices in 2D, or vortex filaments in 3D, whose motion is determined classically through the Biot-Savart law. Yet it is well known that a microscopic model that can describe the motion of quantized vortices exists in the form of Gross-Pitaevskii (GP) equation which captures the structure of the vortices within the healing layers. This model has been successfully tested in predicting vortex dynamics in Bose-Einstein condensates. In this work, we consider the asymptotic regimes under which point vortex dynamics is recovered from the GP equation. We show that the regime under which this occurs corresponds to the so-called Lighthill regime for evaluating the acoustic radiation in a classical fluid. We, therefore, formulate a corresponding theory of radiation that specifies the sound emitted by the motion of quantized vortices in the limit of low Mach number or equivalently large inter-vortex separation. We demonstrate our theoretical predictions with numerical simulations of the GP equation.

Hayder Salman
University of East Anglia
H.Salman@uea.ac.uk

CP3
Local Absorbing Boundary Conditions for Nonlinear Wave Equation on Unbounded Domain

The numerical solution of nonlinear wave equation on unbounded spatial domain is considered. The artificial boundary method is introduced to reduce the nonlinear problem on unbounded spatial domain to an initial boundary value problem on a bounded domain. Using unified approach, which is based on operator splitting method, we construct the efficient nonlinear local absorbing boundary conditions for the nonlinear wave equation, and give the stability analysis of the resulting boundary conditions. Finally, several numerical examples are given to demonstrate the effectiveness of our method. (This talk is based on the joint work with Prof. Xiaonan Wu and Dr. Jiwei Zhang.)

Hongwei Li
Hong Kong Baptist University
hhwqust@gmail.com

CP4
A Discontinuous-Galerkin Spectral Wave Model

Spectral wind-wave models have successfully been used in the ocean for many different applications. We implement a new numerical modeling approach using a discontinuous-Galerkin method in both geographic and spectral space. This allows us to have an unstructured-triangulation in geographic space and a structured spectral space with the ability to use higher-order approximations when needed. We verify and validate the model on test bed cases and achieve higher accuracy when using higher-orders in spectral space.

Jessica D. Meixner
Institute for Computational Engineering and Sciences
University of Texas at Austin
jmeixner@ices.utexas.edu

Casey Dietrich
Institute for Computational Engineering and Sciences
University of Texas at Austin
casey.dietrich@gmail.com

Clint Dawson
Institute for Computational Engineering and Sciences
University of Texas at Austin
clint@ices.utexas.edu

CP4
Numerical Modeling of Internal Waves Generated by Turbulent Wakes Behind Towed Bodies in Stratified Media

Numerical models of an internal waves generated by wakes in stratified fluids have been presented. The calculation results show that the wake’s excess momentum of order of from the total momentum in drag wake has a weak influence on the internal waves and on the turbulent energy decay. As in the case of a homogeneous fluid, a more significant influence of total excess momentum on the axis value of the defect of the longitudinal velocity component was observed.

Nikolay Moshkin
Surameree University of Technology
nikolay.moshkin@gmail.com, moshkin@math.sut.ac.th

Gennadii Chernykh
Institute of Computational Technologies, Russia
chernykh@ict.nsc.ru

CP4
Compatible Numerical Scheme for the Linear Inertial Waves

A compatible numerical model based on a discontinuous
Galarkin FEM discretisation that preserves the Hamiltonian structure of the linear rotating Euler equations is presented. Thus, it conserves the important properties of the PDEs. Dirac theory is applied to derive the incompressible limit of the compressible Euler or acoustic equations which are used as a starting point in the numerical discretisation. Several test cases will be presented to assess the quality of the numerical model.

Shavarsh Nurijanyan
University of Twente
s.nurijanyan@utwente.nl

CP4
A Coupled Boundary-Integral/Level-Set Method for Eigenvalue Optimization Problems

Eigenvalues are ubiquitous in describing wave phenomena and thus constrained eigenvalue optimization problems naturally arise when one seeks to control such phenomena. We study a new, coupled boundary-integral/level-set computational method which demonstrates greater accuracy over previously used methods while maintaining the capability of handling topological changes. Results for several shape and structural eigenvalue optimization problems are discussed, including Krein’s problem on finding the density distribution of a membrane which extremizes the k-th Dirichlet-Laplacian eigenvalue.

Braxton Osting
Columbia University
braxton@math.columbia.edu

Chiu-Yen Kao
The Ohio State University
kao@math.ohio-state.edu; Ckao@claremontmckenna.edu

CP4
Numerical Solutions of Two-Way Propagation of Nonlinear Dispersive Waves Using Radial Basis Functions

In this talk we obtain the solutions of a Boussinesq system for two-way propagation of nonlinear dispersive waves by using the meshless method based on collocation with radial basis functions. The system of nonlinear partial differential equation is discretized in space by using these functions. The discretization leads to a system of coupled non-linear ordinary differential equations. These equations are then solve by using an Adam-Bashforth scheme. The method is tested for exact solitary solutions to these equations. In addition four conserved quantities are calculated numerically. The numerical results show excellent agreement with the analytical solution and calculated conserved quantities.

Pablo U. Suarez
Delaware State University
psuarez@desu.edu

CP5
Fractional Partial Differential Equations Driven by Fractional Gaussian Noise

Some fraction parabolic partial differential equations driven by fraction Gaussian noise are considered. Initial-value problems for these equations are studied. Some properties of the solutions are given under suitable conditions and with Hurst parameter less than half.

Mahmoud M. El-Borai
Prof.of Math. Dep. of Mathematics Faculty of Science
Alexandria University Alexandria Egypt
melmorai@yahoo.com

Khairia E. El-Nadi
Prof of Mathematical Statistics Dep. of Math. Faculty of Science Alexandria University Alexandria Egypt
Khairia.analmaid@hotmail.com

CP5
Semicommutative Operators Associated with Dirac Operator and Darboux Transformation

We clarify a class of differential operators which are semicommutative with the 1-dimensional Dirac operator $P$ defined by $P = i\sigma_2(d/dx) + \sigma_1 v(x)$, where $\sigma_1, \sigma_2$ are Pauli matrices. Such results are already known for the 1-dimensional Schrodinger operator $H = -(d/dx)^2 + u(x)$. We extend these results to the Dirac operator $P$. As a result, we obtain the interesting formula related to the Darboux transformation. Moreover, a new algebraic scheme for solving the eigenvalue problem associated with the Dirac operator $P$ is obtained.

Mayumi Ohmiya, Masatomo Matsushima
Doshisha University
momiyayamail.doshisha.ac.jp,
dtj0905@mail4.doshisha.ac.jp

CP5
Interaction Properties Of Complex Solitons For The Hirota mKdV Equation

The Hirota-mKdV equation has general complex 1-soliton solutions that describe solitary waves with time-varying phase. We use Hirota’s bilinear formalism to find the general complex 2-soliton solution. This solution describes a collision in which a fast soliton over takes a slow soliton. By an asymptotic analysis we show that collisions produce a shift in both the position and the phase of the fast and slow solitary waves. We observe several types of interactions during the collision depending on the speeds and phase angles of the fast and slow solitons.

Abdus Sattar Mia
Brock University, Canada
sattarju@yahoo.com

Stephen Anco
Department of Mathematics
Brock University
sanco@brocku.ca

Mark Willoughby
University of British Columbia, Canada
markw@math.ubc.ca

CP5
Stability of Solitary Waves for the Vector Nonlinear Schroedinger Equation in Higher-Order Sobolev Spaces

In this talk, a sharp form of orbital stability for the
Schrödinger system, also known as the vector NLS,
\[
\frac{\partial}{\partial t} u_j + \frac{\partial^2}{\partial xx} u_j + 2 \sum_{i=1}^{m} |u_i|^2 u_j = 0,
\]
where \(u_j\) are complex-valued functions of \((x,t) \in \mathbb{R}^2, j = 1, 2, \ldots, m\), is presented in \(L^2\)-based Sobolev classes of arbitrarily high order. The result means practically that not only does the bulk of what emanates from the perturbed solitary wave stay close in shape and propagation and phase speed to the original solitary wave, but emerging residual oscillations must also be very small and not only in the energy norm.

Ngheim Nguyen
Utah State University
ngheim.nguyen@usu.edu

CP5
Vanishing Viscosity Limit For An Optimal Control Problem of Scalar Conservation Laws in the Presence of Shocks

To reduce the computational cost for optimal control problems of the inviscid Burgers equation in the presence of shocks, Zuazua et al. have developed an alternating descent method, and revisited it by the method of vanishing viscosity. In the present work, we study theoretically the vanishing viscosity limit of such a problem for 1-D scalar conservation laws with a single shock or finite many non-interacting shocks. We employ the method of matched asymptotic expansions to construct approximate solutions to the smoothed nonlinear, the linearized and the dual problems, respectively. It is then proved that the approximate solutions satisfy the corresponding equations asymptotically, and converge to the solutions of the corresponding inviscid problems with certain rates. The discontinuities of coefficients in these equations, especially the inverse dual equation, lead to difficulties when taking the limits. The equations for the shock and the variation of its position are also derived.

Yaobin Ou
University of Electronic Science and Technology of China
ou@uestc.edu.cn

Peicheng Zhu
University of Basque Country, Spain
pczhu@hotmail.com

CP6
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.

Juan M. Lopez
Arizona State University
School of Mathematical and Statistical Sciences
lopez@math.asu.edu

Judith R. Miller
Georgetown University
Department of Mathematics
jrm32@georgetown.edu

Huuihui Zeng
Tsinghua University
hz55@georgetown.edu

Yaroslav Kartashov
Institut de Ciències Fotòniques
Barcelona, Spain
yaroslav.kartashov@icfo.es

Vladimir V. Konotop
Centro de Física Teórica e Computacional
Universidade de Lisboa
konotop@cii.fc.ul.pt

Dmitry Zezyulin
Centro de Física Teórica e Computacional
Universidade de Lisboa
zezyulin@cii.fc.ul.pt

Fatkhulla Abdullaev
Centro de Física Teórica e Computacional,
Faculdade de Ciencias, Universidade de Lisboa
fatkhulla@yahoo.com

Yaroslav Kartashov
Institut de Ciències Fotòniques
Barcelona, Spain
yaroslav.kartashov@icfo.es

Vladimir V. Konotop
Universidade de Lisboa,
Portugal
konotop@cii.fc.ul.pt

Stability of Solitons in PT-Symmetric Nonlinear Potentials

We consider stationary localized modes \(q(\xi, \eta) = e^{i\beta \xi} w(\eta)\) of the nonlinear Schrödinger equation \(iq_t = -q_{\eta\eta} - |1 + iW(\eta)|q^q q\), where \(W(\eta)\) is an odd function. We report continuous families of the nonlinear modes, which can be parametrized by the propagation constant \(b\). We investigate linear stability of the modes computing the Evans function of the corresponding linear operator. Our analysis shows that for \(\sigma \ll 1\) the localized modes for \(W(\eta) = \sigma \sin \eta\) and \(W(\eta) = \sigma \tanh \eta\) become unstable when \(b\) is below a certain threshold value. However, this threshold disappears for \(W(\eta) = \sigma \eta\).

Dmitry Zezyulin
Centro de Física Teórica e Computacional
Universidade de Lisboa
zezyulin@cii.fc.ul.pt

Fatkhulla Abdullaev
Centro de Física Teórica e Computacional,
Faculdade de Ciencias, Universidade de Lisboa
fatkhulla@yahoo.com

Yaroslav Kartashov
Institut de Ciències Fotòniques
Barcelona, Spain
yaroslav.kartashov@icfo.es

Vladimir V. Konotop
Universidade de Lisboa,
Portugal
konotop@cii.fc.ul.pt

Stability of Traveling Waves for Systems of Nonlinear Integral Recursions in Spatial Population Biology

We use spectral methods to prove a general stability theorem for traveling wave solutions to the systems of integro-difference equations arising in spatial population biology. We show that non-minimum-speed waves are exponentially asymptotically stable to small perturbations in appropriately weighted \(L^\infty\) spaces, under assumptions which apply to examples including a Laplace or Gaussian dispersal kernel a monotone (or non-monotone) growth function behaving qualitatively like the Beverton-Holt function (or Ricker function with overcompensation), and a constant probability \(p \in [0, 1)\) (or \(p = 0\)) of remaining sedentary for a single population; as well as to a system of two populations exhibiting non-cooperation (in particular, Hassell and Comins’ model) with \(p = 0\) and Laplace or Gaussian dispersal kernels which can be different for the two populations.

Judith R. Miller
Georgetown University
Department of Mathematics
jrm32@georgetown.edu

Huuihui Zeng
Tsinghua University
hz55@georgetown.edu

CP5
Stability of Solitons in PT-Symmetric Nonlinear Potentials

We consider stationary localized modes \(q(\xi, \eta) = e^{i\beta \xi} w(\eta)\) of the nonlinear Schrödinger equation \(iq_t = -q_{\eta\eta} - |1 + iW(\eta)|q^q q\), where \(W(\eta)\) is an odd function. We report continuous families of the nonlinear modes, which can be parametrized by the propagation constant \(b\). We investigate linear stability of the modes computing the Evans function of the corresponding linear operator. Our analysis shows that for \(\sigma \ll 1\) the localized modes for \(W(\eta) = \sigma \sin \eta\) and \(W(\eta) = \sigma \tanh \eta\) become unstable when \(b\) is below a certain threshold value. However, this threshold disappears for \(W(\eta) = \sigma \eta\).

Dmitry Zezyulin
Centro de Física Teórica e Computacional
Universidade de Lisboa
zezyulin@cii.fc.ul.pt

Fatkhulla Abdullaev
Centro de Física Teórica e Computacional,
Faculdade de Ciencias, Universidade de Lisboa
fatkhulla@yahoo.com

Yaroslav Kartashov
Institut de Ciències Fotòniques
Barcelona, Spain
yaroslav.kartashov@icfo.es

Vladimir V. Konotop
Universidade de Lisboa,
Portugal
konotop@cii.fc.ul.pt
CP6
Have You Seen Our Water Waves?

When water flows past an obstruction such as a ship or a step in a channel, waves are often produced behind or ahead of the disturbance. Recently, techniques in exponential asymptotics have allowed us to predict the theoretical existence of new classes of gravity-capillary waves. These waves have never been seen before—in nature or in the digital world. Do they truly exist? Come and decide for yourselves!

Philippe H. Trinh
Program in Applied and Computational Mathematics
Princeton University
ptrinh@princeton.edu

Jonathan Chapman
Mathematical Institute
University of Oxford
chapman@maths.ox.ac.uk

MS1
On the Stability of Some Periodic Waves Arising in the Kawahara Equation

The Kawahara equation is a weakly nonlinear model for capillarity-gravity water waves which admits solitary-wave type solutions. For each solitary wave, there exists a family of periodic waves which is asymptotic to the solitary wave when the period tends to infinity. In this talk we study the stability of these periodic waves.

Frederic Chardard
ENS Lyon
France
frederic.chardard@ens-lyon.fr

MS1
Viscosity-induced Instability for Euler and Averaged Euler Equations in a Circular Domain

We consider the infinite time behaviour of a family of stationary solutions of Euler’s equation, which can be described as constrained minima of energy on level sets of enstrophy. For free boundary conditions, this family shadows solutions of 2D Navier-Stokes equations. However, under the no-slip and under the Navier-slip boundary conditions and in a circular domain, the infinite time Navier-Stokes evolution orbit of a starting point on the family of constrained minima has order 1 distance to the family, however small the viscosity is. The viscosity in the Navier-Stokes equations is a singular perturbation for Euler’s equation and one might suspect that the viscosity-induced instability is related to this singularity. This is not the case: we show that the same phenomenon can be observed for the averaged Euler equations and second grade fluids with Navier-slip boundary conditions in a circular domain.

Gianne Derks
University of Surrey
Department of Mathematics
G.Derks@surrey.ac.uk

MS1
Relaxed Variational Principle for Water Wave Modeling

A new method, based on a relaxed variational principle, is presented for deriving approximate equations for water waves. It is particularly suitable for the construction of approximations. The advantages will be illustrated on numerous examples in shallow and deep water. Using carefully chosen constraints in various combinations, several model equations are derived, some being well-known, others being new. These models are studied analytically, exact traveling wave solutions are constructed, and the Hamiltonian structure unveiled.

Denys Dutykh
Université de Savoie-CNRS
denys.dutykh@univ-savoie.fr

MS1
A New Model of Roll Waves: Comparison with Brock’s Experiments

We derive a mathematical model of shear flows for shallow water flowing down an inclined plane. Periodic solutions to this model describing roll waves were obtained. The solutions are in good agreement with the experimental profiles of roll waves measured in Brock’s experiments. In particular, the height of the vertical front of the waves, the shock thickness and the wave amplitude are well captured by the model.

Sergey Gavrilyuk
University Aix-Marseille, UMR CNRS 6595 IUSTI
sergey.gavrilyuk@polytech.univ-mrs.fr

Gaël Richard
Aix-Marseille University
Marseille, France
gael.richard@polytech.univ-mrs.fr

MS1
Geometric Integration for Damped Hamiltonian PDEs

A general framework for constructing numerical methods that exactly preserve dissipative properties of damped Hamiltonian PDEs is presented in detail. These methods are compared analytically and numerically to standard conservative methods, which generally destroy the actual dissipation rates but do retain other advantages in the dissipative context. Semi-linear wave equations and nonlinear Schrodinger equations, both with added dissipation, are used as examples to demonstrate the long-time behavior of the numerical solutions.

Brian E. Moore
University of Central Florida
USA
bmoore@math.ucf.edu

MS2
Asymptotic Methods for Multi-scale Solitary Waves in Periodic Media

Gap solitary waves in a one-dimensional periodic lattice are studied for the case that the solitary wave spans a large number of lattice periods. In this limit, an analytical theory utilizing exponential asymptotics is presented, that reveals the bifurcation of a countable set of solitary-wave families. The stability properties of certain of these
solution families are also discussed, and the analytical predictions are compared against numerical results.

Triantaphyllos R. Akylas
Mechanical Engineering
M.I.T.
trakylas@MIT.EDU

MS2
Light Localization in Specially Designed Photonic Lattices

Optically-induced photonic lattices have served as an ideal platform for exploring discretizing light behaviors. In this talk, we provide a brief overview of our recent work on spatial control of light propagation in specially-designed photonic lattices established by the optical induction technique. In particular, we present our experimental results on controlled Bragg reflection and anomalous diffraction/refraction in ionic-type lattices, surface localization and edge states in photonic superlattices and honey-comb lattices, image transmission through 3D photonic lattices with engineered coupling, along with recent results on disordered lattices.

Zhigang Chen
San Francisco State University
zchen@stars.sfsu.edu

MS2
Multivortex Discrete Solitons in Coupled Nonlinear Waveguides and Photonic Lattices

We introduce discrete solitons with globally linked multiple vortices in a ring of nonlinear oscillators coupled to a central site. The system is described by the nonlinear Schrödinger equation and supports a variety of multivortex solitons with complex phase structures. We study these multivortex solitons and determine their stability analytically and numerically. We show that these solitons may be perturbed to produce stable ‘breather’ states with novel vortex dynamics, such as coordinated charge flipping and vortex spiraling.

Daniel Leykam
The Australian National University
u4515870@anu.edu.au

Anton S. Desyatnikov
Australian National University
asd124@physics.anu.edu.au

MS2
Nonlinear Modes in Finite-dimensional PT-symmetric Systems

Linear parity-time symmetric lattices below the point of the symmetry breaking posses pure real spectra. Such models can be reduced by a unitary transformation either to Hamiltonian systems or to dissipative systems not obeying the symmetry but still having pure real spectrum (termed pseudo-Hermitian). This property, valid for linear systems does not hold when the nonlinearity is taken into account. While Hamiltonian and PT symmetric lattices allow for existence of the continuous branches of the solutions, the pseudo-Hermitian models allow for existence of only a discrete set of the localized modes. The stability properties of localized modes in theses three types of the lattices also show significant differences. Comparative analysis of the properties of the nonlinear modes will be reported.

Vladimir V. Konotop
Universidade de Lisboa,
Portugal
konotop@cii.fc.ul.pt

Dmitry Zezyulin
Centro de Física Teórica e Computacional
Universidade de Lisboa
zezyulin@cii.fc.ul.pt

MS2
Stability Analysis of Solitons in PT Symmetric Lattices

Parity-time (PT)-symmetric potentials are complex potentials in the Schrödinger equation whose real and imaginary parts are symmetric and anti-symmetric respectively. PT potentials have the surprising property that even though they contain gain and loss in the potential, the linear spectrum of the Schrödinger operator can still possess all-real eigenvalues, thus allowing solitons to exist over a continuous range of propagation constants in the presence of nonlinear effects. In this talk, we investigate the stability of solitons in PT-symmetric periodic potentials (optical lattices) in both one and two dimensional systems. First we show analytically that when the strength of the gain-loss component rises above a certain threshold (phase-transition point), an infinite number of Bloch bands turn complex simultaneously. Second, we show numerically that stable families of solitons exist in PT lattices. In one dimension the fundamental solitons in the semi-infinite gap remain stable up until the phase transition point, however, in higher bandgaps and higher dimensions we find that increasing the gain-loss component has a destabilizing effect on soliton propagation. The parameter range of stable solitons shrinks as new regions of instability appear. In fact, in two dimensions stable solitons only exist for a bounded set of propagation constants in the semi-infinite gap, even for very small imaginary components. Thirdly, we investigate the evolution of unstable solitons under perturbation.

Sean Nixon
Department of Mathematics and Statistics
University of Vermont
sean.nixon@uvm.edu

Lijuan Ge
University of Vermont
lijuan.ge@uvm.edu

Jianke Yang
Department of Mathematics and Statistics
University of Vermont
jxyang@uvm.edu

MS3
Space-time Statistics of Capillary Wave Turbulence

We report on the experimental observation of space-time resolved pure capillary wave turbulence. The wave system is studied experimentally with two immiscible fluids of almost equal densities where capillary surface waves are excited by a low-frequency random forcing. The probability density function of the wave amplitude shows a quasi-Gaussian behavior and the power spectral density is shows
a power-law behavior in frequency with a slope of $\alpha = -3.0$ and in wave number with a slope $\beta = -4.0$. These results agree with theoretical predictions on Kolmogorov-Zakharov spectra and wave amplitude statistics for capillary waves.

Claudio Falcon
Departamento de Física
Universidad de Chile, Santiago, Chile
cfalcon@ing.uchile.cl

Andrés Franco
Departamento de Física, Universidad de Chile
andresfrancog54@gmail.com

MS3
Non Linear Dynamics of Flexural Wave Turbulence

We report a direct measurement of the nonlinear timescale $T_{NL}$ related to energy transfer in wave turbulence of flexion waves on a thin elastic plate. This time scale is extracted from the space-time measurement of the deformation of the plate by studying the temporal dynamics of wavelet coefficients of the turbulent field. We discuss the separation between the relevant time scales which is at the core of the weak turbulence theory.

Benjamin Miquel
Laboratoire de Physique Statistique
École Normale Supérieure/CNRS/Univ. P. & M. Curie
miquel@lps.ens.fr

Nicolas Mordant
Laboratoire des Ecoulements Géophysiques et Industriels
Univ. J. Fourier / CNRS / Grenoble INP/IUF
nicolas.mordant@ujf-grenoble.fr

MS3
Wave Turbulence: A Story Far From Over

When is the wave turbulence closure valid and when is it not? When are the Kolmogorov-Zakharov solutions valid and when are they not? This talk will discuss these challenges.

Alan Newell
University of Arizona
Department of Mathematics
anewell@math.arizona.edu

MS3
Can One Hear a Kolmogorov Spectra? Wave Turbulence on a Thin Elastic Plate

We study the long-time evolution of waves of a thin elastic plate in the limit of small deformation so that modes of oscillations interact weakly. According to the theory of weak turbulence (successfully applied in the past to plasma, optics, and hydrodynamic waves), this nonlinear wave system evolves at long times with a slow transfer of energy from one mode to another. A kinetic equation for the spectral transfer in terms of the second order moment is derived. We have shown that such a theory describes the approach to an equilibrium wave spectrum and represents also an energy cascade, often called the Kolmogorov-Zakharov spectrum. We have realized numerical simulations that confirmed this scenario moreover under some conditions a kind of "inverse cascade" may be observed.

Sergio Rica
Universidad Adolfo Ibanez
Facultad de Ingeniería y Ciencias
sergio.rica@uai.cl

MS4
A Fast and Accurate Absorbing Boundary Condition for the Helmholtz Equation

Constructing accurate absorbing or radiating boundary conditions for the Helmholtz equation in heterogeneous media is difficult and costly. We propose here a general framework for rapidly constructing and evaluating ABC’s by compressing the Dirichlet to Neumann map, using matrix probing. This fits the DtN map to a few well-chosen matrices and thus has greater potential for accuracy and flexibility in variable media. This can be used as precomputation for solving the wave equation multiple times.

Rosalie Belanger-Rioux
Massachusetts Institute of Technology
Department of Mathematics
robr@math.mit.edu, laurent@math.mit.edu

MS4
Dispersionless Time-domain PDE Solvers for High-frequency Problems and General Spatial Geometries

We present fast time-domain high-order PDE solvers that address some of the main difficulties associated with simulation of realistic scientific and engineering systems under high-frequency and nonlinearity. Based on a novel Fourier-Continuation (FC) method for the resolution of the Gibbs phenomenon, these solvers can deliver unconditional stability, essentially dispersionless numerics, high order accuracy and perfect parallel scaling for challenging linear and nonlinear problems involving high frequencies and general...
Spatial domains.

Oscar P. Bruno
California Institute of Technology obruno@caltech.edu

MS4
The Gaussian Beam Method for the Dirac Equation in the Semi-classical Regime

The Dirac equation is an important model in relativistic quantum mechanics. In the semi-classical regime $\epsilon \ll 1$, the best existing method time splitting spectral method [Z.Y. Huang, S. Jin, P.A. Markowich, C. Sparber and C.X. Zheng, A time-splitting spectral scheme for the Maxwell-Dirac system, Journal of Computational Physics, 208(2005), pp. 761-789.] require the mesh size to be $O(\epsilon)$, which makes the direct simulation extremely expensive.

In this paper, we present the Gaussian beam method for such problem. With the help of suitable space decomposition technique, the Gaussian beams can be independently evolved and summed to constructed the solution of the Dirac equation efficiently and accurately. Moreover, the proposed Eulerian Gaussian beam keep the advantages of the Hessians matrices by using level set functions’ derivatives. Finally we test our method by several numerical examples.

Zhongyi Huang
Tsinghua University, China zhuy@math.tsinghua.edu.cn

Hao Wu
Department of Mathematical Sciences
Tsinghua University hwu@tsinghua.edu.cn

Shi Jin
Shanghai Jiao Tong University, China and the University of Wisconsin-Madison jin@math.wisc.edu

Dongsheng Yin
Department of Mathematical Sciences
Tsinghua University dyin@math.tsinghua.edu.cn

MS4
Frozen Gaussian Approximation for High Frequency Wave Propagation

We propose the frozen Gaussian approximation for the computation of high frequency wave propagation. It provides a highly efficient computational tool based on the asymptotic analysis on phase plane. Compared to geometric optics, it provides a valid solution around caustics. Compared to the Gaussian beam method, it overcomes the drawback of beam spreading. We will present several numerical examples as well as preliminary applications in geology to verify the performance of the method.

Xu Yang
Courant Institute of Mathematical Sciences
New York University xuyang@cims.nyu.edu

MS4
Global Geometrical Optics Method

We develop a novel approach, named global geometrical optics method, for the numerical solution to wave equations in the high-frequency regime. The initial Cauchy data is assumed in the WKB form. The basic idea of this approach is to reformulating the governing equation in a moving frame, and deriving a globally valid WKB-type function with the aid of partition of unity. This WKB-type function is merely defined on the Lagrangian manifold induced by the Hamiltonian flow, and from which, the wave solution can be retrieved by a coherent state integral within first order accuracy. The merit of the proposed approach is manyfold. First, compared with the thawed Gaussian beam approaches, it presents an approximate wave solution with first order asymptotic accuracy uniformly, even around caustics. Second, compared with the canonical operator method, this approach does not require any a priori knowledge about the structure of Lagrangian manifold. Third, compared with the frozen Gaussian beam approaches such as Herman-Kluk semi-classical propagator method, the proposed approach involves an integral on a manifold of much lower dimension. We report numerical tests on both Schrödinger and Helmholtz equations.

Chunxiang Zheng
Tsinghua University czheng@math.tsinghua.edu.cn

MS5
Coherent Structures, Transport and Invariant Manifolds in Unsteady Flows

Lagrangian coherent structures (LCSs) are ubiquitous in fluid flows at all scales, and are strongly influential in determining scalar transport in unsteady flows. This talk will outline theoretical, diagnostic and numerical issues related to characterizing both LCSs and consequent transport, and introduce the areas to be examined in more detail by the minisymposium speakers. Invariant manifolds (as defining LCSs) will also be addressed under general time-dependence, along with explicit examples in 2D and 3D.

Sanjeeva Balasuriya
Connecticut College sanjeeva.balasuriya@conncoll.edu

MS5
Data Mining Remotely Sensed Image Sequences and Transport Analysis of Spatiotemporal Dynamical Systems

Scientific fields, such as climatology, and oceanography produce large data sets from spatiotemporal video data as remotely sensed hyperspectral satellite data. Variational methods for image processing suited to complex dynamical systems typical of fluid dynamics, and the tools of dynamical systems such as transfer operators have not been brought to bear on data inferred directly from movies. We discuss modeling and transport analysis for remotely sensed ecological systems such as biological products including algae blooms.

Erik Bollt
Clarkson University bolltem@clarkson.edu
MS5  
**A Global Theory of Transport Barriers**

We introduce a unified approach to locating transport barriers in general two-dimensional, non-autonomous dynamical systems. Using tools from continuum mechanics and differential geometry, we show that transport barriers can be obtained as minimal geodesics under an appropriate Riemannian metric induced by the Cauchy-Green strain tensor field. As such, transport barriers can be directly computed (as opposed to just indirectly observed) as solutions of classic Lagrangian or Hamiltonian equations of motion. We show how these results reveal previously undetected transport barriers with mathematical rigour in systems ranging from aperiodically forced models to satellite observations of the ocean.

George Haller  
McGill University  
Department of Mechanical Engineering  
george.haller@mcgill.ca

MS5  
**Lagrangian Coherent Structures and Eddy Diffusion**

Lagrangian coherent structures (LCS) are known as the templates for chaotic mixing in nonlinear aperiodic dynamical systems, such as geophysical flows. In recent years, theoretical developments on the deterministic LCS have allowed the objective identification of mixing barriers and enhancers in geophysical flows. Stochastic transport associated with LCS, on the other hand, is less studied, partly due to the inherent scale separation between coherent structures and molecular diffusion. However, sub-grid scale uncertainty of geophysical flows cannot be neglected when one tries to quantify diffusive transport of substances. In this talk we will discuss some recent efforts on quantifying diffusive mixing associated with the LCS. In particular, eddy diffusivity tensors associated with advection-diffusion are constructed based on Lagrangian measures from LCS. Some archetypal examples will be discussed.

Wenbo Tang  
Arizona State University  
weno.tang@asu.edu

MS5  
**Topological Detection of Coherent Structures**

In many applications, particularly in geophysics, we often have fluid trajectory data from floats, but little or no information about the underlying velocity field. The standard techniques for finding transport barriers, based for example on finite-time Lyapunov exponents, are then inapplicable. However, if there are invariant regions in the flow this will be reflected by a ‘bunching up’ of trajectories. We show that this can be detected by tools from topology.

Jean-Luc Thiffeault  
Dept. of Mathematics  
University of Wisconsin - Madison  
jeanluc@math.wisc.edu

Michael Allshouse  
Dept. of Mechanical Engineering  
Massachusetts Institute of Technology  
mra23@mit.edu

MS6  
**Aggregation and Growth of Clusters During a Thermal Quench**

The creation of clusters in the context of a quench is studied. Two model problems are considered. First, under-saturated vapor is cooled at a prescribed rate. After a time-lag, the nucleation rate rises exponentially. A short burst of nucleation decreases the super-saturation and ends the creation of new clusters. We find asymptotic description of the resulting distribution of cluster sizes and the total amount of clusters generated. The time-lag is related to the quench rate by an implicit formula. Next, the flow of a warm gas onto a cold wall is examined. The creation and growth of clusters in the boundary layer next to the cold wall are the natural extension of the first problem. We find the total amount of clusters generated, the concentration of monomers in the gas and the size of the clusters as functions of the distance to the wall. We also determine the distance from the wall at which the nucleation happens, and the length of the “growth layer”, during which the growth of clusters brings the gas to equilibrium.

Yossi Farjoun  
Massachusetts Institute of Technology  
yfarjoun@ing.uc3m.es

MS6  
**Branching Processes and Coagulation: Asymptotic Self-similarity for a Generalized Smoluchowski Equation**

We investigate the asymptotic self-similarity of solutions to a new coagulation model arising in the theory of branching processes. Informally, the equation models a coalescence process with multiple interactions, where the size and number of interacting clusters are sampled randomly. Under a suitable regular variation assumption on the sampling measure, we characterize all nontrivial scaling limits of solutions. Our results include, as a special case, the scaling limits for the classical kernel $K(x,y) = 2$, previously studied by Menon and Pego, among others.

Nicholas Leger, Gautam Iyer, Robert Pego  
Carnegie Mellon University  
nleger@andrew.cmu.edu, gautam@math.cmu.edu, rpego@cmu.edu

MS6  
**Coagulation Dynamics Driven by Uniform Growth**

We describe progress toward classifying initial data that lead to self-similar growth in a coagulation process that involves uniform growth of domains in one dimension. This is joint work with Jack Carr (Heriot-Watt University).

Robert Pego  
Carnegie Mellon University  
rpego@cmu.edu

MS6  
**Symmetry-breaking in Crystallisation**

A significant stage in the formation of living systems was the transition from a symmetric chemistry involving mirror-symmetric chiral species into a system involving just one-handedness. We derive and analyse systems of coupled coagulation-fragmentation equations which describe crystal-grinding and exhibit symmetry-breaking, with the
aim of elucidating those mechanisms responsible for the bifurcation. The talk will cover and hopefully extend work published in *Orig Life & Evol Biospheres*, 41, 133–173. (2011).

Jonathan Wattis
School of Mathematical Sciences
University of Nottingham
Jonathan.Wattis@nottingham.ac.uk

MS6
Coagulation Equations with Nonhomogeneous Kernels

Coagulation processes are to be found everywhere in nature: from the coalescence of aerosols and polymers on the microscopic scale to the coalescence of water to form hail stones on the macroscopic scale to the formation of planets and stars on the cosmic scale. The earliest equation to model coagulation processes was derived by Smoluchowski in 1916. The Smoluchowski coagulation equation, along with various extensions and generalizations, have been widely studied. While the general coagulation process, namely the coming together of small particle clusters to form larger particle clusters, are common, the physics governing the coalescence of aerosols and the formation of planets is undoubtedly very different. These physical differences are manifested in the particular coagulation kernel that is assumed in the coagulation equation. In their quest to understand symmetry in coagulation processes, mathematicians and physicists have attempted to find self-similar solutions to Smoluchowski’s coagulation equation. When looking for self-similar solutions, it is natural to consider homogeneous coagulation kernels. In this talk I hope to show that some interesting phenomena can be found by considering non-homogeneous coagulation kernels.

Henry van Roessel
University of Alberta
henry.vanroessel@ualberta.ca

MS7
Spectral Stability of Shock Layers in Compressible Fluid Flow

We review the recent developments in our group’s study on the stability theory for high Mach number viscous shock layers in multi-D compressible fluid flow, as well as detonation waves in reactive flow. In particular, we discuss the substantial challenges observed when computing the Evans function in Eulerian coordinates at high frequencies. We then show how we can overcome these problems by transforming into canonical and somewhat general coordinates. The results are surprising.

Jeffrey Humpherys
Brigham Young University
jeffh@math.byu.edu

Blake Barker
Indiana University
BYU
bbbarker@gmail.com

Gregory Lyng
Department of Mathematics
University of Wyoming
glyng@uwyo.edu

Kevin Zumbrun
Indiana University
USA
kzumbrun@indiana.edu

MS7
Horseshoes and Hand Grenades: On Standing Waves in a Gross-Pitaevskii Equation

We look for standing waves in NLS-type equations with a periodic or N-well potential – a popular model for optical propagation and Bose-Einstein condensation. We simplify a shooting strategy by detailing the construction of a horseshoe map. The geometry of the horseshoe varies with the nonlinearity (attracting, repulsive or competing), yet in each case we instantly identify a huge assortment of standing waves. Finally, we discuss how to quickly recover stability information encoded within the horseshoe.

Russell Jackson
U. S. Naval Academy, Mathematics Department
Annapolis MD 21402-5002
rkjackson@usna.edu

MS7
Stability of Solitons Traveling on Vortex Filaments

In this work, we develop a general framework for studying the linear stability of soliton solutions of the vortex filament equation (VFE), based on the correspondence between the VFE and the nonlinear Schrodinger (NLS) equation provided by the Hasimoto map. In particular, we show that the one-soliton solutions of the VFE are linearly stable, which is in agreement with the numerical results obtained by Kida in 1982. Furthermore, it is shown that a similar result hold for the planar VFE. In the planar case, the filament equation is related to the integrable modified Korteweg-de-Vries Equation.

Stephane Lafortune, Annalisa M. Calini
College of Charleston
Department of Mathematics
lafortunes@cofc.edu, calinia@cofc.edu

MS7
Nonlinear Eigenvalues, Keldysh’s Theorem, and the Evans Function

We consider eigenvalue problems for nonlinear Fredholm operator pencils, and show how to count and localize them using contour integrals and an abstract Keldysh Theorem. For pencils of differential operators, this allows one to count the number of zeros of the Evans function by solving boundary value problems on finite intervals.

Yuri Latushkin
Department of Mathematics
University of Missouri-Columbia
yuri@math.missouri.edu

Wolf-Jürgen Beyn, Jens Rottmann-Matthes
University of Bielefeld
beyn@math.uni-bielefeld.de, jrottman@math.uni-bielefeld.de

MS7
Fredholm Determinants and Computing the Sta-
bility of Travelling Waves

We are concerned with the computation of spectra of linear operators; in particular with large scale and multi-dimensional non-selfadjoint spectral problems. We present a general class of multi-dimensional shooting algorithms for computing on Grassmann manifolds, developed by Ledoux, Malham and Thümmler and Ledoux, Malham, Niesen and Thümmler, for this purpose. Further, Ledoux, Malham and Marangell have revealed there is a relation between singularities in the Grassmann to chart Riccati flow and isolated eigenvalues. This is because the Riccati flow generalizes the Weyl–Titchmarsh function in one spatial dimension. In more than one spatial dimension, in terms of the infinite dimensional Fredholm (or Sato) Grassmanian, the operator Riccati flow represents the Dirichlet to Neumann map. If there is time we will try to relate this work to that of Deng and Jones on the Morse/Maslov index for selfadjoint multi-dimensional elliptic operators and also consider connections to Fredholm determinants by Bornemann and Karambal.

Simon Malham
Heriot-Watt University
simonm@ma.hw.ac.uk

MS8
Loops of Energy Bands for Bloch Waves in Optical Lattices

We will consider Stationary Bloch waves of Bose-Einstein condensates in an optical lattice via the Gross-Pitaevskii equation. This talk will be devoted to the bifurcation of stationary states which manifests itself as loops in the energy bands of the Bloch waves. In particular, the bifurcation is shown to be a supercritical pitchfork bifurcation. Analytical results will be illustrated by numerical computations.

Matt Coles
University of British Columbia
colesmp@math.ubc.ca

MS8
Stability of Solutions to a Non-local Gross-Pitaevskii Equation with Applications to Bose-Einstein Condensates

The Gross-Pitaevskii equation is a common model in physics, but it only takes local interactions into account. This paper demonstrates the validity of using a nonlocal formulation as a generalization of the local model. A large class of nonlocalities and potentials is studied. We then establish the orbital stability of a class of parameter-dependent solutions to the nonlocal problem. Numerical results corroborate the analytical stability results.

Chris Curtis
Department of Applied Mathematics
University of Colorado at Boulder
christopher.w.curtis@colorado.edu

MS8
Existence, Stability and Dynamics of Solitary Waves in Local and Nonlocal Discrete Nonlinear Schrodinger and Klein-Gordon Lattices

In this talk, we will review a number of results obtained over the last few years in equations of the discrete nonlinear Schrodinger and of the Klein-Gordon type. In the former class of models, we will consider the existence, stability and dynamics of standing waves and in the latter of time-periodic, exponentially localized discrete breather solutions for mostly local but also nonlocal models.

Panayotis Kevrekidis
UMass, Amherst
kevrekid@gmail.com

MS8
Dark Solitons and Soliton Complexes in Nonlocal Dissipative Systems

Abstract not available at time of publication.

Maxim Molchan
University of Cape Town
m.moltschan@gmail.com

MS8
The Cauchy Problem and Traveling Waves for a Nonlocal Gross-Pitaevskii Equation

We study the Gross-Pitaevskii equation involving a nonlocal interaction. Our aim is to give sufficient conditions that cover a variety of nonlocal interactions such that the associated Cauchy problem is globally well-posed with nonzero boundary condition at infinity. We focus on even potentials that are positive definite or positive tempered distributions. We also provide sufficient conditions such that there exists a range of speeds in which nontrivial traveling waves do not exist.

Andre de Laire
Laboratoire Jacques-Louis Lions
Université Pierre et Marie Curie
delaire@ann.jussieu.fr

MS9
The Reduced Ostrovsky Equation: Integrability and Breaking

The reduced Ostrovsky equation is a modification of the Korteweg-de Vries equation, in which the usual linear dispersive term with a third-order derivative is replaced by a linear non-local integral term, which represents the effect of background rotation. This equation is integrable provided a certain curvature constraint is satisfied. We demonstrate, mainly through numerical simulations, that when this curvature constraint is not satisfied at the initial time, then wave breaking inevitably occurs.

R oger Grimshaw
University of Loughborough, UK
r.h.j.grimshaw@lboro.ac.uk

Karl Helfrich
Woods Hole Oceanographic Institution
khelfrich@whoi.edu

MS9
Transverse Spectral Stability of Periodic Waves

The Kadomtsev-Petviashvili (KP) equation possesses a four-parameter family of one-dimensional periodic traveling waves. We study the spectral stability of the waves with small amplitude with respect to two-dimensional perturba-
tions which are either periodic in the direction of propagation, with the same period as the one-dimensional traveling wave, or non-periodic (localized or bounded). We focus on the so-called KP-I equation (positive dispersion case), for which we show that these periodic waves are unstable with respect to both types of perturbations. Finally, we briefly discuss the KP-II equation, for which we show that these periodic waves are spectrally stable with respect to perturbations which are periodic in the direction of propagation, and have long wavelengths in the transverse direction.

Mariana Haragus
Laboratoire de Mathematiques de Besancon
Universite de Franche-Comte, France
mariana.haragus@univ-fcomte.fr

MS9
Generalized Multi-symplectic Integrators for a Class of Hamiltonian Nonlinear Wave PDEs

Focusing on the dissipative effect of a class of PDEs with small damping in the Hamiltonian setting, a new theoretical framework named generalized multi-symplectic integrator is proposed, extending the concept of multi-symplectic PDEs to the non-conservative setting. To test the idea, several numerical experiments on the compound KdV-Burgers equation are carried out. The numerical results illustrate that the generalized multi-symplectic integrator is structure-preserving and can reproduce the dissipative effect of the non-conservative system.

Weipeng Hu
Northwestern Polytechnical University
China
wphu@nwpu.edu.cn

Zichen Deng
Northwestern Polytechnical University
dweifan@nwpu.edu.cn

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MS9
The Morse and Maslov Indices for Periodic Problems

For Hill’s equations with matrix valued periodic potential, we discuss relations between the Morse index, counting the number of unstable eigenvalues, and the Maslov index, counting the number of signed intersections of a path in the space of Lagrangian planes with the train of a plane.

Chris Jones
University of North Carolina
ckr@email.unc.edu

Yuri Latushkin
Department of Mathematics
University of Missouri-Columbia
yuri@math.missouri.edu

Robby Marangell
University of Sydney
r.marangell@maths.usyd.edu.au

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MS9
Statics and Dynamics of Atomic Dark-bright Solitons in the Presence of Localized Impurities

Adopting a mean-field description for a 2-component atomic Bose-Einstein condensate, dark-bright solitons are studied in the presence of impurities. We use adiabatic perturbation theory and show that, counter intuitively, an attractive (repulsive) delta-like impurity induces an effective localized barrier (well) in the effective potential felt by the soliton; this way, dark-bright solitons are reflected from (transmitted through) attractive (repulsive) impurities. Analytical results for the small-amplitude oscillations are found to be in good agreement with results obtained via a Bogoliubov-de Gennes analysis and direct numerical simulations.

Vassilios Rothos
School of Mathematics, Physics and Computer Sciences
Aristotle University of Thessaloniki
rothos@auth.gr

Vassos Achilleos, Dimitri Frantzeskakis
University of Athens
vassosni@gmail.com, dfrantz@phys.uoa.gr

Panayotis Kevrekidis
UMass, Amherst
Dept of Mathematics
kevrekid@math.umass.edu

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MS10
Stabilizing 1D Solitons Against the Critical Collapse by Quintic Nonlinear Lattices

It has been recently discovered that stabilization of two-dimensional (2D) solitons against the critical collapse in media with the cubic nonlinearity by means of nonlinear lattices (NLs) is a challenging problem. We address the 1D version of the problem, i.e., the nonlinear Schrödinger equation with the quintic or cubic-quintic (CQ) terms, the coefficient in front of which is periodically modulated in space. Stability diagrams for the solitons are produced by means of numerical methods and analytical approximations. It is found that the sinusoidal NL stabilizes solitons supported by the quintic-only nonlinearity in a narrow stripe in the parameter plane, on the contrary to the case of the cubic nonlinearity in 2D, where the stabilization of solitons by smooth spatial modulations is not possible at all. The stability region is much broader in the 1D CQ model, where higher-order solitons may be stable too. Publication: J. Zeng and B. A. Malomed, Phys. Rev. A 85, 023824 (2012).

Boris Malomed
Department of Physical Electronics, Faculty of Engr.
Tel Aviv University, 69978 ISRAEL
malomed@eng.tau.ac.il

Jianhua Zeng
State Key Laboratory of Low Dimensional Quantum Physics
Department of Physics, Tsinghua University, Beijing, China
zengjianhua1981@gmail.com

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MS10
Linear and Nonlinear Properties of Strained Photonic Crystals

Perhaps the two most important properties of photonic crystals are (1) its photonic band gap, which allows for strong light confinement and very efficient lasing, and (2) its ability to strongly increase the density-of-states, en-
hancing nonlinear effects. Here, we show that an inho-

genous strain in a periodic two-dimensional photonic

crystal structure acts to induce an effective magnetic field

near the Brillouin zone corners. This field in turn induces

a complete photonic band gap and gives rise to Landau

levels: highly degenerate energy levels with correspond-

ingly high density-of-states. These Landau levels lead to

enhancement of nonlinear effects (such as harmonic genera-

tion). We show the presence of both defect modes and edge

modes within the band gap (which lies in between the Lan-

dau levels). Experiments are currently on their way, using

a silicon-on-insulator photonic crystal slab system.

Anton Sakovich
McMaster University
sakovias@math.mcmaster.ca

MS10
Multi-site Breathers in Klein–Gordon Lattices: Stability, Resonances, and Bifurcations

We prove the most general theorem about spectral stability of multi-site breathers in the discrete Klein–Gordon equation with a small coupling constant. In the anti-continuum limit, multi-site breathers represent excited oscillations at different sites of the lattice separated by a number of "holes" (sites at rest). The theorem describes how the stability or instability of a multi-site breather depends on the phase difference and distance between the excited oscillators. Previously, only multi-site breathers with adjacent excited sites were considered within the first-order perturbation theory. We show that the stability of multi-site breathers with one-site holes change for large-amplitude oscillations in soft nonlinear potentials. We also discover and study a symmetry-breaking (pitchfork) bifurcation of one-site and multi-site breathers in soft quartic potentials near the points of 1:3 resonance.

Anton Sakovich
McMaster University
sakovias@math.mcmaster.ca

MS10
Stability Analysis of Solitary Waves Near Bifurcation Points in Generalized Nonlinear Schrodinger Equations

Stability properties of solitary waves near bifurcation points in the generalized nonlinear Schrodinger equations with arbitrary potentials are analyzed. First, conditions for three major types of solitary-wave bifurcations, namely saddle-node bifurcations, pitchfork bifurcations and transcritical bifurcations, are derived. Second, we show that at a saddle-node bifurcation point, the stability of solitary waves does not switch. In particular, both branches of saddle-node bifurcations can be stable. This is in stark contrast with saddle-node bifurcations in finite-dimensional dynamical systems, where stability of the two branches always switches. Thirdly, we show that at a pitchfork bifurcation point, the continuous solitary-wave branch switches stability, while the stability of the two bifurcated branches is determined by the sign of their power slopes. Fourthly, we show that at a transcritical bifurcation point, both solitary-wave branches switch stability. Lastly, we use numerical examples to illustrate these analytical results.

Jianke Yang
Department of Mathematics and Statistics
University of Vermont
yang@ems.uvm.edu

MS10
Nonlinear Diffraction and Interband Transitions in Photonic Graphene

Nonlinear diffraction and interband transitions in two-dimensional honeycomb lattices, in nonlinear optics sometimes termed photonic graphene, are studied analytically and numerically. The nonlinear diffraction of the Bloch wave envelope associated with so-called Dirac points where two linear dispersion surfaces touch each other develops a triangular pattern during propagation. This phenomenon is markedly different from conical diffractions which occurs in the leading order ‘pure’ Dirac system in which the diffraction pattern evolves circularly (i.e., conically). The triangular structure is related to the higher order dispersion relation of the honeycomb lattice which has trigonal warping behavior near the Dirac points. A higher-order nonlinear Dirac equation is then derived and used to describe the dynamics of the Dirac wave envelopes. Asymptotic analysis of the linear equations demonstrates the triangular diffraction as well as its decay rate and agrees with numerical simulations. Further, nonlinear analysis is employed to study the energy transitions between two nearby bands which touch at the Dirac point. The sign of the nonlinearity, focusing or defocusing, determines the direction of the triangular pattern. This is due to the preference of energy transitions from one band to another. Analytical results agree well with direct numerical simulations.

Yi Zhu
Zhou-Pei-Yuan Center for Applied Mathematics
Tsinghua University, China
yizhu@mail.tsinghua.edu.cn

Mark Ablowitz
Dept. of Applied Mathematics
University of Colorado
mark.ablowitz@colorado.edu

MS11
Periodic Travelling Waves in Dimer Granular Chains

Bifurcations of periodic travelling waves in granular dimer chains are studied near the anti-continuum limit, when the mass ratio between the light and heavy beads is a small parameter. We show that each limiting periodic wave is uniquely continued with respect to the mass ratio parameter and the periodic waves with the wavelength larger than a certain critical value are spectrally stable. We also prove uniqueness of the continuation of periodic travelling waves that exist in the homogeneous granular crystals with respect to the mass ratio parameter. Numerical computations are developed to study connections between these two solution families, as well as bifurcations and instability onsets along each family.

Matthew Betti
MS11
Highly Nonlinear Stress Waves in 2D Granular Crystals
Highly ordered granular systems, i.e. granular crystals, present a unique nonlinear dynamic behavior stemming from the Hertzian contact potential. We investigate the elastic stress wave propagation through uncompressed two-dimensional granular crystals with variable packing geometries. Experimental results are in good agreement with discrete particle model simulations. The unique dynamic properties of these crystals can be exploited to design granular systems with predetermined stress wave paths, which could be used as impact energy mitigating devices.

Andrea Leonard
California Institute of Technology
andreal@caltech.edu

MS11
Analytical Study of the Interaction of Solitary Waves with Defects in Granular Crystals
It is a well known fact that uncompressed, homogeneous granular chains support the propagating solitary wave solution earlier discovered by Nesterenko. In the present work we develop a systematic analytical approach to describe the interaction of Nesterenko solitary like pulses with various local and nonlocal structural in-homogeneities such as defects in nonlinear stiffness, masses of particles, inter-chain and on-site potentials. The developed analytical model is in a fairly good correspondence with the numerical simulations.

Yuli Starosvetsky
Technion, Israel Institute of Technology
staryuli@tx.technion.ac.il

MS11
Equipartition of Energy in Uncompressed Granular Crystals
Granular crystals are unique nonlinear systems that exhibit interesting properties stemming from the nonlinear contact interactions (Hertzian) between two individual particles. We study numerically and experimentally the dynamic effects of spherical interstitial particles placed between two adjacent uncompressed chains of larger particles. We excite one of the large particle chains with an impact and show energy transfer and equipartition from the excited chain to the adjacent chain. Experimental data is collected using tri-axial accelerometers, and is compared to the numerical simulations, finding very good agreement.

Ivan Szelengowicz
California Institute of Technology
ivanz@caltech.edu

MS12
Large Time-step and Asymptotic-preserving Schemes for Hyperbolic Systems with Sources and their Parabolic Limits
We propose a large time step and asymptotic preserving scheme for the gas dynamics equations with external forces and friction terms. By asymptotic preserving, we mean that the numerical scheme is able to reproduce at the discrete level the parabolic-type asymptotic behaviour satisfied by the continuous equations. By large time-step, we mean that the scheme is stable under a CFL stability condition driven by the (slow) material waves, and not by the (fast) acoustic waves as it is customary in Godunov-type schemes. Nonlinear stability properties are proved and numerical evidences are proposed. A gain of several orders of magnitude in both accuracy and efficiency is showed.

Christophe Chalons
Universite Paris 7
chalons@math.jussieu.fr

MS12
Multipathing Problem in Seismic Imaging and a Numerical Solution of Escape Equations
Seismic reflection imaging using the so-called Kirchhoff migration approach involves the task of computing seismic traveltimes between the image point inside a model of the Earth and points on the surface where data are collected. Because of the non-linear nature of traveltime computations, multiple solutions are possible and lead to the multipathing problem. The first-arrival solution is not the most energetic and therefore is not the most desirable for imaging. A possible solution to the multipathing issue is an angle-domain formulation of seismic imaging, which leads to the set of escape equations. Escape equations are decoupled first-order linear equations defined in the extended phase space. I will present a numerical algorithm for an efficient solution of escape equations and its application in seismic imaging.

Sergey Fomel, Vladimir Bashkardin
University of Texas at Austin
sergey.fomel@beg.utexas.edu, vbash@utexas.edu

MS12
Semiclassical Models for the Schrodinger Equation with Periodic Potentials and Band-crossings
We study the linear Schrodinger equation with a periodic potential in the semiclassical limit. When the so called Bloch band gap is small, the inter-band transition is significant but can not be described by the classical transport model. We derive a quantum classical Liouville system to capture the inter-band transition phenomena. This system can be seen as a first order approximation to the Wigner equation. A classical-quantum hybrid model and the corresponding domain decomposition method are presented to solve this type of system efficiently.

Shi Jin
Shanghai Jiao Tong University, China and the University of Wisconsin-Madison
jin@math.wisc.edu

MS12
High Frequency Approximation in Molecular
Quantum Dynamics

The time dependent Schrödinger equation describing nuclear quantum motion generates high frequency oscillations with respect to time and space. Our results are based on the observation that in the high frequency regime transport equations can either be used for approximating quadratic quantities of the wave function as well as the wave function itself by Gaussian coherent states. The corresponding two families of particle methods are applicable for high dimensional systems.

Caroline Lasser
Technische Universität München
classer@ma.tum.de

MS12
Error Estimates for Gaussian Beam Superpositions

Gaussian beams are asymptotically valid high frequency solutions to hyperbolic partial differential equations, concentrated on a curve through the physical domain. Superpositions of Gaussian beams provide a powerful tool to generate more general high frequency solutions. In contrast to the standard geometrical optics, the Gaussian beam approximation does not break down at caustics. In this talk we discuss numerical methods based on Gaussian beam superpositions and show error estimates in terms of the small wavelength.

Olof Runborg
KTH, Stockholm, Sweden
olofr@nada.kth.se

MS13
Solutions to Maxwell-Bloch Equations with Non-vanishing Boundary Conditions

We formulate the inverse scattering transform with non-zero boundary conditions at infinity for (i) the focusing nonlinear Schrödinger equation (ii) the scalar Maxwell-Bloch equations. For both models we derive soliton solutions and discuss their behavior.

Gino Biondini
State University of New York at Buffalo
biondini@buffalo.edu

Gregor Kovacic
Rensselaer Polytechnic Inst
Dept of Mathematical Sciences
kovacg@rpi.edu

MS13
Light Propagation in Metamaterials with Mixed Positive and Negative Refractive Index

Abstract not available at time of publication.

Alexander O. Korotkevich
Dept. of Mathematics & Statistics, University of New Mexico
L.D. Landau Institute for Theoretical Physics RAS
alexkor@math.unm.edu

MS13
Integrable/Stochastic Polarization Dynamics in Active Media

Resonant interaction of light with a randomly-prepared, lambda-configuration active optical medium is described by exact solutions of a completely-integrable, random partial differential equation, thus combining the opposing concepts of integrability and disorder. An optical pulse passing through such a material will switch randomly between left- and right-hand circular polarizations. Exact probability distributions of the electric-field envelope variables describing the light polarization and their switching times will be presented.

Gregor Kovacic
Rensselaer Polytechnic Inst
Dept of Mathematical Sciences
kovacg@rpi.edu

Katherine Newhall
Courant Institute of Mathematical Science
New York University
newhall@cims.nyu.edu

Barbara Prinari
University of Colorado, Colorado Springs
bprinari@uccs.edu
Mark J. Ablowitz  
Department of Applied Mathematics  
University of Colorado at Boulder  
mark.ablowitz@colorado.edu

Sarbarish Chakravarty  
University of Colorado at Colorado Springs  
schakrav@uccs.edu

MS14  
Coagulation-Fragmentation in Alternative Telomere Length Maintenance

We present a mathematical model of alternative telomere length maintenance based on details of biophysical interactions. The model opens up a couple of interesting mathematical problems such as the validity of a quasi-steady state approximation and dynamic properties of discrete coagulation-fragmentation systems with kernels out of the typically considered classes. We also identify and estimate key factors influencing the length distribution of telomeric circles using numerical simulations for different yeast species.

Katarina Bodova  
Comenius University Bratislava  
bodova@fmph.uniba.sk

Richard Kollar  
Comenius University  
Department of Applied Mathematics and Statistics  
kollar@fmph.uniba.sk

Lubomir Tomaska  
Department of Genetics  
Comenius University Bratislava  
tomaska@fmph.uniba.sk

Jozef Nosek  
Department of Biochemistry  
Comenius University Bratislava  
nosek@fmph.uniba.sk

MS14  
Convergence to Equilibrium for the Coagulation-fragmentation Equations with Detailed Balance and a Finite Critical Mass

We study the speed of convergence to equilibrium of solutions to the coagulation-fragmentation (CF) equations under the assumption of detailed balance. We show that, for a subcritical mass, the linearized equations have a spectral gap in the natural vector space suggested by the entropy. Through estimates of moments of the nonlinear equations, we are able to deduce that subcritical solutions of the CF equations converge to equilibrium exponentially fast whenever uniform-in-time exponential moment bounds are available (such as the Becker-Dring case).

Jose A. Cañizo  
DPMMS, University of Cambridge  
j.a.canizo@dpmms.cam.ac.uk

Bertrand Lods  
Dipartimento di Statistica e Matematica Applicata  
Università degli Studi di Torino  
lods@econ.unito.it

MS14  
On Global Stability for Lifschitz-Slyozov-Wagner Like Systems

This talk is concerned with the stability and asymptotic stability at large time of solutions to a system of equations, which includes the Lifschitz-Slyozov-Wagner (LSW) system in the case when the initial data has compact support. The main result is a proof of weak global asymptotic stability for LSW like systems. Comparison to a quadratic model plays an important part in the proof of the main theorem when the initial data is critical. The quadratic model extends the linear model of Carr and Penrose.

Joseph Conlon  
Department of Mathematics  
The University of Michigan  
conlon@umich.edu

Barbara Niethammer  
Mathematical Institute  
University of Oxford  
niethammer@maths.ox.ac.uk

MS14  
On Self-similarity in Coagulation-annihilation Systems


Fernando P. da Costa  
Universidade Aberta Lisboa  
fcosta@math.ist.utl.pt

Joao Pinto  
Instituto Superior Tecnico, TU Lisbon, Lisbon  
jpinto@math.ist.utl.pt

Henry van Roessel  
University of Alberta, Edmonton, Canada  
hvanroes@ualberta.ca

Rafael Sasportes  
Universidade Aberta, Lisboa  
rafael@uab.pt

MS15  
Modelling Retinal Waves in Starburst Amacrine Cells

Retinal waves are an example of spontaneous activation in the developing central nervous system. This activity occurs in developing neural circuits prior to visual stimulus. The waves are the result of neighboring retinal cells spiking in a coordinated fashion which spreads across the whole retina. We develop a continuous spatial and temporal model of this phenomenon in order to understand how the wave properties depend on underlying parameters. We use the Fitzhugh-Nagumo model of neuron dynamics and include spatial coupling via a neurotransmitter field representing a novel mechanism for generating spatiotemporal patterns in the developing central nervous system.

Ben Lansdell  
University of Washington
MS15
Spike Metric Analysis of Geometrical Effects in Axonal Computation

Axons are much more than reliable cables in which spikes propagate in a stable manner. Specifically, propagation failures and reflection of pulses were observed experimentally in several neural systems. These unusual computations can be explained in classical nerve equations as a result of the interplay between the ionic currents with geometrical properties of the axon. Such effects can dramatically affect spike trains and consequently, neural coding. We compare trains before and after they are affected by axonal inhomogeneities using a recent spike metric framework.

Pedro Maia
University of Washington
pmaia@u.washington.edu

MS15
Disrupting Waves of Disease Spread Through a Population: How Interventions Affect the Propagation of Disease Outbreak

Every year, the population of the world faces a number of terrible diseases that spread through populations wreaking havoc on families and world economies. Only one disease has been successfully eradicated: smallpox in 1977. This event was a great triumph for the world and public health, but many more diseases still haunt humanity. The work presented in this talk will be focused on how current campaign tools (routine vaccinations, behavioral changes, and mass vaccination events) affect mathematical models of disease spread through a population. The goal of this research is to understand how to effectively and efficiently disrupt disease propagation.

Joshua Proctor
Intellectual Ventures

MS16
Emergence of Unsteady Dark Solitary Waves from Large-amplitude Periodic Patterns

DSWs are most well known as exact solutions of the NLS equation. Here it is shown that DSWs can be generated by colliding two periodic patterns. A KdV equation on a periodic background coupled to a phase shift equation is derived. The nonlinearity in the KdV equation is determined by the curvature of the periodic states, and the dispersion is determined by the Krein signature of the periodic state. KdV planforms are also discussed.

Tom J. Bridges
University of Surrey
t.bridges@surrey.ac.uk

MS16
Weakly Nonlinear Solution of Initial Value Problem for Boussinesq-type Equations

We construct a weakly nonlinear solution of the initial-value problem for a system of coupled regularised Boussinesq equations on the infinite line, in terms of solutions of various Ostrovsky-type equations. The solution for a single Boussinesq equation is given in terms of solutions of the Cauchy problems for two Korteweg-de Vries equations. We also perform relevant numerical simulations to test our formula.

Kieron Moore
Loughborough University
K. R. Moore@lboro.ac.uk

Kariina Khusnutdinova
Loughborough University, UK
k.khusnutdinova@lboro.ac.uk

MS16
Whitham Modulation Equations for Korteweg-de Vries/Kuramoto-Sivashinsky Equations

In this talk, we study the stability of periodic waves for a Korteweg de Vries/Kuramoto Sivashinsky equation which model a weakly unstable thin film flow down an incline. We will focus on the validity of Whitham’s modulation equations that describe large scale perturbations of periodic waves. Of particular interest is the KdV limit where a new Whitham’s system is derived which provides new stability criteria.

Pascal Noble, Luis Miguel Rodrigues
University of Lyon
noble@math.univ-lyon1.fr, rodrigues@math.univ-lyon1.fr

MS16
Stability of Homoclinic Orbits of the Nonlinear Schroedinger Equation

We study the linearization of the Nonlinear Schrödinger (NLS) equation about homoclinic orbits of unstable plane wave solutions with two unstable modes. The family of homoclinic orbits as well as a complete set of solutions of the associated linearized NLS equation can be constructed using Bäcklund transformations. We show that iterating Bäcklund transformations saturates instabilities of the seed solution, making the largest dimensional homoclinic orbits...
the most stable in the sense of linear stability.

Constance Schober  
Dept. of Mathematics  
University of Central Florida  
cschober@mail.ucf.edu

MS16  
A Dimension-breaking Phenomenon for Steady Water Waves with Weak Surface Tension

Iooss and Kirchgrässner proved that the two-dimensional water wave problem with weak surface tension admits two families of solitary wave solutions of envelope form. The solutions are to leading order described by the nonlinear Schrödinger equation. In this talk I will discuss how these waves generate families of three-dimensional periodically modulated solitary waves in a dimension-breaking bifurcation. The new solutions decay in the direction of propagation and are periodic in the transverse direction. They are related to the Davey-Stewartson equation. The proof is based on a reversible Hamiltonian spatial-dynamics formulation and an infinite-dimensional version of the Lyapunov centre theorem.

Erik Wahlen  
Lund University  
Sweden  
ewahlen@maths.lth.se

Mark D. Groves  
Universität des Saarlandes  
groves@math.uni-sb.de

Shu-Ming Sun  
Virginia Tech  
Department of Mathematics  
sun@math.vt.edu

MS17  
Nonlinear Optics in Periodic, PT-symmetric Systems

In this talk I will present novel dynamics in nonlinear optical systems with periodic and (P)arity (T)ime symmetric index of refraction. PT symmetry means a complex index of refraction whose real part is an even function and whose imaginary part is odd. We will show how such symmetry adds functionality in recently proposed all optical devices; for example a PT symmetric couplers produce input/output conditions characteristic of an all optical diode.

Alejandro Aceves  
Southern Methodist University  
aaceves@smu.edu

MS17  
Logarithmic Corrections in Formation of Singularities in 2D Radially Symmetric Reduced Keller-Segel Model

The 2D Keller-Segel model (KS) can be used as a model describing phenomena such as dynamics of bacteria in Petri dish and gravitational collapse of interstellar dust cloud. We study radially symmetric solutions of 2D KS which blows-up in finite time. We simulate a collapsing solution with high accuracy to resolve logarithmic corrections in the temporal dynamics of self-similar scaling length L(t). We combine perturbation approach to the logarithmic corrections with the simulations using a spatially adaptive finite difference method (a variation of adaptive mesh refinement). The numerical method relies on self-similar properties of blowing-up solution.

Pavel M. Lushnikov  
Department of Mathematics and Statistics  
University of New Mexico  
plushnik@math.unm.edu

Sergey Dyachenko  
University of New Mexico  
sdyachen@unm.edu

Natalia Vladimirova  
Department of Mathematics and Statistics,  
University of New Mexico  
vvladimi@math.unm.edu

MS17  
Continuations of NLS Solutions Beyond the Singularity

The nonlinear Schrödinger equation (NLS) is one of the canonical nonlinear equations in physics. In 1965, Kelley showed that the NLS admits solutions that collapse (become singular) at a finite time (distance). Since physical quantities do not become singular, a question which has been open since 1965 is whether and how singular NLS solutions can be continued beyond the singularity. A similar situation occurs in hyperbolic conservation laws, where in the absence of viscosity, the solution can become singular (develop shocks). In that case, there is a huge body of literature on how to continue the inviscid solution beyond the singularity. In contrast, very few studies addressed this question in the NLS. In this talk I will present several potential continuations of the NLS beyond the singularity. These continuations share the universal feature that after the singularity, the solution is only determined up to multiplication by a constant phase term. As a result, the interaction between two post-collapse components (beams) is chaotic, as indeed has been observed recently in experiments with high-power laser beams.

Gadi Fibich  
Tel Aviv University  
School of Mathematical Sciences  
fibich@tau.ac.il

Moran Klein  
Tel Aviv University  
mklein@airspan.com

MS17  
A Stochastic Model for Bose-Einstein Condensation

We consider a nonlinear Schrödinger equation with a potential varying randomly in time, which is a model equation in Bose-Einstein condensation or in fiber optics. We study the Cauchy problem in the energy space, establishing random Strichartz estimate. We also give an initial condition for the existence of collapsing state, and discuss the influence of the random potential on a stable standing wave. This is a joint work with Anne de Bouard (Ecole
Reika Fukuizumi  
Tohoku University  
fukuizumi@math.is.tohoku.ac.jp

MS17  
Waves in Microstructures  
Abstract not available at time of publication.

Michael I. Weinstein  
Columbia University  
Dept of Applied Physics & Applied Math  
miw2103@columbia.edu

MS18  
Reduced Models of Stratified Internal Waves  
Abstract not available at time of publication.

Roberto Camassa  
University of North Carolina  
camma@amath.unc.edu

MS18  
Asymptotic Models for Large Amplitude Internal Waves in Weakly Stratified Fluids  
We derive nonlinear evolution equations for large amplitude internal waves in weakly stratified fluids. After the linear dispersion relation of the new model is compared with that of the linearized Euler equations, the solitary wave and conjugate state solutions of the model are obtained and compared with other theoretical solutions and field data.

Wooyoung Choi  
Dept of Mathematics  
New Jersey Institute of Tech  
wchoi@njit.edu

MS18  
Internal Waves in the Ocean Seen from Spectral Perspective  
Abstract not available at time of publication.

Yuri V. Lvov  
Rensselaer Polytechnic Institute  
lvovv@rpi.edu

MS18  
On Stochastic Closures for Finite Amplitude Internal Waves  
Recent results concerning the analytic representation of stochastic closures for weakly interacting internal waves at finite amplitude will be presented and contrasted with existing analytic closures in the resonant (infinitesimal amplitude) limit. The two paradigms will be studied using ray tracing techniques that support the analytic results. The ray tracing results further provide a concrete physical interpretation for a transition from a system of coupled oscillators (the resonant limit) to a particle in a potential well (the finite amplitude limit).

Kurt Polzin  
whoi.edu  
kpolzin@whoi.edu

MS19  
Hydrodynamic Solitons and Vortices in Polariton Condensates  
Exciton-polaritons are composite bosons arising from the strong coupling between quantum well excitons and photons confined in a semiconductor microcavity. They can be easily created by optical excitation, and they can form extended bosonic condensates at relatively high temperatures (10-300 K). Here we will show experiments on the transition from a superfluid phase to shockwaves, vortex and soliton formation when the condensate encounters a potential barrier in its flowpath at different Mach numbers, with specific features arising from the out-of-equilibrium nature of polaritons.

Alberto Amo  
Laboratoire de Photonique et de Nanostructures CNRS  
Marcoussis, France  
alberto.amo@lpn.cnrs.fr

MS19  
Interactions and Asymptotics of Dispersive Shock Waves  
The interaction of dispersive shock (DSWs) and rarefaction waves (RWs) associated with the Korteweg-de Vries (KdV) equation are investigated numerically and with Whitham’s averaging method; the interaction of DSWs lead to multiphase dynamics. General non-vanishing initial conditions for the KdV equation are considered. KdV is solved for using the inverse scattering transform (IST) method. From IST theory and matched asymptotics, an asymptotic solution for large time is determined and it’s found that interacting DSWs eventually form a single DSW.

Douglas Baldwin  
Department of Applied Mathematics  
University of Colorado at Boulder  
douglas.baldwin@colorado.edu

MS19  
From Superfluid Counterflow to Novel Types of Solitons: Quantum Hydrodynamics with Dilute-gas Bose-Einstein Condensates  
Dilute-gas Bose-Einstein condensates provide a versatile tool for the investigation of superfluid hydrodynamics. We experimentally investigate the behavior of a two-component Bose-Einstein Condensate subjected to counterflow between the two components. The counterflow is found to lead to rich dynamics, including a modulational instability, dark-bright soliton trains, and oscillating dark-dark solitons. Our recent and ongoing studies showcase the emergence of intriguing nonlinear behavior in a well controlled model system using ultracold atoms.

Peter Engels  
Washington State University  
engels@wsu.edu

MS19  
Dispersive Dam Breaks and Lock Exchanges in a
Two-layer Fluid
Abstract not available at time of publication.

Gavin Esler
UCL
gavin@math.ucl.ac.uk

MS19
Quantum Hydrodynamics and Turbulence in Bose-Einstein Condensates

Quantum turbulence (QT) is comprised of quantized vortices that are definite topological defects arising from the order parameter appearing in Bose-Einstein condensation. Hence QT is expected to yield a simpler model of turbulence than does conventional classical turbulence. A general introduction to this issue and a brief review of the basic concepts are followed by the recent developments in quantum hydrodynamic instability and turbulence in atomic Bose-Einstein condensates.

Makoto Tsubota
Department of Physics, Osaka City University
Japan
tsubota@sci.osaka-cu.ac.jp

MS20
Asymptotics for a Fredholm Determinant Involving the Second Painleve Transcendent

This talk discusses the large $s$-asymptotics of the determinant $\det(I - \alpha K_s)$ of an integrable Fredholm operator acting on the interval $(-s, s)$ with a real-valued parameter $\alpha$. The kernel of the operator $K_s$ is constructed out of the $\Psi$-function associated with the Hastings-McLeod solution of the Painlevé II equation. This kernel appears in Random Matrix Theory and describes the critical behavior of the eigenvalue gap probabilities of a random Hermitian matrix chosen from the Unitary Ensemble in the bulk double scaling limit near a quadratic zero of the limiting mean eigenvalue density. The given integrable form of the Fredholm operator allows us to connect the resolvent kernel to the solution of a Riemann-Hilbert problem which can be analysed rigorously via the Deift-Zhou nonlinear steepest descent method. We will highlight certain technical features in the implementation of the method related to different choices of the parameter $\alpha$. This is joint work with Alexander Its.

Thomas J. Bothner
Indiana University and Purdue University
tbothner@umail.iu.edu

MS20
Toeplitz-like Structure of Riemann-Hilbert Problems

Associated with a (matrix-valued) Riemann-Hilbert problem is a linear singular integral equation involving the Cauchy transform and its left and right limits. By representing this linear equation as an operator on Chebyshev coefficients, we find that it has the structure of a perturbation of a block-Toeplitz operator. In suitably defined spaces, this perturbation is compact. This allows us to prove convergence and stability of a numerical method for solving Riemann-Hilbert problems.

Sheehan Olver
University of Oxford
UK
Sheehan.Olver@sydney.edu.au

MS20
On the Elliptic Sine-Gordon Equation

In this talk I will outline the problems that arise when trying to solve this equation in a convex polygon for linearisable boundary conditions. These problem arise from the lack of compatibility of such problems at the corners of the domain, that in turn introduces a lack of integrability in the spectral data. I will outline a strategy for defining an alternative Riemann-Hilbert problem whose data are integrable, and discuss the use of this alternative RH problem to solve some linearisable problems explicitly. This is joint work with T Fokas and J Lenells.

Beatrice Pelloni
University of Reading, UK
b.pelloni@reading.ac.uk

Athanassios Fokas
University of Cambridge
t.fokas@damtp.cam.ac.uk

Jonatan Lenells
Department of Mathematics
Baylor University
jonatan_lenells@baylor.edu

MS20
Automatic Contour Deformation

In many cases the standard contour of a Riemann-Hilbert problem is not the most useful one for numerical analysis. For example to calculate the solution of a Riemann-Hilbert problem it is often necessary to deform the contour in order to reduce the condition of the problem. Currently these deformations are done by hand and this talk will give some details on how some of these deformations can also be done by an algorithm.

Georg Wechslberger
Mathematics Department
Technical University Munich
wechslbe@ma.tum.de

MS21
Resonant Dynamics of Fourier Modes

We analyze the resonant transfer of energy between Fourier modes for the 1D nonlinear Schrödinger equation in a finite interval with homogeneous Dirichlet or Neumann boundary conditions. For the cubic nonlinearity we show that there is no long term energy exchange between Fourier modes as opposed to higher nonlinearities. This slow dynamics is explained by simple amplitude equations. This method can be applied to other systems to reveal their long term dynamics.

Jean-Guy Caputo
Universite Rouen
France
caputo@insa-rouen.fr
MS21
Singular Structure of Wave Modes in Rotating Shallow Water

Abstract not available at time of publication.

David J. Muraki
Department of Mathematics
Simon Fraser University
muraki@math.sfu.ca

MS21
Wave Train Defocusing over a Highly Disordered Bathymetry

Different water wave regimes lead to different types of wave-topography interactions. For example when the bottom topography is considered to be random and rapidly varying, pulse shaped waves are attenuated through this interaction. In some cases the attenuation is asymptotically captured in a linear diffusive-like fashion. In the present work wave trains are considered. Then a multiple scale, amplitude modulation analysis leads to a Nonlinear Schrodinger equation. It is shown that large bottom variations can modify the effective nonlinearity coefficient thus leading to a defocusing effect.

Andre Nachbin
IMPA, Rio, Brazil
nachbin@impa.br

Ana Maria Luz
Math. Dept., UFF, Niteroi, Brazil.
anamaria.luz@gmail.com

MS21
Spontaneous Breaking of the Spatial Homogeneity Symmetry in Wave Turbulence and the Emergence of Coherent Structures

Spatial homogeneity, the symmetry property that all statistical moments are functions only of the relative geometry of any configuration of points, can be spontaneously broken by the instability of the finite flux Kolmogorov-Zakharov spectrum in certain (usually one dimensional) situations. As a result, the nature of the statistical attractor changes dramatically, from a sea of resonantly interacting dispersive waves to an ensemble of coherent radiating pulses.

Benno Rumpf
Southern Methodist University
brumpf@mail.smu.edu

MS23
Modulational Instability of Weakly Nonlinear Gravity Waves on a Current of Uniform Vorticity in Arbitrary Depth

A nonlinear Schrodinger equation in one dimension is derived from the fully nonlinear water equations in arbitrary depth in the presence of uniform shear current of constant vorticity by using a multiple-scale method. A stability analysis demonstrates that Stokes waves counter propagating over a shear current are generally stable under given conditions of the value of the vorticity for any value of the dispersive parameter $kh$, where $k$ and $h$ are the carrier wavenumber and depth respectively. The Benjamin-Feir Index (BFI) is a useful parameter to compute the probability of occurrence of rogue waves in a wave field. This index depends on the dispersive and nonlinear coefficients of the NLS equation. We have shown that a shear current co-flowing with the waves increases the value of the BFI and so the number of steep wave events is expected to increase.

Christian Kharif, Roland Thomas
Institut de Recherche sur les Phenomenes Hors Equilibre
kharif@irphe.univ-mrs.fr, thomas@irphe.univ-mrs.fr

MS23
Numerical and Experimental Investigation for Spectral Evolution of Nonlinear Ocean Surface Waves and their Stability

Efficient and accurate computation of evolving nonlinear ocean surface waves is a challenging hydrodynamic problem. Resolution of various spatial and temporal scales and preservation of required coherent structures, is at heart of an efficient asymptotic model. In this study we examine both short and long term spectral evolution of nonlinear ocean surface waves, in the context of a third-order phase-resolving asymptotic model. An array of randomly initialized Monte-Carlo simulations, solved via Fourier pseudo-spectral method, and corresponding stability analysis of various models in question will be presented. Furthermore, to give further validity to several new findings, a preliminary set of laboratory/wave-tank experiments will also be presented. In particular, the downshifting of the spectral peak and a quasi steady-state of the ensemble averaged spectra, in the absence of damping and wave-breaking have been observed in both the experiments and numerical simulations.

Matt Malej
NJIT
matt.malej@usace.army.mil

Wooyoung Choi
Dept of Mathematics
New Jersey Institute of Tech
wychoi@njit.edu

MS23
Time Dependent Hydro-Elastic Waves

The problem of forced unsteady water waves under an elastic sheet is a model for waves under ice or under large floating structures. Even though small amplitude solitary waves are not predicted to exist by standard perturbation analyses, we find large amplitude solitary waves, and explore their crucial role in the forced problem of a moving load on the surface. This is meant to represent a model of the use of extended ice sheets as roads and aircraft runways.

Paul A. Milewski
Dept. of Mathematics
Univ. of Wisconsin
p.a.milewski@bath.ac.uk

MS23
Stability of Traveling Wave Solutions to Euler’s Equations

Euler’s equations describe the dynamics of gravity waves on the surface of an ideal fluid with arbitrary depth. In this
In this talk, we discuss the stability of periodic traveling wave solutions for the full set of Euler’s equations with constant vorticity via a generalization of a non-local formulation of the water wave problem due to Ablowitz, Fokas & Muslimani [Ablowitz et al 2006, J. Fluid Mech., Ashton & Fokas 2011, arxiv.org]. We determine the spectral stability for the periodic traveling wave solution by extending Fourier-Floquet analysis to apply to the non-local problem. We will discuss some interesting and new relationships between the stability of the traveling wave with respect to long-wave perturbations and the structure of the bifurcation curve for small amplitude solutions.

Katie Oliveras
Seattle University
Mathematics Department
oliverak@seattleu.edu

Vishal Vasan
Department of Applied Mathematics
University of Washington
vvason@amath.washington.edu

MS23
On the Evolution of Ocean Swell Over Long Distances

Segur et al. (2005) showed mathematically that even weak dissipation can stabilize Benjamin-Feir instability. Their experiments, on deep-water waves in a wave tank, supported this claim for small perturbations; for larger perturbations, they observed frequency downshifting, which is not explained by any current model. This talk summarizes our work to apply these ideas to ocean swell, and to construct an accurate model of downshifting.

Harvey Segur
Department of Applied Mathematics
University of Colorado
segur@colorado.edu

MS24
Four-wave-mixing and Optical Wave Turbulence in Fiber Lasers

An overview of research in optical wave turbulence in fiber lasers will be presented in this talk. Four-wave mixing induced wave turbulence of a number of weakly interacting longitudinal modes generated in nonlinear and dispersive cavity defines basis properties of fiber lasers. Our recent results on coherent structures generation in fiber lasers will be presented.

Dmitry Churkin
Aston University
d.churkin@aston.ac.uk

MS24
All-optical Control of Polarization State in Optical Fibers for Telecommunication Applications

In this work, we report last developments in all-optical non-linear control of polarization state in optical fibers based on a counter-propagating four-wave mixing interaction. In particular, we will show that it is possible, using a unique segment of fiber, to all-optically manipulate both the polarization state and intensity profile of telecommunication signals. We will also report significant results dealing with a new pump-free configuration, which give rise to a much easier to implement promising device.

Julien Fatome, Stephane Pitois, Philippe Morin
University of Bourgogne
jfatome@u-bourgogne.fr, spitois@u-bourgogne.fr, philippe.morin@u-bourgogne.fr

MS24
Theory of Polarization Attraction in Randomly Birefringent Nonlinear Optical Fibers

We derive the coupled stochastic nonlinear equations describing the interaction among different optical waves in fibers with randomly varying birefringence. These equations describe polarization attraction in conservative lossless polarizers based on cross-polarization modulation, as well as dissipative polarization attraction induced by either stimulated Raman scattering or parametric four-wave mixing. We present extensive numerical simulations that link the stochastic properties of the fiber, such as polarization mode-dispersion, to the repolarization capabilities of the different fiber structures.

Stefan Wabnitz
University of Burgundy
stefano.wabnitz@ing.unibs.it

Victor Kozlov, Massimiliano Guasoni
University of Brescia
victor.kozlov@ing.unibs.it, guasomax@libero.it

MS24
Hamiltonian Relaxation Phenomena and Applications to Nonlinear Optics

In this talk, we provide a generalized understanding of the phenomenon of polarization attraction. More precisely, we analyze the polarization dynamics of counterpropagating waves in two non standard optical fiber systems, i.e. the spun fiber and the randomly birefringent fiber, the latter being relevant to optical telecommunication systems. Our theoretical analysis is based on recently developed mathematical and geometrical techniques, such as the concept of singular torus. Experimental examples will be also given.

A. Picozzi
Université de Bourgogne
antonio.picozzi@u-bourgogne.fr

Elie Assémat, Dominique Sugny, Hans Jauslin
Laboratoire Interdisciplinaire Carnot de Bourgogne
elie.assemat@u-bourgogne.fr, dominique.sugny@u-bourgogne.fr, jauslin@u-bourgogne.fr

MS24
Collapses in Optical Turbulence

We consider turbulence in the framework of Nonlinear Schrödinger Equation with focusing nonlinearity, dissipation, and forcing. Dissipation saturates catastrophic growth of collapses, causing their break down into almost linear waves. These waves form a nearly-Gaussian random field which seeds new collapses. We analyze statistics of the amplitude fluctuations in the turbulent filed and connect it to the evolution and structure of individual collapses and
the statistics of collapses in the field.

Natalia Vladimirova  
Department of Mathematics and Statistics, University of New Mexico  
nvladimi@math.unm.edu

Pavel M. Lushnikov  
Department of Mathematics and Statistics, University of New Mexico  
plushnik@math.unm.edu

MS25  
On the Dynamics of Turbulence Near a Free Surface  
It is becoming increasingly clear that stably-stratified flows can support a stratified turbulence inertial range, different from Kolmogorov’s (e.g., Riley and Lindborg, J. Atmos. Sci., 2008). Stratification inhibits vertical motions at larger scales, but the largescale, quasi-horizontal motions produce a strong vertical shearing and small-scale instabilities. The result is a $k^{-5/3}$ horizontal spectrum for the horizontal velocities and density at scales larger than the Ozmidov scale, the largest scale that can overturn. For smaller scales, the classical Kolmogorov $k^{-5/3}$ spectrum applies. Inspired by data taken near the water surface in a tidal river (Chickadel, Talke, Horner-Devine and Jessup, IEEE Geos. Remote Sens. Lett., 2011), we explore here to what extent the dynamics of the nonlinear spectral energy transfer of near-surface turbulence with no mean shear (i.e., turbulence bounded by a free-slip surface) is analogous to stably-stratified turbulence. To that end we perform DNS of decaying, non-sheared turbulence with $Re\lambda \sim 100$, but bounded by a free-slip surface. We find that, indeed, the behavior of the flow near the free-slip surface is similar to stratified turbulence, with a tentative $k^{-5/3}$ range. Recent field measurements by Thomson and Polagye (private communication, 2011) and by Dugan and Piotrowski (JGR, 2012) indicate a similar behavior for larger-scale quasi-horizontal flows limited by depth. We propose that the mechanism exhibited by strongly stratified flows is a more general feature of turbulent flows in which one component of the velocity has been strongly inhibited.

Oscar Flores  
Universidad Carlos III

James Riley  
University of Washington

MS25  
Transient Interfacial Waves - Nonlinear Calculations in Three Dimensions  
We investigate nonlinear internal wave generation by tidal flow over realistic topography which is three-dimensional, where few or no calculations exist, particularly for highly nonlinear wave amplitudes. Method is fully dispersive and fully nonlinear. Energy transfer processes in the ocean are investigated as well as propagation in two horizontal directions. Successive Fourier transform is extensively used for rapid calculations.

John Grue  
University of Oslo  
joehg@math.uio.no

MS25  
The Effects of Rotation on Internal Solitary Waves  
In the weakly nonlinear long wave regime, internal solitary waves are often modeled by the Korteweg-de Vries equation, which is well-known to support an exact solitary wave solution. However, when the effect of background rotation is taken into account, an additional term is needed and the outcome is the Ostrovsky equation. The addition of this term has the drastic effect of destroying the solitary wave solution. Instead an initial solitary-like disturbance decays into radiating oscillatory waves, with the eventual formation of a nonlinear envelope solitary wave, whose carrier wavenumber is determined by an extremum in the group velocity. This process is addressed through a combination of theoretical analyses, numerical simulations and laboratory experiments.

Karl Helfrich  
Woods Hole Oceanographic Institution  
khelfrich@whoi.edu

Roger Grimshaw  
University of Loughborough, UK  
r.h.j.grimshaw@lboro.ac.uk

MS25  
How Nonlinear are the Internal Tides in the Luzon Strait?  
In recent years, the Luzon Strait has been the focus of extensive field studies, remote observations and numerical simulations to gain more insights on the propagation and generation mechanism(s) of some of the largest internal solitary waves observed worldwide. To complement the previous studies, we performed a laboratory experiment at the Coriolis facility in Grenoble, France, site of the world largest rotating table. We modeled the generation of internal tides using realistic three-dimensional topography, realistic density stratification and barotropic tidal forcing. Particular care was taken to achieve dynamical similarity with the ocean problem. We present here the influence of the tidal characteristics (amplitude, frequency) and of the background rotation on the nonlinear aspects of the internal tide generation.

Matthieu Mercier  
Massachusetts Institute of Technology  
mmercer@mit.edu

Louis Gostiaux  
Laboratoire des Ecoulements Geophysique et Industriels, CNRS  
louis.gostiaux@legi.grenoble-inp.fr

Sasan Saidi  
Massachusetts Institute of Technology  
sjsaidi@mit.edu

Joel Sommeria, Samuel Viboud  
LEGI/Coriolis INPG-UJF-CNRS, Grenoble  
joel.sommeria@legi.grenoble-inp.fr, viboud@coriolis-legi.org

Henri Didelle  
Laboratoire des Ecoulements Geophysique et Industriels CNRS  
henri.didelle@legi.grenoble-inp.fr
MS25
Generation and Propagation of Internal Waves in a Model of the Deep Ocean

We present studies of internal gravity waves in a stratified fluid designed to model the deep ocean. King et al. recently found that stratification in regions of the deep ocean below (previously unknown) turning depths is too weak to support tidally generated internal waves. The present experiments and simulations examine internal wave reflection at turning depths. Further, we study internal wave generation by tidal flow over bottom topography that is below a turning depth.

Matthew S. Paoletti, Harry Swinney
University of Texas at Austin
Center for Nonlinear Dynamics
mpaolett@gmail.com, swinney@chaos.utexas.edu

MS26
Dispersive Shock Wave Propagation in Weakly Non-Uniform Media

We consider the propagation of dispersive shock waves (DSWs) through weakly non-uniform media in the framework of the KdV equation with a slowly varying dispersion coefficient. We show that the interaction of DSWs with variable environments can result in a number of non-local and non-adiabatic responses including the generation of multi-phase regions and expanding soliton trains. In particular, our solutions describe the transformation of shallow-water undular bores on a slope.

Gennady El
Loughborough University, United Kingdom
g.el@lboro.ac.uk

MS26
Dark Solitons, Dispersive Shock Waves and their Transverse Instabilities

Transverse instabilities of dark solitons for the (2+1)-dimensional defocusing nonlinear Schrodinger / Gross-Pitaevskii equation are considered. Asymptotics and computations of the linearized equation yield the dispersion relation, which, in turn, yields the separatrix for the transition between convective and absolute instabilities of dark solitons. The implications for stationary and non-stationary oblique dispersive shock waves are elucidated. Our results have application to controlling nonlinear waves in dispersive media, such as dispersive shocks in Bose-Einstein condensates and nonlinear optics.

Boaz Ilan
School of Natural Sciences
University of California, Merced
bilan@ucmerced.edu

Mark A. Hoefer
North Carolina State University
mahoefer@ncsu.edu

MS26
The Semiclassical Modified Nonlinear Schrdinger Equation

The modified nonlinear Schrödinger (MNLS) equation is a completely integrable system that appears to be a perturbation of the focusing nonlinear Schrödinger (NLS) equation. However, the perturbation is singular and it turns out that one of its effects is that for certain initial data the problem behaves more like a perturbed defocusing NLS equation than a perturbed focusing NLS equation. This effect is particularly dramatic in the semiclassical limit, in which it can be seen that the modulational instability of the unperturbed problem completely disappears in the perturbed problem for certain initial conditions. This is joint work with Jeffery DiFranco and Benson Muite.

Peter D. Miller
University of Michigan, Ann Arbor
millerpd@umich.edu

MS26
Thermodynamic Phase Transitions and Shock Singularities

We show that, under rather general assumptions on the form of the entropy function, the energy balance equation for a system in thermodynamic equilibrium is equivalent to a set of nonlinear equations of hydrodynamic type. This set of equations is integrable via the method of characteristics and it provides the equation of state for the gas. The shock wave catastrophe set identifies the phase transition. A family of explicitly solvable models of non-hydrodynamic type such as the classical plasma and the ideal Bose gas is also discussed.

Antonio Moro
SISSA-International School for Advanced Studies
Trieste, Italy
amoro@sissa.it

MS26
Semiclassical Dynamics and Rogue Waves Formation in Quasi 1D Attractive BoseEinstein Condensates: The Riemann-Hilbert Problem Approach

The strongly interacting regime for attractive Bose-Einstein condensates (BECs) tightly confined in an extended cylindrical trap is studied. For appropriately prepared, non-collapsing BECs, the ensuing dynamics are found to be governed by the one-dimensional focusing Nonlinear Schrödinger (NLS) in the semiclassical (small dispersion) regime. In spite of the modulational instability of this regime, some mathematically rigorous results on the strong asymptotics of the semiclassical limiting solutions were obtained recently. Using these results, implosion-like and explosion-like events are predicted whereby an initial hump focuses into a sharp spike which then explodes into two rapidly oscillating radiative waves (rogue waves), whose initial amplitude is about 3 times the amplitude of the background waves. Seemingly related behavior has been observed in three-dimensional experiments and
models, where a BEC with a sufficient number of atoms undergoes collapse. The dynamical regimes we consider, however, are not predicted to undergo collapse. Instead, distinct, ordered structures, appearing after the implosion, yield interesting new observables that may be experimentally accessible. All the dynamical results follow from the rigorous analysis of the Riemann-Hilbert problem that describes the inverse scattering transformation for the NLS.

Alexander Tovbis
University of Central Florida
Department of Mathematics
alexander.tovbis@ucf.edu

MS27
Painlevé Functions and Critical Behavior in Nonlinear Wave Equations
The solution to a nonlinear wave equation associated to a given initial condition will often display two or more qualitatively different behaviors in different regions of space-time, such as having an oscillatory zone and a non-oscillatory zone. The boundaries between these regions may become well-defined in certain limits (such as small dispersion). In this case it is natural to consider the transition behavior between the two regions. In the past three years, it has been discovered that for several equations, including the Korteweg-de Vries, nonlinear Schrödinger, and Camassa-Holm equations, that certain critical behavior can be described for wide classes of initial conditions in terms of Painlevé functions. These functions, which are solutions of nonlinear ordinary differential equations, seem to play a role for nonlinear equations analogous to the role played by the classical special functions for linear equations. We will discuss recent work with P. Miller using the Riemann-Hilbert approach on Painlevé-type asymptotics. We present a Riemann-Hilbert problem, on the plane, for these Baker-Akhiezer functions.

Robert Buckingham
University of Cincinnati
bucknrt@ucmail.uc.edu

MS27
Large Size Riemann-Hilbert Problems in Random Matrix Theory
We discuss some large size Riemann-Hilbert problems arising from critical phenomena in random matrix theory and non-intersecting Brownian motion models. The size of the Riemann-Hilbert problems is 3x3 or 4x4. The jump contour consists of 10 rays through the origin.

Steven Delvaux
Department of Computer Science
Katholieke Universiteit Leuven, Belgium
steven.delvaux@wis.kuleuven.be

MS27
Finite-Genus Solutions of Integrable Equations: A Numerical Riemann-Hilbert Approach
For many integrable equations, computing finite-genus solutions can be reduced to computing a certain hyperelliptic Baker-Akhiezer function. We present a Riemann-Hilbert problem, on the plane, for these Baker-Akhiezer functions. After deformation, this Riemann-Hilbert problem is solvable via the numerical method of Sheehan Olver. This gives an efficient and spectrally accurate numerical method for computing finite-genus solutions.

Thomas D. Trogdon
Department of Applied Mathematics
University of Washington
trogdon@amath.washington.edu

Bernard Deconinck
University of Washington
bernard@amath.washington.edu

MS28
Wave Propagation in Anharmonic Discrete Systems
We present some anharmonic nonlinear discrete models and study, numerically and asymptotically, the possibility of propagation of coherent structures. In one of the cases we show the possibility of wave propagation of Toda’s solutions type and in another case exponential cusp-like traveling wave solution is shown to exist for a cubic interaction. These results are obtained in the fully discrete regime.

Luis A Cisneros-Ake
ESFM-Instituto Politecnico Nacional
cisneros@esfm.ipn.mx

MS28
Stable, Conservative Solution Methods for Large, Stiff Hamiltonian Systems Modeling Coherent Phenomena in Nonlinear Optics and Biophysics
A variety of problems in biophysics and nonlinear optics lead to the need to solve large, stiff, mildly nonlinear systems of ODEs that have Hamiltonian form, or perturbations of such by slight dissipation or noise. This talk presents a variant of the discrete gradient approach of Gonzales and Simo, adapted to deal with stiffness in the common scenario where this arises only from dominant linear terms, not the nonlinearities. Several applications will be considered as time permits; in particular, some new coherent phenomena in ODE systems of discrete nonlinear Schrödinger equation form relating to a novel continuum limit approximation, quite different from the usual NLS approximation.

Brenton J. LeMesurier
College of Charleston
Department of Mathematics
lemesurierb@cofc.edu

MS28
Second Harmonic Generation in Negative Index Materials
We present novel energy conversion from the fundamental frequency to the second harmonic by use of negative index materials. One of the most fundamental properties of negative index materials is an opposite directionality of the Poynting vector, thus energy transfer occurs while the fields counterpropagate, instead of the traditional co-propagating format. By clever use of conservation laws we can find input output solutions and show efficient energy conversion even in the presence of phase mismatch

Alejandro Aceves
Southern Methodist University
NW12 Abstracts

Zhaxylyk Kudyshev
Department of Physics, Al-Farabi Kazakh National University, Almaty, Kazakhstan
z.kudyshev@gmail.com

Ildar Gabitov, Alyssa Pampell
Department of Mathematics
Southern Methodist University
igabitov@smu.edu, apampell@smu.edu

MS28
Instabilities of Breathers in a Discrete Nls

We review some numerical and analytical results on the continuation of breathers in the cubic discrete NLS equation in finite one dimensional lattices. Breathers can be viewed as fixed points in a reduced system and we use the stability properties of breathers to obtain information on the topology of the energy hypersurface in a system of three sites. The change to a connected energy hypersurface corresponds to elliptic-hyperbolic breathers, and we study numerically Lyapunov periodic orbits, and their stable and unstable manifolds. We see evidence of homoclinic orbits and we also discuss heteroclinic orbits and the question of transport of energy.

Panayotis Panayotaros
Depto. Matematicas y Mecanica
IIMAS-UNAM
panos@mym.iimas.unam.mx

MS28
Light Propagation in Two Dimensional Plasmonic Arrays

We present results on the dynamics of light beams propagating in two dimensional waveguides. We show how different configurations provide a rich dynamics of localization, solitary wave formation and stability.

Danhuaw Wang, Alejandro Aceves
Southern Methodist University
danhuaw@mail.smu.edu, aaceves@smu.edu

MS29
From Newton’s Cradle to the p-Schrödinger Equation

We study localized waves in chains of oscillators coupled by Hertzian interactions, a problem originally motivated by the Newton’s cradle under the effect of gravity. We consider an unusual setting where local oscillations and binary collisions occur on similar time scales. Using both direct numerical computations and an asymptotic model (the discrete p-Schrödinger equation), we obtain static and traveling breathers with unusual properties, including enhanced localization, almost vanishing Peierls-Nabarro barrier and direction-reversing motion.

Guillaume James
Laboratoire Jean Kuntzmann, Université de Grenoble and CNRS
guillaume.james@imag.fr

Panayotis Kevrekidis
Department of Mathematics and Statistics
University of Massachusetts
panayotis kevrekidis @kevrekid@gmail.com

Jesus Cuevas
Departamento de Fisica Aplicada I
Escuela Politecnica Superior. Universidad de Sevilla
jess cuevas maraver @jcuevas@us.es

MS29
Nonlinear Frequency Conversion Through Driven Granular Media

The frequency spectrum of vibrational based sources is important in a variety of applications. We examine methods to control the spectra of these sources through driven granular crystals. The nonlinear Hertzian interaction allows granular systems to be highly tunable and exhibit three distinct regimes, linear, weakly nonlinear, and strongly nonlinear. By varying the precompression and length of the granular chain, we leverage nonlinear phenomena to shift energy between modes of different frequencies.

Joseph Lydon
California Institute of Technology
josephlydon1@gmail.com

MS29
Dispersion Estimation for Weakly and Strongly Nonlinear Periodic Systems

Techniques developed for the estimation of the dispersion properties of nonlinear periodic media are presented. Weekly nonlinear systems are first analyzed through a perturbation approach implemented in a commercial FE tool. Next, strongly nonlinear one-dimensional and two-dimensional granular lattices are studied as examples of strongly nonlinear systems through a harmonic balance method. Both methodologies illustrate the amplitude-dependent dispersion properties of nonlinear systems, and suggest their potentials as tunable waveguides.

Massimo Ruzzene
Georgia Institute of Technology
massimo.ruzzene@ae.gatech.edu

MS29
Resonances, Solitary Waves, and Passive Wave Redirection in Granular Media

We discuss rich dynamics of ordered heterogeneous granular media with no precompression, including countable infinities of nonlinear resonances in dimer chains leading to strong attenuation of propagating pulses; countable infinities of nonlinear anti-resonances in the same dimers leading to families of solitary waves; and capacity for passive wave redirection in weakly coupled homogeneous chains through Landau-Zener tunneling in space. The nonlinear dynamical mechanisms governing these phenomena are studied leading to fully predictive material designs.

Alexander Vakakis
Department of Applied Mathematical and Physical Sciences
National Technical University of Athens
vakakis@central.ntua.gr

Yuli Starosvetsky
University of Illinois at Urbana Champaign
Wavefront propagation in a multiply periodic medium exposes in a very tangible way the small divisor problem of classical mechanics. Consider the speed of a macroscopically planar wavefront as a function of direction angle in $R^2$. Naive perturbation analysis in the limit of small variations from a uniform medium leads to a formal asymptotic expansion, whose terms are in one-to-one correspondence with rational directions: A line from the origin has a rational direction if it intersects a prime integer lattice point \( \mathbf{k} = (m, n) \), where \( m \) and \( n \) are integers with no common factor. The sum diverges in any rational direction, but standard diophantine analysis establishes convergence in almost all of the remaining irrational directions. Obviously the small divisor series begs the question what is the actual structure of the speed function? Formal singular perturbation analysis provides an intriguing clue: Let \( \epsilon \) be the gauge parameter measuring the deviation from a uniform medium: The partial sum of the small divisor series with \( |k| < \epsilon^{-p}\) , \( p = \) positive exponent is regarded as an outer expansion and we examine its asymptotic matching to inner expansions around all the rational directions with \( |k| < \epsilon^{-p}\). The inner expansions are done by Arnold averaging. We use a nonstandard variation of the usual diophantine analysis to show that the outer expansion matches with all the inner expansions if \( 0 < p < 16 \). The conjecture that the uniformly valid expansion based upon this matched asymptotics approximates the real speed function as \( \epsilon \to 0 \) will be tested by a numerical solution by J. Wilkening.

MS30
Variational Methods for Solitary Water Waves

I will speak on variational methods for solitary waves on the free surface of a two-dimensional steady, irrotational flow of water, acted upon by gravity. I will begin by formulating the steady water wave problem as a nonlinear partial differential equation via conformal mappings and compare to Babenko’s equation for Stokes waves. I will argue non-existence in the infinite-depth case by Pohozaev identity techniques. After commenting how the Korteweg-de Vries equation arises in the finite-depth case as the leading-order approximation in a certain weakly-nonlinear long-wave regime, I will explain existence in the finite-depth case of solitary waves as minimizers.

Vera Mikyoung Hur
University of Illinois at Urbana-Champaign, USA
verahur@gmail.com

MS30
Small Divisors Made Visible

Wavefront propagation in a multiply periodic medium exposes in a very tangible way the small divisor problem of classical mechanics. Consider the speed of a macroscopically planar wavefront as a function of direction angle in $R^2$. Naive perturbation analysis in the limit of small variations from a uniform medium leads to a formal asymptotic expansion, whose terms are in one-to-one correspondence with rational directions: A line from the origin has a rational direction if it intersects a prime integer lattice point \( \mathbf{k} = (m, n) \), where \( m \) and \( n \) are integers with no common factor. The sum diverges in any rational direction, but standard diophantine analysis establishes convergence in almost all of the remaining irrational directions. Obviously the small divisor series begs the question what is the actual structure of the speed function? Formal singular perturbation analysis provides an intriguing clue: Let \( \epsilon \) be the gauge parameter measuring the deviation from a uniform medium: The partial sum of the small divisor series with \( |k| < \epsilon^{-p}\) , \( p = \) positive exponent is regarded as an outer expansion and we examine its asymptotic matching to inner expansions around all the rational directions with \( |k| < \epsilon^{-p}\). The inner expansions are done by Arnold averaging. We use a nonstandard variation of the usual Diophantine analysis to show that the outer expansion matches with all the inner expansions if \( 0 < p < 16 \). The conjecture that the uniformly valid expansion based upon this matched asymptotics approximates the real speed function as \( \epsilon \to 0 \) will be tested by a numerical solution by J. Wilkening.

John Neu
Dept. of Mathematics
University of California at Berkeley
neu@Math.Berkeley.edu

MS30
Traveling Water Waves in Three Dimensions

In this talk I shall present a new single equation for the surface elevation of a traveling water-wave in an incompressible, inviscid, irrotational fluid. This new equation is derived from the full set of Euler’s Equations and is valid for both a one- and two-dimensional traveling wave surfaces, with and without surface tension. Some sample solutions, obtained through Stokes expansions as well as numerical computations, will also be presented.

Vishal Vasan
Department of Applied Mathematics
University of Washington
vvasan@amath.washington.edu

Katie Oliveras
Seattle University
Mathematics Department
oliverak@seattleu.edu

MS30
Global Continuation for Solitary Waves with Vorticity

We consider the solitary wave water problem with an arbitrary distribution of vorticity. Small amplitude solutions have been constructed in [Hur, 2008] and later in [Groves and Wahlén, 2008]. We use degree theory to prove a continuation result, constructing a global connected set of solutions.

Miles Wheeler
Department of Mathematics
Brown University
miles@math.brown.edu

MS30
Breakdown of Self-similarity at the Crests of Large-amplitude Standing Water Waves

We study the limiting behavior of large-amplitude standing waves on deep water using high-resolution numerical simulations in double and quadruple precision. While traveling waves are known to approach Stokes’s 120 degree corner wave in an asymptotically self-similar manner, standing waves do not approach Penney and Price’s conjectured 90 degree corner solution. Instead, a variety of oscillatory structures form near the crest tip, causing the bifurcation curve to fragment into disjoint branches. Additional branches of solutions nucleate and merge as fluid depth decreases. For comparison, we consider the effect of small divisors in a model KAM system.

Jon Wilkening
UC Berkeley Mathematics
wilken@math.berkeley.edu

MS31
Applications of Carrier-Envelope Phase-Locked Lasers

Frequency combs broadband phase-coherent optical sources are finding an increasing number of new applications in the field of metrology.

Nathan Newbury
NIST
MS31
Ultraparallel Noise Mode-locked Semiconductor Diode Based Fiber Lasers

The development of ultrafast mode-locked lasers based on harmonic mode-locking have recently produced wide spaced frequency combs (~10 GHz) with long term stability and narrow comb tooth linewidth (~500 Hz). The overall phase noise (timing jitter) integrated to Nyquist can be less that 2 femtoseconds. Key to achieving this level of performance requires a fundamental understanding of the underlying nonlinear optical mechanisms of pulse generation, as well as the environmental that drive can perturb the systems overall stability. This talk will review the recent progress in stabilized combs from harmonically mode-locked diode lasers and highlight key mechanisms that play critical roles in the overall output pulse train characteristics.

Peter Delfyett
Center for Research in Optoelectronics and Lasers
University of Central Florida
delfyett@creol.ucf.edu

MS31
Coherent Combs: Optimized Supercontinuum Generation for Carrier-envelope Phase-locked Lasers

The optical frequency comb has become an indispensable tool in many areas of pure and applied science, opening new frontiers in fields as diverse as astrophysics, atomic physics, and sensing. However, the generation of broadband phase-stable combs for the most demanding applications still often remains a matter of trial and error, limiting the potential uptake of this technology. The use of optical fiber supercontinuum generation for comb stabilization is of course a well-known technique, but surprisingly, the dynamics of this process and the impact on comb stability remain poorly understood. In this talk we review work in this field, with the overall aim of providing clear guidelines for the generation of stable phase-stabilised frequency combs from mode-locked lasers. If time permits, links with other areas of wave instability physics will also be addressed.

John Dudley
Universite de Franche Comte
john.dudley@univ-fcomte.fr

MS31
Chip-Based Parametric Frequency Combs

We describe recent work on the generation of ultrabroadband frequency combs based on parametric four-wave mixing in silicon-based micro resonators. This system exhibits extreme nonlinear optical effects at modest power levels, and many issues related to the dynamics, noise, and mode locking remain not well understood. Ultimately, this system offers the promise of highly compact, robust sources for metrology, spectroscopy, and ultrafast applications.

Alexander Gaeta
Applied and Engineering Physics
Cornell University, Ithaca, NY 14853
alg3@cornell.edu

MS31
Carrier-envelope Phase Locking of Multi-pulse Lasers

We propose the use of an intra-cavity Mach Zehnder interferometer (MZI), for increasing the repetition rate at which carrier-envelope phase-locked pulses are generated in passively mode-locked fiber lasers. The attractive feature of the proposed scheme is that light escaping through the open output ports of the MZI can be used as a monitor signal feeding a servo loop that allows multiple pulses to co-exist in the cavity, while rigidly controlling their separation. The proposed scheme enables in principle a significant increase in the pulse-rate with no deterioration in the properties of the generated pulses.

Mark Shtaif
Physical Electronics
Tel Aviv University
shtaif@eng.tau.ac.il

MS32
Shock-driven Jamming and Periodic Fracture at Particulate Interfaces

When a monolayer of hydrophobic particles at the air-water interface is disturbed by a surfactant droplet, a radially divergent surfactant shock emanates and packs the particles into a jammed annulus that grows with time. This 2D, disordered, elastic solid then fractures to form periodic triangular cracks with robust geometrical features. We describe a simple experiment complemented by minimal simulation that studies the formation and failure of a disordered solid at the air-water interface.

Mahesh Bandi
Okinawa Institute of Science and Technology
Collective Interactions Unit
bandi@oist.jp

MS32
Localized Structures in Complex Fluids

In the Faraday system a thin layer of fluid is vertically vibrated. The primary instability is a transition from a flat to a wavy interface. While much is known about extended states in this system, far less is known about localized structures. Recently, a new class of localized structures kinks and persistent holes were discovered in the Faraday system with particulate suspensions as the working fluid. These structures are markedly different from other examples: they oscillate about an unstable state and are inaccessible via infinitesimal perturbation from the weakly nonlinear states. I will present experimental results on these structures in particulate suspensions, worm-like micellar
solutions, and emulsions.

Robert Deegan
University of Michigan
Department of Physics
rddeegan@umich.edu

MS32
Plants in Motion: Mechanics and Function in Winding Tendrils

The helical coiling of plant tendrils has fascinated scientists for centuries, yet the mechanism of coiling remains elusive. Moreover, despite Darwin’s widely accepted interpretation of coiled tendrils as soft springs, their mechanical behavior is unknown. Our experiments on cucumber tendrils demonstrate that tendril coiling occurs via asymmetric contraction of an internal fiber ribbon of specialized cells. The mechanical behavior of tendrils under tension adds a new twist to the story and quantifies Darwin’s original interpretation.

Sharon Gerbode
Harvey Mudd College
Department of Physics
gerbode@hmc.edu

MS32
Helical Swimming in Viscoelastic Fluids

Many bacteria swim by rotating helical flagella. These cells often live in polymer suspensions, which are viscoelastic. To explore the effect of viscoelasticity on the bacterial motility, the helical swimmer is simulated by a model system - a rotating helical coil. When immersed in a viscoelastic fluid, the helix swims faster as compared with the Newtonian case. The enhancement is maximized when the rotation rate of the helix matches the relaxation time of the fluid.

Bin Liu
Brown University
Department of Physics
bin_lij@brown.edu

MS32
Linking Structure to Dynamics in Weak Turbulence

Despite an enormous range of applications and centuries of scientific study, understanding and predicting the flow of fluids remains a tremendous challenge, particularly when the flow is chaotic or turbulent. Turbulent flows tend to be characterized by violent fluctuations, broad ranges of strongly coupled degrees of freedom, and significant variability in space and time. But despite all this, turbulent is not random. Rather, it tends to self-organize into striking patterns and features. Some of these coherent structures, such as strong vortices, are readily apparent; others are more subtle. But how much can we learn about the flow from studying coherent structures? To begin to answer this question, I will discuss experiments that suggest deep links between flow structure (that is, localized spatiotemporally coherent regions) and dynamics (that is, the flow of energy in the system).

Nicholas T. Ouellette
Yale University
nicholas.ouellette@yale.edu

MS33
A Numerical Study of Stability of Periodic Kuramoto-Sivashinsky Waves

We consider the spectral and nonlinear stability of periodic traveling wave solutions of a generalized Kuramoto-Sivashinsky equation. In particular, we resolve the longstanding question of nonlinear modulational stability by demonstrating that spectrally stable waves are nonlinearly stable when subject to small localized (integrable) perturbations. We carry out a numerical Evans function study of the spectral problem and find bands of spectrally stable periodic travelling waves, in close agreement with previous numerical studies of Frisch-She-Thual, Bar-Nepomnyashchy, Chang-Demekhin-Kopelevich, and others carried out by other techniques. We also compare predictions of the associated Whitham modulation equations, which formally describe the dynamics of weak large scale perturbations of a periodic wavetrain, with numerical time evolution studies, demonstrating their effectiveness at a practical level.

Blake Barker
Indiana University
BYU
bhbarker@gmail.com

Mathew Johnson
University of Kansas
matjohn@math.ku.edu

Pascal Noble, Miguel Rodrigues
University of Lyon
noble@math.univ-lyon1.fr, rodrigues@math.univ-lyon1.fr

Kevin Zumbrun
Indiana University
USA
kzumbrun@indiana.edu

MS33
Stability of Periodic Traveling Waves in a KdV/Kuramoto-Sivashinsky Equation

In this talk, we consider the spectral and nonlinear stability of periodic traveling wave solutions of a KdV/Kuramoto-Sivashinsky equation modeling thin film flow down an incline. 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 recent result and, time permitting, I will discuss numerical and analytical verifications of the required spectral stability and structural hypothesis of this theorem in particular canonical limits of dispersion/dissipation. This is joint work with Blake Barker, Pascal Noble, L. Miguel Rodrigues, and Kevin Zumbrun.

Mat Johnson
University of Kansas
matjohn@math.ku.edu

MS33
(In)stability of Traveling Waves for the Sine-Gordon Equation: How Bands Balloon

Traveling waves of the Sine-Gordon equation exist as kinks
and oscillations in both the subluminal and superluminal regimes. It has been folklore that only subluminal kinks are stable in the spectral sense and all of the other waves are unstable. The spectral problem has, however, not been properly analyzed because of its non self-adjoint structure. We show that spectral bands can become balloons, and do so except in the subluminal kink case, which is indeed stable.

Christopher Jones
University of North Carolina and University of Warwick
ckrtj@email.unc.edu

Robert Marangell
University of Sydney
robertmarangell@gmail.com

Peter D. Miller
University of Michigan, Ann Arbor
millerpd@umich.edu

Ramon G. Plaza
Institute of Applied Mathematics (IIMAS)
National University of Mexico (UNAM)
rgplaza@gmail.com

MS33
On the Spectral Stability of Nonlinear Waves in Continuum Mechanics

We discuss some non-standard spectral problems associated to the stability of nonlinear waves in continuum mechanics. Applications to elasto-chemical waves and waves in thermoelasticity, among others, will be discussed.

Ramon G. Plaza
Institute of Applied Mathematics (IIMAS)
National University of Mexico (UNAM)
rgplaza@gmail.com

MS33
Breather Stability in Klein-Gordon Equations

We will present results on breather stability in Klein-Gordon equations. We will show results for discrete Klein-Gordon chains that relate the type of multibreathers – where oscillators are at rest, in or out of phase – to the sign of eigenvalues in the perturbation matrix. The weak coupling perturbation is with respect to the case without coupling between the oscillators. Next, we will show results for continuous Klein-Gordon equations that approximate the discrete ones.

Zoi Rapti
University of Illinois at Urbana-Champaign
zrapti@math.uiuc.edu

MS34
Localized Oscillations in a Nonvariational Swift-Hohenberg Equation

Stationary spatially localized states occur in many systems of physical interest, and are often organized in a so-called ‘snakes-and-ladders’ structure. In recent years the Swift-Hohenberg equation has garnered much attention as the standard model exhibiting this behavior. In this talk I consider a generalized version of the Swift-Hohenberg equation and show that it exhibits, in addition to the usual stationary localized states, both oscillating localized states and traveling pulses.

John Burke
Boston University
jhb@math.bu.edu

MS34
Interacting Invasion Fronts

We consider invasion fronts in systems of reaction-diffusion equations representing the displacement of an unstable homogeneous state by a stable one. In particular, we are interested in systems for which this transition takes place via a third, intermediate state. In some cases, the invasion process splits into a pair of propagating fronts traveling with different speeds while in other situations a single front is formed. We discuss mechanisms leading to both behaviors and consider applications to pattern forming systems using amplitude equations.

Matt Holzer
School of Mathematics
University of Minnesota
mdholzer@umn.edu

Arnd Scheel
University of Minnesota
scheel@umn.edu

MS34
Colliding Convectons

Convectons are strongly nonlinear spatially localized states found in thermally driven fluid systems. In binary fluid convection with midplane reflection symmetry convectons of odd and even parity lie on a pair of intertwined branches (J. Fluid Mech. 667 (2011) 586) that form the backbone of the snakes-and-ladders structure of the so-called pinning region. These branches are connected by branches of asymmetric localized states that drift. When the midplane reflection symmetry is broken, the odd parity convectons also drift, greatly modifying the snakes-and-ladders structure of the pinning region. The resulting speed depends on the magnitude of the symmetry-breaking and the convecton length. Head-on and follow-on collisions between odd parity drifting convectons of different lengths are described and the results compared with corresponding dynamics in a Swift-Hohenberg model studied by Houghton and Knobloch (PRE 84 (2011) 016204).

Edgar Knobloch
University of California at Berkeley
Dept of Physics
knobloch@berkeley.edu

Isabel Mercader, Oriol Batiste
UPC, Barcelona, Spain
isabel@fa.upc.edu, oriol@fa.upc.edu

Arantxa Alonso
Fisica Aplicada
UPC, Barcelona
arantxa@fa.upc.edu

MS34
Gluing Localized Structures in Reaction-diffusion
**Systems**

The Swift–Hohenberg equation serves as a model system to study pattern formation in reaction-diffusion equations. An infinite family of stationary multi-pulse spot solutions to the radially symmetric Swift–Hohenberg equation are constructed for dimensions one through three. This requires matching a spot and ring solution, which both scale identically with the bifurcation parameter. The multi-pulses exhibit an anomalous scaling that differs from those for each of the glued solutions.

Scott McCalla  
University of California Los Angeles  
sgmccalla@gmail.com

**MS34**

**Heterogeneity-induced Spot Dynamics in Dissipative Systems**

We discuss the behaviors of traveling 2D spots arising in a three component reaction diffusion system when the medium has a jump heterogeneity along the line. The traveling spot responds in various ways depending on the the height of the jump and the incident angle when it encounters the jump line. Refraction and reflection are commonly observed. Two issues are discussed here: One is the relation between the incident angle and the refraction angle when the spot crosses the jump. In a scaling limit near a drift bifurcation, a Snell's-like law holds for the refraction case. The other is the transition from refraction to reflection. Such a transition occurs as the incident angle is increased for a fixed height or the height is increased for a fixed incident angle. As the angle (or height) approaches the critical one, the spot spends much longer time in the right half plane after crossing the jump line and it eventually converges to the one traveling parallel to the jump line but infinitely far from it, namely it is a traveling spot in the homogeneous space located at right infinity. We call such a special solution "scatter" located at infinity.

Takashi Teramoto  
Chitose Institute of Science and Technology  
teraponn@mac.com

Yasumasa Nishiura  
RIES, Hokkaido University  
nishiura@nsc.es.hokudai.ac.jp

**MS35**

**Symbolic Computation of Point Symmetries of an Infinite Family of Multi-point Correlation Equations in Turbulence Theory**

The nonlinear Euler or Navier-Stokes equations governing the incompressible fluid motions can be re-cast through ensemble averaging into an infinite countable system of multi-point correlation equations for the unknown correlation tensors of increasing order. In particular, the first such tensor is the mean flow velocity. The system consists of coupled linear partial differential equations of increasing complexity. We demonstrate the use of a modification of GeM symbolic software for Maple to consistently seek symmetries of such a system of equations, in particular, to discover symmetries of multi-point correlation equations inherited from the original nonlinear model. This is a joint work with Andreas Rosteck and Martin Oberlack from TU Darmstadt.

Alexei F. Cheviakov  
Department of Mathematics and Statistics  
University of Saskatchewan  
cheviakov@math.usask.ca

**MS35**

**Symbolic Computation of Perturbation-Iteration Solutions for Nonlinear Differential Equations**

An algorithm for the symbolic computation of perturbation-iteration solutions of nonlinear differential equations will be presented. In the algorithm, the number of correction terms in the perturbation expansion and the number of terms in the Taylor expansion can be arbitrary. The steps of the algorithm will be illustrated on a Bratu type initial value problem. The algorithm has been implemented in Mathematica. The package PerturbationIteration.m will be discussed and demonstrated.

Unal Goktas  
Dept. Computer Engineering  
Turgut Ozal University, Turkey  
ugoktas@turgutozal.edu.tr

**MS35**

**Symbolic Computation of Scaling Invariant Lax Pairs in Operator Form for Integrable Systems**

Based on scaling symmetry properties, a direct method to compute Lax pairs in operator form for completely integrable systems will be presented. By splitting the determining equations for the Lax pair into kinematic and dynamical constraints, the problem can be reduced to solving nonlinear algebraic equations. The method will be illustrated with well-known examples from soliton theory and applied to a three-parameter class of fifth-order KdV-like evolution equations. A Mathematica implementation will be demonstrated.

Willy A. Hereman  
Department of Mathematical and Computer Sciences  
Colorado School of Mines  
whereman@mines.edu

Mark Hickman  
University of Canterbury  
Christchurch, New Zealand  
mark.hickman@canterbury.ac.nz

**MS35**

**Construction of Lax Pairs in Matrix Form and the Drinfeld-Sokolov Method for Conservation Laws**

We will present an algorithmic method for the construction of a class of Lax pairs in matrix form for completely inte-
Flow Instabilities

A particular interaction-diffusion plant-surface water model system for the development of spontaneous stationary vegetative patterns in an arid flat environment is investigated by means of a weakly nonlinear diffusive instability analysis. The main results of this analysis can be represented by closed-form plots in the rate of precipitation versus the specific rate of plant loss parameter space. From these plots, regions corresponding to bare ground and vegetative patterns consisting of tiger bush, labyrinth-like mazes, pearled bush, irregular mosaics, and homogeneous distributions of vegetation may be identified in this parameter space. Then those Turing diffusive instability predictions are compared with both relevant observational evidence and existing numerical simulations involving differential flow migrating stripe instabilities for the associated interaction-dispersion-advection plant-surface water model system.

Bonni Kealy
Department of Mathematics
Washington State University
bkealy@math.wsu.edu

David J. Wollkind
Washington State University
Department of Mathematics
dwollkind@wsu.edu

MS36
Mussel Pattern Formation Model Systems: Comparison of Turing Diffusive and Differential Flow Instabilities

A particular interaction-diffusion mussel-algae plant-surface water model system for the development of spontaneous stationary young mussel bed patterning on a homogeneous substrate covered by a static marine layer containing algae as a food source is investigated employing a weakly nonlinear diffusive in-
stability analysis. The main results of this analysis can be represented by plots in the ratio of mussel motility to algae lateral diffusion versus the rate of mussel growth parameter space. From these plots, regions corresponding to bare sediment and mussel patterns consisting of bands, labyrinth-like mazes, hexagonal arrays of clumps or gaps, irregular mosaics, and homogeneous distributions of low to high density may be identified in this parameter space. Then those Turing diffusive instability predictions are compared with both relevant laboratory experimental evidence and existing numerical simulations involving differential flow migrating band instabilities for the associated interaction-dispersion-advection mussel-algae model system.

David J. Wollkind
Washington State University
Department of Mathematics
dwollkind@wsu.edu

Richard Cangelosi
Department of Mathematics
Washington State University
richard.cangelosi@email.wsu.edu

MS36
Row Formation in Lepidopteran Wings by Origin-Dependent Cell Adhesion: An Individual Cell Interaction Model

Regardless of the obvious differences in the color patterns exhibited by lepidopteran wings in nature, the scale cells that display colors have a remarkable similarity in spatial patterning. Precursors of scale cells develop and migrate into rows roughly parallel to the proximodistal axis. Experiments have revealed that a gradient of activity along the wings, as well as the maintenance of cell adhesivity within each cell, may have been reasons for the formation of rows. In addition, cell polarization along the proximodistal axis in some species, and the extension of filopodia in response to protein expression, are observed. Based on mechanisms observed in experiments, a model of individual precursor interaction and migration is developed to simulate the formation of parallel rows. The results show that the origin dependent cell adhesion is crucial in producing parallel rows, although short-range and long-range cell interactions are important in generating stable spatial patterns. In contrast, the effect of polarization is less significant. This individual cell interaction model is compared with the existing nonlinear differential integral origin-dependent cell adhesion model using cell density as a model variable.

Mei Zhu
Pacific Lutheran University
Department of Mathematics
zhuma@plu.edu

MS37
Wilton Ripples in Weakly Nonlinear Models

A method for computing Wilton ripples, traveling waves supported at two resonant harmonics, is presented for a class of weakly nonlinear model equations. This method is perturbative in nature; all perturbation orders are computed exactly. The method is used to numerically compute solution profiles as well as the disc of analyticity of branches of solutions. The procedure provides a natural framework to prove existence and analyticity of branches of solutions.

Benjamin Akers
Air Force Institute of Technology
benjamin.akers@afit.edu

MS37
Time-periodic Vortex Sheets with Surface Tension

We present results from joint work with Jon Wilkening on computation of time-periodic solutions of the vortex sheet with surface tension. These are found by defining a functional which is zero for time-periodic solutions and positive otherwise; the functional is then minimized by a gradient descent algorithm. Differences between solutions with zero and nonzero mean vortex sheet strength will be discussed. If time allows, a discussion of analytical progress on the question of existence of these solutions (which is joint work with C. Eugene Wayne) will be included.

David Ambrose
Drexel University
ambrose@math.drexel.edu
MS38
Dependence of Mode-locked Laser Linewidth on Pulse Parameter Jitter

We study the spectral linewidth of a finite sequence of near-identical pulses produced by a model for mode-locked lasers. In particular, we show how dispersive radiation can have a significant impact on the random dynamics of the pulse phases, translating to an increased linewidth relative to studies neglecting this phenomenon. Using simulations, we compare the true probability of critical line broadening with the approximate value obtained by using the computed variance with a Gaussian assumption.

Richard O. Moore, Daniel Cargill
New Jersey Institute of Technology
rmoore@njit.edu, dc26@njit.edu

Tobias Schaefer
Department of Mathematics
The College of Staten Island, City University of New York
tobias@math.csi.cuny.edu

MS38
Effect of the Birefringent Beat Length on Variability in Passively Modelocked Fiber Lasers

Birefringence leads to sensitivity of the power transfer to polarization controller settings, loop length, and birefringent beat length in passively modelocked fiber lasers that use nonlinear polarization rotation for fast saturable absorption. We discuss the parameters that lead to the greatest sensitivity and suggest good operating regimes for these lasers.

Brian Marks, Curtis R. Menyuk
UMBC
Baltimore, MD
marks@umbc.edu, menyuk@umbc.edu

MS38
Engineering the Laser Cavity Transmission for Enhanced Energy in Mode-locked Fiber Lasers

The multi-pulsing instability of mode-locked fiber lasers must be avoided in applications where high energy pulses are required. Recently by using a simple geometric model, we showed that it is possible to engineer the laser cavity dynamics by modifying the nonlinear loss curve. In this paper, we theoretically demonstrated that the energy performance can be increased by including a second set of waveplates and polarizer to a laser cavity mode-locked by a set of waveplates and polarizer.

P. K. Alex Wai
Hong Kong Polytechnic University
Dept. of Electronic and Information Engineering
enwai@inet.polyu.edu.hk

Feng Li
Dept. of Electronic and Information Engineering
Hong Kong Polytechnic University
enl@inet.polyu.edu.hk

Edwin Ding
Azusa Pacific University
eding@apu.edu

Nathan Kutz
Dept. of Applied Mathematics
University of Washington
kutz@amath.washington.edu

MS38
Linearized Stability Analysis of the Haus Mode-Locking Equation

Haus mode-locking equation (HME) is the simplest scalar model for mode-locking, in which the fast saturable absorber is modeled as a loss term proportional to the intensity of the electrical field. There are several models introduced for the fast saturable absorption that claimed would be a better match to the physical saturable absorption process. We perform a parameter study of the HME with these different saturable absorption models.

Shaokang Wang
UMBC
swan1@umbc.edu

Andrew Docherty
University of Maryland Baltimore County
docherty@umbc.edu

Brian Marks, Curtis R. Menyuk
UMBC
Baltimore, MD
marks@umbc.edu, menyuk@umbc.edu

MS39
Swimming and Propulsion in Complex Fluids

Abstract not available at time of publication.

Paulo E. Arratia
Mechanical Engineering and Applied Mechanics
University of Pennsylvania, Philadelphia.
parratia@seas.upenn.edu

MS39
Microbial Flow Fields, Noise, and Cell-cell Interactions

It is currently believed that deterministic long-range fluid dynamical effects govern bacterial cell-cell and cell-surface scattering - the elementary events that lead to swarming and collective swimming in active suspensions and to the formation of biofilms. I will present direct measurements of the bacterial flow field, generated by individual swimming Escherichia coli, and use these measurements to show that rotational diffusion drowns out long-range hydrodynamic effects in cell-cell and cell-surface interactions.

Knut Drescher
Princeton University
knutd@princeton.edu
MS39
Title Not Available at Time of Publication
Abstract not available at time of publication.
William Irvine
University of Chicago
wtmirvine@uchicago.edu

MS39
Fluidic Computation: Dynamics of Drops and Bubbles in Geometrical Fluid Networks
Abstract not available at time of publication.
Manu Prakash
Stanford University
Department of Bioengineering
manup@stanford.edu

MS39
Dynamics of Passive Flexible Wings
We investigate the dynamics of passive flexible wings freely falling under the influence of gravity. Particular attention is given to elucidating the role of flexibility in passive flight. The effect of bending on the dynamics of fluttering wings is examined through an experimental investigation of deformable rectangular wings falling in water. Elastic deformations induced by the flow strongly affect the flight characteristics and suggest the existence of an optimal bending rigidity minimizing the descent velocity.
Daniel Tam, John Bush
MIT
dan_tam@mit.edu,

MS40
Two Parameter Methods for Symmetrizable Non-self-adjoint Eigenproblems
Many apparently non-self-adjoint eigenproblems can be recast in the form \( Ay - \lambda By = 0 \) where \( A \) and \( B \) are self-adjoint operators in a suitable Hilbert space. They may however be indefinite, and the use of a two parameter embedding \( Ay - \lambda By = \mu y \) will be explored. Under fairly general conditions this allows one to “see” certain aspects of the spectrum in terms of the \((\lambda, \mu)\) eigencurves.
Paul Binding
Department of Mathematics
University of Calgary
binding@ucalgary.ca

MS40
Index Theorems for Quadratic Pencils with Applications
In dispersive wave equations which are second-order in time, e.g., sine-Gordon and the “good” Boussinesq, the linearized eigenvalue problem associated with the spectral stability of a wave can be realized as a quadratic pencil, where each coefficient of the pencil is either a self-adjoint or skew-symmetric operator. There is a well-developed unstable eigenvalue index theory for linear pencils (going back to Grillakis, Jones, etc., and continuing to Pelinovsky, K/Kevrekidis/Sandstede, etc.), which arise when discussing generalized KdV, coupled systems of Schrödinger equations, etc.; however, the theory is not as well established for quadratic pencils. In this talk I will discuss the extension of the linear theory to the quadratic theory, and apply the theoretical results to the study of the spectral stability of spatially periodic waves.
Todd Kapitula
Calvin College
tmk5@calvin.edu

MS40
Evans-Krein Function and Eigenvalue Counts
The key question in spectral stability of nonlinear waves is the existence of eigenvalues with positive real part of a linearized operator. Two concepts very different in nature proved to be useful in search for such an unstable spectrum: the Evans function, an analytic function with zeros at isolated unstable eigenvalues, and the Krein signature, an algebraic quantity capturing the ability of an eigenvalue to be or to become unstable under a change of a parameter in a system. Although the Evans function does not provide full information about the Krein signature, we show that its simple extension, the Evans-Krein function, allows to calculate the Krein signature of an eigenvalue at almost no additional computational cost. The method used also enables us to give very elegant proofs of eigenvalue counts for linearized Hamiltonians: the Grillakis-Shatah-Strauss criterion, its generalization for systems with broken Hamiltonian symmetry, and a count of real eigenvalues for diag-onizable Hamiltonians originally obtained by Jones.
Richard Kollar
Comenius University
Department of Applied Mathematics and Statistics
kollar@fmph.uniba.sk

MS40
Stability of Solitary Waves of a Sixth-Order Boussinesq Equation
We consider the stability of solitary waves of a sixth-order Boussinesq equation. For a class of homogeneous nonlinearities, we determine the nodal set of the function \( d''(c) \) that determines the stability of solitary waves.
Steve Levandosky
College of the Holy Cross
spl@mathcs.holycross.edu

MS40
Spectral Pollution and Boundary Conditions for PDEs on Singular Domains
PDE spectral problems on singular domains (waveguides; exterior domains; domains in which coefficients blow up or strong ellipticity fails) often have essential spectra. As a consequence, variational methods and domain truncation methods may suffer from spectral pollution: eigenvalues are generated which converge to points not in the spectrum of the original problem. This talk will review some approaches for avoiding this undesirable phenomenon, including an approach proposed by the author involving the
use of relatively compact dissipative perturbations.

Marco Marletta  
Cardiff University UK  
marco.marletta@cs.cardiff.ac.uk

**MS41**  
**Patterns on Sea Urchin Embryos**

Patterns of bone morphogen proteins (BMP) on embryos are important for development. BMP patterns have been studied extensively on fly (drosophila melanogaster) embryos. This joint project was motivated by experimental work of Prof. C. Bradham on sea urchin embryos. We endeavor to explain a number of experimental observations using ARD modeling, and we are in the process of conducting new experiments suggested by the analysis.

Tasso J. Kaper  
Boston University  
tasso@math.bu.edu

Cyndi Bradham  
Biology, Boston University  
tasso@math.bu.edu

Heather Hardway  
Mathematics, Boston University  
tasso@math.bu.edu

Peter van Heijster  
Division of Applied Mathematics  
Brown University, Providence RI  
heijster@math.bu.edu

**MS41**  
**Poiseuille Flow and Apparent Viscosity of Nematic Liquid-crystals**

Abstract not available at time of publication.

Weishi Liu  
Department of Mathematics  
University of Kansas  
wliu@math.ku.edu

**MS41**  
**Fundamental Chemotactic Traveling Wave Phenomena**

Advection-Reaction-Diffusion systems are commonplace in the mathematical biology literature on pattern formation and structure in cell populations. Where directed cell motion in response to a biochemical gradient occurs - a process termed chemotaxis - simple advection terms in the governing continuum model are typically used. In contrast to the classic models of bacteria chemotaxis by Keller and Segel for highly diffusive populations we consider advection-dominated travelling waves as models of dense motile cell populations.

Graeme Pettet  
Queensland University of Technology  
g.pettet@qut.edu.au

**MS41**  
**Stability of Concatenated Waves**

Doug Ward (Drexel) and Sabrina Selle (Bielefeld) have studied stability of concatenated traveling waves, moving with different speeds, in dissipative systems. Their approach treats concatenated waves as a sum of waves. I will describe an alternate approach that respects the concatenated wave structure and uses Laplace transforms to solve the linearized problem.

Xiao-Biao Lin, Stephen Schecter  
North Carolina State University  
Department of Mathematics  
xblin@math.ncsu.edu, schecter@math.ncsu.edu

**MS41**  
**Transonic Evaporation Waves in a Spherical Symmetric Nozzle**

We study the liquid to vapor phase transition in a cone shaped nozzle. Using geometric singular perturbation theory, we extend results on subsonic and supersonic evaporation waves by Fan and Lin (2011) to transonic waves. We are able to show the existence of evaporation waves that cross from supersonic to subsonic regions and evaporation waves that connect from the subsonic regions to the sonic surface and then continue onto the supersonic branch via the slow flow.

Martin Wechselberger  
University of Sydney  
wm@maths.usyd.edu.au

Xiao-Biao Lin  
North Carolina State University  
xblin@gw.ncsu.edu

**MS43**  
**Modeling Landslides and Landslide-generated Tsunamis**

Landslide-generated tsunamis pose a significant threat, yet assessing their potential is challenging due to an unconstrained source. Dynamically modeling landslides can elucidate the tsunamigenic nature of offshore geomorphology, but this remains a difficult endeavor due to the complicated physics of granular-fluid flows. I will describe a two-phased depth-averaged model for tsunamigenic landslides. The model is a nonconservative system of hyperbolic equations similar to the shallow water equations.

David George  
U.S. Geological Survey  
Cascades Volcano Observatory  
dave.jorge@gmail.com

**MS43**  
**A Probabilistic Tsunami Hazard Assessment Study of Crescent City, Ca**

A probabilistic tsunami hazard assessment (PTHA) of Crescent City, CA will be presented. The study is based on nonlinear tsunami inundation simulations with initial conditions corresponding to near- and far-field earthquake sources in the Cascadia, Alaska, Japan-Kamchatka-Kurile and Chile Subduction Zones. The methodology produces maps that provide an estimate of the maximum flood level
that will be exceeded with a specific annual probability at each cell of the inundation computational grid.

Frank I. Gonzalez  
U. Washington, Dept. of Earth and Space Sciences  
figonzal@u.washington.edu

Randall LeVeque, Jonathan Varkovitzky  
U. Washington, Applied Mathematics  
rjl@uw.edu, jonathan.varkovitzky@gmail.com

MS43  
**Simulation of Landslide-Generated Tsunamis with the Hysea Platform: the Lituya Bay 1958 Event**

We present a multi GPU implementation of the IFCP FV scheme of the two-layer Savage-Hutter type model developed by E. D. Fernández-Nieto et al (JCP, 2008) to study submarine avalanches. In this model, a layer composed of fluidized granular material is assumed to flow within a layer composed of an inviscid fluid. A new web-based platform named HySEA is used as interface for simulating landslide-generated tsunamis focusing in the Lituya Bay 1958 mega-tsunami event.

Jose Manuel Gonzalez-Vida  
University of Malaga, Spain  
vida@anamat.cie.uma.es

M. De La Asunció, M. J. Castro  
Dpt. Análisis Matemático  
University of Málaga  
marc@ugr.es, castro@anamat.cie.uma.es

E. D. Fernández-Nieto  
Dpt. Matemática Aplicada  
University of Seville  
edofer@us.es

J. Macías  
Dpt. Análisis Matemático  
University of Málaga  
macias@anamat.cie.uma.es

T. Morales  
Dpt. Matemáticas  
University of Córdoba  
macias@anamat.cie.uma.es

C. Parés, C. Sánchez-Linares  
Dpt. Análisis Matemático  
University of Málaga  
carlos_pares@uma.es, linares@anamat.cie.uma.es

MS44  
**Detecting Standing Waves in Modeled Tsunami Wave-Fields**

Continental shelves can serve as a barrier protecting from tsunami, or as a resonator trapping tsunami wave energy in standing waves. Bathymetric features in an adjacent ocean can also contribute to standing wave formation by acting as waveguides. Knowing how tsunami wave energy is transferred from the open ocean into oscillations next to the coast, and the spatial distribution of those oscillations, helps identify areas likely to experience the greatest amplitudes. We demonstrate techniques that use tsunami simulations to determine an area’s resonance characteristics.

Elena Tolkova  
JISAO / NOAA Center for tsunami research  
elena.tolkova@noaa.gov

William L. Power  
GNS Science  
w.power@gns.cri.nz

MS44  
**Laser Light Condensation Phenomena**

We present in a theoretical and experimental study various condensation phenomena in cw and mode-locked lasers. They are based on weighting the laser modes in a noisy environment (spontaneous emission, etc.) by a loss-gain scale rather than in photon energy. They are characterized by a sharp transition from multi- to single-mode oscillation. The study uses a simple linear multivariate Langevin formulation with a global constraint which gives a mode occupation hierarchy that functions like Bose-Einstein statistics. We also discuss how and when condensation occurs in photon systems, how it relates to lasing, and the difficulties to observe regular photon Bose-Einstein condensation (BEC) in laser cavities.

Baruch Fischer  
Department of Electrical Engineering  
Technion  
fischer@ee.technion.ac.il

MS44  
**Phase-coherent Repetition Rate Multiplication of a Mode-locked Laser by Injection Locking**

We have used injection locking to multiply the repetition rate of a passively mode-locked femtosecond fiber laser from 40 MHz to 1 GHz while preserving optical phase coherence between the master laser and the slave output. The slave system is implemented almost completely in fiber and incorporates gain and passive saturable absorption. The slave repetition rate is set to a rational harmonic of the master and slave repetition rates.

David Kielpinski  
Australian Attosecond Science Facility  
Griffith University, Brisbane, Australia  
dave.kielpinski@gmail.com

MS44  
**The Sinusoidal Ginzburg-Landau Equation for High-Energy Mode-Locking**

The sinusoidal Ginzburg-Landau Equation (SGLE) is presented to characterize the pulse evolution in a passively...
mode-locked ring cavity laser. The model gives a better description of the cavity dynamics by accounting explicitly for the full periodic transmission generated by the waveplates and polarizer. The SGLE agrees well with the full governing model, and it supports high energy pulses that are not predicted by the master mode-locking theory, thus providing a platform for optimizing the laser performance.

Edwin Ding  
Azusa Pacific University  
eding@apu.edu

J. Nathan Kutz  
University of Washington  
Dept of Applied Mathematics  
kutz@amath.washington.edu

Eli Shlizerman  
University of Washington, Seattle  
shlizee@uw.edu

MS44  
Ultra-short Pulse Dynamics Towards Modeling Atto-second Physics

A new theoretical model is proposed for characterizing the ultrashort (few femtoseconds and below) propagation dynamics in a laser cavity that is mode-locked with a saturable absorbers. The theory circumvents the standard, and problematic, center frequency expansion methods that typically result in the nonlinear Schrödinger based master mode-locking equation. The resulting short-pulse equation framework, which is the equivalent of the nonlinear Schrödinger equation for ultrafast pulses, provides an asymptotically valid description of the electric field amplitude even as pulses are shortened below a single-cycle of the electric field. Given the lack of theory in the ultrafast regime, the model provides the beginning theoretical framework for quantifying the pulse dynamics and stability as pulsewidths approach the attosecond regime.

J. Nathan Kutz  
University of Washington  
Dept of Applied Mathematics  
kutz@amath.washington.edu

Ricardo Barros  
Instituto Nacional de Matematica Pura e Aplicada, Brazil  
rbbarros@impa.br

Anakewit Boonkasame  
University of Wisconsin at Madison, USA  
boonkasa@math.wisc.edu

MS45  
Stable Solitary Waves in Two-layer Flows

The system of equations describing nonlinear and weakly dispersive interfacial waves between two layers of inviscid fluids of different densities and bounded by top and bottom walls is known to be mathematically ill-posed despite the fact that physically stable internal waves have been observed. We obtain a stable nonhydrostatic model for this system and illustrate our results with solitary waves.

J. Nathan Kutz  
University of Washington  
Dept of Applied Mathematics  
kutz@amath.washington.edu

Wooyoung Choi  
Dept of Mathematics  
New Jersey Institute of Tech  
wchoi@njit.edu

MS45  
Strongly Nonlinear Interaction of Crossing Large Amplitude Internal Waves

A regularized model was introduced recently to describe strongly nonlinear internal waves in a two-layer system to eliminate the shear instability at the interface. The two-dimensional time evolution equations for the interface and velocity fields are solved numerically using a pseudospectral method to study the strongly nonlinear interaction of crossing internal solitary waves. Our simulations are compared with the solution of the weakly nonlinear KP equation.

Arnaud Goullet  
NJIT  
arnaud.goullet@gmail.com

MS45  
Modeling Three Dimensional Gravity-capillary Waves in Deep Water

Gravity-Capillary waves enjoy a range of applications. In order to accurately compute complex time dependent solutions, we simplify the full Euler equations by taking a cubic truncation of the Dirichlet-to-Neumann operator for the velocity potential on the free surface with the full surface tension. This equation agrees remarkably well with the full equations of solitary waves. In 3d, fully localised solitary waves are computed and the stability, interaction and focussing phenomena of both line and lump solitary waves are investigated via numerical time evolution, and some interesting dynamical phenomena are observed.

Zhan Wang  
University of Wisconsin-Madison, USA  
zwang@math.wisc.edu

MS45  
Exact Solution of Linear Wave Motion Over Periodic Topography of Large Amplitude and Arbi-
MS46
Modulational Stability for a General Class of Dispersive Waves

Abstract: We consider a very general class of dispersive wave equations having a variational structure of the following form: there are two conserved quantities, a Hamiltonian and a Momentum, and a conserved Casimir, a Mass, along with some scaling relations. This includes a number of models describing water waves. Under these assumptions the stability of long waves is governed by a common mean water depth. Various concrete examples are given and quantitative results are discussed. Comparisons with experimental data are made, and qualitative agreement is achieved. This is a collaboration with Louis N Howard at MIT. Support of JY by NSF (Grants CBET-0756271 and CBET-0845957) is acknowledged.

Jie Yu
North Carolina State University
jie_yu@ncsu.edu

MS46
Spectral Stability of Water Waves: Stable, High-Order Computation in the Presence of Resonance

We study spectral stability of periodic traveling waves in fluids in two dimensions. Rather than simply substituting a computed traveling wave into the linearized water wave problem and appealing to a numerical solver, we use the fact that waves come in analytic branches to show that, generically, the spectral data can also be parametrized analytically. We followed the behavior of the spectrum in the complex plane as a wave height/steepness parameter was increased until divergence of the method. The singularities in the expansions (resulting in the divergence of the numerical scheme) are mandated by the form of the expansions: only purely imaginary eigenvalues can be produced so that the algorithm cannot compute spectrum with a non-zero real part. In the light of this, we pose a conjecture that not only is the presence of a singularity necessary for the onset of (spectral) instability, but it is also sufficient. After careful numerical investigation, we find that the conjecture is largely justified in the case of deep water but unpredicts the onset of instability in shallow water.

David P. Nicholls
University of Illinois at Chicago
nicholls@math.uiuc.edu

MS46
Stability and Bifurcations of Rotating Vortices in the Gross-Pitaevskii Equation with a Harmonic Potential

We show that the rotating symmetric vortices located at the center of a two-dimensional harmonic potential undergo a pitchfork bifurcation with radial symmetry. This bifurcation leads to the family of vortices, which precess constantly along an orbit enclosing the center of symmetry. The radius of the orbit depends on the precessional frequency, or equivalently, on the chemical potential. We show that both symmetric and asymmetric vortices are spectrally stable with respect to small time-dependent perturbations. At the same time, the symmetric vortex becomes a local minimizer of energy in the parameter region where the asymmetric vortex exists, the latter corresponds to a saddle point of energy.

Dmitry Pelinovsky
McMaster University
Department of Mathematics
dmpeli@math.mcmaster.ca

MS46
Asymptotic Stability of Semi-Strong Interactions in Weakly Damped Systems: Attack of the Point Spectrum

We demonstrate the asymptotic stability of semi-strong N-pulse solutions for a class of singularly perturbed reaction diffusion equations. The key step to both the existence and stability is the analysis of a family of non-self adjoint eigenvalue problems, particularly the control of the point spectrum, which we show breaks into a controllable part and a ‘semi-strong’ portion, which is amenable to an analytic reduction. This is joint work with Tom Bellsky.

Keith Promislov
Michigan State University
kpromisl@math.msu.edu

Tom Bellsky
Arizona State University
bellskyt@asu.edu

MS47
Bifurcations of Front Solutions for a Three-component Reaction Diffusion System

By means of a center manifold type reduction we derive an ODE system describing the evolution of front solutions in a three-component reaction-diffusion system. The reduced systems exhibits a surprisingly complicated bifurcation structure including a butterfly catastrophe and a Bogdanov-Takens type scenario. These results shed light on numerically observed accelerations and oscillations and pave the way for the analysis of front interactions in a parameter regime where the essential spectrum of a single front approaches the imaginary axis asymptotically.

Martina Chirilus-Bruckner
Boston University
MS47
Blowup of Solitary Waves of the Generalised Korteweg-de Vries Equation

We study blowup solutions of the generalized Korteweg-de Vries equation (GKdV). These solutions arise when a soliton turns unstable and then becomes infinite in finite time; in other words blow up. Through a dynamical rescaling we reduce the GKdV to an ODE. Then, we use asymptotic methods and matching techniques to construct bounded solutions of the ODE. Moreover, with the asymptotic analysis we determine the parameter range over which these solutions may exist.

Vivi Rottschafer
Leiden University
Dept of Mathematics
vivi@math.leidenuniv.nl

MS47
Pulse Stability in a Gierer-Meinhardt System with a Slow Nonlinearity

The existence and stability of localized pulses in a Gierer-Meinhardt equation with an additional 'slow' nonlinearity is studied. This system is an explicit example of a general class of singularly perturbed, two-component reaction-diffusion equations that go beyond model systems such as Gray-Scott and Gierer-Meinhardt. The additional nonlinearity influences the stability analysis and stability properties of the pulse. Moreover, unlike in GS/GM type models, pulse solutions exhibit complex behaviour near Hopf bifurcations.

Frits Veerman
Mathematical Institute
Leiden University
frits@math.leidenuniv.nl

MS47
Destabilizing of Stationary Spots in a Planar Three-component FitzHugh-Nagumo Equation

In this talk, I will analyze the destabilization of a stable stationary radially symmetric spot arising in a specific planar three-component FitzHugh-Nagumo equation. In particular, I am interested in the bifurcation of the stationary spot to a traveling spot. As it turns out, there is a competition between this drift bifurcation and several other Hopf bifurcations. I will formally determine asymptotic conditions for these bifurcations and also check the asymptotic results with AUTO and a direct solver.

Peter van Heijster
Division of Applied Mathematics
Brown University, Providence RI
heijster@math.bu.edu

Bjorn Sandstede
Brown University
bjorn_sandstede@brown.edu

MS48
Dark Breathers in Granular Crystals

We study the existence, stability and bifurcation structure of dark breathers in a one-dimensional uniform chain of beads under precompression. We derive a defocusing nonlinear Schrödinger equation (NLS) for frequencies that are close to the edge of the linear spectrum and use this to construct targeted initial conditions to numerically find the dark breather solutions. The range of validity of the NLS approximation is also explored and we discuss experimental implications of our results.

Christopher Chong
University of Massachusetts, Amherst
chong@math.umass.edu

MS48
Topological and Spectral Features of Nonlinear Wave Motion in Periodic Chains

Wave motion in periodic chains with cubic nonlinearities is investigated with the objective of providing a comprehensive account of the distinctive topological and spectral features of one-dimensional nonlinear wave propagation. The investigation focuses on analogies and differences between nonlinear chains and their linear dispersive counterparts, as well as on the interplay and competing roles of dispersive and nonlinear mechanisms in the formation and classification of wave distortion. The signatures of salient behavior associated with nonlinear mechanisms are collected both in the physical (space-time) and spectral (frequency-wavenumber) space, and the special case of waves with identical spectral content and markedly different topologies in the physical space is investigated. The analysis is carried out using full-scale simulations in conjunction with a variety of global and local signal processing techniques, and the results are checked against existing unit-cell based perturbation methods.

Stefano Gonella
Department of Civil Engineering
University of Minnesota
gonella@umn.edu

Ganesh Ramakrishnan
University of Minnesota
ramak015@umn.edu

MS48
Ill-Posedness of a Linearized Compacton Equation

After linearizing the $K(2,2)$ equation around a known periodic solution (whose spacial truncation is the famous compacton solution), we are able do demonstrate that the spectrum of the linear operator, as an operator on $H^3([-\pi, \pi])$, is the entire complex plane. This is accomplished by turning the eigenvalue value problem into a discrete dynamical system which we then solve. We will also briefly consider the operators that arise as linearizations of the $K(n,m)$ equation.

Daniel Jordon
Department of Mathematics
Drexel University
dmj36@drexel.edu

MS48
Ill-Posedness Due to Degenerate Dispersion

We study the behavior of solutions for PDEs with degenerate dispersions. Using the degenerate Airy equation
\[ u_t = 2u u_{xxx} \] as an example, we show that unlike uniform dispersive effects, degenerate dispersion even just by itself may lead to ill-posedness of the corresponding initial value problem. In particular, we establish the existence of a compactly supported self-similar solution for the degenerate Airy equation. When combined with certain scaling invariances, such a self-similar solution implies that the degenerate Airy equation is ill-posed for initial data in \( H^2 \), i.e., its solutions do not depend smoothly on initial conditions.

Dennis Guang Yang
Department of Mathematics
Drexel University
gyang@math.drexel.edu

MS49
Threshold Models and Abrupt Change in Social Norms in Complex Social Networks

In our work we seek for description of extensive simulations and mathematical analysis of simple systems of people affected by both personal preferences and observation of their neighbors behavior. We show that the influential Schelling-Granovetter model of threshold behavior change is equivalent to a zero-temperature, mean-field limit of a very well studied model in physics the Ising model. We also show that we can study the effects of locality and mixing rate on behavior change by studying these models on lattices and networks.

Andrei Akhmetzhanov
McMaster University
akhmetzhanov@googlemail.com

Lee Worden
UC Berkeley
worden.lee@gmail.com

Jonathan Dushoff
McMaster University
Department of Biology
dushoff@mcmaster.ca

MS49
An Adversarial Evolutionary Game for Criminal Behavior

We consider an adversarial evolutionary game developed for criminal activity where players may or may not commit crimes and cooperate with authorities. Among the four possible player strategies, the so called “informant” who cooperates while still committing crimes. We find two possible equilibriation regimes, a defection-dominated and an ideal, cooperation-dominated one and show that the number of informants is crucial in determining which of these two regimes is achieved.

Maria Rita D’Orsogna
California State University, Northridge
dorsogna@csun.edu

MS49
Towards Simulating Societies: Simple Models with Complex Dynamics

In order to understand social systems, it is essential to identify the circumstances under which individuals spontaneously start cooperating or developing shared behaviors, norms, and culture. In this connection, it is important to study the role of social mechanisms such as repeated interactions, group selection, network formation, costly punishment and group pressure, and how they allow to transform social dilemmas into interactive situations that promote the social system. Furthermore, it is interesting to study the role that social inequality, the protection of private property, or the on-going globalization play for the resulting “character” of a social system (cooperative or not). It is well-known that social cooperation can suddenly break down, giving rise to poverty or conflict. The decline of high cultures and the outbreak of civil wars or revolutions are well-known examples. The more surprising is it that one can develop an integrated game-theoretical description of phenomena as different as the outbreak and breakdown of cooperation, the formation of norms or subcultures, and the occurrence of conflicts.

Dirk Helbing
ETH Zurich
dirk.helbing@gess.ethz.ch

MS49
Social Interactions on Networks: Self-excitation, Third-party inhibition, and the Link with Game Theory

We introduce a point process model for social interactions on a network, including self-excitation and third-party inhibition. Here, a coupled system of state-dependent jump stochastic differential equations is used to model the conditional intensities of the directed network of interactions. The model produces a wide variety of transient or stationary weighted network configurations and we investigate under what conditions each type of network forms in the continuum limit. We also explore the link between this model and recent work on repeated games.

Martin Short
UCLA
mbshort@math.ucla.edu

PP1
Some Exact Solutions Of Two 5th Order KdV-Type Nonlinear Evolution Equations

We consider the generalized 5th order nonlinear KdV equation which is invariant under a scaling transformation with suitable weighting scheme. An extension of tanh method has been used rigorously for solving this fifth order nonlinear evolutionary partial differential equation. The general solutions of the parameters are formed considering an ansatz of the solution in terms of tanh. Then, using these results some exact solutions are found for the two 5th order KdV-type equations which also include soliton solutions.

Tania Akter
World University
taniaju.durba@yahoo.com

Abdus Sattar Mia
Brock University, Canada
sattarju@yahoo.com
PP1
Compressed Sensing in Retinal Image Processing

Retinal image processing transforms photons into membrane potentials via several nonlinear transformations. This process begins in a large network of photoreceptors and ends in a relatively small ganglion cell network. We posit the loss of visual information despite the decrease in network size is minimized via compressed sensing. Using an idealized mathematical model of the retina and a mean-field analytical reduction, we demonstrate firing patterns among ganglion cells can be used to reconstruct input images.

Victor Barranca
Rensselaer Polytechnic Institute
barrav@rpi.edu

Gregor Kovacic
Rensselaer Polytechnic Inst
Dept of Mathematical Sciences
kovacg@rpi.edu

David Cai
New York University
Courant institute
cai@cims.nyu.edu

PP1
Computational Reductions and Dynamics of Neuronal Models with Adaptation Current

The stiffness and complexities associated with the nonlinearities of the Hodgkin-Huxley neuron model have motivated a wide array of computational reductions. The dynamical systems underlying these reductions, however, rarely generalize to neurons containing realistic adaptive ionic currents. Using several numerical simulations and associated measures of robustness, we demonstrate that our novel modeling algorithm accomplishes the goals of attaining accuracy and efficiency while retaining enough generality to replicate the nontrivial dynamics of specialized neurons.

Victor Barranca
Rensselaer Polytechnic Institute
barrav@rpi.edu

Gregor Kovacic
Rensselaer Polytechnic Inst
Dept of Mathematical Sciences
kovacg@rpi.edu

David Cai
New York University
Courant institute
cai@cims.nyu.edu

PP1
Simultaneous Frequency Conversion, Regeneration and Reshaping of Optical Signals

Nondegenerate four-wave mixing in fibers enables the tunable and low-noise frequency conversion of optical signals. This poster shows that four-wave mixing driven by pulsed pumps can also regenerate and reshape optical signal pulses arbitrarily.

Daniel Cargill
New Jersey Institute of Technology
dc26@njit.edu

PP1
A Numerical Method For Solving Nonlinear Schrodinger Equation

The Finite-Difference Time-Domain (FDTD) method is a well-known technique for the analysis of quantum devices. It solves a discretized Schrodinger equation in an explicitly iterative process. In this research, we apply the idea of the FDTD method to the development of a numerical method for solving the time dependent nonlinear Schrodinger equation. The scheme is shown to satisfy the discrete energy conservation laws. Finally, the scheme is tested by simulating the propagation and formation of solitons.

Weizhong Dai
College of Engineering and Science
Louisiana Tech University
dai@math.latech.edu

Frederick Moxley
Louisiana tech University
fmoxley3@gmail.com

PP1
Fifth Order Evolution Equation for Long Wave Dissipative Solitons

Solitary waves may arise in systems with dissipation and instability if a balance between these effects and nonlinearities exists. We search for a consistent model equation to describe long wave dissipative solitons including fifth order dispersion. The equation found includes quadratic and cubic nonlinearities. For certain parameter values the bifurcation from the basic state is subcritical. In this case we show that periodic solutions in a small box do not blow up in finite time.

Cristina Depassier, Juvenal Letelier
Departamento de Fisica
Universidad Catolica de Chile
mcdepass@gmail.com, jaleteli@uc.cl

PP1
Feigenbaum Universality, Lyapunov Exponents and Fractal Dimensions in Two Dimensional Chaotic Models

This paper highlights the following objectives in some two dimensional chaotic models: (i) Sophisticated numerical methods have been developed to determine Feigenbaum bifurcation tree leading to chaos, (ii) Determination of Lyapunov exponents, Correlation, box-counting and information dimensions as measure of chaos (iii) Statistical tools are employed to confirm the results.

Tarini K. Dutta
PROFESSOR OF MATHEMATICS, GAUHATI UNIVERSITY, GUWAHATI, ASSAM STATE: 781014, INDIA
tkdutta2001@yahoo.co.in

PP1
Confinement of the Eigenvalues of the Ablowitz-
Ladik Eigenvalue Problem.

Klaus and Shaw (2001) proved that if initial conditions for the Nonlinear Schrödinger equation were real and single-lobe, the eigenvalues of the Zakarov-Shabat system should be imaginary. To the knowledge of the authors, there is no analogous to discrete problems. The natural extension for this result is that if the single-lobe property was satisfied by the potentials of the Ablowitz-Ladik (AL) eigenvalue problem, then the eigenvalues should be real. We show an extension of Klaus-Shaw potential for the AL lattice.

J. Adrian Espinola-Rocha
Dept. of Mathematics
Centro de Investigación en Matemáticas, A.C.
jaer.cimat.mx@gmail.com

Patrick Shipman
Department of Mathematics
Colorado State University
shipman@math.colostate.edu

Stephen P. Shipman
Department of Mathematics
Louisiana State University
shipman@math.lsu.edu

PP1
On the Nonlinear Schrodinger Equation with Embedded Eigenvalues

We revisit the inverse scattering transform for the one-dimensional focusing nonlinear Schrödinger equation with zero boundary conditions at infinity. Explicitly, we study cases in which the analytic scattering coefficients admit zeros on the real axis. We present specific examples and we discuss the appropriate formulation of the inverse problem, issues of existence and uniqueness and the long-time behavior of the solutions.

Emily Fagerstrom
State University of New York at Buffalo
emilyrf@buffalo.edu

Gino Biondini
State University of New York at Buffalo
Department of Mathematics
biondini@buffalo.edu

PP1
Travelling Waves of a Reaction-Diffusion Model for the Acidic Nitrate-Ferroin Reaction

We consider a system of two reaction-diffusion equations, which was derived to model the acidic nitrate-ferroin reaction. The existence and stability of travelling waves for this system are investigated. The proofs for the obtained results are rigorous.

Sheng-Chen Fu
Department of Mathematical Sciences
National ChengChi University
fu@nccu.edu.tw

Je-Chiang Tsai
Department of Mathematics
National Chung Cheng University (Taiwan)
tsaijc@math.ccu.edu.tw

PP1
Random and Regular Dynamics of Stochastically Driven Neuronal Networks

Dynamical properties of and uncertainty quantification in Integrate-and-Fire neuronal networks with multiple time scales of excitatory and inhibitory neuronal conductances driven by random Poisson trains of external spikes will be discussed. Both the asynchronous regime in which the network spikes arrive at completely random times and the synchronous regime in which network spikes arrive within periodically repeating, well-separated time periods, even though individual neurons spike randomly will be presented.

Pamela B. Fuller
Rensselaer Polytechnic Institute
Fullep@rpi.edu

PP1
Vaccinating Against HPV in Dynamic Network

We develop a dynamical network model to examine the relative merits of strategies for vaccinating women against the sexually transmitted Human Papillomavirus, which can induce cervical cancer. The model community is represented as a sexual network of individuals with links dynamically created and destroyed through statistical rules based on the node characteristics. Various strategies for distributing an allotted number of doses of vaccine are tested for effectiveness in reducing the incidence of cervical cancer.

Pamela B. Fuller, Toni Wagner, Mark Yuhas
Rensselaer Polytechnic Institute
Fullep@rpi.edu, wagnertonil@gmail.com, markyuhas5@gmail.com

Peter R. Kramer
Rensselaer Polytechnic Institute
Department of Mathematical Sciences
kramep@rpi.edu

PP1
A Hamiltonian Water Wave Model with Horizontally Sheared Currents

We will show the Hamiltonian dynamics of a new, variational water wave model of Cotter and Bokhove (2010). This model has a three-dimensional velocity field consisting of the full threedimensional potential field plus horizontal velocity components, such that the vertical component of vorticity is nonzero. We aim to augment the new model locally with bores and will discuss how our existing variational, potential-flow finite element model can be extended to include bores.

Elena Gagarina, Onno Bokhove
University of Twente
e.gagarina@ewi.utwente.nl, o.bokhove@math.utwente.nl

PP1
Many-Body Interaction in Fast Collisions of Nls Solitons

We study the effects of fast collisions between NLS solitons in the presence of weak nonlinear loss $-\epsilon |\psi|^2 \psi$. We show that for $m \geq 2$, $n$-body interaction with $m + 1 \geq n \geq 3$ gives a significant contribution to the collision-induced
amplitude shift. We characterize the dependence of this contribution on $m$, $n$, the group velocity difference, and the initial soliton positions.

Avner Peleg  
State University of New York at Buffalo  
aplege@buffalo.edu

Yeojin Chung  
Southern Methodist University  
ychung@mail.smu.edu

Paul Glenn  
State University of New York at Buffalo  
paulglen@buffalo.edu

Quan Nguyen  
Vietnam National University at Ho Chi Minh city  
quannm@hcmiu.edu.vn

PP1  
Dynamics of a Mean Field Cortex Model

We study a PDE model of the membrane potential and synaptic interaction of excitatory and inhibitory neuron populations in a two-dimensional slab of cortical tissue. Considering the equations as an autonomous dynamical system, we aim to parse the model using bifurcation analysis. We compute equilibria, waves, and periodic patterns, and study their dependence on external input, connectivity parameters and the domain size. Our computations are done using open source code built on PETSc.

Kevin R. Green, Lennaert van Veen  
UOIT  
kevin.green@uoit.ca, lennaert.vanveen@uoit.ca

PP1  
Pattern Competition in Spatially-Forced Systems

Spatial periodic forcing of pattern-forming systems is an important, but lightly studied, method of pattern control. Forcing can be used to control the wavenumber of one-dimensional periodic patterns, to increase pattern amplitudes, to stabilize unstable patterns, or to induce patterns below instability onset. We show how in one spatial dimension forcing acts to reinforce patterns, while in two dimensions it acts to destabilize or displace them by producing two-dimensional rectangular and oblique patterns.

Aric Hagberg  
Los Alamos National Laboratory  
hagberg@lanl.gov

Yair Mau, Ehud Meron  
Ben-Gurion University  
yairmau@gmail.com, ehud@bgu.ac.il

PP1  
A Slow Pushed Front in a Lotka-Volterra Competition Model

We study the existence and stability of a traveling front in the Lotka-Volterra competition model when the rate of diffusion of one species is small. This front is noteworthy in two respects. First, we show that it is the selected, or critical, front for this system. We utilize techniques from geometric singular perturbation theory and geometric desingularization. Second, we show that this front is a pushed front despite the fact that it propagates slower than the linear spreading speed.

Matt Holzer  
School of Mathematics  
University of Minnesota  
mholzer@umn.edu

Arnd Scheel  
University of Minnesota  
scheel@umn.edu

PP1  
Stability and Dynamics of Solitary Waves in Spinor Lattices

The work presented in this talk focuses on understanding solitary waves in a spinor BEC lattice system. This system is motivated by the spinor BEC which can be described by a quasi-one-dimensional model. Here, we discuss two- and three-component dynamical lattice which contains a mean field nonlinearity. Our analysis of solitary waves involves (i) an examination of the anti-continuum limit for our model of interest, (ii) the existence and stability of these solitary waves via a perturbative approach and (iii) understanding the structure of these waves in excited sites of the lattice.

Rudy L. Horne  
Department of Mathematics  
Morehouse College  
rhorne@morehouse.edu

Hadi Susanto  
The University of Nottingham  
United Kingdom  
hadi.susanto@nottingham.ac.uk

Nathan Whitaker  
University of Massachussets Amherst  
whitaker@math.umass.edu

Panos Kevrekidis  
University of Massachussets  
kevrekid@math.umass.edu

PP1  
Weakly Subcritical Stationary Patterns: Eckhaus Instability and Homoclinic Snaking

The transition from subcritical to supercritical stationary periodic patterns is described by the one-dimensional cubic-quintic Ginzburg-Landau equation $A_t = \mu A + A_{xx} + i(a_1|A|^2A_x + a_2A^2A_x) + b|A|^4A - |A|^6A$, where $A(x,t)$ represents the pattern amplitude and the coefficients $\mu$, $a_1$, $a_2$ and $b$ are real. The conditions for Eckhaus instability of periodic solutions are determined, and the resulting spatially modulated states are computed. Some of these evolve into spatially localized structures in the vicinity of a Maxwell point, while others resemble defect states. The results are used to shed light on the behavior of localized structures in systems exhibiting homoclinic snaking during the transition from subcriticality to supercriticality.

Hsien-Ching Kao  
University of California at Berkeley, Department of Physics
Localized Structures in Rotating Convection

Convection in a horizontal layer heated from below and rotating about the vertical is studied. The system admits 2D spatially localized structures. Such structures are organized in the form of slanted snaking and are present over a large range of Rayleigh numbers, regardless of the direction of branching of periodic convection. This behavior is a consequence of a conserved quantity. The results are compared with predictions based on a fifth order amplitude equation. This is joint work with C Beaume (IMFT), A Bergeon (IMFT) and H-C Kao (UC Berkeley).

Gain-Controlled Soliton Routing in Dissipative Lattices.

We demonstrate an effective mechanism for gain-controlled soliton routing in dissipative lattices. An effective particle model reveals the essential features of soliton dynamics in such structures. The results presented are directly applicable to general inhomogeneous systems where interplay between gain and loss mechanisms occurs. Focusing on the complexity of soliton dynamics rather than on the complexity of their profiles we have analyzed scenarios that are promising for dynamical soliton control concepts and applications.

Mutual Interactions Between Electromagnetic Solitons in Plasmas

We numerically investigate the mutual interactions between two electromagnetic solitons in a cold unmagnetized plasma, both for finite and vanishing group speeds of the interacting structures. The interaction of two spatially overlapping standing electromagnetic solitons is studied for partial as well as complete overlap and the corresponding end states are compared.

Synchronous and Asynchronous Dynamics of Complex Neuronal Networks

For integrate-and-fire neuronal networks with complex connectivity topology, we study the dependence of their pulse rate on the underlying architectural connectivity statistics. We derive the distribution of the firing rate from this dependence and determine when the underlying scale-free architectural connectivity gives rise to a scale-free pulse-rate distribution. We identify the scaling of the pairwise coupling between the dynamical units in this network class that keeps their pulse rates bounded in the infinite-network limit.

Spatiotemporal Dynamics in Three Species Model Systems with Self Diffusion

Input your abstract, including TeX commands, here. In this paper, the complex dynamics of two types of tri-trophic food chain model systems modeling two real situations of marine ecosystem have been investigated in the presence of diffusion, both analytically and through numerical simulations. These models have been studied earlier, but in the absence of diffusion. The numerical simulation leads to spontaneous and interesting pattern formation. Diffusion driven analysis is carried out and effect of diffusion on the chaotic dynamics of the model systems are studied. The existence of chaotic attractor and long term chaotic behavior demonstrate the effect of diffusion on the dynamics of the model systems.
Localized Patterns on the Surface of a Magnetic Fluid

The discovery of two-dimensional solitons on the surface of a ferrofluid under a vertical magnetic field by Richter and Barashenkov (PRL, 2005) has raised many new theoretical questions. Due to the complicated nature of the equations modelling ferrofluids, Richter and Barashenkov proposed a conservative analogue of the Swift-Hohenberg equation

\[ u_{tt} = -(1 + \Delta)^2 u - \nu u + \mu u^2 - u^3, \quad (1) \]

as a phenomenological model that could provide an understanding of localised axisymmetric solitons. Here, \( u = u(x, y, t) \) describes the surface height, \( \nu \) is related to the strength of the magnetic field (and is the usual control parameter) and \( \mu \) is related to the permeability of the ferrofluid. Here, we review what is known about stationary (time-independent) solutions of the equation above and show where this phenomenological model is (un)successful in predicting the qualitative nature of localised patterns on the surface of a ferrofluid. Furthermore, we show numerically that homoclinic snaking does exist in the full Ferrofluid equations.

David Lloyd
University of Surrey
d.j.lloyd@surrey.ac.uk

Transition Between Slow and Fast Wavefronts from the Point of View of Speed Selection

On an example of a system of coupled reaction-diffusion equations, we discuss a sudden transition between slow and fast wavefronts. We relate the mechanism of such transition to the known facts about speed selection for fronts.

Peter Mclarnan
Miami University
mclarnpc@muohio.edu

Anna Ghazaryan
Department of Mathematics
Miami University and University of Kansas
ghazarar@muohio.edu

Christopher Jones
University of North Carolina and University of Warwick
ckrtj@email.unc.edu

Oscillons Near Forced Hopf Bifurcations

Oscillons are planar, spatially localized, temporally oscillating, radially symmetric structures. We present a proof of the existence of oscillons in the forced planar complex Ginzburg-Landau equation through a geometric blow-up analysis. Our analysis is complemented by a numerical continuation study of oscillons in the forced Ginzburg-Landau equation using Matlab and AUTO.

Kelly Mcquighan, Bjorn Sandstede
Brown University
kelly.mcquighan@brown.edu, bjorn_sandstede@brown.edu

Bistable Fronts in Discrete Inhomogeneous Media

Bistable differential-difference equations with inhomogeneous diffusion are considered using McKean’s caricature of the cubic. Front solutions are constructed for essentially arbitrary inhomogeneous discrete diffusion and these solutions correspond, in the case of homogeneous diffusion, to monotone traveling front solutions, or stationary front solutions in the case of propagation failure. Explicit conditions reveal relationships between zero wave speed and defects in the medium, and changes in wave speed and shape are analyzed as fronts propagate.

Brian E. Moore
University of Central Florida
USA
bmoore@math.ucf.edu

Tony R. Humphries
McGill University
Mathematics and Statistics
Tony.Humphries@mcgill.ca

Erik Van Vleck
Department of Mathematics
University of Kansas
evanvleck@math.ku.edu

Numerical Simulation of Internal Wave Generation from a Collapsing Mixed Region in Stratified Fluid

The dynamics of a density perturbed fluid into an ambient fluid with complex stratification is examined by numerical simulations. Algorithms based on the Navier-Stokes equations in the primitive variables and on the Eulerian-Lagrangian coordinate system and moving grid are utilized. High-order, monotone approximation of convective terms are used. Parametric calculations demonstrated the applicability of the numerical models. The analysis focuses upon the generation and propagation of internal waves and on the dynamics of collapsing region.

Nikolay Moshkin
Suranaree University of Technology
nikolay.moshkin@gmail.com, moshkin@math.sut.ac.th

Gennadii Chernykh, Andrey Zudin
Institute of Computational Technologies, Russia
chernykh@ict.nsc.ru, zudin@ict.nsc.ru

Synchrony in Stochastic Pulse-Coupled Neuronal Network Models

We are interested in the synchronous dynamics of simple pulse-coupled models for neuron dynamics. These time correlations in firing times are seen experimentally. In our model, the size of synchronous firing events depends on the probabilistic dynamics between such events as well as the network structure representing the neuron connections. We presents both analytical results and numerical simulations of these global dynamics.

Katherine Newhall
Courant Institute of Mathematical Science
New York University
newhall@cims.nyu.edu
Aaditya Rangan  
Courant Institute of Mathematical Sciences  
New York University  
rangan@cims.nyu.edu

**PP1**

**An Improved Local Well-Posedness Result for the Periodic "Good" Boussinesq Equation.**

We prove that the "good" Boussinesq model with the periodic boundary condition is locally well-posed in the space $H^s \times H^{s-2}$ for $s \geq -3/8$. In the proof, we employ the normal form approach, which allows us to explicitly extract the rougher part of the solution. This also leads to the conclusion that the remainder is in a smoother space $C([0; T]; H^{s+a})$, where $0 < a < \min(2s + 1; 1/2)$. If we have a mean-zero initial data, this implies a smoothing effect of this order for the non-linearity. This is new even in the previously considered cases $s > -1/4$.

Seungly Oh, Atanas Stefanov  
University of Kansas  
soh@math.ku.edu, stefanov@math.ku.edu

**PP1**

**Effects of Stochastic Perturbations on the Atlantic Thermohaline Circulation**

The Atlantic thermohaline circulation (THC) transports large amounts of heat from the equatorial region northward toward the polar regions and is responsible for the relatively mild climate in the northern Atlantic. Various studies have shown the Atlantic THC can have multiple stable equilibria each representing very different climatic states. Stochastic ODEs are derived from simple box models and we will show how stochastic perturbations such as freshwater influx can produce transitions between these equilibria.

Alejandro Aceves  
Southern Methodist University  
aaceves@smu.edu

Alyssa Pampell  
Department of Mathematics  
Southern Methodist University  
apampell@smu.edu

**PP1**

**The Extension of the Generalized Regularized Long Wave Equation**

The Regularized Long-Wave equation, also known as the Benjamin-Bona-Mahony (BBM)-equation was first studied as a model for small-amplitude long waves that propagate on the free surface of a perfect fluid. As an alternative to the Korteweg-de Vries equation, it features a balance between nonlinearity and a frequency dispersion term that allows the existence of traveling waves that are smooth and symmetric about their maximum. Such waves decay rapidly to zero on their outskirts and, because of their tendency to travel alone, are known as 'solitary waves'. We investigate the behavior of solitary-wave solutions for the Extended BBM (EBBM)-equation which is the BBM-equation, but with two power nonlinearities in general, gradient form. We prove that this model is globally well-posed, which provides a rigorous foundation for the stability theory of their solitary-wave solutions. Since solitary-wave solutions of the EBBM-equation are not known analytically, they are generated and investigated numerically. It transpires that there can be as many as three stability regimes for the EBBM-solitary waves. We present numerical simulations of the formation and long-time evolution of solitary waves, the behavior of solitary waves under amplitude perturbations and the interaction of solitary waves. Minimal perturbations necessary to force a solitary wave to change stability regimes are also determined.

Sanja Pantic  
University of Illinois at Chicago  
sanja.pantic@gmail.com

**PP1**

**Complex Soliton Dynamics in Lattices with Longitudinal Modulation**

Soliton dynamics in a large variety of longitudinally modulated lattices are studied in terms of phase-space analysis for an effective particle approach and direct numerical simulations. A rich set of qualitatively distinct dynamical features of soliton propagation that have no counterpart in longitudinally uniform lattices is illustrated. This set includes cases of enhanced soliton mobility, dynamical switching, extended trapping in several transverse lattice periods, and quasiperiodic trapping, which are promising for soliton control applications.

Panagiotis Papagiannis  
School of Electrical and Computer Engineering, National Technical University of Athens  
papgap@gmail.com

Yannis Kominis  
School of Electrical and Computer Engineering, National Technical University of Athens  
gkomin@central.ntua.gr

Kyriakos Hizanidis  
National Technical University, Greece  
kyriakos@central.ntua.gr

Sotiris Droulias  
School of Electrical and Computer Engineering, National Technical University of Athens  
sdroulias@upatras.gr

**PP1**

**Point vortex equilibria and Calogero-Sutherland equation**

We consider linear evolution flows on the space of polynomials and compute the associated dynamics of the polynomial roots. This leads to a set of equations for the root dynamics, whose equilibria are used to compute relative equilibria for the point vortex problem in 2-D fluids. We make use of properties of the Calogero-Sutherland model in two variables to construct novel point vortex configurations.

Ronald Perline  
Drexel University  
ronald.k.perline@drexel.edu
**PP1**

**Snakes and Ladders: Stability of Fronts and Pulses**

The subject of this poster are localized patches composed of spatially periodic structures. These patterns often exhibit snaking: in parameter space, the localized states lie on a vertical sine-shaped bifurcation curve so that the width of the underlying periodic pattern increases as one moves up along the bifurcation curve. The issue addressed here is the stability of these structures as a function of the bifurcation parameter.

Bjorn Sandstede
Brown University
bjorn.sandstede@brown.edu

**PP1**

**On the Spectral Stability of Soliton Solutions of the Vector Nonlinear Schrödinger Equation**

We consider a system of coupled cubic nonlinear Schrödinger (NLS) equations

\[ i \partial \psi_j / \partial t = -\partial^2 \psi_j / \partial x^2 + \sum_{k=1}^{n} \alpha_{jk} |\psi_k|^2 \psi_j \quad j = 1, 2, \ldots, n \]


Natalie Sheils
Department of Applied Mathematics
University of Washington
nsheils@amath.washington.edu

Bernard Deconinck
University of Washington
bernard@amath.washington.edu

Nghiem Nguyen, Rushun Tian
Utah State University
nghiem.nguyen@usu.edu, rushun.tian@aggiemail.usu.edu

**PP1**

**Global Existence for a System of Schrödinger Equations with Power-Type Nonlinearities**

We consider the Cauchy problem for a Schrödinger system with power-type nonlinearities

\[
\begin{cases}
 i \partial \psi_j / \partial t + \Delta \psi_j + \sum_{k=1}^{m} a_{jk} |\psi_k|^p |\psi_j|^{p-2} \psi_j = 0, \\
 \psi_j(x,0) = \psi_{j0}(x),
\end{cases}
\]

where \(\psi_j : \mathbb{R}^N \times \mathbb{R} \to \mathbb{C}, \psi_{j0} : \mathbb{R}^N \to \mathbb{C}\) for \(j = 1, 2, \ldots, m\) and \(a_{jk} = a_{kj}\) are real numbers. Global existence is first established for \(\frac{4}{3} \leq p < 1 + \frac{2}{d}\). Then we deduce a sharp form of vector-valued Gagliardo-Nirenberg inequality and use it to prove global existence in the critical case for small initial data. At the end, we consider the stability of solutions in the critical case.

Rushun Tian, Nghiem Nguyen
Utah State University
rushun.tian@aggiemail.usu.edu, ngyhiem.nguyen@usu.edu

Bernard Deconinck
University of Washington
bernard@amath.washington.edu

Natalie Sheils
Department of Applied Mathematics
University of Washington
nsheils@amath.washington.edu
PP1
A Single Equation Describing Free Surface Water Waves.

Zakharov (1968) introduced canonical coordinates for the free surface water wave equations. Using the same canonical coordinates on the formulation of the water wave problem due to Ablowitz, Fokas and Musslimani (2006), we derive a single nonlinear complex equation describing the dynamics of the free surface. In contrast to Zakharov’s equation, our equation is not restricted to waves of small amplitude. The properties of this equation are examined.

Olga Trichtchenko
Department of Applied Mathematics
University of Washington
ota6@uw.edu

Bernard Deconinck
University of Washington
bernard@amath.washington.edu

PP1
Numerical Inverse Scattering: Uniform Approximation of Solutions of Integrable Pdes

Riemann–Hilbert problems arise in many different applications, ranging from integrable systems and special function theory to card-shuffling and random matrix theory. A recent collocation method allows for the numerical solution of Riemann–Hilbert problems. In this poster I will lay out how to use this method to, in effect, solve integrable equations on the whole line for arbitrary spectral data. Uniformity statements about the approximation can be proved. Additionally, this can be used to examine the validity of the known asymptotic formulas.

Thomas D. Trogdon
Department of Applied Mathematics
University of Washington
trogdon@amath.washington.edu

Sheehan Olver
University of Oxford
UK
Sheehan.Olver@sydney.edu.au

Bernard Deconinck
University of Washington
bernard@amath.washington.edu

PP1
Traveling Waves in a Simplified Model of Calcium Dynamics

We analyze traveling wave propagation in a simplified model of intracellular calcium dynamics. Despite its simplicity, the model is thought to capture fundamental features of wave propagation in calcium models. We explore aspects of the dynamics of traveling front, pulse and periodic wave solutions as \( J \), a parameter in our model, is varied. We focus on the closed-cell version of the model, which corresponds to a singular limit of the full (open-cell) model. We use our results about the closed-cell model to make conjectures about the nature of wave solutions in the open-cell version of the model. A comparison between the properties of wave solutions of the calcium model and wave solutions of the FitzHugh-Nagumo equations reveals that the calcium model is an excitable system essentially different from the FitzHugh-Nagumo equations.

Je-Chiang Tsai
Department of Mathematics
National Chung Cheng University (Taiwan)
tsaijc@math.ccu.edu.tw

Wenjun Zhang
Department of Mathematics
University of Auckland
w.zhang@math.auckland.ac.nz

Vivien Kirk, James Sneyd
University of Auckland
v.kirk@auckland.ac.nz, j.sneyd@auckland.ac.nz

PP1
Behaviour of Torsional Surface Wave in a Homogeneous Substratum over a Dissipative Half Space

The propagation behaviour of Torsional surface wave in a homogeneous isotropic layer lying over a viscoelastic half space has been taken into account. Numerical result has been obtained to show the effect of internal friction, rigidity and wave number on phase velocity of Torsional surface wave. Dispersion equation reduced in classical form when derived as a particular case. Graphical user interface (GUI) has been developed using MATLAB to generalize the effect of various parameter discussed.

Sumit K. Vishwakarma, Shishir Gupta
Indian School of Mines, Dhanbad, Jharkhand, India-826004
sumo.ism@gmail.com, shishir.ism@yahoo.com

PP1
Propagation Failure in Discrete Periodic Media

We study the periodic lattice dynamical systems with bistable nonlinearity. We use Moser’s Theorem to show that there exist infinitely many stationary solutions when one of the migration coefficients is sufficiently small. Moreover, we prove the propagation failure occurs when both migration coefficients are sufficiently small.

Chin-Chin Wu
Department of Applied Math., National Chung Hsing University
chin@email.nchu.edu.tw

Shih-Gang Liao
National Chung Hsing University
gary730720@hotmail.com

PP1
Grain Boundaries in Swift-Hohenberg Equations

We investigate grain boundaries in the Swift-Hohenberg equation posed in the plane. In dimension 2, we show the existence of grain boundaries—stationary solutions which are even in \( x \), periodic in \( y \) and approach rotated members of the family of stationary periodic patterns as \( x \) goes to infinity. Grain boundaries in this spatially extended system resembles defects commonly seen in physical experiments. We employ center manifold reduction and normal form theory to reduce the PDE to a finite-but high-dimensional ODE, in which we can locate heteroclinic orbits. Those correspond to grain boundaries in the Swift-Hohenberg equa-
Qiliang Wu, Arnd Scheel
University of Minnesota
wuxxx410@umn.edu, scheel@umn.edu

PP1
Stationary Nonlinear Modes and Beam Amplification in \( \mathcal{P}\mathcal{T}\)-Symmetric Harmonic Potential

We report a number of unusual properties of stationary modes in the nonlinear Schrödinger equation with \( \mathcal{P}\mathcal{T}\)-symmetric harmonic potential \( x^2 - 2\alpha x \). In particular, the modes, bifurcating from different eigenstates of the underlying linear problem, can actually belong to the same family of nonlinear modes. By proper adjustment of the coefficient \( \alpha \) it is possible to enhance stability of nonlinear modes comparing to the case of real harmonic potential. Linear and nonlinear dynamics of the modes is also discussed.

Dmitry Zezyulin
Centro de Física Teórica e Computacional
Universidade de Lisboa
zezyulin@cii.fc.ul.pt

PP1
Multiple Solutions of Poisson-Nernst-Planck(pnp) Systems for Ion Channels

we consider a one-dimensional PNP model for ionic flow through ion channels for two ion species with permanent charges. The PNP model problem can be viewed as a boundary value problem of a singularly perturbed system and the existence of solutions is reduced to that of an algebraic system. Multiple solutions are shown to exist, under some conditions, through bifurcation analysis and numerical computations are consistent with our analysis. Existence of multiple solutions in such or similar models might be relevant to some complex behaviors of ion channels.

Mingji Zhang
Department of Mathematics, University of Kansas
ming1981@ku.edu

Weishi Liu
Department of Mathematics
University of Kansas
wliu@math.ku.edu
NW12 Speaker and Organizer Index

SIAM Conference on Nonlinear Waves and Coherent Structures

June 13-16, 2012
The University of Washington
Seattle, Washington, USA

Italicized names indicate session organizers.
A
Abdullaev, Fatkhulla, CP3, 4:00 Thu
Aceves, Alejandro, MS21, 10:00 Thu
Aceves, Alejandro, MS17, 10:30 Thu
Aceves, Alejandro, MS28, 2:00 Thu
Akers, Benjamin, MS23, 2:00 Thu
Akers, Benjamin, MS37, 3:00 Fri
Akmetzhanov, Andrei, MS49, 11:00 Sat
Akter, Tania, PP1, 4:30 Thu
Akylas, Triantaphyllos R., MS2, 10:00 Wed
Ambrose, David, MS37, 3:30 Fri
Ambrose, David, MS48, 10:00 Sat
Amo, Alberto, MS19, 12:00 Wed
Arcas, Diego, MS43, 10:00 Sat
Arratia, Paulo E., MS39, 2:30 Fri
Asséméat, Elie, MS24, 2:30 Thu

B
Balasuriya, Sanjeya, MS5, 10:00 Wed
Balasuriya, Sanjeya, MS5, 10:00 Wed
Baldwin, Douglas, MS19, 10:30 Wed
Bandi, Mahesh, MS32, 11:30 Fri
Barker, Blake, MS33, 12:00 Fri
Barranca, Victor, PP1, 4:30 Thu
Barranca, Victor, PP1, 4:30 Thu
Barros, Ricardo, MS45, 10:00 Sat
Barros, Ricardo, MS45, 11:30 Sat
Belanger-Rioux, Rosalie, MS4, 11:30 Wed
Betti, Matthew, MS11, 3:30 Wed
Biktashev, Vadim N., CP2, 10:00 Thu
Biktasheva, Irina, CP2, 10:20 Thu
Binding, Paul, MS40, 3:30 Fri
Biondini, Gino, MS13, 4:00 Wed
Bodova, Katarina, MS14, 2:00 Thu
Bollt, Erik, MS5, 11:30 Wed
Boonkasame, Anakewit, MS45, 10:30 Sat
Bothner, Thomas J., MS20, 11:00 Thu
Bridges, Tom J., MS16, 12:00 Thu
Bridges, Tom J., MS16, 10:00 Thu
Bridges, Tom J., MS59, 2:00 Wed
Bridges, Tom J., MS16, 10:00 Thu
Bridges, Tom J., MS16, 10:00 Thu
Bronski, Jared, IP1, 8:45 Wed
Bronski, Jared, PD1, 6:00 Fri
Bronski, Jared, MS46, 11:00 Sat
Bruno, Oscar P., MS4, 10:30 Wed
Buckingham, Robert, MS27, 3:00 Thu
Burke, John, MS34, 11:00 Fri
Camassa, Roberto, MS18, 11:00 Thu
Cañizo, Jose A., MS14, 2:30 Thu
Caputo, Jean-Guy, MS21, 10:00 Thu
Caputo, Jean-Guy, MS21, 10:00 Thu
Caputo, Jean-Guy, MS28, 2:00 Thu
Cargill, Daniel, PP1, 4:30 Thu
Cargill, Daniel, MS38, 4:00 Fri
Chalons, Christophe, MS12, 4:00 Wed
Charbard, Frederic, MS1, 10:00 Wed
Charbard, Frederic, MS1, 10:00 Wed
Charbard, Frederic, MS9, 2:00 Wed
Chen, Zhigang, MS2, 10:30 Wed
Cheviakov, Alexei F., MS35, 12:00 Fri
Chirilus-Bruckner, Martina, MS47, 11:00 Sat
Choi, Wooyoung, MS18, 11:30 Thu
Chong, Christopher, MS11, 2:00 Wed
Chong, Christopher, MS29, 2:00 Thu
Chong, Christopher, MS48, 11:30 Sat
Churkin, Dmitry, MS24, 3:30 Thu
Cisneros-Ake, Luis A, MS28, 2:30 Thu
Coddington, Ian, MS31, 10:00 Fri
Cole, Christine L., MS36, 11:30 Fri
Coles, Matt, MS8, 11:30 Wed
Conlon, Joseph, MS14, 3:30 Thu
Cui, Zhenlu, CP3, 2:40 Thu
Curtis, Chris, MS8, 12:00 Wed
Da Costa, Fernando P., MS14, 3:00 Thu
Dai, Weizhong, PP1, 4:30 Thu
de Laires, Andre, MS8, 10:30 Wed
Deegan, Robert, MS32, 10:00 Fri
Deinert, Mark, CP3, 3:20 Thu
Delfyett, Peter, MS31, 10:30 Fri
Delvaux, Steven, MS27, 2:30 Thu
Depassier, Cristina, PP1, 4:30 Thu
Derevyanko, Stanislav A., CP1, 2:20 Wed
Dersch, Gianne, MS1, 10:30 Wed
Desyatnikov, Anton S., MS2, 11:00 Wed
D’Orsogna, Maria Rita, MS49, 10:30 Sat
Drescher, Knut, MS39, 3:30 Fri
Dudley, John, MS31, 11:00 Fri
Dutta, Tarini K., PP1, 4:30 Thu
Dutykh, Denys, MS1, 11:00 Wed
Dyachenko, Sergey, MS17, 11:00 Thu

E
El, Gennady, MS26, 2:00 Wed
El-Borai, Mahmoud M., CP5, 3:50 Fri
Engels, Peter, MS19, 11:30 Wed
Esler, Gavin, MS19, 10:00 Wed
Espinola-Rocha, J. Adrian, PP1, 4:30 Thu

F
Fagerstrom, Emily, PP1, 4:30 Thu
Falcon, Claudio, MS3, 12:00 Wed
Farjoun, Yossi, MS6, 10:30 Thu
Fatome, Julien, MS24, 3:00 Thu
Fibich, Gadi, MS17, 10:00 Thu
Fibich, Gadi, MS17, 10:00 Thu
Fischer, Baruch, MS44, 10:30 Sat
Flore, Oscar, MS25, 4:00 Thu
Fomel, Sergey, MS12, 3:30 Wed
Fu, Sheng-Chen, PP1, 4:30 Thu
Fuller, Pamela B., PP1, 4:30 Thu
Fuller, Pamela B., PP1, 4:30 Thu

G
Gaeta, Alexander, MS31, 12:00 Fri
Gagarina, Elena, PP1, 4:30 Thu
Gat, Omri, MS31, 10:00 Fri
Gat, Omri, MS38, 2:30 Fri
Gat, Omri, MS44, 10:00 Sat
Gavrilyuk, Sergey, MS1, 12:00 Wed
Gentz, Barbara, IP2, 8:45 Thu
George, David, MS43, 11:00 Sat

continued on next page
Gerbode, Sharon, MS32, 10:30 Fri
Glenn, Paul, PP1, 4:30 Thu
Goktas, Unal, MS35, 11:30 Fri
Gonella, Stefano, MS48, 10:30 Sat
Gonzalez, Frank L., MS43, 10:30 Sat
Gonzalez-Vida, Jose Manuel, MS43, 12:00 Sat
Goodman, Roy, CP1, 3:20 Wed
Goullet, Arnaud, MS45, 12:00 Sat
Green, Kevin R., PP1, 4:30 Thu
Grimesh, Roger, MS9, 2:00 Wed
Groves, Mark D., MS37, 4:00 Fri

Hagberg, Aric, PP1, 4:30 Thu
Haller, George, MS5, 10:00 Wed
Haller, George, MS5, 12:00 Wed
Haragus, Mariana, MS9, 2:30 Wed
Helbing, Dirk, MS49, 11:30 Sat
Helfrich, Karl, MS25, 2:00 Thu
Heron, Willy A., MS35, 10:00 Fri
Hereman, Willy A., MS35, 10:00 Fri
Hoefler, Mark A., MS19, 10:00 Wed
Hoefler, Mark A., MS26, 2:00 Wed
Hoefler, Mark A., CP2, 11:20 Thu
Holzer, Matt, PP1, 4:30 Thu
Holzer, Matt, MS34, 10:00 Fri
Holzer, Matt, MS34, 10:00 Fri
Holzer, Matt, MS41, 2:30 Fri
Horne, Rudy L., PP1, 4:30 Thu
Hu, Weipeng, MS9, 3:00 Wed
Humpherys, Jeffrey, MS7, 12:00 Wed

Ilan, Boaz, MS19, 10:00 Wed
Ilan, Boaz, MS26, 2:00 Wed
Ilan, Boaz, MS26, 4:00 Wed
Irvine, William, MS39, 4:30 Fri

Jackson, Russell, MS7, 10:30 Wed
James, Guillaume, MS29, 2:30 Thu

Jin, Shi, MS4, 10:00 Wed
Jin, Shi, MS12, 2:00 Wed
Jin, Shi, MS12, 2:00 Wed
Jin, Shi, PD1, 6:00 Fri
Jin, Shi, IP4, 8:45 Sat
Johnson, Mat, MS7, 10:00 Wed
Johnson, Mat, MS33, 11:30 Fri
Jones, Christopher, MS7, 10:00 Wed
Jones, Christopher, MS33, 10:00 Fri
Jones, Christopher, PD1, 6:00 Fri
Jordon, Daniel, MS48, 11:00 Sat

Kao, Hsien-Ching, PP1, 4:30 Thu
Kaper, Tasso J., MS41, 3:30 Fri
Kapitula, Todd, MS40, 3:00 Fri
Kath, William, CP2, 11:40 Thu
Kealy, Bonni, MS36, 10:00 Fri
Kealy, Bonni, MS36, 10:00 Fri
Kevrekidis, Panayotis, MS8, 10:00 Wed
Kharif, Christian, MS23, 2:00 Thu
Kielbinski, David, MS44, 11:00 Sat
Knobloch, Edgar, PP1, 4:30 Thu
Knobloch, Edgar, MS34, 10:30 Fri
Kollar, Richard, MS6, 10:00 Thu
Kollar, Richard, MS14, 2:00 Thu
Kollar, Richard, MS33, 10:00 Fri
Kollar, Richard, MS40, 2:30 Fri
Kollar, Richard, MS40, 2:30 Fri
Kollar, Richard, MS46, 10:00 Sat
Komnin, Yannis, PP1, 4:30 Thu
Konotop, Vladimir V., MS2, 11:30 Wed
Korotkevich, Alexander O., MS13, 2:00 Wed
Korotkevich, Alexander O., MS13, 3:30 Wed
Kourakis, Ioannis, CP3, 3:00 Thu
Kourakis, Ioannis, PP1, 4:30 Thu
Kovacic, Gregor, MS13, 2:00 Wed
Kovacic, Gregor, MS13, 2:00 Wed
Kumari, Nitu, PP1, 4:30 Thu
Kutz, J. Nathan, MS44, 10:00 Sat
Kutz, J. Nathan, MS44, 11:30 Sat

Lafortune, Stephane, MS7, 11:30 Wed
Lansdell, Ben, MS15, 3:30 Wed
Lasser, Caroline, MS12, 3:00 Wed
Latushkin, Yuri, MS7, 10:00 Wed
Leger, Nicholas, MS6, 11:30 Thu
LeMansier, Brenton J., MS28, 3:00 Thu
Leonard, Andrea, MS11, 2:30 Wed
Levandas, Steve, MS40, 4:30 Fri
Li, Hongwei, CP4, 11:00 Fri
Li, Jinglai, CP1, 4:00 Wed
Liu, Bin, MS32, 11:00 Fri
Liu, Weishi, MS41, 4:00 Fri
Lloyd, David, PP1, 4:30 Thu
Lopez, Juan M., CP6, 2:50 Fri
Lowman, Nicholas, CP3, 2:00 Thu
Lvov, Yuri V., MS18, 10:00 Thu
Lvov, Yuri V., MS18, 10:00 Thu
Lydon, Joseph, MS29, 3:30 Thu

Maia, Pedro, MS15, 3:00 Wed
Malej, Matt, MS23, 3:30 Thu
Malham, Simon, MS7, 11:00 Wed
Malomed, Boris, MS10, 4:00 Wed
Manjunath, Mohith, CP2, 10:40 Thu
Marangell, Robby, MS9, 3:30 Wed
Marangell, Robert, MS7, 10:00 Wed
Marks, Brian, MS31, 10:00 Fri
Marks, Brian, MS38, 2:30 Fri
Marks, Brian, MS38, 3:00 Fri
Marks, Brian, MS44, 10:00 Sat
Marletta, Marco, MS40, 4:00 Fri
Matsushima, Masatomo, CP5, 3:30 Fri
McCalla, Scott, MS34, 12:00 Fri
McCalla, Scott, MS49, 10:00 Sat
Mclarnan, Peter, PP1, 4:30 Thu
McQuighan, Kelly, PP1, 4:30 Thu
Meixner, Jessica D., CP4, 10:20 Fri
Menyuk, Curtis R., MS31, 10:00 Fri
Menyuk, Curtis R., MS38, 2:30 Fri
Menyuk, Curtis R., MS44, 10:00 Sat
Mercier, Matthieu, MS25, 3:30 Thu

continued on next page
Mia, Abdus Sattar, CP5, 3:10 Fri
Mikyoung Hur, Vera, MS30, 12:00 Fri
Milewski, Paul A., MS23, 4:00 Thu
Miller, Peter D., MS26, 2:30 Wed
Miller, Peter D., MS33, 10:00 Fri
Miller, Peter D., MS40, 2:30 Fri
Miller, Peter D., MS46, 10:00 Sat
Miquel, Benjamin, MS3, 11:00 Wed
Molchan, Maxim, MS8, 11:00 Wed
Moore, Brian E., MS1, 11:30 Wed
Moore, Brian E., PP1, 4:30 Thu
Moore, Kieron, MS16, 10:00 Thu
Moro, Antonio, MS26, 3:30 Wed
Moshkin, Nikolay, PP1, 4:30 Thu
Moshkin, Nikolay, CP4, 4:30 Thu
Muraki, David J., MS21, 10:30 Thu
Nachbin, Andre, MS21, 11:00 Thu
Nachbin, Andre, MS45, 10:00 Sat
Newell, Alan, MS30, 11:00 Fri
Newell, Alan, PD1, 6:00 Fri
Newhall, Katherine, MS13, 2:30 Wed
Nguyen, Nghiem, CP5, 4:30 Fri
Nicholls, David P., MS23, 2:00 Thu
Nicholls, David P., MS46, 11:30 Sat
Nixon, Sean, MS2, 12:00 Wed
Noble, Pascal, MS16, 10:30 Thu
Nurijanyan, Shavarsh, CP4, 10:40 Fri
Oh, Seungly, PP1, 4:30 Thu
Oliveras, Katie, MS23, 2:30 Thu
Oliveras, Katie, MS30, 10:00 Fri
Oliveras, Katie, MS37, 2:30 Fri
Olver, Sheehan, MS20, 10:00 Thu
Olver, Sheehan, MS20, 10:00 Thu
Olver, Sheehan, MS27, 2:00 Thu
Osting, Braxton, CP4, 10:00 Fri
Ou, Yaobin, CP5, 4:10 Fri
Ouellette, Nicholas T., MS32, 12:00 Fri
Pampell, Alyssa, MS28, 4:00 Thu
Pampell, Alyssa, PP1, 4:30 Thu
Panayotaros, Panayotis, MS21, 10:00 Thu
Panayotaros, Panayotis, MS28, 2:00 Thu
Panayotaros, Panayotis, MS28, 3:00 Thu
Pantic, Sanja, PP1, 4:30 Thu
Paoletti, Matthew S., MS25, 2:00 Thu
Paoletti, Matthew S., MS25, 2:30 Thu
Papagianis, Panagiotis, PP1, 4:30 Thu
Pego, Robert, MS6, 10:00 Thu
Pego, Robert, MS6, 12:00 Thu
Pego, Robert, MS14, 2:00 Thu
Peleg, Avner, CP1, 2:00 Wed
Pelinovsky, Dmitry, MS8, 10:00 Wed
Pelinovsky, Dmitry, MS46, 10:30 Sat
Pelloni, Beatrice, MS20, 10:30 Thu
Pelloni, Beatrice, MT1, 12:30 Fri
Pelloni, Beatrice, MS20, 10:30 Thu
Perline, Ronald, PP1, 4:30 Thu
Petet, Graeme, MS41, 3:30 Fri
Plaza, Ramon G., MS33, 10:30 Fri
Polzin, Kurt, MS18, 10:30 Thu
Prakash, Manu, MS39, 3:00 Fri
Prinari, Barbara, MS13, 3:00 Wed
Proroc, Joshua, MS15, 2:30 Wed
Promislov, Keith, MS46, 10:00 Sat
Prylepkey, Yaroslav, CP1, 3:00 Wed
Rapti, Zoi, MS33, 11:00 Fri
Rechtsman, Mikael, MS10, 3:00 Wed
Rezac, Jacob, MS35, 10:30 Fri
Rica, Sergio, MS3, 10:00 Wed
Rica, Sergio, MS3, 10:30 Wed
Rothos, Vassilios, MS8, 10:00 Wed
Rothos, Vassilios, MS9, 4:00 Wed
Rottschaefer, Vivi, MS47, 10:00 Sat
Rottschaefer, Vivi, MS47, 10:00 Sat
Rozada, Ignacio, MS47, 12:00 Sat
Rumpf, Benno, MS21, 11:30 Thu
Runborg, Olof, MS12, 2:30 Wed
Ruzzene, Massimo, MS29, 3:00 Thu
Sahu, Sanjeev A., CP3, 2:20 Thu
Sakovich, Anton, MS10, 2:00 Wed
Salman, Hayder, CP3, 3:40 Thu
Sandstede, Bjorn, PP1, 4:30 Thu
Schechter, Stephen, MS41, 3:00 Fri
Schober, Constance, MS16, 11:00 Thu
Segur, Harvey, MS23, 3:00 Thu
Sheils, Natalie, PP1, 4:30 Thu
Shen, Yannan, PP1, 4:30 Thu
Shliker, Eli, MS15, 2:00 Wed
Shliker, Eli, MS15, 2:00 Wed
Short, Martin, MS49, 10:00 Sat
Short, Martin, MS49, 10:00 Sat
Shtaif, Mark, MS31, 11:30 Fri
Starosvetsky, Yuli, MS11, 2:00 Wed
Steinhoff, John, CP2, 11:00 Thu
Suarez, Pablo U., CP4, 11:40 Fri
Suret, Pierre, MS3, 10:00 Wed
Suret, Pierre, MS3, 11:30 Wed
Szeglenowicz, Ivan, MS11, 3:00 Wed
Tam, Daniel, MS39, 4:00 Fri
Tang, Wenbo, MS5, 10:30 Wed
Teramoto, Takashi, MS34, 11:30 Fri
Theocharis, Georgios, MS11, 2:00 Wed
Theocharis, Georgios, MS29, 2:00 Thu
Thiffeault, Jean-Luc, MS5, 11:00 Wed
Tian, Rushun, PP1, 4:30 Thu
Tolkova, Elena, MS43, 10:00 Sat
Tovbis, Alexander, MS26, 3:00 Wed
Triandaf, Ioana A., CP1, 3:40 Wed
Trichtchenko, Olga, PP1, 4:30 Thu
Trichtchenko, Olga, MS37, 2:30 Fri
Trinh, Philippe H., CP6, 2:30 Fri
Trogdon, Thomas D., MS20, 10:00 Thu
Trogdon, Thomas D., MS27, 2:00 Thu
Trogdon, Thomas D., MS27, 2:00 Thu
Trogdon, Thomas D., PP1, 4:30 Thu
Tsai, Je-Chiang, PP1, 4:30 Thu
Tsubota, Makoto, MS19, 11:00 Wed

continued on next page
Vakakis, Alexander, MS29, 2:00 Thu
van Heijster, Peter, MS34, 10:00 Fri
van Heijster, Peter, MS41, 2:30 Fri
van Heijster, Peter, MS47, 11:30 Sat
van Roessel, Henry, MS6, 11:00 Thu
Vasan, Vishal, MS30, 10:00 Fri
Vasan, Vishal, MS30, 10:00 Fri
Vasan, Vishal, MS37, 2:30 Fri
Veerman, Frits, MS47, 10:30 Sat
Vishwakarma, Sumit K., PP1, 4:30 Thu
Vladimirova, Natalia, MS24, 4:00 Thu

Wabnitz, Stefan, MS24, 2:00 Thu
Wabnitz, Stefan, MS24, 2:00 Thu
Wahlen, Erik, MS16, 11:30 Thu
Wai, P. K. Alex, MS38, 3:30 Fri
Wang, Danhua, MS28, 2:00 Thu
Wang, Shaokang, MS38, 2:30 Fri
Wang, Zhan, MS45, 10:00 Sat
Ward, Michael, MS36, 10:30 Fri
Watts, Jonathan, MS6, 10:00 Thu
Wechselberger, Martin, MS34, 10:00 Fri
Wechselberger, Martin, MS41, 2:30 Fri
Wechselberger, Martin, MS41, 2:30 Fri
Wechselberger, Georg, MS20, 11:30 Thu
Weinstein, Michael L., MS17, 11:30 Thu
Weiss, Robert, MS43, 11:30 Sat
Wheeler, Miles, MS30, 11:30 Fri
Wilkening, Jon, MS30, 10:30 Fri
Wolf, Thomas, MS35, 10:00 Fri
Wolf, Thomas, MS35, 11:00 Fri
Wollkind, David J., MS36, 10:00 Fri
Wollkind, David J., MS36, 12:00 Fri
Wright, J. Douglas, MS48, 10:00 Sat
Wu, Chin-Chin, PP1, 4:30 Thu
Wu, Hao, MS4, 12:00 Wed
Wu, Qiliang, PP1, 4:30 Thu

Yang, Dennis Guang, MS48, 10:00 Sat
Yang, Jianke, MS2, 10:00 Wed
Yang, Jianke, MS10, 2:00 Wed
Yang, Jianke, MS10, 3:30 Wed
Yang, Xu, MS4, 11:00 Wed
Yu, Jie, MS45, 11:00 Sat
Yulin, Alexey, CP1, 2:40 Wed

Zeng, Huihui, CP5, 2:50 Fri
Zezyulin, Dmitry, PP1, 4:30 Thu
Zezyulin, Dmitry, CP5, 2:30 Fri
Zhang, Jun, IP3, 8:45 Fri
Zhang, Jun, MS32, 10:00 Fri
Zhang, Jun, MS39, 2:30 Fri
Zhang, Jun, PD1, 6:00 Fri
Zhang, Mingji, PP1, 4:30 Thu
Zheng, Chunxiong, MS4, 10:00 Wed
Zheng, Chunxiong, MS4, 10:00 Wed
Zheng, Chunxiong, MS12, 2:00 Wed
Zhu, Mei, MS36, 11:00 Fri
Zhu, Yi, MS10, 2:30 Wed
# NW12 Budget

## 2012 SIAM Conference on Nonlinear Waves and Coherent Structures

### Budget for the NW12 Conference

**Expected Paid Attendance: 250**

<table>
<thead>
<tr>
<th><strong>Revenue</strong></th>
<th><strong>Total</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration</td>
<td>$76,080</td>
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<tr>
<td>Total</td>
<td>$76,080</td>
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</table>

<table>
<thead>
<tr>
<th><strong>Direct Expenses</strong></th>
<th><strong>Cost</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Printing</td>
<td>$1,900</td>
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<tr>
<td>Organizing Committee</td>
<td>$1,700</td>
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<tr>
<td>Invited Speaker</td>
<td>$7,100</td>
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<tr>
<td>Food and Beverage</td>
<td>$8,800</td>
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<tr>
<td>Telecomm</td>
<td>$600</td>
</tr>
<tr>
<td>AV and Equipment (rental)</td>
<td>$0</td>
</tr>
<tr>
<td>Room (rental)</td>
<td>$15,000</td>
</tr>
<tr>
<td>Advertising</td>
<td>$5,000</td>
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<tr>
<td>Conference Staff Labor</td>
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</tr>
<tr>
<td>Other (supplies, staff travel, freight, exhibits, misc.)</td>
<td>$6,600</td>
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</tbody>
</table>

**Total Direct Expenses:** $61,700

<table>
<thead>
<tr>
<th><strong>Support Services:</strong> *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Services covered by Revenue</td>
</tr>
<tr>
<td>Services covered by SIAM</td>
</tr>
</tbody>
</table>

**Total Support Services:** $47,137

**Total Expenses:** $108,837

* Support services includes customer service, 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).
University of Washington Floor Plans

First Floor

Second Floor

Mary Gates Hall

Guggenheim Hall

Second Floor

GUGGENHEIM HALL
A = Conference Site
B = Hotel Deca
C = UW Dorms
D = Restaurants

FSC logo text box indicating size & layout of logo.
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