CP1

Energy Functional of the Dbvp and the First Eigenvalue of the Laplacian

Let B_1 be a ball of radius r_1 in S^n ($\mathbf{H}^n$) with $r_1 < \pi$ for S^n. Let B_0 be a smaller ball of radius r_0 such that $\overline{B_0} \subset B_1$. Let u be a solution of the problem $-\Delta u = 1$ in $\Omega := B_1 \setminus \overline{B_0}$ vanishing on the boundary. It is shown that the energy functional $E(\Omega)$ is minimal if and only if the balls are concentric. It is also shown that first Dirichlet eigenvalue of the Laplacian on Ω is maximal if and only if the balls are concentric.

Anisa Chorwadwala
The Institute of Mathematical Sciences
anisa23in@gmail.com

CP1

Singularities, Not Existing Solutions, Mac and PDE

The non existing solution of Dirichlet problem for simple bounded domain is analyzed. If the domain is a ring for Laplace equation then the solution exist for finite inner and outer radius but it can have singularity in the solution for small inner radius. The solution does not exist for zero inner radius. To obtain the physically acceptable solution the method of additional conditions (MAC) is applied. Then the bounded solution can be obtained.

Igor Neygebauer
Associate Professor
National University of Rwanda
newigor52r@yahoo.com

CP1

A Theory of Infinite-Dimensional Evans Function and the Associated Bundle.

The purpose of this talk is to introduce a topological framework to treat elliptic eigenvalue problems in a channel or bounded domain in higher dimension. The main objects are generalizations of the Evans function and the bundle construction which are originally used in the stability analysis of traveling wave in $\mathbf{R}$.

Shunsaku Nii
Kyushu University
snii@math.kyushu-u.ac.jp

Jian Deng
Central University of Finance and Economics
jdeng@fudan.edu.cn

CP1

Singular Limit Problem for Some Elliptic Systems

For the sharp interface problem arising in the singular limit of some elliptic systems, we prove the existence and the nondegeneracy of solutions whose interface is a distorted circle in a two-dimensional bounded domain without any assumption on the symmetry of the domain.

Yoshihito Oshita
Department of Mathematics
Okayama University
oshita@math.okayama-u.ac.jp

CP1

The Boundary Value Problems with Strong Singularity of Solution.

We consider the boundary value problems with strong singularity. Depending on the coefficients and right-hands sides of the equation and of the boundary conditions, the solution can be infinite at some points (the case of strong singularity, $u \notin H^1(\Omega)$). For these problems we offer to define the solution as R_ν-generalized one. Such a new concept of solution led to distinction of two classes of the boundary value problems: the problems with coordinated and non-coordinated degeneration of initial date; and also made it possible to study the existence and uniqueness of solutions as well as coercivity and differential properties in the weighted Sobolev spaces.

Victor Rukavishnikov
Russian Academy of Scinces
vark@mail.redcom.ru

CP1

Uniqueness and Asymptotic Stability for the Radial Solutions of Semilinear Elliptic Equations

Less is known of the uniqueness for the radial solutions $u = u(r)$ of the problem $\Delta u = f(u_+) = 0$ in R^n $(n > 2)$, $u(\rho) = 0$, $u'(0) = 0$, besides the cases where $lim_{r\to\infty} u(r) = 0$; and for the cases based only on the evolution of the functions $f(t)$ and $\frac{d}{dt}\frac{f(t)}{t}$. This paper proves uniqueness for the problem $D_a + f(u_+) = 0$ $(r > 0)$, $u(\rho) = 0$, $u'(0) = 0$ based on the assumption that $f \in C^1([0,\infty))$ and that ρ satisfies a boundedness condition. Furthermore, we prove asymptotic stability for $D_a + \phi(r)f(u_+) = 0$ based only on the evolution of $u'(r)$ and $u - \phi(r)f(u)$.

Sikiru Adigun Sanni
University of Uyo, Uyo, Nigeria
sikirusanni@yahoo.com

CP2

Ultra-Fast Soliton Propagation in Nonlinear Optical Media

Motivated by the recent interest in optical materials with embedded nanostructures (so-called metamaterials), we study stability of ultra-fast pulses governed by the Maxwell-Duffing model. A solitary wave is obtained as a simulated annealing solution for the two-point boundary-value problem of the 6 by 6 system of ODEs for the traveling wave. Stability of solitary waves is demonstrated through a series of DNS as well as through a numerical linearized stability analysis.

Yevgeniy Frenkel, Victor Roytburd
Department of Mathematical Sciences
RPI
frenky@rpi.edu, roytbv@rpi.edu

CP2

Evaluation of the Finite Impulse in Plastic-Elastic Wave Propagation

We consider a wave picture in semi-infinite bar in case of plastic-elastic loading and elastic unloading. The stress in the endpoint of the bar represents the finite impulse. The boundary between loading and unloading zones is called the unloading wave. In case under consideration the initial part of the unloading wave is the strong wave, but a jump of strains decreases. We obtain the condition for impulse amplitude, such that this jump equals zero within finite time. After this jump has equaled zero the unloading wave becomes the weak wave. We obtain the form of this wave analytically.

Alexander A. Kosmodemyanskiy
MIIT (Moscow Institute of Railways)
Comp. Math Department
dakosm@gmail.com

CP2

A Variational Approach to Inverse Recovery of Coefficient Functions in the Acoustic Wave Equation

We present a full waveform, fully nonlinear minimization approach for the reflection seismology problem of recovering the subsurface density ρ, sound speed κ, and absorption γ from direct measurements of pressure over a part of the water surface. Our approach consists of transforming the underlying hyperbolic partial differential equation

$$\frac{1}{\rho(x)\kappa^2(x)}(p_{tt} + \gamma(x)p_t) - \nabla.\frac{1}{\rho(x)}\nabla p = F(x,t)$$

to the self-adjoint elliptic equation

$$-\nabla.(A(x)\nabla u) + (\lambda^2 B(x) + \lambda C(x))u = -e^{-\lambda}(\lambda R(x) + S(x)) + \hat{F}(x,\lambda)$$

via the finite Laplace transform and minimizing a functional that is believed to possess a unique stationary point. The minimization procedure is based on a conjugate gradient descent algorithm using Sobolev gradients.

Ian W. Knowles
University of Alabama at Birmingham
Department of Mathematics
iwk@math.uab.edu

Mandar S. Kulkarni
Department of Mathematics
University of Alabama at Birmingham
mandar@uab.edu

CP2

Discrete Nonlinear Waves As Solutions of Linear Wave Equation

A new method is described to compute thin pulse solutions to the linear wave equation, discretized on a uniform lattice. Unlike conventional Eulerian numerical solutions, these waves remain narrow, several grid cells (h) in width, and do not spread due to discretization error even over indefinite distances. These “pulses” represent a traveling wave front as a codimension 1 surface in the limit h-¿0. The pulse is essentially a nonlinear solitary wave that “lives” on the lattice. It accurately represents the total amplitude of an arriving pulse at each lattice point in one or three dimensions, as well as the arrival time. Multiple arrival times can also be computed.

Subhashini Chitta
UTSI
schitta@utsi.edu

John Steinhoff
UTSI
Goethert Pkwy
jsteinho@utsi.edu

CP2

Numerical Simulation on Optimal Quantum System Control

Amazing quantum world is the most frontier realm. Among this, quantum system control, with its supprisingly developing and rapidly growing, is extensively demanded area. It attracts numerous attention of worldwide researchers and scientists. Fortunately, laboratory simulation provides the essential step to realize quantum control in advanced laser technology. With this motivation, the novel point of this work focus on exploring substantial stage in the direction of real quantum control via computational experiment.

Quan-Fang Wang
Mechanics and Automation Engineering
The Chinese University of Hong Kong
quanfangwang@yahoo.co.jp

CP3

The Stability and Stabilization of Solutions of the Nonlinear Differential Equations And Their Applications

The presentation consists of the three parts. In the first part we give a review of the works of the author devoted to Liaponov stability of the motion. Given new criterion’s of stability of nonlinear differential and difference equations in Banach spaces, of stability of solution of nonlinear systems of differential equations with lateness, nonlinear systems of differential equations with a small parameter attached to derivative, nonlinear systems of partial differential equations. Stability of solution of nonlinear systems of differential equations with discontinuous right-hand sides is investigated also. We investigate the Turing stability of solution of partial differential equations. Criterion’s of Liapunov stability are applied to regular case and to all possible critical cases simultaneously. In the second part of the presentation we give some new criterion’s of stabilization of solutions of differential equations. In the third part of the presentation we give applications of these criterions to some tasks of physics, ecology and economics. In particular, we offer new criterion of stability of Hotelling-Scellam models in ecology and economics, dissipative and Schrodinger systems. New criterion of stability of Kolmogorov model in ecology are given too.

Ilya V. Boykov
Professor
boikov@stup.ac.ru

CP3

The Extremal Solutions of Nonlinear Singular Boundary Value

We consider the nonlinear boundary value problems for partial differential equations, that are not satisfy the coercivity condition and for which there are not the global solvability results. By using the method of the insertion of spurious control function the given problem is regularized. For each value of control functions the obtained problem has at least one global solution. We form the discrepancy functional, then we prove some theorems for existence of optimal control. The obtained solutions are regularizators for original problem.

Victor Ivanenko
Institute for Applied and System Analysis NAS of Ukraine
vivan@zeos.net

Pavlo Kasyanov
Kyiv National Taras Shevchenko University, Ukraine
kasyanov@univ.kiev.ua

Valeriy Melnik
Institute for Applied and System Analysis NAS of Ukraine, K
vsmelnik@ukr.net

CP3

The Multivalued Penalty Method for Evolution Variational Inequalities with 0-Pseudomonotone Multivalued Maps

We consider the evolution variational inequalities with 0-pseudomonotone maps. The main properties of the given maps have been investigated. By using the finite differences method, the strong solvability for the class of evolution variational inequalities with 0-pseudomonotone map has been proved. Due to the penalty method for multivalued maps, the existence of weak solutions for evolution variation inequalities on closed convex sets has been shown. The class of multivalued penalty operators has been constructed. We have been considered one model example to illustrate the given theory.

Victor Ivanenko
Institute for Applied and System Analysis NAS of Ukraine
vivan@zeos.net

Pavlo Kasyanov
Kyiv National Taras Shevchenko University, Ukraine
kasyanov@univ.kiev.ua

Luisa Toscano
Second University of Naples, Aversa, Italy
luisatoscano@libero.it

CP3

Krylov Subspace Spectral Methods for Hyperbolic Systems

It has been demonstrated that for time-dependent variable-coefficient scalar equations, Krylov subspace spectral methods are capable of simultaneously achieving high-order accuracy in time, along with remarkable stability, considering that they are explicit methods. In this talk, we explore the generalization of these methods to hyperbolic systems of PDE. We also examine the use of homogenization via unitary similarity transformations to enhance accuracy and stability even further.

James V. Lambers
Stanford University
Department of Energy Resources Engineering
lambers@stanford.edu

CP3

Boundary Integral Approach for a Problem in Linear Viscoelasticity

In this paper it will be studied the boundary integral formulation of the initial-boundary value problem of a Volterra type integro-differential equation

$$\begin{aligned} \frac{\partial u(x,t)}{\partial t} - \mu\Delta u(x,t) - \int_0^t \frac{(t-s)^{\alpha-1}}{\Gamma(\alpha)}\Delta u(x,s)ds &= 0, \\ \text{in } \Omega \; u &= f, \\ \text{on } \partial\Omega \; u(x,0) &= 0. \end{aligned}$$

We present the boundary integral formulation of the problem by using the fundamental solution of the integro-differential operator in question. The mapping properties of the boundary integral operators in anisotropic Sobolev spaces will be given. Furthermore we show the validity of the Gårding inequality. These properties are needed in the analysis of the numerical approximation methods. Finally we will show that the Galerkin and collocation methods are stable and convergent.

Keijo M. Ruotsalainen
Professor, University of Oulu
keijo.ruotsalainen@ee.oulu.fi

CP3

Reduction of Dynamical Systems Under Stochastic Parametric Forcing

A novel model reduction strategy for stochastic ODE/PDE systems with parametric forcing is discussed and illustrated with a SEIR system. In particular: 1) We show how Markov multiplicative parametric noise can be accurately modeled using additive noise provided non static effects are taken into consideration in estimating its variance, in contrast with the standard approach (Freidlin and Wentzell, Skorokhod). 2) We present results on how the nature of the stochastic/harmonic forcing affects the dynamics in various parameter regimes.

Bruno D. Welfert
Arizona State University
Department of Mathematics & Statistics
bdw@math.asu.edu

Reynaldo Castro, Juan Lopez
Arizona State University
rcastro@mathpost.la.asu.edu, lopez@math.la.asu.edu

CP4

Blade-Vortex Interaction Analysis Using Potential Flow Theory

Abstract not available at time of publication.

Marcel Ilie
Carleton University
Department of Mechanical and Aerospace Engineering
milie@connect.carleton.ca

CP4

Exact Solution of the 3D Linear Eulers Equations As a Benchmark Test

We obtain an exact solution of the three-dimensional linear Eulers equations containing a combination of entropy, vorticity, and acoustic waves in a mean flow. The solution is a good benchmark test for numerical schemes developed for

Computational Aeroacoustics problems. We examine the accuracy of a sliding mesh interface method for problems involving moving geometry. The sliding interface method uses an optimized interpolation scheme with coefficients obtained by minimizing interpolation error in wave number space.

Philip P. Lepoudre
Florida State University
plepoudr@math.fsu.edu

CP4

Stable Interface Conditions for Discontinuous Galerkin Approximations of the Navier-Stokes Equations

The lecture presents a methodology for constructing well-posed boundary and interface conditions for one-dimensional Discontinuous Galerkin approximations of advection-diffusion equations. While Riemann solvers have traditionally been used at element interfaces to compute the interface flux for the case of pure advection, most discretizations of the Navier-Stokes equations use an average of the viscous fluxes on the two sides of an interface. Requiring the norm of the solution to not increase in time, a set of boundary/interface conditions that can be thought of as "viscous" Riemann solvers can be devised, which are compatible with the pure advection limit.

Arunasalam Rahunanthan
Department of Mathematics, University of Wyoming
Laramie, Wyoming 82071-3036
rahu@uwyo.edu

Dan Stanescu
Department of Mathematics, University of Wyoming,
Laramie, Wyoming 82071-3036
stanescu@uwyo.edu

CP4

The PDE2D Collocation Finite Element Method

PDE2D (www.pde2d.com, sold through Visual Numerics' e-commerce site) is a finite element program which solves very general PDE systems in 1D intervals, arbitrary 2D regions and a wide range of simple 3D regions. Both Galerkin and collocation options are available for 1D and 2D problems, only collocation for 3D problems. The collocation algorithms have some novel features, particularly relating to how non-rectangular regions are handled. Some advantages and disadvantages of these collocation algorithms are discussed, relative to the more standard Galerkin methods. A new GUI now allows extremely easy access to the PDE2D collocation methods, in fact, the new GUI is impossible to beat in terms of ease-of-use because it requires the user to supply the absolute minimum of information necessary to describe the PDEs and boundary conditions.

Granville Sewell
Mathematics Dept.
University of Texas El Paso
sewell@math.utep.edu

CP4

Accurate and Robust Transmissibility Upscaling on Unstructured Grids

In this talk, we consider coarse-scale modeling of flow in porous media consisting of geological features, such as faults and fractures, that are challenging from a gridding standpoint. We demonstrate an approach for obtaining an unstructured grid, and accompanying finite volume scheme, using spatially-varying multi-point flux stencils computed from local fine-scale solutions in such a way as to simultaneously achieve accuracy and robustness.

Elizabeth J. Spiteri
Chevron Energy Technology Company
espiteri@chevron.com

James V. Lambers
Stanford University
Department of Energy Resources Engineering
lambers@stanford.edu

CP5

A Positivity Preserving Central-Upwind Scheme for Chemotaxis and Haptotaxis Models

The paper is concerned with development of a new finite-volume method for a class of chemotaxis models and for a closely related haptotaxis model. In its simplest form, the chemotaxis model is described by a system of nonlinear PDEs: a convection-diffusion equation for the cell density coupled with a reaction-diffusion equation for the chemoattractant concentration. The first step in the derivation of the new method is made by adding an equation for the chemoattractant concentration gradient to the original system. We then show that the convective part of the resulting system is typically of a mixed hyperbolic-elliptic type and therefore straightforward numerical methods for the studied system may be unstable. The proposed method is based on the application of the second-order central-upwind scheme, originally developed for hyperbolic systems of conservation laws in [A. Kurganov, S. Noelle, and G. Petrova, SIAM J. Sci. Comput., 21 (2001), pp. 707–740], to the extended system of PDEs. We show that the proposed central-upwind scheme is positivity preserving, which is a very important stability property of the method. The scheme is applied to a number of two-dimensional problems including the most commonly used Keller-Segel chemotaxis model and its modern extensions as well as to a haptotaxis system modeling tumor invasion into surrounding healthy tissue. Our numerical results demonstrate high accuracy, stability, and robustness of the proposed scheme.

Alina Chertock
North Carolina State University
Department of Mathematics
chertock@math.ncsu.edu

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

CP5

Traveling Waves in Reaction-Diffusion Equations with Density-Dependent Diffusion

We consider a coupled system of reaction-diffusion equations with density-dependent diffusion, which arises as a model of spreading of a bacterial population in a surface environment. Traveling wave solutions of the system and their asymptotical behaviors are investigated. We further study the traveling wave speed dependence on various parameters. Numerical examples are presented as an illustration of the above results. The results are in agreement with experimental data.

Haiyan Wang
Arizona State University
wangh@asu.edu

Zhaosheng Feng
University of Texas-Pan American
zsfeng@utpa.edu

CP5

Global Stability for Lotka-Volterra Systems

We study Cauchy problem for the n-species Lotka-Volterra tree systems of reaction-diffusion equations. We obtain a set of sufficient conditions for the globally asymptotic stability of the solutions to Cauchy problem . The criteria in this paper are in explicit forms of the parameters, and thus, are easily verifiable. Moreover, this criteria is applicable to competition model, cooperation model, as well as to predator-prey model.

Xinhua Ji
Institute of Mathematics
Academia Sinica
xhji@mail.math.ac.cn

CP5

A Competition Model for Two Invasive Species and a Native Species

The dynamics of three competing species is examined in space-time. The model is a system of Lotka-Volterra type partial differential equations, with one equation lacking a diffusion term. The system is analyzed in terms of traveling waves, including conditions on the propagation speed of the wave front. Comments include material applicable to ecological invasions by multiple species.

Daniel L. Kern
University of Nevada, Las Vegas
Dept of Mathematical Sciences
kernd@unlv.nevada.edu

CP5

Dependence of the Speed of Traveling Wave on Invader Species and Dynamics in Two-Prey, One-Predator Commensal Effect Model

We propose the relation between invader species and the diffusion speed of traveling wave in three species prey-pedator model. It is important problem biologically what affects the spreding speed (diffusion speed) by invasion of outsider species. We apply the problem to two-prey, one-predator model involving the effect of carcasses. The model has a commensalism interaction that resident prey species eat the remains of carcasses of invader species after predator species have consumed it. Under some biological assumptions, we propose the model as ODE system and also consider the spatial diffusion effect as PDE system. The PDE system is given as the following:

$$\frac{\partial}{\partial t}h_1 = d_1\frac{\partial^2}{\partial x^2}h_1 + e_1\left(1-\frac{h_1}{k_1}\right)h_1 - \alpha_1 h_1 p + \omega h_2 p h_1,$$
$$\frac{\partial}{\partial t}h_2 = d_2\frac{\partial^2}{\partial x^2}h_2 + e_2\left(1-\frac{h_2}{k_2}\right)h_2 - \alpha_2 h_2 p,$$
$$\frac{\partial}{\partial t}p = d_3\frac{\partial^2}{\partial x^2}p - \gamma p + \beta_1 h_1 p + \beta_2 h_2 p.$$

For the ODE system, we prove permanence as well as uniform boundedness and show that the effect of the carcasses leads to chaotic dynamics for biologically reasonable choices of parameters by numerical simulations. Then we consider the spatial diffusion problem as the PDE system and propose that the diffusion speed depends only on the diffusion coefficient of 'invader species'.

Sungrim S. Lee
Graduate school of environmental sciences
Okayama university
seirin@ems.okayama-u.ac.jp

CP5

Anguilliform Swimming Through Activation in An Elastic Rod

I will discuss a model for anguilliform swimming that incorporates a simple model for muscle forces involving the release of calcium ions from the sarcoplasmic reticulum, and coupled to an activated elastic rod. Most fish swim by rhythmically passing a wave of muscle activation from head to tail, which creates a corresponding wave of curvature. I will provide an explanation for the fact that the wave of activation travels faster than the wave of curvature.

Tyler McMillen
California State University, Fullerton
Department of Mathematics
tmcmillen@fullerton.edu

Philip Holmes
Princeton University
MAE Dept.
pholmes@math.princeton.edu

Thelma Williams
St. Georges Hospital Medical School
twilli@blueyonder.co.uk

CP6

Nondegenerate Isentropic and Anisentropic One-Dimensional Wave-Wave Regular Interaction Structures: Details of a Parallel

We use two concurrent approaches [“algebraic” (Burnat; essential for isentropic multidimensional extensions) and “differential” (Martin)] to characterize nondegenerate one-dimensional wave-wave regular interaction structures. The *anisentropic* “differential” characterization results from a significant [Monge−Ampère] extension and is proven to be strictly “non-algebraic” (the *isentropic* “differential” and “algebraic” characterizations are proven to coincide). A parallel between two contexts [isentropic, anisentropic], focused on significant contrasts between the “differential” types of wave-wave regular interaction structures respectively associated, is finally considered.

Marina Ileana Dinu
Polytechnical University of Bucharest, Dept. of Math. III
ROMANIA
marinadinu@gmail.com

Liviu Florin Dinu
Institute of Mathematics of the Romanian Academy
Liviu.Dinu@imar.ro, lfdinu2@gmail.com

CP6

Coupled Mode Theory of Resonant Scattering of Water Waves by a Two Dimensional Array of Vertical Cylinders

We study the Bragg resonance of surface water waves by a two-dimensional array of vertical cylinders covering a large area of the sea. Using the resonance criterion known in the solid- state and crystallography, we employ asymptotic techniques to derive two-dimensional coupled-mode equations for the envelopes of scattered waves resonated by a plane incident wave. Explicit analytical solutions are obtained for a long strip of cylinder array. Examples of both two-wave and three-wave resonances are discussed in detail. Roles of the bandgaps are examined. The analysis and results may also apply to sound or optical waves in periodic media.

Chiang C. Mei
Dept of Civil and Environmental Engineering
MIT
ccmei@mit.edu

Yile Li
Shell International Exploration & Production
Houtson TX
yile.li@gmail.com

CP6

Wave-Breaking Dissipation in Wave/Current Interactions

Wave breaking dissipates energy in oceanic waves and it is agreed that it affects currents as well. The question to be answered are what aspects of the dynamics of waves, currents and their interactions are affected and how. Using multi-scale ideas and a stochastic parametrization of the Lagrangian fluid path it is possible to model the deterministic interactions and include in these dissipative effects. The resulting model is then capable of answering some of the phenomenological questions, and further, it can be used to make specific and testable predictions. The talk will focus on the modeling strategy and on preliminary results derived from the analysis of the model.

Juan M. Restrepo
University of Arizona
restrepo@math.arizona.edu

CP6

Standing Waves for a Generalized Davey-Stewartson System: Revisited

The existence of standing waves for a generalized Davey–Stewartson (GDS) system was shown in [A. Eden and S. Erbay, Standing waves for a generalized Davey–Stewartson system, *J. Phys. A: Math. Gen.* **39** 13435–13444 (2006)] using an unconstrainted minimization problem. Here, we consider the same problem but relax the condition on the parameters to $\chi + b < 0$ or $\chi + \frac{b}{m_1} < 0$. Our approach is to use a constrained minimization problem and utilize Lions' concentration compactness lemma. When both methods apply we show that they give the same minimizer and we obtain a sharp bound for a Gagliardo–Nirenberg type inequality. This leads to a global existence result for small-mass solutions. Moreover, we show that when $p > 2$, the L^p-norms of solutions to the Cauchy problem for a GDS system converge to zero as $t \to \infty$.

Ihsan A. Topaloglu
Indiana University
itopalog@indiana.edu

Alp Eden
Bogazici University
Feza Gursey Institute
eden@boun.edu.tr

CP7

Numerical Analysis for the Nonlocal Allen-Cahn Equation

We propose a stable, convergent and linear finite difference scheme to solve numerically the nonlocal Allen-Cahn equation which can model a variety of physical and biological phenomena involving media with properties varying in space. Also we prove that the scheme is uniquely solvable and the numerical solution will approach the true solution in the L^∞ norm.

Sarah M. Brown, Jianlong Han
Southern Utah University
brown_s@suu.edu, han@suu.edu

CP7

Title Not Available at Time of Publication

Abstract not available at time of publication.

Ming Chen
University of Minnesota
chenm@umn.edu

CP7

Multiscale Phase Field Modeling of Martensitic Microstructure Evolution and Nucleation

A three-dimensional Landau theory for multivariant stress-induced martensitic phase transformations was recently developed (V. I. Levitas, D. L. Preston and D. W. Lee, Phys. Rev. B, 134201, 2003) This new theory describes correctly the stress and temperature effect on PTs. The time dependent Ginzburg-Landau equation is used to simulate microstructures evolution. The barrierless martensitic nucleation at various dislocation configurations (single dislocation, dislocation dipole and low angle grain boundary) is also considered.

Dong-Wook Lee
Mechanical Engineering
Texas Tech University
dong-wook.lee@ttu.edu

CP7

The Numerical Computation of the Critical Boundary Displacement for Radial Cavitation

We study radial solutions of the equations of isotropic elasticity in two dimensions (for a disc) and three dimensions (for a sphere). This is equivalent to a nonlinear (quasilinear) boundary value problem depending parametrically on the boundary displacement. We describe a numerical scheme for computing the critical boundary displacement for cavitation. We give examples for specific materials and compare our numerical computations with some previous analytical results. We give a characterization in the phase plane of the nonconstant solutions of the corresponding Euler–Lagrange equations for radial solutions in terms of the curves of constant normal component of Cauchy stress for general classes of stored energy functions.

Pablo Negron
University of Puerto Rico - Humacao
pnm@math.uprh.edu

Jeyabal Sivaloganathan
Department of Mathematical Sciences
University of Bath, Bath
akshara9@aol.com

CP7

Analysis of Microbial Depolymerization of Xenobiotic Polymers Based on Mathematical Models and Experimental Data

A microbial depolymerization process falls into one of two categories: exogenous type and endogenous type. Assuming that a degradation rate is a product of a molecular factor and a time factor, a time dependent depolymerization model is transformed into a time independent model. Given the weight distribution before and after degradation, the molecular factor is determined with techniques developed in the previous studies. These techniques and techniques to determine the time factor will be discussed.

Masaji Watanabe
Graduate School of Environmental Science, Okayama University
watanabe@math.ems.okayama-u.ac.jp

Fusako Kawai
Research Institute for Bioresources
Okayama University
fkawai@rib.okayama-u.ac.jp

CP8

Mathematical Model of Filtration in Membrane

We study a general mathematical model of permeate flux in two variables. First, we state the fundamental differential equation for the inner flow and the permeate flux, which are obtained from the continuity equation. The flux satisfies a first order linear partial differential equation and the inner flow it obtained from a second order non-linear differential equation.We solve all the equations.For the linear one, the method of characteristics is used.

Ezio Marchi
IMASL-UNSL
emarchi@speedy.com.ar

Carlos Tarazaga
Universidad Nacional de SanLuis,San Luis,5700, Argentina
ctarazag@unsl.edu.ar

CP8

Finite Element Method for the Plane Stationary Free Boundary Flow

We consider the stationary flow in a bounded domain $\Omega \subset R^2$ with boundary $\Gamma = \Gamma_1 \cup \Gamma_2$. Γ_1 is a fixed part of the boundary, Γ_2 is an unknown free boundary. The flow is governed by the Navier-Stokes equations. The solution is found by the successive approximations. Every approximation is the solution to the linearized problem in the domain with known boundary. This solution is constructed by the finite element method.

Ilya S. Mogilevskiy
Tver university
Mathematical Department
Ilia.Mogilevski@mail.ru

CP8

An H^2-Compatible Finite Element Solver for the Navier-Stokes Equations

Liu, Liu, and Pego have developed an unconditionally stable algorithm for finite element discretization of the Navier-Stokes equations in the setting of the H^2 Sobolev spaces. The algorithm enforces conservation of mass without a need for the inf-sup condition that is common in H^1 formulations. In domains with reentrant corners the solution of the Navier-Stokes equations need not be in H^2, therefore the algorithm needs to be modified. We have modified the algorithm by recasting it in weighted Sobolev spaces where appropriate weights at reentrant corners compensate for the solution's singularities. The numerical results obtained this way show good agreement with those obtained by the usual H^1 methods.

Ana Maria Soane
University Of Maryland, Baltimore County
Department of Mathematics and Statistics
asoane@math.umbc.edu

CP8

On a 1D Model of the 3D Euler/Navier-Stokes Equations

In 1985 a simple 1D equation $\omega_t = H(\omega)\omega$ is proposed by P. Constantin, P. Lax and A. Majda as a model of the vortex streteching phenomenon in 3D incompressible Euler equations. This model equation blows up in finite time. Later S. Schochet discovered a counter-intuitive phenomenon: the "viscous" model $\omega_t = H(\omega)\omega + \omega_{xx}$ blows up faster for certain initial values. In this talk I will present new understanding of the interaction between stretching and dissipation. With this understanding, the phenomenon discovered by Schochet is no longer counter-intuitive.

Xinwei Yu
UCLA
xinweiyu@math.ucla.edu

CP9

Multiscale Particle Method for Hyperbolic PDEs

A meshless particle method in a multiscale framework is investigated. The aim is to obtain numerical solutions for PDEs by avoiding the mesh generation and by employing a set of particles arbitrarily placed in problem domain. The elimination of a mesh combined withthe properties of dilation and translation of scaling and wavelets functions is particularly suitable for problems with large deformations and high gradients. Numerical examples are presented to illustrate the flexibility of the proposed approach.

Elisa Francomano
Dipartimento di Ingegneria Informatica
Università degli Studi di Palermo - Italia

e.francomano@unipa.it

Adele Tortorici
Universita degli Studi di Palermo - Italia
a.tortorici@unipa.it

Elena Toscano
Universita degli Studi di Palermo
etoscano@unipa.it

CP9

Non-Oscillatory Central Schemes for a Traffic Flow Model with Arrhenius Look-Ahead Dynamics

We develop non-oscillatory central schemes for a traffic flow model with Arrhenius look-ahead dynamics. This model, takes into account interactions of every vehicle with other vehicles ahead ("look-ahead" rule) and can be written as a one-dimensional scalar conservation law with a global flux. The proposed schemes are extensions of the first-order staggered Lax-Friedrichs scheme and the second-order Nessyahu-Tadmor scheme, which belong to a class of Godunov-type projection-evolution methods, but does not require any (approximate) Riemann problem solver, which is unavailable for conservation laws with global fluxes. Our numerical experiments demonstrate high resolution, stability, and robustness of the proposed method, which is used to numerically investigate both dispersive and smoothing effects of the global flux.

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

MS1

Vortex Solutions of a "Semi-Stiff" Boundary Value Problem for the Ginzburg-Landau Equation

We study solutions of 2D Ginzburg-Landau equation $-\Delta u + \frac{1}{\varepsilon^2} u(|u|^2 - 1) = 0$ subject to the so-called "semi-stiff" boundary conditions: the Dirichlet condition for the modulus, $|u| = 1$, and the homogeneous Neumann condition for the phase. The principal result of this work shows that there are stable solutions of this problem with vortices that are located near the boundary and have bounded energy as $\varepsilon \to 0$. The proof is based on the introduction of a notion of the approximate bulk degree which is stable with respect to the weak $H1$ convergence unlike the standard degree boundary conditions. This is a joint work with V. Rybalko.

Leonid Berlyand
Penn State University
Eberly College of Science
berlyand@math.psu.edu

Volodymir Rybalko
Institute for Low Temperature Physics
Kharkov, Ukraine
vrybalko@ilt.kharkov.ua

MS1

Global Minimizers for a P-Ginzburg-Landau Energy Functional

For a p-Ginzburg-Landau energy on the plane we prove the existence of global minimizers in the class of functions with degree equal one at infinity.

Leonid Berlyand
Penn State University
Eberly College of Science
berlyand@math.psu.edu

Dmitry Golovaty
The University of Akron
Department of Theoretical and Applied Mathematics
dmitry@math.uakron.edu

Yaniv Almog
Louisana State University
almog@math.lsu.edu

Itai Shafrir
Technion - I.I.T
shafrir@math.technion.ac.il

MS1

On a Minimization Problem with a Mass Constraint Involving a Potential Vanishing on Two Curves

We study a singular perturbation type minimization problem with a mass constraint on a domain involving a potential vanishing on two curves in the plane. We analyse the limiting behavior of both the minimizers and their energies when the small parameter epsilon goes to zero and demonstrate the effect of the domain geometry on this behavior.

Itai Shafrir
Department of Mathematics, Technion- I.I.T
shafrir@math.technion.ac.il

Nelly Andre
Department of Mathematics
University of Tours, France
nelly.andre@gmail.com

MS1

Superconducting Wires Subjected to Electric Currents

We consider a one-dimensional time-dependent Ginzburg-Landau model for the current in a superconducting wire driven by an applied current. We discuss the co-existence of normal and supercurrent in the wire and the bifurcation from the normal state of both steady-state supercurrents and periodic solutions possessing vortices.

Kevin Zumbrun
Indiana University
USA
kzumbrun@indiana.edu

Peter Sternberg
Indiana University
Department of Mathematics
sternber@indiana.edu

Jacob Koby Rubinstein
Indiana University and The Technion, Israel
Department of Mathematics
jrubinst@indiana.edu

MS2

Modeling the Inhomogeneous Response in Steady and Transient Flows of Wormlike Micellar Solutions

Surfactants are amphiphilic molecules that self-assemble in solution. Under certain conditions they self-assemble into long worm-like micelles. Wormlike micellar solutions have important uses in the petroleum industry and the health-care products industry. In solution these long flexible wormlike structures entangle thus exhibiting viscoelastic properties like polymers; but, in contrast to polymers, they also break and reform continuously thus presenting an additional relaxation mechanism. Experimental observations show that these solutions exhibit distinctive (inhomogeneous) behaviors under different deformation conditions; for example, in steady shear flow these surfactant solutions develop shear bands (or more accurately shear rate bands). Concurrent with this banding is the development of a shear stress plateau in the flow curve over a broad range of shear rates. In this talk, several constitutive models (VCM, PEC, PEC+M) are investigated numerically and analytically in a cylindrical Taylor Couette geometry. These models are described through coupled systems of nonlinear partial differential equaitons. The VCM model is a two- species network model that incorporates a discrete version of Cates' breaking and reforming dynamics. The PEC and PEC+M models are, respectively, a one mode and a two mode approximation of the full VCM model (without the effects of stress-concentration coupling). The VCM model has been studied in viscometric (homogeneous) flow in Vasquez et. al. JNNFM.07. The rheological predictions of these constitutive model are investigated analytically and computationally in steady and transient shear and in "step strain" and the results are compared with experiment. The flows described are inhomogeneous and do exhibit shear banding. The effects of curvature, of diffusive terms in the stress equations, and of inertia are discussed. This work was supported by the NSF-DMS #0405931

L. Pamela Cook
Department of Mathematical Sciences
University of Delaware
cook@math.udel.edu

Lin Zhou
ENSUREDMAIL, INC.
Wilmington, DE
lin@ensuredmail.com

Paula Vasquez
Dept of Mathematical Sciences
University of Delaware
vasquez@math.udel.edu

Gareth McKinley
Dept of Mechanical Engineering
Massachusetts Institute of Technology
gareth@mit.edu

MS2

Numerical Simulations of Drop Deformation for Viscoelastic Liquid-Liquid Systems

We investigate the motion of the interface separating a drop and its surrounding liquid (matrix) in a large channel driven by wall-induced shear. The governing equations are the momentum equation, incompressibility, and constitutive equations for the Giesekus model. The Giesekus liquid is a viscoelastic liquid with first and second normal stresses and shear-thinning. We implement a volume-of-fluid algorithm with a parabolic re-construction of the interface for the calculation of the surface tension force (VOF-PROST). Numerical results are checked against small deformation theory for a viscoelastic matrix liquid, an Oldroyd-B extensional flow simulation, and experimental data on viscoelastic drop/liquid systems from S. Guido and P. Moldenaers (private communication). Reasons for the difference between Newtonian and viscoelastic drop shapes are explored with numerical simulations.

Yuriko Renardy
Virginia Tech
Department of Mathematics
renardyy@math.vt.edu

MS2

Singularities and Transport in Viscoelastic Flows

In the past several years it has come to be appreciated that in low Reynolds number flow the nonlinearities provided by non-Newtonian stresses of a complex fluid can provide a richness of dynamical behaviors more commonly associated with high Reynolds number Newtonian flow. For example, experiments by V. Steinberg and collaborators have shown that dilute polymer suspensions being sheared in simple flow geometries can exhibit highly time dependent dynamics and show efficient mixing. The corresponding experiments using Newtonian fluids do not, and indeed cannot, show such nontrivial dynamics. To better understand these phenomena we study numerically the 2D Oldroyd-B Viscoelastic model at low Reynolds number. A background force is used to create a periodic cell with four-roll mill vertical structure around a hyperbolic fixed point. We consider both steady and time-periodic forcing. For low Weissenberg number (Wi) the elastic stresses are bounded and .slaved. to the forcing, with mixing confined to small sets near the hyperbolic point. At larger Wi an analog to the coil-stretch transition occurs yielding large stresses and stress gradients concentrated on sets of small measure, perhaps indicating the development of singularities. The flow then becomes very sensitive to perturbations in the forcing and there is a transition to global mixing in the fluid.

Becca Thomases
Courant Institute
New York University
thomases@cims.nyu.edu

MS2

Mathematical Modeling and Computational Issues

The properties of viscoelastic fluids are governed by the flow-induced evolution of molecular configurations. In addition to the usual balance equations this requires constitutive equations for the configuration and stress tensor. Modeling and numerical simulation of viscoelastic fluids is not an easy task and improvements are needed in both areas. Recently, various new constitutive equations have been derived from microscopic theory. We discuss some traditional and recently proposed constitutive equations. The focus will be on mathematical modeling and computational issues.

Peter Wapperom
Department of Mathematics,Virginia Tech
wapperom@math.vt.edu

MS3
Semi-Strong Pulse Dynamics

Pulse interactions play a central role in a variety of pattern formation phenomena. They can be distinguished into three types: weak interactions, in which the pulses are assumed to be sufficiently far apart, the fully strong interactions, and the intermediate concept of semi-strong interactions, that has been introduced in the context of singularly perturbed systems, in which only some components of the pulse interact weakly. In this talk, an overview will be given of the dynamics of semi-strong pulse interactions, as well as the methods by which they can be studied analytically.

Tasso J. Kaper
Boston University
Department of Mathematics
tasso@math.bu.edu

Arjen Doelman
CWI Amsterdam, the Netherlands
A.Doelman@cwi.nl

Keith Promislow
Michigan State University
kpromisl@math.msu.edu

MS3
Asymptotic Behavior Near Planar Transition Fronts for the Cahn-Hilliard Equation

I will discuss recent results on the stability of stationary solutions for the Cahn-Hilliard equation in $\mathbf{R}^d$, $d \geq 1$. For the case $d = 1$, there are precisely three types of non-constant bounded stationary solutions, periodic solutions, pulse-type (reversal) solutions, and monotonic transition fronts. These solutions can be categorized as follows: the periodic and reversal solutions are both spectrally unstable, while the transition fronts are nonlinearly (phase-asymptotically) stable. The cases $d \geq 2$ are more complicated, and I will discuss what is known about stationary solutions in these cases. Particular emphasis will be placed on planar transition front (or "kink") solutions.

Peter Howard
Texas A&M
peter.howard@math.tamu.edu

MS3
Pulse Dynamics in a Three-Component Model

We analyze the 3-component RD system developed by Schenk, Or-Guil, Bode, and Purwins. The system consists of bistable activator-inhibitor equations with an additional inhibitor that diffuses more rapidly than the standard inhibitor. It is a prototype 3-component system that generates rich pulse dynamics and interactions. We establish the existence and stability of stationary 1-pulse and 2-pulse solutions, as well as of travelling 1-pulse solutions. Also, we analyze various bifurcations, including the SN bifurcations in which they are created, as well as the bifurcation from a stationary to a travelling pulse. For 2-pulse solutions, we show that the third component is essential, since the reduced bistable 2-component system does not support them. Finally, as we illustrate with numerical simulations, these solutions form the backbone of the rich pulse dynamics this system exhibits, including pulse replication, pulse annihilation, breathing pulses, and pulse scattering, among others.

Tasso J. Kaper
Boston University
Department of Mathematics
tasso@math.bu.edu

Arjen Doelman
CWI Amsterdam, the Netherlands
A.Doelman@cwi.nl

Peter van Heijster
CWI
p.j.a.van.heijster@cwi.nl

MS3
A Numerical Method for Coupled Surface and Grain Boundary Motion

We study the coupled surface and grain boundary motion in a bi-crystal in the context of the "quarter loop" geometry. Two types of normal curve velocities are involved in this model: motion by mean curvature and motion by surface diffusion. Three curves meet at a single point where junction conditions are given. A numerical formulation that describes the coupled normal motion of the curves and preserves arc length parametrization up to scaling is proposed. The formulation is shown to be well-posed in a simple, linear setting. Equations and junction conditions are approximated by finite difference methods. Numerical convergence to exact traveling wave solutions is shown. Other formulations of the problem and their numerical properties are discussed.

Brian R. Wetton, Zhenguo Pan
University of British Columbia
Department of Mathematics
wetton@math.ubc.ca, panzg@math.ubc.ca

MS4
Compactness for the Landau State in Thin Films Micromagnetics

We study a model for the magnetization in thin ferromagnetic films. It comes as a variational problem, depending on two parameters η and ε, for S^2-valued maps m (the magnetization). We are interested in the behavior of minimizers as $\eta, \varepsilon \to 0$. The minimizers are expected to concentrate on lines at a scale η with an energy of order $O(1/\eta|\log\eta|)$ and around a vortex at a scale ε with an energy of order $O(|\log\varepsilon|)$. We prove compactness of magnetizations in the regime where a vortex energy is more important than a line energy.

Radu Ignat
Universite Paris 11 (Orsay)
ignat@ann.jussieu.fr

Felix Otto
University of Bonn
Germany
otto@iam.uni-bonn.de

MS4
2-D Stability of the Néel Wall

We are interested in thin–film samples in micromagnetism, where the magnetization m is a 2–d unit–length vector field. More precisely we are interested in transition layers which connect two opposite magnetizations, so called Néel walls. We prove stability of the 1–d transition layer under 2–d perturbations. This amounts to the investigation of the following singularly perturbed energy functional:

$$E_{2d}(m) \;=\; \epsilon \int |\nabla m|^2 \, dx + \frac{1}{2} \int |\nabla^{-1/2} \nabla \cdot m|^2 \, dx.$$

The topological structure of this two–dimensional problem allows us to use a duality argument to infer the optimal lower bound. The lower bound relies on an ϵ–perturbation of the following *logarithmically failing* interpolation inequality

$$\int |\nabla^{1/2} \phi|^2 \, dx \;\not\lesssim\; C \, \sup |\phi| \int |\nabla \phi| \, dx.$$

Hans Knuepfer
University of Bonn
knuepfer@riemann.iam.uni-bonn.de

MS4

Z-Invariant Micromagnetic Configurations in Cylindrical Domains

In this presentation, we have proposed a rather complete study of the micromagnetic model when the configurations are assumed to be vertically invariant, the (fixed) domain is cylindrical and when the exchange constant vanishes to 0. The result is given as a $\Gamma-$ convergence theorem and when the external magnetic field has a small enough magnitude, it fully explains the Van den Berg construction. Moreover, the hypothesis of a small exterior field enables us to catch the (form of) the next order term in energy. This term is achieved with a kind of Bloch walls instead of Néel walls for thin films. From a physical point of view, it is known that typical walls in thick films are the so-called "assymetric Bloch walls" which consist in a Bloch wall inside the thickness of the sample closed by Néel caps on the top and bottom parts of wall. Thus, our results may seem physically meaningless. On the other hand, the numerical computations given in show that in thick films, the magnetization is vertically invariant in the core part of the wall and the top and bottom Néel caps are small in thickness. Hence, our model could well explain the core part of the (asymetric) Bloch wall, the Néel parts being caught energetically by the fact that our configurations are not tangent to the (horizontal) boundaries on the top and bottom parts. Indeed, if most of the configuration is vertically invariant, our ansatzes become relevant.

Stephane Labbe
Universite Paris-Sud Orsay
Stephane.Labbe@math.u-psud,fr

MS4

Slow Motion of Gradient Flows

Sometimes physical systems exhibit "dynamic metastability," in the sense that states get drawn toward so-called metastable states and are trapped near them for a long time. A familiar example is the one-dimensional Allen Cahn equation. In this work, we give sufficient conditions for a gradient flow system to exhibit metastability. We then apply the abstract result to give a new analysis of the 1-d Allen Cahn equation. The central ingredient is a nonlinear energy-energy-dissipation relationship.

Maria G. Westdickenberg
Georgia Institute of Technology
maria@math.gatech,edu

Felix Otto
University of Bonn
Germany
otto@iam.uni-bonn.de

MS5

Numerical Stencils for Large Scale Wave Propagation Problems

We have developed numerical schemes for the acoustic wave equation that minimize the dispersion error. To control complexity in large 3D computations we are forced to use only a few grid points per wavelength. The resulting dispersion is a larger source of error than order. In geophysics, the wave equations have discontinuous velocity and density functions, for instance, at the water-solid interface and also rock-salt interface. When the numerical stencil crosses a discontinuity, we need to consider modifications to the weights in the stencil, so that we get the correct reflection coefficients at the discontinuities. We will review analytic and numerical results.

Phillip Bording
Memorial Univeristy of Newfoundland
Department of Earth Sciences
pbording@mun.ca

Andreas Atle
Dept of Earth Sciences
Memorial University of Newfoundland
aoatle@mun.ca

MS5

Maximization of the Quality Factor of an Optical Resonator

We consider resonance phenomena for the scalar wave equation in an inhomogeneous medium. Resonance is a solution to the wave equation which is spatially localized while its time dependence is harmonic except for decay due to radiation. The decay rate, which is inversely proportional to the qualify factor Q, depends on the material properties of the medium. In this work, the problem of designing a resonator which has high Q (low loss) is considered. High Q resonators are desirable in a variety of applications, including photonic band gap devices. We demonstrate a numerical optimization approach to find high Q structures.

Chiu-Yen Kao
Dept. of Mathematics
Ohio State University
kao@math.ohio-state.edu

Fadil Santosa
School of Mathematics
University of Minnesota
santosa@math.umn.edu

MS5

A Fast Phase Space Method for Computing Creep-

ing Waves

Creeping waves can give an important contribution to the solution of medium to high frequency scattering problems. They are generated at the shadow lines of the illuminated scatterer by grazing incident waves and propagate along geodesics on the scatterer surface, continuously shedding diffracted waves in their tangential direction. In this talk we show how the wave propagation problem can be formulated as a partial differential equation (PDE) in a three-dimensional phase space. To solve the PDE we use a fast marching method. The PDE solution contains information about all possible creeping waves. This information includes the phase and amplitude of the field, which are extracted by a fast post-processing. Computationally the cost of solving the PDE is less than tracing all rays individually by solving a system of ordinary differential equations. We consider an application to mono-static radar cross section problems where creeping waves from all illumination angles must be computed. The numerical results of the fast phase space method and a comparison with the results of ray tracing are presented.

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

Mohammad Motamed
Department of Computer Science and Communication
Royal Institute of Technology (KTH)
mohamad@nada.kth.se

MS5
Efficient Numerical Methods Based on Wiener Chaos Expansion for Stochastic Maxwell Equations

We propose a new stochastic model for general spatially incoherent sources with applications in photonic crystal. The model naturally incorporates the incoherent property and leads to stochastic Maxwell equations. Fast numerical methods based on Wiener Chaos Expansions (WCE), which convert the random equations into coupled system of deterministic equations, are developed. The new methods can achieve 2 order of magnitude faster computation time over the standard method in photonic crystal spectrometer design.

Haomin Zhou
Georgia Tech
School of Mathematics
hmzhou@math.gatech.edu

MS6
Fluid-Structure Interaction in Blood Flow: An Overview

The focus of this minisymposium and of this talk will be on the analysis and computation of fluid-structure interaction in blood flow. Understanding solutions to moving-boundary problems describing fluid-structure interaction between blood flow and arterial walls is important in understanding the mechanisms leading to various complications in cardiovascular function. Although fascinating progress has been made in some areas of modeling and simulation of the human cardiovascular system many of the basic difficulties remain open and will continue to present major challenges in the years to come. The speaker will give an overview of the main problems and difficulties associated with the study of fluid-structure interaction in blood flow. Recent results in the analysis of solutions to the benchmark problem in blood flow will be presented and recent developments in the numerical algorithm design will be mentioned. Applications involving certain cardiovascular interventions will be shown. Colalborators: Dr. Z. Krajcer and Dr. D. Rosenstrauch (Texas Heart Institute), Dr. C. Hartley (Baylor College of Medicine), Prof. R. Glowinski, Prof. T.W. Pan, Prof. G. Guidoboni (University of Houston), Prof. A. Mikelic (University of Lyon 1, FR), Prof. J. Tambaca (University of Zagreb, CRO)

Suncica Canic
Department of Mathematics
University of Houston
canic@math.uh.edu

MS6
Proof of the Existence of a Solution to a Fluid-Structure Interaction Problem in Blood Flow

We prove the existence of a solution to a free boundary problem modeling blood flow in viscoelastic arteries.The model equations are obtained using asymptotic reduction from the incompressible, viscous Navier-Stokes equations,coupled with the linearly viscoelastic membrane equations. The reduced, effective equations are defined on the cylindrical geometry. The resulting problem is nonlinear with a free boundary. The existence of a weak solution is obtained by using the fixed point arguments.

Taebeom Kim
Department of Mathematics
University of Houston
taebeom@math.uh.edu

MS6
Title Not Available at Time of Publication

Abstract not available at time of publication.

Alfio Quarteroni
Ecole Pol. Fed. de Lausanne
Alfio.Quarteroni@epfl.ch

MS6
A Fictitious Domain Method for Simulating Viscous Flow in a Constricted Elastic Channel Subject to a Uniform External Pressure

Cardiovascular illness is most commonly caused by a constriction, called a stenosis. A nonlinear mathematical model with a free moving boundary is used to model elastic wall with constriction subjected to a uniform external pressure and a prescribed pressure drop. A fictitious domain method combined with operator splitting techniques and finite element method has been developed to simulate viscous incompressible flow in the above channel. Numerical results will be presented in this talk.

Tong Wang
Department of Mathematics
University of Houston
twang@math.uh.edu

MS7
Free Surface Problems in Irrotational 2D and 3D

Fluids

We consider the irrotational water wave and the vortex sheet. We describe a formulation of the problems using special parameterizations and convenient variables. In 2D, the parameterization is by arclength and in 3D the parameterization is isothermal. The formulation leads to a quasilinear hyperbolic system of evolution equations for the vortex sheet (with surface tension) or for the water wave (either with or without surface tension). Having written the evolution equations in this way, we are then able to make energy estimates. In the water wave case, these estimates are uniform in surface tension, allowing us to take the limit as surface tension tends to zero. This gives a new proof of well-posedness of the irrotational water wave in 3D. Most of this is joint work with Nader Masmoudi. If possible, there will be some discussion of singularity formation for some of these problems.

David Ambrose
Clemson University
dambros@clemson.edu

MS7

Well-Posedness of the Free-Boundary Compressible Euler Equations in Vacuum

We prove well-posedness for the free-boundary compressible Euler equations in vacuum. In this setting, the density vanishes on the boundary, and leads to a degenerate nonlinear wave equation for the Jacobian determinant of the Lagrangian coordinate. This is joint work with D. Coutand and H. Lindblad.

Steve Shkoller
Univiversity of California, Davis
Department of Mathematics
shkoller@math.ucdavis.edu

MS7

Effect of Vorticity on Steady Water Waves

We compute 2D finite-depth steady periodic water waves with general vorticity and large amplitude. In particular, the effect of a shear surface layer, which could be produced by the action of wind, is investigated. We find that the maximum amplitude increases as a function of vorticity. This occurs along the connected set of water waves up to a possible stagnation point in the interior or at the bottom.

Walter Strauss, Joy Ko
Brown University
wstrauss@math.brown.edu, joyko@math.brown.edu

MS7

Free Boundary Problems of the Euler Equation and Hydrodynamical Instabilities

We consider the evolution of free surfaces of incompressible and invicid fluids. Neglecting the gravity, we are interested in the cases of 1.) the motion of a droplet in the vacuum with or without surface tension and 2.) the motion of the interface between two fluids with surface tension. The evolution of these fluid boundaries and the velocity fields is determined by the free boundary problem of the Euler's equation. Each of these problems can be considered in a Lagrangian formulation on an infinite dimensional Riemannian manifold of volume preserving diffeomorphisms. In the absence of surface tension, the well-known Rayleigh-Taylor and Kelvin-Helmholtz instabilities appear naturally related to the signs of the curvatures of those infinite dimensional manifolds. The surface tension produces stronger conservative forces than the instabilities and thus regularizes the surface evolution. A scale of functionals as "energies" are defined and they bound high Sobolev norms of the velocity field as well as the mean curvature of the fluid boundary. Thus we establish the regularity of the solutions for a short time depending on the initial data. In the one fluid case, the energy estimates is uniform as the surface tension tends to zero if the Rayleigh-Taylor sign condition is satisfied. This justifies the zero surface tension problem as the limit of small surface tension problem.

Chongchun Zeng
Georgia Tech
zengch@math.gatech.edu

Jalal Shatah
New York University
shatah@cims.nyu.edu

MS8

AeroElastic Flutter Boundary Expansion with Boundary Control

No aeroelastic system is stable; and cannot be be stabilized with controls (Linear or Non-Linear) on the structure. The possibility of increasing the flutter speed with self-straining actuators is discussed.

A. V. Balakrishnan
University of California, Los Angeles
Flight System Research Center
bal@ee.ucla.edu

MS8

Boundary Control and Stability in Dynamic Fluid Structure Interaction Models

Fluid structure interaction comprising of Navier-Stokes and dynamic system of elasticity is considered . The coupling holds on interface between fluid and solid and is prescribed via matching conditions imposed on Cauchy Polya stress tensors and velocities. Problems to be discussed are: Stability and boundary uniform stabilization of the nonlinear model. Optimal Bolza boundary control problem defined for linearization of the model Optimal rates of singularity (blow up) of controls and of transfer function will be given.

Irena Lasiecka
University of Virginia, Charlottesville
Department of Mathematics
il2v@weyl.math.Virginia.EDU

MS8

Nonlocal Models of Transport in Multiscale Porous Media

We discuss "usual" model for advection-diffusion-dispersion in porous media and its validity in the presence of multiple scales especially when they are not well separated. Problem is motivated by recent experimental results by Zinn, Haggerty et al. We present a new model based on variational duality principles extending the classical double porosity models. Model preserves mass and has discrete

and continuous variants. Some computational realizations emphasizing transition between scales and nonlocal effects similar to non-Fickian dispersion will be given.

Malgorzata Peszynska, Ralph Showalter
Department of Mathematics
Oregon State University
mpesz@math.oregonstate.edu,
show@math.oregonstate.edu

MS8

Possio Integral Equation in Aeroelasticity (Asymptotical Version)

The Possio integral equation in Aeroelasticity relates the pressure distribution over a slender wing in subsonic compressible air flow to the normal velocity (downwash). Derived by C.Possio in 1938, it is crucially important in stability analysis. In spite of enormous amount of numerical papers with strong results, the fundamental problem of solvability of the equation has not been solved. We report preliminary results towards solvability.

Marianna Shubov
University of New Hampshire
Department of Mathematics and Statistics
marianna.shubov@euclid.unh.edu

MS9

Quantum Fokker-Planck Models: Global Solutions, Steady States, and Large-Time Behavior

Dissipative open quantum systems like the quantum-Fokker-Planck (QFP) model are important for quantum Brownian motion and numerical simulations of nano-semiconductor devices. The evolution equation can be written in the Wigner phase-space framework or equaivalently for density matrix operators. We discuss global-in-time wellposedness of the nonlinear QFP-Poisson model using density matrices, steady states of the linear QFP equation in a given confinement potential in the Wigner framework, and establish large-time convergence (with an exponential rate).

Anton Arnold
Vienna University of Technology (Austria)
anton.arnold@tuwien.ac.at

MS9

Title Not Available at Time of Publication

Abstract not available at time of publication.

Maria Gualdani
The University of Texas at Austin
gualdani@ices.utexas.edu

MS9

Semiclassical Transport Models in Thin Slabs

Quantum transport in simulation domains with a small aspect ratio is often approximated by semiclassical limit equations, so called sub - band models, which assume that the transport picture is classical only in one direction. This talk is concerned with sub - band models in the presence of strong forces in the quantum mechanical direction. After giving an overview of the general approach to sub - band modeling, we derive and discuss a system of coupled sub - band drift diffusion equations with an inter - band collision operator which dissipates the quantum mechanical equivalent of a thermodynamic entropy.

Christian Ringhofer
Arizona State University
ringhofer@asu.edu

MS10

Electrical Impedance Tomography with Resistor Networks

We present an inversion method that handles the severe ill-posedness of Electric Impedance Tomography by proper sparse parametrization of the unknown conductivity. Specifically, we consider finite volume grids, which are resistor networks in disguise, where the resistors are averages of the conductivity over grid cells. By interpreting the resistor network that matches the measurements as such discretization we are able to efficiently estimate the conductivity. Our method can also incorporate a priori information about the solution, if available.

Liliana Borcea
Rice University
Dept Computational & Appl Math
borcea@caam.rice.edu

Vladimir Druskin
Schlumberger-Doll Research
druskin1@boston.oilfield.slb.com

Fernando Guevara Vasquez
Stanford University
guevara@math.stanford.edu

MS10

Solving the Electrical Impedance Tomography Problem with Optimization Techniques

Electrical Impedance Tomography is an inverse problem of determining the conductivity function inside a conductive domain from the simultaneous measurements of voltages and currents on the boundary of the domain. The problem is solved in three steps by first obtaining an optimal finite difference grid for discretization of the PDE, then solving a discrete EIT problem for a resistor network, and finally finding a parameterized continuous conductivity. All three subproblems can be formulated as unconstrained optimization problems, so that we can apply a modified Gauss-Newton method. Certain regularization techniques are considered including adaptive SVD truncation of the Jacobian and a penalty function approach. We test our method on a well-studied case of a conductive disk in 2D for which a direct method of finding optimal grids and resistors in a network is available. Then we generalize our approach to a quasi-3D setting with domain of interest being an infinite cylinder and the conductivity which does not depend on Z coordinate.

Alexander Mamonov
Rice University
mamon@rice.edu

MS10

On Combining Model Reduction and Gauss-

Newton Algorithms for Inverse PDE Problems

We suggest an approach to speed up the Gauss-Newton solution of inverse PDE problems by minimizing the number of forward problem calls. The acceleration is based on effective incorporation of the information from the previous iterations via a reduced order model (ROM). It is designed with the help of Galerkin and pseudo-Galerkin methods for self-adjoint and complex symmetric problems respectively. The constructed ROM generates effective multivariate rational interpolation matching the forward olutions and the Jacobians from the previous iterations. Numerical examples for the inverse conductivity problem for the 3D Maxwell system show significant accelerations.

Vladimir Druskin
Schlumberger-Doll Research
druskin1@boston.oilfield.slb.com

Mikhail Y. Zaslavsky
Schlumberger-Doll Research,
Boston
mzaslavsky@ridgefield.oilfield.slb.com

MS11

Galloping Instability of Viscous Shock Waves

Abstract not available at time of publication.

Benjamin Texier
Institut de Mathématiques de Jussieu
Université Paris 7/Denis Diderot
texier@math.jussieu.fr

MS11

Long Tails in the Long Time Asymptotics of Quasi-Linear Hyperbolic-Parabolic Systems of Conservation Laws

We consider the long-time behaviour of solutions of systems of conservation laws. Liu and Zeng have given a detailed exposition of the leading order asymptotics close to a constant background state. We extend their analysis by examining higher order terms in the asymptotics in the framework of the so-called two dimensional *p-system*, though our methods and results should also apply to more general systems. We give a constructive procedure for obtaining these terms, and we show that their structure is determined by the interplay of the parabolic and hyperbolic parts of the problem. In particular, we prove that the corresponding solutions develop *long tails* that precede the characteristics.

Guillaume Van Baalen
Boston University
Dept. of Mathematics and Statistics
gvb@math.bu.edu

Gene Wayne
Boston University
cew@math.bu.edu

Nikola Popovic
Boston University
Center for BioDynamics and Department of Mathematics
popovic@math.bu.edu

MS11

Solitary Waves and Their Linear Stability in Weakly Coupled KdV Equations

Abstract not available at time of publication.

Douglas Wright
School of Mathematics
University of Minnesota
jdoug@math.umn.edu

MS11

New Problems in Stability of Viscous Conservation Laws

Recent Lyapunov-type theorems established by Mascia-Zumbrun, Gues-Metivier-Williams-Zumbrun, Howard-Raoofi-Zumbrun, Lyng-Raoofi-Texiier-Zumbrun, Texier-Zumbrun, and others have reduced the study of nonlinear stability, asymptotic behavior, and bifurcation of viscous traveling waves in gas dynamics combustion and MHD to determination of point spectra of the corresponding linearized operator about the wave: that is, the study of the associated eigenvalue ODE. We discuss the mathematical issues arising in this new landscape and propose general strategies for their analysis, by a balanced approach combining numerical computation, asymptotic ODE/singular perturbation theory, and classical energy estimates.

Kevin Zumbrun
Indiana University
USA
kzumbrun@indiana.edu

MS12

Title Not Available at Time of Publication

Abstract not available at time of publication.

Andrew J. Christlieb
Michigan State Univerity
Department of Mathematics
christlieb@math.msu.edu

MS12

Well-Posedness of Spatially Inhomogeneous Becker-Doering Kinetic System and Vanishing Diffusion Limit

We prove the existence, uniqueness, and stability for the Becker-Doering infinite dimensional dynamic system of merging and splitting particles in the spatially inhomogeneous case with spatial transport and diffusion. Our approach and new estimates based on a modified version of maximum principle allow the consideration of broad classes of unbounded kinetic coefficients. The results hold both for parabolic, or hyperbolic, or mixed parabolic-hyperbolic system. Moreover, we prove that the solution with vanishing diffusion tends to the solution of purely convection problem.

Pavel B. Dubovski
Stevens Institute of Technology
pdubovsk@stevens.edu

MS12

A Multi-Species Kinetic Model for Microelectronics Manufacturing Processes in the Transition and

Knudsen Regimes

We present a model for the gas flow inside chemical reactors used in the microelectronics industry to produce computer chips. The ranges of pressures on the one and of the length scales of interest on the other hand necessitate the use of a kinetic model for this problem. We will present the kinetic transport and reaction model developed for this problem and show results with a focus on multi-scale effects in time.

Matthias K. Gobbert
University of Maryland, Baltimore County
gobbert@math.umbc.edu

MS12
Title Not Available at Time of Publication

Abstract not available at time of publication.

Robert Strain
Harvard University
strain@math.harvard.edu

MS13
Shallow Water Approximation: A Mathematical Justification.

In this talk, we will focus on a Shallow Water approximation coming from the Navier-Stokes equations with free surface. We will propose a mathematical justification of such simplification based on a careful study of the approximation process and based on the use of adequate estimates. This is a joint work with P. Noble (Institut Camille Jordan, Lyon 1, France).

Didier Bresch
Université de Savoie
Didier.Bresch@univ-savoie.fr

MS13
KdV Cnoidal Waves are Linearly Stable

Going back to considerations of Benjamin (1974), there has been significant interest in the question of stability for the stationary periodic solutions of the Korteweg-deVries equation, the so-called cnoidal waves. In this paper, we exploit the squared-eigenfunction connection between the linear stability problem and the Lax pair for the Korteweg-deVries equation to completely determine the spectrum of the linear stability problem for eigenfunctions that are bounded on the real line. We find that this spectrum is confined to the imaginary axis, leading to the conclusion of spectral stability. An additional completeness argument allows for a statement of linear stability.

Bernard Deconinck
University of Washington
bernard@amath.washington.edu

MS13
Wall Laws at a Boundary with Non Periodic Irregularity

The concern of this talk is the effect of a rough wall on an incompressible fluid. Mathematical studies of this effect have been carried out under the strong assumptions of periodic irregularities. More realistic configurations (like a random distribution of irregularities) raise both physical and mathematical questions. We will address some of these questions in the talk.

David Gérard-Varet
ENS Paris
David.Gerard-Varet@ens.fr

MS13
Spectral Stability of Traveling Water Waves

The motion of the free surface of an ideal fluid under the effects of gravity and capillarity arises in a number of problems of practical interest, consequently, the reliable and accurate numerical simulation of these "water waves" is of central importance. Recently, in collaboration with F. Reitich, the author has developed a new, efficient, stable and high-order Boundary Perturbation scheme for the numerical simulation of traveling solutions of the water wave equations. In this talk we will discuss the extension of this Boundary Perturbation technique to address the equally important topic of dynamic stability of these traveling wave forms. More specifically, we describe a new numerical algorithm to compute the spectrum of the linearized water wave problem as a function of the amplitude of the traveling wave. In addition, we will present numerical results for two and three dimensional waves subject to quite general perturbations.

Dave Nicholls
University of Illinois, Chicago,
USA
nicholls@math.uic.edu

MS14
Regularity of the Solutions to Higher Order Elliptic Equations on Non-Smooth Domains

We explore the connections between the properties of the solution to the Dirichlet problem for a higher order elliptic equation and the geometry of the domain. In the case of the biharmonic equation on an arbitrary 3-dimensional domain we prove that the gradient of the solution is bounded. The result is sharp in the sense that the solution is not necessarily continuously differentiable. In this connection, we show that certain geometrical properties of the domain yield necessary and sufficient conditions for the continuity of the gradient. When the domain is convex, we show that the second derivative of the solution is bounded in all dimensions. Moreover, we derive new results regarding the well-posedness of the corresponding boundary value problem on Lipschitz domains.

Vladimir Maz'ya
The Ohio State University
Linköping University, University of Liverpool
vlmaz@math.ohio-state.edu

Svitlana Mayboroda
Mathematics, Ohio State University
Brown University
svitlana@math.ohio-state.edu

MS14
Regularity for Elasticity and Laplacean and FEM

We prove a well posedness result for anisotripic elasticity in weighted Sobolev spaces. Then we discuss the relevance of this result for improving the convergence of the Finite

Element Method.

Victor Nistor, Mazzucato
Pennsylvania State University
nistor@math.psu.edu

MS14

Quadrature for Meshless Methods and Generalized Finite Element Methods

The creation of eective quadrature schemes for Meshless Methods and Generalized Finite Element Methods is an important problem. We discuss such quadrature schemes, and prove an energy-norm error estimate. The major hypothesis is that the quadrature stiness matrix has zero row sums, a hypothesis that can be easily achieved by a simple correction of the diagonal elements. This talk is based on joint work with Ivo Babuska, Uday Banerjee and Qiaoluan(Helen) Li.

John Osborn
Department of Mathematics
University Of Maryland, College Park
jeo@math.umd.edu

MS14

Essential Boundary Conditions for Elliptic Equations in the Generalized Finite Element Method

One of the major problems in the implementation of the Generalized Finite Element Method is the enforcement of essential (Dirichlet type) boundary conditions. In this talk we address this topic in the case of boundary value problems involving second-order elliptic operators. In particular, we are interested in boundary data with low regularity (possibly a distribution).

Nicolae Tarfulea
Mathematics, Purdue University Calumet
tarfulea@caumet.purdue.edu

MS15

Transport in Porous Media. Microgemetric Effects in Capillary Networks

We model porous media as capillary networks and develop methods to study the effect of the network geometry (i.e. “microgeometry”) on the “macroscopic” transport properties of the media. In particular, we study solute transport, energy transport and fines migration and clogging.

Guillermo Goldsztein
Georgia Tech
Atlanta, GA
ggold@math.gatech.edu

MS15

Singularity of the Overall Viscous Dissipation Rate of Highly Concentrated Suspensions

We present a two-dimensional mathematical model of a highly concentrated suspension of rigid particles in an incompressible Newtonian fluid. The overall viscous dissipation rate $\widehat{W}$ of such a suspension exhibits a singular behavior. We obtain all singular terms in the asymptotics of $\widehat{W}$ as an interparticle distance tends to zero. Our analysis allows for a complete qualitative description of microflows in thin gaps between neighboring particles in the suspension.

Yuliya Gorb
Texas A&M University
gorb@math.tamu.edu

Alexei Novikov
Penn State University
Mathematics
anovikov@math.psu.edu

Leonid Berlyand
Penn State University
Eberly College of Science
berlyand@math.psu.edu

MS15

Asymptotic and Numerical Approximation of the Resonances of Thin Photonic Structures

We study the computation of the resonances of thin dielectric structures by using both asymptotics and PML. Of great interest in the study of photonic band gap materials is when these structures are periodic with a defect. We derive a limiting resonance problem as a the thickness goes to zero, and for the case of a simple resonance find a first order correction. The limiting problem and correction have one dimension less, which can make the approach very efficient. Convergence estimates are proved for the asymptotics. We then proceed to compute these resonances by two very different methods: the asymptotic method by solving a dense, but small, nonlinear eigenvalue problem; and PML, which yields a large, but linear and sparse generalized eigenvalue problem. Both methods reproduce a photonic band gap type mode found previously by finite difference time domain methods.

Jay Gopalakrishnan
University of Florida
jayg@math.ufl.edu

Shari Moskow
University of Florida
Department of Mathematics
moskow@math.ufl.edu

Fadil Santosa
School of Mathematics
University of Minnesota
santosa@math.umn.edu

MS15

Asymptotic Analysis of Boundary Layer Correctors and Applications.

Abstract not available at time of publication.

Daniel Onofrei
Mathematics Department
Rutgers University
onofrei@math.rutgers.edu

MS16

Mode Competition in Extended Domains

In many extended systems, governed by PDEs, the transition is from a spatially uniform one-dimensional state to a two-dimensional periodic pattern. Classically, these

systems have been simulated in periodic domains of the wavelength of the pattern. Nevertheless, this periodicity can be broken by secondary bifurcations or in laboratory experiments due to imperfections. Recent computations accounting for spatial non-homogenities and the transition to spatio-temporal complexity observed in hydrodynamic systems will be discussed.

Marc Avila
Universitad Politecnica de Catalunya
Applied Physics
marc@fa.upc.edu

MS16

The Role of Spatio-Temporal Symmetries in the Transition Towards Turbulence

Transitions from 2D to 3D are fundamental steps towards turbulence. A classic problem is periodically shedding bluff body wakes; the transition breaks spanwise O(2) symmetry. Considering only the O(2) symmetry breaking is insufficient as there are additional spatio-temporal symmetries with important dynamic consequences; their joint actions must be considered. The transitions to spatio-temporal complexity in a variety of problems related by their symmetry group are described.

Juan Lopez
Arizona State University
Department of Mathematics and Statistics
lopez@math.asu.edu

MS16

Organizing Centers and Their Connections

The competition between different instability mechanisms leads to very complicated dynamics, including homoclinic and heteroclinic phenomena. The dynamics are organized by codimension-two bifurcations, where modes due to the different instability mechanisms bifurcate simultaneously. The dynamics are explored using a three-dimensional Navier-Stokes solver, which is also implemented in a number of invariant subspaces in order to follow some unstable solution branches and obtain a fairly complete bifurcation diagram of the mode competitions.

Francisco Marques
Univ. Polit
'ecnica de Catalunya
Applied Physics
marques@fa.upc.edu

MS16

Travelling Waves in Modulated Rotating Convection

Recent experiments in rotating convection have shown that the chaotic Kuppers-Lortz dynamics can be suppressed by small amplitude modulations of the rotation rate. Axisymmetric target patterns develop into axisymmetric travelling wave states as the modulation amplitude and Rayleigh number are increased. Using fully 3D time-dependent Navier-Stokes-Boussinesq equations with physical boundary conditions, the experimental results are reproduced numerically gaining physical insight into the responsible mechanism, associated with a SNIC bifurcation.

Antonio M. Rubio
Arizona State University
antonio.rubio@asu.edu

MS17

Sharp Well-Posedness and Long-Time Bounds for the BBM Equation

We discuss recent results on well posed-ness and long time bounds for a certain nonlinear dispersive wave equation.

Jerry Bona
University of Illinois at Chicago
bona@math.uic.edu

MS17

On Partial Regularity for the Navier-Stokes Equations

A classical result of Caffarelli, Kohn, and Nirenberg states that the one dimensional Hausdorff measure of singularities of a suitable weak solution of the Navier-Stokes system is zero if the force belongs to the space $L^{5/2+q}$ where $q > 0$ is arbitrary. We present a shorter proof of the partial regularity result which requires the force to belong only to $L^{5/3+q}$ where $q > 0$ is arbitrary.

Igor Kukavica
USC
kukavica@usc.edu

MS17

N-Vortex Dynamics on a Rotating Sphere Coupled to a Background Field

We describe a model for the evolution of N-point vortices embedded in a background flow field that initially corresponds to solid-body rotation on the sphere. The full 'embedded' dynamical system is a discretization of the Euler equations for incompressible flow on a rotating spherical shell, hence a barotropic model of the one-layer atmosphere. We show how the coupling of the N-point vortices (in ring formation) to the background Rossby waves breaks the integrability of the problem when the center of vorticity vector associated with the ring is misaligned with the axis of rotation of the background field. Joint work with T. Sakajo.

Paul K. Newton
U Southern California
newton@usc.edu

MS17

Time Dependent Darcy-Stokes Flow with Beavers-Joseph Interface Boundary Condition

We show that the time dependent coupled Darcy-Stokes system is well-posed with the classical Beavers-Joseph interface boundary condition instead of the modified Beavers-Joseph-Saffman-Jones interface boundary condition. Convergence of fully discretized finite element schemes will be presented. Generalization to nonlinear models as well as applications to karst aquifer will be discussed.

Xiaoming Wang
Florida State University
e-mail: TBA

Yanzhao Cao
Department of Mathematics
Florida A and M U.
caoy@scs.fsu.edu

Fei Hua
Department of Mathematics
Florida State University
fhua@math.fsu.edu

Max Gunzburger
Florida State University
School for Computational Sciences
gunzburg@scs.fsu.edu

MS18

Well-Posed Boundary Value Problems for Smectic Liquid Crystals

We prove existence of minimizers to variational models for smectic liquid crystals with various types of prescribed boundary values of interest for applications.

Patricia Bauman
Purdue University
bauman@math.purdue.edu

Daniel Phillips
Department of Mathematics, Purdue University
phillips@math.purdue.edu

MS18

Energies of Ferroelectric Liquid Crystal Elastomers and Filaments

Models of elastomer liquid crystals are discussed and analyzed, with emphasis on those presenting ferroelectric properties. We discuss well-possedness of boundary value problems and present an application to filament geometry.

Maria-Carme Calderer
Deparment of Mathematics
University of Minnesota, USA
mcc@math.umn.edu

MS18

Modeling of Ferroelectricity in the Chiral Smectic Liquid Crystals and Bent Core Molecules

In this presentation, we study the structure of ferroelectric liquid crystals with interactions of polarizations. Such a material is very interesting with respect to practical applications, such as a fast switching between the active and inactive state. We introduce a model for ferroelectric liquid crystals including nonlocal energy term and discuss equilibrium configurations of the energy. We will focus on periodic configurations which appear in the physics literature.

Jinhae Park
Purdue University
park196@math.purdue.edu

MS18

Orientable and Non-Orientable Director Fields For Liquid Crystals

Uniaxial nematic liquid crystals are often modelled using the Oseen-Frank theory, in which the mean orientation of the rod-like molecules is modelled through a unit vector field n. This theory has the apparent drawback that it does not respect the head-to-tail symmetry in which n should be equivalent to -n, that is, instead of n taking values in the unit sphere S2, it should take values in the sphere with opposite points identified, i.e. in the real projective plane RP2. The de Gennes theory respects this symmetry by working with the tensor Q=s(nn- 1/3 Id). In the case of a non-zero constant scalar order parameter s the de Gennes theory is equivalent to that of Oseen-Frank when the director field is orientable. We report on a general study of when the director fields can be oriented, described in terms of the topology of the domain filled by the liquid crystals, the boundary data and the rate of blow-up of possible singularities. We also analyze the circumstances in which the non-orientable configurations are energetically favoured over the orientable ones. This is joint work with John Ball.

John Ball
University of Oxford, United Kingdom
ball@maths.ox.ac.uk

Arghir Zarnescu
University of Oxford
zarnescu@maths.ox.ac.uk

MS19

Title Not Available at Time of Publication

Abstract not available at time of publication.

Sujeet Bhat
IMA
bhat@ima.umn.edu

MS19

Electromagnetic Transmission Spectra in Periodic Hole Arrays

Several recent experimental studies have investigated the transmission resonances which occur at certain frequencies when a thin perforated conducting plate is illuminated by an electromagnetic wave. There is hope that this phenomenon will prove useful in constructing filters and other devices for manipulating radiation in the terahertz range. We will describe an analytical and a numerical approach for studying this problem. Numerical results will be presented, along with some clues as to how the transmission spectrum depends on the pattern and shape of the holes.

David C. Dobson
University of Utah
dobson@math.utah.edu

MS19

Title Not Available at Time of Publication

Abstract not available at time of publication.

Alexei Novikov
Penn State University
Mathematics
anovikov@math.psu.edu

MS19

Modeling Brittle Fracture Through an Extension

of Continuum Mechanics to the Nanoscale

Described in this talk is a new approach to modeling fracture in brittle materials based upon an extension of continuum mechanics to the nanoscale. The approach accepts bulk continuum constitutive properties away from material interfaces but corrects material behavior for effects due to long range intermolecular forces in the vicinity of material interfaces which in the context of fracture are the fracture surfaces. The correction is in the form of a nonlinear mutual force in the bulk differential momentum balance equations and a nonlinear boundary condition coming from the jump momentum balance across fracture surfaces. Both correction terms derive from atom-atom interaction potentials. It is proved that this new modeling paradigm avoids the crack edge singularities found in classical elastic fracture theories.

Jay R. Walton
Department of Mathematics
Texas A&M
jwalton@math.tamu.edu

K.-B. Fu
Department of Mathematics
Texas A&M University
kfu@math.tamu.edu

J. Slattery
Department of Aerospace Engineering
Texas A&M University
j1s3936@aeromail.tamu.edu

T. Sendova
Department of Mathematics
Texas A&M University
sendova@math.tamu.edu

MS20

Nonlinear Stability of Time-Periodic Viscous Shock Waves

Time-period viscous Lax shocks are shown to be nonlinearly stable. The result is obtained by formulating the linear evolution using a contour integral and using the components of the Green's function associated to the neutral directions to define time-dependent shifts of the phase and spatial translate. Using the integral formulation of solutions, we show these shifts converge to asymptotic limits and the solution converges to the resulting space and time translate of the periodic shock.

Kevin Zumbrun
Indiana University
USA
kzumbrun@indiana.edu

Bjorn Sandstede
University of Surrey
b.sandstede@surrey.ac.uk

Margaret Beck
University of Surrey
Department of Mathematics
m.beck@surrey.ac.uk

MS20

Stability of Large-Amplitude Viscous Shocks

By a combination of Evans function methods, spectral energy estimates, and boundary layer analysis, we are able to prove stability of (1-D) large-amplitude viscous shocks in isentropic Navier-Stokes (or the p-system with real viscosity). We then describe our latest results in generalizing this work to other systems, including the full (ideal gas) Navier-Stokes equations. Finally, we give an overview of the strategies used and how they may be applied more generally.

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

Kevin Zumbrun
Indiana University
USA
kzumbrun@indiana.edu

MS20

On Darcy's Law for Compressible Porous Medium Flows

The motion of compressible flow through porous medium can be modeled by compressible Euler equations with frictional damping. Physically, Darcy's law is valid for large time and the density obeys the porous medium equation. In 1-d, the mathematical verification on this conjecture was given by Hsiao & Liu in 1992 for small smooth solutions. We will give a proof for any physical weak solutions.

Ronghua Pan
Georgia Tech.
panrh@math.gatech.edu

MS20

Stability of Undercompressive Viscous Shock Profiles of Hyperbolic-Parabolic Systems

We show for viscous shock profiles of arbitrary amplitude and type, for hyperbolic-parabolic systems of conservation laws, that necessary spectral (Evans function) conditions for linearized stability are also sufficient for linearized and nonlinear phase-asymptotic stability, yielding detailed pointwise estimates and sharp rates of convergence in L^p, $1 \leq p \leq \infty$.

Kevin Zumbrun
Indiana University
USA
kzumbrun@indiana.edu

Mohammadreza Raoofi
University of Minnesota
raoofi@umn.edu

MS21

Diffusive Expansion in Kinetic Theory

In this talk, the diffusive expansion to the Vlasov-Maxwell-Boltzmann system is discussed. Such an expansion yields a set of dissipative new macroscopic PDEs and its higher order corrections for describing a charged fluid, where the self-consistent electromagnetic field is present. The uniform estimate on the remainders is established via a unified nonlinear energy method and it guarantees the global in time validity of such an expansion up to any order.

Juhi Jang
Institute for Advanced Study
juhijang@math.ias.edu

MS21

Mathematical Problems in Reactive and Inert Kinetic Models for Dense Gases

In the kinetic theory of simple reacting spheres (SRS), the molecules behave as if they were single mass points with two (or more) internal states of excitation. Collisions alter the internal states when the kinetic energy associated with the reactive motion exceeds the activation energy. Both reactive and non-reactive collision events are considered to be hard–spheres like. Thus, one considers a four component mixture A, B, A^*, B^*, and the chemical reaction of the type

$$A + B \rightleftharpoons A^* + B^*.$$

Here, A^* and B^* are distinct species from A and B, and we use the indices 1, 2, 3, and 4 for the particles A, B, A^*, and B^* respectively. I assume that mass transfer in reactive collisions satisfies the condition $m_1 + m_2 = m_3 + m_4$, where m_i denotes the mass of the i-th particle, $i = 1, \ldots, 4$. Reactions take place when the reactive particles are separated by a distance $\sigma_{12} = \frac{1}{2}(d_1 + d_2)$, where d_i denotes the diameter of the i-th particle.

The SRS, being a natural extension of the hard–sphere collisional model, reduces itself to the revised Enskog theory (RET) when the chemical reactions are turned off. Thus, it can be considered as a good candidate for the RET analog of the reacting hard-spheres.

I will show that the kinetic theory of simple reacting spheres has an H–function. Its functional form depends on a specific type of the closure relation used in the first hierarchy equation. In addition to its physical importance, the H–function is utilized to obtain existence and stability theorems for the corresponding kinetic equations.

Jacek Polewczak
California State University, Northridge
jacek.polewczak@csun.edu

MS21

Treatment of Multiscale Hybrid Deterministic/Stochastic Coupled Systems

A class of model prototype hybrid systems comprised of a microscopic Arrhenius surface process describing adsorption/desorption and/or surface diffusion of particles coupled to an ordinary or partial differential equation displaying bifurcations triggered by the microscopic process is presented and analyzed. These models arise from diverse applications ranging from surface processes and catalysis to atmospheric and oceanic sciences.

Alexandros Sopasakis
University of North Carolina, Charlotte
Mathematics
asopasak@uncc.edu

MS21

A Kinetic Formulation for Homogenization Problems

We develop an analytical tool which is adept for detecting shapes of oscillatory functions, is useful in decomposing homogenization problems into limit-problems for kinetic equations, and provides an efficient framework for the validation of multi-scale asymptotic expansions. We apply it first to a hyperbolic homogenization problem and transform it to a hyperbolic limit problem for a kinetic equation, and establish conditions determining an effective equation and counterexamples for the case that such conditions fail. Second, when the kinetic decomposition is applied to the problem of enhanced diffusion, it leads to a diffusive limit problem for a kinetic equation that in turn yields the effective equation of enhanced diffusion.

Athanasios Tzavaras
University of Maryland
Tzavaras@math.umd.edu

Pierre-Emmanuel Jabin
University of Nice
pierre-emmanuel.jabin@unice.fr

MS22

Homogenization of Polyconvex Functionals

Using two-scale Young measures, I will describe the zero level set of an effective energy density related to a periodic microstructure. I will use this analysis to show that polyconvex energies are not closed with respect to periodic homogenization. The counter-example is based on a rank-one laminated structure obtained by mixing two polyconvex functions with p-growth, where $p \geq 2$ can be fixed arbitrarily. I will also discuss a counter-example to the continuity of the determinant with respect to two-scale convergence.

Marco Barchiesi
Carnegie Mellon University
marcob@andrew.cmu.edu

MS22

Variational Principles in L^∞ and Aronsson Equations

Connections between highly nonlinear degenerate PDEs arising as Aronsson equations associated to variational principles for supremal functionals under general PDE constraints will be discussed.

Marian Bocea
North Dakota State University
marian.bocea@ndsu.edu

MS22

Quasistatic Evolution in Plasticity with Softening

In this talk a quasistatic evolution problem in plasticity with softening is considered in the framework of small strain associative elastoplasticity. The presence of a nonconvex term due to the softening phenomenon requires a nontrivial extension of the variational framework for rate-independent problems to the case of a nonconvex energy functional. In this case the use of global minimizers in the corresponding incremental problems appears to be not justified from the mechanical point of view. Thus, a different selection criterion for the solutions of the quasistatic evolution problem is proposed, which is based on a viscous approximation. This leads to a generalized formulation in terms of Young measures. This is a joint work with G. Dal Maso, A. De Simone, and M. Morini.

Maria Giovanna Mora
SISSA, Trieste, Italy
mora@sissa.it

MS22

Epitaxial Growth of Strained Crystalline Films: a Variational Approach

We consider strained epitaxial films grown on a relatively thick substrate in the context of plane linear elasticity. Adopting a variational approach, we look at equilibrium configurations; i.e., at local minimizers of the total energy functional, which is assumed to be the sum of the energy of the free surface of the film and the strain energy. In this talk we will focus on some qualitative properties of such configurations that can be rigorously inferred from the model.

Massimiliano Morini
SISSA
Trieste,Italy
morini@sissa.it

MS22

Nusselt Number Scaling in Thermal Convection

Rayleigh-Benard convection is a paradigm of nonlinear dynamics. One key feature is the enhancement of heat transport as characterized by the Nusselt number, a nondimensional parameter whose scaling with respect to the Rayleigh number has been widely studied. The background method is a variational method for producing an upper bound on the scaling relationship. We use the background method together with a novel background temperature profile and a new weighted inequality for the bi-Laplacian operator to produce the best analytical result to date. This is joint work with Felix Otto

Maria G. Westdickenberg
Georgia Institute of Technology
maria@math.gatech.edu

MS23

Nonlinear Water Waves in Random Bathymetry

This talk discusses the behavior of surface water waves in fluid domains whose boundaries are not precisely known, and therefore treated as random. It is and important topic to coastal engineering as well as to the theory of tsunami propagation. We consider the long-wave asymptotic limit of nonlinear surface waves over bathymetry given by a stationary ergodic process. It is a problem of homogenization theory. However it turns out that in the appropriate scaling regime, and in the case in which the bottom variations are decorrolated on length scales that are long with respect to the surface waves, there remain random, realization dependent effects which are as important as the dispersion and nonlinearity of the problem. The talk will describe the methods of Hamiltonian averaging, the probability theory that goes into the analysis of these random processes and their canonical limits, and the results for surface water waves propagating over a random bottom. This talk should be considered joint with the presentation of C. Sulem.

Walter Craig
Department of Mathematics and Statistics
McMaster University
craig@math.mcmaster.ca

MS23

Solitary Waves of the Kadomtsev-Petviashvili Equation with Effects of Rotation

The rotation-modified Kadomtsev-Petviashvili (RMKP) equation was formally derived by Roger Grimshaw to describe small-amplitude, long internal waves with weak transverse effects in a rotating channel of shallow water, where the effects of rotation balance with weakly nonlinear and dispersive effects. A brief account is given of its formulation and of connections to other model equations in oceanography and geophysics, for instance, the usual KP equation and the Ostrovsky equation. Comments are made on the local and the global well-posedness of the Cauchy problem for the RMKP equation. Presented with proofs are the existence of localized, traveling solutions, namely, solitary waves, of the RMKP equation and their symmetry properties, stability. Emphasis is given to the effects of rotation.

Robin Ming Chen
University of Minnesota
chenm@math.umn.edu

Yue Liu
University of Texas at Arlington
yliu@uta.edu

Vera Mikyoung Hur
Massachusetts Institute of Technology
verahur@math.mit.edu

MS23

A Shallow Water Approximation for Water Waves

In this talk we are concerned with the initial value problem for water waves in arbitrary space dimensions. We will give a mathematically rigorous justification of the shallow water approximation for water waves in Sobolev spaces. One of the main part of the analysis is to give some uniform estimates for the Dirichlet-to-Neumann map for a scaled Laplace's equation by using a suitable diffeomorphism.

Tatsuo IGUCHI
Keio University
JAPAN
iguchi@math.keio.ac.jp

MS23

Water Waves Over a Random Topography

We discuss the problem of nonlinear wave motion of the free surface of a body of fluid over a variable bottom. The object is to describe the character of wave propagation in a long wave asymptotic regime. We assume that the bottom of the fluid region can be described by a stationary random process whose variations take place on short length scales. It is a problem in homogenization theory. Our principal result is the derivation of effective equations and a consistency analysis. This talk constitutes one part in a series of two talks on this topics, the other talk being given by Walter Craig.

Catherine Sulem

University of Toronto
sulem@math.toronto.edu

MS24

Time-Analyticity and Backwards Uniqueness for Weak Solutions of the Navier-Stokes Equations of Compressible Flow

We prove that solutions of the Navier-Stokes equations of three-dimensional, compressible flow, restricted to fluid-particle trajectories, can be extended as analytic functions of complex time. One important corollary is backwards uniqueness: if two such solutions agree at a given time, then they must agree at all previous times as well as at subsequent times. Additionally, analyticity yields sharp estimates for the time derivatives of arbitrary order of solutions along particle trajectories. Our analysis depends on a careful study of solutions of a suitably complexified version of the Navier-Stokes system written in Lagrangean coordinates.

Eugene Tsyganov, David Hoff
Indiana University
entsygan@indiana.edu, hoff@indiana.edu

MS24

Boundary Behavior of Compressible, Viscous Fluid Flows

In this talk we will discuss some results on the existence of the weak solutions to the Navier-Stokes equations for the motion of compressible, viscous fluid flows in the half-space with the no-slip boundary condition. The emphasis is made on the boundary behavior of weak solutions with the discontinuous density field.

Mikhail Perepelitsa
Vanderbilt University
mikhail.perepelitsa@vanderbilt.edu

MS24

From the Dynamics of Gaseous Stars to the Incompressible Euler Equations

A model for the dynamics of gaseous stars is introduced formulated by the Navier-Stokes-Poisson system for compressible, reacting gases. The combined quasineutral and inviscid limit of the NSP system in the torus T^d is investigated. The convergence of the Navier-Stokes-Poisson system to the incompressible Euler equations is proven for the global weak solution and for the case of general initial data.

Konstantina Trivisa
University of Maryland
trivisa@math.umd.edu

Donatella Donatelli
University of L'Aquila -Italy
donatell@univaq.it

MS24

Global Solution to the Multi-Dimensional Equations of Compressible Magnetohydrodynamic Flows

An initial-boundary value problem for the three-dimensional compressible magnetohydrodynamic flow is studied in a bounded domain with large data. The existence and large-time behavior of global weak solution are established.

Dehua Wang
University of Pittsburgh
Department of Mathematics
dwang@math.pitt.edu

MS25

Output Tracking Control of a PDE Model of a Factory Production Line

Semiconductor factory production is essentially a transport problem that can be modelled by hyperbolic PDEs. The associated transport velocity can be modelled as a state equation leading to a non-local nonlinear equation. A major practical problem is the determination of the influx that generates a desired outflux over a given period of time. Using a Lagrangian approach we present several different algorithms to solve this problem for different types of state equations.

Dieter Armbruster
Arizona State University
Dept of Mathematics
dieter@math.la.asu.edu

Michael LaMarca
Arizona State University
lamarca@mathpost.asu.edu

MS25

Optimization Techniques For Network Models II

We consider optimization problems for production networks. This talk continues the presentation Optimization Techniques For Network Models I. We further investigate the optimality system. We present presolve techniques inspired by the continuous dynamics to reduce the computational effort. We show that large–scale instances of the MIP can be solved only if the new presolve techniques are used. Furthermore. we show that under certain conditions on the objective functional, the MIP is in fact equivalent to a linear programming problem. We present numerical results for large-scale production facilities.

Simone Goettlich
Kaiserslautern University of Technology, FRG
goettlich@mathematik.uni-kl.de

MS25

Optimization Techniques For Network Models I

We consider optimization problems arising in the continuous modeling of production networks. We introduce an optimization problem based on recently established continuous model for supply chains. We present an adjoint calculus for solving the optimality system and discuss suitable discretizations of this system. For particular discretizations the resulting problem is in fact a MIP. We present extensions to this model including a discretized priority model as well as numerical results for sample supply chain networks.

Michael Herty
Kaiserslautern University of Technology, FRG
herty@rhrk.uni-kl.de

MS25

Modelling and Control of Production Networks Based on Road Network Traffic Management Methods

This paper is concerned with a fluid approach towards modelling of production networks inspired by the macroscopic modelling of freeway networks. The manufacturing process is modelled as a system whose dynamics are described by a PDE and its state is influenced by controlled inputs and uncontrolled disturbances. The modelling PDE expresses the principle of the manufactured items' conservation over the range of product completion and can be used for both simulation and control design purposes. Production systems can be controlled with the use of control measures similar to those applied in freeway networks. These control measures will be reviewed and their interpretation within the manufacturing framework will be discussed. A number of different scenarios will be examined involving serial and parallel manufacturing lines.

Apostolos Kotsialos
Durham University, UK
apostolos.kotsialos@durham.ac.uk

MS26

Gradient flow of the Aviles Giga functional

Aviles and Giga introduced the functional

$$\int \frac{\varepsilon}{2}(\Delta\Theta)^2 + \frac{1}{4\varepsilon}\left(1 - |grad\Theta|^2\right)^2 dx$$

in the context of liquid crystals. It has since appeared in various guises for models of thin-film blistering, micromagnetics, and pattern formation. The dynamical analog (the L^2 gradient flow) is also of interest, because of the implications for microstructure formation. This talk considers the singular, sharp interface limit $\varepsilon \to 0$ which gives rise to time-evolving grain boundary networks. Formal computations lead to a complex free boundary problem coupling motion of network edges and junctions. Two junction types, characterized by their geometry, are identified. The gradient flow of the (conjectured) Gamma-limit is also considered, and is show to be equivalent. Consequences of the resulting reduced dynamics, including dynamic scaling, will be discussed.

Karl Glasner
The University of Arizona
Department of Mathematics
kglasner@math.arizona.edu

MS26

Singular Interfacial Energy, Faceting, and Crystal Microstructure in Epitaxial Relaxation

The relaxation of crystal surfaces is driven by the motion of atomic line defects ("steps"). In the continuum limit, the evolution equation can be viewed as a steepest-descent system on the basis of a singular surface energy. Corner singularities of the energy density correspond to macroscopically flat regions ("facets"). In this talk I will discuss continuum solutions consistent with the motion of steps. In particular, I will show how the crystal microstructure, in the form of individual steps on top of the physical facet, affects the slope profile macroscopically.

Dionisios Margetis
University of Maryland, College Park
dio@math.umd.edu

MS26

On a Nonlocal Model of Biological Aggregation

I will discuss some features of a continuum model of biological aggregation introduced by Topaz, Bertozzi and Lewis. Individuals, described by the model, are attracted to each other at a distance, but avoid overcrowding via a local dispersal mechanism. In the continuum model for the population density the attraction is described via a nonlocal operator, while the repulsion is modeled by a differential operator. We show that the density profile develops interfaces between a near-constant-density aggregate state and the empty space. The interfaces evolve under surface-tension-like "forces". More precisely, using the gradient flow structure and asymptotic analysis, we show that the sharp interface limit for the interfacial motion is the Hele-Shaw flow. On long time scales the interfacial motion leads to coarsening of length scales present in the system. The rate of coarsening can be investigated using the Kohn-Otto framework.We will describe a geometric viewpoint, which unites the coarsening results in a variety of interfacial models. The talk is based on joint work with Andrea Bertozzi.

Dejan Slepcev
Carnegie Mellon University
slepcev@math.cmu.edu

MS26

Title Not Available at Time of Publication

I will discuss some asymptotic limits of the Ginzburg-Landau and Chern-Simons-Higgs energies via Gamma convergence methods.

Daniel Spirn
University of Minnesota
spirn@umn.edu

MS26

The IVP for Euler/Euler-Poisson Type Systems

The "sticky particles" model at the discrete level is employed to obtain global solutions for a class of systems of conservation laws among which lie the pressureless Euler and pressureless Euler-Poisson systems. We consider the case of finite, nonnegative initial Borel measures with finite second-order moments, along with continuous initial velocities of at most quadratic growth and finite energy.

Adrian Tudorascu
Georgia Institute of Technology
adriant@math.gatech.edu

MS27

On a Diffuse Interface Model for a Binary Mixture of Compressible Viscous Fluids

We consider a model describing the time evolution of a binary mixture of compressible viscous fluid consisting of the compressible Navier-Stokes system coupled with a Cahn-Hilliard equation for the order parameter. We show that the problem posesses a global-in-time weak solution for any finite energy initial data. Related questions are also discussed.

Eduard Feireisl

Mathematical Institute ASCR, Zitna 25, 115 67 Praha 1
Czech Republic
feireisl@math.cas.cz

Helmut Abels
Max Planck Institute
Leipzig
abels@mis.mpg.de

MS27

Contact Discontinuity for Jin-Xin Relaxation System

We construct the contact waves for Jin-Xin relaxation system in 1-D. Such waves are relaxation correspondence of contact discontinuity for hyperbolic conservation laws at equilibrium. We further prove that they are stable under generic small intial perturbations.

Ronghua Pan
Georgia Tech.
panrh@math.gatech.edu

MS27

Stability of Perfect-Fluid Shock Waves in Special and General Relativity

For general relativity, the persistence problem of shock fronts in perfect fluids is also a continuation problem for a pseudo-Riemannian metric of reduced regularity. We solve the problem by considerations on a Cauchy problem which combines a well-known formulation of the Einstein-Euler equations as a first-order symmetric hyperbolic system and Rankine-Hugoniot type jump conditions for the fluid variables with an extra (non-)jump condition for the first derivatives of the metric. As in non-relativistic settings, the shock front must satisfy a Kreiss-Lopatinski condition in order for the persistence result to apply.

Mohammadreza Raoofi
University of Minnesota, School of Mathematics
raoofi@umn.edu

Heinrich Freistuehler
Universit
"at Leipzig
heinrich.freistuehler@math.uni-leipzig.de

MS27

Title Not Available at Time of Publication

Abstract not available at time of publication.

Zhouping Xin
Chinese University of Hong Kong
zpxin@ims.cuhk.edu.hk

MS28

On a Free Boundary Problem Arising from Material Science

In this talk, we will study a free boundary problem arising from material science. The regularity of both the phase function and the free boundary will be discussed.

Huiqiang Jiang
Department of Mathematics, University of Pittsburgh
hqjiang@math.pitt.edu

MS28

Threshold-Based Quasi-Static Brittle Damage Evolution

We will first consider a variational model for damage proposed by Francfort and Marigo, and then give an existence result (for a quasi-static version) by Francfort and Garroni. A case for a strain-threshold damage model will be made, and precise definitions for both an unrelaxed (i.e., the damage region is a set at each time) and relaxed (i.e., the damage "set" is given by a density function, together with an effective tensor that stores the microstructure of the damage) quasi-static evolution will be given. It turns out that solutions of the unrelaxed variational problem are solutions to the unrelaxed threshold problem, but there is an interesting issue in showing the same for the relaxed problems. This issue is related to a question regarding G-closure and the relative scalings of damage microstructure at different times. A new variational formulation, arguably more physical than the existing one, will be given, and we will show that relaxed solutions of this variational problem are solutions of the relaxed threshold problem. This is based on joint work with A. Garroni.

Christopher Larsen
Worcester Polytechnic Institute
Math Dept
cjlarsen@wpi.edu

MS28

Nonuniqueness in a Free Boundary Problem From Combustion

We will present a rigorous justification for a nonuniqueness example in the parabolic free boundary problem with fixed gradient condition, which appears in combustion theory to describe the propagation of premixed equidiffusional flames in the limit of high activation energy.

Aaron Yip, Arshak Petrosyan
Purdue University
Department of Mathematics
yip@math.purdue.edu, arshak@math.purdue.edu

MS28

Infinity Laplace Equation And Related Issues

The speaker plans to introduce the basic theory of Infinity Laplace Equation and related topics. In particular, he plans to cover some recent progress in the theory.

Peiyong Wang
Department of Mathematics
Wayne State University
pywang@math.wayne.edu

MS28

Global Minimizers of Chern-Simons-Higgs Functional Below Critical Magnetic Field

For CSH functional of superconductors in an external field, we prove the global minimizer is verticesless when the external field is below critical field. It is a joint work with Daniel Spirn from Minnesota

Xiaodong Yan
Michigan State University
Department Of Mathematics
xiayan@math.msu.edu

MS29

An Analytic Model in Finding Geodesic Path Between Shapes

Curve matching plays a crucial role for many problems in computer vision and medical image analysis. In this paper, we built a novel model based on Hellinger distance for curve matching. In this model, we can construct a geodesic path between two shapes analytically. Besides, this model with slight modifications is capable of finding optimal correspo-nendents among a group of curves simultaneously. Our experiments show the effectiveness of this model.

Pengwen Chen, Yunmei Chen
University of Florida
pchen@math.ufl.edu, yun@math.ufl.edu

MS29

Upper Bounds on the Coarsening Rate of Discrete, Ill-Posed, Nonlinear Diffusion Equations

We prove a weak upper bound on the coarsening rate of the discrete-in-space version of an ill-posed, nonlinear diffusion equation. The continuum version of the equation violates parabolicity and lacks a complete well-posedness theory. In particular, numerical simulations indicate sensitive dependence on initial data. Nevertheless, models based on its discrete-in-space version, which we study, are widely used in a number of applications, including population dynamics (chemotactic movement of bacteria), granular flow (formation of shear bands), and computer vision (image denoising and segmentation). Our bounds have implications for all three applications. They are obtained by following a recent technique of Kohn and Otto. Based on joint works with John Greer and Dejan Slepcev.

Selim Esedoglu
Department of Mathematics
University of Michigan
esedoglu@umich.edu

MS29

A Second Order Variational Model for Staircase Reduction

The one-dimensional version of the higher order total variation-based model for image restoration proposed by Chan, Marquina, and Mulet is analyzed. A suitable functional framework is proposed in which the minimization problem is well posed, and it is proved analytically that the higher order regularizing term prevents the occurrence of the staircasing effect.

Irene Fonseca
Carnegie Mellon University
fonseca@andrew.cmu.edu

MS29

Nonlocal Operators for Image Processing

We propose the use of nonlocal operators to define new types of flows and functionals for image processing. A main advantage over standard algorithms is the ability to simultaneously the texture and cartoon parts of images. Applications to denoising, segmentation and inpainting are given. This work builds on much research done earlier in a host of related fields.

Guy Gilboa
UCLA Mathematics
gilboa@math.ucla.edu

Stanley J. Osher
University of California
Department of Mathematics
sjo@math.ucla.edu

MS29

Redistancing by Flow of Time Dependent Eikonal Equation

Construction of signed distance to a given inteface is a topic of special interest to level set methods. There are currently, however, few algorithms that can efficiently produce highly accurate solutions. We introduce an algorithm for constructing an approximate signed distance function through manipulation of values calculated from flow of time dependent eikonal equations. We provide operation counts and experimental results to show that this algorithm can efficiently generate solutions with a high order of accuracy. Comparison with the standard level set reinitialization algorithm shows ours is superior in terms of predictability and local construction,critical, for example, in local level set methods. We further apply the same ideas to extension of values off interfaces. Together, our proposed approaches can be used to advance the level set method for fast and accurate computations of the latest scientific problems.

L.T. Cheng
University of California, San Diego
lcheng@math.ucsd.edu

Richard Tsai
Department of Mathematics
Univesity of Texas
ytsai@math.utexas.edu

MS30

A Long-Short Wave Equation in Fermi-Pasta-Ulam Lattice

It is well known that the Boussinesq equation, further, the KdV equation can be derived from the Fermi-Pasta-Ulam (FPU) lattice as a long wave continuum approximation. Taking into account both the acoustic and optical modes, we derive a coupled partial differential equations in attempt to study the long-short wave interaction in FPU lattice. Some numerical and analytical results of this long-short wave equation will also be presented.

Baofeng Feng
U. of Texas-Pan American
feng@utpa.edu

MS30

Dynamics of the Localized Waves in Rayleigh-Benard Convection With Heterogeneous Concentration Field

We study the Rayleigh-Benard convection in binary fluid mixture by an amplitude equation derived by Riecke. This equation has a variable, corresponding to the concentration field, which works as a heterogeneous driving force for fluid motion. This equation gives interesting dynamical phenomena among localized waves(pulses), i.e., formation of bound states by both co- and counter-propagating pulses and various input-output relation by pulse collision. These phenomena are analyzed in terms of the network topology constructed by stable and unstable manifolds in phase space, forcusing on the role of the concentration field.

Yasumasa Nishiura, Makoto Iima
Research Institute for Electronic Science
Hokkaido University
nishiura@nsc.es.hokudai.ac.jp,
makoto@nsc.es.hokudai.ac.jp

MS30

Pinning and Depinning for Particle-Like Solutions in Dissipative Systems

Particle-like dissipative patterns arise in many fields such as chemical reaction, gas-discharge system, liquid crystal, binary convection, and morphogenesis. We discuss about the dynamics of moving particles in heterogeneous media, especially we are interested in the case in which traveling pulses or spots encounter heterogeneities of bump type. A variety of dynamics are produced such as penetration, annihilation, rebound, splitting, and relaxing to an ordered pattern, i.e., pinning. It turns out that global bifurcation such as heteroclinic one and a basin switching controlled by the unstable manifolds of saddless called scattors play a crucial role for the transition from pinning to depinning. We also discuss a wave-generator created near the jump of heterogeneity.

Yasumasa Nishiura
RIES, Hokkaido University
Japan
nishiura@aurora.es.hokudai.ac.jp

Takashi Teramoto
Chitose Institute of Science and Technology
teraponn@mac.com

MS30

Behavior of an Amoeba Crossing an Environmental Barrier

In this talk, we will focus on the effect of inhomogeneous environments on tip migration behavior in the *Physarum* plasmodium of true slime mold. The plasmodium migrating in a narrow lane shows penetration, rebound, and splitting dynamics when it encounters the presence of a chemical repellent, quinine. In order to understand the dynamics, a phenomenological model based on reaction-diffusion systems is proposed. We discuss how the origin of the three different outputs could be reduced to the hidden instabilities of internal dynamics of the tip.

Kei-Ichi Ueda
Kyoto University, Japan
ueda_sg@ybb.ne.jp

MS31

Coupling of Finite Element and Boundary Integral Methods for a Scattering Problem in Near-Field Optics

This talk is concerned with the solution of the Helmholtz equation in the modeling of a scattering problem for one of important experimental modes of near-field optics, photon scanning tunneling microscopy. The well-posedness for the continuous and discrete problems of coupling finite element and boundary integral methods will be addressed, error estimates for the coupling procedure will be provided, and numerical examples will be presented.

Gang Bao
Michigan State University
bao@math.msu.edu

Peijun Li
Department of Mathematics
University of Michigan
lipeijun@umich.edu

MS31

Superposition of Multi-Valued Solutions in High Frequency Wave Dynamics

The weakly coupled WKB system captures high frequency wave dynamics in many applications. For such a system a level set method framework has been recently developed to compute multi-valued solutions to the Hamilton-Jacobi equation and evaluate position density accordingly. In this paper we propose two approaches for computing multi-valued quantities related to density, momentum as well as the energy. Within this level set framework we show that physical observables evaluated in [**?**, **?**] are simply the superposition of their multi-valued correspondents. A series of numerical tests is performed to compute multi-valued quantities and validate the established superposition properties.

Hailiang Liu
Iowa State University
USA
hliu@iastate.edu

MS31

A Field Space-Based Level Set Method for Computing Multi-Valued Solutionsto 1D Euler-Poisson Equations

We present a field space based level set method for computing multi-valued solutions to one-dimensional Euler-Poisson equations. The system of these equations has many applications, and in particular arises in semiclassical approximations of the Schrödinger-Poisson equation. The proposed approach involves an implicit Eulerian formulation in an augmented space — called field space, which incorporates both velocity and electric fields into the configuration. Both velocity and electric fields are captured through common zeros of two level set functions, which are governed by a field transport equation. Simultaneously we obtain a weighted density f by solving again the field transport equation but with initial density as starting data. The averaged density is then resolved by the integration of the obtained f against the Dirac delta-function of two level set functions in the field space. Moreover, we prove that such obtained averaged density is simply a linear superposition of all multi-valued densities; and the averaged field quantities are weighted superposition of corresponding multi-valued ones. Computational results are presented and compared with some exact solutions which demonstrate the effectiveness of the proposed method.

Zhongming Wang
Iowa State University
ericwang@iastate.edu

MS31

Computation of the Radiative Transfer Equation with Interface Reflection and Transmission

Abstract not available at time of publication

Xu Yang
Department of Mathematics
University of Wisconsin-Madison
xyang@math.wisc.edu

MS32

Variational Principles for Supremal Functionals and Applications to Polycrystal Plasticity

Γ-convergence results for a general class of power-law functionals acting on divergence free fields are presented. Some consequences are described in the settings of antiplane shear and plane stress plasticity.

Marian Bocea
North Dakota State University
marian.bocea@ndsu.edu

MS32

Inverse Homogenization - Recovery of the Structure of Composite Materials

The talk deals with inverse homogenization problem which is a problem of deriving information about the microgeometry of composite material from its effective properties. The approach is based on reconstruction of the spectral measure in the analytic Stieltjes representation of the effective tensor of two-component composite. This representation relates the n-point correlation functions of the microstructure to the moments of the spectral measure, which contains all information about the microgeometry. The problem of identification of the spectral function from effective measurements in an interval of frequency has a unique solution, however the problem is ill-posed. The talk discusses several stabilization techniques as well as Pade approximation used to reconstruct the spectral function. Results of reconstruction of microstructural parameters are shown for visco-elastic composites and for composites of two materials with different complex permittivity. The reconstructed spectral function can be used to compute other effective properties of the same composite; this gives solution to the problem of coupling of different effective properties of a two-component composite material with random microstructure.

Elena Cherkaev
University of Utah
Department of Mathematics
elena@math.utah.edu

MS32

Coupled-Mode Theory of Wave Resonance in a Periodic Medium

We study the Bragg resonance of surface water waves by a two-dimensional array of vertical cylinders covering a large area of the sea. Employing some concepts of solid state and crystallography, we combine the techniques homogenization and inner-outer expansion to derive two-dimensional equations for the envelopes of scattered waves resonated by a plane incident wave. Solutions for two- and three-wave scattering are obtained for a long strip of cylinder array. Roles of the bandgaps are examined.

Chiang C. Mei
Dept of Civil and Environmental Engineering
MIT
ccmei@mit.edu

Yile Li
Shell International Exploration and Production Inc
Houston TX
yile.li@gmailcom

MS32

G-Convergence and Homogenization of Fluid-Structure Interaction and Two-Fluid Flow

We study two homogenization problems for flows with moving interfaces: a small deformation model of fluid-structure interaction and a Stokes flow of two immiscible fluids without surface tension. Since the interfaces are moving, we work in the framework of G-convergence that requires no a priori geometric assumptions. To pass to the limit we propose a new construction of divergence-free oscillating test functions. The construction involves several auxiliary funcitons that are found by solving auxiliary problems. The effective equations for fluid-structure interaction are of viscoelastic type with long memory terms not present in the microscale problems. In the case of two fluid flow, the effective equations are of the same type as microscale problems, but the effective viscosity tensor depends of time in general. Since constitutive equations for viscosity should not depend on time explicitly, it would be desirable to obtain sufficient conditions for existence of an equation of state that would prescribe the effective viscosity as a time-independent function of the effective density and effective pressure. We present some results in this direction (joint work with Elena Cherkaev).

Alexander Panchenko
Washington State University
panchenko@math.wsu.edu

MS33

High Confinement Limit and Time Averaging for the Gross-Pitaevski Equation

Abstract not available at time of publication.

Naoufel Ben Abdallah
University of Toulouse
naoufel@mip.ups-tlse.fr

MS33

Quantum Charge Transport in Random Media

In this talk, we discuss some recent results addressing quantum charge transport in a weak random potential. We focus on the derivation of Boltzmann equations, obtained from a macroscopic, hydrodynamic limit, both in the one-particle, and in the fermionic manybody framework. In connection with the latter, we report on a recent joint work with I. Sasaki.

Thomas Chen
Princeton University
tc@math.princeton.edu

MS33

5-Moment-Corrections to a Drift-Collision Balance Model of Quantum Transport

We present a fluid–dynamical model which describes quantum–driven electron transport in the so-called "drift–collision balance" regime. Here, external field and interaction with a phonon bath are the dominant phenomena and have comparable strength. More precisely, in the rescaled Wigner–BGK equation they appear at the same order in the parameter ϵ. The BGK term contains the (Wigner) $\mathcal{O}(\zeta^{\in})$–correction to the thermal equilibrium function, parametrized by the electron position density and the bath temperature, which models the state to which the system shall be driven by the sole interaction with the crystal ions. Via a Chapman–Enskog procedure we find $\mathcal{O}(\epsilon)$–correction to the solution of the scaled Wigner-BGK equation. Then, by applying the moment method, we find $\mathcal{O}(\epsilon)$–corrections to the equations for position density, velocity flux and energy density. In these corrective terms appear five moments of the $\mathcal{O}(\infty)$–in–ϵ solution and they are of diffusive type in the fluid unknowns. High-field $\mathcal{O}(\zeta^{\in})$–corrections are present that are peculiar of quantum-driven transport.

Giovanni Frosali
Dept. of Applied Mathematics
University of Florence
giovanni.frosali@unifi.it

Giovanni Borgioli
Dept. of Electronics
University of Florence
giovanni.borgioli@unifi.it

Chiara Manzini
Dept. of Applied Mathematics "G.Sansone"
Universita' di Firenze, Italy
chiara.manzini@unifi.it

MS33

On the Global Existence of Smooth Solution to the 2-D FENE Model

In two space dimension, we prove the global existence of smooth solutions to a coupled microscopic-macroscopic FENE dumbbell model which arises from the kinetic theory of diluted solutions of polymeric liquids with noninteracting polymer chains.

Ping Zhang
Beijing Academy of Science
zp@amss.ac.cn

MS34

A Novel Algorithm for Fluid-Structrure Interaction in Blood Flow

The fluid-structure interaction in blood flow involves two media, blood and arterial walls, whose densities are of the same order of magnitude. This leads to a highly nonlinear interfacial coupling. To date, only strongly coupled algorithms (implicit/monolithic) seem applicable to blood flow simulations. In this talk, we present a novel class of loosely coupled (partitioned) algorithms which combine the stability properties of implicit schemes with the low computational costs of explicit schemes.

Suncica Canic
Department of Mathematics
University of Houston
canic@math.uh.edu

Tsorng-Whay Pan
Department of Mathematics
University of Houstofn
pan@math.uh.edu

Roland Glowinski
University of Houston
roland@math.uh.edu

Giovanna Guidoboni
University of Houston
Department of Mathematics
gio@math.uh.edu

Sergey Lapin
Department of Mathematics
Washington State University
slapin@math.wsu.edu

MS34

Adhesion and Slough-off of Chondrocytes Under Controlled Flow Conditions

Cell adhesion under conditions of fluid flow plays an important role in many physiological and biotechnological processes. Recently auricular chondrocytes were studied for lining a stent, which is a potential treatment of coronary artery disease. To improve the biocompatibility, it is crucial for cells to remain firmly on surface initially. In this presentation, we mathematically model and simulate adhesion and slough-off of chondrocytes in shear flow. We first discuss the Adhesive Dynamics for bonding between cell and surface; then introduce a Lagrange multiplier based fictitious domain method to solve the fluid-cell system. Numerical results for the cells in shear flow and the case with deterministic adhesion will be presented.

Jian Hao
University of Houston
Department of Mathematics
jianh@math.uh.edu

MS34

Critical Thresholds in a Quasilinear Hyperbolic Model of Blood Flow

We study critical threshold phenomena in a quasilinear hyperbolic model of blood flow through compliant axisymmetric vessels with viscous effects. We identify critical thresholds for global existence of smooth solutions and for the finite time singularities. We prove the existence of a smooth solution under some conditions on the slope of the pressure data. We obtain that for certain physiologically relevant data one has shock formation.

Tong Li
Department of Mathematics
University of Iowa
tli@math.uiowa.edu

Suncica Canic
Department of Mathematics
University of Houston
canic@math.uh.edu

MS34

Simulating Blood Flow and Vessel Dynamics in Patient-Specific Arterial Models

In recent years, image-based computational methods have been described for modeling blood flow in the cardiovascular system and test hypotheses related to the localization of vascular disease. We will present results related to modeling blood flow and vessel dynamics in the systemic and pulmonary circulations of individual subjects. We then describe a new approach for cardiovascular treatment planning in which the physician utilizes computational tools to construct and evaluate a combined anatomic/physiologic model to predict the outcome of alternate treatment plans for an individual patient. In order to ensure that these predictive tools are clinically relevant, they must faithfully represent the anatomy and physiology of individual patients. Recent progress in constructing subject specific anatomic models from medical imaging data, acquiring physiologic data under resting and exercise conditions, planning treatments, and modeling blood flow and vessel deformation will be described. Verification of FSI methods with analytical solutions will be discussed. Results from in vitro and animal studies utilizing magnetic resonance imaging techniques to validate computational blood flow simulations will be presented.

Charley Taylor
Stanford University
Mechanical Engineering
taylorca@stanford.edu

MS35

Maximum Enstrophy Production in the 3D Navier-Stokes

It is still not known whether solutions to the 3D Navier-Stokes equations for incompressible flows in a finite periodic box can become singular in finite time. It is known that solutions remain smooth as long as their enstrophy (mean-square vorticity) is finite. The generation rate of enstrophy is given by a functional that can be bounded using elementary functional estimates. Those estimates establish short-time regularity but do not rule out finite-time singularities in the solutions. In this work we formulate and solve the variational problem for the maximal growth rate of enstrophy and display flows that generate enstrophy at the greatest possible rate. Implications for questions of regularity or singularity in solutions of the 3D Navier-Stokes equations are discussed.

Charles R. Doering
University of Michigan
Dept of Mathematics
doering@umich.edu

Lu Lu
Wachovia Investments
New York, NY
lluz@umich.edu

MS35

The Bifurcation and Stability Analysis of Double-Diffusive Convection

In this talk, we present a bifurcation and stability analysis on the double-diffusive convection. Both steady state bifurcation and the Hopf bifurcation are considered.

Tian Ma
Sichuan University
/

Shouhong Wang
Department of Mathematics
Indiana University
showang@indiana.edu

Jerry Bona
University of Illinois at Chicago
bona@math.uic.edu

Chun-Hsiung Hsia
U Illinois Chicago
willhsia@uic.edu

MS35

Stochastic Parametrization of Wave Breaking and Wave/Current Interactions

If wave breaking modifies the Lagrangian fluid orbital paths by inducing an uncertainty in the path itself and this uncertainty on wave motion time scales is observable as additive noise, it is shown that within the context of a wave/current interaction model for basin and shelf scale motions it persists on long time scales. A model of conservative dynamics, developed in collaboration with Lane and McWilliams, provides the general framework for the dynamics of the wave-current interactions. In addition to the deterministic part, the vortex force, which couples the total flow vorticity to the residual flow due to the waves, will have a part which is associated with the dissipative mechanism. At the same time the wave field will experience dissipation, and tracer advection is affected by the appearance of a dissipative term in the Stokes drift velocity. Consistency leads to other dynamic consequences: the boundary conditions are modified to take into account the diffussive process and proper mass/momentum balances at the surface of the ocean. I will present an overview of the model, how wave dissipation effects are included as a stochastic parametrization, and show preliminary results on a model problem.

Juan M. Restrepo
University of Arizona
restrepo@math.arizona.edu

MS35

On the Motion and Regularity of Vortex Sheets with Surface Tension

We prove well-posedness of vortex sheets with surface tension in the 3D incompressible Euler equations with vorticity. This is a moving boundary-value problem for the motion of two incompressible perfect fluids separated by a surface of discontinuity, wherein the motion of the fluid interacts with the motion and regularity of the vortex sheet at highest-order.

Steve Shkoller
Univiversity of California, Davis
Department of Mathematics
shkoller@math.ucdavis.edu

MS36

Incompressible Fluids in Thin Domains with Navier Friction Boundary Conditions

This study is motivated by problems arising in oceanic dynamics. Our focus is the Navier-Stokes equations in a three-dimensional domain Ω_ε, whose thickness is of order $0(\varepsilon)$ as $\varepsilon \to 0$, having non-trivial topography. The velocity vector field is subject to the Navier friction boundary conditions on the bottom and the top boundaries of Ω_ε with the friction coefficients $\gamma_{0,\varepsilon}$ and $\gamma_{1,\varepsilon}$, respectively. Assume that $\gamma_{0,\varepsilon}$ and $\gamma_{1,\varepsilon}$ are of order $0(1)$, and $|\gamma_{0,\varepsilon} - \gamma_{1,\varepsilon}|$ is of order $0(3/4)$ as $\varepsilon \to 0$. It is shown that if the initial velocity field and the body force belong to "large sets", then the strong solution of the Navier-Stokes equations exists for all time. Our proofs rely on the study of the dependence of the Stokes operator on ε, and the non-linear estimate in which the contributions of the boundary integrals are non-trivial.

Luan T. Hoang
SCHOOL OF MATHEMATICS
UNIVERSITY OF MINNESOTA
LTHOANG@MATH.UMN.EDU

MS36

Averaged Bounds on Moments for the 2D Navier-Stokes Equation

Upper and lower bounds for the ensemble averages of energy, enstrophy, and palinstrophy (the first three moments of the 2D, periodic, Navier-Stokes equations) are derived both in the general case, and in the case where the energy spectrum for fully developed turbulence holds. In the turbulent case, the bounds are sharp, up to a logarithm, and provide a new lower bound on the Landau-Lifschitz degrees of freedom. A key Sobolev-type estimate of the inertial term is shown to be sharp on a significant portion of the global attractor.

Michael S. Jolly
Indiana University
Department of Mathematics
msjolly@indiana.edu

Ciprian Foias
Texas A & M Univ
foias@tamu.edu

Radu Dascaliuc
Indiana University
Department of Mathematics
rdascali@indiana.edu

MS36

Discrete in Time Coupling and Synchronization in the 2D Navier-Stokes Equations

Abstract not available at time of publication.

Eric Olson
UNR
ejolson

MS36

Singularly Perturbed Convection-Diffusion Equations with a Turning Point

Turning points occur in many circumstances in fluid mechanics. When the viscosity is small, very complex phenomena can occur near turning points, which are not yet well understood. A model problem, corresponding to a linear convection-diffusion equation (e.g., suitable linearization of the Navier-Stokes or Benard convection) equation is considered. Our analysis shows the diversity and complexity of behaviors and boundary or interior layers which already appear for our equations simpler than the Navier-Stokes or Benard convection equations. Of course the diversity and complexity of these structures will have to be taken into consideration for the study of the nonlinear problems. In our case, at this stage, the full theoretical asymptotic analysis is provided.

Chang-yeol Jung
Indiana University
chajung@indiana.edu

Roger Temam
Inst. f. Scientific Comput. and Appl. Math.
Indiana University
temam@indiana.edu

MS37

Thin-Film Coarsening Driven by Surface Relaxation and the Ehrlich-Schwoebel Effect

The surface of an epitaxially growing thin film often exhibits a mound-like structure with its characteristic lateral size increasing in time. In many material systems, such a coarsening process is driven mainly by two competing mechanisms. One is the surface relaxation described by high-order gradients of the surface profile, and the other the Ehrlich-Schwoebel effect which is the upper-lower terrace asymmetry in the adatom attachment and detachment to and from atomic steps. In this talk, we present an analysis of a class of partial differential equation models that are mathematically gradient-flows of some effective free-energy functionals describing these mechanisms. Our analysis consists of two parts: (1) variational properties of the energies, such as "ground states" and their large-system-size asymptotics, showing the unboundedness of surface slope and revealing the relation between some of the models; (2) rigorous bounds for the scaling law of the roughness, the rate of increase of surface slope, and the rate of energy dissipation, all of which characterize the coarsening process.

Bo Li
Department of Mathematics, UC San Diego
bli@math.ucsd.edu

MS37

Modeling and Analysis of Stepped Crystal Surfaces

The morphological evolution of crystal surfaces is studied as a prototypical case of modeling across the scales. At the nanoscale, the governing discrete schemes describe the motion of line defects ("steps") of atomic height. At the macroscale, the resulting free-boundary problems for PDEs retain a novel microstructure. I will focus on recent progress and challenges in answering the question: For what continuum theory is step motion a consistent numerical solution scheme ? I will present the continuum laws and free-boundary problems that result from step motion. I will also explore the validity of the continuum theory from the perspective of kinetic BBGKY-type hierarchies for step correlation functions.

Dionisios Margetis

University of Maryland, College Park
dio@math.umd.edu

MS37

Epitaxial Growth, Atomistic Simulations on Diffusive Time Scales

We apply a phase field crystal model to epitaxial growth and study equilibrium shapes of islands and mounds. The model is derived from classical density functional theory (DFT) and leads to a higher order parabolic PDE for the atom density. The derivation from DFT as well as a coarse graining which leads to classical phase field models will be discussed. Furthermore efficient numerical methods based on finite element discretizatioins will be shown.

Andreas Raetz
University of Dresden
andreas.raetz@tu-dresden.de

MS37

A Continuum Model for the Long-Range Elastic Effect on Epitaxial Surfaces

Below the roughening transition, the surface of an epitaxial film consists of steps whose distribution and motion determine the surface morphology. The elastic effects on the epitaxial surface provide a driving force for the motion of these surface steps. The stress in the epitaxial film, which may be due to the misfit between the lattice constants in the film and in the substrate, generates a long-range elastic effect on the epitaxial surface. We present a continuum model for this long-range elastic effect, incorporating the discrete features of the stepped surface. The model is obtained by taking continuum limit of the discrete model for the elastic interaction between surface steps.

Yang Xiang
Hong Kong University of Science and Technology
maxiang@ust.hk

MS38

A Variational Theory for Point Defects in Patterns

We derive a rigorous scaling law for minimizers in a natural version of the regularized Cross-Newell model for pattern formation far from threshold. These energy-minimizing solutions support defects having the same character as what is seen in experimental studies of the corresponding physical systems and in numerical simulations of the microscopic equations that describe these systems.

Shankar C. Venkataramani
University of Arizona
Department of Mathematics
shankar@math.arizona.edu

Nick Ercolani
University of Arizon
ercolani@math.arizona.edu

MS38

Scaling Dynamics for Smoluchowski's Coagulation Equations with Dust and Gel

We study limiting behavior of rescaled size distributions that evolve by Smoluchowski's rate equations for coagulation, with rate kernel K=2, x+y or xy. We find that the dynamics naturally extend to probability distributions on the half-line with zero and infinity appended, representing populations of clusters of zero and infinite size. The "scaling attractor" (set of subsequential limits) is compact and has a Levy-Khintchine-type representation that linearizes the dynamics and allows one to establish several signatures of chaos. In particular, for any given solution trajectory, there is a dense family of initial distributions (with the same initial tail) that yield scaling trajectories that shadow the given one for all time.

Govind Menon
Applied Mathematics, Brown University
menon@dam.brown.edu

Robert Pego
Carnegie Mellon University
rpego@cmu.edu

MS38

Aggregation of Floating Particles by Surface Tension Forces: From Nano- to Millimeter Scales.

We derive an evolution equations for self-assembly of floating particles. First, we present results of numerical simulations showing that energy density of a realistic particle clump of an arbitrary shape is described by a surprisingly simple formula, and that the continuum approximation may be used for clumps with as few as five particles. Next, we deduce an evolution equation for density evolution for in the case of central potential and describe analytically stationary and spatio-temporal solutions forming the base of the dynamics. Finally, we suggest an evolution equations for particles with interaction potential dependent not only on their density, but also on the mutual orientation. In the process, we also derive the analogue of Darcy's law and corresponding equation of motion for an arbitrary geometric quantity.

Darryl Holm
Imperial College London and
Los Alamos National Laboratory
d.holm@ic.ac.uk

Vakhtang Putkaradze
Colorado State University
putkarad@math.colostate.edu

MS38

Rigorous Scaling Laws and Crossover Behavior in Elastic Ridges

Abstract not available at time of publication.

Shankar C. Venkataramani
University of Arizona
Department of Mathematics
shankar@math.arizona.edu

MS39

Controllability of a Cochlea and Related Fluid-Elastic Systems

Standard 2-dimensional cochlea model consists of one-dimensional elastic structure surrounded by incompressible fluid within cochlear cavity. Dynamics are typically driven by pressure differential across the basilar membrane transmitted through round and oval windows. Idealized basilar

membrane is modeled as infinite array of oscillators and fluid is described by Laplace's equation. We show approximate controllability with control acting on arbitrary open set of membrane. If membrane has longitudinal elasticity, then exact controllability can be proved.

Scott Hansen
Iowa State University
Department of Mathematics
shansen@orion.math.iastate.edu

MS39
Optimal Static Control of Groundwater

Control theory has been less developed for elliptic partial differential equations than it has for hyperbolic and parabolic variety. In this talk we indicate how control can be applied to study certain problems for elliptic systems. We use Darcy's equation for groundwater flow together with mathematically idealized representation of control intervention by means of pumping and transport as an example. We will indicate the relevant theoretical questions and present the results of some computational simulations.

David Russell
Virginia Tech
russell@math.vt.edu

MS39
Multiscale Modeling of Preferential Flow

We discuss new multi-scale models of fully saturated flow coupled to transport through highly heterogeneous media. These are systems of partial differential equations that include the usual diffusion effects from various spatial scales and additionally model the effects of local advective transport through fast flow regions.

Malgorzata Peszynska, Ralph Showalter
Department of Mathematics
Oregon State University
mpesz@math.oregonstate.edu,
show@math.oregonstate.edu

MS39
Fluid-Structure Interaction Problems

We consider parabolic-hyperbolic fluid-structure interaction PDE model (dimensions 2 and 3): structure of arbitrary shape, modeled by the system of dynamic elasticity, is immersed in a fluid modeled by Navier-Stokes equation, with coupling at the interface. In linear case, semigroup well-posedness in the energy space is asserted. Spectral properties of the generator are described. Strong stability is analyzed. To obtain uniform stability, the interface condition is modified to become dissipative. Backward uniqueness result is presented. uniqueness.

George Avalos
University of Nebraska-Lincoln
Department of Mathematics and Statistics
gavalos@math.unl.edu

Roberto Triggiani
University of Virginia
rt7u@virginia.edu

MS40
On the Spectrum Associated with Periodic Waves for Generalized KdV Equations

Abstract not available at time of publication.

Todd Kapitula
Department of Mathematics
Calvin College
tkapitula@gmail.com

MS40
Semi-Strong N-Pulse Interaction in a Hypberbolic-Parabolic System

We consider the semi-strong interaction of optical pulses in a thermally detuned optical parametric oscillator. The pulses evolve under a parametrically forced nonlinear Schrodinger equation coupled to a thermal profile generated by the optical heating. The thermal profile decays at a much slower spatial rate and provides for long-range interaction in what is effectively a three species, hyperbolic-parabolic, singularly perturbed system. We show that by controlling the commutator of a scaling operator and a spectral projection, that the associated semi-group is strongly contractive and use the RG machinary to derive interaction laws for N pulses comprised of optical pulse and long-range thermal envelope.

Keith Promislow
Michigan State University
kpromisl@math.msu.edu

MS40
A Simple Technique for Solving Partial Differential Equations on Surfaces

Abstract not available at time of publication.

Steve Ruuth
Simon Fraser University
Department of Mathematics
sruuth@sfu.ca

MS40
HydroGel Swelling: Models and Analysis

Abstract not available at time of publication.

Hang Zhang
Michigan State University
hzhang@math.msu.edu

MS41
Shock Reflection, Transonic Flow, and Free Boundary Problems

In this talk we will start with various shock reflection phenomena and their fundamental scientific issues. Then we will describe how the shock reflection problems can be formulated into free boundary problems for nonlinear partial differential equations of mixed-composite type. Finally we will discuss some recent developments in the study of the shock reflection problems. In particular, we will discuss our recent results on the global theory for solutions to shock reflection by wedges for potential flow. The approach includes techniques to handle transonic shocks via free boundary techniques, sonic curves via degenerate ellip-

tic techniques, and corner singularities when sonic curves meet transonic shocks that connect the subsonic phase with the supersonic phase. Further remarks, trends, and open problems in this direction will be also addressed. This talk is based mainly on our joint work with Mikhail Feldman.

Gui-Qiang G. Chen
Department of Mathematics, Northwestern University
USA
gqchen@math.northwestern.edu

MS41

Symmetric Stationary Inviscid and Viscous Profiles in Multi-D

We construct stationary solutions with spherical or cylindrical symmetry for the 2D and 3D compressible Euler and Navier-Stokes equations. The solutions are defined in the region between two concentric spheres or cylinders and satisfy Dirichlet boundary conditions at the inner and outer boundaries. We first build stationary solutions with a single shock for the Euler equations (both isentropic and full system). These are then used in the construction of corresponding solutions of the Navier-Stokes equations. In particular, the viscous solutions converge to the inviscid shock solutions as the viscosities tend to zero.

Mark Williams
Department of Mathematics
UNC Chapel Hill
williams@email.unc.edu

Kris Jenssen
Pennsylvania State University
hkj1@psu.edu

Erik Endres
Pennsylvania State University
Department of Mathematics
eee121@psu.edu

MS41

Shocks, Rarefactions and Triple Points in Multidimensional Conservation Laws

Following the initial work of Tesdall and Hunter [SIAP, 2003] which found a new shock reflection pattern in the unsteady transonic small disturbance equations, we have now exhibited this Guderley Mach reflection in numerical simulations of a number of equations – specifically the nonlinear wave system and the adiabatic gas dynamics equations. Within this complicated pattern, the details of how the rarefaction wave interacts with the sonic line form a mathematically appealing subproblem. We present some numerical and analytical results on this problem.

Barbara L. Keyfitz
Fields Institute and University of Houston
bkeyfitz@fields.utoronto.ca or keyfitz@uh.edu

Allen Tesdall
Southern Methodist University
atesdall@mail.smu.edu

Mary Chern
Fields Institute
cher_nmin@hotmail.com

MS41

Instability Criteria in a Model for Shear Bands

We consider a system of hyperbolic-parabolic equations describing the material instability mechanism associated to the formation of shear bands at high strain-rates. We derive a quantitative criterion for the onset of instability: Using ideas from the theory of relaxation systems we derive equations that describe the effective behavior of the system. The effective equation turns out to be a forward-backward parabolic equation regularized by fourth order term.

Athanasios Tzavaras
University of Maryland
Tzavaras@math.umd.edu

MS42

A Model-Based Inversion Algorithm for the Controlled-Source Electromagnetic Data

We present the parametric inversion algorithm (PIA), which uses a priori information on the geometry to reduce the number of unknown parameters and improve the quality of the reconstructed conductivity image. This PIA approach can be also used to refine the conductivity image that we obtained using the pixel-based inversion (PBI) algorithm. The PIA adopts the Gauss-Newton minimization method, with nonlinear constraints and regularization for the unknown parameters. It also employs a line search approach to guarantee the reduction of the cost function after each iteration. The forward modeling simulation is a two-and-half dimensional finite-difference solver, and the parameters that govern the location and the shape of a reservoir include the depth and the location of the user-defined nodes for the boundary of the region. The unknown parameter that describes the physical property of the region is the electrical conductivity. We will show some numerical examples to illustrate the advantageous of using this PIA approach.

Tarek Habashy, Yan Zhang, Maokun Li
Schlumberger-Doll Research
habashy1@slb.com, yzhang37@ridgefield.oilfield.slb.com, maokunli@uiuc.edu

Andrea Zerilli
Schlumberger
azerilli@richmond.oilfield.slb.com

Aria Abubakar
Schlumberger Doll Research
aabubakar@slb.com

MS42

Title Not Available at Time of Publication

Abstract not available at time of publication.

Aria Abubakar
Schlumberger-Doll research
aabubakar@boston.oilfield.slb.com

MS42

Optimal Reduced Models for Dispersive Multi-Conductor Transmission Line Systems

Through the use of non-uniform grids generated by Gaussian spectral rules we develop reduced models for dispersive, multi-conductor transmission line systems. The synthesized multi-port is represented as the concatenation of sections of lumped circuits; hence, it is compatible with circuit simulators such as SPICE. The passivity of the reduced model is guaranteed through the use of passive circuit representations of the frequency-dependent, per-unit-length series impedance and shunt admittance matrices of the transmission line system.

Aravind Ramachandran, Andreas Cangellaris
University of Illinois at Urbana-Champaign
ramacha1@uiuc.edu, cangella@uiuc.edu

MS42
Spectrally Matched Grids for Anistropic Problems

Spectral convergence of grids targeted for the Neumann to Dirichlet map is observed for anisotropic problems, despite the fact that the grids were designed for isotropic ones. We explain why this happens. For elliptic problems, the gridding algorithm is reduced to a Stieltjes rational approximation on an interval of a line in the complex plane instead of the real axis as in the isotropic case. We show rigorously why this occurs for a semi-infinite and bounded interval. We then extend the gridding algorithm to hyperbolic problems on bounded domains. For the propagative modes, the problem is reduced to a rational approximation on an interval of the negative real semiaxis, similarly to in the isotropic case. For the wave problem we present numerical examples in 2-D anisotropic media.

Shari Moskow
University of Florida
Department of Mathematics
moskow@math.ufl.edu

MS43
From Kinetic Fokker-Planck Traffic Models to Second Order Conservation Laws

We revisit multilane kinetic traffic models of Fokker-Planck type and show that the Aw-Rascle second order model of conservation type can be derived from such models. Furthermore, we present a linear stability analysis of the equilibria associated with the (multivalued) fundamental diagram.

Reinhard Illner
The University of Victoria, Canada
rillner@math.uvic.ca

MS43
Analysis of a Fluid-Kinetic System of Equations

We study a coupled system of kinetic and fluid equations modeling fluid-particles interactions arising in sprays, aerosols or sedimentation problems. More precisely, we consider a Vlasov-Fokker-Planck equation coupled to compressible Navier-Stokes equation via a drag force. We establish the existence of solutions and we rigorously derive the asymptotic regime corresponding to a strong drag force and a strong Brownian motion.

Antoine Mellet
University of British Columbia
mellet@math.ubc.ca

MS43
Title Not Available at Time of Publication

Abstract not available at time of publication.

Vladislav Panferov
McMaster University
Department of Mathematics and Statistics
panferov@math.mcmaster.ca

MS43
Recent Results on Transport in Random Media

Abstract not available at time of publication.

Alexis Vasseur
University of Texas at Austin
vasseur@math.utexas.edu

MS44
Existence and Stability of Ginzburg-Landau Vortices in Arbitrary Two Dimensional Domains

We consider Ginzburg-Landau equation with Neumann or Dirichlet boundary conditions in a bounded domain. We show that whenever the renormalized energy W has critical points (*not necessary nondegenerate*) then there exist solution to Ginzburg-Landau equation with vortices located near the set of critical points of W. We also show that the Morse index of these solutions is equal to the number of the negative eigenvalues of the hessian of the renormalized energy.

Manuel Del Pino, Michal Kowalczyk
Departamento de Ingeniera Matemática
Universidad de Chile
delpino@dim.uchile.cl, kowalczy@dim.uchile.cl

Monica Musso
Facultad de Matemáticas
Pontificia Universidad Católica de Chile
mmusso@mat.puc.cl

MS44
A Gradient Flow Approach to a Mean Field Model of Superconductivity

In a joint work with Luigi Ambrosio we studied an evolution problem proposed by Chapman-Rubinstein-Schatzman as a mean-field model for the evolution of the vortex density in a superconductor. We consider the case of a bounded domain where vortices can exit or enter the domain. We show that the equation can be derived rigorously as a gradient-flow of a specific energy for the Riemmanian structure induced by the Wasserstein distance on probability measures. This leads to some existence and uniqueness results and some energy-dissipation identities. We also exhibit some "entropies" which decrease along the flow and allow to get regularity results.

Sylvia Serfaty
Courant Institute, NYU
New York, NY
serfaty@cims.nyu.edu

MS45
Optimal Lower Bounds on the Stress Inside Ran-

dom Two-Phase Composites

A prescribed uniform stress is applied to the boundary of a composite material made from two perfectly bonded isotropic linear elastic components. We present lower bounds on the maximum stress generated inside the composite that apply to all mixtures made from two elastic materials in fixed volume fractions. We present several situations in which these lower bounds are attained by simple configurations of the two materials.

Bacim Alali
Mathematics Department
Louisiana State University
alali@math.lsu.edu

Robert P. Lipton
Department of Mathematics
Louisiana State University
lipton@math.lsu.edu

MS45

Gradient Estimates for the Perfect Conductivity Problem

We consider the optimal bound on the stress occurring between a pair of closely spaced fibers in a bounded domain. With Dirichlet boundary condition, the conductivity problem can be described as follows

$$\begin{cases} div\Big\{[1+\chi(D_1\cup D_2)(k-1)]\nabla u_k\Big\}=0 & \text{in} \quad \Omega,\\ u_k=\varphi & \text{on} \quad \partial\Omega \end{cases} \qquad (1)$$

where Ω contains two inclusions D_1 and D_2 which are ε-apart, and ∇u_k represents the stresses.We study the perfect conductivity problem, where $k=+\infty$. We provide an optimal blow-up rate of the gradient estimate as the separation distance ε approaches 0. It is shown that the blow-up rate depends not only on the dimension, but also on the shape of the inclusions.

ShiTing Bao, YanYan Li, Biao Yin
Mathematics Department
Rutgers University
shbao@math.rutgers.edu, yyli@math.rutgers.edu, byin@math.rutgers.edu

MS45

On Cohesive Fracture Without Relaxation

Cohesive models of fracture involve energies of the form

$$E(u) := \int_\Omega W(\nabla u)dx + \int_K \phi([u])dH^{n-1},$$

where u is a deformation with crack set (i.e., discontinuity set) K and $[u]$ is the jump in u across K. What makes the model cohesive is that $\phi(x)\to 0$ as $x\to 0$, so that there are forces across K if $[u]$ is small enough. If ϕ is concave with $\phi'(0)=\infty$, then existence of a minimizer is straightforward. However, if $\phi'(0)<\infty$, there at first seems to be a fatal issue in that one needs to relax the energy to functions u that have singular behavior besides discontinuities (i.e., relaxed from SBV to BV), resulting in the addition of a new term to the energy. Precisely, a sequence $\{u_i\}$ in SBV with bounded energy might converge to a function $u\notin SBV$, which appears fatal to applying the direct method of the calculus of variations. However, there is reason to believe that minimizing sequences cannot have this property, and in fact, minimizers of the relaxed energy must be in SBV. I will describe work in this direction, which is joint with G. Dal Maso and A. Garroni.

Christopher Larsen
Worcester Polytechnic Institute
Math Dept
cjlarsen@wpi.edu

MS45

On the Eshelby Conjecture and a Symmetry Result for Overdetermined Elliptic Problems

In this paper we present solutions to the Eshelby conjecture. We first discuss the exact meanings of the original Eshelby conjecture. We then prove one version of the Eshelby conjectures and construct a counterexample to the other by exploring a related variational inequality problem. In particular we construct multiply-connected regions in all dimensions and nonellipsoidal connected regions in three and higher dimensions that share the special property of an ellipsoid that some uniform eigenstress of the region induces uninform strain on the region. We also show that one version of the Eshelby conjecture is equivalent to asserting that some overdetermined elliptic problem has a solution if and only if the region is an ellipsoid. We therefore obtain a symmetry result for this overdetermined elliptic problem by studying the Eshelby conjecture.

Liping Liu
Mechanical Engineering Department
California Institute of Technology
liulp@caltech.edu

MS46

Stable Numerical Schemes for Constitutive Equations of Complex Fluids

Modelling of polymeric fluids can be done using two approaches: macro-macro formulations or micro-macro formulations using kinetic equations to model the evolution of the microstructures in the fluid. Macro-macro models are cheaper to discretize than micro-macro models, but are known to blow up when a parameter, the Weissenberg number, increases. Many studies (e.g. [1]) have identified possible reasons for that so-called High Weissenberg Number Problem (HWNP), but have not led yet to a complete understanding of the numerical instabilities. Micro-macro models often yield more information and better understanding of the coupling between scales than macro-macro models. The key role of the Free energy in long-time behaviour was first understood thanks to the equivalence of the Oldroyd-B model with a kinetic model [2]. We will discuss the stability of finite element methods to discretize macro-macro models, using Free energy estimates. [1] R. Fattal and R. Kupferman, Time-dependent simulation of viscoelastic flows at high Weissenberg number using the log-conformation representation, J. Non- Newtonian Fluid Mechanics, 126 (1) (2005) 23-37. [2] B. Jourdain and C. Le Bris and T. Lelievre and F. Otto, Long-Time Asymptotics of a Multiscale Model for Polymeric Fluid Flows , Archive for Rational Mechanics and Analysis, 181 (2006) 97-148.

Sebastien Boyaval
CERMICS
Ecole Nationale des Ponts et Chaussees
boyaval@cermics.enpc.fr

Tony Lelievre

ENPC
lelievre@cermics.enpc.fr

MS46

Global Orientation Dynamics for Liquid Crystalline Polymers

We study global orientation dynamics of the Doi-Smoluchowski equation with the Maier-Saupe potential on the sphere, which arises in the modeling of rigid rod-like molecules of polymers. Using the orientation tensor we first reconfirm the structure and number of equilibrium solutions established in [Comm. Math. Sci. 3 (2), (2005), 201-218] by H. Liu, H. Zhang and P.-W. Zhang. We then examine global orientation dynamics in terms of eigenvalues of the orientation tensor via the Doi closure approximation. It is shown that for small intensity $0 < \alpha < 4$, all states will evolve into the isotropic phase; for large intensity $\alpha > 4.5$, all states will evolve into the nematic prolate phase; and for the intermediate intensity $4 < \alpha < 4.5$, an initial state will evolve into either the isotropic phase or the nematic prolate phase, depending on whether such an initial configuration crosses a critical threshold. Moreover, the uniaxial symmetry structure is shown to be preserved in time.

Hailiang Liu
Iowa State University
USA
hliu@iastate.edu

MS46

On the New Multiscale Rod-Like Model of Polymeric Fluids

It is concerned with the well-posedness for the new rigid rod-like model in a polymeric fluid and the structure of some solutions in special case. The constitutive relations considered in this work are motivated by the kinetic theory. The micro equation has five spatial freedom variables, two of them are in the configuration domain and the others are in the macro flow domain.

Hui Zhang
Beijing Normal University
hzhang@bnu.edu.cn

MS46

Dynamical Modeling and Simulation of Fluid Bio-Membranes

This work provides a set of equations for the dynamics of evolving fluid membranes, such as cell membranes, in the presence of bulk fluids. We model the membrane as a surface endowed with a director field, which describes the local average orientation of the molecules on the membrane. A model for the elastic energy of a surface endowed with a director field is derived using liquid crystal theory. This elastic energy reduces to the well-known Helfrich energy in the limit when the directors are constrained to be normal to the surface. We then derive the full dynamic equations for the membrane that incorporate both the elastic and viscous effects, with and without the presence of the bulk fluids. We also consider the effect of local spontaneous curvature, arising from the presence of membrane proteins. Overall the new systems of equations allow us to carry out stable, accurate and robust numerical modeling for the dynamics of the membranes. In addition, we consider the coupling between the bulk fluid and the membrane dynamics. Dynamic structure factors are computed in varies cases. These new systems of equations allow us to carry out stable and robust numerical simulations for the dynamics of the membranes.

Pingwen Zhang
Peking University
pzhang@pku.edu.cn

MS47

Asymptotics of the Semiclassical Sine-Gordon Equation

The study of the sine-Gordon equation with a fixed initial condition and dispersion tending to zero is motivated by the modeling of magnetic flux propagation in Josephson junctions. We discuss the recent discovery of two families of initial data, with topological charge zero and one, respectively, for which the sine-Gordon equation can be solved explicitly for arbitrarily small dispersion. Plots of the solutions for small dispersion reveal, depending on the choice of other parameters, regions of pure librational and rotational motion, as well as regions of multi-phase waves separated by primary and secondary nonlinear caustics. We present current progress on the asymptotic analysis of these solutions for small dispersion.

Robert J. Buckingham
University of Michgan
robbiejb@umich.edu

MS47

Universality Classes for Semiclassical Eigenvalue Problems

We will discuss some generalized eigenvalue problems (in which the eigenvalue does not necessarily enter linearly) in a semiclassical scaling (where derivatives are multiplied by small coefficients). Such problems arise frequently in the asymptotic analysis of nonlinear problems solvable by an inverse-scattering transform. We will show how the asymptotics of the discrete spectrum leads to the idea of universality classes of potentials and describe how this idea can be used to approximate the discrete spectrum with quantitative error estimates.

Peter D. Miller
University of Michigan
millerpd@umich.edu

MS47

Semiclassical Limit Scattering Map (Direct and Inverse) for the Focusing Nonlinear Schroedinger Equation.

We discuss the progress in finding the semiclassical (zero dispersion) limit of the scattering map for the focusing NLS, that put into correspondence the initial potential $q(x, \epsilon)$ and the scattering data. In the solitonless case, the scattering data consists of the reflection coefficient $r(z, \epsilon)$, where z is the spectral and ϵ is the semiclassical parameter respectively. So, in this case, we are considering the $\epsilon \to 0$ limit of the maps $q \mapsto r$ and $r \mapsto q$.

Stephanos Venakides
Duke University
Department of Mathematics
ven@math.duke.edu

Alexander Tovbis
University of Central Florida
Department of Mathematics
atovbis@pegasus.cc.ucf.edu

Xin Zhou
Duke University
zhou@math.duke.edu

MS47

Persistence of Modulated Post-Break NLS Waveforms in the Presence of Solitons.

We analyze the persistence of modulated 2-phase NLS waves developed after the first break (first nonlinear caustic line in space-time). In previous work, we have shown (within an initial wave structure) global time-persistence of these waves when the initial data are solitonless. We now show that, for initial data containing solitons, the same is true for all space points whose distance from the origin is less than a calculated distance d. For spatial points closer to the origin, we calculate an asymptotic formula (as $|x|$ increases to d) for time $t = t(x)$ up to which the waveform is guaranteed not to undergo a second break.

Stephanos Venakides
Duke University
Department of Mathematics
ven@math.duke.edu

Alexander Tovbis
University of Central Florida
Department of Mathematics
atovbis@pegasus.cc.ucf.edu

Xin Zhou, Sergey Belov
Duke University
zhou@math.duke.edu, belov@math.duke.edu

MS48

Wiener's Criterion for the Regularity of the Point at Infinity and its Measure-Theoretical Counterpart

We introduce a notion of regularity (or irregularity) of the point at infinity for the unbounded open set concerning the heat equation, according as whether the parabolic measure of the point at infinity is zero or positive. We prove the necessary and sufficient condition for the existence of a unique bounded solution to the parabolic Dirichlet problem in an arbitrary unbounded open set expressed in terms of the Wiener's criterion for the regularity of the point at infinity.

Ugur G. Abdulla
Department of Mathematical Sciences
Florida Institute of Technology
abdulla@fit.edu

MS48

Connecting Non–Negative Solutions to Quasi–Linear Degenerate Equations, Sub-potentials

Non–negative weak solutions of quasilinear degenerate parabolic equations of p–Laplacian type are shown to be locally bounded below by sub–potentials. As a consequence non–negative solutions expand their positivity set and satisfy alternative, equivalent forms of the Harnack inequality

Emmanuele DiBenedetto
Department of Mathematics
Vanderbilt University
em.diben@vanderbilt.edu

MS48

Continuity of the Saturation in the Flow of Two Immiscible Fluids Through a Porous Medium

We consider a weakly coupled, highly degenerate system of an elliptic equation and a parabolic equation, arising in the theory of flow of immiscible fluids in a porous medium. The unknown functions in the system are u and v, and represent pressure and saturation respectively. By using suitable DeGiorgi's techniques, we prove that the saturation is a continuous function in the space–time domain of definition. Here the main technical point is that no assumptions at all are made on the nature of the degeneracy of the system.

Vincenzo Vespri
Department of Mathematics
University of Florence
vespri@math.unifi.it

Ugo P. Gianazza
Department of Mathematics
University of Pavia
gianazza@imati.cnr.it

Emmanuele DiBenedetto
Department of Mathematics
Vanderbilt University, Nashville
em.diben@vanderbilt.edu

MS48

Beyond the Laplacian

In this talk we discuss some applications of boundary Harnack inequalities for positive p-harmonic functions (recently proved by Lewis and Nystrom) vanishing on the boundary of a Lipschitz or Reifenberg flat domain. Possible topics include the dimension of p-harmonic measure for Wolff snowflake, the construction of p-harmonic quasispheres, and codimension ¿ 1 Harnack - free boundary regularity.

John Lewis
University of Kentucky
john@ms.uky.edu

MS48

On the Regularity of the Free Boundary for the Classical Stefan Problem

The regularity of the temperature and the free boundary for the Stefan problem has attracted much attention over the last 3 decades or so. In this talk I will consider the classical one- or two-phase Stefan problem, where the free boundary is represented as the graph of a function. Under mild regularity assumptions on the initial data it will be shown that the problem admits a local solution that is analytic in space and time. The approach is based on optimal regularity results for a linearized problem, and on a scaling-translation argument in conjunction with the implicit function theorem.

Gieri Simonett
Vanderbilt University
gieri.simonett@vanderbilt.edu

Jan Prüss
Martin-Luther University Halle
jan.pruess@mathematik.uni-halle.de

Jürgen Saal
University of Konstanz, Germany
juergen.saal@uni-konstanz.de

MS49

On Long-Time Dynamics for Competition-Diffusion Systems with Inhomogeneous Dirichlet Boundary Conditions

We consider a two-component competition-diffusion system with equal diffusion coefficients and inhomogeneous Dirichlet boundary conditions. When the interspecific competition parameter tends to infinity, the system solution converges to that of a freeboundary problem. If all stationary solutions of this limit problem are non-degenerate and if a certain linear combination of the boundary data does not identically vanish, then for sufficiently large interspecific competition, all non-negative solutions of the competition-diffusion system converge to stationary states as time tends to infinity. Such dynamics are much simpler than those found for the corresponding system with either homogeneous Neumann or homogeneous Dirichlet boundary conditions.

Norman Dancer
School of Mathematics and Statistics
University of Sydney
normd@maths.usyd.edu.au

Danielle Hilhorst
Laboratoire de Mathématiques
Université de Paris-Sud
Danielle.Hilhorst@math.u-psud.fr

Elaine Crooks
Oxford University
crooks@maths.ox.ac.uk

MS49

High Lewis Number Combustion Fronts: a Geometric Singular Perturbation Theory Point of View

I will discuss combustion wavefronts that arise in a mathematical model for high Lewis number combustion processes. An efficient method for the proof of the existence and uniqueness of combustion fronts is provided by geometric singular perturbation theory. The fronts supported by the model with very large Lewis numbers are small perturbations of the front supported by the model with infinite Lewis number. The question of stability of fronts is more complicated. I will describe the issues arising in the stability analysis and up to date known results, in particular, how a geometric approach which involves construction of the augmented unstable bundles can be used to relate the spectral stability of the wavefront with high Lewis number to the spectral stability in the case of infinite Lewis number. This is a joint work with C.K.R.T. Jones

Anna Ghazaryan
The University of North Carolina at Chapel Hill
ghazaryan@niss.org

MS49

Propagation of a KPP-Type Fronts in a Model of Pressure Driven Flames

We study the model of pressure driven-flames in porous media introduced by G. Sivashinsky et. al. Under the assumption that the chemical kinetics is described by the KPP-type nonlinearity, we show that the problem admits a family of positive traveling solutions. Moreover, it is shown that the long time behavior of the model is prescribed by the rate of decay of initial data at infinity. This is a joint work with A. Ghazaryan.

Peter Gordon
New Jersey Insitute of Technology
peterg@oak.njit.edu

MS49

Blow Up and Regularity for Burgers Equation with Fractional Dissipation

I will discuss recent results on regularity and blow up of solutions of Burgers equation with fractional dissipation. Fluid mechanics models with fractional dissipation, such as surface quasi-geostrophic equation, have recently attracted significant attention. The Burgers equation is perhaps the simplest model for studying interaction between nonlinearity and fractional viscosity. We establish a sharp transition between singular front formation and smooth evolution as the fractional dissipation exponent passes 1/2. We also prove analyticity of the solutions in the subcritical case, and prove existence of solutions for rough initial data.

Alexander Kiselev
University of Wisconsin, Madison
kiselev@math.wisc.edu

MS50

Global Well-Posedness of the Three-Dimensional Geostrophic Turbulence Mixing Model

The three-dimensional viscous Boussinesq equations under hydrostatic balance govern large scale dynamics of atmosphere and oceanic motion. To overcame the turbulence mixing a vertical diffusion is added. In this paper we prove the global existence and uniqueness (regularity) of strong solutions to this model.

Edriss Titi
Department of Mathematics
University of California, Irvine
etiti@math.uci.edu

Chongsheng Cao
Department of Mathematics
Florida International University
caoc@fiu.edu

MS50

Wave Turbulence: A Story Far from Over

Wave turbulence, the study of the long time statistical behavior of solutions of nonlinear field equations describing weakly nonlinear dispersive waves in the presence of sources and sinks, is a subject far from over. Among the remaining challenges are: 1. Since wave turbulence theory almost never holds at all scales, one has to understand how the wave turbulence stationary states coexist with fully nonlinear states. 2. Understanding how the Kolmogorov-Zakharov spectra are realized in cases where these solutions have finite capacity. The results of 2. may very well have relevance for turbulence in general. I will briefly discuss these challenges and suggest some resolutions.

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

MS50

Daynimic Transitions in Geophysical Fluid Dynamics

First we shall present a new dynamic transition theory for nonlinear dynamical systems, both finite and infinite dimensional. The theory will be used to 1) classify dynamic transitions of different flow regimes of rotating Boussinesq equations, a basic model in geophysical fluid dynamics, and 2) to provide a new theory for ENSO.

Tian Ma
Sichuan University
matian56@sina.com

Shouhong Wang
Department of Mathematics
Indiana University
showang@indiana.edu

MS50

The Surface Quasi-Geostrophic Equation

This talk reports several recent results concerning solutions of the inviscid quasi-geostrophic (QG) equation and of the dissipative QG equation with supercritical dissipation.

Jiahong Wu
Oklahoma State University
jiahong@math.okstate.edu

MS51

Diffuse Interface Methods for Image Reconstruction

We consider some recent diffuse interface methods for image reconstruction. Applications include image inpainting, in which missing information must be recovered in some region, and deconvolution, in which an image is blurred due to the process of obtaining the data. Real life applications include document explotation, following roads in sattelite imagery, and bar code scanners. We present some new methods with fast solvers based on diffuse interface equations from materials science. One class of methods involves the Cahn-Hilliard equation for binary mixtures. Another class of methods involves a nonlinear wavelet-based functional related by scaling to the Ginzburg-Landau energy from diffuse interface methods. We consider both binary and greyscale applications with possible extension to high dimensional pixel data. This is joint work with Julia Dobrosotskaya, Selim Esedoglu, and Alan Gillette.

Andrea L. Bertozzi
UCLA Department of Mathematics
bertozzi@math.ucla.edu

MS51

Some Numerical Results on Rudin-Osher-Fatemi Smoothing

We present some numerical algorithms, their analyses, and results for ROF-style variational image smoothing.

Bradley Lucier
Department of Mathematics
Purdue University
lucier@math.purdue.edu

MS51

Some Properties of a Perturbed Version of the Perona-Malik Equation

The one-dimensional version of Perona-Malik equation, originally proposed for image selective smoothing, is considered. This is an ill-posed parabolic equation for which stable numerical schemes exist. We investigate a perturbed version of the equation such that the perturbation does not change the order of the differential operator. The perturbed problem is well posed and the asymptotic behaviour of its solutions is analyzed when a suitable perturbation parameter tends to zero.

Riccardo March
Istituto per le Applicazioni del Calcolo, CNR
march@iac.rm.cnr.it

Mario Rosati, Andrea Schiaffino
Universita' Roma II
marosati40@libero.it, schiaffi@mat.uniroma2.it

MS51

Curvature of Level Sets of BV Functions

Abstract not available at time of publication.

Murali Rao
University of Florida
rao@math.ufl.edu

MS51

(Phi,Phi*) Image Decomposition Models and Minimization Algorithms

We review minimization algorithms for image restoration and decomposition using dual functionals and dual norms. In order to extract a clean image u from a degraded version f=Ku+n, where f is the observation, K is a blurring operator and n represents additive noise, we impose a standard regularization penalty on u, of the form Phi(u), depending on the gradient of u; however, on the residual f-Ku, we impose a weaker dual penalty Phi*(f-Ku), instead of the more standard L2 data fidelity term. In particular, when Phi(u) is the total variation of u, we recover the (BV,BV*) decomposition of the data f, as suggested by Y. Meyer. Practical minimization methods are presented, together with experimental results and comparisons to illustrate the validity of the proposed models.

Luminita A. Vese
University of California, Los Angeles
Department of Mathematics
lvese@math.ucla.edu

Triet M. Le

Yale University
triet.le@yale.edu

Linh M. Lieu
University of California, Davis
llieu@math.ucdavis.edu

MS52

A Variational Model for Bent-Core Liquid Crystals

We present a nonlinear variational model for bent-core (banana-shaped) liquid crystals which contains energy terms including polarization, smectic aned chiral effects, elasticity, and surface tension. We analyze solutions in a physically realistic regime involving a free boundary problem for the energy and the existence of a Gamma limit.

Daniel Phillips
Department of Mathematics, Purdue University
phillips@math.purdue.edu

Patricia Bauman
Purdue University
bauman@math.purdue.edu

MS52

Equilibrium Configurations of Epitaxially Strained Crystalline Films: Existence and Regularity Results

Strained epitaxial films grown on a relatively thick substrate are considered in the context of plane linear elasticity. The total free energy of the system is assumed to be the sum of the energy of the free surface of the film and the strain energy. Due to the lattice mismatch between film and substrate, flat configurations are, in general, energetically unfavorable and a corrugated or islanded morphology is the preferred growth mode of the strained film. New regularity results for volume constrained local minimizers of the total free energy are established, leading to a rigorous proof of the zero contact-angle condition between islands and wetting layers.

Irene Fonseca
Carnegie Mellon University
Center for Nonlinear Analysis
fonseca@cmu.edu

MS52

A Gamma-Convergence Approach to the Cahn-Hilliard Equation

We study the asymptotic dynamics of the Cahn-Hilliard equation via the "Gamma convergence" of gradient flows scheme initiated by Sandier and Serfaty. This gives rise to an H^1-version of a conjecture by De Giorgi, namely, the slope of the Allen-Cahn functional with respect to the H^{-1}-structure Gamma-converges to a homogeneous Sobolev norm of the scalar mean curvature of the limiting interface. We confirm this conjecture in the case of constant multiplicity of the limiting interface. Finally, under suitable conditions for which the conjecture is true, we prove that the limiting dynamics for the Cahn-Hilliard equation is motion by Mullins-Sekerka law.

Nam Le
Courant Institute, NYU
quangle@cims.nyu.edu

MS52

Lorentz Space Estimates for Ginzburg-Landau Vortices

We discuss the Ginzburg-Landau model of superconductivity in two dimensions. We present a technical improvement of the "vortex balls construction" that allows for the extraction of a new positive term in the energy lower bounds in the vortex balls. This term is then estimated using the Lorentz space $L^{2,\infty}$, which is critical for the expected vortex profiles. From this we can estimate the total number of vortices and prove improved convergence results.

Ian Tice
Courant Institute, NYU
tice@cims.nyu.edu

MS53

Monge's Mass Transportation in the Heisenberg Group

Abstract not available at time of publication

Robert Berry
University of Pittsburgh.
rdb6@pitt.edu

MS53

Title Not Available at Time of Publication

Abstract not available at time of publication.

Nicola Garofalo
Purdue University
garofalo@math.purdue.edu

MS53

Regularity of Lipschitz Free Boundaries in Two-Phase Problems for the p-Laplace Operator

In this paper we study the regularity of the free boundary in a general two-phase free boundary problem for the p-Laplace operator and we prove, in particular, that Lipschitz free boundaries are $C^{1,\gamma}$-smooth for some $\gamma \in (0,1)$. As part of our argument, and which is of independent interest, we establish the Hopf boundary principle for non-negative p-harmonic functions vanishing on a portion of the boundary of a Lipschitz domain.

Kaj Nystrom
Umea University, Sweden
kaj.nystrom@math.umu.se

John Lewis
University of Kentucky
john@ms.uky.edu

MS53

P-Harmonic Measure on Wolff Snowflakes.

We study the dimension of p-harmonic measure on Wolff snowflakes using some of the new results on boundary Harnack inequalities of Lewis and Nystrom.

Kaj Nystrom
Umea University, Sweden
kaj.nystrom@math.umu.se

John Lewis
University of Kentucky
john@ms.uky.edu

Andrew Vogel
Syracuse University
alvogel@syr.edu

Bjorn Bennewitz
University of Jyvaskyla
bennew@maths.jyu.fi

MS54

Rheology of Bacterials Suspensions

Modeling of bacterial suspensions and, more generally, of suspensions of active microparticles has recently become an increasingly active area of research. The focus of this work is on the development and analysis a mathematical PDE model for a multiscale problem of bacterial suspensions. We start from a comparison of bacterial suspensions (active suspensions) and suspensions of solid particles (passive suspensions). The ultimate goal is to develop a model which describes large scale pattern formationand rhelogical properties of bacterial suspensions. We discuss recent results on effective viscosity of dulite bacterial suspensions (with Aronson, Haines and Karpeev) and asymptotic analysis of swimming patterns of bacteria (with Aronson, Gyrya and Karpeev).

Leonid Berlyand
Penn State University
Eberly College of Science
berlyand@math.psu.edu

MS54

New Exact Bounds for Effective Conductivity of Multiphase Composites and Optimal Microstructures

Abstract not available at time of publication.

Andrej V. Cherkaev
Department of Mathematics
University of Utah
cherk@math.utah.edu

MS54

Homogenization and Field Concentrations in Heterogeneous Media

A method for upscaling the local field concentrations inside random composite and polycrystalline media is presented. The talk focuses on gradient or strain fields associated with solutions of second order elliptic PDE used in the description of thermal transport and elasticity inside random media. We develop a method for assessing the L^p integrability of gradient and strain fields inside microstructured media. The results are described in terms of the p^{th} order moments of the solution of two-scale corrector problems. Examples are provided that illustrate the theory and its application.

Robert P. Lipton
Department of Mathematics
Louisiana State University
lipton@math.lsu.edu

MS54

Darcy-Brinkman Models of Fast Channel Flow at an Interface

We show that preferential flow or channeling effects at the boundary of a porous medium can be effectively modeled by a Darcy-Brinkman interface system.

Fernando Morales
Oregon State University
morales@math.oregonstate.edu

Ralph Showalter
Department of Mathematics
Oregon State University
show@math.oregonstate.edu

MS55

Mathematical Problems Arising in Near-Shore Zone Sediment Trasport

A wave - sediment interaction model is put forward and validated. Some mathematical issues that arise as a consequence will be described.

Jerry Bona
University of Illinois at Chicago
bona@math.uic.edu

MS55

Water Waves Over Bottom Topography

We present a Hamiltonian formulation for water waves over bottom topography based on potential flow theory. In this formulation, the problem is reduced to a lower-dimensional system involving boundary variables alone. This is accomplished by introducing the Dirichlet-Neumann operator which expresses the normal fluid velocity at the free surface in terms of the velocity potential there, and in terms of the surface and bottom variations which determine the fluid domain. A Taylor series expansion of the Dirichlet-Neumann operator in powers of the surface and bottom variations is proposed. This formulation has implications for the convenience of perturbation calculations and numerical simulations of the full Euler equations. We develop an efficient and accurate spectral method based on the fast Fourier transform to evaluate numerically the Dirichlet-Neumann operator and solve the full Euler equations. Tests and validation will be shown. This is joint work with W. Craig (McMaster University), D. P. Nicholls (UIC) and C. Sulem (University of Toronto).

Philippe Guyenne
University of Delaware
guyenne@math.udel.edu

MS55

Long Nonlinear Internal Waves Models

We derive systematically and justify rigorously asymptotic models for the propagation of long nonlinear internal waves in 2+1 dimensions. This is a joint work with Jerry Bona and David Lannes.

Jean-Claude Saut
Paris-Sud
France
jean-claude.saut@math.u-psud.fr

MS56
On a Variational Approach for Stokes Conjecture on Water Waves

We study the behaviour of a two-dimensional, inviscid, irrotational fluid in a domain of finite depth and in the presence of gravity. More precisely, we investigate the minimizers of the functional

$$J_\lambda(u) = \int_\Omega \left(|\nabla u|^2 + (\lambda - y)_+ \chi_{\{u>0\}} \right) dx\, dy$$

with Dirichlet boundary condition at the bottom. We show that for large values of the paremeter λ, minimizers of J_λ have a regular (analytic) free boundary while for small values of λ, minimizers are "nonphysical". This leads to a critical value of λ related to Stokes wave of greatest height.

Danut Arama
Carnegie Mellon University
Pittsburgh, PA 15213
darama@andrew.cmu.edu

MS56
A Variational Formulation for Level Set Representation of Multiphase Flow.

We discuss variational formulations for level set representations of various multiphase flows that involve curvature. Our formulations lead to practical algorithms for computing these flows accurately. Joint work with Peter Smereka.

Selim Esedoglu
Department of Mathematics
University of Michigan
esedoglu@umich.edu

MS56
Phase Transitions in Thin Films

In this talk, I will present some models for solid-solid phase transitions in thin films obtained by Γ-convergence. The different models are determined by the asymptotic ratio between the characteristic length scale of the phase transition and the thickness of the film. Depending on the regime, I will show that a separation of scales holds or not and how this later case is related to some rigidity results. This is a joint work with V. Millot.

Bernardo Galvao-Sousa
Carnegie Mellon University
bsousa@andrew.cmu.edu

MS56
Optimal Transport for the System of Isentropic Euler Equations

In this talk we report on a variational time discretization for the system of isentropic Euler equations. The scheme is inspired by the theory of abstract gradient flows on the space of probability measures, and by Dafermos' entropy rate criterion: The total energy should be decreased at maximal rate. This is joint work with Wilfrid Gangbo.

Michael Westdickenberg
Georgia Institute of Technology
mwest@math.gatech.edu

MS56
Pulsating Wave for Motion by Mean Curvature in Inhomogeneous Medium

We prove the existence and uniqueness of pulsating waves for the motion by mean curvature of a hypersurface in an inhomogeneous medium given by periodic forcing. The main difficulty is caused by the degeneracy of the equation and the fact the inhomgeneity is allowed to change its sign. Under the assumption of weak forcing, we obtain uniform oscillation and gradient bounds so that the evolving surface can be represented as a graph over a hyperplane. The existence of an effective speed of propagation is established for any normal direction. We further prove the Lipshitz continuity of the speed with respect to the normal and various stability properties of the pulsating wave. Some connection with homogenization theory will also be discussed. This is joint work with N. Dirr and G. Karali.

Aaron Yip
Purdue University
Department of Mathematics
yip@math.purdue.edu

MS57
Ginzburg-Landau Vortices Concentrating on Curves

We study a two-dimensional Ginzburg-Landau functional, which describes superconductors in an externally applied magnetic field. We are interested in describing the energy minimizers at the critical value of the magnetic field for which vortices first appear in the superconductor (the "lower critical field".) The vortices are quantized singularities, and we are interested in their number and their distribution in the sample nearby the critical field. I will describe recent results with L. Bronsard and V. Millot in which we study the number and distribution of these vortices which concentrate along a curve. Their distribution is determined by a classical problem from potential theory.

Stanley Alama
McMaster University
Department of Mathematics and Statistics
alama@mcmaster.ca

Vincent Millot
Carnegie Mellon University
Pittsburgh, PA 15213
vmillot@andrew.cmu.edu

Lia Bronsard
McMaster University
bronsard@mcmaster.ca

MS57
Global Minimizers of the LawrenceDoniach Model with Oblique External Field

We study periodic minimizers of the Lawrence-Doniach model for layered superconductors, in various limiting regimes. We are particularly interested in determining the direction of the internal magnetic field (and vortex lattice) as a function of the applied external magnetic strength and its orientation with respect to the superconducting planes. We identify the corresponding lower critical fields, and compare the Lawrence-Doniach and anisotropic Ginzburg-Landau minimizers in the periodic setting. This talk represents joint work with S. Alama and E. Sandier.

Stanley Alama
McMaster University
Department of Mathematics and Statistics
alama@mcmaster.ca

Etienne Sandier
Univ. Paris 12
Creteil, France
sandier@univ-paris12.fr

Lia Bronsard
McMaster University
Department of Mathematics
bronsard@mcmaster.ca

MS57

Analysis of Heterogeneous Superconducting Systems Via the Ginzburg-Landau Approach.

Generalizations of the Ginzburg-Landau energy functional have been introduced in the physics literature to describe composite superconducting bodies. For example, the presence of a metal or semiconductor that surrounds or coats a superconductor can be modeled by a suitable extension of the energy to the non-superconducting components or by the addition of surface integrals. We will present analytical results which illustrate how effective these models can be in describing the physical response of the systems under examination.

Tiziana Giorgi
New Mexico State Univeristy
Department of Mathematics
tgiorgi@nmsu

MS57

Vortex Lines in Bose-Einstein Condensates

In this talk I will present some results that give a preliminary description of the vortex lines exhibited by Bose Einstein condensates, as well as super-conductors, subject to a stirring in an appropriate range. What one finds is that these vortex lines can be described by means of an ODE that represents the equation of the geodesics in an appropriate manifold. This is joint work with Ben Stephens.

Alberto Montero
University of Toronto
Department of Mathematics
alberto@math.toronto.edu

MS58

Strong Convergence to Homogeneous Cooling States

We study solutions of the spatially homogeneus Boltzmann equation with inelastic collisions with rescaling to fix the temperatures. We prove regularity properties for these solutions that are valid uniformly in time, and use thses to quantify the rate of convergence to the homogeneous cooling state in the strong L^1 norm. This is joint work with M.C. Carvalho and J. Carrillo.

Eric A. Carlen
Georgia Tech
carlen@math.gatech.edu

MS58

Propagation of Fisher Information for Inelastic Collisions

We prove bounds on the Fisher information for solutions of the spatially homogeneus Boltzmann equation with inelastic collisions. The bounds diverge as time tends to infinity, as they must, due to the dirac mass limit, but nonetheless, the sharp bound obtained here plays a key role in a proof that when the solutions are rescaled to preserve the second moment, the result is regular uniformly in time. This is joint work with E. Carlen and J. Carillo.

Maria Carvalho
University of Lisbon and Georgia Tech
mcarvalh@math.gatech.edu

MS58

Kinetic Dynamics of Multilinear Stochastic Interactions

Abstract not available at time of publication.

Irene M. Gamba
Department of Mathematics and ICES
University of Texas
gamba@math.utexas.edu

MS58

Spectral - Lagrangian Based Deterministic Method for Space Inhomogenous Boltzmann Equation.

A new spectral Lagrangian based deterministic solver for the non-linear Boltzmann Transport Equation for Variable Hard Potential VHP) modeling collision kernels has been proposed for both conservative and non-conservative binary interactions. The method is based on the symmetries of the Fourier transform of the collision integral, where the complexity in computing it is reduced to a separate integral over the unit sphere S^2. In addition the conservation of moments is enforced by Lagragian constrains. The resulting scheme is very versatile and adjust to in a very simple manner to several that involved energy dissipation due to local micro-reversibility (inelastic interactions) or elastic model of slowing down process. The issue of convergence has also been addressed. Since the equation is solved for explicit distribution function, the high velocity tail behavior can be analyzed explicitly. Such an analysis is crucial in understanding the physical processes involved in certain problems such as boundary and strong shock layer formation and sheared flows in classical elastic diluted gases or rapid granular flows or a mixture of gases where classical fluid dynamical models fail.The proposed numerical method has been used to solve the space inhomogenous Boltzmann equation for Riemann problem and Couette flow problems.

Sri Harsha Tharkabhushanam
The University of Texas at Austin
harsha@math.utexas.edu

MS59

Some Mathematical Models in Emerging Biomedical Imaging

Abstract not available at time of publication.

Habib Ammari
CNRS & Ecole Polytechnique, France

ammari@cmapx.polytechnique.fr

MS59

Modeling and Design of Coated Stents in Interventional Cardiology

Stents are used in interventional cardiology to keep a diseased vessel open. New stents are coated with a medicinal agent to prevent early reclosure due to the proliferation of smooth muscle cells. It is recognized that it is the dose of the agent that effectively controls the growth. This paper focusses on the asymptotic behavior of the dose for general families of coated stents under a fixed ratio between the coated area of the stent and the targeted area of the vessel and set therapeutic bounds on the dose. It generalizes the results of Delfour, Garon, and Longo (SIAM J. Appl Math) for stents made of a sequence of thin equally spaced rings to stents with an arbitrary pattern. It gives the equation of the asymptotic dose for a normal tiling of the target region.

Michel C. Delfour
Centre de recherches mathematiques
Université de Montréal, Canada
delfour@crm.umontreal.ca

MS59

Optimization and Control Techniques for Medical Image Registration

Abstract not available at time of publication.

Günter Leugering
University Erlangen-Nuremberg
Institute of Applied Math.
leugering@am.uni-erlangen.de

MS59

Drag Minimization for Stationary, Compressible Navier-Stokes Equations

Abstract not available at time of publication.

Jan Sokolowski
Institut Elie Cartan
Universite Henri Poincare Nancy I
sokolows@iecn.u-nancy.fr

Pavel Plotnikov
Lavryentyev Institute of Hydrodynamics
Novosibirsk, Russia
plotnikov@hydro.nsc.ru

MS60

Defect Eigenvalues and Diophantine Conditions Via the Evans Function.

We consider Schrodinger eigenvalue problem in one dimension with a potential consisting of a compactly supported "defect" potential plus a periodic part. This is a model for similar structures in optics. We give a result which allows one to count the number of point eigenvalues which are created in a gap in the periodic spectrum. This count can be expressed either in terms of an associated purely periodic spectral problem or as the Maslov index of a certain curve in the symplectic group. This count is always within one of the actual number of eigenvalues (in either direction) and is frequently exact.

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

MS60

Dispersion Relations for Subwavelength Photonic Crystals

We examine wave propagation in sub-wavelength dielectric/metal photonic crystals near the high plasma frequency limit. We characterize the band structure for this case. Examples are presented for layered media and wave guides.

Stephen P. Shipman, Robert P. Lipton, Santiago Fortes
Department of Mathematics
Louisiana State University
shipman@math.lsu.edu, lipton@math.lsu.edu,
santiago@math.lsu.edu

MS60

Fano Resonance in Photonic Crystal Slabs

Spectrally embedded guided modes in photonic crystal slabs are nonrobust under perturbations of the structure or the wave vector. When the eigenvalue for the nonrobust mode dissolves into the continuous spectrum, it leaves a spectral region of anomalous transmission in its wake. This phenomenon has its analog in the Fano resonances in quantum mechanics. Our rigorous asymptotic formula for the transmission anomalies for periodic slabs is a generalization of the Fano formula for line shapes in physical chemistry. Joint work with S. Venakides.

Stephen P. Shipman
Department of Mathematics
Louisiana State University
shipman@math.lsu.edu

Stephanos Venakides
Duke University
Department of Mathematics
ven@math.duke.edu

MS61

Schroedinger Maps (Landau-Lifschitz equation)

Abstract not available at time of publication.

Stephen Gustafson
Department of Mathematics
University of British Columbia
gustaf@math.ubc.ca

MS61

On the Lifetime of Quasi-Stationary States in Non-Relativistic QED

We consider resonances in the Pauli-Fierz model of nonrelativistic QED. We use and slightly modify the analysis developed by V. Bach, J. Froehlich, and I.M. Sigal to obtain an upper and lower bound on the lifetime of quasi-stationary states. This is joint work with I. Herbst and M.

Huber.

David Hasler
University of Virginia
dh8ud@virginia.edu

MS61

Fractional Nonlinear Schroedinger Equations

This talk reviews recent results on fractional nonlinear Schroedinger equations (NLS). This novel class of dispersive PDEs contains model equations for various physical applications, ranging from relativistic astrophysics to molecular dynamics. I will present results concerning well-posedness of the initial-value problem, finite-time blowup, and solitary wave solutions for fractional NLS. As a guiding example, I will discuss the so-called pseudo-relativistic Hartree equation which arises as an effective model equation for relativistic, self-gravitating matter in astrophysics.

Enno Lenzmann
Mathematics
MIT
lenzmann@math.mit.edu

MS61

Mathematical Aspects of Bose-Einstein Condensation

The Bose-Einstein condensation (BEC) was predicted in 1924 and discovered experimentally in trapped gases in 1995. It offers challenging and beautiful mathematical problems in Quantum Many-Body Theory and in nonlinear PDEs. In the latter case the main questions deal with behavior of solitons in the nonlinear Schrdinger equation with an external potential (the Gross-Pitaevskii equation). In this talk I review some recent results and open problems in the theory of BEC and, specifically, on the dynamics of solitons in the Gross-Pitaevskii equations.

Michael Sigal
University of Toronto
Toronto, Canada
sigal@math.toronto.edu