

Schedule for the International Conference on Mechanics and PDE's

REGISTRATION: PLEASE REPORT TO 218 VAN VLECK BETWEEN 8:00-3:00 ON FRIDAY, APRIL 30.

IF YOU HAVE QUESTIONS, PLEASE EMAIL: lkmillier@math.wisc.edu

On Friday morning the lectures will be at Van Vleck Hall 9th floor lounge; the lectures for other times will be given in Van Vleck Hall Room B239.

Friday, April 30, 2004

- 9:00-9:45 a.m. Professor John Ball, Oxford University
Lecture Title: Global Attractors for Semiflows Without Uniqueness
Abstract: The talk will describe an abstract framework for semiflows with possible non-unique solutions for given initial data. The measurability and continuity properties of such 'generalized semiflows' will be discussed. Necessary and sufficient conditions are given for the existence of a global attractor. As applications, the existence of a global attractor is proved (a) for damped semilinear hyperbolic equations under weak growth hypotheses (b) for the 3D Navier-Stokes equations under the (unproved) hypothesis that all weak solutions are continuous in time with values in L^2 .
- 9:45-10:30 a.m. Professor Mortin E. Gurtin, Carnegie-Mellon University
Lecture Title: Motion by Curvature: A Primer on Configurational Forces
Abstract: In this talk I will discuss the derivation of partial differential equations for the evolution of a curve in R^2 . Specifically, using the theory of configurational forces, I will develop generalizations of the well-known Mullins equation, "velocity=curvature", that account for anisotropy, dissipation due to surface rotation, and curvature-dependent energy.
- 10:30-11:00 a.m. Coffee Break
- 11:00-11:45 a.m. Professor Stanley Osher, UCLA
Lecture Title: Computing Multivalued Physical Observables for the Semiclassical Limit of the Schrodinger Equation
Abstract: We develop a level set method for the computation of multivalued physical observables (density, velocity, etc.) for the semiclassical limit of the Schrodinger equation in an arbitrary number of space dimensions. The main idea is to evolve the density near an n dimensional manifold identified as the common zeros of n level set functions in phase space. These level set functions are generated by solving the Liouville equation with data chosen to embed the phase gradient. The method allows us to compute, for the first time, all physical observables for multidimensional problems. Extensions to general multidimensional symmetric hyperbolic systems are straightforward. This is joint work with S. Jin, H. Liu and R. Tsai.

11:45-12:30
Lecture Title:

Professor Mihalis Dafermos, MIT
The Geometry and Analysis of Black Holes, Price's Law, and the Strong Cosmic Censorship Conjecture

Abstract:

The central physical problem in classical general relativity is the study of the collapse of isolated self-gravitating systems. Mathematically the problem is associated with spectacular predictions: the formation of black holes, naked singularities, and Cauchy horizons, predictions which raise fundamental questions about the validity of the principle of determinism in the context of classical physics. These questions find a definite mathematical formulation in the celebrated weak and strong cosmic censorship conjectures of Roger Penrose.

In this talk, I will present rigorous results pertaining to a well-known model for gravitational collapse, which has been heuristically and numerically studied for many years now in the physics literature. In particular, under a definite formulation, strong cosmic censorship is found to be false, and Cauchy horizons are shown to be stable, albeit in a weak sense. (The results confirm a scenario, known as "mass inflation", first postulated in 1990 by Israel and Poisson.)

An important component of the results I will describe is the proof of the so-called "Price's law". (This part is joint with Igor Rodnianski.) This "law", dating back to 1972, postulates inverse-power decay rates for the gravitational radiation flux on the event horizon and null infinity, with respect to appropriately normalized advanced and retarded null coordinates. Besides relating to strong cosmic censorship and the fate of observers who dare cross the event horizon, this law has independent interest, as it can be interpreted in terms of observations in the astrophysical regime. The methods employed may be relevant for understanding the general problem of stability of black hole solutions in the absence of symmetry.

12:30-2:30

Lunch

2:30-3:15
Lecture Title:

Professor Barbara Keyfitz, University of Houston
The Nonlinear Wave System as a Prototype for Multidimensional Conservation Laws

Abstract:

For the last ten years or so, I have been working with Suncica Canic and others on the analysis of self-similar solutions of multidimensional conservation laws. For a large class of conservation law systems, including compressible gas dynamics, analysis of two-dimensional Riemann problems requires solving free boundary problems for quasilinear degenerate elliptic equations. A simplified problem, the nonlinear wave system, proves to be more tractable than the full gas dynamics system, and we have succeeded in solving some simple problems. This talk should explain the techniques we have found useful, especially the Schauder fixed point theorem and estimates for oblique derivative boundary value problems, and will describe the many problems which remain open.

3:15-4:00
Lecture Title:
Abstract:

Professor David Kinderlehrer, Carnegie-Mellon University
Gain Growth in Polycrystals and Interfacial Energy
TBA

4:00-4:30 Coffee Break

4:30-5:15 Professor Sijue Wu, University of Michigan
Lecture Title: Recent Progress in Mathematical Analysis of Vortex Sheets
Abstract: The vortex sheet problem serves as a prototype for the evolution of the vorticity in fluid flows. One can think for example of the wake of an airfoil as a typical problem of this type. We investigate the specific nature of the vortex sheet motion, in particular after the singularity formation. We answer this question through the results on the regularity of the vortex sheet, and the existence and nonexistence of solutions to the initial value problem.

6:00-8:00 Banquet

Saturday, May 1, 2004

9:00-9:45 a.m. Professor Peter Constantin, University of Chicago
Lecture Title: Smoluchowski Equations
Abstract: Smoluchowski Equations are nonlinear Fokker-Planck equations describing the distribution of the directions of polymeric rods in a liquid suspension. The equations have very nice mathematical properties: global smooth solutions, dissipative properties in several functional settings, and a gradient structure. One can investigate the cardinality and qualitative properties of the set of steady solutions, and say a few things about the long time dynamics.

9:45-10:30 a.m. Professor Michel Rascle, Universite de Nice
Lecture Title: "Second Order" Fluid Models of Traffic Flow
Abstract: There are essentially three classes of models of traffic flow: fully discrete, ("Follow the-Leader": FLM), kinetic, and fluid. The latter are commonly classified either as "first order" (Lighthill-Whitham-Richards: a scalar conservation law) or "second order" (Payne-Whitham: two equations, based on the isentropic gas dynamics system). In the mid nineties, in a celebrated paper ("Requiem"), C. Daganzo pointed out the severe inconsistencies of the PW model, such as cars going backwards ... A couple of years later, we introduced with A. Aw a very simple (heuristic) fixing of this model ("Resurrection"), just replacing in PW the momentum conservation equation (nonsense !) by a *Lagrangian* time dependence of the velocity with respect to the density. This class of models, independently rediscovered in the traffic flow community by M. Zhang, has a very high ratio quality/price (thanks to the denominator!). In the talk, I will describe some aspects of this type of toy models, including their links with the microscopic FLM models.

10:30-11:00 a.m. Coffee Break

11:00-11:45 a.m. Professor James Greenberg, Office of Navel Research, International Field Office
Lecture Title: Conjestion Redux
Abstract: In this talk I'll focus on a class of 2nd order traffic models and show that these models support stable oscillatory traveling waves typical of the waves observed on

a congested roadway. The basic model has trivial or constant solutions where cars are uniformly spaced and travel at a constant equilibrium velocity that is determined by the car spacing. The stable traveling waves arise because there is an interval of car spacing for which the constant solutions are unstable. These waves consist of a smooth part where both the velocity and spacing between successive cars are increasing functions of a Lagrange mass index. These smooth portions are separated by shock waves that travel at computable negative velocity.

11:45-12:30 p.m. Professor Seung-Yeal Ha, Seoul National University

Lecture Title: L^1 Stability of the Boltzmann Equation

Abstract: In this talk, we will study the Boltzmann equation for hard sphere molecules. When initial datum is a small perturbation of a vacuum and decays fast enough in the phase space, we show that classical solutions are L^1 -stable. For this, we employ a nonlinear functional approach and use a detailed pointwise estimate of a positive part of the collision operator.

12:30-2:30 p.m. Lunch Break

2:30-3:15 p.m. Professor Ed Spiegel, Columbia University

Lecture Title: Hysterical Dynamics on a Checkerboard Map

Abstract: TBA

3:15-4:00 p.m. Professor Gui-Qiang Chen

Lecture Title: Multidimensional Transonic Shocks and Free Boundary Problems

Abstract: In this talk, we will discuss some of the recent developments on the existence and stability of multidimensional transonic shocks for the Euler equations for compressible fluid flow by developing nonlinear free boundary techniques and elliptic estimate methods (based on joint work with M. Feldman).

4:00-4:30 p.m. Coffee Break

4:30-5:15 p.m. Professor Carme Calderer, University of Minnesota

Lecturer Title: From LCD's to Ferroelectric Rubber: A Mathematical Survey

Abstract: This presentation deals with continuum theory models of materials characterized by long range ordering of molecules and that may also sustain mechanical deformation. Examples of such materials can be found among synthetic as well as biological polymers. One underlying feature is the rigid nature of molecular components, causing liquid crystal behavior, due to the long range orientational and positional ordering of molecules. Moreover, typical liquid crystals (such as those in standard LCD devices) are fluid. It is the increase of cross-linkage among polymer chains that gives rise to gel networks exhibiting solid behavior. Chirality is another property of the materials that we study. It is characterized by the molecules following a helical pattern of length scale of about 1000 times that of a typical molecule.

Interaction between chirality and ordering mechanisms gives rise to a wealth of physical behavior. We will study variational problems associated with ordering phase transitions of chiral systems in order to estimate the critical fields, emphasizing optically driven transitions in switching devices. The molecular properties of the materials that we consider may yield ferroelectricity, with polarization magnitudes comparable to conventional ferroelectric solids. We will analyze the 'telephone cord' instabilities that result from the interaction between the polarization and the elastic deformation. We will conclude the presentation with an example of bending of a column by an electric field.

Sunday, May 2, 2004

9:00-9:45 a.m. Professor Richard D. James, University of Minnesota
Lecture Title: Why Are Some Big First Order Phase Transformations Highly Reversible and Others Not?

Abstract: These thoughts begin with the observation by physicists, probing new phenomena through the use of first principles studies, that the simultaneous occurrence of properties like ferromagnetism and ferroelectricity is unlikely. These studies do not consider the possibility of a phase transformation, but there is a lot of indirect evidence that, if the lattice parameters are allowed to change a bit, then one might have co-existence of such properties. This seems to extend to other sets of nominally incompatible properties. Thus, one could try the following: seek a reversible first order phase transformation, necessarily also involving a distortion, from, say, ferroelectric to ferromagnetic phases. If it were highly reversible, there would be the extremely interesting additional possibility of controlling the volume fraction of phases with fields or stress. The key point is reversibility.

Even big first order phase changes can be highly reversible (liquid water to ice, shape memory materials), and we argue that it is the nature of the shape change that is critical. We suggest, based on a close examination of measured hysteresis loops in transforming materials, that an idea based on "good fitting of the phases" governs reversibility. The theoretical status of this idea is not completely clear, as I explain, but it has links to modern ideas in nonlinear pde. The idea lends itself to the systematic discovery of new ideas.

9:45-10:30 a.m. Professor Zvi Artstein, Weizmann Institute of Science
Lecture Title: Quantitative and Linear-type Structures of Young Measures
Abstract: The traditional analysis and applications of Young measures involve qualitative properties of the topology of the space of Young measures, e.g., handling convergence of solutions. Recent developments call for metric and linear analysis, e.g., the examination of rates of convergence and linear-type projections. An overview of some developments in this direction and applications will be presented.

10:30-11:00 a.m. Coffee Break

- 11:00-11:45 a.m.** Professor Konstantina Trivisa, University of Maryland
Lecture Title: Decay of Solutions in Hyperbolic Systems of Conservation Laws With General Flux
Abstract: This work deals with the study of the decay of solutions for hyperbolic systems of conservation laws as well as for systems of hyperbolic balance laws with general flux. The main tools of investigation are continuous Glimm type functionals. Following the work by Baiti-Bressan on genuinely nonlinear systems, we show how such functionals can be extended to general functions with bounded variation and we investigate their lower semi-continuity properties with respect to the strong L^1 topology. The results that will be presented to apply to the functionals introduced by Iguchi-LeFloch and Liu-Yang for systems with general flux-fuctions, to the functional introduced by Baiti-LeFloch-Piccoli for the study of nonclassical entropy solutions for the study of a class of hyperbolic balance laws with general flux. As an illustration of the use of continuous Glimm-type functionals, we provide results on the decay of solutions to these systems.
- 11:45-12:30 p.m.** Professor Constantine Dafermos, Brown University
Lecturer Title: Hyperbolic Systems of Conservation Laws with Weak Dissipation
Abstract: The lecture will demonstrate how BV solutions may be constructed for hyperbolic systems of conservation laws with weak dissipation induced by relaxation mechanisms.