CUNY Geometric Analysis 2005

March 19-20, 2005

CUNY Graduate Center

The CUNY Graduate Center is 365 Fifth Avenue (at 34th Street). The conference will be on the Fourth Floor, 4217. Please bring your ID and arrive early to sign in with the guard. Feel free to stop by at Starbucks on 33rd and Fifth before the meeting.

SATURDAY PROGRAM:

10:00 am: Sergiu Klainerman, Princeton University

Injectivity radius of null hypersurfaces and uniform curvature bounds in General Relativity

Abstract: I will talk about my recent work with Rodnianski concerning conditional pointwise estimates for the curvature tensor of vacuum solutions of the Einstein equations. The assumptions we make allow us to derive, or we simply require, bounds for the energy and flux of curvature across space-like and null hypersurfaces. This allows us to control the geometry of null hypersurfaces and thus to define a " good" parametrix for the covariant wave equation. Finally we use the parametrix to get pointwise estimates for the curvature tensor. One can regard our results as a General Relativity version of the well known Beale-Kato-Majda removal of singularities theorem in Hydrodynamics.

11:15 am: Penelope Smith, Lehigh University

Viscosity solutions for Quasilinear Symmetric Hyperbolic Systems and Application to The Einstein Cauchy Problem

We define a notion of Viscosity Solution for the above systems, prove a comparision principle for smooth and nonsmooth sub and super solutions, and prove the existence of such a solution by a method of upper and lower envelopes. We show the existence (under appropriate conditions) of continuous Viscosity solutions to the Einstein-Cauchy Problem.

12:15 pm-1:15 pm: Short Lunch Break

There are many restaurants on 33rd and 35th. Try to split into small groups.

1:15 pm: Charles N. Moore, Kansas State University

Regularity of the free boundary in the two-phase Stefan problem

We consider the two-phase Stefan problem $u_t = \Delta\alpha(u)$ where $\alpha(u) = u + 1$ for $u < -1$, $\alpha(u) = 0$ for $-1 \leq u \leq 1$, and $\alpha(u) = u - 1$ for $u > 1$. This models the flow of heat within a substance which can be in a liquid phase or a solid phase, and for which there is a latent heat to initiate phase change. This allows for the presence of a *mushy zone* , that is, a region which is between liquid and solid states. We will show energy estimates and regularity results for solutions. This is joint work with Marianne Korten.

2:20pm: Ivan Blank, Worcester Polytechnic Institute

The Hele-Shaw problem as a "Mesa" limit of Stefan problems: existence, uniqueness, and regularity of the free boundary

Abstract: We study a Hele-Shaw problem with a mushy region obtained as a mesa type limit of one phase Stefan problems in exterior domains. We study the convergence, determine some of the qualitative properties and regularity of the unique limiting solution, and prove regularity of the free boundary of this limit under very general conditions on the initial data. Indeed, our results handle changes in topology and multiple injection slots. This paper is joint work with Marianne Korten and Chuck Moore.

3:20-3:50 pm: Short Tea Break

3:50 pm: Marianne K. Korten, Kansas State University

A new approach to the regularity of free boundaries via free boundary measures

Abstract: In free boundary problems one finds a measure (supported on the free boundary) accounting for e.g. loss of energy at a phase change. This measure is related to the jump condition if the free boundary is, say, Lipschitz. Jumps occur, reminiscent of conservation laws, at certain level sets of solutions (or some combination of derivaties of solutions). Recently I have shown the rectifiability of the free boundary measure in the one phase Stefan problem with a degenerate phase $u_t = \Delta(u-1)_+$. Jointly with D. Danielli I have shown that the Rankine-Hugoniot condition can be retrieved at H^n a.e. point of the reduced free boundary via the n-densities of different disintegrations (obtained from the equation) of the free boundary measure. Exploring how far this approach can be extended to other problems, I have applied it (with C. Moore and I. Blank) to the Hele-Shaw (injection) problem, with Moore to the two phase Stefan problem with a degenerate phase, and with G-Q. Chen and Moore to a mixed type parabolic-conservation law equation. Some of the work I will describe in this talk is in print, some submitted, and some in progress.

5:00 pm: Igor Rodniansky, Princeton University

Global stability of Minkowski space in harmonic gauge

Abstract: I will present a new proof of the stability of Minkowski space obtained in joint work with H. Lindblad. The new approach shows that the Einstein-vacuum and Einstein-scalar field equations with general asymptotically flat data satisfying a smallness assumption produce geodesically complete solutions convergent to Minkowski space-time. The proof uses the classical harmonic (Lorentz) gauge.

SUNDAY PROGRAM:

On Sunday the conference starts after lunch. Be sure to come early and bring your id to sign in.

1:00 pm: Bruce Kleiner, University of Michigan

Singular structure of the mean curvature flow

Abstract: The lecture will discuss singularities of mean curvature flow. After a review of background material, the focus will be on the case of surfaces of positive mean curvature evolving in 3-space. This is joint work with Toby Colding.

2:15 pm: Jalal Shatah, Courant Institute, NYU

Schrodinger Maps with Applications to Feromagnetics

Abstract: The Heisenberg model of Ferromagnetics is given by $u_t = u \times \Delta u$, where u is the unit magnetic spin vector. This initial value problem can be interpreted as Schrödinger maps into Kähler manifold (in this case $\mathbb{S}^2$). We will present results on existence uniqueness and regularity of solutions to such equations. We will also discuss the problem of restricting such maps to Lagrangian submanifolds.

3:15-3:45 pm: Short Tea Break

3:45 pm: Mao-Pei Tsui, Columbia University

When minimal graphs are planar: Bernstein type results in higher dimensions

Abstract: Let Σ be a minimal submanifold of R^{n+m} that can be represented as the graph of a smooth map $f : R^n \mapsto R^m$. We identify regions in the Grassmannian so that whenever the image of the Gauss map of Σ lies in one of these regions, then Σ is an affine space. The conditions are stated in terms of the singular values of df. This is joint work with M.T. Wang.

5:00pm: Jean Taylor, Courant Institute NYU

Rotating crystals: coupled motion and grain growth

Abstract: The set of interfaces between crystals in polycrystalline materials can be likened to soap froths, and annealling metals to motion by mean curvature. The internal structure of crystals leads to many interesting additional phenomena, such as dependence of surface free energy per unit area on the normal direction at each point on an interface and the misorientation of the two crystals meeting at that interface. A phenomenon now being elucidated via molecular dynamics is the tendency of crystals to shift laterally with respect to each other when the interface between them moves due to one crystal growing into the other. The combination of such forces on an embedded crystal can cause it to rotate as it shrinks, with obvious problems of how to accomplish shape accommodation. I discuss the challenge of trying to model this geometrically.

Participant list and further information is available at
http://comet.lehman.cuny.edu/sormani/conf/2005/geom05.html