SCHEDULE AND ABSTRACTS OF TALKS PRESENTED AT THE 3^{rd} ANNUAL IPFW ANALYSIS MINI-SYMPOSIUM

Friday, November 8, 2013.

Sponsored By

- IPFW Department of Mathematical Sciences
- IPFW Office of Research, Engagement, and Sponsored Programs
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Friday Schedule

All talks in Kettler 216.

- Coffee starting before 9:00 in Tea Room, Kettler 200
- 9:00 – 9:10 Welcoming remarks, J. Albayyari
- 9:10 – 9:50 D. Hardin
- 9:50 – 10:10 coffee break
- 10:10 – 10:50 D. Chakrabarti
- 11:00 – 11:40 N. Zorii
- 11:50 – 12:10 Y. Pan
- Lunch
- 2:00 – 2:20 J. Anderson
- 2:30 – 3:10 E. Saff
- 3:10 – 3:30 coffee break
- 3:30 – 3:50 Y. Zhang
- Reception/Dinner off-campus

Abstracts of Talks

Presenter: Jeff Anderson, IPFW

Global solvability for degenerate diffusion models with memory boundary conditions arising in the study of tumor induced angiogenesis

Drawing motivation from the work of Judah Folkman in the 1970's on angiogenesis and possible cancer treatments, a system of differential equations has been previously introduced with the goal of building accurate mathematical models for the phenomenon of tumor induced capillary growth. The system features coupled degenerate diffusion, mean curvature flow, and ordinary differential equations both in the domain (here, the extracellular matrix) and on the boundary (which contains the interface with the tumor and a nearby existing capillary). Although numerical studies have produced results comparing well with laboratory observations, qualitative mathematical studies are yet in development.

Toward analyzing a subset of the full problem, we study one component of the model, which reduces to a degenerate diffusion equation with memory type boundary condition not previously studied in the literature. An analysis of power law cases reveals similarities between global solvability of the simplified model and a corresponding one with more standard localized boundary conditions. In this presentation, we give a brief account of the background related to angiogenesis, difficulties inherent in degenerate diffusion equations, and the methods of analysis used for establishing global solvability in the presence of memory boundary conditions.

Presenter: Debraj Chakrabarti, Central Michigan University

Joint work with: Kaushal Verma

Proper holomorphic maps of product domains

One of the most famous theorems of mathematics is the Riemann Mapping Theorem, which says that every simply connected domain in the plane which is not the whole the plane is conformally equivalent to the unit disc. The search for multidimensional analogs of this result led Poincaré to the discovery that the unit ball and the unit polydisc are not biholomorphically equivalent. Remmert and Stein generalized Poincaré's result to proper holomorphic maps of product domains. We discuss a new approach to these classical topics using techniques based on the study of boundary regularity of proper mappings.

Presenter: Douglas Hardin, Vanderbilt University

Energy minimization, packing, and lattices: Kissing in eight dimensions

We review techniques for obtaining bounds on separation and energy of point configurations in n-dimensional Euclidean space and on the sphere. These techniques originated with Delsarte in the 1970's and have been extended and applied by a long list of researchers including E. Andreev, H. Cohn, N. Elkies, V. Levenstein, A. Kumar, O. Musin, A. Odlyzko, N. Sloane, and V. Yudin. In particular, we will review the now classical proof that the "kissing number" in eight dimensions (i.e., the maximal number of non-overlapping unit spheres that can touch a single unit sphere) is 240.

Presenter: Yifei Pan, IPFW
Joint work with: Shaoyu Dai
A Schwarz Lemma for harmonic mappings between unit balls
I will discuss a version of the Schwarz Lemma for harmonic mappings that is similar to that of holomorphic functions.

Presenter: Ed Saff, Vanderbilt University
Joint work with: S. Borodachov, D. Hardin
Minimal energy and maximal polarization
This talk deals with problems that are asymptotically related to best-packing and best-covering. In particular, we discuss how to efficiently generate N points on a d-dimensional manifold that have the desirable qualities of well-separation and optimal order covering radius, while asymptotically having a prescribed distribution. Even for certain small numbers of points like $N = 5$, optimal arrangements with regard to energy and polarization can be a challenging problem.

Presenter: Yuan Zhang, IPFW
Joint work with: Yifei Pan
On the existence of solutions to nonlinear systems of higher order Poisson type
In this talk, we discuss the existence of higher order Poisson type nonlinear systems. We prove a residue type phenomenon for the fundamental solution of the Laplacian in $\mathbb{R}^n$, $n \geq 3$. This is analogous to the Residue Theorem for the Cauchy kernel in $\mathbb{C}$. With the aid of the residue type formula for the fundamental solution, we derive the higher order derivative formula for the Newtonian potential and obtain its appropriate $\mathcal{C}^{k,\alpha}$ estimates. The existence of solutions to higher order Poisson type nonlinear systems is concluded as an application of the fixed point theorem.

Presenter: Natalia Zorii, Institute of Mathematics, National Academy of Sciences of Ukraine; and IPFW Scholar-in-Residence
Joint work with: P. Dragnev, D. Hardin, E. Saff
Minimum Riesz energy problem for a condenser with touching plates
Minimum energy problems have applications in various areas of sciences, such as Physics, Biology, Chemistry, Crystallography, Cryptography, etc. In this talk we will consider an electrostatic problem for a condenser, where the plates containing positive and negative charges touch. In general, a short circuit would result, unless proper conditions are imposed. The interaction considered is via Riesz kernels including the important Newton case (or Coulomb interaction in 3-D space).