Graduate Research Day 2015 Speaker List

2015-2016 Grad Reps

November 6, 2015

- 10:00AM, **Mr. Nick Miller**,

  Arithmetic progressions in the primitive length spectrum

  Abstract: There have been a host of prime geodesic theorems over the last 30 years displaying a surprising analogy between the behavior of primitive, closed geodesics on hyperbolic manifolds and the behavior of the prime numbers in the integers. For instance, just as the prime number theorem dictates the asymptotic growth of the number of primes less than n, there is an analogous asymptotic growth for primitive, closed geodesics of length less than n. In this talk, I will give a brief review of the definitions of closed and primitive geodesics as well as hyperbolic manifolds. I will then go on to give the history of this analogy. As time allows, I will discuss some recent work extending this relationship to give the geodesic analogue of the Green–Tao theorem on arithmetic progressions in the prime numbers.

- 10:30AM, **Mr. Kevin Rotz**,

  Struwe's energy monotonicity for solutions to the heat equation

  Abstract: The heat equation $\Delta u = u_t$ was one of the first partial differential equations studied by mathematicians and physicists. Hundreds of years later, heat flow is still an open area of research. One recent focus has been on heat flow in non-Euclidean and even non-Riemannian settings. This talk will focus on a so-called "monotonicity formula" in Euclidean space due to Michael Struwe (1988). The calculations involved are simply taking derivatives and integration by parts. I'll end by giving an indication of how Struwe's monotonicity can be generalized to heat flow associated to diffusion operators $\mathcal{L}$ on complete (not necessarily Riemannian!) manifolds which satisfy the curvature-dimension inequality.

- 11:00AM, **Ms. Cuiyu He**,

  Finite element methods for interface problems: robust residual-based a posteriori error estimates

  For elliptic interface problems, this paper studies residual-based a posteriori error estimations for various finite element approximations. For the conforming and the Raviart-Thomas mixed elements in two-dimension and for the Crouzeix-Raviart nonconforming and the discontinuous Galerkin elements in both two- and three-dimensions, the global reliability bounds are established with constants independent of the jump of the diffusion coefficient. Moreover, we obtain these estimates with no assumption on the distribution of the diffusion coefficient.

- 11:30AM, **Mr. Jimmy Vogel**,

  Unfriendly eigenvalues and where to find (and solve) them

  Abstract: Three notoriously nasty problems in numerical linear algebra are finding the eigenvalues of matrices that are highly non-normal, have very clustered spectra, or are huge and have no zero entries. I will first describe why these problems are so difficult numerically, I will then give some examples of important real-life applications where matrices have one (or all three!) of these pathological structures, and finally I will discuss my work with my advisor, Jianlin Xia, where we deal with these difficulties in a systematic way but still have very fast algorithms.

- 2:00PM, **Ms. Alejandra Gaitan**,

  Hardy spaces and self-similar structures

  Abstract: In this talk, we discuss some results in the harmonic analysis in fractals, in particular the study of Hardy spaces of functions defined in post-critically finite sets K provided with a harmonic structure. We give a quick summary of classic Hardy spaces, its elements and their atomic decomposition. We introduce the Poisson integral of functions in K and its respective non-tangential maximal function in order to define the Hardy spaces in K, with this definition we discuss the accuracy of the classic results in post-critically finite sets.

- 2:30 PM, **Mr. Paul Kepley**,

  Applying the boundary control method

  Abstract: The Boundary Control Method (BCM) is a technique originally introduced by Belishev to solve the inverse boundary problem for the acoustic wave equation with a smooth wave speed. Later, it was extended to solve the inverse boundary problem for wave equations posed on a Riemannian manifold with boundary. In this talk, we consider some variations on the ideas of how to solve this latter geometric problem. In particular, we will show that BCM can be used to process boundary data in order to compute the volumes of certain sets known as "domains of influence" and that these volumes can in turn be used to compute a certain set of distances that are known to determine the geometry of the manifold. We will demonstrate our results with a numerical implementation of our technique. Furthermore, we also describe a technique to "move" the boundary data into a known near-boundary region.

- 3:00 PM, **Mr. Sung Won Ahn**,

  Oscillations of quenched slowdown asymptotics for ballistic one-dimensional random walk in a random environment

  Abstract: We consider a one dimensional random walk in a random environment (RWRE) with a positive speed $\lim_{n\to\infty} \frac{X_n}{n} = v_\alpha > 0$. Gantert and Zeitouni showed that if the environment has both positive and negative local drifts then the quenched slowdown probabilities $P_\omega(X_n < xn)$ with $x \in (0, v_\alpha)$ decay approximately like $\exp\{-n^{1-1/s}\}$ for a deterministic $s > 1$. More precisely, they showed that $n^{-\gamma} \log P_\omega(X_n < xn)$ converges to 0 or $-\infty$ depending on whether $\gamma > 1 - 1/s$ or $\gamma < 1 - 1/s$. We improve on this by showing that $n^{-1+1/s} \log P_\omega(X_n < xn)$ oscillates between 0 and $-\infty$, almost surely. This had previously been shown only in a very special case of random environments by Gantert.

- 3:30 PM, **President Andrew Zeller**,

  Higher regularity of the free boundary in the parabolic Signorini problem

  Abstract: Optimal regularity for the Signorini problem, also known as the thin obstacle problem, has received great deal of research interest as of late. Following Daniella De Silva's and Ovidiu Savin's recent work for harmonic functions, I will prove a higher order boundary Harnack inequality for caloric functions in slit domains. I'll then discuss how this can be applied to obtain C^∞ regularity at regular points of the free boundary in the parabolic Signorini problem. This is joint work with Mariana Smit Vega Garcia and Agnid Banerjee.