Colloquium 2016-2017

Spring 2017

February 23, 4:30 pm
Speaker: **Ofer Zeitouni** (NYU / Weizmann Institute of Science)
Topic: **Extrema of logarithmically correlated fields: Branching random walks, Gaussian free fields, cover times and random matrices.**

Abstract: TBA

March 16, 4:30 pm
Speaker: **Ivan Corwin** (Columbia University)
Topic: **A drunk walk in a drunk world**

Abstract: A simple symmetric random walk jumps up or down with equal probability. What happens if its jump probabilities are instead taken themselves to be random in space and time (e.g. uniformly distributed on 0% to 100%)? In this talk (based on joint work with Guillaume Barraquand) I will describe the effect of this random environment on a random walk, and elucidate a new connection to the world of quantum integrable systems and the Kardar-Parisi-Zhang universality class and stochastic PDE. No prior knowledge of any of these areas will be expected.

May 4, 4:30 pm, Dean's Lecture
Speaker: **Guozhen Lu** (University of Connecticut)
Topic: **Sharp geometric and functional inequalities and applications to geometry and PDEs**

Abstract: Sharp geometric and functional inequalities play an important role in applications to geometry and PDEs. In this talk, we will discuss some important geometric inequalities such as Sobolev inequalities, Hardy inequalities, Hardy-Sobolev inequalities Trudinger-Moser and Adams inequalities, Gagliardo-Nirenberg inequalities and Caffarelli-Kohn-Nirenberg inequalities, etc. We will also brief talk about their applications in geometry and nonlinear PDEs. Some recent results will also be reported.

This talk is intended to be for the general audience.

Fall 2016

December 13, 4:40 pm

Speaker: **Florian Sprung** (U. Of Illinois)
Topic: **Analytic ideas in the theory of elliptic curves and the Birch and Swinnerton-Dyer conjecture**

Abstract:The Birch and Swinnerton-Dyer conjecture, one of the millenium problems, is a bridge between algebraic invariants of an elliptic curve and its (complex analytic) L-function. In the case of low ranks, we prove this conjecture up to the finitely many bad primes and the prime 2, by proving the Iwasawa main conjecture in full generality. The ideas in the proof and formulation also lead us to new and mysterious phenomena. This talk assumes no specialized background in number theory.

December 12, 4:40 pm
Speaker: **Jenya Sapir** (U. Of Illinois)
Topic: **Geodesics on surfaces**

Abstract: Let S be a hyperbolic surface. We will give a history of counting results for geodesics on S. In particular, we will give estimates that fill the gap between the classical results of Margulis and the more recent results of Mirzakhani. We will then give some applications of these results to the geometry of curves. In the process we highlight how combinatorial properties of curves, such as self-intersection number, influence their geometry.

December 12, 3:00 pm
Speaker: **Cary Malkiewich** (U. Of Illinois)
Topic: **The Euler characteristic and the Reidemeister trace**

Abstract: Suppose that M is a closed connected manifold of dimension at least three, and that f is a continuous map from M to itself. Can f be deformed to a map without fixed points? When f is the identity, the Euler characteristic chi(M) is the complete obstruction, meaning the fixed points can be removed precisely when chi(M) = 0. When f is not the identity, the complete obstruction is instead a more sophisticated invariant called the Reidemeister trace of f.

In this talk we will consider the Reidemeister trace, not just for manifolds, but for a very general class of cell complexes. At this level of generality, it becomes highly nontrivial to relate the Reidemeister trace back to the Euler characteristic, but such a relationship would have far-reaching consequences. We will give a precise conjecture about the two, generalizing an earlier conjecture of Geoghegan. Finally, we will outline two recent results that provide new evidence for this conjecture.

December 9, 4:30 pm
Speaker: **Hung P. Tong-Viet** (Kent State University)
Topic: **Degrees of representations of alternating groups**

Abstract: Group theory is the study of symmetry and group representation theory is the study of a group via its actions on various vector spaces over the field of comp lex numbers. Group representations carry lots of information about the groups and so group representation theory has numerous applications in other areas of mathematics such as probability, cryptography, number theory as well as in chemistry and physics. Group representation theory, founded by F.G. Frobenius $1 20$ years ago, is still an active research area with many interesting and long-standing open conjectures. Simple groups, a concept introduced by Galois in 1832, are the building blocks of all finite groups. With the completion of the classification of finite simp le groups, many important conjectures in group representation theory have been solved or reduced to simple groups.

Bertram Huppert conjectured in 2000 that all nonabelian simple groups are determined by the set of the degrees of their complex irreducible representations up to an abelian direct factor. This conjecture is the best possible and is related to the famous Brauer's Problem 2 which asked the following: which fini te groups are uniquely determined up to isomorphism by the structure of their group algebras? In this talk, I will review some basic concepts in group representation theory, discuss some interesting results on Brauer's Problem 2 and will outline the proof of Huppert's conjecture for alternating groups, one of the most important family of simple groups. This is joint work with Christine Bessenrodt and Jiping Zhang.

December 8, 4:30 pm
Speaker: **Lionel Levine** (Cornell University)
Topic: **Circles in the sand**

Abstract: I will describe the role played by an Apollonian circle packing in the scaling limit of the abelian sandpile on the square grid Z^2. The sandpile solves a certain integer optimization problem. Associated to each circle in the packing is a locally optimal solution to that problem. Each locally optimal solution can be described by an infinite periodic pattern of sand, and the patterns associated to any four mutually tangent circles obey an analogue of the Descartes Circle Theorem. Joint work with Wesley Pegden and Charles Smart.

December 7, 4:40 pm
Speaker: **Chen Le** (University of Kansas)
Topic: **Stochastic heat equation: intermittency and densities.**

Abstract: Stochastic heat equation (SHE) with multiplicative noise is an important model. When the diffusion coefficient is linear, this model is also called the parabolic Anderson model, the solution of which traditionally gives the Hopf-Cole solution to the famous KPZ equation. Obtaining various fine properties of its solution will certainly deepen our understanding of these important models. In this talk, I will highlight several interesting properties of SHE and then focus on the probability densities of the solution. In a recent joint work with Y. Hu and D. Nualart, we establish a necessary and sufficient condition for the existence and regularity of the density of the solution to SHE with measure-valued initial conditions. Under a mild cone condition for the diffusion coefficient, we establish the smooth joint density at multiple points. The tool we use is Malliavin calculus. The main ingredient is to prove that the solutions to a related stochastic partial differential equation have negative moments of all orders.

December 6, 4:40 pm
Speaker: **Steven Frankel** (Yale)
Topic: **Hyperbolicity in dynamics and geometry**

Abstract: A dynamical system, such as a flow or transformation, is called hyperbolic if it tends to stretch and contract the underlying space in different directions. This behavior often appears in systems that are sufficiently mixing – think of the striations that appear when stirring a drop of milk into coffee – and it lends these systems a kind of rigidity that can be useful in understanding their long-term behavior.

We will look at a number of hyperbolic dynamical systems, including Anosov and pseudo-Anosov maps and transformations, and illustrate some of the uses and consequences of their hyperbolic behavior. In addition, we will see that the dynamics of a hyperbolic system can often be understood in terms of a simpler, lower-dimensional dynamical system that lies “at infinity,” the universal circle. This plays an important role in the proof of Calegari’s conjecture, which relates the dynamical hyperbolicity of a flow with the geometric hyperbolicity of its underlying space: It says that any flow on a closed hyperbolic 3-manifold whose orbits are coarsely comparable to geodesics is equivalent, on the large scale, to a pseudo-Anosov flow.

December 5, 4:40 pm
Speaker: **Gang Zhou** (CalTech)
Topic: **On Singularity Formation Under Mean Curvature Flow**

Abstract: In this talk I present our recent works, jointly with D.Knopf and I.M.Sigal, on singularity formation under mean curvature flow. By very different techniques, we proved the uniqueness of collapsing cylinder for a generic class of initial surfaces. In the talk some key new elements will be discussed. A few problems, which might be tackled by our techniques, will be formulated.

December 2, 4:40 pm
Speaker: **Ling Xiao** (Rutgers)
Topic: **Translating Solitons in Euclidean Space**

Abstract: Mean curvature flow may be regarded as a geometric version of the heat equation. However, in contrast to the classical heat equation, mean curvature flow is described by a quasilinear evolution system of partial differential equations, and in general the solution only exists on a finite time interval. Therefore, it's very typical that the flow develops singularities.

Translating solitons arise as parabolic rescaling of type II singularities. In this talk, we shall outline a program on the classification of translating solitons. We shall also report on some recent progress we have made in the joint work with Joel Spruck.

December 1, 4:30 pm
Speaker: **Ilya Vinogradov** (Princeton University)
Topic: **Sequences modulo one: convergence of local statistics**

Abstract: The study of randomness of fixed objects is an area of active research with many exciting developments in the last few years. We will discuss recent results about sequences in the unit interval

specializing to directions in affine lattices, $\sqrt n$ modulo 1, and directions in hyperbolic lattices. Theorems about these sequences address convergence of moments as well as rates of convergence, and their proofs showcase a beautiful interplay between dynamical systems and number theory.

November 17, 4:30 pm
Speaker: **Todd Fisher** (Brigham Young University)
Topic: **Entropy for smooth systems**

Abstract: Dynamical systems studies the long-term behavior of systems that evolve in time. It is well known that given an initial state the future behavior of a system is unpredictable, even impossible to describe in many cases. The entropy of a system is a number that quantifies the complexity of the system. In studying entropy, the nicest classes of smooth systems are ones that do not undergo bifurcations for small perturbations. In this case, the entropy remains constant under perturbation. Outside of the class of systems, a perturbation of the original system may undergo bifurcations. However, this is a local phenomenon, and it is unclear when and how the local changes in the system lead to global changes in the complexity of the system. We will state recent results describing how the entropy (complexity) of the system may change under perturbation for certain classes of systems.

November 3, 4:30 pm
Speaker: **William Menasco** (SUNY at Buffalo)
Topic: **The Kawamuro Cone and the Jones Conjecture**

October 20, 4:30 pm
Speaker: **Ted Chinburg** (University of Pennsylvania)

Title: Capacity theory and cryptography

Abstract: This talk is about an unexpected connection between cryptography and the theory of electrostatics. RSA cryptography is based on the presumed difficulty of factoring a given large integer N. In the 1990's, Coppersmith showed how one could quickly determine whether there is a factor of N which is within $N^{1/4}$ of a given number. Capacity theory originated in studying how charged particles distribute themselves on an object. I will discuss how an arithmetic form of capacity theory can be used to show that one cannot increase the exponent 1/4 in Coppersmith's method. This is joint work with Brett Hemenway, Nadia Heninger and Zach Scherr.
