Alisa Knizel

Title: Discrete loop equations and Gaussian asymptotics

We introduce and study a class of particle ensembles. We prove that under certain assumptions on the potential, the global fluctuations for such ensembles are asymptotically Gaussian as number of particles goes to infinity. We also explicitly compute the covariance.
Based on joint work with Evgeni Dimitrov (Columbia University).

Boris Hanin

Title: Gradients in Deep Neural Nets and Random Matrix Products

Abstract: Deep learning is the study and use of artificial neural networks, which are finite dimensional spaces of non-linear functions. Although neural nets have been around since the 1940's, they have recently achieved state-of-the-art in a variety of machine learning tasks, ranging from machine vision to natural language processing, and reinforcement learning. The fact that they work at all is a bit surprising and leads to a number of interesting mathematical and statistical questions.

I will begin by defining neural networks and giving a sense of how they are used in practice. I will then focus on an important problem related to numerical stability of gradient-based optimization, called the exploding and vanishing gradient problem (EVGP). I will explain how to reformulate the EVGP in terms of products of random matrices in the regime where both the size and number of terms grow simultaneously. I will then present several recent results in this direction. This is joint work with Mihai Nica (Toronto) and Grigoris Paouris (Texas A&M).

Misha Shkolnikov

Title: The supercooled Stefan problem

Abstract: We will consider the supercooled Stefan problem, which captures the freezing of a supercooled liquid, in one space dimension. A probabilistic reformulation of the problem allows to define global solutions, even in the presence of blow-ups of the freezing rate. We will provide a complete description of such solutions, by relating the temperature distribution in the liquid to the regularity of the ice growth process. The latter is shown to transition between (i) continuous differentiability, (ii) Holder continuity, and (iii) discontinuity. In particular, in the second regime we rediscover the square root behavior of the growth process pointed out by Stefan in his seminal paper [Ste89] from 1889 for the ordinary Stefan problem. In our second main theorem, we will establish the uniqueness of the global solutions, a first result of this kind in the context of growth processes with singular self-excitation when blow-ups are present.
Based on joint work with Francois Delarue and Sergey Nadtochiy.

Vivian Healy

Title: Multiple SLE from a Loop Measure Perspective

Abstract: I will discuss the role of Brownian loop measure in the study of Schramm-Loewner evolution. This powerful perspective allows us to apply intuition from discrete models (in particular, the λ-SAW model) to the study of SLE while simultaneously reducing many SLE computations to problems of stochastic calculus. I will discuss recent work on multiple radial SLE that employs this method, including the construction of global multiple radial SLE and its links to locally independent SLE and Dyson Brownian motion. (Ongoing work with Gregory F. Lawler.)

Jian Ding

Title: Localization near the edge for the Anderson Bernoulli model on the two dimensional lattice

Abstract: We consider a Hamiltonian given by the Laplacian plus a Bernoulli potential on the two dimensional lattice. We prove that, for energies sufficiently close to the edge of the spectrum, the resolvent on a large square is likely to decay exponentially. This implies almost sure Anderson localization for energies sufficiently close to the edge of the spectrum. Our proof follows the program of Bourgain-Kenig, using a new unique continuation result inspired by a Liouville theorem of Buhovsky-Logunov-Malinnikova-Sodin. This is based on joint work with Charles Smart.

Yuri Bakhtin

Title: Ergodic theory of the stochastic Burgers equation.

Abstract: The stochastic Burgers equation is one of the basic evolutionary SPDEs. The ergodic properties of the system in the compact space case were understood in 2000's. With my coauthors, Eric Cator, Kostya Khanin, Liying Li, I have been studying the noncompact case. The one force - one solution principle has been proved for positive and zero viscosity in 1D. The analysis is based on long-term properties of action minimizers and polymer measures.

Shirshendu Ganguly

Some exponents governing the geometry of the Airy sheet.

In Last passage percolation models lying in the Kardar-Parisi-Zhang (KPZ) universality class, polymers are oriented paths accruing maximum energy. Varying the endpoints of such polymers gives rise to a random energy field which under proper scaling and centering has been conjectured to converge to a random function termed as the Space-Time Airy sheet. The latter object has been constructed recently as such a limit for one particular integrable model in the

KPZ universality class. Understanding the behavior of this rich universal object is a fundamental research direction.

We will present some recent results about the coupling structure of the polymer energy in space and time concerning aging properties and fractal behavior via an understanding of coalescence of polymers, and Brownian regularity properties of the energy profiles.