NSF/CBMS Conference
Analysis of Stochastic Partial Differential Equations
August 19–23, 2013
Michigan State University
Tentative Schedule and Abstracts

TENTATIVE SCHEDULE

All the lectures and talks will be in Room 1279, Anthony Hall, and all the coffee breaks will be in Anthony Hall.

Monday, August 19

8:40-9:10 On-site Registration

9:10-9:35 Opening Remarks

Morning Session (Chair: Atma Mandrekar)

9:40-10:30 Main Lecture 1, **Davar Khoshnevisan** (University of Utah)

10:30-11:00 Break

11:00-11:50 Main Lecture 2, **Davar Khoshnevisan** (University of Utah)

11:50-12:30 Invited lecture, **Amarjit Budhiraja** (University of North Carolina at Chapel Hill),
Asymptotics of Infinite Dimensional Small Noise Systems

12:30-2:00 Lunch break

Afternoon Session (Chair: Carl Mueller)

2:00-2:50 Main Lecture 3, **Davar Khoshnevisan**

2:50-3:30 Invited lecture, **Robert Dalang** (Ecole Polytechique Fédéral de Lausanne)
Hitting Probabilities for Systems of Stochastic Partial Differential Equations: an Overview

3:30-4:00 Break

4:00-4:30 Contributed talk, **Eyal Neuman** (Technion-Israel Institute of Technology)
Pathwise Uniqueness of the Stochastic Heat Equations with Spatially Inhomogeneous White Noise

4:30-5:00 Contributed talk, **Xiangjin Xu** (Binghamton University-SUNY)
New Heat Kernel Estimates on Riemannian Manifolds with Negative Curvature

Tuesday, August 20

Morning Session (Chair: Sandra Cerrai)

9:00-9:50 Main Lecture 4, **Davar Khoshnevisan**

9:55-10:35 Invited lecture, **Eulalia Nualart** (University Pompeu Fabra, Spain)
Hitting Probabilities for General Gaussian Processes

10:35-11:00 Break

11:00-11:50 Main Lecture 5, **Davar Khoshnevisan**

11:55–12:25 Contributed talk, **Shannon Starr** (University of Alabama at Birmingham)
Fluctuation Bounds for the Mallows Measure on Permutations

12:25-2:00 Lunch break

Afternoon Session (Chair: Leszek Gawarecki)

2:00-2:50 Main Lecture 6, **Davar Khoshnevisan**

2:55-3:35 Invited lecture, **Sergey Lototsky** (University of Southern California)
Systems of Stochastic Evolution Equations With Constant Coefficients

3:35-4:00 Break

4:00-4:30 Contributed talk, **Xinghua Zheng** (Hong Kong University of Science and Technology)
A Phase Transition for Measure-valued SIR Epidemic Processes

4:35-5:05 Contributed talk, **Paul Jung** (University of Alabama at Birmingham)
A Tanaka Formula for the Derivative of Self-intersection Local Time of FBM

Wednesday, August 21

Morning Session (Chair: Eulàlia Nualart)

9:00-9:50 Main Lecture 7, **Davar Khoshnevisan**

9:55-10:35 Invited lecture, **Frederi G Viens** (Purdue University)
Limit Theorems for Quadratic Variations of Stochastic Heat Equations and Other Processes

10:35-11:00 Break

11:00-11:40 Invited lecture, **Sandra Cerrai** (University of Maryland)
Large Deviations and the Exit Problem for 2-D Stochastic Navier-Stokes Equations Driven by Space Time White Noise

11:45-12:15 Contributed talk, **Gabriel Deugoue** (University of Pretoria)
Strong Solutions for the Stochastic 3D LANS-alpha Model Driven by Non-Gaussian Lévy Noise

12:20-2:00 Lunch break

Afternoon Session (Chair: Frederi G Viens)

2:00-2:50 Main Lecture 8, **Davar Khoshnevisan**

2:55-3:35 Invited lecture, **David Nualart** (The University of Kansas)
Hölder Continuity for the Solution to the Three Dimensional Stochastic Wave Equation

3:35-4:00 Break

4:00-4:30 Contributed talk, **Raluca Balan** (University of Ottawa)
PDEs with α-stable Lévy Noise: a Random Field Approach

4:35-5:05 Contributed talk, **Erkan Nane** (Auburn University)
Continuous Time Random Walk Limits: Governing Equations and Fractal Dimensions

Thursday, August 22

Morning Session (Chair: David Nualart)

9:00-9:50 Main Lecture 9, **Davar Khoshnevisan**

9:55-10:35 Invited lecture: **Leszek Gawarecki** (Kettering University)
Solving Stochastic Partial Differential Equations as Stochastic Differential Equations in Infinite Dimensions - a Review

10:35-11:00 Break

11:00-11:40 Invited lecture, **Daniel Conus** (Lehigh University)
Chaotic Properties for a Family of Stochastic Heat Equations

11:45–12:15 Contributed talk **Le Chen** (École Polytechnique Fédérale de Lausanne)
Moments, Intermittency and Growth Indices for Nonlinear Stochastic Space-fractional Heat Equation

12:20-2:00 Lunch break

2:00-5:00 Picnic at Lake Lansing Park

Friday, August 23

Morning Session (Chair: Robert Dalang)

9:00-9:50	Main Lecture 10, **Davar Khoshnevisan**
9:55-10:35	Invited lecture, **Carl Mueller** (University of Rochester) *Multiple Points of the Brownian Sheet in the Critical Case*
10:35-11:00	Break
11:00–11:30	Contributed talk, **Yu Gu** (Columbia University) *Weak Convergence Approach to a Parabolic Equation with Large Random Potential*
11:35–12:05	Contributed talk, **Sunder Sethuraman** (University of Arizona) *A Stochastic Burgers Equation from Zero-range Microscopic Interactions*
12:05-2:00	Lunch break

Afternoon Session (Chair: Davar Khoshnevisan)

2:00-2:30	Contributed talk, **Latifa Debbi** (University of York, UK) *Well-posedness of the Multidimensional Fractional Stochastic Navier-Stokes Equations on the Torus and on Bounded Domains*
2:35-3:05	Contributed talk, **Oana Mociano** (Kent State University) *Analysis of Dynamic Compositional Data Using Diffusion Processes*
3:05-3:30	Problems/discussions
3:30-4:00	Break

ABSTRACTS

Ten Lectures on Analysis of Stochastic Partial Differential Equations, Davar Khoshnevisan (University of Utah)

The following is a more detailed plan for the lectures.

1. *Introduction.* overview and applications. We present an informal description of stochastic partial differential equations. Concrete examples of SPDEs are drawn from science and engineering.

2. *Interacting diffusions.* We introduce and study examples of families of interacting diffusions in order to discuss many of the fundamental techniques of SPDEs in a less technical setting. Particular attention is paid to two models of mathematical physics: The parabolic Anderson model; and Funaki's discrete approximation to the "random string."

3. *Gaussian noise.* One of the fundamental objects in SPDEs is "noise." Here we lay rigorous foundations of Gaussian noise [including "white noise" and "colored noise"], as well as stochastic integration à la Wiener, Itô, and Walsh.

4. *Linear equations.* Linear SPDEs are introduced and studied. This is a simple setting in which one can learn many of techniques that will be used later on in order to analyze more complicated SPDEs. We describe various structural properties of the solutions to linear SPDEs that highlight the effect of noise [or lack thereof] in the behavior of the solution.

5.*Non-linear equations.* Non-linear equations are introduced, and defined rigorously. General issues of existence and uniqueness are addressed. Special attention is paid to various function classes that arise naturally in the context of some non-linear SPDEs of interest.

6. *Local behavior.* The preceding lectures cover aspects of the "standard theory." From here on, we study in greater detail more concrete families of SPDE models. In these two lectures we continue our analysis of non-linear SPDEs by studying various local properties of these solutions. Typical examples of such local properties are regularity theory [smoothness of the solution], the analysis of the local effect of noise, comparison principles [including positivity principles], and several of their consequences.

7. *Intermittency. (multiple lectures)* In the first lecture on this module, we first introduce physical intermittency, via examples, together with various mathematical models that attempt to describe physical intermittency. Then we establish moment estimates that show the existence of non-trivial moment Lyapunov exponents, thereby suggesting the existence of "intermittent islands" for a class of non-linear SPDE models. In the subsequent two lectures we describe aspects of the recently-developed description of the geometry of the intermittency islands.

Invited Talks

Asymptotics of Infinite Dimensional Small Noise Systems, *Amarjit Budhiraja* (University of North Carolina at Chapel Hill)

Abstract: Some general large deviations results for measurable functionals of Gaussian and Poisson processes will be presented. Applications to the asymptotic study of small noise stochastic dynamical systems driven by Poisson, Brownian or fractional Brownian noises will be discussed.

Large deviations and the exit problem for 2-D Stochastic Navier-Stokes equations driven by space time white noise, *Sandra Cerrai* (University of Maryland)

Abstract: We are dealing with the Navier-Stokes equation in a bounded regular domain D of $\mathbb{R}^2$, perturbed by an additive Gaussian noise $\partial w^{Q_\delta}/\partial t$, which is white in time and colored in space. We assume that the correlation radius of the noise gets smaller and smaller as $\delta \searrow 0$, so that the noise converges to the white noise in space and time. For every $\delta > 0$ we introduce the large deviation action functional $S^\delta_{0,T}$ and the corresponding quasi-potential U_δ and, by using arguments from relaxation and Γ-convergence we show that U_δ converges to $U = U_0$, in spite of the fact that the Navier-Stokes equation has no meaning in the space of square integrable functions, when perturbed by space-time white noise. Moreover, in the case of periodic boundary conditions the limiting functional U is explicitly computed.

Finally, we apply these results to estimate of the asymptotics of the expected exit time of the solution of the stochastic Navier-Stokes equation from a basin of attraction of an asymptotically stable point for the unperturbed system.

Chaotic Properties for a Family of Stochastic Heat Equations, *Daniel Conus* (Lehigh University)

Abstract: We study a family of non-linear stochastic heat equations under different assumptions on the noise, the non-linearity and the initial condition. Our purpose is to show that the supremum (and, hence the solution to the equation) exhibits strongly different behavior for different initial condition and non-linearity, thereby illustrating a *chaotic* behavior of the equation. This chaotic behavior is related to the intermittency of the solution. Quantitative estimates are given, which will illustrate, in the case of the Parabolic Anderson Model, connections to the KPZ universality class. Time permitting, we will say a few words on some open problems.

The presentation is based on joint works with M. Joseph (Sheffield), D. Khoshnevisan (Utah) and S.-Y. Shiu (NCU Taiwan).

Hitting Probabilities for Systems of Stochastic Partial Differential Equations: an Overview, *Robert Dalang* (Ecole Polytechique Fédéral de Lausanne)

Abstract: We consider a d-dimensional random field $u = \{u(t, x)\}$ that solves a non-linear system of stochastic partial differential equations in spatial dimensions $k \geq 1$, such as heat or wave equations. We mainly consider two cases: $k = 1$ and the noise is space-time white noise, and $k \geq 1$ and the noise is white in time with spatial covariance given by a Riesz kernel with exponent β. We explain how to obtain upper and lower bounds on the probabilities that the random field visits a deterministic subset of $\mathbb{R}^d$, in terms, respectively, of Hausdorff measure and Newtonian capacity of the subset. These bounds determine the critical dimension above which points are polar, but do not, in general, determine whether points are polar in the critical dimension: see [1–3]. We also mention some work in progress (with Carl Mueller and Yimin Xiao) concerning how to resolve the issue of polarity of points in the critical dimension.

References

[1] R.C. Dalang, D. Khoshnevisan & E. Nualart. "Hitting probabilities for systems of non-linear stochastic heat equations with multiplicative noise". *Probab. Th. Rel. Fields* **144** (2009), 371-427.

[2] R.C. Dalang, D. Khoshnevisan & E. Nualart. "Hitting probabilities for systems of nonlinear stochastic heat equations in spatial dimensions $k \geq 1$". *Journal of SPDE's: Analysis and Computations* **1**-1 (2013), 94-151.

[3] R.C. Dalang & M. Sanz-Solé. "Hitting probabilities for non-linear systems of stochastic waves" (Preprint, 2012).

Solving Stochastic Partial Differential Equations as Stochastic Differential Equations in Infinite Dimensions - a Review, *Leszek Gawarecki* (Kettering University)

Abstract: One method for solving Stochastic Partial Differential Equations (SPDE) is to cast them as ordinary infinite dimensional Stochastic Differential Equations (SDE)whose coefficients are operators on a function space. Interesting cases result in coefficients whose ranges are larger than their domains. In an approximation scheme the solution, as a limit, may end up outside the domain of the coefficients. Hence, more than one function space needs to be involved and the solution is typically sought in a multi-Hilbertian space or as a variational solution in a Gelfand triplet. Alternatively, the coefficients may be viewed as unbounded operators on one function space and a mild solution to a semilinear SDE can be constructed.

We discuss the problems of existence, uniqueness, and stability of solutions when the infinite dimensional SDE is driven by a Hilbert space valued Wiener process or by a compensated Poisson random measure. We point out similarities and differences among major methods for solving such problems.

References

[1] L. Gawarecki, V. Mandrekar. Stochastic Differential Equations in Infinite Dimensions with Applications to Partial Stochastic Differential Equations, Springer (2011).

Systems of Stochastic Evolution Equations With Constant Coefficients, *Sergey Lototsky* (University of Southern California)

Abstract: While solvability of stochastic hyperbolic and parabolic equations is well known, the questions remain mostly open for more general stochastic evolution systems. Our objective is to investigate well-posedness and stability in Sobolev spaces of the initial value problem for stochastic evolution systems with constant coefficients and multiplicative time-only Gaussian white noise. A general criterion for well-posedness and stability of such systems is derived in terms of sums of certain Kronecker products of the system matrices, leading, in particular, to a stochastic analogue of the Petrowski parabolicity condition.

This is joint work with Jie Zhong.

Multiple Points of the Brownian Sheet in the Critical Case, *Carl Mueller* (University of Rochester)

Abstract: (joint with R. Dalang) We show that in the critical dimension, the Brownian sheet does not have k-multiple points. The Brownian sheet is an analogue of Brownian motion with d-dimensional time, taking values in N-dimensional space. Given k and d, the critical dimension N_0 is such that for $N > N_0$ there are no k-multiple points a.s, and for $N < N_0$ there are k-multiple points a.s. Dalang, Khoshnevisan, Nualart, Wu, and Xiao showed a partial result in this direction. Among other things, they showed that there are no double points in the critical dimension. Our proof has the same starting point, a result of Peres which states that in the critical dimension, k independent Brownian sheets do not have a nontrivial common point in their range. Then we use some conditioning and Girsanov's theorem to complete the proof.

Hölder continuity for the solution to the three dimensional stochastic wave equation, *David Nualart* (The University of Kansas)

Abstract: We will present some recent results on the Hölder continuity of the solution to the three dimensional wave equation driven by a Gaussian noise which is white in space and it possesses an homogenous spatial covariance. Some sufficient conditions on the spectral measure of the noise are given to have a Hölder continuous solution in the space and time variables. Several concrete examples will be discussed, in particular, we will consider the case where the spacial covariance is that of a fractional Brownian motion with different Hurst parameter in each coordinate.

Hitting Probabilities for General Gaussian Processes, *Eulalia Nualart* (University Pompeu Fabra, Spain)

Abstract: For a d-dimensional Gaussian process B with a prescribed general variance function γ^2 and a canonical metric which is commensurate with γ^2, we estimate the probability to hit a bounded set A in $\mathbb{R}^d$, with conditions on γ which place no restrictions of power type or of approximate self-similarity, assuming only that γ is continuous, increasing, and concave, with $\gamma(0) = 0$ and $\gamma'(0+) = +\infty$. We identify optimal base (kernel) functions which depend explicitly on γ, to derive upper and lower bounds on the hitting probability in terms of the corresponding generalized Hausdorff measure and non-Newtonian capacity of A respectively. The proofs borrow and extend some recent progress for hitting probabilities estimation, including the notion of two-point local-nondeterminism in Biermé, Lacaux, and Xiao. We also use new density estimation techniques based on the Malliavin calculus in order to handle the probabilities for scalar processes to hit points and small balls.

Limit Theorems for Quadratic Variations of Stochastic Heat Equations and Other Processes, *Frederi G. Viens* (Purdue University)

Abstract: We present recent results with L. Neufcourt, S. Torres, and C. Tudor, on the asymptotic distribution for quadratic variations of various types of Gaussian processes with long-range dependence, including the stochastic heat equation with fractional-colored noise in space and time. These results can be used to devise estimators of the memory length, but we show that the convergence theorems are highly sensitive to whether or not the processes have stationary increments or are self-similar, and to other characteristics of the processes. Cutting-edge tools from the Malliavin calculus which facilitate the study will be presented.

Contributed talks

PDEs with α-stable Lévy Noise: a Random Field Approach, *Raluca Balan* (University of Ottawa)

Abstract: The goal of this talk is to introduce some tools which are needed for the stochastic analysis with respect to an α-stable Lévy noise, using the random field approach introduced by Walsh (1986), and show how to use them for the study of a non-linear SPDE with this type of noise. The stochastic integral with respect to this noise is constructed by means of a maximal inequality for the tail of the integral process, an idea which was used for the first time by Giné and Marcus (1983) in the case of a symmetric α-stable Lévy process in dimension 1. A key component of our method is a p-th moment inequality for the integral process, which is obtained using different methods for the cases $\alpha < 1$ and $\alpha > 1$. This inequality seems to be new in the literature and can be viewed as a replacement for the Burkholder-Davis-Gundy inequality used in the martingale theory. With these tools in hand, we consider the equation:

$$Lu(t,x) = \sigma(u(t,x))\dot{Z}(t,x), \quad t > 0, x \in \mathcal{O}, \tag{1}$$

where $\mathcal{O}$ is a bounded domain in $\mathbb{R}^d$ and $\dot{Z}$ is an α-stable Lévy noise with index $\alpha \in (0,2)$, $\alpha \neq 1$. The idea is to solve first the equation with the "truncated" noise Z_K (obtained by removing the jumps of Z which exceed in modulus a value K), yielding a solution u_K, and then identify a sequence $(\tau_K)_K$ of stopping times with $\tau_K \uparrow \infty$ a.s. such that for any $t > 0$, $x \in \mathcal{O}$ and $L > K$, $u_K(t,x) = u_L(t,x)$ a.s. on the event $\{t \leq \tau_K\}$. The final step is to show that the process u defined by $u(t,x) = u_K(t,x)$ on $\{t \leq \tau_K\}$ is a solution of (1). In the case of the heat equation, the solution exists if $(1-\alpha)d/2 + 1 > 0$. This work was motivated by the work of Peszat and Zabczyk (2007) using the approach based on integration with respect to Hilbert-space valued processes, as well as the work of Mueller (1998) and Mytnik (2002) who examined the same equation in the more difficult case of a non-Lipschitz function σ.

Moments, Intermittency and Growth Indices for Nonlinear Stochastic Space-fractional Heat Equation, *Le Chen* (École Polytechnique Fédérale de Lausanne, Switzerland)

Abstract: In this talk, we will consider the following nonlinear stochas-

tic heat equation:

$$\begin{cases} \left(\dfrac{\partial}{\partial t} - {}_xD_\delta^a\right) u(t,x) = \rho\left(u(t,x)\right)\dot{W}(t,x), \quad t \in \mathbb{R}_+^* := \left]0,+\infty\right[\,,\ x \in \mathbb{R} \\ u(0,\cdot) = \mu(\cdot) \end{cases} \tag{2}$$

where ${}_xD_\delta^a$ is the fractional differential operator of order $a \in\ ]1,2]$ and skewness δ ($|\delta| \lneqq 2-a$), $\dot{W}$ is the space-time white noise, and the function $\rho : \mathbb{R} \mapsto \mathbb{R}$ is Lipschitz continuous. The initial condition μ is taken to be a measure on $\mathbb{R}$, such as the Dirac delta function, but this measure may also have non-compact support. Existence and uniqueness are proved as an application of [1, Theorem 3.2.16]. Upper and lower bounds on all p-th moments ($p \geq 2$) are obtained. Sample path regularity under rough initial conditions is proved. We improve the *weak intermittency* statement of [3]. We show that the *growth indices* introduced by Conus and Khoshnevisan [2] are infinite and hence propose a modified notion of growth indices in order to characterize the locations of high peaks. We answer the second open problem in [2], namely, under certain mild growth conditions on the nonlinear term ρ, the function $t \mapsto \mathbb{E}\left(|u(t,x)|^2\right)$ (and also the function $t \mapsto \sup_{x\in\mathbb{R}} \mathbb{E}\left(|u(t,x)|^2\right)$) does have at least exponential growth in t for nonvanishing initial data.

This is an ongoing joint work with Robert C. Dalang.

References

[1] Le Chen. *Moments, intermittency, and growth indices for nonlinear stochastic PDE's with rough initial conditions.* PhD thesis, No. 5712, École Polytechnique Fdrale de Lausanne, 2013.

[2] D. Conus and D. Khoshnevisan. On the existence and position of the farthest peaks of a family of stochastic heat and wave equations. *Probab. Theory Related Fields*, 2010.

[3] M. Foondun and D. Khoshnevisan. Intermittence and nonlinear parabolic stochastic partial differential equations. *Electr. J. Probab.*, 14(14):548–568, 2008.

Well-posedness of the Multidimensional Fractional Stochastic Navier-Stokes Equations on the Torus and on Bounded Domains., *Latifa Debbi* (University of York, UK)

Abstract: In this work, we introduce and study the well-posedness of the multidimensional fractional stochastic Navier-Stokes equations on bounded domains and on the torus (Briefly dD-FSNSE). For the subcritical regime, we establish thresholds for which a maximal local mild solution exists and satisfies required space and time regularities. We prove that under conditions of Beale-Kato-Majda type, these solutions are global and unique. These conditions are automatically satisfied for the 2D-FSNSE on the torus if the initial data has H^1-regularity and the diffusion term satisfies growth and Lipschitz conditions corresponding to H^1-spaces. The case of 2D-FSNSE on the torus is studied separately. In particular, we established thresholds for the global existence, uniqueness, space and time regularities of the weak (strong in probability) solutions in the subcritical regime. For the general regime, we prove the existence of a martingale solution and we establish the uniqueness under a condition of Serrin's type on the fractional Sobolev spaces.

Keywords: Fractional stochastic Navier-Stokes equation, classical Navier-Stokes equation, fractional stochastic vorticity Navier-Stokes equation, Q-Wiener process, trace class operators, subcritical, critical, supercritical, dissipative and hyperdissipative regimes, martingale, mild, global, local and weak-strong solutions, Riesz transform, Serrin's condition, Beale-Kato-Majda condition, fractional Sobolev spaces, $\gamma-$radonifying operators, UMD Banach spaces of type 2, pseudo-differential operators, Skorokhod embedding theorem, Faedo-Galerkin approximation, compactness method, representation theorem.

Strong Solutions for the Stochastic 3D LANS-alpha Model Driven by Non-Gaussian Lévy noise, *Gabriel Deugoue*(University of Pretoria)

Abstract: In this talk, we establish the existence, uniqueness and approximation of the strong solutions for the stochastic 3D LANS-α model driven by a non-Gaussian Lévy noise. Moreover, we also study the stability of solutions. In particular, we prove that under some conditions on the forcing terms, the strong solution converges exponentially in the mean square and almost surely exponentially to the stationary solution.
This is a joint work with Mamadou Sango, University of Pretoria, South Africa.

Weak Convergence Approach to a Parabolic Equation with Large

Random Potential, *Yu Gu* (Columbia University)

Abstract: Solutions to partial differential equations with highly oscillatory, large random potential have been shown to converge either to homogenized, deterministic limits or to stochastic limits depending on the statistical properties of the potential. In this paper we consider a large class of piecewise constant potentials and precisely describe how the limit depends on the the correlation properties of the potential and on spatial dimension $d \geq 3$. The derivations are based on a Feynman-Kac probabilistic representation and on an invariance principle for Brownian motion in a random scenery.

A Tanaka Formula for the Derivative of Self-intersection Local Time of FBM *Paul Jung* (University of Alabama at Birmingham)

Abstract: The derivative of self-intersection local time (DSLT) for Brownian motion was introduced by Rogers and Walsh (1990) and also studied by Rosen (2005). A version of the DSLT for fractional Brownian motion (fBm) was introduced by Yan, Yang, Lu (2008). We show the existence of a modified DSLT for fBm using an explicit Wiener chaos expansion. We argue that our modification is a more natural version of the DSLT for fBm by way of a Tanaka formula. In the course of this endeavor we prove a generalized Fubini theorem for Hida distributions.

Analysis of Dynamic Compositional Data Using Diffusion Processes, *Oana Mociano* (Kent State University)

Abstract:

Continuous Time Random Walk Limits: Governing Equations and Fractal Dimensions, *Erkan Nane* (Auburn University)

Abstract: In a continuous time random walk (CTRW), each random jump follows a random waiting time. CTRW scaling limits are time-changed processes that model anomalous diffusion. The outer process describes particle jumps, and the non-Markovian inner process (or time change) accounts for waiting times between jumps.

In this talk, I will consider fractal properties of the sample functions of a time-changed process, and establishes some general results on the Hausdorff dimensions of its range, graph and level sets. I will also talk about the Cauchy problems for CTRW limit processes. We obtain fractional Cauchy problems or Cauchy problems involving the powers of the generator of the Markov processes. In some special cases we obtain the equivalence of these two types of Cauchy problems.

Pathwise Uniqueness of the Stochastic Heat Equations with Spatially Inhomogeneous White Noise, *Eyal Neuman* (Technion - Israel Institute of Technology)

Abstract: We study the solutions of the stochastic heat equation with spatially inhomogeneous white noise. This equation has the form

$$\frac{\partial}{\partial t}u(t,x) = \frac{1}{2}\Delta u(t,x) + \sigma(t,x,u(t,x))\dot{W}, \quad t \geq 0, \quad x \in \Re. \tag{3}$$

Here Δ denotes the Laplacian and $\sigma(t,x,u) : \Re_+ \times \Re^2 \to \Re$ is a continuous function with at most a linear growth in the u variable. We assume that the noise $\dot{W}$ is a spatially inhomogeneous white noise on $\Re_+ \times \Re$. When $\sigma(t,x,u) = \sqrt{u}$ such equations arise as scaling limits of critical branching particle systems which are known as *catalytic super Brownian motion.* In particular we prove pathwise uniqueness for solutions of (3) if σ is Hölder continuous of index $\gamma > 1 - \frac{\eta}{2(\eta+1)}$ in u. Here $\eta \in (0,1)$ is a constant that defines the spatial regularity of the noise.

Fluctuation Bounds for the Mallows Measure on Permutations, *Shannon Starr* (University of Alabama at Birmingham)

Abstract: A random permutation of n objects has the Mallows distribution if the probability of pi is proportional to q-to-the-power of I(pi) equal to the number of inversions, the number of pairs (i,j) such that pi inverts the order of i and j. When q is 1 - c/n for some c, Carl Mueller and I showed that there is a weak law of large numbers for the length of the longest increasing subsequence. I will talk about joint work with Meg Walters, a graduate student at University of Rochester, to get bounds on the fluctuations.

A Stochastic Burgers Equation from Zero-range Microscopic Interactions, textitSunder Sethuraman (University of Arizona)

Abstract: We derive a type of stochastic Burgers equation, formally given by taking the gradient of the KPZ equation, in terms of a martingale characterization, as a scaling limit of fluctuation fields in weakly asymmetric zero-range interacting particle systems.

New Heat Kernel Estimates on Riemannian Manifolds with Negative Curvature, *Xiangjin Xu* (Binghamton University - SUNY)

Abstract: Apply the new Li-Yau type Harnack estimates for the heat equations on manifolds with negative Ricci curvature by Junfang Li and author [Advance in Mathematics 226(5) (2011)4456-4491], I prove a better

upper bound estimate for the heat kernel of manifolds with negative Ricci curvature without ϵ-loss, while there were ϵ-loss for the heat kernel upper bound estimates in the seminal work of Li-Yau [Acta Math. 156 (1986) 153-201.](Theorem 3.2) due to non sharp Harnack estimates on manifolds with negative Ricci curvature.

A Phase Transition for Measure-valued SIR Epidemic Processes,
Xinghua Zheng (Hong Kong University of Science and Technology)

Abstract: We study a scaling limit of the long range SIR epidemic model in which infected individuals cannot be reinfected. The limit is a Dawson-Watanabe process with drift θ and a killing term given by its local time. We show that there is a non-trivial phase transition in θ for dimensions 2 and 3, above which the process survives and below which it goes extinct, and prove that in one dimension there is always extinction. Moreover we show that in any dimension there is always local extinction.

Based on joint work with Steve Lalley and Ed Perkins.