Invited Talks

Bénédicte Haas, University of Paris-Dauphine, France
Limits of Non-increasing Markov Chains and Applications to Random Trees and Coalescents

Consider a non-increasing Markov chain with values in the set of non-negative integers, starting from a large integer $n$. We describe its scaling limit as $n \to \infty$, under the assumption that the large jump events are rare and happen at rates that behave like a negative power of the current state. This result entails various applications, in particular to the description of scaling limits of a large set of sequences of random trees satisfying a branching property (Markov branching trees). For example, from this, we can prove that a tree uniformly distributed among the set of rooted un-ordered unlabeled trees with $n$ vertices has the so-called Brownian continuum random tree as scaling limit. We can also recover the well-known results by Aldous and Duquesne on large conditioned critical Galton-Watson trees that converge to the Brownian continuum random tree or to the stable Lévy trees. Last, other applications of the Markov chains scaling limits will be discussed, for example to the number of collisions in certain coalescent processes $\lambda$-coalescents starting with a large number of particles.

Martin Hairer, University of Warwick, United Kingdom
Solving the KPZ Equation

The KPZ equation was originally introduced in the eighties as a model of surface growth, but it was soon realized that its solution is a "universal" object describing the crossover between the Gaussian universality class and the KPZ universality class. The mathematical proof of its universality however is still an open problem, in particular because of the lack of a good approximation theory for the equation. Indeed, the only known way so far to mathematically interpret solutions to the KPZ equation is to reduce it to a linear stochastic PDE via a non-linear transformation called the Cole-Hopf transform. Unfortunately, the resulting linear equation does itself lack a good approximation theory and many microscopic models do not behave well under the Cole-Hopf transform.

In this talk, we present a new notion of solution to the KPZ equation that bypasses the use of the Cole-Hopf transform. Our approach also allows to factorize the solution map into a "universal" (i.e. independent of initial condition) measurable map, composed with a solution map with good continuity properties. This lays the foundations for a robust approximation theory to the KPZ equation, which is needed to prove its universality. As a byproduct of the construction, we obtain very detailed regularity estimates on the solutions, as well as a new homogenisation result.
Jean-Francois Le Gall, University of Paris-Sud Orsay, France
Kai Lai Chung Lecture
The Brownian Map: A Continuous Limit for Large Random Planar Maps
Consider a triangulation of the sphere chosen uniformly at random among all
triangulations with a fixed number of faces (two triangulations are identified if they
correspond via an orientation-preserving homeomorphism of the sphere). We equip
the vertex set of this triangulation with the usual graph distance. When the number of
faces tends to infinity, the (suitably rescaled) resulting metric space converges in
distribution, in the sense of the Gromov-Hausdorff distance, towards a random
compact metric space called the Brownian map. This result, which confirms a
conjecture of Schramm in 2006, holds with the same limit for much more general
random graphs drawn on the sphere. The Brownian map thus appears as a universal
model of a random surface, which is homeomorphic to the sphere but has Hausdorff
dimension 4.

Soumik Pal, University of Washington
Eigenvalues of Sparse Random Regular Graphs
Adjacency matrices of sparse random regular graphs are long conjectured to lie within
the universality class of random matrices. However, there are few rigorously known
results. We focus on fluctuations of linear eigenvalue statistics of a stochastic process
of such adjacency matrices growing in dimension. The idea is to compare with
eigenvalues of minors of Wigner matrices whose fluctuation converges to the Gaussian
Free Field. We show that linear eigenvalue statistics can be described by a family of
Yule processes with immigration. Certain key features of the Free Field emerge as the
degree tends to infinity. Based on joint work with Tobias Johnson.

Giovanni Peccati, University of Luxembourg, Luxembourg
A Poisson/Gaussian Alternative on Configuration Spaces
We shall describe a class of analytic inequalities on configuration spaces, allowing to
assess normal and Poisson approximations of functionals of random measures.
Strong motivations come from stochastic geometry—in particular from the theory of
geometric U-statistics and random graphs. Partially based on joint works with Raphaël
Lachièze-Rey.
Short Presentations/Open Problems

Haidar Al-Talibi, Linnaeus University, Sweden

Differentiable Approximation of Lévy and Fractional Processes

We study the scaling limit of Ornstein-Uhlenbeck processes with Lévy noise and Fractional Brownian motion with drift when the scaling parameter in front of the noise and the drift tends to infinity. The Gaussian nature of the Ornstein-Uhlenbeck processes driven by Fractional Brownian motion is exploited. The Girsanov theorem for Fractional Brownian motion is also used in order to show weak convergence when including nonlinear drift.

Anita Behme, Michigan State University

Multivariate Generalized Ornstein-Uhlenbeck Processes

By embedding an AR(1) time series into a continuous time setting, De Haan and Karandikar (1989) introduced the well-known generalized Ornstein-Uhlenbeck process driven by a bivariate Levy process. This type of process has since then found various areas of applications like, e.g., as squared volatility in financial mathematics. In this talk we investigate an extension of the setting of De Haan and Karandikar to random matrices with real valued entries to obtain a multivariate generalized Ornstein-Uhlenbeck (MGOU) process. Additionally we study under which conditions the obtained processes obtain a causal or non-causal stationary solution and discuss how one can construct positive semidefinite processes of MGOU-type which may be used as multivariate squared volatilities.

Karthik Bharath, University of Connecticut

Are Jumps a Clustering Mechanism?

In this work, we propose an alternative and intuitive way of considering jumps in a discretely observed semimartingale process using clustering criteria. As a consequence, a new asymptotic test for the presence of jumps in such processes is derived. The problem of detecting and testing for jumps is eventually reduced to a problem of testing for the presence of one or more clusters in the given observations. Using ideas from Hartigan's seminal paper on asymptotics of clustering, we construct, what we refer to as, the Empirical Cross-over Function (ECF). The ECF turns out to be an interesting probabilistic object in its own right: an L-statistic with irregular weights. We prove its consistency and asymptotic normality which consequently provides us with the required test statistic whose asymptotic normality is also proved thereby providing us with the asymptotic test for the presence of jumps in the Merton/Kou models.

Krzysztof Burdzy, University of Washington

On Obliquely Reflected Brownian Motion

The "rate of rotation" of obliquely reflected Brownian motion around a point z in a simply connected planar domain is a harmonic function of z. The harmonicity of this function is intriguing because it is not easy to explain in heuristic terms. Joint work with Zhenqing Chen, Donald Marshall and Kavita Ramanan.
**Simon Campese**, University of Luxembourg, Luxembourg  
*Generalized Chaos and the Fourth Moment Theorem in Multiple Dimensions*  
For vectors of multiple integrals with respect to some isonormal Gaussian process, the fourth moment theorem tells us that componentwise distributional convergence to a Gaussian random variable implies joint convergence. We investigate this implication in a more general setting, where the chaos is defined in terms of Eigenspaces of a symmetric Markov generator.

**Xia Chen**, University of Tennessee  
*Quenched Asymptotics for Brownian Motion in Generalized Gaussian Potential*  
In this short talk, we consider the long-term asymptotics for Brownian motion in a generalized Gaussian field. The major progress reported in this talk includes: solution to an open problem posted by Carmona and Molchanov with an answer different from what was conjectured; the quenched laws for Brownian motions in Newtonian-type potentials, and in the potentials driven by white noise or by fractional white noise.

**Timothy Chumley**, Washington University  
*A Central Limit Theorem and Weak Invariance Principle for a Billiard-Markov Model*  
We present a Markov model of gas-surface scattering and interaction called a random billiard and then discuss a central limit theorem and weak invariance principle for such a model.

**Wai Fan**, University of Washington  
*Hydrodynamic Limits for a Reaction Diffusion System*  
We will investigate a particle system for which two types of particles annihilate at a certain rate when they're near the interface of their respective domains. This can serve as a mathematical model for the propagation of charges in a solar cell. We will discuss how the particle density relates to the solution of a coupled PDE and obtain a probabilistic representation of the solution.

**Haziem Hazaimeh**, Southern Illinois University  
*Stochastic Wave Equations with Cubic Nonlinearities in Two Dimensions*  
I plan to present some of the results of my dissertation. I evaluated the stochastic wave nonlinear equation in terms of Fourier coefficient. I proved that the strong solution of that equation is existence and uniqueness. Also, I studied the stability of N-dimensional truncation and conclusions in three cases; stability in probability, estimates of $L^p$-growth, and almost surely exponential stable. Finally, I studied the numerical methods for Fourier coefficients. I studied the linear implicit Euler method and the linear implicit mid-point method. I represented the scheme as an explicit representation, and then I studied mean consistent and mean square consistent.
Lebesgue Approximation of \((2, \beta)\)-superprocesses

Let \(\xi = (\xi_t)\) be a locally finite \((2, \beta)\)-superprocess in \(\mathbb{R}^d\) with \(\beta < 1\) and \(d > 2/\beta\). Then for any fixed \(t > 0\), the random measure \(\xi_t\) can be a.s. approximated by suitably normalized restrictions of Lebesgue measure to the \(\varepsilon\)-neighborhoods of \(\text{sup} \, \xi_t\). This extends the Lebesgue approximation of Dawson-Watanabe superprocesses. Our proof is based on a truncation of \((\alpha, \beta)\)-superprocesses and uses bounds and asymptotics of hitting probabilities.

On Compositions of Some Random Integrals

We will show that some classes of random integrals are closed under compositions. As a by-product we will get an identity on complex numbers.

For Hawkes Process Some Existence and Stability Properties are Observed

The main result is that under suitable conditions on parameters we show existence of unique invariant distribution of the process; the main difference with previous results is that Lipschitz condition of is not required. These methods also provide estimates on the difference at later times of the distributions of the process starting from two different initial conditions. Multi-type generalization is provided.

Stochastic Moving Boundary Problems

Moving boundary problems arise in many areas of science and engineering and they are of great importance in the areas of partial differential equations since they characterize phase-change phenomena where a system has two phases. In this short talk, we consider random perturbations of one-dimensional moving boundary problems: the Stefan problem which describes melting of the ice and the free boundary problem studied by Caffarelli and Vazquez. We consider existence and uniqueness of solutions and, in particular, investigate the effects of noise on the moving boundary.

Commute Times of Random Walks on Random Trees

We use the connection between random walks and electric networks to determine the commute time between two nodes of some random trees.

Some Stability Properties of a Reflected Fractional Brownian Motion on the Positive Orhant

We consider a multidimensional reflected fractional Brownian motion process (rfBm) on the positive orthant with drift and Hurst parameter \(0 < H < 1\). Under a natural stability condition on the drift vector and reflection directions, we show uniform return time results to some compact sets hold. Also, under slightly stronger stability assumptions, we establish a geometric drift towards a compact set for the 1-skeleton rfBm chain. These results can be viewed as steps towards the further analysis of rfBm with the aim
of establishing long time asymptotic properties for reflected processes driven by non Markovian processes. Motivation for this study is that rfBm appears as a limiting workload process for fluid queueing network models fed by a large number of heavy tailed ON/OFF sources in heavy traffic.

**Xin Liu, University of Minnesota**

*Stability Properties for Markov Modulated Constrained Diffusion Processes*

We study a family of constrained diffusions in a random environment. Constraint set is a polyhedral cone and coefficients of the diffusion are governed by, in addition to the system state, a finite state Markov process that is independent of the driving noise. Such models arise as limit objects in the heavy traffic analysis of stochastic processing networks (SPN) with Markov modulated arrival and processing rates. We give sufficient conditions (which in particular includes a requirement on the regularity of the underlying Skorohod map) for positive recurrence and geometric ergodicity. The case, where the pathwise Skorohod problem is not well-posed but the underlying reflection matrix is completely-S, is treated as well. As consequences of geometric ergodicity, various results, such as exponential integrability of invariant measures and CLT for fluctuations of long time averages of process functionals about their stationary values, are obtained. Conditions for stability are formulated in terms of the averaged drift, where the average is taken with respect to the stationary distribution of the modulating Markov process. Finally, steady state distributions of the underlying SPN are considered and it is shown that, under suitable conditions, such distributions converge to the unique stationary distribution of the constrained Markov modulated diffusion.

**Shuwen Lou, University of Washington**

*Multi-dimensional Brownian Motion with Darning*

The reason that we define multi-dimensional Brownian motion as a darning process is that, even for the simplest case which is $\mathbb{R}^2$ being unioned with $\mathbb{R}^1$, such a process cannot be defined in the usual sense, because 2-dimensional Brownian motion never hits a singleton. Constructions of darning processes are based on one-point extension theory which was first studied by M. Fukushima. Lots of very interesting examples, for instance, circular Brownian motion, Brownian motion with a “knot”, etc., can be constructed in this way, some of which will be provided in the talk. The rest of the talk will be focusing on the heat kernel estimates of multi-dimensional Brownian motion with darning.

**Pejman Mahboubi, University of Utah**

*Let $L$ be the $L^2$-generator of a Levy Process on a Torus*

We consider the parabolic stochastic heat equation $u_t=Lu+f(u)W$, where $W$ is a white noise. We show that the Malliavin derivative $Du$, is intermittent.
Maryssa Metheny, Wichita State University
*Covariance Matrix Structures of Stationary Multivariate Time Series with Long Memory*
Although univariate time series with long memory have been extensively studied in the past few decades, the development of multivariate time series with long memory is still in the early stages. Specifically, there has been very little discussion about how to construct the covariance matrices of such series, especially ones with power law and log law decaying covariance structures. In this talk, I will provide methods for constructing covariance matrix functions of multiple time series from univariate stationary time series, with the conditionally negative definite matrix playing an important role. As a special case, I will discuss a multivariate time series with long memory that has a power-law decaying covariance structure and in another case, one with a log-law decaying covariance structure.

Jasmine Ng, Washington University
*Billiard Markov Operators and Second-Order Differential Operators*
I will be speaking about a class of Markov operators that arise from billiard dynamical systems. In addition to discussing results about their convergence to second-order differential operators, I will talk about approximating the spectrum of one in terms of the other.

Cheng Ouyang, University of Illinois, Chicago
*Some Functional Inequalities for Stochastic Differential Equations Driven by Fractional Brownian Motions*
The concentration of measure phenomenon and logarithmic Sobolev inequalities are closely related. In this talk, I will present some recent results in this direction for stochastic differential equations (SDEs) driven by fractional Brownian motions. In particular, as a consequence of the concentration property, we obtain a Gaussian upper bound for the density of solution to such SDEs. The presentation is based on a joint work with F. Baudoin and S. Tindel.

Dimitrios Papadimitriou, Ghent University, Ghent
*Large-scale Multi-agent Systems with Stochastic Dynamics*
In many multi-agent systems where interacting agents have to coordinate their actions in order to realize certain tasks, stochastic influence in the dynamics of the agents are often not taken into account, modeled deterministically or assumed negligible. Moreover, existing approaches for such large-scale multi-agent systems where dynamics is modeled stochastically assume that the joint state space of the agents is fully observable to all agents (full observation of the global state assumption). For large-scale multi-agent systems, it is however much more reasonable to consider that each agent observes its own state and may have different partial information about other agents it observes (partial observation assumption). In this talk, we outline the research challenges in modeling such systems when agents’ dynamics evolve according to various stochastic processes.
Steffen Sjursen, University of Oslo, Norway

On Chaos Representation and Orthogonal Polynomials for the Doubly Stochastic Poisson Process

We introduce an orthogonal basis for the centered doubly stochastic Poisson process (CDSPP) in an \( L^2 \)-framework. From here we can analyze the chaos representation property and explicit integral representations. The latter will depend strongly on the filtration available, we focus on two filtrations that occur naturally: The first filtration is generated by the CDSPP and the second filtration is generated by the CDSPP and the entire history of the stochastic intensity. Finally we study the relationship with the Clark-Ocone type formulae, via the Malliavin derivative with respect to random measures with conditionally independent values. Based on a joint work in progress with Giulia Di Nunno.

Xiaoming Song, University of North Carolina, Chapel Hill

Convergence of Workload Processes in the Infinite Source Poisson Model with Heavy Tails and Admission Control

In this paper we study the convergence of workload processes. In our model the workload sessions arrive to a system at Poisson arrival times with certain admission controls and the distribution of duration time of each workload is heavy-tailed. We can show that the limit of the workload processes satisfies a linear stochastic differential equation. In a particular case, a fractional Brownian motion will be derived from the random component of the linear stochastic differential equation.

Kursad Tosun, Southern Illinois University

Exponential Decay Rates for Stochastic Logistic Equation

I would like to present an open problem on an exponential decay rates for a stochastic SIS model a.k.a. Stochastic Logistic Equation. How can we prove almost sure exponential stability of the equilibrium solution \( x=K \) for stochastic SIS?

Vladimir Vinogradov, Ohio University

On a Class of Poisson-exponential Levy Processes

We derive several fluctuation properties for Poisson-exponential Levy processes. One of them provides an interpretation of Letac-Mora self-reciprocity for the marginals of this class in terms of the "truncated" first-passage-time process. This result is similar to that which holds for the class of exponentially tilted negatively skewed stable processes with the stability index from \((1, 2]\). The other assertion addresses a property related to the overshoot.

Yizao Wang, University of Michigan

An Invariance Principle for Fractional Brownian Sheets

We establish a central limit theorem for partial sums of stationary linear random fields with dependent innovations, and an invariance principle for anisotropic fractional Brownian sheets. Our result is a generalization of the invariance principle for fractional Brownian motions by Dedecker et al. (2011) to high dimensions. A key ingredient of their argument, the martingale approximation, is replaced by an \( m \)-approximation argument. An important tool of our approach is a moment inequality for stationary random fields recently established by El Machkouri et al. (2011).
Rongwing Wu, Baruch College
Least Absolute Deviation Estimation for General MA(1) Models
We consider the general MA(1) model under a non-Gaussian setting and study least absolute deviation estimation. We try to establish consistency and asymptotic normality of the global LAD estimator when the innovation distribution has heavier tails than the Gaussian distribution.

Fei Xing, University of Tennessee
Quenched Asymptotics for Ornstein-Uhlenbeck Processes of Poisson Potential
In this talk, we consider the long time asymptotic behavior of Ornstein-Uhlenbeck process under homogeneous Poisson potential. It turns out that the growth speed as well as the rate function of this model are different from the Brownian motion model studied by other researchers before.

Fangjun Xu, University of Kansas
Regularity of Harmonic Functions for Some Markov Chains with Unbounded Range
We consider a class of continuous time Markov chains on $\mathbb{Z}^d$. These chains are the discrete space analogue of Markov processes with jumps. Under some conditions, we show that harmonic functions associated with these Markov chains are Hölder continuous.

Qiang Zeng, University of Illinois, Urbana-Champaign
Noncommutative Bennett and Rosenthal Inequalities
We extend Bennett’s and Bernstein’s inequality to the noncommutative setting, and provide an improved version of the noncommutative Rosenthal inequality. We also present new best constants in Rosenthal's inequality. Applying these results to random Fourier projections, we recover fundamental results from compressed sensing, due to Candes, Romberg, and Tao.

Liang Zhang, University of Utah
Hausdorff Dimension of Limsup Random Fractals
We compute the Hausdorff dimension of a family of limsup random fractals which are defined on the boundary of spherically symmetric trees. This result improved that of Khoshnevisan, Peres, and Xiao (2000).

Lingjiong Zhu, Courant Institute, New York University
Large Deviations for General Hawkes Processes
Hawkes process is a self-excitatory point process that has been extensively studied and applied in various fields, especially for the case of linear rate. In this talk, I will establish a large deviation principle of nonlinear Markovian Hawkes process, i.e. with nonlinear rate function and exponential or sum of exponentials exciting function. Then, I will state and talk about the ideas of the proof of a process-level, i.e. level-3 large deviation principle for general nonlinear Hawkes process.