SPA 36

University of Colorado Boulder
July 29, 2013 - August 2, 2013

Program of Abstracts

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1. Schedules and Orientation

All lectures will be held in the Eaton Humanities (HUMN) building located on the Norlin Quadrangle of campus; plenary lectures will be in HUMN 1B50.

1.1 Week at a glance

Monday

8:45-9:00 Opening remarks

9:00-9:50 G. Ben Arous, *Slowing down: some universal phenomena for slow random walks on complex structures*

9:50-10:40 H. Duminil-Copin, *Discrete parafermions in planar lattice models*

10:40-11:00 Coffee

11:00-12:30 Sessions (pg. 3)

12:30-2:00 Break

2:00-3:30 Sessions (pg. 3)

3:30-4:00 Coffee

4:00-4:50 K. Ramanan, *New perspectives on reflecting diffusions*

4:50-5:00 Schramm Memorial Introduction, R. Williams

5:00-5:50 I. Benjamini, *Random walk on planar graphs*

6:00-7:30 Opening reception at Koenig Alumni Center (Beer and wine will be served)

Tuesday

9:00-9:50 R. Doney, *First passage times for random walks and Lévy processes*

9:50-10:40 Q.-M. Shao, *From Stein's method to self-normalized moderate deviations*

10:40-11:00 Coffee & Poster Session

11:00-12:30 Sessions (pg. 3)

12:30-2:00 Break (Early Researcher Panel Discussion in HUMN 135)

2:00- 3:30 Sessions (pg. 4)

3:30-4:00 Coffee & Poster Session

4:00-4:50 N. O'Connell, *From Pitman's 2M-X theorem to random polymers and integrable systems*

4:50-5:40 J. Quastel, *The Kardar-Parisi-Zhang equation and universality class*

Wednesday

9:00-9:50 A. Veber, *Evolution in a spatial continuum*

9:50-10:40 O. Zeitouni, *From branching random walks to Gaussian fields*

10:40-11:00 Coffee

11:00-12:30 Sessions (pg. 4)

(Rest of day open. RMNP tour leaves at 1pm)

Thursday

9:00-9:50 H. Osada, *Infinite-dimensional stochastic differential equations arising from random matrices*

9:50-10:40 N. Jacob, *The symbol and the associated geometry of a Lévy-type process*

10:40-11:00 Coffee

11:00-12:30 Sessions (pg. 4)

12:30-2:00 Break

2:00-3:30 Sessions (pg. 5)

3:30-4:00 Coffee

4:00-4:50 T. Funaki, *Invariant measures for a linear stochastic heat equation related to the KPZ equation*

4:50-5:00 Bernoulli Society Lecture Introduction, E. Waymire

5:00-5:50 K. Golden, *Mathematics and the melting polar ice caps*

6:30-8:30 Conference Dinner at the Boulderado Hotel

Friday

9:00-9:50 B. Virág, *The Stochastic Airy Operator and universality*

9:50-10:40 V. Kaimanovich, *Random graphs: invariance, unimodularity, stochastic homogenization*

10:40-11:00 Coffee

11:00-11:50 Z.-Q. Chen, *Invariance principle for random walks in domains*

11:50-12:40 P. Ferrari, *A free boundary symmetric simple exclusion process and the Stefan problem*

12:40-2:00 Break

2:00-3:30 Sessions (pg. 5)

1.2 Session schedules

Monday, 11:00-12:30

	SLE and related topics (S. Sheffield) HUMN 1B50	*Stochastic Analysis* (D. Nuarlart) HUMN 150	*Analysis of stochastic networks* (C. Lee) HUMN 250
11:00-11:30	J. Miller	F. Baudoin	E. Chong
11:30-12:00	N. Sun	D. Conus	X. Liu
12:00-12:30	D. Wilson	T. Pham	A. Weerasinghe

	Lévy and Branching Processes (V. Rivero) HUMN 135	*Convergence of Markov Processes* HUMN 1B80	*Extremal Laws* HUMN 1B90
11:00-11:30	L. Chaumont	O. Butkovsky	B. Basrak
11:30-12:00	A. Kyprianou	Z. Pajor-Gyulai	Y. Wang
12:00-12:30	J.C.P. Millan	B. Forghani	C. Bartholme

Monday, 2:00-3:30

	Stochastics and Evolutionary Biology (S. Méléard) HUMN 1B50	*Random Combinatorial Structures* (A. Gnedin) HUMN 150	*Set indexed Processes* (E. Merzbach) HUMN 250
2:00-2:30	V. Bansaye	A. Holroyd	E. Herbin
2:30-3:00	P. Pfaffelhuber	T. Mueller	V. Schmidt
3:00-3:30	F. Redig	A. Nikeghbali	D. Nualart

	Aspects of Brownian Motion (V. Rivero) HUMN 135	*Ergocity and Mixing* HUMN 1B80	*Applications to Finance* HUMN 1B90
2:00-2:30	T. Ichiba	W. Barta	J. Esunge
2:30-3:00	J. Song	D. Herzog	Y. Luo
3:00-3:30	J. Wang	H. Qiao	F. Watier

Tuesday, 11:00-12:30

	Stochastic Dynamics (J. Mattingly) HUMN 1B50	*Random Walks with Memory* (S. Volkov) HUMN 150	*Probabilistic Potential Theory* (T. Kumagai) HUMN 250
11:00-11:30	Y. Bakhtin	C. Cotar	S. Andres
11:30-12:00	H. Weber	R. Pemantle	P. Kim
12:00-12:30	L Rey-Bellet	O. Raimond	T. Kumagai

	Lévy Driven Processes (A. Behme & A. Schnurr) HUMN 135	*Percolation* HUMN 1B80	*Time Series and Inference* HUMN 1B90
11:00-11:30	A. Behme	J. Björnberg	C. Lee
11:30-12:00	A. Sikorskii	B. Rath	G. Petris
12:00-12:30	A. Schnurr	D. Sivakoff	F. Tunno

Tuesday, 2:00-3:30

	Stochastic Control (A. Budhiraja) HUMN 1B50	*Random Graphs* (S. Chatterjee) HUMN 150	*Lévy and Stable Processes* HUMN 250
2:00-2:30	R. Carmona	S. Bhadimi	A. Kuznetsov
2:30-3:00	J. Ma	M. Kang	H. Park
3:00-3:30	R. Williams	M. Luczak	M. Ryznar

	Stochastic PDE (contributed) HUMN 135	*Models from Math Physics* HUMN 1B80	*Applications to Biology* HUMN 1B90
2:00-2:30	E. Nualart	Q. Berger	D. Landon
2:30-3:00	E. Neuman	L. Field	D. Loukianova
3:00-3:30	N. Sidorova	S. Hottovy	B. Mélykúti

Wednesday, 11:00-12:30

	Mixing rates for Markov chains (E. Lubetzky) HUMN 1B50	*Self avoiding walk* (T. Kennedy) HUMN 150	*Branching Processes* HUMN 250
11:00-11:30	J. Ding	N. Beaton	M. Caballero
11:30-12:00	B. Morris	N. Clisby	J. Schweinsberg
12:00-12:30	A. Stauffer	A. Hammond	A. Turner

	Large Deviations HUMN 135	*Random Graphs and Trees* HUMN 1B80	*Optimal Stopping and Control* HUMN 1B90
11:00-11:30	M. Day	E. Candellero	S. LeCorff
11:30-12:00	J. Peterson	W. Ruszel	A. Korzeniowski
12:00-12:30	W. Wu	S. Sen	A. Ocejo

Thursday, 11:00-12:30

	Stochastic PDE (L. Mytnik) HUMN 1B50	*Dirichlet forms* (R. Schilling) HUMN 150	*Stochastic Processes in Bayesian Analysis* (Special ISBA Section - V. Dukic & I. Pruenster) HUMN 250
11:00-11:30	D. Khoshnevisan	L. Denis	S. Baccallado
11:30-12:00	E. Perkins	Y.-H. Mao	P. Orbanz
12:00-12:30	J. Mattingly	W. Stannat	M. Ruggiero

	Recurrence and Stochastic Completeness (F. Sobieczky) HUMN 135	*Random Discrete Structures* HUMN 1B80	*Heat Kernels...* HUMN 1B90
11:00-11:30	J. Masamune	D. Aldous	J. Lieri
11:30-12:00	R. Wojciechowski	H. Crane	T. Melcher
12:00-12:30	F. Sobieczky	R. Pinsky	A. Takeuchi

Thursday, 2:00-3:30

	Random Planar Maps (G. Miermont) HUMN 1B50	*Statistical Theory of Turbulence* (B. Birnir) HUMN 150	*Inference in Stochastic Processes* (G. Roberts) HUMN 250
2:00-2:30	M. Albenque	H. Bessaih	V. Minin
2:30-3:00	J. Bettinelli	X. Chen	O. Stramer
3:00-3:30	S. Sheffield	E. Waymire	H. van Zanten

	Degenerate PDEs (P. Feehan) HUMN 135	*Particle Systems* HUMN 1B80	*Long Range Dependence* HUMN 1B90
2:00-2:30	R. Gong	D. Bertacchi	M. Çağlar
2:30-3:00	C. Pop	E. Lee	E. Merzbach
3:00-3:30	P. Feehan	M. Shkolnikov	Y. Shen

Friday, 2:00-3:30

	Interacting Particle Systems (M. Balázs) HUMN 1B50	*Boundary Theory* (F. Ledrappier) HUMN 150	*Discrete Models in Biology* (R. Schinazi) HUMN 250
2:00-2:30	S. Grosskinsky	S. Gouëzel	I. Ben-Ari
2:30-3:00	S. Sethuraman	T. Das	A. Roitershtein
3:00-3:30	B. Vető	J. Mather	F. Zucca

	Problems in Stochastic Analysis HUMN 135	*Random Matrices* HUMN 1B80	*Queues and Copulas* HUMN 1B90
2:00-2:30	N. Eldridge	A. Basak	M. Longla
2:30-3:00	M. Hinz	S. O'Rourke	V. Vinogradov
3:00-3:30	Q. Zeng	H. Tanemura	G. Pang

2. Plenary Talks

Slowing down: some universal phenomena for slow random walks on complex structures

Gérard Ben Arous, New York University, USA
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Monday, 9:00-9:50

Lévy Lecture

How does a random walk behave on a complex random structure like, say a supercritical random tree or a supercritical percolation cluster, with or without a bias? Obviously, the random walk can be slowed down considerably by trapping phenomena due to the complex geometry of the medium and to the bias. I will describe general and rather universal features of this slowing down phenomena, which are in fact present in many other situations, like slow convergence to equilibrium for spin-glasses.

Discrete parafermions in planar lattice models

Hugo Duminil-Copin, Université de Geneve, Switzerland
hugo.duminil@unige.ch

Monday, 9:50-10:40

In the early eighties, physicists Belavin, Polyakov and Zamolodchikov postulated conformal invariance of critical planar statistical models. This prediction enabled physicists to harness Conformal Field Theory in order to formulate many conjectures on these models. From a mathematical perspective, proving rigorously the conformal invariance of a model (and properties following from it) constitutes a formidable challenge. In recent years, the connection between discrete holomorphicity and planar statistical physics led to spectacular progress in this direction. Kenyon, Chelkak and Smirnov exhibited discrete holomorphic observables in the dimer and Ising models and proved their convergence to conformal maps in the scaling limit. These results paved the way to the rigorous proof of conformal invariance for these two models.

Other discrete observables have been proposed for a number of critical models, including self-avoiding walks and Potts models. While these observables are not exactly discrete holomorphic, their discrete contour integrals vanish, a property shared by discrete holomorphic functions. This property sheds a new light on the critical models, and we propose to discuss some of its applications.

We will sketch the proof of a conjecture made by Nienhuis regarding the connective constant of the hexagonal lattice. More precisely, we will show (joint work with Smirnov) that the number a_n of self-avoiding walks of length n starting at the origin satisfies

$$\lim_{n\to\infty} a_n^{1/n} = \sqrt{2+\sqrt{2}}.$$

We will also discuss the absence of spontaneous magnetization for the critical planar Potts models with 2, 3 or 4 colors (joint work with Sidoravicius and Tassion), a fact conjectured by Baxter. Both results are based on observables, called parafermionic observables, possessing the property mentioned above. We will conclude the talk by explaining why establishing a slightly stronger property of these observables would lead to a proof of conformal invariance for these models.

New perspectives on reflecting diffusions

Kavita Ramanan, Brown University, USA
kavita_ramanan@brown.edu

Monday, 4:00-4:50

Reflecting diffusions in non-smooth domains arise in diverse fields, ranging from interacting particle systems and queueing networks to mathematical finance. We provide several illustrative examples and introduce a general framework for the characterization of these processes and their invariant measures, which extends classical results available for (unconstrained) diffusions. Time permitting, we will also describe a new perspective that unifies several different approaches to the study of reflecting diffusions, and show how it can be applied to gain insight into several models arising in applications.

Random walk on planar graphs

Itai Benjamini, Weizmann Institute, Israel
itai.benjamini@weizmann.ac.il

Monday, 5:00-5:50

Schramm Lecture

We will review several qualitative results regarding the behavior of random walks on infinite graphs.

First passage times for random walks and Lévy processes
Ron Doney
University of Manchester, UK
ron.doney@manchester.ac.uk

Tuesday, 9:00-9:50

The behavior of the tail of the distribution of the first passage time over a fixed level x has been known for many years, but until recently little was known about the behavior of the probability mass function or density function. In this talk we describe recent results of Vatutin and Wachtel, Doney, and Doney and Rivero which give such information whenever the random walk or Lévy process is asymptotically stable. The analysis is carried out not just for fixed levels, and gives uniform estimates which are valid as long as x does not grow faster than the norming function.

From Stein's method to self-normalized moderate deviations
Qi-Man Shao, Chinese University of Hong Kong
qmshao@cuhk.edu.hk

Tuesday, 9:50-10:40

We shall review recent developments on Stein's method and self-normalized limit theory. The focus will be on randomized concentration inequalities and their applications to self-normalized Cramer type moderate theorems.

From Pitman's 2M-X theorem to random polymers and integrable systems
Neil O'Connell, University of Warwick, UK
n.m.o-connell@warwick.ac.uk

Tuesday, 4:00-4:50

Doob Lecture

Pitman's (1975) '2M-X' theorem relates one-dimensional Brownian motion to the three-dimensional Bessel process in a surprising way. It has many variations and generalizations which are closely related to representation theory and integrable systems, on one hand, and to random matrices and statistical physics, including the study of random polymers, on the other. This talk will be a survey.

The Kardar-Parisi-Zhang equation and universality class
Jeremy Quastel, University of Toronto, Canada
quastel@math.toronto.edu

Tuesday, 4:50-5:40

The KPZ equation is a stochastic partial differential equation used to describe randomly evolving interfaces. It is a member of a large universality class characterized by unusual size and distribution of fluctuations. Among the surprising developments in the last few years has been the discovery of a number of exact formulas. The talk will describe these, along with the background.

Evolution in a spatial continuum
Amandine Véber, Ecole Polytechnique, France
veber@cmap.polytechnique.fr

Wednesday, 9:00-9:50

The spatial Λ-Fleming-Viot process was introduced a few years ago to model the evolution of the genetic composition of a population spread over some continuous space. In this talk, we shall review some recent results and open questions on this model, and their implications for structured populations. In particular, we shall focus on the case where natural selection favours one allele over the other(s). We shall describe the 'invasion' front as well as the resulting genealogy under different scenarios (joint work with A. Etheridge and N. Barton).

From branching random walks to Gaussian fields
Ofer Zeitouni, University of Minnesota, USA & Weizmann Institute, Israel
zeitouni@umn.edu

Wednesday, 9:50-10:40

I will discuss techniques for proving limit laws for the maximum of (one dimensional) branching random walks, and will explain how these techniques adapt to proving analogous results concerning the maximum of certain log-correlated fields. In particular, I will discuss the proof of the following.

Theorem Let M_N denote the maximum of the two-dimensional GFF with Dirichlet boundary conditions on a box of side N. Then,

$$M_N - 2\sqrt{2/\pi}\big(\log N - \frac{3}{8}\log\log N\big)$$

converges in distribution as $N \to \infty$.

The limit distribution in the theorem can be expressed as a mixture of Gumbel distributions. Joint work with Maury Bramson and Jian Ding.

Infinite-dimensional stochastic differential equations arising from random matrices

Hirofumi Osada, Kyushu University, Japan
urajiromidori@gmail.com

Thursday, 9:00-9:50

Itô Prize Lecture

We give general theorems to construct unique, strong solutions of infinite-dimensional stochastic differential equations whose unlabeled processes are reversible with respect to random point fields related to random matrices. Typical examples of applications of our results are Dyson, Airy, and Bessel random point fields, and the Ginibre random point field. All canonical Gibbs measures with Ruelle's class interaction potentials (satisfying suitable marginal assumptions) are covered by our theorems as trivial applications. In particular, we detect the infinite-dimensional stochastic differential equations describing the stochastic dynamics related to Airy random point fields with $\beta = 1, 2, 4$. When $\beta = 2$, this dynamics coincides with that given by the space-time correlation functions constructed by Spohn, Johansson, and others. This is joint work with Hideki Tanemura.

The symbol and the associated geometry of a Levy-type process

Niels Jacob, University of Wales Swansea, UK
n.jacob@swansea.ac.uk

Thursday, 9:50-10:40

As we can associate with every Levy process its characteristic exponent, every (reasonable) Feller process with Euclidean state space is characterized by its symbol generalizing the characteristic exponent. Transition densities of many Levy processes have a natural geometric interpretation by using a pair of metrics related to the characteristic exponent. We first discuss both, the notion of the symbol of a process and the geometry encoded in the characteristic exponent of a Levy process. Then we ask for a geometric content of the symbol in case of a general Feller process.

Invariant measures for a linear stochastic heat equation related to the KPZ equation
Tadahisa Funaki, University of Tokyo, Japan
funaki@ms.u-tokyo.ac.jp

Thursday, 4:00-4:50

An approximation due to a particle system called a weakly asymmetric simple exclusion process to the Cole-Hopf solution of the Kardar-Parisi-Zhang equation suggests the invariance of the distribution of geometric Brownian motion for a linear stochastic heat equation. We will present a direct approach to this problem based on a stochastic analytic method. Indeed, we first consider KPZ approximating equation with a smeared noise involving a certain renormalization structure in the drift term, and find its invariant measure by showing an integration by parts formula on the path space by means of Wiener-Itô expansion. Then, we pass to the limit. Under the time average, a rather complicated nonlinear term can be replaced by a linear one in the limit. This has a similarity to the so-called Boltzmann-Gibbs principle, which is known in the derivation of a linear SPDEs from large scale interacting systems under a fluctuation limit. This is a joint work with Jeremy Quastel.

Mathematics and the melting polar ice caps
Kenneth M. Golden, University of Utah, USA
golden@math.utah.edu

Thursday, 5:00-5:50

Bernoulli Society Open Lecture

In September of 2012, the area of the Arctic Ocean covered by sea ice reached its lowest level ever recorded in more than three decades of satellite measurements. In fact, compared to the 1980's and 1990's, this represents a loss of more than half of the summer Arctic sea ice pack. While global climate models generally predict sea ice declines over the 21st century, the precipitous losses observed so far have significantly outpaced most projections.

I will discuss how stochastic processes and mathematical models of composite materials are being used to study key sea ice properties and advance how sea ice is represented in climate models. This work is helping to improve projections of the fate of Earth's ice packs, and the response of polar ecosystems. In addition, an exciting video from a 2012 Antarctic expedition where sea ice properties were measured will be shown.

The Stochastic Airy Operator and universality
Bálint Virág, University of Toronto, Canada
balint@math.toronto.edu

Friday, 9:00-9:50

IMS Medallion Lecture

The Stochastic Airy Operator is the continuum limit of random matrices at the edge. I will give an introduction, then explain how it arises as a limit of Dyson's beta ensembles with arbitrary uniformly convex polynomial potential. This is joint work with Manju Krishnapur and Brian Rider.

Random graphs: invariance, unimodularity, stochastic homogenization
Vadim Kaimanovich, University of Ottawa, Canada
vkaimano@uottawa.ca

Friday, 9:50-10:40

The idea that one can talk about invariance (or quasi-invariance) of measures not only in the presence of a group of transformations, but also with respect to more sophisticated structures, first appeared in geometry in the form of holonomy (quasi-)invariant measures on foliations in mid-70's. Shortly afterwards Feldman and Moore (prompted by ergodic theory motivations) developed a comprehensive theory of measured discrete equivalence relations. As particular cases it included orbit equivalence relations of group actions or induced equivalence relations on transversals of foliations and laminations. Although additional graph structures on equivalence classes had been implicitly used already in the 70's, a formal definition was given only in 1990 by Adams. Graphed equivalence relations have since found numerous applications in ergodic theory. From probabilistic point of view a graphed equivalence relation gives rise to a probability measure on the space of pointed graphs. As it was suggested by the author, one can also directly consider probability measures just on the latter space invariant with respect to its natural "root moving" equivalence relation. In a somewhat different form this notion was reintroduced by Benjamini and Schramm under the name of the "intrinsic mass transport principle", and the associated measures are currently known as "involution invariant" or "unimodular". The author has also introduced a weaker notion of "stochastic homogeneity", which amounts to existence of a measure on the space of pointed graphs stationary with respect to the simple random walk. In the talk we shall survey this area and discuss its main results and challenges.

Invariance principle for random walks in domains

Zhen-Qing Chen, University of Washington, USA
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Friday, 11:00-11:50

I will present some recent progress on invariance principle for random walks in domains in deterministic as well as in random environments. More specifically, the following three models will be discussed:

(i) invariance principle for simple random walks on grids inside a bounded Euclidean domain;

(ii) invariance principle for Metropolis Markov chains;

(iii) quenched invariance principle for random walks in random media with boundary (including random walks on supercritical percolation clusters and random conductance models in domains).

For the first and third model, the random walk converges weakly to reflected Brownian motion on the domain, while for the second model, it converges weakly to reflected distorted Brownian motion on the domain. A unified theme of our approaches to these models is the use of a Dirichlet form method.

A free boundary symmetric simple exclusion process and the Stefan problem

Pablo Ferrari
Universidad de Buenos Aires
pferrari@dm.uba.ar

Friday, 11:50-12:40

The hydrodynamic limit of the one-dimensional symmetric simple exclusion process (SSEP) converge to the solution of the heat equation. Consider initial configurations having a rightmost particle and a leftmost hole that at a given rate are substituted by a hole and a particle, respectively. This substitution is superposed to the exclusion to obtain the free boundary SSEP. The hydrodynamic limit of this process converges to the solution of a Stefan problem, i.e., the heat equation with moving boundaries. Joint with Anna de Masi and Errico Presutti.

3. Invited Sessions

3.1 SLE and related topics

Monday, 11:00-12:30
HUMN 1B50

Organizer: **Scott Sheffield**, MIT, USA
sheffield@math.mit.edu

Recent developments in conformal random geometry
Jason Miller, MIT, USA
jasonpmil@gmail.com

This talk will provide an overview of some very recent results in conformal random geometry that involve the Gaussian free field and the Schramm Loewner evolution.

Hausdorff dimension of the CLE gasket
Nike Sun, Stanford University, USA
nikesun@stanford.edu

The conformal loop ensemble CLE_κ is a conformally invariant ensemble of random non-crossing loops in a proper simply connected domain in the complex plane. In this work we study the geometry of the CLE gasket, the set of points not surrounded by any loop in the CLE. We show that the Hausdorff dimension of the gasket is bounded from below by $2-(8-\kappa)(3\kappa-8)/(32\kappa)$ when $4<\kappa<8$, which matches an upper bound obtained by Schramm–Sheffield–Wilson for all κ. Combined with work of Nacu–Werner, which gives the matching lower bound for $8/3<\kappa\leq 4$, this completes the determination of the CLE_κ gasket dimension for all values of κ. This value agrees with the prediction of Saleur–Duplantier (1987) for the FK gasket.
Joint work with Jason Miller and David Wilson.

The extremes and the nesting field of the conformal loop ensemble
David B. Wilson, Microsoft Research, USA
David.Wilson@microsoft.com

The conformal loop ensemble $\mathrm{CLE}(\kappa)$ with parameter $8/3<\kappa<8$ is the canonical conformally invariant measure on countably infinite collections of non-crossing loops in a simply connected domain. Given κ and ν, we compute the almost-sure Hausdorff dimension of the set of points z for which the number of CLE loops surrounding the disk of radius ϵ centered at z has asymptotic growth $\nu * \log(1/\epsilon)$ as ϵ goes to 0. We also show that the number of loops surrounding an epsilon ball minus the expected number, a random function of z and ϵ, converges almost surely as epsilon goes to 0 to a (random) conformally invariant limit in the space of distributions, which we call the nesting field. Using a coupling between the Gaussian free field and CLE(4), we give a CLE-based treatment of the extremes of the Gaussian free field. Joint work with Jason Miller and Samuel S. Watson.

3.2 Stochastic Analysis

Monday, 11:00-12:30
HUMN 150

Organizer: **David Nualart**, University of Kansas, USA
nualart@math.ku.edu

Smoothing effect of rough differential equations driven by fractional Brownian motions
Fabrice Baudoin, Purdue University, USA
fbaudoin@math.purdue.edu

In this talk we show the smoothing effect of rough differential equations driven by a fractional Brownian motion with parameter $H > 1/4$. The regularization estimates we obtain generalize to the fractional Brownian motion previous results by Kusuoka and Stroock and can be seen as a quantitative version of the existence of smooth densities under Hörmander's type conditions. This is a joint work with Cheng Ouyang (UIC) and Xuejing Zhang (Purdue University).

Intermittency and chaos for a family of stochastic heat equations
Daniel Conus, Lehigh University, USA
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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. Based on joint work with M. Joseph (Sheffield), D. Khoshnevisan (Utah) and S.-Y. Shiu (NCU Taiwan).

Zero-sum stochastic differential games under feedback controls and related nonlinear expectations dominated by G-expectation

Triet Pham, University of Southern California, USA
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We study two person zero-sum stochastic differential games where both players use feedback controls. This is different from the setting usually studied in the literature, where one player uses strategies and the other uses controls. We show the game value exists under the control versus control setting and characterize the value process as the unique viscosity solution of the corresponding path dependent Bellman-Isaacs equation. We introduce a nonlinear expectation induced by the game value process and show how it is dominated by the G-expectation in an appropriate sense. We give a conjecture on characterizing all nonlinear expectations dominated by G-expectation. Finally we present the Doob-Meyer decomposition for G-submartingale, which maybe crucial to the above characterization. This is joint work with Jianfeng Zhang.

3.3 Stochastics and Evolutionary Biology

Monday, 2:00-3:30
HUMN 1B50

Organizer: **Sylvie Méléard**, École Polytechnique, France
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Letting Markov chains evolve along genealogies

Vincent Bansaye, École Polytechnique, France
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We consider Markov chains indexed by genealogies to model the evolution of a trait in a population whose size tends to infinity. We want to take into account non-homogeneity with respect to time, both in the genealogy and in the evolution of the trait. We also make the genealogy depend on the evolution of the traits of the individuals. We describe the asymptotic behavior of the number of individuals with a given trait. We pay a particular attention to branching genealogies and tackle the problem of large deviations or extremal traits. The results rely on the study of the typical ancestral lineages, in the vein of spine decompositions. Joint work with Chunmao Huang.

The duration of a selective sweep in a structured population
Peter Pfaffelhuber, Albert-Ludwigs-Universität, Germany
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If a strongly beneficial allele enters a population, chances are that this allele eventually spreads through the whole population. Conditioned on this event the question we are going to answer in this talk is: At what time does every individual in the population carry the beneficial allele? While a classical calculation using one-dimensional diffusions gives the right answer in a panmictic population, the situation is more complex if the population is located on several islands. Here, we use the ancestral selection graph of Neuhauser and Krone and find several regimes for the fixation time, depending on the migration rate and the selecive advantage. This is joint work with Andreas Greven (Erlangen), Cornelia Pokalyuk (Lausanne) and Anton Wakolbinger (Frankfurt).

Dualities and symmetries in population dynamics
Frank Redig, TU Delft, Netherlands
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We explain and apply our general method of duality, introduced in [Giardina, Kurchan, Redig, J. Math. Phys. 48, 033301 (2007)], in the context of models of population dynamics. This method consists in identifying the generator of the process as an element of a Lie algebra, and investigate the commuting operators. Dual processes are obtained by a change of representation, and self-duality arrizes from a commuting operator (symmetry). The classical dualities between forward and ancestral processes can be obtained as a change of representation in the classical creation and annihilation operators, both for diffusions dual to coalescents of Kingman's type, as well as for models with finite population size. Next, using SU(1,1) raising and lowering operators, we find new dualities between the Wright-Fisher diffusion with d types and the Moran model, both in presence and absence of mutations. These new dualities relates two forward evolutions. From our general scheme we also identify self-duality of the Moran model. This is based on joint work with G. Carinci, C. Giardina and C. Giberti.

3.4 Random combinatorial structures

Monday, 2:00-3:30
HUMN 150

Organizer: **Alexander Gnedin**
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Random permutations and prime numbers

Ashkan Nikeghbali, University of Zurich, Switzerland
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The goal of this talk is to propose a new framework, which can be viewed as a higher order CLT, and from which one can derive precise deviations results or distributional approximations. We illustrate this with two examples, one coming from random permutations (and models from the study of the Bose quantum gas) and the other one from arithmetic. We shall also see that there seems to exist some deep links between the two examples, similar to the conjectured links between random unitary matrices and the moments of the Riemann zeta function.

Self-organizing cellular automata

Alexander E Holroyd, Microsoft Research, USA
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Cellular automata display an extraordinary range of behavior, ranging from the very simple to the apparently chaotic, with many cases in between. Perhaps the most interesting rules are those that yield multiple behavior types from different initial conditions - this is common even for one-dimensional rules started from finitely-supported seeds. If a rule yields chaos from some initial conditions, it is tempting to conclude by analogy with the second law of thermodynamics that chaos should be prevalent from almost all initial conditions. For a certain natural class of rules, we prove that the opposite holds: typical (i.e. random) initial seeds self-organize into predictable (but non-trivial) evolution, while exceptional seeds generate more complicated behavior, including chaos. The key technique is the application of percolation arguments to the highly non-independent setting of space-time configurations of cellular automata.

Logic and random graphs from minor closed classes

Tobias Mueller, Universiteit Utrecht, Netherlands
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A classical result of Glebskii et al. 1969 and indepently Fagin 1976 states that in the Erdos-Renyi model with edge-probability $p = 1/2$ every graph property that can be expressed as a sentence in first order logic holds with probability tending to either zero or one.

A class of graphs is minor closed, if it is closed under the operations of removing edges and of "contracting" edges. (An example of a minor closed class of graphs is the class of all graphs that have a crossing-free drawing on some fixed surface S.) I will discuss ongoing work, joint with P. Heinig, M. Noy and A. Taraz, on analogues of the classical result of Glebskii et al./Fagin for random graphs from a minor closed class (i.e. we sample a graph uniformly at random from all graphs on n vertices from some minor closed class). The proofs build on the major progress that was made in recent years in the study of these random graph models.

3.5 Stochastic dynamics

Tuesday, 11:00-12:30
HUMN 1B50

Organizer: **Jonathan Mattingly**, Duke University, USA
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Burgers equation with random forcing in noncompact setting

Yuri Bakhtin, Georgia Tech, USA
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The Burgers equation is one of the basic nonlinear evolutionary PDEs. The study of ergodic properties of the Burgers equation with random forcing began in 1990's. The natural approach is based on the analysis of optimal paths in the random landscape generated by the random force potential. For a long time only compact cases of the Burgers dynamics on a circle or bounded interval were understood well. In this talk I will discuss the Burgers dynamics on the entire real line with no compactness or periodicity assumption on the random forcing. The main result is the description of the ergodic components and existence of a global attracting random solution in each component. The proof is based on ideas from the theory of first or last passage percolation. This is a joint work with Eric Cator and Kostya Khanin.

KL Approximations for measures on infinite dimensional spaces

Hendrik Weber, University of Warwick, UK
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Measures on infinite dimensional spaces are ubiquitous in many applications and constitute a central topic of stochastic analysis. We will concentrate on measures that that are absolutely continuous with respect to a Gaussian measure on a Banach space. These measures arise for example in the Bayesian approach to inverse problems or in path sampling.

It is often challenging to produce samples of such measures or to computationally analyse properties of typical draws. We propose to reduce the complexity by replacing the measure with the Gaussian that is closest with respect to the Kullbach-Leibler (KL) divergence. We discuss some theoretical well-posedness problems as well as numerical implementations. Finally, we will discuss the minimisation in two concrete examples: The invariant measures of stochastic reaction diffusion equations as well as diffusion bridges.

This is a joint work with F. Pinski, G. Simpson, and A. Stuart.

Measuring irreversibility in stochastic processes and applications
Luc Rey-Bellet, University of Massachusetts, USA
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The concept of entropy production (rate) originates in physics and is a central theme in non-equilbrium statistical mechanics. From a probabilistic point of view the entropy production rate is a quantitative measure of the lack of time-reversibility of a stochastic process. We discuss some applications of these ideas to physical systems and also use it as a novel tool to assess numerical schemes for stochastic processes. Finally we draw some connections between time non-reversible stochastic processes and game theory.

3.6 Random walks with memory

Tuesday, 11:00-12:30
HUMN 150

Organizer: **Stas Volkov**, Lund University, Sweden
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On a preferential attachment and generalized Polya's urn model
Codina Cotar, University College London, UK
`ccotar@fields.utoronto.ca`

We study a general preferential attachment and Polya's urn model. At each step a new vertex is introduced, which can be connected to at most one existing vertex. If it is disconnected, it becomes a pioneer vertex. Given that it is not disconnected, it joins an existing pioneer vertex with a probability proportional to a function of the degree of that vertex, called reinforcement function. Consider the set whose elements are the vertices with cardinality tending a.s. to infinity. Depending on the type of reinforcement, we prove that this set either is empty, or it has exactly one element, or it contains all the pioneer vertices. (Joint work with Andrea Collevecchio and Marco LiCalzi.)

How much does a random power series remember its first coefficients?
Robin Pemantle, University of Pennsylvania, USA
`pemantle@math.upenn.edu`

Coefficients of random power series whose zeros are IID exhibit certain regularities, which seem to include macroscopic parameters. We examine the question of the change of the macroscopic parameters within a sample power series.

Vertex reinforced random walk on complete graphs
Olivier Raimond, Université Paris-Sud, France
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We consider the model of Vertex Reinforced Random Walk introduced by Pemantle, in the linear regime. Here we focus on the strongly reinforced regime, more precisely when the weight sequence is of the form $w(n) = n^{\alpha}$, with $\alpha > 1$. We see that on a complete graph, unlike for the Edge-Reinforced-Random-Walk, which in this case localizes a.s. on 2 sites, we observe various phase transitions. In particular, provided α is close enough to 1, localization on arbitrary large sets is possible.

Joint work with Michel Benaïm and Bruno Schapira

3.7 Stochastic Control

Tuesday, 2:00-3:30
HUMN 1B50

Organizer: **Amarjit Budhiraja**, UNC Chapel Hill, USA
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Probabilistic Approach Analysis of Mean Field Games and the Control of McKean-Vlasov Dynamics
Rene Carmona, Princeton University, USA
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We review a series of recent results on Mean Field Games, including existence and the construction of approximate Nash equilibria. We also present analogs of the stochastic maximum principle approach for the optimal control of stochastic dynamics of the McKean-Vlasov type. In both cases existence results are proven by solving forward-backward stochastic differential equations of the McKean-Vlasov type. (joint works with F. Delarue).

Stochastic Viscosity Solutions for Nonlinear Stochastic PDEs
Jin Ma, University of Southern California, USA
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We first prove a new result on pathwise stochastic Taylor expansion, using a variation of the path-derivatives initiated by Dupire. We then introduce a notion of stochastic viscosity solution for a class of fully nonlinear

SPDEs and the corresponding Path-dependent PDEs (PPDEs), in terms of the new form of pathwise Taylor expansion, without having to invoke the stochastic characteristics for the localization. The issues of consistency, stability, comparison principles, and ultimately the well-posedness of the stochastic viscosity solutions will be discussed under this new framework. This is a joint work with Rainer Buckdahn and Jianfeng Zhang.

Correlation of intracellular components due to limited processing resources
Ruth Williams, UC San Diego, USA
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A major challenge for systems biology is to deduce the molecular interactions that underlie correlations observed between concentrations of different intracellular components. Of particular interest is obtaining an understanding of such effects when biological pathways share common elements that are limited in capacity.

Here we use stochastic models to explore the effect of limited processing resources on correlations when these resources are positioned downstream or upstream of the molecular species of interest. Of particular interest is the effect of system parameters on correlations and how these might be controlled to produce extremes in correlations. As time permits, related experimental work will be described.

Based on joint work with William H. Mather, Natalie A. Cookson, Tal Danino, Octavio Mondragon-Palomino, Jeff Hasty and Lev S. Tsimring.

3.8 Random graphs

Tuesday 2:00-3:30
HUMN 150

Organizer: **Sourav Chatterjee**, New York University, USA
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Limited choice and randomness in evolution of networks
Shankar Bhamidi, University of North Carolina, Chapel Hill, USA
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The last few years have seen an explosion in network models describing the evolution of real world networks. In the context of math probability, one aspect which has seen an intense focus is the interplay between randomness and limited choice in the evolution of networks, ranging from the description of the emergence of the giant component, the new phenomenon of "explosive percolation" and power of two choices. We will describe on going work in understanding such dynamic network models, their connections to classical constructs such as the standard multiplicative coalescent and applications of these simple models in fitting Retweet networks in Twitter.

Phase transitions in random graph processes
Mihyun Kang, TU Graz, Austria
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The phase transition is a fascinating phenomenon observed in mathematics and natural sciences in many different contexts. It deals with a sudden change in the properties of an asymptotically large structure by altering critical parameters. The phase transition in random graphs refers to a phenomenon that there is a critical edge density, to which adding a small amount results in a drastic change of the size and structure of the largest component. In the Erdős and Rényi random graph process, which begins with an empty graph on n vertices and edges are added randomly one at a time to a graph, a phase transition takes place when the number of edges reaches $n/2$ and a giant component emerges. Since this seminal work of Erdős and Rényi, various random graph processes have been introduced and studied. In this talk we will discuss key techniques to study the size and structure of components of random graph processes, including the classical ordinary differential equations method, quasi-linear partial differential equations method, and singularity analysis.

SIR epidemic on a random graph with given degrees
Malwina Luczak, Queen Mary, University of London
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We study the susceptible-infective-recovered (SIR) epidemic on a random graph chosen uniformly subject to having given vertex degrees. In this model infective vertices infect each of their susceptible neighbors, and recover, at a constant rate.

Suppose that initially there are only a few infective vertices. We prove that there is a threshold for a parameter involving the rates and vertex degrees below which only a small number of infections occur. Above the threshold a large outbreak may occur. We prove that, conditional on a large outbreak, the evolutions of certain quantities of interest, such as the fraction of infective vertices, converge to deterministic functions of time.

In contrast to earlier results for this model, our results only require basic regularity conditions and a uniformly bounded second moment of the degree of a random vertex.

This is joint work with Svante Janson and Peter Windridge.

3.9 Self avoiding walk

Wednesday, 11:00-12:30
HUMN 150

Organizer: **Tom Kennedy**, University of Arizona, USA
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Monte Carlo simulation of self-avoiding walks
Nathan Clisby, University of Melbourne, Australia
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Recent improvements in the computer implementation of the pivot algorithm for self-avoiding walks have allowed us to efficiently simulate walks with many millions of steps. We will give an overview of the simulation method, with emphasis on explaining *why* self-avoiding walks (and indeed other walk models) are particularly amenable to efficient simulation. Finally, we will discuss some recent applications.

Polymer adsorption on the honeycomb lattice
Nicholas Beaton, Université Paris 13, France
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Self-avoiding walks in a half-space of a lattice, equipped with a weight associated with visits to the boundary of the half-space, are known to undergo an adsorption phase transition at a critical value of the surface weight. This is a pleasing model for long chain polymers in solution interacting with an impenetrable surface. For most lattices in two or more dimensions the critical value of the surface weight is not known; the honeycomb lattice, however, is special. Here there are two natural ways to orient the half-space; I will discuss the proofs of the critical surface weight for each case, which are based on a generalization of an identity obtained by Duminil-Copin and Smirnov.

New rigorous results on the global geometry of self-avoiding walk
Alan Hammond, University of Oxford, UK
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Self-avoiding walk was introduced by chemists Flory and Orr in the 1940s as a model of a long chain of molecules. As a mathematical model, it is remarkable for its simplicity of definition and its impregnability to rigorous analysis. Well-known rigorous results from 1960s and 70s are Kesten's pattern theorem, concerning the typical local geometry of the walk, and the Hammersley-Welsh bound, which provides a stretched exponential lower bound on the probability that two long self-avoiding walks avoid each other. A notable recent result is

Duminil-Copin and Smirnov's rigorous derivation of the connective constant - the exponential rate of growth in walk length - of self-avoiding walk on the hexagonal lattice.

After a review of some of these results, I will turn to discuss two recent results concerning the global geometry of the model: a proof that self-avoiding is sub-ballistic (work with Hugo Duminil-Copin), and results concerning delocalization of the walk's endpoint (with Hugo Duminil-Copin, Alexander Glazman and Ioan Manolecu).

3.10 Mixing rates for Markov chains

Wednesday, 11:00-12:30
HUMN 1B50

Organizer: **Eyal Lubetzky**, Microsoft Research, USA
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Sensitivity of mixing times
Jian Ding, University of Chicago, USA
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I will present an instance of bounded-degree graphs, where the mixing times can be changed drastically (almost up to a factor which is logarithmic in the size of the graph) if one changes the edge conductance up to a factor of 2 in a certain manner. As a result, this implies that any geometric bound on mixing time that is robust under the conductance perturbation will lose a super-constant factor in general. Joint work with Yuval Peres.

Mixing time of the overlapping cycles shuffle
Ben Morris, UC Davis, USA
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The overlapping cycles shuffle mixes a deck of n cards by moving either the n-th card or $(n-k)$-th card to the top of the deck, with probability half each. Angel, Peres and Wilson determined the spectral gap for the location of a single card and found the following surprising behavior. Suppose that k is the closest integer to cn for a fixed c in $(0,1)$. Then for rational c, the spectral gap is on the order of n^{-2}, while for poorly approximable irrational numbers c, such as the reciprocal of the golden ratio, the spectral gap is on the order of $n^{-3/2}$. We show that these bounds also apply, up to logarithmic factors, to the mixing time for all the cards. The talk is based joint work with Olena Blumberg.

Random lattice triangulations
Alexandre Stauffer, University of Bath, UK
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We consider lattice triangulations as triangulations of the integer points in the square $[0, n]x[0, n]$. Our focus is on random triangulations in which the probability of obtaining a given lattice triangulation T is proportional to $\lambda^{|T|}$, where λ is a positive real parameter and $|T|$ is the total length of the edges in T. Empirically, this model exhibits a phase transition at $\lambda = 1$ (corresponding to the uniform distribution): for $\lambda < 1$ distant edges behave essentially independently, while for $\lambda > 1$ very large regions of aligned edges appear. We substantiate this picture as follows. For $\lambda < 1$ sufficiently small, we show that correlations between edges decay exponentially with distance (suitably defined), and also that the Glauber dynamics (a local Markov chain based on flipping edges) is rapidly mixing (in time polynomial in the number of edges in the triangulation). By contrast, for $\lambda > 1$ we show that the mixing time is exponential.

Joint work with Pietro Caputo, Fabio Martinelli and Alistair Sinclair.

3.11 Stochastic PDE

Thursday, 11:00-12:30
HUMN 150

Organizer: **Leonid Mytnik**, The Technion, Israel
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Some very rough differential equations
Davar Khoshnevisan, University of Utah, USA
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We consider differential equations of the type $\mathrm{d}Y = f(Y)\mathrm{d}X$, where $X = X(t)$ is very rough and f is Lipschitz continuous. Among other things we prove weak existence of a solution in the case that X is fractional Brownian motion of Hurst index $H \leq 1/4$. More significantly, we describe the law of our solution. The surprising fact is that the solution is connected intimately to certain equations of random media. Time permitting, we will show how the analogue of "the stochastic exponential of fBm(1/4)" is the solution to "KPZ." This is based on various ongoing collaborations with Jason Swanson, Yimin Xiao, and Liang Zhang.

A Phase Transition for Measure-valued SIR Epidemics
Edwin Perkins, University of British Columbia, Canada
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We study a scaling limit of the long range SIR epidemic model in which infected individuals cannot be reinfected. The limit, which exists in up to 3 dimensions, has been studied by Lalley and Zheng and is reminiscent of a one-dimensional model proposed by Durrett and studied by Mueller and Tribe. It is a measure-valued process similar to super-Brownian motion with drift θ but with an additional killing term proportional to its local time. We show there is a non-trivial phase transition in θ for dimension 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 extinction on compact sets. This is joint work with Steve Lalley and Xinghua Zheng.

Ellipticity in infinite dimensions
Jonathan Mattingly, Duke University, USA
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I will discuss, through some examples, how the idea of elliptically is is more subtle in infinite dimensions SDEs. In particular how there are many possible directions one could take a definition depending on which of the classical “elliptic properties” one cares about. I will discuss one choice, give a method for probing such results and discuss some boarder line cases.

3.12 Dirichlet forms

Thursday, 11:00-12:30
HUMN 150

Organizer: **René Schilling**, TU Dresden, Germany
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Dirichlet Forms Methods for Poisson Point Measures and Lévy Processes
Laurent Denis, University of Evry-Val-d’Essonne, France
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We present an approach to absolute continuity and regularity of laws of Poisson functionals based on the framework of local Dirichlet forms. The method mainly uses the chaos decomposition of the Poisson L^2 space which extends naturally to a chaos decomposition of the domain of the candidate closed form and gives rise to a new explicit calculus: it consists in adding a particle and taking it back after computing the gradient. This method that we call *the lent particle method* permits to develop a Malliavin calculus on the Poisson space and to obtain in a simple way existence of density and regularity of laws of Poisson functionals. This talk is devoted to the practice of the method first on some simple examples and then on more sophisticated ones. Based on several joint works with N. Bouleau.

Hitting Time Distributions for Denumerable Birth and Death Processes

Yong-Hua Mao, Beijing Normal University, China
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For an ergodic continuous-time birth and death process on the nonnegative integers, a well-known theorem states that the hitting time $T_{0,n}$ starting from state 0 to state n has the same distribution as n independent exponential random variables. Firstly, we generalize this theorem to absorbing birth and death process (say state -1 absorbing), to derive the distribution of $T_{0,n}$. We then give the explicit formulas for Laplace transforms of hitting times between any two states for an ergodic or absorbing birth and death process. Secondly these results are all extended to birth and death processes on the nonnegative integers with the infinity an exit, entrance, or regular boundary. Finally, we apply these formulas to fastest strong stationary times for strongly ergodic birth and death processes

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Stochastic stability of traveling waves in nerve axon equations

Wilhelm Stannat, TU Berlin, Germany
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We study stochastic partial differential equations modeling the propagation of the action potential along the nerve axon of a single neuron subject to channel noise fluctuations, including stochastic FitzHugh-Nagumo systems. Stochastic stability of the action potential is proven using functional inequalities and an implicitly defined phase adaption. Our approach is new even for the deterministic case. A stochastic differential equation for the speed of the action potential is derived that allows to decompose the stochastic dynamics into the propagating action potential and noise fluctuations. Our approach also allows to calculate the probability of a propagation failure w.r.t. the to underlying channel noise fluctuations.

3.13 Random planar maps

Thursday, 2:00-3:30
HUMN 1B50

Organizer: **Grégory Miermont**, Ecole Normale Supérieure de Lyon, France
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Convergence of random simple triangulations
Marie Albenque, LiX, Ecole Polytechnique, France
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Asymptotic behavior of large random maps has been largely investigated in the last few years. In particular, Miermont and Le Gall defined in 2011, the so-called "Brownian map" and proved that quadrangulations – properly rescaled – converge towards this object. In this this talk, I'll show that simple triangulations, that is triangulations without loops nor multiple edges, converge as well towards the Brownian map after proper renormalization. This is the first result of convergence obtained for a model of maps with a connectivity constraint, which strengthens the conjecture that all "reasonable" model of maps should converge to the Brownian map. This is joint work with Louigi Addario-Berry (McGill University, Montreal).

Scaling limit of arbitrary genus random maps
Jérémie Bettinelli, Institut Elie Cartan, Nancy, France
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A map is a gluing of polygons along their edges forming either the sphere or a torus with an arbitrary number of handles. These objects naturally appear in various domains such as mathematics, computer science and physics, and they have been the subject of many studies. During this talk, we will adopt the point of view of scaling limits, consisting roughly in trying to see what a large random map looks like. More precisely, we will address the problem of the convergence, as the size tends to infinity, of rescaled maps chosen uniformly at random in some privileged classes of maps with fixed size. We will see that a scaling limit exists for some specific classes of maps. This defines random metric spaces with interesting properties. We will in particular focus here on their topology. I will expose in this talk the main results of the field and try to give some of the principal ideas behind the study of these objects.

Quantum gravity and planar maps

Scott Sheffield, MIT
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I will survey several developments in the continuum theory of quantum gravity (which involves continuum random "surfaces" that are in some sense canonical) and discuss relationships between these results and the theory of planar maps (which can be understood as discrete random surfaces).

3.14 Statistical Theory of Turbulence

Thursday, 2:00-3:30pm
HUMN 150

Organizer: **Bjorn Birnir**, UC Santa Barbara, USA
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On some stochastic shell models of turbulence

Hakima Bessaih, University of Wyoming, USA
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We are going to give an introduction to some models related to turbulent fluids, shell models of turbulence. Results on the well-posedness of their stochastic version, existence, uniqueness and some regularity will be given. Their longtime behavior will be studied through their invariant measures.

Symmetry-based analysis for wall bounded turbulent flow

Xi Chen, Peking University, China
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Accurate drag prediction in aircraft design is one of the key technologies, behind which the search for relevant symmetry for wall-bounded turbulent flow is the basic scientific problem of theoretical physics nature. According to Feymann, it is the last difficult problem in classical physics, and some name it a "real Nobel prize level problem" (Falkovich, 2011). An empirical theory of Prandtl (1925) and von Karman (1930) predicted a logarithmic distribution for the mean velocity in a so-called overlap region over eighty years ago, which serves as the base of the modern computational fluid dynamics applications. Yet, no theory has been developed in its support, leaving a vivid debate between the log-law and power law since 1990s. The worse is that the coefficient in front of the log-law, a so-called Karman constant, κ, is found to vary among the three canonical wall-bounded flows (channel, pipe and turbulent boundary layer) and with Reynolds numbers (Re). Here, we discuss a new approach addressing the question in three steps. First, identify a series of order functions, including the mixing length, which describe effects of turbulent fluctuations on the mean, in analogy to order parameters in the statistical mean field theory. Secondly, discover a set of relevant dilation symmetries which predict a multi-layer structure for the order function. Finally, we propose a re-interpretation of κ as a global coefficient describing both the overlap region and outer flow. All three steps are accurately tested against empirical data from direct numerical simulations and experimental measurements. A remarkable outcome of the new approach is that $\kappa \approx 0.45$ for all canonical wall-bounded flows, independent of Re and roughness. The new theory obtains a $98 \sim 99\%$ accuracy in the description of mean velocity data for Re covering more than three decades. An intriguing problem now is: what is the stochastic process giving rise to such a turbulent flow with a multi-layer structure, the answer of which is key to the physical understanding of wall bounded turbulence and of the nature of the universal Karman constant. Joint work with Zhen-Su She and Fazle Hussain.

Turbulence models and branching random walks: some results and open problems
Ed Waymire, Oregon State University, USA
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There are numerous mathematical ways in which to frame and analyze turbulence; for example, PDE models, such as (a) incompressible Navier-Stokes equations, or purely statistical models, such as (b) random multiplicative cascades. In each case there is a role for contemporary theory of branching random walk of probabilistic interest that will be illustrated by recent results and open problems within each framework. The talk is based on collaborations with Enrique Thomann, Oregon State University, and Partha Dey, Courant Institute of Mathematical Sciences, respectively.

3.15 Inference in Stochastic Processes

Thursday, 2:00-3:30
HUMN 250

Organizer: **Gareth Roberts**, University of Warwick, UK
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Bayesian Inference for Diffusion Processes
Osnat Stramer, University of Iowa, USA
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The problem of formal likelihood-based (either classical or Bayesian) inference for discretely observed multi-dimensional diffusions is particularly challenging. In principle this involves data-augmentation of the observation data to give representations of the entire diffusion trajectory. In this talk, we provide a generic and transparent framework for data augmentation for diffusions. We introduce a generic program which can be followed in order to identify appropriate auxiliary variables, to Markov chain Monte Carlo algorithms that are valid even in the limit where continuous paths are imputed, and to approximate these limiting algorithms. We also present the Pseudo-marginal (PM) approach for Bayesian inference in diffusion models. The PM approach can be viewed as a generalization of the popular data augmentation schemes that sample jointly from the missing paths and the parameters of the diffusion volatility. The efficacy of the proposed algorithms is demonstrated in a simulation study of the Heston models, and is applied to the bivariate S&P 500 and VIX implied volatility data.

Nonparametric Bayesian inference for diffusions on the circle

Harry van Zanten, University of Amsterdam, Netherlands
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Diffusions on the circle generated by one-dimensional stochastic differential equations with periodic coefficients are used in a variety of applications, for instance to model the dynamics of angles. In this talk we will discuss recently developed methods for doing nonparametric Bayesian inference for such models. Both computational methods and theoretical results about the asymptotic performance of posterior distributions will be discussed. It will be explained how the theoretical investigations motivate the development of new limit theory for the local time of diffusions on the circle. Based on joint work with Frank van der Meulen, Yvo Pokern, Moritz Schauer, and Andrew Stuart.

Bayesian inference for Kingman's coalescent process via thinning

Vladimir Minin, University of Washington, USA
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Kingman's coalescent is a stochastic process that generates genealogies relating individuals randomly sampled from the population of interest. The coalescent model can be parameterized in terms of unknown demographic parameters, such as an effective population size trajectory, making it possible to estimate changes in the effective population size from genetic data collected from the sampled individuals. To construct such estimators, we take a Bayesian perspective and view the coalescent as a prior for latent/unobservable genealogies. Moreover, we do not want to impose a parametric form on the effective population size trajectory and propose a new Gaussian process-based Bayesian nonparametric framework for the effective sample size estimation. Unfortunately, our Bayesian model formulation results in doubly intractable posterior distribution that cannot be approximated using standard Markov chain Monte Carlo (MCMC) methods without time domain discretization. Viewing the coalescent process as a point process, we develop a new MCMC algorithm that allows us to approximate the posterior distribution of population size trajectories efficiently without discretization. Thinning — a technique for constructing point processes from other, usually simpler, point processes — is a key ingredient in our algorithm development. Using simulations, we show that our new method is more accurate and more precise than a competing Gaussian Markov random field smoothing approach that relies on a discretization of the time domain. Our analyses of population dynamics of hepatitis C and human influenza viruses demonstrate that our new method produces biologically plausible reconstructions.

3.16 Interacting Particle Systems

Friday, 2:00-3:30
HUMN 1B50

Organizer: **Márton Balázs**, Budapest University of Technology, Hungary
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Dynamics of condensation in the inclusion process
Stefan Grosskinsky, University of Warwick, UK
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The inclusion process is an interacting particle system where particles on connected sites attract each other in addition to performing independent random walks. The system has stationary product measures and exhibits condensation in the limit of strong interactions, where all particles concentrate on a single lattice site. We study the equilibration dynamics on finite lattices in the limit of infinitely many particles, which, in addition to jumps of whole clusters, includes an interesting continuous mass exchange between clusters given by Wright-Fisher diffusions. During equilibration the number of clusters decreases monotonically, and the stationary dynamics consists of jumps of a single remaining cluster (the condensate). Joint work with Frank Redig and Kiamars Vafayi.

Connections between occupation times and KPZ exponents in long-range exclusion systems
Sunder Sethuraman, University of Arizona, USA
sethuram@math.arizona.edu

Informally, the exclusion process on Z^d is a collection of random-walks which interact in that they cannot jump on to each other, a model of ‘traffic’. Starting under an invariant measure, which fills the lattice ρ percent, the time the origin is occupied by a particle up to time t has different scaling behaviors depending on the form of the jump law, the density ρ and dimension d. We will discuss some work on this problem when the jump law is long-range and make some connections with KPZ exponents. In progress with Cedric Bernardin (Lyon) and Patricia Goncalves (Minho).

Stationary Solution of 1D KPZ Equation
Bálint Vető, Universität Bonn, Germany
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The KPZ equation is believed to describe a variety of surface growth phenomena that appear naturally, e.g. crystal growth, facet boundaries, solidification fronts, paper wetting or burning fronts. In the recent years, serious efforts were made to describe the solution with different types of initial data. In the present work, we derive an explicit solution for the equation with stationary, i.e. two-sided Brownian motion initial condition. Our approach to the solution for the KPZ equation is via its representation as the free energy of a certain directed random polymer model. By providing integral formulas for the action of Macdonald difference operators, we characterize explicitly the free energy of another polymer model by giving a Fredholm determinant formula which is suitable for asymptotic analysis. In the large time limit of the solution, we recover the distribution obtained for the limiting fluctuations of the height function of the stationary totally asymmetric simple exclusion process (TASEP).

3.17 Boundary Theory

Friday, 2:00-3:30
HUMN 150

Organizer: **François Ledrappier**, University of Notre Dame, USA
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Martin boundary for random walks with unbounded jumps on hyperbolic groups
Sébastien Gouëzel, Université Rennes, France
sebastien.gouezel@univ-rennes1.fr

The identification of the Martin boundary of random walks with bounded jumps on hyperbolic groups dates back to Ancona in the 80's. It is a crucial tool to understand fine properties of such random walks. We will explain how to obtain similar results for random walks with possibly unbounded jumps (under a necessary condition of super-exponential moment). Applications to the local limit theorem will also be discussed.

Random walks on groups
Joseph Maher, CUNY Staten Island, USA
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We will discuss how to use random walks to pick generic elements of groups, and consider what properties a generic element may possess. We will be particularly interested in discrete groups with some sort of coarse negative curvature condition, such as Gromov hyperbolic groups, the mapping class groups of surfaces and $\mathrm{Out}(F_n)$. The properties of group elements we consider will include translation length and stable commutator length.

Dynamics of discrete isometric actions on infinite-dimensional Gromov hyperbolic spaces
Tushar Das, University of Wisconsin - La Crosse, USA
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We survey our ongoing work exploring infinite-dimensional models of hyperbolic space and the related dynamics of analogues of discrete isometric actions. We emphasize differences between our work and the well-developed theory generalizing the study of Kleinian groups in finite dimensions to proper Gromov hyperbolic metric spaces. New phenomena induced by the greater degrees of freedom in infinite dimensions (e.g. the lack of properness and the variety of ways to define what it means for an action to be "discrete") both force some delicacy as well as open various new lines of investigation. Highlights will include a generalization of the Bishop-Jones formula equating the Poincare exponent of the group to the Hausdorff dimensions of the uniformly-radial and radial/conical limit sets respectively, Bowen's formula from the thermodynamic formalism for Schottky groups with totally disconnected limit sets, and an extension of Patterson-Sullivan theory for groups of divergence-type. This project is joint work with David Simmons (Ohio State) and Mariusz Urbanski (North Texas). Time permitting we will also point to recent Diophantine applications by Fishman-Simmons-Urbanski.

4. Organized Contributed Sessions

4.1 Analysis of Stochastic Networks

Monday, 11:00-12:30
HUMN 250

Organizer: **Chihoon Lee**, Colorado State University, USA
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Approximating Extremely Large Networks via Continuum Limits of Markov Chains
Edwin Chong, Colorado State University, USA
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We investigate the continuum limits of a class of Markov chains, motivated by the desire to model networks with a very large number of nodes. We show that a sequence of such Markov chains indexed by N, the number of components in the system that they model, converges in a certain sense to a continuum limit, which is the solution of a partial differential equation (PDE), as N goes to infinity. We provide sufficient conditions for the convergence and characterize the rate of convergence. As an application we approximate Markov chains modeling large wireless networks by PDEs. While traditional Monte Carlo simulation for very large networks is practically infeasible, PDEs can be solved with reasonable computation overhead using well-established mathematical tools.

Dynamic scheduling for Markov modulated single-server multiclass queueing Systems in heavy traffic
Xin Liu, IMA, University of Minnesota, USA
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Queueing networks arise as models in various areas including computer systems, telecommunications, manufacturing, and service industry. One of the key objectives in the queueing network settings is to obtain “good” (or nearly optimal) control policies for scheduling, sequencing, and routing of jobs in the system. In this talk, I'll present a recent study on scheduling control problem for a single-server multiclass queueing network in heavy traffic, operating in a changing environment. The changing environment is modeled as a finite state Markov process that modulates the arrival and service rates in the system. Various cases are considered: fast changing environment, fixed environment and slow changing environment. In each of the cases, using weak convergence analysis, in particular functional limit theorems for renewal processes and ergodic Markov processes, it is shown that an appropriate “averaged” version of the classical cμ-policy (the priority policy that favors classes with higher values of the product of holding cost c and service rate μ) is asymptotically optimal for an infinite horizon discounted cost criterion.

Diffusion approximations for G/M/n+GI queues with state dependent service rates
Ananda Weerasinghe, Iowa State University, USA
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We consider a sequence of many server queueing systems with impatient customers in heavy traffic. This sequence is indexed by n, where the parameter n represents the number of servers in the n-th system. The state process is considered to be the total population in the system and the service rate is a state-depndent perturbation of a given basic service rate $\mu_0 > 0$. When the system is critically loaded in the Halfin-Whitt heavy traffic regime, we obtain the limiting diffusion for the scaled state process. We also establish the limiting relationships among diffusion-scaled processes representing the total customer count, number of customer abandonments and the virtual waiting time.

4.2 Lévy and branching processes

Monday, 11:00-12:30
HUMN 135

Organizer: **Victor Rivero**, CIMAT, Mexico
riverovm@gmail.com

Coding multitype branching forest through multidimensional random walks
Loïc Chaumont, University of Angers, France
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By extending the breadth first search algorithm to any d-type critical or subcritical irreducible branching tree, we show that such trees may be encoded through d independent, integer valued, d-dimensional random walks. An application of this coding together with a multivariate extension of the Ballot Theorem allow us to give an explicit form of the law of the total progeny, jointly with the number of subtrees of each type, in terms of the offspring distribution of the branching process.

Censored stable processes
Andreas Kyprianou, University of Bath, UK
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We look at a general two-sided jumping strictly alpha-stable process where alpha is in (0,2). By censoring its path each time it enters the negative half line we show that the resulting process is a positive self-similar Markov

Process. Using Lamperti's transformation we uncover an underlying driving Lvy process and, moreover, we are able to describe in surprisingly explicit detail the Wiener-Hopf factorization of the latter. Using this Wiener-Hopf factorization together with a series of spatial path transformations, it is now possible to produce an explicit formula for the law of the original stable processes as it first "enters" a finite interval, thereby generalizing a result of Blumenthal, Getoor and Ray for symmetric stable processes from 1961. This is joint work with Alex Watson (Bath) and JC Pardo (CIMAT).

On the extinction of Continuous State Branching Processes with catastrophes

Juan Carlos Pardo Millán, CIMAT, Mexico
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We consider continuous state branching processes (CSBP's for short) with additional multiplicative jumps, which we call catastrophes. Informally speaking, the dynamics of the CSBP is perturbed by independent random catastrophes which cause negative (or positive) jumps to the original process. These jumps are described by a Lévy process with paths of bounded variation. Conditionally on these jumps, the process still enjoys the branching property.

We construct this class of processes as the unique solution of a SDE and characterize their Laplace exponent as the solution of a backward ODE. We can then study their asymptotic behavior and establish whether the process becomes extinct. For a class of processes for which extinction and absorption coincide (including the α-stable CSBP plus a drift), we determine the speed of extinction of the process. Then, three subcritical regimes appear, as in the case for branching processes in random environments. To prove this, we study the asymptotic behavior of a certain divergent exponential functional of Lévy processes. Finally, we apply these results to a cell infection model, which was a motivation for considering such CSBP's with catastrophes.

4.3 Set-indexed processes

Monday, 2:00-3:30
HUMN 250

Organizer: **Ely Merzbach**, Bar-Ilan University, Israel
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Local regularity of SI processes

Erick Herbin, École Centrale Paris, France
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On the contrary to the one-parameter case, the set-indexed Brownian motion is known to be not continuous for some indexing collection which is not a Vapnik-Cervonenkis class. In the study of the set-indexed Lévy processes, we consider a weak form of continuity which is satisfied by the SI Brownian motion. Thanks to the Lévy-Ito decomposition, an SI Lévy process is proved to have no point mass jumps if and only if its increments are Gaussian. In the framework of Ivanoff-Merzbach, the approximation of the indexing collection by a nested sequence of finite sub-collections allows to prove a Kolmogorov-like criterion for Hölder-continuity of a set-indexed process. The localization of these previous properties leads to various definitions of Hölder exponents.The local regularity of the set-indexed fractional Brownian motion is proved to be constant, with probability one. Based on joint work with Ely Merzbach and Alexandre Richard.

First passage percolation on random geometric graphs and an application to shortest-path trees
Volker Schmidt, Ulm University, Germany
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We consider Euclidean first-passage percolation on a large family of connected fibre processes in the d-dimensional Euclidean space encompassing various well-known models from stochastic geometry. In particular, we establish a strong linear growth property for shortest-path lengths on fibre processes which are generated by point processes. This result comprehends two special cases which are of independent interest, where we consider the event that the growth of shortest-path lengths between two (end-) points of the path does not admit a linear upper bound. Our linear growth property implies that the probability of this event tends to zero sub-exponentially fast if the direct (Euclidean) distance between the endpoints tends to infinity. Moreover, the shortest-path length between two points at fixed distance admits a sub-exponential tail. Besides, for a wide class of stationary and isotropic fibre processes, our linear growth property implies a shape theorem for the Euclidean first-passage model defined by such fibre processes. Finally our shape theorem can be used to investigate a problem which is considered in structural analysis of fixed-access telecommunication networks, where we determine the limiting distribution of the length of the longest branch in the shortest-path tree extracted from a typical segment system if the intensity of network stations converges to zero. Joint work with Christian Hirsch, David Neuhaeuser and Catherine Gloaguen.

Central limit theorem for functionals of two independent fractional Brownian motions
David Nualart, University of Kansas, USA
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We present a new central limit for a two-parameter additive functional of two independent multidimensional fractional Brownian motions. The limit is a conditionally Gaussian random variable, whose variance is a multiple of the intersection local time of both processes. As it happens usually, the partial order of the two parameters makesthis problem much harder than the one-dimensional counterpart.

4.4 Probabilistic potential theory

Tuesday, 11:00-12:30
HUMN 250

Organizer: **Takashi Kumagai**, Kyoto University, Japan
kumagai@kurims.kyoto-u.ac.jp

Harnack inequalities for random walks on graphs with unbounded weights

Sebastian Andres, University of Bonn, Germany
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In this talk we consider nearest-neighbour random walks on infinite graphs, which have with a uniformly bounded vertex degree and regular volume growth and which satisfy an isoperimetric inequality. We are interested in obtaining elliptic and parabolic Harnack inequalities in the non-elliptic case, that is without assuming the jump rates of the random walk to be uniformly bounded and bounded away from zero. Due to this non-ellipticity assumption the resulting Harnack inequalities become effective only on large balls and only if the space average of the jump rates can be controlled on such large balls. For the proof we use the well-established Moser iteration technique. At the end we discuss some applications for the Random Conductance Model with a degenerate ergodic environment, in particular heat kernel bounds and a local limit theorem. Based on joint work with Jean-Dominique Deuschel and Martin Slowik (TU Berlin).

Dirichlet Heat Kernel Estimates for Symmetric Markov processes dominated by stable like processes in $C^{1,\gamma}$-open sets

Panki Kim, Seoul National University, Korea
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We discuss the behavior of transition density (Dirichlet heat kernel) for a large class of symmetric pure jump Markov processes in open subset. The jumping kernels of symmetric Markov processes we consider are dominated by the one of stable like processes. We present a recent result on the sharp Dirichlet heat kernel estimates on $C^{1,\gamma}$-open sets. Based on joint work with Kyung-Youn Kim.

Quenched invariance principles for random walks and random divergence forms in random media with a boundary

Takashi Kumagai, Kyoto University, Japan
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Via a Dirichlet form extension theorem and making full use of two-sided heat kernel estimates, we establish quenched invariance principles for random walks in random environments with a boundary. In particular, we show that the random walk on a supercritical percolation cluster or amongst random conductances bounded

uniformly from below in a half-space, quarter-space, etc., converges when rescaled diffusively to a reflecting Brownian motion. We establish a similar result for the random conductance model in a box, which allows us to improve existing asymptotic estimates for the relevant mixing time. This is a joint work with Z.Q. Chen (Seattle) and D.A. Croydon (Warwick).

4.5 Lévy driven processes

Tuesday, 11:00-12:30
HUMN 135

Organizers: **Anita Behme**, TU Munich, Germany
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Alexander Schnurr, TU Dortmund, Germany
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Exponential Functionals of Lévy Processes
Anita Behme, TU Munich, Germany
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The generalized Ornstein-Uhlenbeck (GOU) process driven by a bivariate Lévy process is widely known for its applications e.g. in finance, insurance and physics. In this talk we present the generator of the GOU process and show that GOU processes are Feller processes. Using these results, we will then gather information on the stationary distributions of GOU processes, also known as exponential functionals of Lévy processes. In particular we can show that under some regularity conditions and for independent driving Lévy processes the mapping of (the law of) one Lévy process on the corresponding (law of the) exponential functional is injective and give conditions for continuity of this mapping in a distributional sense. This is joint work with Alexander Lindner, TU Braunschweig.

Correlation Structure of Time-changed Lévy Processes
Alla Sikorskii, Michigan State University, USA
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Processes obtained by changing the time in Lévy processes to positive non-decreasing stochastic processes are useful in many applications. The use of time-changed processes in modeling often requires the knowledge of their second order properties, such as the correlation function. This paper provides the explicit expression for the correlation function for time-changed Lévy processes. The processes used to model random time include subordinators and inverse subordinators, and the time-changed Lévy processes include limits of continuous time random walks. Several examples useful in applications are discussed.

Path Properties of Lévy Driven Processes
Alexander Schnurr, TU Dortmund, Germany
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Within the past 10 years a rich variety of sophisticated models has been introduced in the area of mathematical finance which went far beyond (geometric) Brownian motion. Some of these models have in common that the underlying dynamics are given by Lévy processes. We analyze and compare path properties of different processes of this kind. We consider e.g. the well-balanced Ornstein-Uhlenbeck process and solutions of stochastic differential equations. The properties under consideration include γ-variation, growth properties and the question in which Besov spaces the paths are contained.

4.6 Stochastic processes in Bayesian analysis (Special ISBA Section)

Thursday 11:00-12:30
HUMN 150

Organizers: **Vanja Dukic**, CU Boulder, USA
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Igor Pruenster, University of Torino, Italy
igor.pruenster@unito.it

Sufficientness characterization of infinite Markov models
Sergio A. Bacallado, Stanford University, USA
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Infinite Markov models are ubiquitous in Bayesian nonparametric analyses of dynamical data. A prior distribution on a Markov chain with infinitely many states is typically defined by allowing the vectors of transition probabilities out of different states to be exchangeable, each one distributed as a Dirichlet Process or its two-parameter extension. Recently, a prior distribution over reversible Markov chains with infinitely many states was introduced, which does not have exchangeability between rows of the transition probability matrix. This model and previous Bayesian nonparametric models have in common a notion of Markov exchangeability, which is agnostic to labels on the states in the same way that exchangeable random partitions are agnostic to labels on the sets of a partition. We show that all these models can be characterized by this notion of Markov exchangeability in addition to natural conditions on the Bayesian predictive distribution. These results are related to the classic characterization of the Dirichlet distribution by W. E. Johnson and extensions thereof by Zabell and Rolles. Joint work with Lorenzo Trippa and Stefano Favaro.

Statistical models of exchangeable graphs and arrays

Peter Orbanz, Columbia University, USA
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Suppose we observe data that aggregates into a graph, or more generally, a matrix or a higher-order array. As more data becomes available, the size of the graph increases. In my talk, I will discuss the statistical problem associated with such data: To estimate the distribution of the graph or its parameters from data consisting of a single, large graph. The theory of exchangeable random graphs pioneered by Aldous, Hoover and Kallenberg and recent advances in the theory of graph limits by Lovasz and Szegedy help to explain what statistical estimation means in this setting. I will give an overview of the theory's implications for statistical estimation, and describe a specific Bayesian statistical model as an example.

Optimal filtering and the dual process

Matteo Ruggiero, University of Torino & Collegio Carlo Alberto
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We link optimal filtering for hidden Markov models to the notion of duality for Markov processes. We show that when the signal is dual to a process that has two components, one deterministic and one a pure death process, and with respect to functions that define changes of measure conjugate to the emission density, the filtering distributions evolve in the family of finite mixtures of such measures. Special cases of our framework are the Kalman filter, but also models where the signal is the Cox-Ingersoll-Ross and the one-dimensional Wright-Fisher diffusions, which have been investigated before in the literature. We also discuss an extension of these results to an infinite-dimensional signal modelled as a Fleming-Viot process, which involves finite mixtures of posterior Dirichlet processes.

4.7 Stochastic representation problems for degenerate differential operators

Thursday, 2:00-3:30
HUMN 135

Organizer: Paul Feehan, Rutgers University, USA
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Feynman-Kac formulae for solutions to degenerate elliptic boundary value and obstacle problems with Dirichlet boundary conditions

Ruoting Gong, Rutgers University, USA
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We prove stochastic representation formulae for solutions to the elliptic boundary value and obstacle problems associated with a degenerate Markov diffusion process. The degeneracy in the diffusion coefficient is proportional to the α-power of the distance to the boundary of the half-space, where $\alpha \in (0, 1)$. This generalizes the well-known Heston stochastic volatility process, which is widely used as an asset price model in mathematical finance and a paradigm for a degenerate diffusion process. The generator of this degenerate diffusion process with killing, is a second-order, degenerate-elliptic partial differential operator where the degeneracy in the operator symbol is proportional to the 2α-power of the distance to the boundary of the half-plane. Our stochastic representation formulae provide the unique solutions to the elliptic boundary value and obstacle problems, when we seek solutions which are suitably smooth up to the boundary portion Γ_0 contained in the boundary of the half-plane. In the case when the full Dirichlet condition is given, our stochastic representation formulae provide the unique solutions which are not guaranteed to be any more than continuous up to the boundary portion Γ_0.

Degenerate-parabolic partial differential equations with unbounded coefficients, martingale problems, and a mimicking theorem for Itô processes

Camelia Pop, University of Pennsylvania, USA
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We solve four intertwined problems, motivated by mathematical finance, concerning degenerate-parabolic partial differential operators and degenerate diffusion processes. First, we consider a parabolic partial differential equation on a half-space whose coefficients are suitably Hölder continuous and allowed to grow linearly in the spatial variable and which becomes degenerate along the boundary of the half-space. We establish existence and uniqueness of solutions in weighted Hölder spaces which incorporate both the degeneracy at the boundary and the unboundedness of the coefficients. Second, we show that the martingale problem associated with a degenerate elliptic differential operator with unbounded, locally Hölder continuous coefficients on a half-space is well-posed in the sense of Stroock and Varadhan. Third, we prove existence, uniqueness, and the strong Markov property for weak solutions to a stochastic differential equation with degenerate diffusion and unbounded coefficients with suitable Hölder continuity properties. Fourth, for an Itô process with degenerate diffusion and unbounded but appropriately regular coefficients, we prove existence of a strong Markov process, unique in the sense of probability law, whose one-dimensional marginal probability distributions match those of the given Itô process. This is joint work with Paul Feehan.

Martingale problems for degenerate differential operators and mimicking theorems for degenerate Itô processes

Paul M. N. Feehan, Rutgers University, USA
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In two previous articles with Camelia Pop (2012), we used a Schauder approach to prove existence of solutions to a degenerate-parabolic partial differential equation and solve three intertwined problems concerning degenerate stochastic processes. First, we showed that the martingale problem associated with a degenerate-parabolic partial differential operator with unbounded, locally Hölder continuous coefficients on a half-space is well-posed in the sense of Stroock and Varadhan. Second, we proved existence, uniqueness, and the strong Markov property for weak solutions to a stochastic differential equation with degenerate diffusion and unbounded coefficients with suitable Hölder continuity properties. Third, for an Itô process with degenerate diffusion and unbounded but appropriately regular coefficients, we proved existence of a strong Markov process, unique in the sense of probability law, whose one-dimensional marginal probability distributions match those of the given Itô process. On the one hand, our "matching marginals" result considerably strengthens the well-known "mimicking theorem" of Gyöngy (1986), by removing assumptions of boundedness and degeneracy in the diffusion coefficients and in addition obtaining uniqueness and the strong Markov property. However, we achieved those stronger conclusions at the cost of imposing rather strong Hölder continuity requirements on the coefficients of the mimicking process. In this presentation, we describe recent work which allows us to remove those undesirable Hölder continuity requirements with the aid of new viscosity and $W^{2,p}$ techniques for proving existence to degenerate-parabolic differential equations.

4.8 Recurrence and stochastic completeness

Thursday, 11:00-12:30
HUMN 135

Organizer: **Florian Sobieczky**, University of Denver, USA
florian.sobieczky@du.edu

Intrinsic metrics on graphs
Radoslaw Wojciechowski, York College, CUNY, USA
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We will introduce the notion of intrinsic metrics on graphs and discuss how these are used to reconcile certain differences between the manifold and graph settings. Specific applications to the problems of stochastic completeness, estimating the bottom of the spectrum of the Laplacian in terms of volume growth and Cheeger constants, and a Gaffney-type result on essential self adjointness will be given.

Non-explosiveness and recurrence of Markov processes
Jun Masamune, Tohoku University, Japan
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I will present new conditions for a Markov process defined on a general metric measure space to be non-explosive and recurrent. The results are derived from an analysis of the local and non-local part of the associated Dirichlet form with respect to the given distance function.

The bee in the balloon - Recurrence of random walks on growing balls
Florian Sobieczky, University of Denver, USA
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A random walk on an initially transient graph confined to balls of growing radius and reflecting boundaries is investigated with respect to recurrence. Recurrence occurs exactly for the radius growing at a rate of order less or equal to $t^{1/d}$. The result is derived independently for the delayed random walk on the d-dimensional euclidean lattice as well as for Brownian motion in R^d. This is joint work with Steven Lalley.

4.9 Discrete models in Biology

Friday, 2:00-3:30
HUMN 250

Organizer: **Rinaldo Schinazi**, CU Colorado Springs, USA
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Colored maximal branching process
Alexander Roitershtein, Iowa State University, USA
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I will discuss a limit theorem for empirical frequencies of types in a certain multi-type maximal branching process. The result shows explicitly how the initial distribution of types is modified in the long run by a mechanism of selection among competing individuals in a maximal branching process.

An empirical process interpretation of a model of species survival
Iddo Ben-Ari, University of Connecticut, USA
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I will discuss a model of species survival proposed by Guiol, Machado and Schinazi and later generalized by Michael and Volkov. In the work I will present, the model is interpreted as a variant of empirical processes, in which the sample size is random and when decreasing, samples of smallest numerical values are removed. In earlier works, it was proved that the empirical distributions converge to the sample distribution conditioned not to be below a certain threshold. I will present a functional central limit theorem for the fluctuations. This result is analogous to the classical central limit theorem for fluctuations in the Glivenko-Cantelli theorem, but unlike the classical case, the limit is not a Brownian Bridge. There exists a threshold above which the limit process is Gaussian with explicitly given covariance (this involves a Brownian Bridge, but an additional component). At the threshold the process is half-Gaussian. An interesting and somewhat nonstandard feature of this limit process is that it is not right-continuous at the threshold.

Fixed points of generating functions and strong local survival of Branching Random Walks

Fabio Zucca, Politencnio di Milano, Italy
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Survival probabilities of branching random walks can be seen as fixed points of a (possibly infinite-dimensional) generating function. In the irreducible, finite case there are at most two fixed points, but this is not true if the state space is infinite, even if the process is irreducible. This leads to many interesting relations between global survival and local survival probabilities. In particular, for a generic continuous-time branching random walk, the so-called “strong local survival” is not a monotone property with respect to the reproduction rates. This is a joint work with D. Bertacchi.

5. Contributed Sessions

5.1 Extremal laws and their properties

Monday, 11:00-12:30
HUMN 1B90

On extremal behavior of random variables observed in renewal times
Bojan Basrak, University of Zagreb, Croatia
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We consider the asymptotic extremal behavior of iid observations $X_1, X_2, \ldots$, until a random time $\tau(t)$ which is determined by a renewal process, possibly dependent on X_i's. The maximum of these observations

$$M(t) = \max_{i \leq \tau(t)} X_i \,,$$

has been studied for decades. The first advances were made already in 1960's in the relatively straightforward case of renewal process with finite mean interarrival times (Berman, 1962). Anderson (1987) was the first to study the limiting behavior of $M(t)$ in the case of renewal process with infinite mean interarrival times. More recently, his result have been extended to describe the limiting behavior of $(M(t))$ on the level of processes.

Using point processes techniques, we show how one can recover these known results and characterize asymptotic behavior of all upper order statistics in the sequence X_i until time $\tau(t)$. We also allow certain types of dependence between observations and interarrival times, relaxing the conditions previously used in the literature. Finally, we show how our approach yields some well known and apparently new results concerning e.g. the longest run of heads and the maximal sojourn time of a continuous time random walk.

Limiting distribution for maximal standardized increment of a random walk
Yizao Wang, University of Cincinnati, USA
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We investigate the limiting distribution of the largest jump over all intervals between [1,n], after standardization, of a random walk. We assume that the jump distribution has finite Laplace transform. We show that although most of the cases the limiting distribution is Gumbel, as in the Gaussian case, the normalization rates may have different orders. In particular, we distinguish 4 different cases in term of the log-Laplace transform of the jump distribution. Our results cover most widely-applied light-tailed distributions.

Arc-sine law and exponential functional of Lévy processes
Carine Bartholmé, Université Libre de Bruxelles, Belgium
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Doney (1987) proved the following distributional identity

$$\frac{S_t^\alpha}{S_t^\alpha + \widehat{S}_t^\alpha} \stackrel{(d)}{=} X_\rho,$$

where X_ρ denotes the generalized arc-sine distribution of order ρ, $S_t = \sup_{0\le s\le t}(Y_s)$ and $\widehat{S}_t = \sup_{0\le s\le t}\left(-\widehat{Y}_s\right)$, with Y a stable process of index α and positivity parameter ρ and $\widehat{Y}$ an independent copy of Y. This striking factorization of the arc-sine law in terms of the supremum of two independent stable processes was derived by random walks approximation. Thanks to a result due to Getoor (1979), a similar factorization could be easily derived involving the last passage time to the level 1 of transient Bessel processes. More precisely, if R_ν is a Bessel process, starting from 0, of dimension $2(1+\nu)$, with $\nu > 0$ and $L_1(R_\nu) = \sup\{t > 0 : R_{\nu t} = 1\}$, then, for $0 < \alpha < 1$,

$$\frac{L_1(R_{1-\alpha})}{L_1(R_\alpha) + L_1(R_{1-\alpha})} \stackrel{(d)}{=} X_\alpha.$$

We provide an unified proof and a generalization of these two apparent unconnected factorizations of the arc-sine law. This will be achieved by deriving such a factorization with exponential functional of independent Lévy processes which can be shown to be related to the variables discussed earlier. Our proof relies on a recent Wiener-Hopf type factorization of the distribution of the exponential functional of Lévy processes whose most general form can be found in Patie and Savov (2012). We will also discuss several interesting implications of this type of factorization. Joint work with Pierre Patie.

5.2 Convergence of Markov process

Monday, 11:00-12:30
HUMN 1B80

Convergence of Markov processes in the Wasserstein metric with applications to stochastic delay equations
Oleg Butkovsky, Moscow State University, Russia
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In this talk we study convergence rate to stationarity of Markov processes in the Wasserstein metric. While convergence of Markov processes in total variation is quite well understood by now, less is known about convergence in the Wasserstein metric. In the discrete time setting we prove that the Lyapunov-type drift condition and the existence of a "good" d-small set imply subgeometric convergence to the invariant measure. In the continuous time setting we obtain the same convergence rate provided that there exists a "good" d-small set and the Douc–Fort–Guillin supermartingale condition holds. This generalizes recent results of M. Hairer, J. Mattingly, M. Scheutzow (2011) and R. Douc, G. Fort, A. Guillin (2009). As an application of our results, we prove that the extended Veretennikov–Khasminskii condition is sufficient for subexponential convergence of strong solutions of stochastic functional differential equations. This research was partially supported by RFBR grant 13-01-00612a.

Transition from averaging to homogenization in cellular flows

Zsolt Pajor-Gyulai, University of Maryland, USA
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Let v be an incompressible periodic vector field on the plane of amplitude A without unbounded flow lines. We assume that the plane is divided periodically into cells, with the motion along v consisting of rotation along the closed flow lines inside each cell.

If we consider an elliptic Dirichlet problem on this backround in a domain of size of order R, then for fixed A and $R \to \infty$, homogenization methods yield the asymptotic while for fixed R and $A \to \infty$, the classical averaging theory applies.

We obtain a limit theorem for the corresponding diffusion process that will imply the asymptotics of the solution to the corresponding PDE, encompassing both the averaging and the homogenization regimes, as well as the regime where the transition between the averaging and homogenization occurs.

Joint work with Leonid Koralov.

Transformations of random walks on groups via Markov stopping times

Behrang Forghani, University of Ottawa, Canada
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We describe a new construction of a family of measures on a group with the same Poisson boundary. Our approach is based on applying Markov stopping times to an extension of the original random walk.

5.3 Applications to finance

Monday, 2:00-3:30
HUMN 1B90

Risk minimization in Lévy markets
Julius Esunge, University of Mary Washington, USA
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Our goal is to investigate the minimization of the convex risk using g-expectation, in the context of Levy markets. Our main contribution is the five-step-scheme for solving forward backward stochastic differential equations (FBSDEs, for short) for jump diffusions. It is shown that the solution obtained using the scheme minimizes the convex risk induced by the g-expectation. We also prove that whenever the five step scheme is realizable, the solution obtained is unique

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Goal achieving probabilities of mean-variance cone-contrained switch-when-safe portfolio processes
Francois Watier, Université du Quebec a Montreal, Canada
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Li and Zhou (2006) devised a switch-when-safe (SWS) financial strategy in which an investor follows an optimal mean-variance strategy up to a hitting time where the accumulated wealth may be large enough so he can, at this point, safely reinvest all of it in a risk-free bank account in order to achieve his financial target at the end of the investment horizon. They established, for an unconstrained mean-variance portfolio in a continuous-time Black-Scholes market model, that there is at least an 80% probability that the investor will meet his goal with a SWS strategy process. Surprisingly, we will show that for cone-constrained mean-variance strategies (which includes no- short selling restrictions) the 80% lower bound probability still holds. Furthermore, we will give an expression for the probability that the investor reaches his target before bankruptcy in terms of a "greediness" parameter. Joint work with C. Labbé (HEC-Montreal).

Small time expansion for local jump-diffusion models with state-dependent jump intensity and infinite activity
Yankeng Luo, Purdue University, USA
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We construct a jump-diffusion process $\{X_t\}_{t\geqslant 0}$ starting from $x \in \mathbb{R}$, solving an SDE driven by a Brownian motion and an independent pure jump process, which has state-dependent jump intensity and infinite jump activity. We prove that the equation admits a unique solution. Furthermore, under additional assumptions on the coefficients of the SDE, we obtain the second order expansion in time t of the tail distribution $\mathbb{P}[X_t \geqslant x+y]$

for $y > 0$. As an application of this expansion, we obtain the second order expansion in time t of the price of a European call option, where the stock price is modeled by the exponential of the jump-diffusion process $\{X_t\}_{t\geqslant 0}$, and a locally equivalent measure technique is applied to this model. This is a joint work with José E. Figueroa-López.

5.4 Aspects of Brownian motion

Monday, 2:00-3:30
HUMN 135

Two Brownian particles with rank-based characteristics and skew-elastic collisions
Tomoyuki Ichiba, UC Santa Barbara, USA
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We construct a two-dimensional diffusion process with rank-dependent local drift and dispersion coefficients, and with a full range of patterns of behavior upon collision that range from totally frictionless interaction, to elastic collision, to perfect reflection of one particle on the other. These interactions are governed by the left- and right-local times at the origin for the distance between the two particles. We realize this diffusion in terms of appropriate, apparently novel systems of stochastic differential equations involving local times, which we show are well posed. Questions of pathwise uniqueness and strength are also discussed for these systems. The analysis depends crucially on properties of a skew Brownian motion with two-valued drift of the bang-bang type, which we also study in some detail. These properties allow us to compute the transition probabilities of the original planar diffusion, and to study its behavior under time reversal. We shall also discuss the system through theory of excursions. This is joint work with E. Robert Fernholz and Ioannis Karatzas.

Exponential asymptotics for time-space Hamiltonians
Jian Song, University of Hong Kong
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We investigate the long time asymptotics of the exponential moment for the following time-space Hamiltonian

$$\int_0^t\int_0^t \frac{1}{|r-s|^{\alpha_0}}\gamma(B_r-B_s)dudv\,,\ t\geq 0\,,$$

where $(B_s\,, s\geq 0)$ is a d-dimensional Brownian motion and the kernel $\gamma(x)$: $\mathrm{R}^d\to[0,\infty)$ is a homogeneous function with singularity at zero. Our work is partially motivated by the studies of the short-range sample-path intersection, the strong coupling polaron and the parabolic Anderson models with a time-space fractional white noise potential.

Brownian motions on Heisenberg groups and related transformations
Jing Wang, Purdue University, USA
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In this talk we show that stereographic projection from the Heisenberg group H_{2n+1} to the CR sphere S_{2n+1} transforms the Brownian motion paths on H_{2n+1} to the Brownian motion paths on S_{2n+1} conditioned to hit the center of the stereographic projection at an exponential time with parameter n^2. As a by-product we give an interpretation of the Kelvin transform of the Brownian motion on H_{2n+1}.

5.5 Ergodicity and mixing

Monday, 2:00-3:30
HUMN 1B80

Mixing time of random walk Metropolis chains on the hypercube
Winfried Barta, George Washington University, USA
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We consider the random walk Metropolis algorithm for a class of unimodal and radially symmetric distributions on the hypercube $\{0,1\}^n$. This algorithm specifies an ergodic Markov chain that converges to the specified distribution on the hypercube. We study the convergence rate or mixing time of this Markov chain. Under a smoothness condition on the given stationary distribution, we establish cutoff of order $n \log(n)$ for the chain in this class of distributions. The proof relies on coupling and a projection to a two-dimensional Markov chain that only records the number of ones and the Hamming distance to the starting state. Mixing of these two features is necessary and sufficient for mixing of the underlying chain on the hypercube. In general, these two features mix at different rates, and the slower of the two determines the mixing time of the underlying chain.

Stabilization by noise and the existence of optimal Lyapunov functions
David Herzog, Duke University, USA
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With broad interests in mind, we discuss certain, explosive ODEs in the plane that become stable under the addition of noise. In each equation, the process by which stabilization occurs is intuitively clear: Noise diverts the process away from any instabilities in the underlying ODE. However, in many cases, proving rigorously this phenomenon occurs has thus far been difficult and the methods used to do so seem rather ad hoc. Here we present a general, novel approach to showing stabilization by noise and apply it to these examples. We will see that the methods used streamline existing arguments as well as produce optimal results, in the sense that they help uncover "optimal" Lyapunov functions.

Multiplicative ergodic theorem for discontinuous random dynamical systems
Huijie Qiao, Southeastern University, China
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Motivated by studying stochastic systems with non-Gaussian Lévy noise, spectral properties for linear discontinuous cocycles are considered. These linear cocycles have countable jump discontinuities in time. A multiplicative ergodic theorem is proved for such linear cocycles. Then, the result is illustrated for a linear stochastic system with general Lévy motions. Finally, Lyapunov exponents are considered for linear stochastic differential equations with α-stable Lévy motions.

5.6 Percolation and related models

Tuesday, 11:00-12:30
HUMN 1B80

Percolation in contact processes: sharpness, robustness, and applications to vegetation patterns
J. E. Björnberg, Uppsala Universitet, Sweden
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The contact process, introduced by Harris in the 1970's, provides a natural framework to model processes such as the spread of disease or vegetation. It possesses a phase transition: depending on the parameters, the upper invariant measure (limit distribution obtained when initially all 'sites' are 'infected') is trivial or nontrivial.

We study versions of the contact process with 2 or 3 states, and with spontaneous infections occurring as a function of the particle density. Motivated by a model for vegetation patterns in arid landscapes, we focus on *percolation* under invariant measures of such processes. For the 2-state process we prove that the percolation transition is *sharp*, and the same holds for the 3-state process under a reasonable assumption. This is shown to contradict a form of 'robust critical behaviour' suggested in a recent paper in *Nature*.

This is joint work with Rob van den Berg (CWI, Amsterdam) and Markus Heydenreich (Leiden).

Critical mean field frozen percolation and the multiplicative coalescent with linear deletion
Balázs Ráth, University of British Columbia, Canada
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The mean field frozen percolation process is a modification of the dynamical Erdős-Rényi random graph process on n vertices: edges appear with rate $1/n$ and connected components of size k are deleted with rate $\lambda(n) \cdot k$. It is known that if $1/n \ll \lambda(n) \ll 1$ then the model exhibits self-organized criticality: the component size statistics for any $t \geq 1$ have the same power-law decay as the Erdős-Rényi graph at $t = 1$.

The aim of the present talk is to describe the results of our upcoming joint paper with James Martin (Oxford) in which we show that if we choose $\lambda(n) = \lambda \cdot n^{-1/3}$, then for any fixed $t \geq 1$ the scaling limit of the process of the ordered sequence of component sizes at time $t + s \cdot n^{-1/3}$, $s \in \mathbb{R}$ can be identified as a modification of Aldous' multiplicative coalescent process where components of size x are deleted with rate λx. Somewhat surprisingly, the limit process is stationary for any $t > 1$.

Bootstrap percolation on the Hamming torus
David Sivakoff, Duke University, USA
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The Hamming torus of dimension d is the graph with vertices $1, ..., n^d$ and an edge between any two vertices that differ in a single coordinate. Bootstrap percolation with threshold θ starts with a random set of open vertices, to which every vertex belongs independently with probability p, and at each time step the open set grows by adjoining every vertex with at least θ open neighbors. We assume that n is large, d and θ are fixed, and that p scales as $n^{-\alpha}$ for some $\alpha > 1$, and study the probability that an i-dimensional subgraph ever becomes open. For some parameter values we can compute the critical exponent, α, exactly, and even compute the spanning probability in the critical window, while for other parameter values we give bounds on the critical exponents. Joint work with Janko Gravner, Christopher Hoffman and James Pfeiffer.

5.7 Time series and inference

Tuesday, 11:00-12:30
HUMN 1B90

Parameter estimation methods for reflected fractional Ornstein-Uhlenbeck processes

Chihoon Lee, Colorado State University, USA
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The reflected fractional Ornstein-Uhlenbeck (RFOU) process arises as the key approximating process for stochastic flow systems with reneging customers/jobs. Our aim is to statistically estimate the key parameters of the system based on the (partially) observed data. We derive the explicit formulas for the standard and sequential maximum likelihood estimators, and their asymptotic/nonasymptotic properties. Our analysis is based on the fractional Girsanov formulas and fundamental martingales for the fractional Brownian motions. This is joint work with Jian Song.

A Bayesian framework for functional time series analysis

Giovanni Petris, University of Arkansas, USA
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We present a framework for Bayesian functional time series analysis, based on the extension of the classical Dynamic Linear Model to Banach space-valued observations and states. We define a general Functional Dynamic Linear Model and we show how inference on future observations and hidden states can be performed, conditional on any unknown model parameters. Inferences that include unknown parameters can be performed using standard Markov chain Monte Carlo techniques. Examples and open problems will conclude the presentation.

Bounded area tests for comparing the dynamics between ARMA processes

Ferebee Tunno, Arkansas State University, USA
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We present a new test for discerning whether or not two independent autoregressive moving average (ARMA) processes have the same autocovariance structure. This test utilizes a specific geometric feature of a time series plot - namely, the area bounded between the line segments that connect adjacent points and the time axis. It will be shown that if you sample two ARMA processes and calculate the magnitudes of the two resulting bounded areas, then a significant difference among these areas tends to imply a significant difference in autocovariances.

5.8 Lévy and stable processes

Tuesday, 2:00-3:30
HUMN 250

The hitting time of zero for a stable process
Alexey Kuznetsov, York University, Canada
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It is known that any α-stable Levy process will hit zero in a finite time a.s., provided that the parameter α is greater than one. The first hitting time is an important object: for example, its distribution can give us the entrance law of the excursions of the stable process from zero. The distribution of the first hitting time was known explicitly only in two special cases: when the process is symmetric or has one-sided jumps. We compute the distribution of the first hitting time for a general asymmetric stable process. Our approach is based on a mix of analytical and probabilistic techniques, such as Lamperti-Kiu transformation, exponential functionals of Markov additive processes, complex analytical methods and Diophantine approximations. This talk is based on joint work with A.E. Kyprianou, J.C. Pardo and A.R. Watson.

Dirichlet heat kernels and exit times for rotation invariant Lévy processes
Michal Ryznar, Wroclaw University of Technology, Poland
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In this talk I will consider a Lévy rotation invariant process killed after exiting a smooth domain. Under some weak scaling assumptions about the symbol of the process some estimates of the distribution of the exit time will be presented. Next, sharp estimates of the transition density of the killed process will be described, usually for small values of time. Under global scaling conditions for the symbol, for some special domains as balls and complements of balls, the obtained estimates are very sharp and they show clear dependence on the size of the domain. In particular they apply to subordinate Brownian motions for which many results of the above type were obtained recently. Even in this case our results are more general then existing ones. The talk is based on joint work with Krzysztof Bogdan and Tomasz Grzywny.

Trace estimates for relativistic stable processes
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We study the asymptotic behavior, as the time t goes to zero, of the trace of the semigroup of a killed relativistic α-stable process in bounded $C^{1,1}$ open sets and bounded Lipschitz open sets. More precisely, we establish the asymptotic expansion in terms of t of the trace with an error bound of order $t^{2/\alpha}t^{-d/\alpha}$ for $C^{1,1}$ open sets and of order $t^{1/\alpha}t^{-d/\alpha}$ for Lipschitz open sets. Compared with the corresponding expansions for stable processes, there are more terms between the orders $t^{-d/\alpha}$ and $t^{(2-d)/\alpha}$ for $C^{1,1}$ open sets, and, when $\alpha \in (0, 1]$, between the orders $t^{-d/\alpha}$ and $t^{(1-d)/\alpha}$ for Lipschitz open sets.

5.9 Stochastic PDE

Tuesday 2:00-3:30
HUMN 135

Localization and ageing in the parabolic Anderson model
Nadia Sidorova, University College London, UK
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The parabolic Anderson problem is the Cauchy problem for the heat equation on the d-dimensional integer lattice with random potential. It describes mass transport through a random field of sinks and sources and is being actively studied by mathematical physicists. One of the most important situations is when the potential is time-independent and is represented by a collection of independent identically distributed random variables. We discuss the intermittency effect occurring for such potentials and consisting in increasing localization and randomization of the solution. We also discuss the ageing behaviour of the model showing that the periods, in which the profile of the solutions remains nearly constant, are increasing linearly over time.

Pathwise uniqueness of the stochastic heat equations with spatially inhomogeneous white noise
Eyal Neuman, Technion, Israel
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We study the solutions of the stochastic heat equation with spatially inhomogeneous white noise:

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

Here Δ denotes the Laplacian and $\sigma(t,x,u) : \mathbb{R}_+ \times \mathbb{R}^2 \to \mathbb{R}$ 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 $\mathbb{R}_+ \times \mathbb{R}$. 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 the above 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.

Gaussian bounds for the spatially homogeneous Landau equation for Maxwellian molecules
Eulalia Nualart, University Pompeu Fabra, Spain
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We will introduce the spatially homogeneous Landau equation for Maxwellian molecules, widely studied by Villani and Desvillettes, among others. It is a non-linear partial differential equation where the unknown function is the density of a gas in the phase space of all positions and velocities of particles. This equation is a common kinetic model in plasma physics and is obtained as a limit of the Boltzmann equation, when all the collisions become grazing. We will first recall some known results. Namely, the existence and uniqueness of the solution to this PDE, as well as its probabilistic interpretation in terms of a non-linear diffusion due to Guérin. We will then show how to obtain Gaussian lower and upper bound for the solution via probabilistic techniques. Joint work with François Delarue and Stéphane Menozzi.

5.10 Models from Math Physics

Tuesday, 2:00-3:30
HUMN 1B80

The critical curve of the Copolymer Model at weak coupling
Quentin Berger, University of Southern California, USA
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We will present the Copolymer Model introduced by Sinai, used to describe a heteregeneous polymer chain (say composed of hydrophilic or lipophilic monomers) lying at the interface between two solvents (say water and oil). When increasing the temperature, one observes a localization/delocalization phase transition: at low temperature, the polymer stays close to the interface to maximize the matches, whereas at high temperature, it wanders in one of the two solvents. We focus here on the critical curve, that separates the two regimes in this phase transition. In particular, we study its weak coupling limit, which is known to be universal. The value of the limit has however been subject to discussions, leading to contradictory conjectures. The result we will present is that we are actually able to compute the limit, under the assumption that the underlying return distribution has a power-law tail with finite mean. Joint work with F. Caravenna, J. Poisat, R. Sun, N. Zygouras

Relating variants of SLE using the Brownian loop measure
Laurie Field, University of Chicago, USA
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In this talk I will discuss a framework for transforming one variant of the SchrammLoewner evolution (SLE) into another. The main tool in this approach is the Brownian loop measure. A simple case is to relate the reversal of radial SLE to whole-plane SLE, which looks the same locally. Writing the formula one might navely expect fails, because the loop measure term is infinite. In joint work with Greg Lawler, we show that there is a finite normalized version of the loop measure term, and that with this change, the nave formula relating the two SLEs becomes correct.

The dynamics of a Brownian particle using the small mass approximation for state dependent friction
Scott Hottovy, University of Arizona, USA
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A small particle with diameter on the order of nano-meters to micrometers undergoes random motion when in a fluid. The motion is described by a stochastic Newton equation, using stochastic differential equations (SDE), relating acceleration with the forces acting on the particle with the Langevin equation. Experimentally, the motion of the particle is of interest on the long diffusion time scale. However, there are multiple short time scales that, if averaged in the wrong order, lead to different dynamics. Therefore, valid approximations to the SDE are useful for applications. One such approximation is the small mass, also called the Smoluchowski-Kramers, approximation. I will describe a new way to identify and prove this limit for systems with arbitrary state-dependent friction and give applications of this theorem to systems of experimental interest.

5.11 Applications to Biology

Tuesday, 2:00-3:30
HUMN 1B90

Mixed-Mode Oscillations in FitzHugh Nagumo model
Damien Landon, University of Bourgogne, France
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We present some results around the FitzHugh-Nagumo equation. This equation describe the membrane potential of neurons and is a simplification of Hodgkin-Huxley equation. The general model is a slow-fast system of stochastic differential equations:

$$\begin{cases} \varepsilon dx_t = \left(x_t - \dfrac{x_t^3}{3} + y_t \right) dt + \sqrt{\varepsilon}\sigma_1 \, dW_t^{(1)} \\ dy_t = (\alpha - \beta x_t - \gamma y_t) \, dt + \sigma_2 \, dW_t^{(2)} \end{cases}$$

Here x is the fast variable and represents the membrane potential, y is the slow variable, α, β and γ are parameters such that we have a single equilibrium point, ε is a small positive parameter ($\varepsilon << 1$), σ_1 and σ_2 are a small positive parameter ($\sigma << 1$) representing the noise amplitude of the two independent standard Brownian Motions $W_t^{(1)}$ and $W_t^{(2)}$.

Studying the case of deterministic equation associated to the stochastic system, according to the value of the parameters α, β and γ, we demonstrate different behaviors in the neighborhood of the Hopf bifurcation point When we add noise, we observe three different main regimes following the value of the parameters and we observe alternation between small and large oscillations. We obtain an approximation of its dependence on the system's parameters for a large range of noise intensities. This yields a precise description of the probability distribution of observed mixed-mode patterns and interspike intervals.

The interspike time interval is related to the random number of small-amplitude oscillations separating consecutive spikes, which correspond to large oscillations. We prove that this number has an asymptotically geometric distribution, whose parameter is related to the principal eigenvalue of a substochastic Markov chain. We provide rigorous bounds on this eigenvalue in the small-noise regime.

Joint work with João P. Hespanha (UCSB) and Mustafa Khammash (ETH Zürich).

Statistical Inference for Random Walk in Random Environment and applications to DNA unzipping
Dasha Loukianova, Evry University, France
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During the last two decades, new statistical data emerged from DNA unzipping experiments, in which the two strands of the molecule are pulled apart, e.g. with a constant velocity, and the signal measured, e.g. the force, while breaking successive nucleotides bonds pairs is recorded. The simplified mathematical model of the DNA unzipping is a one-dimensional nearest-neighbor RWRE. The observation of the trajectory of this RWRE gives information on both biophysical properties of the molecule and its composition. In this talk we give an overview of this model. For a transient RWRE we estimate the parameter of the random environment by Maximum Likelihood Estimator (MLE). Using the link between RWRE and Branching Process with Immigration in a Random Environment we show the consistency and the normal limit for the MLE. We apply these results to the estimation of free energies of nucleotides bonds pairs.

Equilibrium distributions of simple biochemical reaction systems for time-scale separation in stochastic reaction networks
Bence Mélykúti, University of Freiburg, Germnay
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We study the equilibrium distribution of continuous-time Markov processes on simple, discrete state spaces. The motivation is that these Markov processes model important biochemical motifs, such as enzymatic reactions and ones that play roles in the control of gene expression.

Many biochemical reaction networks are inherently multiscale in time and in the counts of participating molecular species. A standard technique to treat different time scales in the stochastic kinetics framework is averaging or quasiequilibrium analysis: it is assumed that the fast dynamics reaches its equilibrium distribution on the time scale where the slowly varying molecular counts are unlikely to have changed. I derive analytic equilibrium distributions for various simple biochemical systems. These can be directly inserted into simulations of the slow time-scale dynamics. They also provide insight into the stimulus-response of these systems. Among the models there is the cooperative binding of two ligands to a macromolecule, or equivalently, the cooperative binding of two transcription factors to a gene. This gene regulation mechanism is compared to the cases of the binding of single transcription factors to one gene or to multiple copies of a gene, and to the case of the binding of single dimer transcription factors that first have to form from monomers. The calculation for dimer transcription factors rests on product-form stationary distributions and uses complex analysis, the saddle-point method.

Joint work with João P. Hespanha (University of California, Santa Barbara) and Mustafa Khammash (ETH Zürich).

5.12 Branching processes

Wednesday, 11:00-12:30
HUMN 250

Critical branching Brownian motion with absorption
Jason Schweinsberg, UC San Diego, USA
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We consider critical branching Brownian motion with absorption, in which there is initially a single particle at $x > 0$, particles move according to independent one-dimensional Brownian motions with the critical drift of negative the square root of 2, and particles are absorbed when they reach zero. Kesten (1978) showed that almost surely this process eventually dies out. Here we obtain upper and lower bounds on the probability that the process survives until some large time t. These bounds improve upon results of Kesten (1978), and partially confirm nonrigorous predictions of Derrida and Simon (2007). We will also discuss results concerning the behavior of the process before the extinction time, as x tends to infinity. We estimate the number of particles in the system at a given time and the position of the right-most particle, and we obtain asymptotic results for the configuration of particles at a typical time. Based on joint work with Julien Berestycki and Nathanael Berestycki.

A Lamperti type representation for continuous branching processes with immigration

Maria Emilia Caballero, UNAM, Mexico
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We construct a Lamperti type representation of continuous-state branching processes with immigration by solving a random ordinary differential equation driven by a pair of independent Lévy processes. Stability of the solutions is studied and we give, in particular, limit theorems (of a type previously studied by Grimvall, Kawazu and Watanabe, and Li) and a simulation scheme for these processes. Joint work with J.L Prez and G. Uribe Bravo.

The emergence of branching in Hastings-Levitov type random clusters

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In 1998 Hastings and Levitov proposed a one-parameter family of models for planar random growth in which clusters are represented as compositions of conformal mappings. This family includes physically occurring processes such as diffusion-limited aggregation (DLA), dielectric breakdown and the Eden model for biological cell growth. In the simplest case of the model (corresponding to the parameter alpha=0), James Norris and I showed how the Brownian web arose in the limit resulting from small particle size and rapid aggregation. In particular this implied that beyond a certain time, all newly aggregating particles share a single common ancestor. I shall show how small changes in alpha result in the emergence of branching structures within the model so that the beyond a certain time, the number of common ancestors is a random number whose distribution can be obtained. Based on joint work with Fredrik Johansson Viklund (Columbia) and Alan Sola (Cambridge).

5.13 Large Deviations

Wednesday, 11:00-12:30
HUMN 135

Large deviations for random walks in a random environment on a strip
Jonathan Peterson, Purdue University, USA
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We consider large deviations of random walks in a random environment on the strip $\mathbb{Z} \times \{1, 2, \ldots, d\}$. Large deviations for random walks in random environments have been studied in a variety of different types of graphs, but only in the one-dimensional nearest-neighbor case is there a known variational formula relating the quenched and averaged rate functions. We will generalize the argument for the one-dimensional case to that of a strip of finite width and prove quenched and averaged large deviation principles with a variational formula relating the two rate functions. The main novelty in our approach will be to use an idea of Furstenburg and Kesten to obtain probabilistic formulas for the limits of certain products of random matrices.

Large deviations for mean field interacting particle systems
Wei Wu, Brown University, USA
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We establish a large deviation principle (LDP) for the empirical measure process of a general class of finite state mean field interacting particle systems. The applications cover various mean field Markov dynamics in statistical mechanics and queueing systems. One highlight of our proof is it applies to models that allow simultaneous jumps of particles, which is novel in the literature of LDPs for weakly interacting processes. Under some mild additional conditions, we also establish a locally uniform refinement of LDP. Based on joint work with Paul Dupuis and Kavita Ramanan.

Viscosity characterization of the quasipotential for reflected diffusions
Marty Day, Virginia Tech, USA
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Consider a diffusion with constant drift and diffusion coefficients, constrained to the nonnegative orthant by a Skorokhod reflection mechanism on the faces of the orthant. Subject to a stability condition the equilibrium distribution satisfies a large deviation principle with respect to spacial scaling. The rate function $V(x)$ is the analogue of the Wentzel-Freidlin quasipotential in the presence of reflecting boundaries. We discuss the characterization of $V(x)$ as the viscosity solution to a Hamilton-Jacobi equation with boundary conditions. It is the formulation of these boundary conditions, and the formulation of a uniqueness result which is the new contribution of this work, joint with Kasie Farlow. The results have been completely proven in two dimensions, but only in part for higher dimensions.

5.14 Random graphs and trees

Wednesday, 11:00-12:30
HUMN 1B80

Clustering in random geometric graphs on hyperbolic spaces
Elisabetta Candellero, University of Birmingham, UK
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In this talk we introduce the concept of random geometric graphs on hyperbolic spaces and discuss its applicability as a model for social networks. In particular, we will discuss issues that are related to clustering, which is a phenomenon that often occurs in social networks: two individuals that have a common friend are somewhat more likely to be friends of each other. We give a mathematical expression of this phenomenon and explore how this depends on the parameters of our model. (This is a joint work with Nikolaos Fountoulakis).

Cascades on random trees
Wioletta Ruszel, TU Delft, Netherlands
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Inspired by experiments in neuroscience studying self-organized critical behavior in the brain we study the abelian sandpile model on a random binary and binomial tree. Using a transfer matrix approach introduced by Dhar & Majumdar, we prove exponential decay of correlations, and in a small supercritical region (i.e., where the branching process survives with posi- tive probability) exponential decay of avalanche sizes. This shows a phase transition phenomenon between exponential decay and power law decay of avalanche sizes. Finally we discuss some extensions to sandpile models on Galton-Watson trees.

On rate of convergence in the central limit theorem for weights of minimal spanning trees
Sanchayan Sen, New York University, USA
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Kesten and Lee (1996) proved that the total weight of minimal spanning trees on the complete graph on random points arising from a Poisson process and i.i.d. Uniform observations on subsets of $\mathbb{R}^d$ satisfy a central limit theorem. In this paper we prove upper bounds on the speed at which the convergence to normality takes place when the configuration arises from a Poisson process. We also consider subsets of the lattice $\mathbb{Z}^d$ having i.i.d. edge weights and obtain upper bounds on the distance between the law of appropriately normalized weight of the minimal spanning tree and the normal distribution. This is joint work with Sourav Chatterjee.

5.15 Optimal stopping and control

Wednesday, 11:00-12:30
HUMN 1B90

Continuous-time importance sampling for Jump diffusions
Sylvain Le Corff, University of Warwick, UK
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We introduce a new algorithm to sample from continuous-time jump diffusions and to estimate expectations of functionals of such diffusions. Simulation and inference for jump diffusions are challenging tasks due to the intractability of some basic quantities related to diffusions such as transition probabilities. A common approach is to use a discretization scheme (*e.g.* Euler or Milstein schemes) to obtain independent draws approximately distributed as the target process. However, every discretization procedure introduces a systematic bias which vanishes only when the number of discretization steps grows to infinity.

Recently, new exact algorithms have been proposed to draw samples from finite-dimensional distributions of diffusion processes without any discretization step. These algorithms are based on a rejection sampling procedure and draw skeletons at some random time steps. These techniques have also been extended to the case of jump diffusions. However, these exact methods rely on strong assumptions such as the reducibility to a unit-volatility jump diffusion using the Lamperti transform. While this assumption can be proved under mild assumptions for scalar diffusions, much stronger conditions are required in the multidimensional case.

In this contribution, we introduce a new algorithm to compute unbiased estimates of expectations of functionals of jump diffusions which can be used under weaker assumptions. This Jump Continuous Importance Sampling (JCIS) algorithm draws weighted skeletons using an importance sampling mechanism recently introduced for diffusion processes. In this case, the sampled paths are not distributed as the diffusion process but the weighted samples can be used to produce unbiased Monte Carlo estimates. The JCIS algorithm is compared to several other algorithms (Euler scheme with thinned jumps, Multilevel Monte Carlo path simulation, Jump Exact algorithm) using different models (Merton model, Sinus model, Double Jump model).

Optimal Stopping for Hybrid Diffusions
Andrzej Korzeniowski, UT-Arlington, USA
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We consider Itô Processes whose drift and diffusion coefficients are driven by continuous time finite state Markov chain. Optimal stopping times and regions are derived for killed processes on infinite time horizon. Examples will illustrate closed form solutions, related computational aspects, and applications to finance.

On a zero-sum game of stopping and control
Adriana Ocejo, University of Warwick, UK
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Consider a pair (X,Y) of processes, where X solves (in the strong sense) the equation $dX = a(X)YdB$ driven by a Brownian motion and Y is an autonomous diffusion with a drift controlled by a predictable process π. We study a zero-sum game in which the maximizer chooses a stopping rule τ to maximize the expected payoff $\mathbb{E}e^{-\alpha\tau}g(X_\tau)$, whereas the minimizer chooses a control π and seeks to minimize this expectation. The function g is assumed to be continuous and $\alpha \geq 0$ is a constant. We show the existence of a saddle point using the Bellman principle as well as a monotonicity condition of the value function for a certain two-dimensional optimal stopping problem, corresponding to the value of a zero-sum game when the set of controls π is a certain singleton.

5.16 Random discrete structures

Thursday, 11:00-12:30
HUMN 1B80

Fluctuations of Martingales and Winning Probabilities of Game Contestants
David Aldous, UC Berkeley, USA
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Within a contest there is some probability $M_i(t)$ that contestant i will be the winner, given information available at time t, and $M_i(t)$ must be a martingale in t. Assume continuous paths, to capture the idea that relevant information is acquired slowly. Provided each contestant's initial winning probability is at most b, the optional sampling theorem tells us, without needing further model specification, the expectations of the random variables N_b = number of contestants whose winning probability ever exceeds b, and D_{ab} = total number of downcrossings of the martingales over an interval $[a, b]$. The distributions of N_b and D_{ab} do depend on further model details, and we study how concentrated or spread out the distributions can be. The extremal models for N_b correspond to two contrasting intuitively natural methods for determining a winner: progressively shorten a list of remaining contestants, or sequentially examine contestants to be declared winner or eliminated. The talk will emphasize the pedagogical aspect of this topic, in that it can be illustrated with data (e.g. prediction markets) and can be discussed at many different levels: in a general-audience talk, in an undergraduate stochastic processes course, in a graduate course on continuous martingales, as solved research problems, or as open research problems. Joint with Mykhaylo Shkolnikov.

Lévy-Itô representations for partition-valued Markov processes

Harry Crane, Rutgers University, USA
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I will discuss a Lévy-Itô type characterization of the jump measure of exchangeable Feller processes on the space of set partitions with a bounded number of blocks. Such processes arise naturally in certain population genetics applications. Intuitively, the representation can be viewed as a multi-dimensional version of Kingman's paintbox representation. On the other hand, the decomposition resembles analogous characterizations of the jump rates of exchangeable coalescent and fragmentation processes (à la Bertoin and Pitman). By projecting to the simplex, we also establish a clear connection between the paths of discrete-time chains and products of i.i.d. random matrices, which we can exploit to study convergence rates of these Markov chains.

Probabilistic and combinatorial aspects of the card-cyclic to random insertion shuffle

Ross Pinsky, The Technion, Israel
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Consider a permutation $\sigma \in S_n$ as a deck of cards numbered from 1 to n and laid out in a row, where σ_j denotes the number of the card that is in the j-th position from the left. We study some probabilistic and combinatorial aspects of the shuffle on S_n defined by removing and then randomly reinserting each of the n cards once, with the removal and reinsertion being performed according to the original left to right order of the cards. The novelty here in this nonstandard shuffle is that every card is removed and reinserted exactly once. The bias that remains turns out to be quite strong and possesses some surprising features.

5.17 Heat kernels and Malliavin Calculus

Thursday, 11:00-12:30
HUMN 1B90

Two-sided bounds for the Dirichlet heat kernel on inner uniform domains
Janna Lieri, University of Bonn, Germany
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I will present sharp two-sided bounds for the heat kernel in domains with Dirichlet boundary condition. The domain is assumed to satisfy an inner uniformity condition. This includes any convex domain, the complement of any convex domain in Euclidean space, and the interior of the Koch snowflake. The heat kernel estimates hold in the abstract setting of metric measure spaces equipped with a (possibly non-symmetric) Dirichlet form. The underlying space is assumed to satisfy geometric conditions like a Poincare inequality and volume doubling. For instance, the results apply to the Dirichlet heat kernel associated with a divergence form operator with bounded measurable coefficients and symmetric, uniformly elliptic second order part.

Smoothness properties for some infinite-dimensional heat kernel measures
Tai Melcher, University of Virginia, USA
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Smoothness is a fundamental principle in the study of measures on infinite-dimensional spaces, where an obvious obstruction to overcome is the lack of an infinite dimensional Lebesgue or volume measure. Canonical examples of smooth measures include those induced by a Brownian motion, both its end point distribution and as a real-valued path. More generally, any Gaussian measure on a Banach space is smooth. Heat kernel measure is the law of a Brownian motion on a curved space, and as such is the natural analogue of Gaussian measure there. We will discuss some recent smoothness results for these measures on certain classes of infinite-dimensional groups, including in some degenerate settings. Joint work with Fabrice Baudoin, Daniel Dobbs, and Masha Gordina.

Asymptotic behavior of densities for stochastic functional differential equations
Atsushi Takeuchi, Osaka City University, Japan
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Consider stochastic functional differential equations depending on the past histories. Under the uniform ellipticity on the diffusion coefficients, the solution admits a smooth density with respect to the Lebesgue measure. In this talk, we shall study the large deviations for the family of the solution process, and the asymptotic behavior of the density.

5.18 Particle systems

Thursday, 2:00-3:30
HUMN 1B80

Local and global survival for frog models on Z
Daniela Bertacchi, Universitá di Milano, Italy
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We consider the frog model on Z where at time 0 there is an active particle at 0 and at each $n \geq 1$ there is an inactive particle. Particles become active when hit by another active particle. Once activated, the particle starting at n performs an asymmetric, translation invariant, nearest neighbor random walk with left jump probability l_n. We give conditions for global survival, local survival and infinite activation both in the case where all particles are immortal and in the case where particles have geometrically distributed lifespan (with parameter p_n depending on the starting location of the particle). As an application, we describe completely the phase diagram in the cases $1/2 - l_n \sim \pm n^{-\alpha}$ and $1 - p_n \sim n^{-\beta}$ (where $\alpha, \beta > 0$). From a joint work with Fabio Prates Machado and Fabio Zucca.

The current distribution of the Zero-Range Process by the Bethe ansatz
Eunghyun Lee, Centre de Recherches Mathématiques, Canada
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The Zero-Range Process (ZRP) is a continuous-time Markov process of particles on $\mathbb{Z}$. The dynamics of particles is in general defined by the *rate* function $g(\eta_i(t))$ where $\eta_i(t)$ is the number of particles at site i at time t. Given a special condition that the *rate* function is written as a q-bracket, we provide the transition probability of the N-particle ZRP on $\mathbb{Z}$ which is represented by contour integrals with *nested* contours. By using this formula, provided the initial configuration, we find the probability distribution for the leftmost occupied position at time t. For a special initial configuration this probability distribution is written as the contour integral of a determinant. Joint work with Marko Korhonen.

Scaling limits of certain exclusion processes
Mykhaylo Shkolnikov, UC Berkeley, USA
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We show the convergence to the appropriate scaling limits for the multilevel version of the totally asymmetric simple exclusion process (TASEP) and certain asymmetric exclusion processes with speed change. The corresponding continuum objects are identified with the process of interlacing Dysons Brownian motions and the collection of elastically colliding Brownian particles with unequal masses, respectively. The results rely on a detailed study of some recent generalizations of the classical Skorokhod map. The talk will be based on joint works with Vadim Gorin, Ioannis Karatzas and Soumik Pal.

5.19 Processes with long range dependence

Thursday, 2:00-3:30
HUMN 1B90

Maximum loss for fractional Brownian motion
Mine Çağlar, , M. Koc University, Turkey
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The maximum loss can be defined as the maximum decrease from the higher values to the lower values of a real-valued process. There exist recent results on the maximum loss for Brownian motion over fixed time intervals. We find bounds on the expectation and the distribution of the maximum loss for fractional Brownian motion with $H > 1/2$. Asymptotically, we show that the tail of the distribution over $[0, t]$ behaves like the tail of the marginal distribution at time t. These results are valid also for fractional Brownian motion with drift. On the other hand, the loss process itself is self-similar and has the same marginal distribution as the supremum when there is no drift. Joint work with Ceren Vardar

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Fractional Poisson fields
Ely Merzbach, Bar-Ilan University, Israel
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There are essentially four different approaches to the concept of Fractional Poisson process on the real line: The "integral representation" method follows the integral representation of the Fractional Brownian motion, replacing the Brownian motion by the Poisson process (Wang, Wen, Zhang). Another approach that we can call the "Renewal" approach consists of considering the characterization of the Poisson process as a sum of independent non-negative random variables, and relaxing the assumption that these random variables have an exponential distribution (assuming instead they have the Mittag-Leffler distribution) (Mainardi, Gorenflo, Scalas). A third approach, the "differential" one, uses the differential equations of the Poisson process and replaces them by fractional derivatives (Beghin-Orsingher). Finally, using "inverse subordinator", a kind of Fractional Poisson process can be constructed (Meerschaert, Nane, Vellaisamy). Here, we will follow the fourth method to generalize and define a Fractional Poisson field parameterized by points by the Euclidean space $\mathbb{R}^2$, as has been done for fractional Brownian fields and by using two independent ”inverse stable subordinators”. Joint work with Nikolai Leonenko.

Stationarity and random locations: properties and representations
Yi Shen, Cornell University, USA
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We introduce a family of random locations called ”intrinsic location functional”, which includes most of the random locations that one may encounter in many cases, e.g., the location of the path supremum/infimum over an interval, the first/last hitting times, etc. The properties of the distribution of intrinsic location functionals under stationarity are derived. Moreover, we develop alternative equivalent descriptions for intrinsic location functionals in terms of partially ordered random point sets and piecewise linear functions. We will also discuss the link between the random locations in this class and certain queueing models with deadlines.

5.20 Problems in stochastic analysis

Friday 2:00-3:30
HUMN 135

Widder's representation theorem for local Dirichlet forms
Nate Eldridge, Cornell University, USA
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A well-known defect of the classical heat equation in $\mathbb{R}^n$ is that, in the absence of boundary conditions, the Cauchy initial-value problem admits non-unique solutions. Widder's Theorem says this defect disappears if we restrict our attention to non-negative solutions, and indeed says that every non-negative solution can be represented as a convolution with the heat kernel. I will discuss an extension of this theorem to the heat equation on metric measure spaces equipped with a local Dirichlet form. A key ingredient is the parabolic Harnack inequality. If time permits, I will also describe some current work considering the time-dependent and non-Markovian case. Joint work with Laurent Saloff-Coste.

First order calculus on fractals and related stochastic analysis
Michael Hinz, Bielefeld University, Germany
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We will discuss analysis and stochastic processes on fractals and survey some items of a recently developed first order calculus based on Dirichlet forms. They have probabilistic counterparts in terms of additive functionals of the underlying Markov process, what allows to rephrase them using Nakao's stochastic calculus. We discuss some applications to scalar and vector PDE on fractals

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Poincare type inequalities for group von Neumann algebras
Qiang Zeng, UIUC, USA
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We prove the L^p Poincare inequality for certain group von Neumann algebras. Our approach is based on Pisiers method on Riesz transform, which was further developed by Lust-Piquard for general spin systems.

5.21 Random matrices

Friday, 2:00-3:30
HUMN 1B80

Limiting Spectral Distribution of sum of Unitary and Orthogonal matrices
Anirban Basak, Stanford University, USA
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We consider the empirical distribution of the eigenvalues of the sum of d independent Haar distributed Unitary or Orthogonal matrices, and show that this sequence of measures converge to the Brown measure of free sum of d unitary operators. Joint work with Amir Dembo.

Random matrices: Partial Linear eigenvalue statistics
Sean O'Rourke, Yale University, USA
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In random matrix theory, Wigner's semicircle law can be thought of as a natural analog to the Law of Large Numbers from classic probability theory. In the same way, the fluctuation of linear eigenvalue statistics corresponds to the Central Limit Theorem.

I will give a brief survey of these results for Wigner random matrices and present a recent result (obtained jointly with A. Soshnikov) regarding partial sums of eigenvalue statistics. In particular, the partial sums behave differently than one might expect from classic probability theory (e.g. the limiting distribution is not Gaussian).

Strong Markov property of determinantal processes
Hideki Tanemura, Chiba University, Japan
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When the number of particles is finite, the non-colliding Brownian motion (the Dyson model) and the non-colliding squared Bessel process are determinantal diffusion processes for any deterministic initial configuration, in the sense that any multi-time correlation function is given by a determinant associated with the correlation kernel, which is specified by an entire function. Then we construct three infinite-dimensional determinantal processes, as the limits of sequences of determinantal diffusion processes with finite numbers of particles in the sense of finite dimensional distributions. The main result of this talk is that these infinite-dimensional determinantal processes are non-colliding diffusion processes. We also discuss stochastic differential equations associated with the diffusions.

5.22 Queues and copulas

Friday, 2:00-3:30
HUMN 1B90

Copulas and dependence coefficients
Martial Longla, University of Cincinnati, USA
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Dependence coefficients have been widely studied for Markov processes defined by a set of transition probabilities and an initial distribution. This work clarifies some aspects of the theory of dependence structure of Markov chains generated by copulas that are useful in time series econometrics and other applied fields. The main aim of this paper is to clarify the relationship between the notions of geometric ergodicity and geometric ρ-mixing; namely, to point out that for a large number of well known copulas, such as Clayton, Gumbel or Student, these notions are equivalent. Some of the results published in the last years appear to be redundant if one takes into account this fact. We apply this equivalence to show that any mixture of Clayton, Gumbel or Student copulas generate both geometrically ergodic and geometric ρ-mixing stationary Markov chains, answering in this way an open question in the literature. We shall also point out that a sufficient condition for ρ-mixing, used in the literature, actually implies Doeblin recurrence.

On "Truncated" FPT Processes Which Correspond to Poisson–Erlang Lévy Processes
Vladimir Vinogradov, Ohio University, USA
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We derive the closed-form expression in terms of the Wright special function for the density of the first-passage times (or the FPT's) for the Poisson-Erlang Lévy processes. For Poisson-exponential Lévy processes, we establish an analogue of Zolotarev space-time duality between the original process and its FPT process "truncated" at zero. We show that an asymptotic duality holds in the sense of weak convergence of a certain family of marginals of the incremental stochastic processes, thereby providing the probabilistic interpretation of an analytical property, which is known as the Letac-Mora reciprocity. Surprisingly, the corresponding limits in the sense of convergence in mean and in mean square have an additional multiplier, which is also present in the asymptotic relationship between the marginals of a Poisson-Erlang Lévy process and its "truncated" FPT process. We prove that for Poisson-exponential Lévy processes, the FPT and the overshoot are independent. Joint work with Richard Paris.

Generalized Kiefer process and queues
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We will discuss generalized Kiefer process and its use in the study of the impact of dependent service times in queues with many servers. We show that under certain mixing conditions on the sequence of successive service times, the number of busy servers in the infinite server queues can be approximated by a Gaussian process (random field) driven by a generalized Kiefer process. We characterize the effect of the dependence among service times upon the mean and variance in steady state. We also use this result to approximate the delay probability in many-server queues with dependent service times. (Joint work with Ward Whitt, Columbia University.)

6. Poster Session

Tuesday
HUMN Lobby

Freezing properties of radial Dunkl Processes
Sergio Andraus, University of Tokyo, Japan
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Radial Dunkl processes are the stochastic processes realized by a system of multiple interacting Brownian particles in one dimension, where the interaction is dictated by a logarithmic potential. These processes are interesting from a theoretical point of view due to the fact that they are exactly solvable, because they constitute a generalization of several ensembles of random matrices and because they cover several different types of logarithmic interactions. We consider the freezing limit of these processes, which is a scaled limit of the final position of the particles of the system as their coupling constant of interaction tends to infinity. We find that, under this regime, there is an interesting structure underlying the behavior of the system. This structure is closely related to the roots of certain families of orthogonal polynomials, the Hermite polynomials for Dyson's model (the radial Dunkl process of type A_{N-1}) and the associated Laguerre polynomials for the interacting Bessel process (the Dunkl process of type B_N). Joint work with Seiji Miyashita.

Thick points for the Gaussian Free Field in 4 dimensions
Alessandra Cipriani, Zurich, Switzerland
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We study the fractal properties of the thick points of the 4-dimensional massive Gaussian Free Field (GFF). We adopt the definition of GFF on $\mathbb{R}^4$ introduced by Chen and Jakobson (2012) viewed as an abstract Wiener space with underlying Hilbert space given by the Sobolev space $H^2(\mathbb{R}^4)$. In this talk we show that for $0 \leq a \leq 4$ the Hausdorff dimension of the set of a-high points is 4-a. The set of thick points can be related to the support of the Liouville quantum gravity measure in 4 dimensions introduced by Chen and Jakobson. These results can be seen as an extension of the results obtained in 2 dimensions by Hu, Miller and Peres for the thick points of the GFF on a domain. Joint work with Rajat Subhra Hazra.

Periodic oscillations in a genetic circuit with delayed negative feedback

David Lipshutz, UC San Diego, USA
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Dynamical system models with delayed feedback, state constraints and small noise arise in a variety of applications in biology. Under certain conditions oscillatory behavior has been observed. Here we consider a prototypical fluid model approximation for such a system — a one-dimensional delay differential equation with reflection. We provide sufficient conditions for the existence, stability and uniqueness of slowly oscillating periodic solutions of such equations. We illustrate our findings with a simple genetic circuit model. This is joint work with Ruth J. Williams.

A note on the p-th moment of the solutions of stochastic functional differential equations

Young-Ho Kim, Changwon University, Korea
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This poster is concerned with the p-th moment of solution for the stochastic functional differential equations under non-Lipschitz condition and a weakened linear growth condition. Furthermore, uniform L^p-continuity of the solution for the stochastic functional differential equation is given. Joint work with Tae In Kwon.

Near critical catalyst reactant branching processes with controlled immigration

Dominik Reinhold, Clark University, USA
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Near critical catalyst-reactant branching processes with controlled immigration are studied. The reactant population evolves according to a branching process whose branching rate is proportional to the total mass of the catalyst. The bulk catalyst evolution is that of a classical continuous time branching process; in addition there is a specific form of immigration. Immigration takes place exactly when the catalyst population falls below a certain threshold, in which case the population is instantaneously replenished to the threshold. Such models are motivated by problems in chemical kinetics where one wants to keep the level of a catalyst above a certain threshold in order to maintain a desired level of reaction activity. A diffusion limit theorem for the scaled processes is presented, in which the catalyst limit is described through a reflected diffusion, while the reactant limit is a diffusion with coefficients that are functions of both the reactant and the catalyst. Stochastic averaging principles under fast catalyst dynamics are established. In the case where the catalyst evolves "much faster" than the reactant, a scaling limit, in which the reactant is described through a one dimensional SDE with coefficients depending on the invariant distribution of the reflected diffusion, is obtained. This is joint work with Amarjit Budhiraja

Generators of quadratic harnesses

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Quadratic harnesses are stochastic processes with linear conditional expectation and quadratic conditional variance when conditioning is with respect to the past-future filtration of the process. Typically such processes are non-homogeneous Markov and are uniquely determined up to five numerical constants appearing explicitly in the formula for conditional variance. Their transition probabilities are related to measures which orthognalize Askey-Wilson and Wilson polynomials. The family of quadratic harnesses includes: Wiener, Poisson, Lévy-Meixner processes, as well as classical versions of non-commutative free Brownian motion and q-Gaussian process and many others. Here we present an approach which allows to find explicit expressions for generators of quadratic harnesses restricted to the polynomial domain.

Comparison of Euclidean metrics between spike trains and their application in defining spike train template and variability

Sergiusz Wesolowski, Florida State University, USA
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Spike trains usually arise as observables when investigating neural activity. They represent the response of a neuron or group of neurons to certain stimuli. Those observed behaviors are modeled as stochastic point processes and spike trains are understood as realizations of such. Although there are several well known ways of investigating distance between point processes, they prove to be inadequate, due to complexity of the experiment and neural behavior. Those methods tend not to capture the temporal structure of the neural response, which is proved to be crucial in understanding and discriminating between stimuli, thus a different approach should be taken. Joint work with Wei Wu (Florida State University).

On this poster we summarize three Euclidean metrics, Van Rossum metric, Dubbs metric, and elastic metric and use of these metrics in defining summarize statistics such as mean spike trains which can be directly used to characterize the template of prototyped firing pattern in a set of spike trains. We compare the measurement by these statistics. We also show the application of those in decoding neural activity with respect to different stimuli.