Titles and Abstracts

The directed landscape from Brownian motion

Bálint Virág
University of Toronto

Probabilists prefer objects constructed from iid random variables. But so far, in the Kardar-Parisi-Zhang universality class, the limiting objects had to be defined using determinantal formulas or a Gibbs property.
In joint work with Duncan Dauvergne, we show that the directed landscape in the upper half plane is in natural deterministic bijection with an iid sequence of Brownian motions. In fact, this bijection is the ultimate limit of the RSK correspondence.

Airy beta line ensemble

Lingfu Zhang
California Institute of Technology

In the past decades, a family of distributions, indexed by a parameter β and named after Tracy-Widom, have been found in a wide range of correlated random systems: first in random matrices (β=1,2,4), then random permutations, interacting particle systems, growth processes, and many others. The β=2 Tracy-Widom distribution has been extended to a random process called Airy line ensemble, which has been proven to be the limit of, e.g., interfaces from the KPZ universality class. For any other β>0, such an extension has been expected, while much less is known, due to the absence of many structures special for β=2. In this talk, I will report our recent progress, in two perspectives: we construct the Airyβ line ensemble through exact formulas, and we characterize it using an SDE, thereby providing a general framework of proving convergence. This is based on a joint work with Vadim Gorin and Jiaming Xu, and a joint work with Jiaoyang Huang.

Applications of optimal transport to non-intersecting paths

Xuan Wu
University of Illinois Urbana-Champaign

Non-intersecting random paths naturally arise in probability theory and mathematical physics, appearing in settings such as level curves of random surfaces and the evolution of eigenvalues of random matrices. Understanding the regularity of these paths is crucial for analyzing their local structures and asymptotic behaviors. Previously, path regularity has been achieved through Gibbs resampling techniques. In this talk, we introduce a novel approach that uses optimal transport to establish path regularity. This method sharpens several previous estimates and also yields new results that were previously inaccessible.

Functional Inequalities for Sticky-Reflecting Diffusions

Fengyu Wang
Tianjin University

By developing a new technique, the spectral gap and log-Sobolev constant are estimated for sticky-reflecting diffusion processes on manifold with Wentzell-type boundary condition. We also consider the super and weak Poincar\'e inequalities.

On sharp interface limit problems of 1D stochastic Allen-Cahn equation

Weijun Xu
Peking University

We present two results on the sharp interface limit of 1D stochastic Allen-Cahn equation with two slightly different setups. Both results depend on self-cancellations of divergent terms, but they occur in different manners. Cancellations in the first situation is designed to happen via specific constructions of correctors, while that in the second situation is somewhat miraculous. Based on joint works with Wenhao Zhao (EPFL) and Shuhan Zhou (PKU).

On CLT for range of critical branching random walk in high dimensions

Tianyi Bai
Academy of Mathematics and Systems Science

We present recent progress on central limit theorem for the range of a critical branching random walk (CBRW) in $\mathbb{Z}^d$ conditioned to be large. Law of large number for range of CBRW was given by Le Gall and Lin in 2016, and we aim at strengthening the result to a central limit theorem, based on general theory for stationary process and relation between height process of CBRW and random walk excursions. This talk is based on an ongoing joint work with Yueyun Hu.

On the Poisson equation for irreversible jump processes

Christian Maes
KU Leuven

We study the Poisson equation for Markov jump processes which satisfy a condition of local detailed balance. Solutions can be related to mean first-passage times and to excess heat, depending on the source function in the Poisson equation. We give a powerful graphical representation of the solution, enabling an extension of the Third Law of Thermodynamics to irreversible processes, and, as a second application, we give a simple proof of an affine relation between stationary currents over different edges in the graph. [Joint work with Faezeh Khodabandehlou and Karel Netocny]

Inhomogeneous random graphs of preferential attachment type

Peter Mörters
University of Cologne

Inhomogeneous random graphs of preferential attachment type are a solvable model of a scale-free network that shares many features with more involved preferential attachment networks. In this talk I will survey some of its features that can be obtained using the theory of branching random walks.

Random walk on dynamical percolation: separating critical and supercritical regimes

Jianping Jiang
Tsinghua University

In dynamical percolation each edge is open with probability p, refreshing its status at rate \mu>0. We study random walk on dynamical percolation in the lattice Z^d, where the walk moves along open edges at rate 1. Let p_c=p_c(d) denote the critical value for static percolation. In the critical regime p=p_c, we prove that if d=2 or d>10, then the mean squared displacement is O(t \mu^a) where a=a(d)>0. For p>p_c, we prove that the mean squared displacement is of order t, uniformly in 0<\mu<1, refining earlier results obtained by Peres,Sousi and Steif. (For p<p_c and \mu<1, it is known that the mean squared displacement is of order t \mu.) Based on joint work with Chenlin Gu, Yuval Peres, Zhan Shi, Hao Wu and Fan Yang.

Noise sensitivity problem on groups

Ryokichi Tanaka
Kyoto University

Noise sensitivity problem asks the following: Given a stochastic process defined in terms of i.i.d. sequences, does a small number of resampling produce an independent copy of the original one asymptotically? In this talk, we discuss the following questions: Is a random walk on a group noise sensitive? What group admits a noise sensitive random walk?

Some easy optimization problems have the overlap-gap property

Shuangping Li
Stanford University

We show that the shortest s-t path problem has the overlap-gap property in (i) sparse G(n,p) graphs and (ii) complete graphs with i.i.d. Exponential edge weights. Furthermore, we demonstrate that in sparse G(n,p) graphs, shortest path is solved by O(log n)-degree polynomial estimators, and a uniform approximate shortest path can be sampled in polynomial time. This constitutes the first example in which the overlap-gap property is not predictive of algorithmic intractability for a (non-algebraic) average-case optimization problem.
This is based on joint work with Tselil Schramm.

Conditioned random walks on the general linear group

Hui Xiao
Academy of Mathematics and Systems Science

Our objective is to explore random walks on the general linear group, constrained to a specific domain, with a primary focus on establishing the conditioned local limit theorem. In this talk, we show how to construct the target harmonic measure, which, together with the harmonic function, serves as a pivotal component in shaping the conditioned local limit theorem. Using a reversal identity, we introduce a reversed sequence characterized as a dual random walk with a perturbation depending on future observations. The investigation of such walks, which rely on future information, lies at the heart of the research. To carry out this study, we develop an approach based on the finite-size approximation of perturbations, enabling us to simplify the investigation to an array of Markov chains with increasing dimensions. This is based on joint work with Ion Grama and Jean-François Quint.

Authority Measure for Opinion Dynamics

Ron Peretz
Bar Ilan University

We propose a formal framework for measuring the authority of individuals in a setting of opinion dynamics. Our framework is based on an axiomatic approach in the tradition of coalitional game theory. We show that the unique solution concept satisfying our axioms is a generalization of the ``authority distribution" notion of Hu and Shapley(2003). A novelty of our approach is that it is based on the dynamics of opinion exchange rather than on network topology. However, for any fixed opinion dynamics, our approach associates a network centrality measure with any given network topology. Previous as well as new network centrality measures are obtained in this way.
Joint work with Igal Milchtaich (Bar Ilan U, Israel) and Yevgeny Tsodikovich (Ben Gurion U, Israel)

Time-changed Lévy processes at infinity

Quan Shi
Academy of Mathematics and Systems Science

Starting Markov processes from boundary points of the state space has a long history, dating back all the way to William Feller. In the present article we study different ways to start time-changed Lévy processes from infinity, a question that has attracted a lot of interest in the past decade for instance in the study of self-similar Markov processes or branching processes with state-dependent immigration.
Our main results give sharp conditions on the Lévy process and the time-change function to allow entrance or regular boundary.
Joint work with Leif Döring (Mannheim) and Samuel Baguley (Postdam).

Polynomial lower bound on the effective resistance for the one-dimensional critical long-range percolation

Lujing Huang
Fujian Normal University

In this work, we study the critical long-range percolation on $\mathbb{Z}$, where an edge connects i and j independently with probability 1 for $|i-j|=1$ and with probability $1-\exp\{-\beta\int_i^{i+1}\int_j^{j+1}|u-v|^{-2}\mathrm{u}\mathrm{v}\}$ for some fixed $\beta>0$. Viewing this as a random electric network where each edge has a unit conductance, weT show that with high probability the effective resistances from the origin 0 to $[-N,N]^c$ and from the interval $[-N,N]$ to $[-2N,2N]^c$ (conditioned on no edge joining $[-N,N]$ and $[-2N,2N]^c$) both have a polynomial lower bound in N. Our bound holds for all $\beta>0$ and thus rules out a potential phase transition (around $\beta=1$) which seemed to be a reasonable possibility. This is based on a joint work with Jian Ding and Zherui Fan.

On the eigenvalue rigidity of the Jacobi unitary ensemble

Dan Dai
City University of Hong Kong

We consider rigidity estimates for the eigenvalues of the Jacobi unitary ensemble. Following ideas in Claeys et al. (Duke Math. J., 2021), our investigation focuses on the extreme values of the associated log-correlated stochastic processes, and asymptotics of large Hankel determinants with various singularities. Through these analyses, we achieve sharp upper and lower bounds for the eigenvalue fluctuation.

Random conformal weldings and the matter-Liouville-ghost factorisation

Guillaume Baverez
Aix-Marseille University

We establish and explore the consequences of various integration by parts formulas related to the Gaussian free field (GFF), Schramm-Loewner evolutions (SLE), and their coupling.
First, we prove a characterisation of SLE as conjectured by Kontsevitch & Suhov. Second, we perform the harmonic analysis of the Neumann GFF in the disc, singling out the boundary length as a spectral parameter. Third, we give a mathematical interpretation of the Jacobian of conformal welding, making contact with the "ghost anomaly" from bosonic string theory. Fourth, we introduce a new approach to Sheffield's "quantum zipper" theorem, with an independent proof of a result due to Ang-Holden-Sun on the conformal welding of quantum discs.
Based on joint and ongoing work with Antoine Jego.

On the subcritical self-catalytic branching Brownian motions

Zhenyao Sun
Beijing Institute of Technology

Self-catalytic branching Brownian motions (SBBM) are a class of one-dimensional branching Brownian motions that incorporate pairwise catalytic branchings, triggered by the intersection local times of particle pairs. These processes naturally arise as the moment duals of certain reaction-diffusion equations perturbed by multiplicative space-time white noise. For the subcritical case of the catalytic branching mechanism, we construct the SBBM allowing an infinite number of initial particles. Additionally, we establish the coming down from infinity (CDI) property for these systems and characterize their CDI rates. This is based on ongoing joint research with Haojie Hou.

Spectral edge of non-Hermitian random matrices

Hong Chang Ji
University of Wisconsin-Madison

We report recent progress on the spectral edge of non-Hermitian random matrices with a non-zero mean. We consider square random matrices of the form $A + X$ where X has centered i.i.d. entries and A is a deterministic bias, and A and X are on the same scale so that their contributions to the spectrum of $A + X$ are comparable. Under this setting, we show that there are universal patterns arising in eigenvalue statistics of $A + X$ around its boundary, on macroscopic and microscopic scales. The first result shows that the macroscopic eigenvalue density of $A + X$ typically can only have two types of behavior around the boundary of its support, (i) a jump discontinuity and (ii) a quadratic decay. The second result is the microscopic universality around the two types of edges; it shows that the local eigenvalue statistics of $A + X$ around a typical boundary point is universal, depending only on the type and the symmetry class. The talk is based on joint works with A. Campbell, G. Cipolloni, and L. Erd\H{o}s.

Phase transition for the bottom singular vector of rectangular random matrices

Jaehun Lee
City University of Hong Kong

In physics, the phase transition between localized and delocalized phases in disordered systems, often called the Anderson transition, has attracted significant interest. Several intriguing models display this behavior, including random Schrödinger operators, random band matrices, and sparse random matrices. Heavy-tailed random matrices similarly capture this phase transition, making them a crucial class of models in understanding localization phenomena. In this talk, we will discuss the phase transition of the right singular vector associated with the smallest singular value of a rectangular random matrix. This work is in collaboration with Zhigang Bao (University of Hong Kong) and Xiaocong Xu (University of Southern California).

BRW in IID environment: Yaglom theorem and Stein method

Xinxin Chen
Beijing Normal University

We consider a branching random walk in i.i.d. random environment where the branching law depends on the spatial environment. In the critical (0, 2)-branching case, we prove the Yaglom theorem via Stein method. This is a joint work with Chenlin Gu and Zhiqi Zhao.

Two dimensional dimers beyond planarity

Wei Wu
NYU Shanghai

We study the dimer model and the monomer double dimer model, and prove that on two-dimension like graphs (not necessarily planar), both the correlation function and the loop connectivity probability decays to zero. Our analysis is by introducing a new (complex) spin representation for all models belonging to this class, and by deriving a new proof of the Mermin-Wagner theorem which does not require the positivity of the Gibbs measure. Based on joint work with Lorenzo Taggi (Sapienza).

On free energy in non-convex mean-field spin glass models

Hongbin Chen
Institut des Hautes Études Scientifiques

We start by reviewing the classical Sherrington-Kirkpatrick (SK) model. In this model, +1/-1-valued spins interact with each other subject to random coupling constants. The covariance of the random interaction is quadratic in terms of spin overlaps. Parisi proposed the celebrated variational formula for the limit of free energy of the SK model in the 80s, which was later rigorously verified in the works by Guerra and Talagrand. This formula has been generalized in various settings, for instance, to vector-valued spins, by Panchenko. However, in these cases, the convexity of the interaction is crucial. In general, the limit of free energy in non-convex models is not known and we do not have variational formulas as valid candidates. Here, we report recent progress through the lens of the Hamilton-Jacobi equation. Under the assumption that the limit of free energy exists, we show that the value of the limit is prescribed by a characteristic line; and the limit (as a function) satisfies an infinite-dimensional Hamilton-Jacobi equation "almost everywhere". This talk is based on a joint work with Jean-Christophe Mourrat.

Extract one-arm exponent in FK models from the convergence of height functions to GFF

Jiaming Xia
Institut des Hautes Études Scientifiques

We consider FK models with q in [1,4] on the square lattice and the whole plane. We assume the

convergence of height functions to GFF and in particular we assume that we know the variance σ^2 of the GFF. Then, we sketch an approach to get the exponent α_1 describing the probability of having a primal crossing of an annulus. The basis for this approach is the BKW coupling relating the height function to the interface loops of FK. We show that by choosing appropriate test functions (viewd as placing charges on the plane), we can get relations between σ^2, α_1 , and a factor accounting for local concentration of small interface loops.

Incipient Infinite Clusters in Metric Graph Gaussian Free Fields

Zhenhao Cai
Weizmann Institute of Science

The Gaussian free field (GFF) on the metric graph was introduced by Titus Lupu (2016) as a natural extension of the discrete GFF. Its level-set (i.e., the collection of points where the GFF exceeds a given threshold) is a random object with favorable properties and a strong connection to numerous models in statistical physics (including loop soups, random interlacements, etc). This talk will introduce our recent progress in establishing the incipient infinite clusters of this level-set, as well as a series of regularity properties for its connecting probabilities. Some of these properties lead to new conjectures in Bernoulli percolation. This is a joint work with Jian Ding (Peking University).

Moderate deviation principles for a reaction diffusion model in non-equilibrium

Linjie Zhao
Huazhong University of Science and Technology

We consider moderate deviations from hydrodynamic limits of a reaction diffusion model. The process is defined as the superposition of the symmetric simple exclusion process with Glauber dynamics. When the process starts from a product measure with a constant density, a non-equilibrium measure for the process, we prove that the rescaled density fluctuation field satisfies the moderate deviation principle. When time permits, we will also outline the main ideas of the proof.

The Edge Statistics of Random Band Matrices

Guangyi Zou
University of Science and Technology of China

Random band matrices are interpolation models between Wigner matrices and random Schrödinger operators. When the bandwidth changes at different rates relative to the system size, the eigenvalues of band matrices exhibit two distinct behaviors: Wigner matrix eigenvalue statistics and Poisson eigenvalue statistics. In this talk, we consider the edge statistics of band matrices for and discuss the mechanism behind the transition between Wigner statistics and Poisson statistics of eigenvalues. Our discussion involves certain Feynman diagram expansion and Feynman integral estimates. This discussion is based on collaborative work with Professor Dang-Zheng Liu (USTC), arxiv:2401.00492.