Interactions and Random Media

A conference in honor of

Alejandro Ramírez

on the occasion of his 60th birthday

Conference Abstracts

Talks

Scaling Limits of Line Models in Degenerate Environment

Jean-Dominique Deuschel *TU Berlin*

We consider a 2-dimensional model of random walk in random environment known as line model. The environment is described by two independent families of i.i.d. random variables dictating rates of jumps in vertical, respectively horizontal directions, and whose values are constant along vertical, respect. horizontal lines. When jump rates are heavy-tailed in one of the directions, we prove that the random walk becomes superdiffusive in that direction, with an explicit scaling limit written as a two-dimensional Brownian motion time-changed (in one of the components) by a process introduced by Kesten and Spitzer in 1979. In the case of a fully degenerate environment, a sufficient condition for non-explosion is provided, and conjectures on the associated scaling limit are formulated.

Joint work with Henri Elad Altman.

Strong Connectivity in Directed Percolation

Leonardo T. Rolla *University of São Paulo*

On an amenable infinite transitive graph, replace each edge by a pair of directed edges with opposite orientations. Each directed edge is declared open with probability p, independently of all other directed edges. We say that two sites x and y are strongly connected if there are open directed paths from x to y and from y to x. We show that, as soon as the undirected model has an infinite cluster, the directed model has a unique infinite strongly connected cluster. We also identify the distribution of the size of the finite directed branches going into or coming out of the unique infinite strongly connected cluster as that of undirected percolation, which implies stretched exponential tails. Joint work with Yuliang Shi.

Homogenization of nonconvex Hamilton–Jacobi equations in stationary ergodic media

Atilla Yilmaz *Temple University*

I will start with a self-contained introduction to the homogenization of inviscid (first-order) and viscous (second-order) Hamilton–Jacobi (HJ) equations in stationary ergodic media in any dimension and then give a survey of the classical works that are concerned with periodic media or convex Hamiltonians. Afterwards, I will drop both of these assumptions and outline the results obtained in the last decade that: (i) establish homogenization for inviscid HJ equations in one dimension; and (ii) provide counterexamples to homogenization in the inviscid and viscous cases in dimensions two and higher. Finally, I will present my recent joint work with Elena Kosygina (CUNY) in which we prove homogenization for viscous HJ equations in one dimension and also describe how the solution of this problem differs qualitatively from that of its inviscid counterpart.

Tales of non-backtracking reinforced random walk

Mark Holmes *University of Melbourne*

In this talk I will introduce non-backtracking reinforced random walks and discuss their wondrous properties (some known, but mostly conjectured) that depend on the strength of reinforcement. This is based on joint work, in particular with Victor Kleptsyn and Frank den Hollander.

Self-interacting random walks beyond exchangeability

Pierre Tarrès *NYU Shanghai*

We discuss a new approach for the quantitative analysis of once-reinforced random walks (ORRW) on general graphs, based on a novel change of measure formula.

This approach enables us to prove that ORRW is transient on all non-amenable graphs for small reinforcement, and to obtain large deviations estimates for the range of the walk to have cardinality of the order $N^{d/(d+2)}$ in dimension larger than or equal than two.

Finally, we present new local time formulas for a general self-interacting random walks, including random walks in a random environment and general reinforced processes on oriented graphs.

Shocks, instability, and the twenty networks of infinite geodesics in the Directed Landscape

Firas Rassoul-Agha *University of Utah*

For stochastic Hamilton–Jacobi (SHJ) equations, instability points are the space-time locations where two eternal solutions with the same asymptotic velocity differ. Another fundamental structure in such equations is shocks, which are the space-time locations where the velocity field is discontinuous. In this work, we study the KPZ fixed point, the central object of the KPZ universality class, which can be viewed as a prototype—albeit degenerate—of an inviscid SHJ equation in one spatial dimension. We describe the geometric structure of the instability region and give a detailed and precise analysis of its interplay with the shock structures of the two eternal solutions. We show that these shock structures allow one to reconstruct the instability region. Along the way, we obtain a complete classification of all possible configurations of semi-infinite geodesics emanating from arbitrary space-time points, in the directed landscape—the random environment in which the KPZ fixed point evolves. This is joint work with Mikhail Sweeney.

Title to be announced

Inés Armendáriz *Universidad de Buenos Aires*

Abstract to be announced.

Random Hadamard matrices

Stanislav Molchanov *University of North Carolina Charlotte*

The talk will present a review of the recent results on the determinants of the random Hadamard matrices $H_n^\omega = [\varepsilon_{ij},\ i,j = 1,\dots,n]$. Here ε_{ij} are independent Bernoulli r.v., $P(\varepsilon_{ij} = 1) = P(\varepsilon_{ij} = -1) = 1/2$. The classical (and still unsolved) problem by Hadamard: prove that $\max\{\det H_n\} = n^{n/2}$ for $n \equiv 0 \pmod 4$, generated many related problems. M. Kac proposed the approach to studying the large deviations for $M_n = \det H_n$ based on the analysis of the statistical moments of M_n, $n \to \infty$. The central points of the talk are the asymptotic formulas for the moments of M_n, $n \to \infty$, and applications of the Hadamard matrices H_n^ω (for small n) to the testing of random number generators (RNGs).

Self-repellent branching random walks

Anton Bovier *Universität Bonn*

We consider a system of particles performing a discrete-time binary branching random walk with independent standard normal increments subject to a penalty β for every pair of particles that get within distance ε of each other at every time. We study the optimal configurations that minimise the sum of the spread out cost and the repulsion cost up to a given time horizon N. We show that at time N particles are spread out over a distance $\asymp (\beta\varepsilon)^{1/3}\, 2^{2N/3}$. We also show that the total cost of the optimal configurations up to time N is $\asymp (\beta\varepsilon)^{2/3}\, 2^{4N/3}$. This is joint work with Frank den Hollander and Lisa Hartung.

Long time behaviour of PAM on hyperbolic space

Weijun Xu *Westlake University*

We consider the quenched long time behaviour of the parabolic Anderson model on the standard hyperbolic space $\mathbb{H}^d$. The random potential is a smooth, stationary and time-independent Gaussian field. We show that the first order logarithmic asymptotics is different from its Euclidean counterpart, both in the growth exponent and in the determination of the constant. In trying to understand the mechanisms behind, some interesting questions for future investigation also arise. Joint work with Xi Geng and Sheng Wang, both from Melbourne.

Polaron, its effective mass and stochastic quantization

Chiranjib Mukherjee *Universität Münster*

We will report on recent progress on the construction of the polaron path measure, the proof of the quartic divergence rate of its "effective mass" and construction a singular stochastic PDE that leaves the constructed measure invariant. (Based on joint works with S. R. S. Varadhan, R. Bazaes, M. Sellke, F. Espinosa, M. Gubinelli and P. Zoubouloglou)

Scaling limits for self-interacting random walks via joint Ray–Knight theorems

Elena Kosygina *City University of New York*

For several classes of self-interacting random walks on the integers, B. Tóth proved generalized Ray–Knight theorems (gRKT) and used them to study the limiting behavior of these walks. A natural question is whether these theorems uniquely identify the limiting process. In a joint paper with T. Mountford and J. Peterson, we showed that this need not be the case. Subsequently, with J. Peterson, we used the joint gRKT to prove convergence of "true" self-avoiding walks to the "true" self-repelling motion constructed by B. Tóth and W. Werner in 1998. This resolved a long-standing conjecture and showed that the joint gRKT might be the right tool.

In our current work (with L. Marêché, T. Mountford, and J. Peterson), we show that, under mild conditions, the joint gRKT can be "inverted" to establish functional limit theorems, thereby constructing a unique limiting process. We apply our general results to "true" self-avoiding walks and polynomially self-repelling walks. The latter application gives rise to a new class of non-Markovian processes—polynomially self-repelling motions.

Trapping in Elliptic Environments and Renewal Structures for Tree-Building Walks

Rodrigo Ribeiro *IMPA Tech*

We discuss two distinct classes of random walks in random or dynamic environments.

First, we consider random walks in i.i.d. elliptic environments that are not uniformly elliptic. In dimension $d = 2$, we introduce a geometric framework to classify how the walk becomes trapped in edges, wedges, or squares. This leads to explicit, computable criteria on the exit times from a box which ensure that local trapping does not inhibit ballistic behavior. This part represents joint work with Alejandro Ramírez.

Second, we transition to the Tree Builder Random Walk (TBRW), a model where the walker attaches a random number of leaves to its current position at each step. By introducing a renewal framework analogous to the Sznitman–Zerner structure for RWRE, we establish fundamental limit theorems under an i.i.d. hypothesis, including the Strong Law of Large Numbers, an Invariance Principle, and the continuity of the asymptotic speed with respect to the environment distribution.

The talk will be based on the papers:

- R.R. *Renewal structure of the tree builder random walk.* SPA, 2025.
- Alejandro F. Ramírez, R.R. *Computable criteria for ballisticity of random walks in elliptic random environment.* Electronic Journal of Probability, 2022.

GUE Fluctuations Near the Origin in One-Sided Ballistic Deposition

Pablo Groisman *Universidad de Buenos Aires*

We will introduce a variation of the ballistic deposition model in which vertically falling blocks can only stick to the top or the upper right corner of growing columns. For this model, we will establish that the fluctuations of the height function at points near the origin are given by the GUE ensemble and its correspondent Tracy–Widom limiting distribution. The talk is based on joint work with Alejandro Ramírez, Santiago Saglietti and Sebastian Zaninovich.

Pfaffian transition probabilities for half-space TASEP

Daniel Remenik *Universidad de Chile*

In 1997, Gunter Schütz found explicit transition probabilities for the totally asymmetric simple exclusion process (TASEP) in terms of a determinant based on the Bethe ansatz. This formula, which was later extended to several related models, is at the basis of many subsequent breakthroughs in the study of universal scaling limits within the KPZ universality class.

This talk will focus on TASEP in half-space with particle insertion at the boundary. I will present a Bethe ansatz solution for the transition probabilities of this model, which had remained elusive. The formula follows from a more general one for the asymmetric simple exclusion process (ASEP) in half-space. In the limit of total asymmetry, the expression reduces to a Pfaffian. I will also explain how the formula leads to an explicit Fredholm Pfaffian formula for the multipoint distribution of half-space TASEP conditioned on the number of particles in the system.

Based on joint work with Jan de Gier, William Mead, and Michael Wheeler.

Title to be announced

Pablo Ferrari *Universidad de Buenos Aires*

Abstract to be announced.