

Rencontres de Probabilités 2025

Rouen, 6-7 novembre 2025

Programme

Thursday November 6, 2025

- 11h - 12:30 mini-course A (Part I), Quentin Berger

Title: Modèle de polymère dirigé, limite d'échelle et équation de la chaleur stochastique

- 12:30 - 14:00 lunch

- 14:00 - 14:30 Audrey Chaudron

Title: Exceptional configurations in a high-intensity random covering

- 14:30 – 15:00 Maxence Poutrel

Title: Study of a percolation model defined by a circular neighborhood

- 15:00 - 15:30 coffee break

- 15:30 - 17:00 mini-course B (Part I), Dimitrios Tsagkarogiannis

Title: Combinatorial species and thermodynamic quantities

- 17:00 - 17:30 Nicolas Prevost

Title: From the Simple Exclusion Process to the Kac Blume-Capel Model: Hydrodynamic Limits and Large Deviation Principles

- 17:30 – 18:00 Fabio Frommer

Title: Realizability of point processes via the Kirkwood-Salsburg equations

- 18:00 – 18:30 Federico Sau

Title: A conservative-gradient stochastic heat equation and the averaging process

Friday November 7, 2025

- 09:00 – 10:30 mini-course A (Part II), Dimitrios Tsagkarogiannis

Title: Combinatorial species and thermodynamic quantities

- 10:30 - 11:00 Pierre Le Bris

Title: Linearized Landau equation from a mean field particle system

- 11:00 – 11:30 coffee break

- 11:30 - 12:00 Francesca Cottini

Title: Directed polymer in critical spatial correlated environment

- 12:00 – 12:30 Nicolas Petrelis

Title: Non local random deposition models for earthquakes

- 12:30 - 14:00 lunch

- 14:00 – 15:30 mini-course B (Part II), Quentin Berger

Title: Modèle de polymère dirigé, limite d'échelle et équation de la chaleur stochastique

-15:30 - 16:00 Éric Luçon

Title: Stability of traveling wave profiles for interacting Hawkes processes

Abstracts

Mini-courses

Quentin Berger (Université Sorbonne, Paris Nord)

Title: Modèle de polymère dirigé, limite d'échelle et équation de la chaleur stochastique

Abstract: In this mini-course, I will present the directed polymer model, which describes a random walk in dimension d that interacts with a random environment (i.i.d. in time-space). The goal is to present some recent results on this model and to explore its relation with the Stochastic Heat Equation (SHE) with multiplicative noise.

We will start with the simpler case of dimension $d=1$: in this case, by normalising properly the parameters of the model, one can obtain a non-trivial scaling limit, which is intimately related to the SHE in dimension 1. We will then turn to the case of dimension $d=2$, where important results have been obtained in the last couple of years. In that case, one needs to tune the parameters of the model in some very delicate manner (in a *critical window*) to obtain an interesting limit: the limiting object that one obtains is then a natural candidate for the solution of the SHE in dimension 2, which is a priori ill-defined.

Dimitrios Tsagkarogiannis (Università Dell'Aquila)

Title: Combinatorial species and thermodynamic quantities

Abstract: In this mini-course we first review some recent progress in deriving power series representations for various thermodynamic quantities such as pressure, free energy and correlation functions for inhomogeneous systems of interacting particles in a continuous medium. We use cluster expansion techniques in the context of generating functions of various combinatorial species. In the second part of the course, we specialize in the case of hard spheres for two different species modelling colloidal particles (large spheres) within a substrate (small spheres). One interesting phenomenon is that despite the originally repulsive forces between all particles, when we look at the effective system of only large spheres, an attractive force emerges between them, usually referred to as "depletion attraction". We will discuss a sufficient condition for the convergence of the related cluster expansion that involves the surface of the large spheres rather than their volume (as it would have been the case in a direct application of existing methods to the binary system).

Some relevant references:

S. Jansen, T. Kuna, D. Tsagkarogiannis, Virial inversion and density functionals, J. Funct. Anal. 284 (2023).

S. Jansen, D. Tsagkarogiannis, Cluster expansions with renormalized activities and applications to colloids, Ann. Henri Poincaré 21 (2020).

D. Tsagkarogiannis, Cluster expansions, trees, inversions and correlations, Ensaios Matemáticos 38 (2023).

Talks

Audrey Chaudron (Université de Rouen Normandie)

Title: Exceptional configurations in a high-intensity random covering

Abstract: The Boolean model of random covering was introduced by Gilbert in the 1960s as a simplified representation of a radio transmission network [2]. It is obtained by considering the union of balls of fixed radius centered at the points of a homogeneous Poisson point process in Euclidean space.

In this setting, we study the probability that a uniformly chosen connected component is exceptionally small, that is, composed of exactly k balls for some fixed integer k , in the regime where the intensity of the process, i.e. the mean number of points per unit volume, tends to infinity. In particular, we derive a two-term asymptotic expansion for this probability.

To achieve this, the talk will provide an introduction to the Boolean model in $\mathbb{R}^d$ with a special focus on recent work by Penrose and Yang [3]. They established an integral equivalent for the probability of interest, thereby improving upon the logarithmic equivalent obtained by Alexander in 1992 [1]. Our geometric interpretation of this integral equivalent leads to a new method of computation and yields the two-term expansion. Finally, if time allows, we will discuss the case of k tends to infinity and possible extensions of these results in the hyperbolic setting.

[1] K. S. Alexander. Finite clusters in high-density continuous percolation: compression and sphericity. *Probab. Theory Related Fields*, 97(1-2), 35–63, 1993.

[2] E. N. Gilbert. Random plane networks. *J. Soc. Indust. Appl. Math.*, 9, 533–543, 1961.

[3] M. D. Penrose, X. Yang. On k -clusters of high-intensity random geometric graphs, 2022

Francesca Cottini (LPSM, Sorbonne Université)

Title: Directed polymer in critical spatial correlated environment

Abstract: Directed polymers in random environments describe a perturbation of the simple random walk given by a random disorder (environment). The partition functions of this model have been thoroughly investigated in recent years, also motivated by their link with the solution of the Stochastic Heat Equation. While classical results focus on space-time independent disorder, we consider a Gaussian environment with (critical) spatial correlations decaying as $|x|^{-2}$ times a slowly varying function. We show that a phase transition, analogous to that in the space-time independent case, still occurs: in the high temperature regime the log-partition function satisfies a central limit theorem, while it vanishes in law in the low temperature regime. Remarkably, the inverse temperature needs to be tuned differently from the independent case, where the scaling constant $\hat{\beta}$ emerges from a nontrivial multi-scale dependence in the second moment computation — the core technical challenge of the work.

Fabio Frommer (University of Mainz)

Title: Realizability of point processes via the Kirkwood-Salsburg equations

Abstract: Given a family of functions $\rho(n)$, $1 \leq n \leq M$ it is a natural question if there is a point process such that the given functions are the first M correlation functions of this process. This is known as the realizability problem of point processes.

A special case of this problem is when these functions can be written as the negative exponential of some Hamiltonian H . For the case that H only consists of a pair potential u the functions $\rho(n)$ coincide with the Kirkwood superposition approximation from statistical physics. In this case existence of the so-called Kirkwood closure process was first shown by Ambartsumian and

Sukiasian under the restriction that u is non-negative and $\rho(1)$ is sufficiently small. Kuna, Lebowitz and Speer generalized this result to the case that u is a locally stable and regular pair potential. In this talk, it is shown that it suffices for u to be stable and regular to ensure the existence of the Kirkwood closure process. Furthermore, for locally stable u it is proved that the Kirkwood closure process is Gibbs and that the kernel of the GNZ-equation satisfies a Kirkwood-Salsburg type equation. Lastly, we mention how this ansatz can be generalized to multi-body Hamiltonians.

References

- [1] R.V. Ambartzumian and H.S. Sukiasian: Inclusion-exclusion and point processes, *Acta Appl. Math.* 22 (1991), pp. 15–31.
- [2] J.G. Kirkwood and E.M. Boggs: The radial distribution function in liquids, *J. Chem. Phys.* 10 (1942), pp. 394–402.
- [3] T. Kuna, J.L. Lebowitz and E.R. Speer: Realizability of point processes, *J. Stat. Phys.* 129 (2007), pp. 417–439.
- [4] V.I. Skrypnik: Solutions of the Kirkwood-Salsburg equation for particles with finite-range nonpairwise repulsion, *Ukr. Mat. J.* 60 (2008), pp. 1329–1334.

Pierre Le Bris (IHES)

Title: Linearized Landau equation from a mean field particle system

Abstract: We consider a tagged particle in mean field interaction with a Rayleigh gas of density N , and prove the convergence of its trajectory, as N goes to infinity, to the one of a diffusion process associated with the linearized Landau equation. This is joint work with T. Bodineau (IHES).

Éric Luçon (Université d'Orleans)

Title: Stability of traveling wave profiles for interacting Hawkes processes

Abstract: This is joint work with C. Poquet. The motivation of this work comes from mathematical neuroscience. Wilson, Cowan and Amari introduced in the 70' the Neural Field Equation (NFE) that models the dynamics of neural systems on a mesoscopic scale. Ermentrout and McLeod have proven that this integro-differential equation exhibits traveling wave solutions in dimension 1. The aim of the talk is to introduce a system of microscopic point processes of Hawkes type, modeling the spiking activity of interacting neurons. We show that this system correctly approximates the traveling wave solutions to the NFE in a large population regime and identify a diffusive correction to these traveling waves on a long time scale.

Nicolas Petrelis (Université de Nantes)

Title: Non local random deposition models for earthquakes

Abstract: In this presentation, we consider a class of deposition models that originate from the study of geophysical problems, such as earthquakes. The basic model is as follows: We consider a sequence $(h_n)_{n \in \mathbb{N}}$ of real-valued functions defined on $[0, D]^d$ (with $d = 1$ or $d = 2$). The first function h_0 is uniformly zero. Then, recursively, we compute h_{n+1} by adding to h_n a symmetric function that is centered at a random point Y_{n+1} and is non-zero on a width determined by a heavy-tailed random variable Z_{n+1} .

The distribution of those points $(Y_n)_{n \in \mathbb{N}}$ determines the type of physical system we aim to study:

a) the rand. model if $(Y_n)_{n \in \mathbb{N}}$ are sampled independently and uniformly over $[0, D]^d$ (for instance to model the filtration of radiations by aerosols)

b) the min. model if the center of the $(n+1)$ -th transformation corresponds to the point where the minimum of h_n is attained (for instance to model earthquakes close to the boundary of two tectonic plates).

For both models we will study, as n diverges, the convergence in distribution of $(h_n)_{n \in \mathbb{N}}$ and of the fluctuations of $(h_n)_{n \in \mathbb{N}}$.

This is joint work with P. Carmona and F. P  tr  lis.

Maxence Poutrel (Universit   de Rouen Normandie)

Title: Study of a percolation model defined by a circular neighborhood

Abstract: We introduce a new model of percolation for which there is more dependency than in the classical Bernoulli percolation. We place a point uniformly at random in each square of the infinite grid $\mathbb{Z}^2$. These points correspond to the vertices of our graph, and two points are connected by an edge if the distance between them is smaller than a given radius R . We study the value of the critical radius R_c from which there exists almost surely an infinite connected component.

Our estimates rely on comparisons with the Bernoulli percolation and also on a combinatorial study of the possible self-avoiding paths for small radiuses.

This is a joint work with J  r  me Casse and Ir  ne Marcovici.

Nicolas Prevost

Title: From the Simple Exclusion Process to the Kac Blume-Capel Model: Hydrodynamic Limits and Large Deviation Principles

Abstract: We study various interacting particle systems, starting with the simple exclusion process and extending to systems of particles with negative, neutral, and positive charges, the Blume-Capel model. Our focus includes weakly asymmetric dynamics for the interior and the Kac dynamics, which correspond to long-range interactions. We investigate the hydrodynamic limit of these systems, transitioning from the microscopic to the macroscopic scale. By introducing boundary dynamics that are accelerated according to specific parameters, we analyze the different hydrodynamic limits resulting from this acceleration. Finally, we establish a large deviations principle for the hydrodynamic limit, which quantifies the probability of deviations from the limit.

Federico Sau

Title: A conservative-gradient stochastic heat equation and the averaging process

Abstract: In this talk, we introduce a conservative-gradient variant of the multiplicative stochastic heat equation, a one-parameter family of linear SPDEs (with the parameter controlling the noise intensity), ill-posed in any dimension. Nevertheless, suitable space discretizations of these equations give rise to the averaging process and other related stochastic exchange models. For these models, we discuss fluctuation limits and the corresponding phase transitions.

Joint ongoing work with Matteo Quattropani (Rome).