# An International Conference On Applied Probability

# June 2-6, Peking Univeristy

## Venue

June 2,3,4,6: Ding Shisun Lecture Hall, Zhihua Bldg

June 5, Wang Xuan Lecture Hall, Zhihua Bldg

## Schedule

| Mon, June 2 | Tue | Wed | Thu | Fri |
|---|---|---|---|---|
| OPENING REMARK 0900-0910 | Pengkun Yang 0900-0945 | Yuanyuan Xu 0900-0945 | | Scott Armstrong 0900-0945 |
| Alejandro Ramirez 0910-0955 | TEA BREAK 0945-1015 | TEA BREAK 0945-1015 | TEA BREAK 0945-1015 | TEA BREAK 0945-1015 |
| GROUP PHOTO 0955-1000 | Rongchan Zhu 1015-1100 | Kavita Ramanan 1015-1100 | Xue-Mei Li 1015-1100 | Jean Christophe Mourrat 1015-1100 |
| TEA BREAK 1000-1030 | Xian Chen 1105-1150 | Yuval Peres 1105-1150 | Matthias Birkner 1105-1150 | Rongfeng Sun 1105-1150 |
| Wei-Kuo Chen 1030-1115 | LUNCH BREAK | LUNCH BREAK | LUNCH BREAK | CLOSING REMARK 1150-1200 |
| Si Tang 1120-1205 | *Hang Du 1400-1430 | FREE AFTERNOON | Kuan Yang 1400-1445 | |
| LUNCH BREAK | *Zhangsong Li 1430-1500 | | TEA BREAK 1445-1515 | |
| Bing-Yi Jing 1400-1445 | TEA BREAK 1500-1530 | | Jonathan Weare 1515-1600 | |
| TEA BREAK 1445-1515 | *Shuyang Gong 1530-1600 | | | |
| Wenxin Zhou 1515-1600 | *Jiamin Wang 1600-1630 | | | |
| | Banquet 1800~ | * indicates a student talk | | |

## Title and Abstract

### June 2

June 2, 09:10-09:55

**Alejandro Ramírez** (NYU Shanghai)

Title: **GUE fluctuations of the one-sided ballistic deposition model near the time axis**

Abstract: Ballistic deposition is a model of interface growth introduced by Vold in 1959, which has remained largely mathematically intractable. In dimension d=2, it is conjectured to belong to the KPZ universality class. It is defined as a process of vertically falling blocks that stick to the top, the right or the left of growing columns. Here we introduce a variant, the one-sided ballistic deposition model, in which vertically falling blocks can only stick to the top or the upper right corner of growing columns. We establish that in dimension d=2, strong KPZ universality holds near the

time axis, proving that the fluctuations of the height function there are given by the Tracy-Widom GUE distribution. The proof is based on a graphical construction of the process in terms of a last passage percolation model. This talk is based on a joint work with Pablo Groisman, Santiago Saglietti and Sebastián Zaninovich.

June 2, 10:30-11:15

**Wei-Kuo Chen** (University of Minnesota)

Title: **Joint Parameter Estimations in Spin Glasses**

Abstract: Spin glasses are disordered statistical physics system with competing ferromagnetic and anti-ferromagnetic spin interactions. The Gibbs measure belongs to the exponential family with parameters, such as inverse temperature $\beta>0$ and external field $h$ in $R$. One interesting statistical perspective of this measure is concerned with the estimation problem of the system parameters from a given sample. This question was firstly addressed by Chatterjee in 2007, who proved that the maximum pseudo-likelihood estimator for $\beta$ is $\sqrt{N}$-consistent for a broad class of spin glass models with two-spin interactions in the absence of external field. It was left open if one can achieve joint estimation of $(\beta,h)$. In this talk, I will present a recent progress, which shows that under some easily verifiable conditions, the bi-variate maximum pseudo-likelihood estimator is indeed jointly $\sqrt{N}$-consistent for a large collection of spin glasses, including the Sherrington-Kirkpatrick model and its diluted variants. Based on a joint work with Arnab Sen and Qiang Wu.

June 2, 11:20-12:05

**Si Tang (Lehigh University)**

Title: **The time constant of high dimensional first passage percolation, revisited**

Abstract: We prove high-dimensional asymptotics for the time constants in first-passage percolation (FPP) on $Z^d$ along all diagonal-like directions $v=(1, 1, .., 1, 0, 0, \cdots, 0)$ of $f(d)$ nonzero entries. We show that if $f(d) \sim o(d)$, the time constant along the direction $v$ behaves similarly to the axis directions, whereas if $f(d)$ is a linear fraction of $d$, the asymptotic behavior is characterized by the Lambert W function. The proof was based on a cluster exploration idea, which allowed us to estimate moments of non-backtracking first-passage times as well as to fix an error in [AT'16].

LUNCH BREAK

June 2, 14:00-14:45

**Bing-Yi Jing (SUSTech)**

Title: **The Intersection of Embodied and Agentic Intelligence: New Horizons for AI Development**

Abstract: In the pursuit of Artificial General Intelligence (AGI), researchers are exploring diverse approaches to enhance machine learning and reasoning capabilities. This talk explores the intersection of two emerging paradigms: embodied intelligence and agentic AI. While embodied intelligence seeks to ground AI in the physical world, allowing machines to interact and adapt through sensorimotor experiences, agentic AI offers an alternative through virtual environments where autonomous agents learn, reason, and perform tasks. By investigating the strengths and limitations of both models, we highlight the complementary nature of these approaches and propose a unified vision for developing AI systems that are both adaptive in real-world scenarios and capable of autonomous decision-making in complex digital spaces.

June 2, 15:15-16:00

**Wenxin Zhou** (University of Illinois Chicago)

Title: **Expected Shortfall Regression**

Abstract: Expected Shortfall (ES), also known as superquantile or Conditional Value-at-Risk, has been recognized as an important risk measure in economics and finance. In this talk, we consider a joint regression framework that simultaneously models the conditional quantile and ES of a response variable given a set of covariates, for which the state-of-the-art approach is based on minimizing a joint loss function that is non-differentiable and non-convex. Motivated by the idea of using orthogonal scores to reduce sensitivity to nuisance parameters, we study a two-step framework for fitting joint quantile and ES regression models under both linear and nonlinear models. We establish non-asymptotic estimation and inferential theory for the proposed estimators, carefully characterizing the impact of quantile estimation without relying on sample splitting.

## June 3

June 3, 09:00-09:45

**Pengkun Yang** (Tsinghua University)

Title: **Graph alignment problems with partially correlated nodes**

Abstract: The graph alignment problem aims to find the underlying node correspondence present in two correlated graphs. Applications span various fields such as networks de-anonymization, computer vision, natural language processing, and computational biology. In this talk, I will discuss the model under which not all nodes from both graphs are correlated. By extending the functional digraph under partial correlation, we provide a tight characterization of the information-theoretic thresholds of the problem. Additionally, I will discuss polynomial-time algorithms and evidence supporting the computational hardness of the problem in certain regimes.

June 3, 10:15-11:00

**Rongchan Zhu** (Beijing Institute of Technology)

Title: **Derivation of $\Phi^4_3$ theory from many-body quantum Gibbs states**

Abstract: We derive the $\Phi^4_3$ measure on the torus as a rigorous limit of the quantum Gibbs state of an interacting Bose gas just above the Bose-Einstein phase transition. The proof is based on two key ingredients: first, we approximate the local $\Phi^4_3$ theory by a Hartree measure with a nonlocal interaction using techniques from stochastic quantization and paracontrolled calculus; and then, we connect the Hartree theory to the quantum problem using correlation inequalities and a finite-dimensional semiclassical approximation. This result is inspired by previous works of Lewin-Nam-Rougerie and Fröhlich-Knowles-Schlein-Sohinger on the derivation of 3D Hartree and $\Phi^4_2$ theories. The talk is based on joint work with Phan Thanh Nam and Xiangchan Zhu.

June 3, 11:05-11:50

**Xian Chen** (Xiamen University)

Title: **A variational formula for discrete-time Markov control processes under risk-sensitive average reward criterion**

Abstract: We study the risk-sensitive average reward criterion for discrete-time Markov control processes. The state space is a Borel space and the reward function can be unbounded. We prove the existence of a solution to the risk-sensitive average reward optimality equation and the existence of an optimal stationary policy via a new technique of constructing an approximating sequence of coercive reward functions and introducing the split chain. Moreover, we develop a new approach to obtain a variational formula for the risk-sensitive average reward criterion without the compactness condition on the state space in the existing literature.

LUNCH BREAK

June 3, 14:00-14:30

**Hang Du** (Massachusetts  Institute of Technology)

Title: **Optimal recovery of correlated Erdős–Rényi graphs**

Abstract: For two unlabeled graphs $G_1,G_2$ independently sub-sampled from an \ER graph $\mathbf G(n,p)$ by keeping each edge with probability $s$, we aim to recover \emph{as many as possible} of the corresponding vertex pairs. We establish a connection between the recoverability of vertex pairs and the balanced load allocation in the true intersection graph of $ G_1 $ and $ G_2 $. Using this connection, we analyze the partial recovery regime where $ p = n^{-\alpha + o(1)} $ for some $ \alpha \in (0, 1] $ and $ nps^2 = \lambda = O(1) $. We derive upper and lower bounds for the recoverable fraction in terms of $ \alpha $ and the limiting load distribution $ \mu_\lambda $ (as introduced in \cite{AS16}). These bounds coincide asymptotically whenever $ \alpha^{-1} $ is not an atom of $ \mu_\lambda $. Therefore, for each fixed $ \lambda $, our result characterizes the asymptotic optimal recovery fraction for all but countably many $ \alpha \in (0, 1] $.

June 3, 14:30-15:00

**Zhangsong Li** (Peking University)

Title: **Robust random graph matching in dense graphs via vector approximate message passing**

Abstract: We focus on the matching recovery problem between a pair of correlated Gaussian Wigner matrices with a latent vertex correspondence. We are particularly interested in a robust version of this problem such that our observation is a perturbed input $(A+E,B+F)$ where $(A,B)$ is a pair of correlated Gaussian Wigner matrices and $E,F$ are adversarially chosen matrices supported on an unknown $\epsilon n * \epsilon n$ principle minor of $A,B$, respectively. We propose a vector-approximate message passing (vector-AMP) algorithm that succeeds in polynomial time as long as the correlation $\rho$ between $(A,B)$ is a non-vanishing constant and $\epsilon = o\big( \tfrac{1}{(\log n)^{20}} \big)$. The main methodological inputs for our result are the iterative random graph matching algorithm proposed in [Ding and Li 2022, 2023] and the spectral cleaning procedure proposed in [Ivkov and Schramm 2024]. To the best of our knowledge, our algorithm is the first efficient random graph matching type algorithm that is robust under any adversarial perturbations of $n^{1-o(1)}$ size.

June 3, 15:30-16:00

**Shuyang Gong** (Peking University)

Title: **A Proof of The Changepoint Detection Threshold Conjecture in Preferential Attachment Models**

Abstract: We investigate the problem of detecting and estimating a changepoint in the attachment function of a network evolving according to a preferential attachment model on $n$ vertices, using only a single final snapshot of the network. Bet et al. \cite{bet2023detecting} show that a simple test based on thresholding the number of vertices with minimum degrees can detect the changepoint when the change occurs at time $n-\Omega(\sqrt{n})$. They further make the striking conjecture that detection becomes impossible for any test if the change occurs at time $n-o(\sqrt{n}).$ Kaddouri et al.~\cite{kaddouri2024impossibility} make a step forward by proving the detection is impossible if the change occurs at time $n-o(n^{1/3}).$ In this paper, we resolve the conjecture affirmatively, proving that detection is indeed impossible if the change occurs at time $n-o(\sqrt{n}).$ Furthermore, we establish that estimating the changepoint with an error smaller than $o(\sqrt{n})$ is also impossible, thereby confirming that the estimator proposed in Bhamidi et al.~\cite{bhamidi2018change} is order-optimal. This talk is based on joint work with Hang Du (MIT) and Jiaming Xu (Duke).

June 3, 16:00-16:30

**Jiamin Wang** (Peking University)

Title: **Universality of Cutoff for Riffle Shuffling**

Abstract: A Gilbert--Shannon--Reeds (GSR) shuffle is performed by cutting a deck of $N$ cards into two parts of binomial size $Bin(N,1/2)$ and interleaving them uniformly at random. Bayer and Diaconis famously proved that this Markov chain exhibits cutoff: to leading order, $\frac{3}{2}\log_2 N$ GSR shuffles are necessary and sufficient to randomize a deck of $N$ cards. We show this cutoff is universal in the sense that the binomial condition can be entirely removed. This talk is based on joint work in progress with Mark Sellke and Jialu Shi.

## June 4

June 4, 09:00-09:45

**Yuanyuan Xu** (AMSS, Chinese Academy of Sciences)

Title: **Optimal decay of eigenvector overlap for non-Hermitian random matrices**

Abstract: We consider the standard overlap of any bi-orthogonal family of left and right eigenvectors of a large random matrix with centred i.i.d. entries and we prove that it

decays as an inverse second power of the distance between the corresponding eigenvalues. This extends similar results for the complex Gaussian ensemble from Bourgade and Dubach, as well as Benaych-Georges and Zeitouni, to any i.i.d. matrix ensemble in both symmetry classes. Based on a joint work with Giorgio Cipolloni and Laszlo Erdos.

June 4, 10:15-11:00

**Kavita Ramanan** (Brown University)

Title: **H-theorems for conditional McKean-Vlasov processes related to interacting diffusions on random regular graphs**

Abstract: We consider conditional McKean-Vlasov (CMV) processes that arise in the study of hydrodynamic limits of interacting gradient diffusions on random $\kappa$-regular graphs. We establish an H-theorem that characterizes the long-time behavior of these processes. Specifically, we identify a certain sparse free energy functional that arises as the limit of suitably renormalized relative entropies and show that it serves as a global Lyapunov function for the associated measure flow. We also use the H-theorem to characterize the stationary distributions of the CMVE process as translation invariant splitting Gibbs measures on the infinite $\kappa$-regular tree. Moreover, when $\kappa = 2$ we establish a nonlinear log Sobolev inequality and establish exponential convergence of the measure flow to the unique stationary distribution. We also state several open problems. This is joint work with Kevin Hu.

June 4, 11:05-11:50

**Yuval Peres (BIMSA)**

Title: **Convergence rate of p-energy minimization on graphs: sharp polynomial bounds and a phase transition at p=3**

Abstract: Fix p>1 and consider the following dynamics on a connected graph with n nodes. Given an initial opinion profile on the vertices, at each step select uniformly a node v, and update the opinion at v to the value that minimizes the p-energy (i.e., the sum of p'th powers of gradients). The case p=2 yields averaging dynamics, but for all other p the dynamics are nonlinear. In the limiting case when p tends to infinity, the new opinion at the chosen vertex v is the average of the highest and lowest opinions among neighbours of v. We show that the number of steps needed to reduce the oscillation of opinions by a factor of 2 is polynomial in n, and find the sharp exponent is the maximum of 2p/(p-1) and 3. Thus this exponent is nonincreasing in p and exhibits a phase transition at p=3. We also derive matching upper and lower bounds

for convergence time as a function of n and the average degree; these are the most challenging to prove. (Joint work with G. Amir and F. Nazarov).

FREE AFTERNOON

## June 5

June 5, 10:15-11:00

**Xue-Mei Li** (EPFL)

Title: **Functional limit theorems for Gaussian processes and SDEs with fast evolving coefficients**

Abstract: We discuss Functional central and non-central limit theorems in the rough path topology, slow fast SDEs driven by Gaussian processes and their effective motions.

June 5, 11:05-11:50

**Matthias Birkner** (University of Mainz)

Title: **Long-time behavior of a branching annihilating random walk**

Abstract: We study a system of particles which evolve on the lattice in discrete generations: Each particle produces a Poissonian number of offspring which independently move to a uniformly chosen site within a fixed distance from their parent's position. Whenever a site is occupied by at least two particles, all the particles at that site are annihilated. This can be interpreted as a very strong form of local competition and implies that the system is not monotone. We prove that the system dies out when the mean offspring number is too small or too large, for a set of intermediate values and sufficiently large jump range the system survives with positive probability. In a restricted parameter range, we can establish complete convergence with a non-trivial invariant measure and show that the occupied region expands with linear speed. A central tool is comparison with oriented percolation on a coarse-grained level, using suitably tuned density profiles which expand in time and are reminiscent of discrete travelling wave solutions. Based on joint work, partly in progress, with Alice Callegaro, Jiří Černý, Nina Gantert and Pascal Oswald.

LUNCH BREAK

June 5, 14:00-14:45

**Kuan Yang** (Shanghai Jiao Tong University)

Title: **Sampling and Counting Solutions to Random k-SAT Formulae**

Abstract: The random k-SAT problem has attracted lots of attention in both computer science and statistical physics. The fundamental problem is to understand for what value of the clause density, a solution (i.e., satisfying assignment of variables) exists and can be found efficiently by an algorithm. While significant progress has been made toward the thresholds for satisfiability and solution search in recent years, this talk explores two deeper challenges: the problems of uniformly sampling solutions, and counting the number of them. We present a near-linear-time almost uniform sampler when clause densities $\alpha \lesssim 2^{k/3}$, and an efficient approximate counting algorithm that succeeds up to densities $\alpha \leqslant 2^k/\mathrm{poly}(k)$. In particular, the $2^k$ term matches the satisfiability and algorithmic threshold for random k-SAT formulae and extends beyond the $2^{k/2}$ lower bound established for worst-case instances.

June 5, 15:15-16:00

**Jonathan Q Weare** (NYU Courant)

Title: **Convergence of Unadjusted Langevin in High Dimensions: Delocalization of Bias**

Abstract: The unadjusted Langevin algorithm is commonly used to sample probability distributions in extremely high-dimensional settings. However, existing analyses of the algorithm for strongly log-concave distributions suggest that, as the dimension d of the problem increases, the number of iterations required to ensure convergence within a desired error in the W2 metric scales in proportion to d or its square root. In this paper, we argue that, despite this poor scaling of the W2 error for the full set of variables, the behavior for a small number of variables can be significantly better: a number of iterations proportional to K, up to logarithmic terms in d, often suffices for the algorithm to converge to within a desired W2 error for all K-marginals. We refer to this effect as delocalization of bias. We show that the delocalization effect does not hold universally and prove its validity for Gaussian distributions and strongly log-concave distributions with certain sparse interactions. Our analysis relies on a novel $W2,\ell^\infty$ metric to measure convergence. A key technical challenge we address is the lack of a one-step contraction property in this metric. Finally, we use asymptotic arguments to explore potential generalizations of the delocalization effect beyond the Gaussian and sparse interactions setting. This is joint work with Yifan Chen, Xiaoou Cheng, and Jonathan Niles-Weed.

## June 6

June 6, 09:00-09:45

**Scott Armstrong** (NYU Courant)

Title: **Superdiffusivity for a diffusion in a critically-correlated incompressible random drift**

Abstract: We consider a Brownian particle in a divergence-free drift, where the vector field is a stationary random field exhibiting "critical" correlations. Predictions from physicists in the 80s state that, almost surely, this process should behave like a "sped-up" Brownian motion at large scales, with variance at time~$t$ being of order~$t \sqrt{\log t}$. In joint work with Ahmed Bou-Rabee and Tuomo Kuusi, we give a rigorous proof of this prediction using an iterative quantitative homogenization procedure, which is a way of formalizing a renormalization group argument. We consider the generator of the process and coarse-grain this operator, scale-by-scale, across an infinite number of scales. The random swirls of the vector field at each scale enhance the effective diffusivity. As we zoom out, we obtain an ODE for the effective diffusivity as a function of the scale (the "beta function" in physicist's language), to deduce that it diverges at the predicted rate. New coarse-graining arguments allow us to rigorously (and quenchedly) integrate out the smaller scales and prove the scaling limit.

June 6, 10:15-11:00

**Jean-Christophe Mourrat** (ENS Lyon)

Title: **Spin glasses and the Parisi formula**

Abstract: Spin glasses are models of statistical mechanics in which a large number of elementary units, called spins, interact in a disordered manner. One of the main results of the theory is the Parisi formula, which describes the limit of the free energy of these systems. The goal of my talk will be to present this formula and some open problems that relate to it, as well as partial progress.

June 6, 11:05-11:50

**Rongfeng Sun** (National University of Singapore)

Title: **An Invariance Principle for a Random Walk Among Moving Traps**

Abstract: We consider a random walk among a Poisson cloud of moving traps on Z^d, where the walk is killed at a rate proportional to the number of traps occupying the same position. Previously, we showed that conditioned on survival up to time t under the annealed law, the walk is sub-diffusive in dimension d=1. Here we show that in

d>=6, the walk is diffusive and satisfies an invariance principle. Our proof is based on the theory of thermodynamic formalism, for which we extend some classic results for Markov shifts with a finite alphabet and a potential of summable variation to the case of an uncountable non-compact alphabet. Based on joint work with S. Athreya and A. Drewitz.