Young Probabilists Workshop

(November 5-9, 2018, Chern Institute of Mathematics)

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Speaker List for "Young Probabilists Workshop" (November 5-9, 2018)

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Workshop Schedule

- **NOV 5th , Monday**

  Venue: Room 216, Chern Institute of Mathematics

Time	Content	Chair
8:30-9:30	Francis Comets *Edwards-Wilkinson regime for Kardar-Parisi-Zhang equation in large dimension*	Hao Wu
9:30-10:30	Yanqi Qiu *Patterson-Sullivan construction for point processes and the reconstruction for harmonic functions*	
10:30-11:00	**Tea Time**	
11:00-12:00	Wei Liu *Stochastic 3D Leray-alpha model with fractional dissipation*	
12:00-14:00	**Lunch**	
14:00-15:00	Renjie Feng *Random matrices and SYK model*	Francis Comets
15:00-16:00	Jerome Casse *Applications of probabilistic cellular automata in statistical physics*	
16:00-16:30	**Tea Time**	
16:30-17:30	Grégoire Véchambre *General self-similarity properties for Markov processes and exponential functionals of Lévy processes*	
18:00-19:00	**Dinner**	

- **NOV 6th , Tuesday**

  Venue: Room 216, Chern Institute of Mathematics

Time	Content	Chair
8:30-9:30	Jeremie Bettinelli	Leonardo T. Rolla
	Brownian disks	
9:30-10:30	Zhehua Li	
	Discretize random loops	
10:30-11:00	**Tea Time**	
11:00-12:00	Joseba Dalmau	
	The quasispecies regime for the Wright-Fisher model	
12:00-14:00	**Lunch**	
14:00-15:00	Leonardo T. Rolla	Yanqi Qiu
	Soliton decomposition of the Box-Ball System	
15:00-16:00	Yuan Zhang	
	Stabilization of DLA in a wedge	
16:00-16:30	**Tea Time**	
16:30-17:30	Zhiyong Yu	
	Probabilistic interpretation for a system of quasilinear	
	Parabolic partial differential-algebraic equation	
18:00-19:00	**Dinner**	

- **NOV 7th , Wednesday**

  No Talk! Free Activities.

- **NOV 8th , Thursday**
  Venue: Room 216, Chern Institute of Mathematics

Time	Content	Chair
8:30-9:30	Igor Kortchemski *Asymptotic behavior of large random structures*	Remi Rhodes
9:30-10:30	Jinjiong Yu *Biased voter model interface*	
10:30-11:00	**Tea Time**	
11:00-12:00	Jianliang Zhai *Well-posedness for 2-D Stochastic Navier-Stokes equations driven by multiplicative Levy noise*	
12:00-14:00	**Lunch**	
14:00-15:00	Hao Wu *Crossing probabilities in 2D critical lattice models*	Igor Kortchemski
15:00-16:00	Vittoria Silvestri *Planar aggregation models with subcritical fluctuations*	
16:00-16:30	**Tea Time**	
16:30-17:30	Lun Zhang *Gap probability at the hard edge for random matrix ensembles with pole singularities in the potential*	
17:30-18:30	Jinghai Shao *Stabilization of regime-switching processes by feedback control based on discrete time observations*	
18:30-19:30	**Dinner**	

- **NOV 9th , Friday**

  Venue: Room 216, Chern Institute of Mathematics

Time	Content	Chair
8:30-9:30	Remi Rhodes	Renjie Feng
	Liouville quantum theory and the DOZZ formula	
9:30-10:30	Dangzheng Liu	
	Lyapunov exponents for products of random matrices:	
	From Gauss to Tracy-Widom	
10:30-11:00	**Tea Time**	
11:00-12:00	Jianping Jiang	
	Random field Ising model	
12:00-14:00	**Lunch**	
14:00-15:00	Xiangchan Zhu	Jeremie Bettinelli
	Stochastic heat equation taking values in a manifold	
15:00-16:00	Anshui Li	
	On the treewidth of random geometric graphs	
16:00-16:30	**Tea Time**	
16:30-17:30	Vladas Sidoravicius	
	TBA	
18:00-19:00	**Dinner**	

Titles and Abstracts

Talk 1. **Brownian disks**

Jeremie Bettinelli (École polytechnique, France)

In the same manner as the Brownian motion appears as the universal scaling limit of any mild random walk, Brownian disks are random metric spaces that appear as the universal scaling limits of mild models of random maps on the disk. These objects generalize the Brownian map of Miermont and Le Gall, which is obtained in the case of random maps of the sphere.

We will introduce the Brownian disks et give some of their remarkable properties. This talk is based on a joint work with Grégory Miermont.

Talk 2. **Applications of probabilistic cellular automata in statistical physics**

Jerome Casse (NYU-Shanghai)

Consider the discrete line $\mathbb{Z}$ colored by some elements of a discrete space E (the color of the element $i \in \mathbb{Z}$ is $x(i)$) and consider a rule (that is a function f from E^2 to E) to color another discrete line whose colors will be ($y(i)$: $i \in \mathbb{Z}$) such that, for any $i \in \mathbb{Z}$, $y(i)=f(x(i),x(i+1))$. The generated dynamics on $E^{\mathbb{Z}}$ is a cellular automaton. Cellular automata have been introduced in the 40's by Von Neuman and have been studied thereafter by many people in the 70's and 80's in particular Wolfram.

Now, if the way to choose $y(i)$ is no more deterministic but stochastic and whose probability measure depend only of $(x(i),x(i+1))$ knowing x, we get a stochastic dynamics on $E^{\mathbb{Z}}$ that is a probabilistic cellular automaton (PCA). PCA have been first introduced and studied in 80's. They are also known as combinatorial gases in combinatorics and Dhar uses them in this area to enumerate directed animals according to their area in 1982.

In this talk, I will explain the most recent results about their invariant measures. In particular, what are the conditions on a PCA to get an invariant markovian law on $E^{\mathbb{Z}}$? Moreover, I will show you that PCA with invariant markovian laws appear in many models of statistical physics such as 8-vertex model, parallel TASEP, last passage percolation, etc. Thanks to that, we can prove some new results on these different models.

Talk 3. **Edwards-Wilkinson regime for Kardar-Parisi-Zhang equation in large dimension**

Francis Comets (Univ. Paris Diderot and NYU Shanghai)

We study KPZ equation in dimension 3 or larger driven by a Gussian white noise with a small convolution in space. When the noise intensity is small, the corresponding polymer is in weak disorder. Then, we prove that the fluctuations are Gaussian as in the Edwards-Wilkinson model. Joint work with Clement Cosco and Chiranjib Mukherjee.

Talk 4. **The quasispecies regime for the Wright-Fisher model**

Joseba Dalmau (NYU-Shanghai)

We will consider the Wright-Fisher model with mutation and selection, and we will study it in a particular asymptotic regime: genomes are long, mutations are rare, and the population is large. We will obtain an error threshold phenomenon, in the form of a curve in the parameter space, separating two different regimes. In one of the regimes, the fittest genotype dies out, while in the other regime, the fittest genotype remains present in the population. Instead of taking over the whole population, this fittest individual is constantly giving birth to mutants, thus creating a stable but highly heterogeneous population, which we call the quasispecies.

Talk 5. **Random matrices and SYK model**

Renjie Feng (Beijing University)

The SYK model is a random matrix model arising from condensed matter theory in statistics physics and black hole theory in high energy physics. In this talk, we will first review some elementary results in random matrix theory and our recent results on the extreme gap problem, then we will introduce the SYK model. I will explain the spectral properties of the random matrix of SYK model, such as the global density where a phase transition is observed, the central limit theorem of the linear statistics and the concentration of measure theory. In particular, we will derive the large deviation principle when the number of interaction of fermions is 2.

Talk 6. **Random field Ising model**

Jianping Jiang (NYU-Shanghai)

We will review some recent results on the decay rate of correlations for the random field Ising model. We will show exponential decay either **(1)** the temperature is large and the magnetic filed strength is small or **(2)** at any temperature with strong magnetic field strength. This is joint work with Federico Camia and Charles M. Newman.

Talk 7. **Asymptotic behavior of large random structures**

Igor Kortchemski (École polytechnique, France)

We will be interested in the asymptotic behavior of random “discrete” objects (such as random walks and random trees) as their size tends to infinity, and investigate whether “continuous” scaling limits exist. In this case, we will see that the existence of such scaling limits allow to obtain interesting consequences in both the discrete and the continuous worlds. Then, we will more specifically focus on the model of random minimal factorizations of the n-cycle in transpositions (that is factorizations of the cycle (1, 2,..., n) as a product of n-1 transpositions), which is a joint work with Valentin Féray.

Talk 8. **On the treewidth of random geometric graphs**

Anshui Li (Hangzhou Normal University)

We prove a conjecture of Mitsche and Perarnau [1] stating that the treewidth $\mathrm{tw}(\mathrm{G}) = \Theta(\mathrm{r}\sqrt{n})$

of random geometric graph $\mathrm{G} \in \mathcal{RGG}(\mathrm{n}, \mathrm{r})$ for all $\mathrm{r} > r_c$, in which r_c is the threshold radius for the appearance of the giant component in $\mathcal{RGG}(\mathrm{n}, \mathrm{r})$. The talk is based on a joint work with Tobias Müller.

References

[1] D. Mitsche and G. Perarnau, On treewidth and related parameters of random geometric graphs, *STACS'12*, 2012.

[2] A. Li, T. Müller, On the treewidth of random geometric graphs and percolated grids, *Advances in Applied Probability.* **49**: 49-60, 2017.

Talk 9. **Discretize random loops**

Zhehua Li (NYU-Shanghai)

We consider random loops sampled from a path integral formally expressed as

$$\frac{1}{Z}\int_{\mathcal{L}_{o,T}(M)} e^{-E(\sigma)}\,\mathcal{D}\sigma,$$

where $\mathcal{L}_{o,T}(M)$ is the space of based loops on manifold with fixed time duration, $E(\sigma)$ is the energy of the loop σ, $\mathcal{D}\sigma$ is "Lebesgue measure" and Z is a normalization constant. Although widely used in physics for "quantizing" classical mechanical systems, it suffers from flaws mathematically. In this talk, I will present work on defining the path integral on the loop space. The idea is to approximate $\mathcal{L}_{o,T}(M)$ by finite dimensional subspaces consisting of broken geodesics loops and then to pass to the limit of finer and finer approximations. Following Lars Andersson and Bruce Driver, we interpret $\mathcal{D}\sigma$ as volume measures and thus the resulting limit measure will depend on the curvature of M and choice of Riemannian metrics on approximate spaces.

Talk 10. **Lyapunov exponents for products of random matrices: From Gauss to Tracy-Widom**

Dangzheng Liu (University of Science and Technology of China)

We prove that the finite Lyapunov exponents for products of random matrices undergo a phase transition from Gaussian to Tracy-Widom distribution.

Talk 11. **Stochastic 3D Leray-alpha model with fractional dissipation**

Wei Liu (Jiangsu Normal University)

In this talk, we will present some recent results (e.g. well-posedness, Large deviation principle and ergodicity) concerning stochastic 3D Leray-alpha model with general fractional dissipation. This model is the stochastic 3D Navier-Stokes equations regularized through a smoothing kernel in the bilinear term and a fractional Laplacian.

Talk 12. **Patterson-Sullivan construction for point processes and the reconstruction for harmonic functions**

Yanqi Qiu (Chinese Academy of Sciences)

In a recent joint work with Alexander Bufetov, we show that the classical Patterson-Sullivan construction can be generalized to the random setting in the theory of point processes. This construction allows us to recover the value of any harmonic function with additional regularity at any point of the disc from its restriction to a random configuration of the determinant point process with the Bergman kernel. Similar result is then extended to real and complex hyperbolic spaces of higher dimension. Recovering continuous functions by the Patterson-Sullivan construction is also shown to be possible in more general Gromov hyperbolic spaces.

Talk 13. Liouville quantum theory and the DOZZ formula

Remi Rhodes (Universite Paris-Est Marne-la-Vallee, France)

In this talk I will present the construction of Liouville quantum theory. This theory was introduced in physics by Polyakov in 1981 in the context of string theory. This is a conformal field theory based on a Feynman type path integral and it can be seen as the natural extension of the theory of Riemann surfaces to the probabilistic framework.

Solving this theory, namely computing the correlation functions, has been a great challenge in physics. In this direction and in the 90s, Dorn-Otto and Zamolodchikov brothers conjectured that the 3 point correlation function satisfies a mysterious formula based on number theory, called the DOZZ formula. I will present recent advances on this topic.

Based on a series of works with F. David, A. Kupiainen and V. Vargas.

Talk 14. Soliton decomposition of the Box-Ball System

Leonardo T. Rolla (NYU-Shanghai, University of Buenos Aires, Argentina)

The Box-Ball System was introduced by Takahashi and Satsuma as a discrete counterpart of the KdV equation. Both systems exhibit solitons whose shape and speed are conserved after collision with other solitons. Conservation of solitons suggests that this dynamics has many spatially-ergodic invariant measures besides the i.i.d. distribution. Momentary change of speeds during collision suggests that the asymptotic speed for solitons of different sizes is given by the interaction with other solitons. We introduce a decomposition of configurations through slots, reducing the dynamics to a simple hierarchical translation of the components. Using this property we obtain an explicit recipe to construct a rich family of invariant measures. Finally, we obtain explicit equations for the velocities in terms of spacial density of solitons. Joint work with Pablo A. Ferrari, Chi Nguyen, and Minmin Wang.

Talk 15. Stabilization of regime-switching processes by feedback control based on discrete time observations

Jinghai Shao (Tianjin University)

This work investigates the stabilization of a class of regime-switching systems based on discrete-time observations of both continuous and discrete components. We provide sufficient conditions and necessary conditions for the moment stability and almost sure stability of these systems. To realize this development, we establish an estimation of the exponential functional of

Markov chains based on the spectral theory of linear operator. Besides, through constructing order-preserving coupling for jumping processes, we realize the control of state-dependent jumping processes by Markov chains.

Talk 16. **TBA**

Vladas Sidoravicius (NYU, NYU-Shanghai)

TBA

Talk 17. **Planar aggregation models with subcritical fluctuations**

Vittoria Silvestri (NYU-Shanghai)

The Hastings-Levitov planar aggregation models describe growing random clusters on the complex plane, built by iterated composition of random conformal maps. A striking feature of these models is that they can be used to define natural off–lattice analogues of several fundamental discrete models, such as the Eden model or Diffusion Limited Aggregation, by tuning the correlation between the defining maps appropriately. In this talk I will discuss shape theorems and fluctuations of large clusters in the subcritical regime. Based on joint work with James Norris (Cambridge) and Amanda Turner (Lancaster).

Talk 18. **General self-similarity properties for Markov processes and exponential functionals of Lévy processes**

Grégoire Véchambre (NYU-Shanghai)

Positive self-similar Markov processes (pssMp's) are Markov processes on the real half-line that fulfill the scaling property. A famous result by Lamperti has shown that such processes can be represented as the exponential of a time-changed Lévy process. This result is called Lamperti representation. In this work, we are interested in Markov processes that satisfy self-similarity properties of a very general form (we call them general self-similar Markov processes, or gssMp's for short) and we prove a generalized Lamperti representation for these processes. More precisely, we show that, in dimension 1, a gssMp can be represented as a function of a time-changed Lévy process, which shows some kind of universality for the classical Lamperti representation in dimension 1. In dimension 2, we show that a gssMp can be represented in term of the exponential functional of a bivariate Lévy process, and we can see that processes which can be represented as functions of time-changed Lévy processes form a strict subclass of gssMp's in dimension 2. In other words, we show that the classical Lamperti representation is not universal in dimension 2. We also study the case of more general state spaces and show that, under some conditions, we can exhibit a topological group structure on the state space of a gssMp which allows to write a Lamperti type representation for the gssMp in term of a Lévy process on this group.

Talk 19. **Crossing probabilities in 2D critical lattice models**

Hao Wu (Yau Mathematical Science Center, Tsinghua University)

The planar Ising model is one of the most studied lattice models in statistical physics. It was

introduced in the 1920s by W. Lenz as a model for magnetic materials. R. Peierls showed in 1936, in two (and higher) dimensions, an order-disorder phase transition in fact occurs at a certain critical temperature. Ever since, there has been active research to understand the 2D Ising model at criticality, where it enjoys conformal invariance in the scaling limit. In this talk, we give crossing probabilities of multiple interfaces in the critical planar Ising model with alternating boundary conditions. Besides, we also explain that a similar formula on the crossing probabilities also holds for critical Percolation and level lines of Gaussian Free Field.

Talk 20. **Biased voter model interface**

Jinjiong Yu（NYU-Shanghai)

When a one-dimensional interacting particle system is in a state with two constant configurations of different types at two ends, the interval of mixed types in between is called its interface. In this talk, we will first review the interface results for the classical voter models. We will then introduce recent results for the biased voter models, where in such models there is a bias towards one particular type of the opinions. Finally, we will demonstrate the relation between tightness for the biased voter model interface and tightness for branching-coalescing random walks. This is based on joint work with Rongfeng Sun and Jan M. Swart.

Talk 21. Probabilistic interpretation for a system of quasilinear parabolic partial differential-algebraic equation

Zhiyong Yu (Shandong University)

In this talk, we study a kind of system of second order quasilinear parabolic partial differential equation combined with algebraic equations. Introducing a family of coupled forward-backward stochastic differential equations, and by virtue of some delicate analysis techniques techniques, we give a probabilistic interpretation for it in the viscosity sense and the classical sense.

Talk 22. Well-posedness for 2-D Stochastic Navier-Stokes equations driven by multiplicative Levy noise

Jianliang Zhai (University of Science and Technology of China)

Under the classical Lipschitz and linear growth assumptions, we prove the existence and uniqueness of strong (in probability sense and PDE sense) solutions for 2-D Stochastic Navier-Stokes equations driven by multiplicative Levy noise.

Talk 23. Gap probability at the hard edge for random matrix ensembles with pole singularities in the potential

Lun Zhang (Fudan University)

In this talk, we consider the Fredholm determinant of an integrable operator acting on the interval (0,s) whose kernel is constructed out of the Ψ-function associated with a hierarchy of higher order analogues to the Painleve III equation. This Fredholm determinant describes the critical behavior of the eigenvalue gap probability at the hard edge of unitary invariant random

matrix ensembles perturbed by poles of order k in a certain scaling regime. Using the Riemann-Hilbert method, we obtain the large s asymptotics of the Fredholm determinant. Moreover, we derive a Painleve type formula of the Fredholm determinant, which is expressed in terms of an explicit integral involving a solution to a coupled Painleve III system. Joint work with Dan Dai and Shuai-Xia Xu.

Talk 24. **Stabilization of DLA in a wedge**

Yuan Zhang (Beijing University)

We consider diffusion limited aggregation in a wedge. We prove that if the angle of the wedge is smaller than π/4 there is some $a > 2$ such that almost surely for all R large enough, after time R^a all new particles attached to the DLA will be of distance larger than R from the origin. This means that DLA stabilizes in growing balls, thus allowing a definition of the infinite DLA in a wedge via a finite time process.

Talk 25. **Stochastic heat equation taking values in a manifold**

Xiangchan Zhu (Beijing Jiaotong University)

In this talk we give the existence of martingale solutions to the stochastic heat equations with values in a manifold, which admits Wiener measure as an invariant measure by using Dirichlet form. Moreover, in finite volume case, exponential ergodicity has been obtained under the condition that the Ricci curvature is bounded from below. In infinite volume case, we obtain the exponential ergodicity of the solution if the Ricci curvature is strictly positive and the non-ergodicity of the process if the sectional curvature is negative.

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