Stochastic Processes and Related Fields

4-8 September 2023

Research Institute for Mathematical Sciences, Kyoto University

Monday 4th September	Tuesday 5th September	Wednesday 6th September	Thursday 7th September	Friday 8th September
09:20–10:05 Zeitouni	09:20–10:05 Collins	09:20–10:05 Virag	09:20–10:05 Tassion	09:20–10:05 Kajino
10:30–11:15 Wu	10:30–11:15 Liang	10:30–11:15 Okada	10:30–11:15 Nakajima	10:30–11:15 Murugan
11:30–12:15 Shiraishi	11:30–12:15 Kusuoka	11:30–12:15 Goldschmidt	11:30–12:15 Sasada	11:30–12:15 Inahama
13:40–14:25 Hutchcroft	13:40–14:25 Salez		13:40–14:25 Tsunoda	13:40–14:25 Hoshino
14:50–15:35 Wang*	14:40–15:25 Peccati*		14:40–16:00 Poster talks	14:50–15:35 Hairer
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	16:50–17:35 Shiozawa			

$*$ = online presentation.

Ofer Zeitouni .... *Extremes for disordered and nonlinear 2D models*
Hao Wu .... *Connection probabilities for FK-Ising model and their relation to Dyson's circular ensemble*
Daisuke Shiraishi .... *Loop-erased random walk in three dimensions*
Tom Hutchcroft .... *Locality of the percolation critical probability*
Yilin Wang* .... *Quasiconformal deformation of the Loewner driving function*
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Vincent Tassion .... *Robust noise sensitivity of percolation*
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Makiko Sasada .... *Independence preserving property and integrable systems*
Kenkichi Tsunoda .... *Sharp interface limit for Glauber-Kawasaki process*
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`https://www.kurims.kyoto-u.ac.jp/~croydon/SPRF2023.html` `sprf2023@kurims.kyoto-u.ac.jp`

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Committees and Additional Support

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Additional Support

JSPS Grant-in-Aid for Scientific Research (A) Grant Number 19H00643
「ディリクレ形式に基づく確率解析の研究–空間構造と特異性の解明–」
Principal Investigator: Masanori Hino (Kyoto University)

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「複雑な系の上の確率過程と確率解析の展開」
Principal Investigator: Takashi Kumagai (Waseda University)

Abstracts

Ofer Zeitouni (Weizmann Institute of Science)

Extremes for disordered and nonlinear 2D models

The extremes of log-correlated Gaussian fields have been described in great precision over the last decade. I will review the existing theory and discuss two variants (time permitting): first, disordered systems such as DGFF over random conductances/percolation clusters, and second, Ginzburg-Landau models. Joint works with Florian Schweiger and with Wei Wu.

Hao Wu (Tsinghua University)

Connection probabilities for FK-Ising model and their relation to Dyson's circular ensemble

Conformal invariance of critical lattice models in two-dimensions has been vigorously studied for decades. In this talk, we focus on connection probabilities for FK-Ising model. This talk has two parts.

- In the first part, we consider critical FK-Ising model and give the connection probabilities of multiple interfaces. Such probabilities are related to solutions to BPZ equations in conformal field theory.
- In the second part, we explain a relation between multiple Ising interfaces and Dyson's circular ensemble.

Daisuke Shiraishi (Kyoto University)

Loop-erased random walk in three dimensions

Loop-erased random walk (LERW) is a random simple path obtained through erasing all loops chronologically from a simple random walk path. In this talk, I will discuss some progress toward the convergence of 3D LERW as a stochastic process along arbitrary lattice spacings. This is joint work with Xinyi Li (Peking University).

Tom Hutchcroft (California Institute of Technology)

Locality of the percolation critical probability

Around 2008, Schramm conjectured that the critical probability p_c of a transitive graph is entirely determined by the local geometry of the graph, subject to the global constraint that $p_c < 1$. In other words, if G_n is a sequence of transitive graphs with $p_c(G_n) < 1$ for all n converging locally to a transitive graph G then $p_c(G_n)$ converges to $p_c(G)$. Previous works had verified the conjecture in various special cases, including nonamenable graphs of high girth (Benjamini, Nachmias and Peres 2012); Cayley graphs of abelian groups (Martineau and Tassion 2013); nonunimodular graphs (H. 2017 and 2018); graphs of uniform exponential growth (H. 2018); and graphs of (automatically uniform) polynomial growth (Contreras, Martineau and Tassion 2022). In this talk I will describe our complete resolution of the conjecture in forthcoming joint work with Easo.

Yilin Wang* (IHES)

Quasiconformal deformation of the Loewner driving function

Loewner's transform encodes a Jordan curve into a real-valued driving function and lies at the center of the construction of SLE whose driving function is a multiple of Brownian motion. The Loewner energy is the Dirichlet energy of the driving function, hence the large deviation rate function of SLE, but also shown to equal the universal Liouville action introduced by Takhtajan and Teo in the context of Teichmüller theory.

We derive the variational formula of the Loewner driving function under infinitesimal quasiconformal deformation and obtain the first variation of the Loewner energy of a Jordan curve. Considering quasiconformal deformations allows us to identify the holomorphic stress-energy tensor of the Loewner energy with the Schwarzian derivative of the uniformizing conformal map of the complement of the curve, which explains many identities of the Loewner energy, e.g., with the universal Liouville action, renormalized volume, a Fredholm determinant involving the Grunsky operator, etc. This is a joint work with Jinwoo Sung (U. Chicago).

Ryoki Fukushima (University of Tsukuba)

Recent results on random walk among random obstacles

Consider a random walk conditioned to stay in a site percolation cluster on the integer lattice. Regarding the closed sites with obstacles, we can think of this model as the random walk conditioned to survive among randomly located obstacles. This model has a long history and, for example, Donsker and Varadhan's series of papers in 1975 aimed to analyze the long time asymptotics of the survival probability. Late in the 1990s, Sznitman and other people studied the behavior of the conditional random walk and quite sharp results are established under quenched and annealed settings. I will report some recent progress on this problem which complements the earlier results. This talk is based on joint works with Jian Ding, Rongfeng Sun and Changji Xu.

Benoit Collins (Kyoto University)

On the norm of random matrices with a tensor structure

Random matrices with tensor structures are important in many areas, including operator algebras, artificial intelligence, graph theory, etc. An important problem is to establish limit theorems for the operator norm of models obtained from algebraic operations involving multiple copies of such random tensors. This talk will describe more precisely relevant questions and recent progress and applications. It is primarily based on collaborations with Charles Bordenave.

Song Liang (Waseda University)

Stochastic Newton equations in strong potential limit for $d \geq 1$

We consider the motion of a particle in $\mathbb{R}^d$ ($d \geq 1$) with its position X_t^λ and velocity V_t^λ at time t given by the following stochastic differential equation.

$$\begin{cases} dX_t^\lambda = V_t^\lambda dt \\ dV_t^\lambda = -bV_t^\lambda dt - \lambda \nabla g(X_t^\lambda)dt + \sigma(X_t^\lambda)dB_t \\ (X_0^\lambda, V_0^\lambda) = (X_0, V_0). \end{cases}$$

Here $b > 0$ is the damping parameter, B is a d-dimensional Brownian motion, and $\sigma\sigma^\top$ is smooth, bounded and uniformly elliptic. Also, the potential function g is smooth, compactly supported, and spherical symmetric taking a particular single-well form, which gives an attractive force in an inner neighborhood of the boundary of its support. By introducing several new stochastic processes, we formulate the limiting behavior of the particle when the parameter $\lambda \to \infty$. In particular, the limiting process is deterministic for $d = 1$, and is stochastic in terms of the direction of the particle for $d > 1$.

Seiichiro Kusuoka (Kyoto University)

The three-dimensional polymer measure with self-interactions and the stochastic quantization

In this talk we consider the polymer measure with self-interactions, which is called the Edward model. The two-dimensional case had been studied around 2000, and the polymer measure and the associated Dirichlet form were constructed. Here, we consider the three-dimensional case, which requires harder calculation than the two-dimensional case. It has been known that, to construct the measure we need the renormalization, because of the singularity of the interactions. Moreover, the renormalization constant coincides with that of the Φ^4-quantum field measure. In this talk, I will explain the strategies to construct the measure and the Dirichlet form. This is an ongoing joint work with Sergio Albeverio, Makoto Nakashima and Song Liang.

Justin Salez (Université Paris-Dauphine and PSL)

Do there exist expanders with non-negative curvature?

In this talk I will briefly recall the framework of local weak limits of finite graphs introduced by I. Benjamini and O. Schramm, and explain how this probabilistic viewpoint allowed me to answer a classical open question in discrete geometry raised by E. Milman, A. Naor and Y. Ollivier.

Giovanni Peccati* (Luxembourg University)

Quantitative CLTs in deep neural networks and coupling of Gaussian fields

Fully connected random neural networks are fascinating examples of random fields, obtained by hierarchically juxtaposing layers of computational units – sometimes referred to as neurons. Since the pioneering work of Neal (1996), it is known that neural networks exhibit Gaussian behavior in the so-called "large-width limit", that is when the sizes of the layers simultaneously diverge to infinity. One crucial question – which has been relatively little explored in the literature – is how to measure the distance between the distribution of a fixed neural network and its Gaussian counterpart. In this talk, I will explain how one can obtain probabilistic bounds on such discrepancy – featuring an algebraic dependence on the network's width – by exploiting some classical formulae about the optimal coupling of Gaussian fields. Interestingly, the core step in our approach (combining optimal coupling, eigenvalue estimates, and Sobolev embedding) significantly expands a strategy recently used to establish some local universality properties for Gaussian random waves on manifolds. Based on joint work with S. Favaro, B. Hanin, D. Marinucci, and I. Nourdin.

Karl-Theodor Sturm* (University of Bonn)

Spectral estimates under variable and distributional Ricci bounds

We discuss the role of variable and distributional (synthetic lower) bounds for the Ricci curvature in studying spectral gap and gradient estimates for the heat semigroup. In particular, we present a novel sharp lower bound for the spectral gap on a nonnegatively curved Riemannian manifold or, more generally, on an RCD(k, N) space with a variable Ricci bound $k : X \to \mathbb{R}_+$. Our estimate in terms of the L^{-p} norm of k for $p = 1 - 1/N$ improves upon the celebrated Lichnerowicz estimate (1958, case $p = \infty$) and the estimate of Veysseire (2010, case $p = 1$). Also, spectral gap estimates with negative Ricci curvature in the Kato class will be briefly discussed. Moreover, we present gradient estimates for the Neumann heat semigroup on non-convex domains which leads to a negative, distribution-valued Ricci curvature in the Kato class.

Yuichi Shiozawa (Osaka University)

Hausdorff dimensions of inverse images and collision time sets for symmetric Markov processes

This talk is based on a joint work with Jian Wang (Fujian Normal University). In this talk, we establish the Hausdorff dimensions of inverse images and collision time sets for a large class of symmetric Markov processes on metric measure spaces. In order to do so, we apply the approach of the works by Hawkes and Jain–Pruitt, and make full use of heat kernel estimates. Our results efficiently apply to symmetric diffusion processes, symmetric stable-like processes, and symmetric diffusion processes with jumps in d-sets.

Balint Virag (University of Toronto)

The planar stochastic heat equation and the directed landscape

The planar SHE describes heat flow or random polymers on an inhomogeneous surface. It is a finite-temperature version of planar first passage percolation such as the Eden growth model. It is the first model with plane symmetries for which we can show convergence to the directed landscape. The methods use a Skorokhod integral representation and Gaussian multiplicative chaos on path space. Joint work with Jeremy Quastel and Alejandro Ramirez.

Izumi Okada (Chiba University)

Capacity of the range of random walk

We study the capacity of the range of a simple random walk in three and higher dimensions. It is known that the order of the capacity of the random walk range in n dimensions is similar to that of the volume of the random walk range in $n-2$ dimensions. We show that this correspondence breaks down for the law of the iterated logarithm for the capacity of the random walk range in three dimensions. We also prove the law of the iterated logarithm in higher dimensions. In addition, we introduce the relation between the analysis and the estimate of the capacity of the range of a simple random walk.

Christina Goldschmidt (University of Oxford)

Random tree encodings and snakes

There are several functional encodings of random trees which are commonly used to prove (among other things) scaling limit results. We consider two of these, the height process and Lukasiewicz path, in the classical setting of a branching process tree with critical offspring distribution of finite variance, conditioned to have n vertices. These processes converge jointly in distribution after rescaling by $n^{-1/2}$ to constant multiples of the same standard Brownian excursion, as n goes to infinity. Their difference (taken with the appropriate constants), however, is a nice example of a discrete snake whose displacements are deterministic given the vertex degrees; to quote Marckert, it may be thought of as a "measure of internal complexity of the tree". We prove that this discrete snake converges on rescaling by $n^{-1/4}$ to the Brownian snake. We believe that our methods should also extend to prove convergence of a broad family of other "globally centred" discrete snakes which seem not to be susceptible to the methods of proof employed in earlier works of Marckert and Janson. This is joint work in progress with Louigi Addario-Berry, Serte Donderwinkel and Rivka Mitchell.

Vincent Tassion (ETH Zürich)

Robust noise sensitivity of percolation

Consider critical site Bernoulli percolation on the triangular lattice, where each vertex is colored black or white with probability 1/2, independently of the other vertices. In 1999, Benjamini, Kalai and Schramm proved that crossing probabilities are noise sensitive: resampling a small proportion of the vertices lead to an independent percolation picture. Ten years later, Garban, Pete and Schramm obtained a sharp quantitative version of this result. These works rely on Fourier analysis, and are restricted to Bernoulli percolation (i.e. product measure) and the independent resampling dynamics.

In this talk, we will discuss noise sensitivity for more general percolation models, and more general dynamics. Based on a recent approach to noise sensitivity with Hugo Vanneuville (that relies on geometrical arguments and not on spectral methods), we show noise sensitivity of crossing probabilities for high temperature Ising under Glauber dynamics.

Based on a joint work with Hugo Vanneuville.

Shuta Nakajima (Meiji University)

Leading-order asymptotic of maximal edge-traversal time in FPP

In this talk, we will consider the maximal edge-traversal time in first-passage percolation, the maximum value that optimal paths can take when traversing random weighted graphs. We will discuss our use of upper tail large deviation and resampling argument as primary analytical tools. These have enabled us to determine the leading-order asymptotic of the maximal edge-traversal time for several Weibull distributions. This talk is based on joint work with Ryoki Fukushima.

Makiko Sasada (University of Tokyo)

Independence preserving property and integrable systems

The celebrated Kac-Bernstein theorem states that if X and Y are independent real-valued random variables and $X+Y$ and $X-Y$ are also independent, then X and Y have normal distributions with the same variance. This implies that the bijection $F(x,y)=(x+y,x-y)$ has a class of quadruplets of non-Dirac probability distributions $(\mu,\nu,\tilde{\mu},\tilde{\nu})$ satisfying $F(\mu\times\nu)=\tilde{\mu}\times\tilde{\nu}$, and F with this property is said to have the independence preserving property (IP property for short). In earlier works, the IP property has been mostly studied for explicit functions F and used to characterize special probability distributions such as normal, gamma, exponential, inverse-Gaussian, beta and so on. Such property is also called Matsumoto-Yor property if F is given by a special form. In recent years, these characterization results with the IP property are also used to study stationary solutions of stochastic integrable models and invariant measures of discrete (deterministic) integrable systems. Most recently, we start to search for a direct relationship between the IP property of F and the “integrability” of F and obtain some unexpected results. In this talk, I will review recent developments in the study of relationship between the IP property and integrable systems. This talk based on the joint works with David Croydon and Ryosuke Uozumi.

Kenkichi Tsunoda (Kyushu University)

Sharp interface limit for Glauber-Kawasaki process

We discuss scaling limits for Glauber-Kawasaki process. The Glauber-Kawasaki process has been introduced by De Masi et al. to study a reaction-diffusion equation from a microscopic interacting system. They have derived a reaction-diffusion equation as a limiting equation of the density of particles. This limit is usually called hydrodynamic limit. In this talk, I will focus on several scaling limits related to this hydrodynamic limit. Especially, I will discuss a sharp interface limit for this particle system and its large deviation rate function.

Naotaka Kajino (Kyoto University)

Energy measures on fractals: old results and recent progress

This talk will survey the studies on energy measures associated with symmetric diffusions and Dirichlet forms on fractals, which were initiated by Shigeo Kusuoka in [Publ. RIMS **25** (1989), 659–680]. The energy measure of a function u is a Borel measure on the state space which corresponds to a certain positive linear functional defined in terms of the Dirichlet form, and plays, in the theory of regular symmetric Dirichlet forms, exactly the same roles as the classical energy integral measure $|\nabla u|^2 dx$ for Brownian motion on $\mathbb{R}^d$. Despite this clarity of its theoretical roles, its analytic and geometric nature for forms on fractals is a deep mystery.

In the paper mentioned above, Kusuoka proved, in an abstract framework including the Brownian motion on the standard Sierpinski gasket (SG) in any dimension as the principal examples, the following results:

(1) The energy measures are SINGULAR with respect to the standard Hausdorff measure on the fractal.

(2) The martingale dimension of the diffusion is ONE.

He also defined an energy-measure-a.e. defined gradient operator so that the Dirichlet form is expressed as the L^2-norm of the length of the gradient, and Kigami (1993) gave a geometric realization of this gradient structure in the case of SG, known as the harmonic SG. Later Kigami (2008) further proved the following result:

(3) For the two-dimensional SG, this gradient structure, together with the geodesic metric induced by the embedding of the harmonic SG in the plane, satisfies the two-sided GAUSSIAN heat kernel bounds.

The first 30 minutes of this talk will be devoted to surveying central results obtained so far toward better understanding of the phenomena (1), (2), (3) above for diffusions on fractals, including results of recent joint works with Mathav Murugan (UBC) on (1) and (3).

The last 15 minutes of this talk will briefly mention recent studies on *p-forms* and *p-energy measures*, natural L^p-analogs of Dirichlet forms and energy measures, on fractals. The case of $p \neq 2$ is poorly understood at the moment, but jointly with Ryosuke Shimizu (Waseda University) the speaker has recently made some progress on the analog of (1) and (3) and on relations among the p-energy measures for distinct values of p, in the case of the standard SG.

Mathav Murugan (University of British Columbia)

Quasisymmetric uniformization in analysis and probability

The quasisymmetric uniformization problem asks if a given metric space is quasisymmetric to a model space with more desirable properties. Quasisymmetric maps are a metric space analogue of conformal maps. The conformal dimension of a metric space is the infimum of the Hausdorff dimension among all metric spaces that are quasisymmetric to the given space. Conformal dimension was introduced by Pansu (1989) to study Gromov-hyperbolic groups. More recently, the notion of conformal walk dimension was introduced to study Harnack inequalities for symmetric diffusion processes. In both cases, if the infimum is attained, then the attaining space has desirable properties. So the quasisymmetric uniformization problem is often rephrased as follows: is the infimum in the definition of conformal (walk) dimension attained? This talk is a survey on quasisymmetric uniformization in analysis and probability highlighting some parallels and differences. This is based on joint works with Martin Barlow, Zhen-Qing Chen, Naotaka Kajino and Ryosuke Shimizu.

Yuzuru Inahama (Kyushu University)

Quasi-sure analysis on rough path space

Quasi-sure analysis is a potential theoretic part of Malliavin calculus and is known to be a powerful tool to study pinned diffusion processes. In this talk we discuss quasi-sure analysis on the geometric rough path space and apply it to a large deviation principle of Freidlin-Wentzell type and a support theorem of Stroock-Varadhan type for pinned diffusion processes. (Since the speaker has talked on the large deviations several times before, he will put emphasis on the support theorem).

Masato Hoshino (Osaka University)

A regularity structure for the quasilinear generalized KPZ equation

We prove the deterministic local well-posedness result of a regularity structure formulation of the quasilinear generalized KPZ equation and give an explicit form of the renormalized equation in the full subcritical regime. Stochastic convergence results for the solution of the renormalized equation are obtained in regimes that cover the spacetime white noise case.

Martin Hairer (EPFL and Imperial College London)

Renormalisation and symmetries

Abstract TBC

Poster Titles

Matthew Buckland (University of Oxford)
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Masahisa Ebina (Kyoto University)
. . . . *Ergodicity and central limit theorems for stochastic wave equations in high dimensions*

Yuyang Feng (University of Chicago)
. . . *Scaling limit of the critical Fortuin-Kasteleyn decorated random planar map in the supercritical case*

Yushi Hamaguchi (Osaka University)
. . . . . *Markovian lifting and asymptotic log-Harnack inequality for stochastic Volterra integral equations*

Kohei Hayashi (RIKEN iTHEMS)
. . . . . *Derivation of the Kardar-Parisi-Zhang equation from microscopic systems under high temperature regime*

Luis Ivan Hernandez Ruiz (Kyoto University)
. . . . *Limit theorems and construction of renewal Hawkes processes*

Yanyan Hu (Delft University)
. . . . *Large deviations for Cox-Ingersoll-Ross processes with fast switching*

Jonas Köppl (Weierstrass Institute Berlin and TU Berlin)
. . . . *The long-time behaviour of interacting particle systems*

Xinyi Li (Peking University)
. . . . *Sharp asymptotics of arm probabilities in critical planar percolation*

Takahiro Mori (Kyoto Institute of Technology)
. . *Interpretation of capacities and hitting distributions via the boundary theory for symmetric Markov processes*

Takuya Murayama (Kyushu University)
. . . . *Loewner chains and evolution families on parallel slit half-planes*

Hirotatsu Nagoji (Kyoto University)
. . . *Normalizability of the Gibbs measures associated with multivariate version of $P(\Phi)_2$ model*

Kohei Noda (Kyushu University)
. . . . *Integrable structure of the overlap of non-Hermitian random matrices*

Ryoichiro Noda (Kyoto University)
. . . . *Convergence of local times of stochastic processes associated with resistance forms*

Takumu Ooi (Kyoto University)
. . . . *Convergence of processes time-changed by Gaussian multiplicative chaos*

Kohei Sasaya (Kyoto University)
. . . *Some inequalities between Ahlfors regular conformal dimension and spectral dimensions for resistance forms*

Ryosuke Shimizu (Waseda University)
. . . . *First-order Sobolev spaces on the Sierpinski carpet*

William Turner (Imperial College London)
. . . . *LévyGAN: Generative modelling of Lévy area*

Anh Duc Vu (Weierstrass Institute Berlin)
. . . . *Percolation on the Manhattan grid*

Satomi Watanabe (Kyoto University)
. . . . *Asymptotic behavior of simple random walk on uniform spanning tree and loop-erased random walk*

Conference Location

Access information for the Research Institute for Mathematical Sciences (RIMS) can be found here: `www.kurims.kyoto-u.ac.jp/en/access-01.html`.

See also: `www.kyoto-u.ac.jp/en/access/north-campus-map`.

Source: `www.kyoto-u.ac.jp/en/access/campus-maps-for-download`

The locations for the conference activities are as follows.

Talks (including poster talks) Room 420 of RIMS (no. 7 on the above campus map).

Poster session Meeting room and lounge of the Former Head Office of Forest Research Station (no. 15 on the above campus map). Posters also displayed in room 110 of RIMS on Friday.

Lunch can be found in the cafeteria shown on the above campus map. There are also various restaurants located close to RIMS on Imadegawa Street.

The conference dinner on Wednesday evening will be held at Ganko Takasegawa Nijo-en from 6pm. For those attending, please meet directly at the restaurant, or in the RIMS lobby, from which there will be a guide leaving at 5pm. You might like to arrive 20-30 minutes early, as the restaurant has a nice garden in which you will be able to stroll. Map: `https://goo.gl/maps/uyde8vht27AwgEbW9`.