Probability Workshop in Korea 2022

December 18-21, 2022

High1 Resort, Mountain Condominium

Organizers:
Sung-Soo Byun
Nam-Gyu Kang
Jaehun Lee

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KIAS KOREA INSTITUTE FOR ADVANCED STUDY

Timetable

	12.18(Sun)	12.19(Mon)	12.20(Tue)	12.21(Wed)
9:10-9:20		Opening Remark		
9:20-10:00		Panki Kim	Zoran Vondracek	Hyun Jae Yoo
10:00-10:20		Coffee Break	Coffee Break	Coffee Break
10:20-11:00		Jinsu Kim	Seonwoo Kim	Sung Chul Park
11:00-11:20		Coffee Break	Coffee Break	Coffee Break
11:20-12:00		Kyeongsik Nam	Ildoo Kim	Kunwoo Kim
12:00-14:00	Arrival	Lunch	Lunch	Departure
14:00-18:00	Intensive Discussion	Intensive Discussion	Intensive Discussion	
18:00-19:00	Banquet	Dinner	Dinner	
19:00-19:40		Hong Chang Ji	Jaeyun Yi	
19:40-20:00		Coffee Break	Coffee Break	
20:00-20:40		Jaehun Lee	Beom-Seok Han	

December 19(Mon)

Heat kernel upper bounds for symmetric Markov semigroups

Panki Kim (SNU) (9:20 - 10:00)

It is well known that Nash-type inequalities for symmetric Dirichlet forms are equivalent to on-diagonal heat kernel upper bounds for the associated symmetric Markov semigroups. In this talk, we discuss the equivalence among these and off-diagonal heat kernel upper bounds under some mild assumptions. Our approach is based on a new generalized Davies' method. We also discuss some applications too.

This talk is based on joint works with Zhen-Qing Chen, Takashi Kumagai and Jian Wang.

Positive recurrence and mixing times for stochastically modeled biochemical reaction systems

Jinsu Kim (POSTECH) (10:20 - 11:00)

Reaction networks, which describe graphically biochemical interactions, have been used to study qualitative behaviors of biochemical systems based on their structural features. When a reaction network is modeled stochastically, we often use continuous-time Markov chains that represent the counts of species in the associated biochemical system. One of the main interests in study of those Markov chains is to find which structural conditions of the underlying reaction network imply positive recurrence and exponential ergodicity. In this talk, we discuss some tools for exploring those main problems: Lyapunov function approaches and spectral gap approaches.

Universality of Poisson-Dirichlet law for log-correlated fields

Kyeongsik Nam (KAIST) (11:20 - 12:00)

It is widely conjectured that Poisson-Dirichlet behavior appears universally in the low-temperature disordered system. However, this principle has been verified only for the particular models which are exactly solvable. In this talk, I will talk about the universal Poisson-Dirichlet behavior for the general log-correlated Gaussian fields. This is based on the ongoing work with Shirshendu Ganguly.

Eigenvalues, eigenvector overlaps, and singular values of non-Hermitian random matrices

Hong Chang Ji (IST Austria) (19:00 - 19:40)

In this talk, we consider spectral properties of a large random non-Hermitian matrix X, whose entries consist of IID random variables. On macroscopic and mesoscopic scales, it is widely known that the eigenvalues of X are subject to the celebrated circular law, that is, they are asymptotically uniformly distributed on the unit disk in the complex plane. However, eigenvalues of X on microscopic scale remain largely untouched, mainly due to the instability of the spectrum of X. In this talk, we discuss recent developments on the three subjects in the title, all closely related to this instability. In particular, we show that the overlaps between the left and right eigenvectors X are bounded by the size of X in probability.

Least singular value of a random regular digraph

Jaehun Lee(HKUST) (20:00 - 20:40)

Let A be the adjacency matrix of a random d-regular digraph on n vertices. Jain-Sah-Sawhney recently showed that the least singular value $s_n(A)$ of A has a lower bound $\delta/\sqrt{n}$ with probability at least $1-O(\delta+e^{-cn})$ for some small constant $c>0$ when A is dense. Jain-Sah-Sawhney recently showed that the following holds for the least singular value $s_n(A)$ of A: $\mathbb{P}(s_n(A))$ for some small constant $c>0$ if A is dense, i.e. $d=\lambda n$ for some $\lambda\in(0,1)$. As a main input to get a nice small ball probability, they used the concept called *combinatorical least common denominator* (CLCD), which was introduced by Tuan Tran. In this talk, I will review the method using CLCD and discuss some possible extensions. This talk is based on the ongoing work with Zhingang Bao and Yukun He.

December 20(Tue)

Dirichlet forms with jump kernels degenerate at the boundary

Zoran Vondracek (University of Zagreb) (9:20 - 10:00)

In this talk I will give an overview of recent results on Dirichlet forms and corresponding Markov processes with jump kernels degenerate at the boundary. I will discuss the general framework as well as motivating examples, and will describe some unexpected new features of potential theory and analysis of such Markov processes.

The talk is based on several joint papers with Soobin Cho, Panki Kim and Renming Song.

Approximation method to metastability: an application to Ising/Potts models without external fields

Seonwoo Kim (SNU) (10:20 - 11:00)

We introduce a new method to prove metastable behaviors, which is the H^1-approximation method of the equilibrium potential function. The strength of this method lies on the fact that one may avoid referring to complicated objects or principles in potential theory, such as the flow structure, the Dirichlet and Thomson principles, etc. As an application, we explain the metastable behavior of Ising/Potts models without external fields in the low-temperature regime. This talk is based on a joint work with Insuk Seo.

An L_p-maximal regularity estimate of moments of solutions to second-order stochastic partial differential equations

Ildoo Kim (Korea University) (11:20 - 12:00)

In this talk, we present a short history of L_p-theories to second-order stochastic partial differential equations and introduce a recent "moment first" estimate to second-order stochastic partial differential equations.

Fractal geometry of the parabolic Anderson model with spatial white noise

Jaeyun Yi (KIAS) (19:00 - 19:40)

In this talk, we discuss the fractal geometry of the parabolic Anderson model (PAM) with spatial white noise. The PAM is a default model that describes diffusion phenomena in random environments, which exhibits a localization property called intermittency or Anderson localization. We will show that tall peaks of PAM with spatial white noise in dimension two and three is macroscopically multifractal. More precisely, we compute the macroscopic Hausdorff dimension of the tall peaks of the solution to the PAM. As a byproduct, we obtain the spatial asymptotics of the PAM. The key idea of the proof is the estimation of the solution using the theory of paracontrolled distribution which is a modern tool for studying singular (S)PDEs.

L_p-solvability for stochastic Burgers' equations perturbed by space-time white noise with time-fractional derivatives

Beom-Seok Han (POSTECH) (20:00 - 20:40)

Burgers' equation is recognized as the fundamental nonlinear partial differential equation, and it is used in various fields. In this talk, we discuss L_p-solvability for stochastic Burgers' equations perturbed by space-time white noise with time-fractional derivatives. Additionally, we provide the Holder-regularity of the solution.

December 21(Wed)

Stochastic spin systems, symmetry, and entropy production

Hyun Jae Yoo (HKNU) (9:20 - 10:00)

In this talk we discuss the interacting particle systems in the discrete spaces, e.g. lattice systems, with equilibrium measures the Gibbs measures for the system. We construct Markov jump processes resulting from spin flips or spin changes (namely, Glauber dynamics or Kawasaki dynamics). Then we discuss the symmetry and entropy production for the dynamics. The Gibbsian nature of the reference measures will greatly facilitate the analysis of the dynamical systems.

Universality in the scaling limit of the planar Ising model

Sung Chul Park (KIAS) (10:20 - 11:00)

The conjecture that the critical Ising model on the square lattice in two dimensions is conformally invariant has broadly been verified rigorously, thanks in large part to the discrete complex analytic formalism developed by Smirnov and others. In this talk I will give an overview of recent developments generalizing this setup in both the directions of thermal perturbation (near-criticality) and the type of the lattice (universality). I will end by describing ongoing research in the framework of Chelkak's s-embedding, which aims to replace assumptions based on specific lattice topology with ones largely based on geometric and analytic notions. Based on joint works with Chelkak, Wan, Mahfouf and others.

Long-time behavior of stochastic heat equations

Kunwoo Kim (POSTECH) (11:20 - 12:00)

The long-time behavior of stochastic heat equations perturbed by space-time white noise depends on the spatial domain and the initial data. In this talk, we consider stochastic heat equations on a one-dimensional torus and the real line and investigate how the long-time behavior depends on the spatial domain and the initial data. This is based on joint work with Davar Khoshnevisan and Carl Mueller.

List of participants

Last Name (성)	First Name (이름)	Affiliation (소속)
Byun	Sung-Soo	KIAS
Cho	Soobin	Seoul National University
Choi	Jae-Hwan	KAIST
Han	Beomseok	POSTECH
Ji	Hongchang	IST Austria
Jung	Ji Hyung	KAIST
Kang	Nam-Gyu	KIAS
Kim	Kunwoo	POSTECH
Kim	Seonwoo	Seoul National University
Kim	Panki	Seoul National University
Kim	Jinsu	POSTECH
Kim	Ildoo	Korea University
Lee	Jinbong	Seoul National University
Lee	Jung-Kyoung	Seoul National University
Lee	Jaehun	KIAS
Lee	Jaehun	HKUST
Lee	Sanha	Seoul National University
Lee	Yongwoo	Seoul National University
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Nam	Kyeongsik	KAIST
Park	Sung Chul	KIAS
Park	Daehan	KAIST
Ramil	Mouad	Seoul National University
Ryu	Junhee	Korea University
Ryu	Jeeho	Seoul National University
Seo	Jinsol	Korea University
Seo	Insuk	Seoul National University
Sung	Jinwoo	University of Chicago
Vondracek	Zoran	University of Zagreb
XU	Xiaocong	HKUST
Yang	Seoyeon	Princeton University
Yi	Jaeyun	KIAS
Yoo	Hyun Jae	Hankyong National University