12th Sendai Workshop on

Non-Commutative Stochastic Analysis and Applications

Venue: Graduate School of Information Sciences, Tohoku University
Dates: October 17-19, 2016
Organizers: Nobuaki Obata (Tohoku University), Un Cig Ji (Chungbuk National University)
Sponsors: (1) JSPS-NRF Basic Scientific Cooperation Program "Non-commutative stochastic analysis: New prospects of quantum white noise and quantum walk" (Leader: Nobuaki Obata, Graduate School of Information Sciences, Tohoku University; Co-leader: Un Cig Ji, Department of Mathematics, Chungbuk National University)
(2) JSPS Program for Advancing Strategic International Networks to Accelerate the Circulation of Talented Researchers "Development of Concentrated Mathematical Center Linking to Wisdom of the Next Generation" (Leader: Nobuo Tsuzuki, Institute of Mathematics, Tohoku University)

Program

October 17 (Mon) 6F Small Lecture Room

10:00 – 10:50
Implementation problems for operators on vector-valued white noise functionals
Un Cig Ji (Chungbuk National University, Korea)

We discuss a systematic study of operator-valued quantum white noise and then apply it to implementation problems for operators on vector-valued white noise functionals. This talk is based on a long-term collaboration with Nobuaki Obata.

11:00 – 11:50
The Fourier walk on the integer lattice
Norio Konno (Yokohama National University, Japan)

The Fourier walk is a discrete-time quantum walk whose quantum coin is given by the Fourier matrix. In this talk, we consider Fourier walks on one and two dimensional lattices. In particular, we discuss localization of the walks.

13:30 – 14:20
Persistence of unvisited sites in quantum walks on a line
Martin Stefanak (Czech Technical University, Czech)

We analyze the asymptotic scaling of persistence of unvisited sites for quantum walks on a line. In contrast to the classical random walk there is no connection between the behaviour of persistence and the scaling of variance. In particular, we find that for a two-state quantum walks persistence follows an inverse power-law where the exponent is determined solely by the coin parameter. Moreover, for a one-parameter family of three-state quantum walks containing the Grover walk the scaling of persistence is given by two contributions. The first is the inverse power-law. The second contribution to the asymptotic behaviour of persistence is an exponential decay coming from the trapping nature of the studied family of quantum walks. In contrast to the two-state walks both the exponent of the inverse power-law and the decay constant of the exponential decay depend also on the initial coin state and its coherence. Hence, one can achieve various regimes of persistence by altering the initial condition, ranging from purely exponential decay to purely inverse power-law behaviour. In some sense this problem is complementary to the problem of recurrence and Polya number. So I can give a short review of classical and quantum walks, talk about recurrence and Polya number and then move to persistence.

14:30 – 15:20
Open quantum random walks on the crystal lattices
Hyun Jae Yoo (Hankyong National University, Korea)

We consider open quantum random walks (OQRW's) on the crystal lattices and discuss the limit distributions. It is known that on the regular lattices, the OQRW's meet the central limit theorem in general. We investigate whether the local structure of the quotient graph of crystal lattices have some effect on the limit distributions or not.

15:30-16:20
Generalized log-majorization and multivariate trace inequalities
Fumio Hiai (Tohoku University, Professor Emeritus, Japan)

We show a multivariate matrix norm inequality and certain variations thereof for unitarily invariant norms, whose special cases give multivariate generalizations of the Araki-Lieb-Thirring inequality and the Golden-Thompson inequality. The main technical contribution is a generalization of the concept of log-majorization that allows us to treat majorization with respect to logarithmic integral averages of singular value vectors. This is joint work with Robert König and Marco Tomamichel.

October 18 (Tue) AM: 6F Small Lecture Room PM: 2F Middle Lecture Room

10:00 – 10:50 *Tutorial Lecture*
Convolutions in noncommutative probability I
Takahiro Hasebe (Hokkaido University, Japan)

Many convolutions were introduced in noncommutative probability. I explain what is going on in this field. The main emphasis is put on classical, free, monotone and boolean convolutions. If time allows I will also mention other convolutions such as bi-free convolution and finite free convolution.

11:00 – 11:50

The product of distributions and WN-distribution valued stochastic processes

Kimiaki Saitô (Meijo University, Japan)

In this talk we introduce a new locally convex space of distributions, as a generalization of the space from [2], in which we have the product of any distributions as a series expansion. Then we discuss higher powers of the complex white noise on the space consisting of distributions without any renormalization. We also extend the Lévy and Volterra Laplacians to operators on a locally convex space taking the completion of the set of all distribution-coefficient polynomials on distributions with respect to some topology, and give an infinite dimensional Brownian motion generated by the Lévy Laplacian with a divergent part as a distribution. Based on those results, we obtain white noise distribution-valued stochastic differential equations, for the delta distribution centered at the infinite dimensional Brownian motion and also a sum of delta distributions centered at one dimensional Brownian motions.

References:

[1] Accardi, L., Ji, U. C. and Saitô, K.: The exotic (higher order Lévy) Laplacians generate the Markov processes given by distribution derivatives of white noise, Infinite Dimensional Analysis, Quantum Probability and Related Topics, 16, no. 3 (2013) 1-26.

[2] Saitô, K. and Shimada, T.: Powers of an infinite dimensional Brownian motion associated with the product of distributions, Communications on Stochastic Analysis 8, no. 3 (2014) 343-364.

[3] Kuo, H.-H., Saitô, K. and Shibata, Y.: The product of distributions and WN-distribution valued stochastic differential equations, to appear in Communications on Stochastic Analysis (2016).

13:30 – 14:20

Multiple recurrence and ergodic property in C-dynamical system*

Jaeseong Heo (Hanyang University, Korea)

In this talk, we study the ergodic properties of C*-dynamical systems which are related to multiple recurrence results of Furstenberg. We also consider multiple weak mixing properties in the C*-algebra framework.

14:30-15:20

Essential selfadjointness of the Laplacian and 2-parameter Brownian motion

Jun Masamune (Hokkaido University, Japan)

In this talk, we will learn a characterization of essential selfadjointness of the Laplacian in terms of 2-parameter Brownian motion. This can be considered as a quantum version of the relationship between the Markov uniqueness of the Laplacian and that standard Brownian motion; indeed, in both cases, proper notions of capacities play crucial role. This is a joint project with Michael Hinz from Bielefeld University.

16:00-17:00 *Colloquium Lecture*
Attempting to understand QM using the algebraic approach and quantum probability
Philippe Blanchard (University of Bielefeld, Germany)

Von Neumann's algebraic framework of QM is general enough to accommodate both classical and quantum systems and thus facilitates the description of situations in which quantum systems develop classical behavior in a FAPP fashion. For this reason, foundational issues of quantum physics (theory of experiments, events, decoherence) are best discussed in this framework.

References:

[1] Ph. Blanchard, J. Fröhlich (Editors): The Message of Quantum Science Attemps Towards a Synthesis, With a Foreword by Serge Haroche, Lecture Notes in Physics 899, Springer 2015

October 19 (Wed) 2F Middle Lecture Room

10:00 – 10:50 *Tutorial Lecture*
Convolutions in noncommutative probability II
Takahiro Hasebe (Hokkaido University, Japan)

11:00-11:50
Distance matrices and quadratic embedding of graphs
Nobuaki Obata (Tohoku University, Japan)

For a connected graph G we define the distance matrix by $D = [\, d\,(x,y)]$. It follows from the famous results by Schoenberg (1935-1937) that the graph G admits a quadratic embedding if and only if D is conditionally negative definite. I will report on the investigation of graphs which admit quadratic embedding and related questions. The Q-matrix of G is defined by $Q = Q_q = [\, q^{d(x,y)}\,]$, which is the entrywise exponential of the distance matrix D. We are interested in the domain of q for which Q_q is positive definite. I will discuss some examples and related questions.

12:00-12:50
Construction of the eigenspace of Grover walk on regular trees
Etsuo Segawa (Tohoku University, Japan)

In this talk, we completely construct the eigenspace of the Grover walk on the regular tree. We show that this eigenspace is generated by combinatorial flow on the regular tree. We suggest that the Grover walk on infinite trees may provide a limit of not so much the Grover walk on its nth depth finite tree as the quantum walk with all marked vertices at the nth depth.

13:00 Closing