43rd International Conference on Quantum Probability and Infinite Dimensional Analysis (QP-43)

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Location : Utop Marina, Yeosu, Korea

Sponser : NRF of Korea

Research Institute for Natural Sciences
(한양대학교 자연과학연구소)

43rd International Conference on Quantum Probability and Infinite Dimensional Analysis (QP-43)

Scientific Committee:

- Luigi Accardi, (Universita di Roma Tor Vergata, Italy)
- B V Rajarama Bhat (Indian Statistical Institute, India)
- Marek Bozejko (Wroclaw University, Poland)
- Franco Fagnola (Politecnico di Milano, Italy)
- Uwe Franz (Universite de Franche-Comte, France)
- Kalyan B Sinha (JN Centre for Advanced Scientific Research, India)
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- Jaeseong Heo (Hanyang University, Korea)
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Sponsors:

- National Research Foundation of Korea (NRF)
- Department of Mathematics, Hanyang University
- Research Institute for Natural Sciences

Speakers

- Luigi Accardi (University of Roma Torvergata)
- Joonwoo Bae (KAIST: Korea Advanced Institute of Science and Technology)
- B V Rajarama Bhat (Indian Statistical Institute, Bangalore)
- Santanu Dey (Indian Institute of Technology Bombay)
- Franco Fagnola (Politecnico di Milano)
- Malte Gerhold (NTNU Trondheim)
- Fumio Hiroshima (Kyushu University)
- Jaewan Kim (KIAS; Korea Institute for Advanced Study)
- Sangho Kum (Chungbuk National University)
- Seung-Hyeok Kye (Seoul National University)
- Hun Hee Lee (Seoul National University)
- Hyun Ho Lee (University of Ulsan)
- Wojciech Mlotkowski (Wroclaw University)
- Habib Ouerdiane (University of Tunis El Manar)
- Sang-Jun Park (Seoul National University)
- Habib Rebei (Qassim University)
- Kalyan B. Sinha (JN Centre for Advanced Scientific Research)
- EL Gheteb Soueidi (University of Nouakchott Al-Aasriya)
- Sivaguru S. Sritharan (Air Force Research Laboratory)
- Alexander Teretenkov (Steklov Mathematical Institute of Russian Academy of Sciences)
- Noboru Watanabe (Tokyo University of Science)
- Janusz Wysoczanski (University of Wroclaw)
- Quanhua Xu (Université de Franche-Comté)
- Hyun Jae Yoo (Hankyong National University)
- Sang-Gyun Youn (Seoul National University)

Time Table

time	January 8 (Sun)	January 9 (Mon)	January 10 (Tue)	January 11 (Wed)	January 12 (Thu)	January 13 (Fri)	January 14 (Sat)
07:00 ~ 09:00		Breakfast	Breakfast	Breakfast	Breakfast	Breakfast	Breakfast
09:25 ~ 09:30		Opening					
09:30 ~ 10:15		Accardi	Seung Hyeok Kye	Sinha	Jaewan Kim	Xu	Free Discussion
10:15 ~ 11:00		Hiroshima	Wysoczanski	Fagnola	Ouerdiane	Bhat	
11:00 ~ 11:15		Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Departure
11:15 ~ 12:00		Hun Hee Lee	Sritharan	Mlotkowski	Watanabe	Hyun Jae Yoo	
12:00 ~ 14:00		Lunch	Lunch	Lunch	Lunch	Lunch	
14:00 ~ 14:40	Arrival	Joonwoo Bae	Rebei	Sangho Kum	Free Afternoon	Free Discussion	
14:40 ~ 15:20		Soueidi	Dey	Gerhold			
15:20 ~ 15:40	Free Discussion	Coffee Break	Coffee Break	Coffee Break		Coffee Break	
15:40 ~ 16:20		Hyun Ho Lee	Teretenkov	AQPIDA meeting		Free Discussion	
16:20 ~ 17:00		Sang Jun Park	Sang Gyun Youn	IDAQP EB meeting			
18:00 ~ 20:00	Dinner	Dinner	Dinner	Dinner	Banquet	Dinner	

Titles and Abstracts

Luigi Accardi (University of Roma Torvergata)

Title: TBA

Abstract: TBA

Joonwoo Bae (KAIST : Korea Advanced Institute of Science and Technology)

Title: Verifying entanglement with minimal measurements

Abstract: Entanglement witnesses (EWs) are a versatile tool to detect entangled states and also characterize the set of separable states. In this talk, I discuss a practical scenario of verifying entangled states and present cost-effective strategies for constructing and exploiting EWs. I show the minimal measurement setting of mutually biased bases (MUBs), the most experiment-friendly measurement that can be applied to quantum tomography in general, that can detect bound entangled states. I then present a brand new framework called EW 2.0 that upgrades the capabilities of existing EWs. Finally, a conjecture concerning EW 2.0 is addressed.

B V Rajarama Bhat (Indian Statistical Institute, Bangalore)

Title: Peripheral Poisson boundary

Abstract: It is shown that the operator space generated by peripheral eigenvectors of a unital completely positive map on a von Neumann algebra has a C^*-algebra structure. This extends the notion of non-commutative Poisson boundary by including the point spectrum of the map contained in the unit circle. The main ingredient is dilation theory. This theory provides a simple formula for the new product. The notion has implications to our understanding of quantum dynamics. For instance, it is shown that the peripheral Poisson boundary remains invariant in discrete quantum dynamics. This talk is based on a joint work with Samir Kar and Bharat Talwar.

Santanu Dey (Indian Institute of Technology Bombay)

Title: Characteristic function of row contractions and colligations

Abstract: We show that the characteristic function of lifting is a complete invariant for liftings of row contractions. A certain class of colligations with defect spaces of finite dimension is characterized. Transformations of the characteristic function of lifting based on Blaschke factor are studied.

Franco Fagnola (Politecnico di Milano)

Title: Gaussian Quantum Markov Semigroups

Abstract: Gaussian (quasi-free) QMS describe the evolution of open quantum systems of bosons interaction with the surrounding environment. They also generalize bosonic quadratic Hamiltonians. In this talk we first introduce QMS and describe the Gorini – Kossakowski – Lindblad – Sudharshan (GKLS) structure of their generators. Next, we illustrate the construction of Gaussian QMS by the minimal semigroup method and discuss some properties of the Markovian dynamics such as irreducibility, ergodicity, existence of invariant states, the structure of the decoherence-free subalgebra in which the reduced evolution is homomorphic. Finally, we outline the computation of the spectral gap.

References

J. Agredo, F. Fagnola and D. Poletti, Gaussian QMSs on a One-Mode Fock Space: Irreducibility and Normal Invariant States. Open Sys. Information Dyn. 28 no. 01, 2150001 (2021). https://doi.org/10.1142/S1230161221500013

J. Agredo, F. Fagnola and D. Poletti, The decoherence-free subalgebra of Gaussian QMSs. Milan J. Math. 90 (2022) 257–289. https://doi.org/10.1007/s00032-022-00355-0 arxiv.org/abs/2112.13781.

F. Fagnola and D. Poletti, Irreducibility of Gaussian Quantum Markov Semigroups. Infin. Dimens. Anal. Quantum Probab. Relat. Top. 25 (2022). https://doi.org/10.1142/S021902572240001X

Malte Gerhold (NTNU Trondheim)

Title: Classification of two-faced independences

Abstract: Two-faced independences are independence relations for pairs of noncommutative random variables, such as bifree independence, which models the relation between left and right regular representation of the free group in the canonical tracial state. Around 2000, in works of Speicher, Ben Ghorbal & Schürmann, and Muraki, a complete classification of "single-faced" independences was obtained: the only independences in this case are boolean, tensor, free, monotone and anti-monotone independence. I report on the current status of the classification program for two (or multi-faced) independences.

Based on joint work with Takahiro Hasebe & Michaël Ulrich (arXiv:2111.07649) and Philipp Varšo (in preparation, many results can be found in his PhD thesis).

Fumio Hiroshima (Kyushu University)

Title: Semi-classical analysis in quantum field theory

Abstract: The Newton-Maxwell equation is derived from the semi-classical limit of the Pauli-Fierz Hamiltonian in quantum field theory through the so-called Wigner measure on the infinite dimensional phase space. This is the great extension of the results by P.L.Lions and T. Paul (1993) who studied the semi-classical analysis of Schroedinger operators through the Wigner measure on the finite dimensional phase space.

Jaewan Kim (KIAS; Korea Institute for Advanced Study)

Title: quDit entanglements using cross-Kerr and self-Kerr nonlinearity

Abstract: A coherent state can be interpreted as a superposition of pseudo-number states with equal weight. Using cross-Kerr nonlinearity two coherent states can be made into a maximal entanglement of pseudo-number states and pseudo-phase states. Some applications of the entanglements of pseudo-number/phase states, such as quDit teleportations, will be discussed. Using self-Kerr nonlinearity and beam splitting, a coherent state can be transformed into a maximal entanglement of pseudo-number states, which is an equivalent of a maximal entanglement of pseudo-phase states.

Sangho Kum (Chungbuk National University)

Title: A GPM-based algorithm for solving regularized Wasserstein barycenter problems in some spaces of probability measures

Abstract: In this talk, we focus on the analysis of the regularized Wasserstein barycenter problem. We provide uniqueness and a characterization of the barycenter for two important classes of probability measures, each regularized by a particular entropy functional: (i) Gaussian distributions and (ii) q-Gaussian distributions. We propose an algorithm based on gradient projection method (GPM) in the space of matrices in order to compute these regularized barycenters. Finally, we numerically show the influence of parameters and stability of the algorithm under small perturbation of data and compare the gradient projection method with Riemannian gradient method.

Seung-Hyeok Kye (Seoul National University)

Title: Connecting compositions and tensor products of linear maps between matrix algebras

Abstract: Compositions and tensor products play essential roles to define and characterize basic notions in current quantum information theory like entanglement breaking quantum channels, superpositive maps, completely positive maps and k-positive maps as well as separability, entanglement, Schmidt numbers and blockpositivity.

In this talk, we exhibit an identity which connects compositions and tensor products of linear maps between matrix algebras through Choi matrices. With this identity, we recover various known characterizations of the aforementioned notions in a single framework. As another application of the identity, we provide equivalent claims to the PPT square conjecture in terms of tensor products.

Hun Hee Lee (Seoul National University)

Title: Gaussian states and channels over general quantum kinematical systems

Abstract: We develop a theory of Gaussian states and channels over general quantum kinematical systems with finitely many degrees of freedom. The underlying phase space is described by a locally compact abelian group G with a symplectic structure determined by a 2-cocycle on G. We completely characterize Gaussian states over groups of the form $G=F\times\hat{F}$ when F is either totally disconnected and 2-regular, or the n-torus $\mathbb{T}^n$. As a corollary, we generalize the discrete Hudson theorem to finite 2-regular groups.

We also introduce the class of metaplectic quantum channels, a generalization of linear bosonic channels, and obtain Gaussian channels as a natural subclass. We exhibit single letter formulae for the quantum capacity and minimum output entropy for arbitrary Gaussian channels over finite 2-regular groups. In angle-number systems, we present explicit formulae for the action of every Gaussian channel on the canonical matrix units.

Hyun Ho Lee (University of Ulsan)

Title: Dualities of finite group actions

Abstract: We review the notion called Rokhlin property of finite group action on a unital C*-algebra due to M. Izumi and various weakened versions of such a rigid action.

Among them, we focus on the weak tracial Rokhlin property of a finite group action which is available even for projectionless situations. We will present a recent recast of this property in term of a mapping property, or an equivalent approach and show some applications of this property.

Wojciech Mlotkowski (Wroclaw University)

Title: Probability distributions with rational free R-transform

Abstracts: We study the class of those probability distributions for which the free R-transforms are rational functions. This class is closed under the additive free convolution, additive free powers and under the monotone convolution. We prove a sufficient condition that a rational function is the free R-transform of a probability distribution. Several examples are provided, including that of free deconvolutions.

Habib Ouerdiane (University of Tunis El Manar)

Title: Solutions of Infinite Dimensional Evolution Equations

Abstract: In this talk, we develop the theory of operators defined on infinite dimensional holomorphic functions. Then we give a characterization theorem between this class of operators and their symbols.

As application we give an explicit solution of some linear white noise differential equations by applying the convolution calculus on a suitable distribution spaces. In particular we obtain explicite solutions of some evolution equation. The main tool is the interpretation of the power of the Gross Laplacian as a convolution operator.

Sang-Jun Park (Seoul National University)

Title: A universal framework for entanglement detection under group symmetry

Abstract: Entanglement of quantum states is one of the most fundamental notions in quantum information theory because of its usefulness in many quantum protocols and computations. However, studying entanglement is in general difficult, both from mathematical and computational points of view. In this talk, we propose a method that can be efficient to characterize the entanglement of quantum states having group symmetry. Moreover, we apply our method to characterize entanglement-breaking properties of covariant channels with respect to the signed symmetric group.

Habib Rebei (Qassim University)

Title: The quadratic Weyl operators

Abstract: In this talk we introduce the exponential operators $e^{B_f^+}, e^{B_f^-}$ and e^{N_f} defined by their action on the quadratic exponential vectors. We define the continuous version of the quadratic Weyl operators canonically associated to the one-mode renormalized square of white noise (RSWN) algebra as unitaryoperators acting on the quadratic Fock space. Especially, we compute their action on the family of the quadratic exponential vectors.

Kalyan B. Sinha (JN Centre for Advanced Scientific Research)

Title: Convex Analysis and Statistical Theory of Machine Learning - Classical and Quantum.

Abstract: There exists a large body of beautiful theory of Convex Analysis, developed in 60-mid-70's, which forms the abstract, fundamental backbone of the Statistical Decision Theory of Wald (as well as of von Neumann's Theory of Games). Some of it will be discussed, as will be their applications to the theories of Machine Learning in both Classical and Quantum Domain.

EL Gheteb Soueidi (Faculty of Sciences and Technologies, Nouakchott, Mauritania**)**

Title: Hidden Quantum Markov Chains

Abstract: In this talk, we introduce briefly the notions of hidden quantum processes. We study the case were the hidden process is a quantum Markov chain. We prove that the diagonal restriction of the hidden quantum Markov process produce a new family of classical stochastic processes called a 3-tier hidden Markov process. In particular, processes in this family produce a first class of examples of the generalized hidden processes, namely: hidden processes whose underlying process is not Markov.

Sivaguru S. Sritharan (Air Force Research Laboratory)

Title: Stochastic quantization and white noise analysis of nonlinear wave propagation problems in laser and plasma

Abstract: In this talk we will study a large number of important nonlinear wave problems in Laser propagation and plasma interaction subject to singular white noise initial data and forcing. The models include nonlinear Schrodinger equation, stochastic KDV equation, stochastic transport equation, Benjamin-Ono equation, Davey-Stewartson equation, etc. We use Wick quantization of nonlinearities and product terms and then use S-transform (or Hermite transform) to convert the problems to deterministic nonlinear PDEs with complex parameters. We deduce the solvability of S-transformed models using deterministic PDE theory and then apply inverse S-transform to deduce the stochastic solvability of these models. Since a majority of nonlinear partial differential equations that arise in mechanics and physics have polynomial or quasilinear structure white noise theory enjoys its full power in dealing with singular noise situations. We will describe a holistic perspective of several important applications in this context and white noise analysis.

Alexander Teretenkov (Steklov Mathematical Institute of Russian Academy of Sciences)

Title: Closed linear dynamics of moments for quantum master equations

Abstract: We consider several examples of quantum master equations such that the dynamics of moments up to any finite order of (bosonic or fermionic) creation and annihilation operators is (exactly) closed and linear. Namely, we consider the quantum master equations which occur in the case of averaging of unitary dynamics with quadratic generators with respect to classical Levy fields, in particular with respect to Poisson and Wiener stochastic processes. We show that the dynamics of the moments of any fixed order (even without lower order ones) is described by the closed system of ordinary linear differential equations. We also consider quantum master equations which occur in the case of averaging of the dynamics with arbitrary quadratic Gorini-Kossakowski-Sudarshan-Lindblad generators with respect to classical subordinators. We show that the dynamics of the moments up to fixed order (i.e. of given order and all the lower ones) is also described by the closed system of ordinary linear differential equations. We discuss some recent physical applications of these results.

The talk is based on the works:

1. D. D. Ivanov, A. E. Teretenkov, “Dynamics of Moments and Stationary States for GKSL Equations of Classical Diffusion Type”, Math. Notes, 112:2 (2022), 318–322.

2. Iu. A. Nosal, A. E. Teretenkov, “Higher Order Moments Dynamics for Some Multimode Quantum Master Equations”, Lobachevskii J. Math., 43:7 (2022), 1726–1739.

3. T. Linowski, A. Teretenkov, L. Rudnicki, “Dissipative evolution of quantum Gaussian states”, Physical Review A, 106 (2022), 052206.

Noboru Watanabe (Tokyo University of Science)

Title: On Transmitted complexity for Quantum Compound Systems

Abstract: The study of complexity is strongly related to the study of entropy theory for classical and quantum systems. The quantum entropy was introduced by von Neumann around 1932, which describes the amount of information of the quantum state itself. It was extended by Ohya for C^*-systems before CNT entropy. The quantum relative entropy was first defined by Umegaki for σ-finite von Neumann algebras, which was extended by Araki and Uhlmann for general von Neumann algebras and $*$-algebras, respectively. By introducing a new notion, the so-called compound state, in 1983 Ohya formulated the mutual entropy in a complete quantum mechanical system (i.e., input state, output state and channel are all quantum mechanical) describing the amount of information correctly transmitted through the quantum channel.

In this talk, we briefly review the transmitted complexities for classical and quantum dynamical systems. We introduce some complexities by means of entropy functionals in order to treat the transmission processes consistently. We apply the general frames of quantum entropy for quantum dynamical systems. Finally, we define a transmitted complexity (quantum dynamical mutual entropy) by mean of the modified compound states and we prove the fundamental inequalities of the transmitted complexity for the independent quantum dynamical systems.

Janusz Wysoczanski (University of Wroclaw)

Title: Distributions for Nonsymmetric Weakly Monotone Position Operators

Abstract: We study the vacuum distributions of sums of non-symmetric position operators on weakly monotone Fock space. For single operators the distribution is shown to be in the free Meixner class. The same is shown for the limit distribution. For finite sums we present the combinatorial description of moments of the distributions, using the combinatorics of Motzkin and Riordan paths.

Quanhua Xu (Université de Franche-Comté)

Title: Quantized differential calculus on quantum tori

Abstract: We provide a generalization of McDonald, Sukochev and Xiong's result on quantum differentiability in the sense of Connes on quantum tori. We also characterize the Schatten class membership of Schatten type operators on quantum tori.

Hyun Jae Yoo (Hankyong National University)

Title: Interacting particle systems associated with determinantal point processes in discrete spaces

Abstract: In this talk we discuss the interacting particle systems in the discrete spaces, e.g. lattice systems, with equilibrium measures the determinantal point processes (DPPs). For some restricted class of DPPs, namely when the spectrum of the kernel operators are strictly less than 1, we can show that the DPPs are Gibbs measures for certain potentials. Then we construct the Glauber and Kawasaki dynamics for the systems. Then we discuss the symmetry and entropy production for the dynamics.

Sang-Gyun Youn (Seoul National University)

Title: Information-theoretic analysis of covariant quantum channels

Abstract: It has a long history in quantum information theory to study quantum channels with symmetries, which we call covariant quantum channels. Some standard examples are the depolarizing quantum channels and Werner-Holevo quantum channels arising from the fundamental symmetries of the unitary group. There have been lots of studies for more general group symmetries, but with non-unified approaches and limitations to the fundamental group symmetries without the representation theory. This talk divides into two different topics. One part is to present a universal representation-theoretic framework to understand the structure of covariant quantum channels, and the other part is to discuss detailed information-theoretic properties of SU(2)-covariant quantum channels in some low-dimensional situations. More precisely, we present the complete characterization of their entanglement -breaking property, degradability, Holevo information, and (almost) super-activation of the coherent information.

List of Participants

Alexander Teretenkov (Steklov Mathematical Institute of Russian Academy of Sciences)

B V Rajarama Bhat (Indian Statistical Institute)

Byoung Jin Choi (Jeju National University)

Dong Uy Shin (Hanyang University)

Doo Seok Lee (DGIST (Daegu Gyeongbuk Institute of Science & Technology))

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