جامعة نيويورك أبوظبي

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# Titles and Abstracts

**Luigi Amico (Technology Innovation Institute)**
Title: TBD
Abstract: TBD

**Octavio Arizmendi (Centro de Investigacion en Matemáticas)**
**Title:** Freeness for Block Modified Random Matrices
Abstract: In this talk I will talk about Unitarily Invariant Random Matrices which are modified by a block linear transformation. First, we solve the problem of finding the asymptotic spectral distribution by using Operator Valued Free Probability. Second, we find some situations where one can show that such modifications can be written as sums of asymptotically free random matrices, thus, explaining the appearance of some of the formulas. This talk is based on a couple of papers in collaboration with James Mingo and with Ion Nechita and Carlos Vargas.

**Andreas Bluhm (CNRS, Grenoble Computer Science Laboratory (LIG))**
**Title:** Quantifying the Incompatibility of Quantum Measurements
**Abstract:** In this talk, we will focus on measurement incompatibility: Two quantum measurements are compatible if there exists a third one which implements both measurements at the same time. The best-known example of incompatible measurements are the position and the momentum of a particle. Using a connection to matrix convex sets, we can show that the ratio of the sizes of the maximal and the minimal matrix convex set for the hypercube corresponds to the robustness of measurement incompatibility to white noise of dichotomic measurements. Finally, we will explore how free probability can help to quantify measurement incompatibility.

**Ian Charlesworth (Cardiff University, UK)**
Title: TBD
Abstract: TBD

**Guillaume Cébron (Université Paul Sabatier, Toulouse)**
**Title:** (Cyclic)-Conditional Freeness for Random Matrices
**Abstract:** Voiculescu's freeness emerges in computing the asymptotic of randomly rotated random matrices with respect to the normalized trace. In this talk, we will explain recent extensions of this result: considering a sequence of deterministic vectors v_N, the asymptotic distribution of randomly rotated NxN random matrices with respect to the associated vector states can be computed thanks to the conditional freeness as defi ned by Bozejko and Speicher. The rotation matrix can be taken as uniform unitary matrices leaving invariant v_N (it is the so-called Vortex model), and in this case, the infinitesimal distribution with respect to the normalized trace is ruled by a new non-commutative independence: the cyclic-conditional freeness. The talk is based on joint results with O. Arizmendi, A. Dahlqvist, F. Gabriel and N. Gilliers.

**Benoît Collins (University of Kyoto)**
**Title:** Lectures on Free Probability for Quantum Information Theory
**Abstract:**
Lecture 1. **Random Quantum Channels & Basics of Free Probability**:
Lecture 2. **Non-additivity of Quantum Channels via Free Probability **:
These two sessions are somehow linked will review key aspects of random quantum channels, particularly their application in the study of the additivity problem of minimal output entropy. We will introduce essential concepts of free probability and delve into the problem of minimum output entropy additivity, presenting various solutions, including two derived from free probability theory.

**Uwe Franz (University of Franche-Comte)**
Title: Schoenberg Correspondence for Channels on Matrix Algebras
Abstract: "We prove a general Schoenberg-type correspondence for non-unital semigroups which generalizes an analogous result for unital semigroup proved by Michael Schürmann. It can be used to characterizes the generators of semigroups of linear maps on $M_n(C)$ which are k-positive, k-superpositive, or k-entanglement breaking. We present some concrete examples of such semigroups, and study how their positivity properties can improve with time.
Based on https://doi.org/10.1007/s11117-023-01003-6. Joint work with B.V.R. Bhat and Purbayan Chakraborty

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**Takahiro Hasebe (Hokkaido University)**

**Title:** Free Probability of Type B Prime

**Abstract:** Biane, Goodman, Nica introduced a notion of freeness of type B in 2003. It is an example of infinitesimal freeness defined by Belinschi, Shlyakhtenko, Fevrier, Nica around 2009. In this talk, we introduce a slight modification of freeness of type B, which also gives an example of infinitesimal freeness. The new framework is substantially based on freeness and cyclic-monotone independence. Moreover, it describes well relationships between large random matrices and their finite rank perturbations. Finally, we present an application of type B prime theory to the principal minor of large random matrices.
This talk is based on a joint work with Katsunori Fujie.

**Haowei Huang (National Tsing Hua University)**

Title: Hadamard Products Of Random Matrices and Their Limiting Spectral Distributions

Abstract: In this talk we shall present the limiting spectral distributions of the Hadamard products of random matrices GUE. In certain scenarios, the limiting spectral distributions of such random matrix models exist and can be described in terms of square free convolutions. One related question to square free additive convolution is when the multiplicative convolution of the semi-circular law and a probability law on the positive real line has a semi-circular law as a component in the free additive convolution. We shall answer this question by offering necessary and sufficient conditions.

**Faedi Loulildi (Okinawa Institute of Science and Technology)**

Title: Random Tensor Network

Abstract: Random tensor networks provide a powerful framework for understanding the properties and the behavior of entanglement in quantum gravity. In this talk, I will present an ongoing project on random tensor networks where the entanglement entropy of a given subregion of the tensor network admits higher-order corrections given by the moments of a graph-dependent measure.

**Ion Nechita (CNRS, Institut de Mathématiques de Toulouse)**

Title: Lectures on Quantum Information Theory

Abstract:
Lecture 1: Introduction to quantum information theory
I will introduce the basic notions of quantum information theory, drawing parallels and emphasising differences with the classical information theory of Shannon

Lecture 2: Quantum channels
I will present the different equivalent characterizations of quantum channels, and introduce the quantities appearing in the Holevo-Schumacher-Westmoreland formula for the classical capacity of quantum channels.

**Brent Nelson (Michigan State University)**

Title: Ergodic Quantum Processes on Finite von Neumann Algebras

Abstract: Let $(M,\tau)$ be a tracial von Neumann algebra with a separable predual and let $(\Omega, \mathbb{P})$ be a probability space. An ergodic quantum process on $M$ is a composition of the form $\gamma_{T^n\omega}\circ \gamma_{T^{n-1}\omega}\circ \cdots \circ \gamma_{T^m\omega}$, where $\gamma\colon \Omega \times L^1(M,\tau)\to L^1(M,\tau)$ is a bounded positive linerar operator, $T\in \text{Aut}(\Omega, \mathbb{P})$ is ergodic, and $n,m\in \mathbb{Z}$. Physically, such processes model a discrete time evolution of a quantum system that is subject to (ergodically constrained) disorder. Movassagh and Schenker recently studied ergodic quantum processes in the finite dimensional case $M=M_n(\mathbb{C})$, and they showed that under reasonable assumptions such processes collapse to rank-one maps on $L^1(M,\tau)$ exponentially fast almost surely. In this talk, I will discuss how to generalize their results to all separable finite von Neumann algebras. Essential to the analysis in the infinite dimensional case is the so-called Hennion metric on the normal state space of $M$, which is defined using the natural ordering on $L^1(M,\tau)_+$. This is based on joint work with Eric B. Roon.

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**Andreas Osterloh (Technology Innovation Institute)**
Title: Condensed Matter Applications of Multipartite SL-Entanglement
Abstract: Multipartite entanglement is one of the big open riddles in quantum information. Many versions of multipartite measures are currently being applied to physical systems in order to characterize the system and respective phases due to the quality of their entanglement content. Decisive in this context is the mere possibility of calculating the respective measures for mixed states. I am focusing on the convex-roof construction itself that gives the extension to mixed states from an entanglement measure for pure states. First studies in this direction give hope that it could be feasible to obtain reasonable bounds similar to perturbation theory. I will present excerpts out of various projects on the threetangle in the quasi-exact area of rank-two density matrices: for Vertraetes 9-fold way of four partite systems, the generalizations to the W-state with nothing but the threetangle, and finally its analysis in the XY models in a non-transversal field.

**Félix Parraud (KTH Royal Institute of Technology)**
Title: TBD
Abstract: TBD

**Daniel Perales (Texas A&M University)**
Title: Finite Free Probability and Hypergeometric Polynomials
Abstract: We will introduce two binary operations of polynomials that behave well with respect to the roots and can be understood as a finite analogue of free probability that involves only discrete measures. We will use these finite free convolutions to systematically construct hypergeometric polynomials with real roots and obtain interlacing results for certain families of hypergeometric polynomials. Moreover, the known limit behavior of finite free convolutions allows us to write the asymptotic root distribution of some hypergeometric polynomials as free convolutions of Marchenko-Pastur, reversed Marchenko-Pastur, and free beta laws.
This is a joint work with Andrei Martinez-Finkelshtein and Rafael Morales (arXiv:2309.10970)

**Jenifer Pi (University of California, Irvine)**
Title: A Classical Approach for Relating Free Entropic Quantities
Abstract: Voiculescu introduced two main notions of free entropy for a given tuple of self-adjoint operators $X$: the microstates free entropy $\chi(X)$ and the non-microstates free entropy $\chi^*(X)$. In joint work with David Jekel, we give an elementary proof of the inequality $\chi(X) \leq \chi^*(X)$, originally proved by Biane, Capitaine, and Guionnet. We furthermore extend the inequality to conditional free entropy, conditioning upon any separable $W^*$-subalgebra. The proof leverages relationships between the free entropy of a tuple $X$ and the classical entropy of matrix approximations to $X$.

**Adrián Celestino Rodriguez (Uni Graz, Austria)**
Title: Conditionally Monotone Cumulants via Shuffle Algebra
Abstract: In this talk, we will describe a group-theoretical approach for conditionally monotone cumulants, based on the shuffle-algebraic framework of Ebrahimi-Fard and Patras for free, Boolean and monotone cumulants. We will see how we can identify c-monotone cumulants as a special linear form on a certain Hopf algebra and show how shuffle-algebraic relations of linear forms are translated into combinatorial formulas in terms of non-crossing partitions. This talk is based on a joint work with Kurusch Ebrahimi-Fard (arXiv:2312.04614).

**Noriyoshi Sakuma (Nagoya City University)**
Title: Fluctuations of Eigenvalues of a Polynomial on Haar Unitary and Finite Rank Matrices
Abstract: We calculate the fluctuations of eigenvalues of polynomials on large Haar unitaries cut by finite rank deterministic matrices. When the eigenvalues are all simple, we can give a complete algorithm for computing the fluctuations. When multiple eigenvalues are involved, we present several examples suggesting that a general algorithm would be much more complex.

**Pei-Lun Tseng (NYU Abu Dhabi)**
Title: Infinitesimal Operators and the Law of Polynomials in Monotone Independent Elements
Abstract: This talk will be divided into two parts. The first part will focus on infinitesimal operators, distinguished by a spectral measure concentrated at 0 but with a non-trivial infinitesimal law. We will delve into their properties; in particular, we will show how they can be applied to construct Boolean and monotone independent elements. In the second part of the presentation, we will introduce a methodology for computing polynomials in monotone independent elements. Specifically, we will derive the explicit distribution of $\alpha ab+\beta ba$ whenever a and b are monotone independent. The talk is based on my recent works with Jamie Mingo (arXiv: 2308.02064) and Marwa Banna (arXiv: 2311.05979).

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**Sang-Gyun Youn (Seoul National University)**

Title: Additivity Violation of the Regularized Minimum Output Entropy in the Commuting-Operator Framework

Abstract: The additivity question of the minimum output entropy (MOE) was a long-standing open question in quantum information theory (QIT), and it was disproved by Hastings in 2009. The result suggests that regularization process of MOE is unavoidable in QIT and would be highly complicated to compute. Indeed, very few results are known for the regularized MOE, and the associated additivity question is still open. We introduce a class of quantum channels whose regularized MOE is computable thanks to a generalized Haagerup inequality. Moreover, we present additivity violation of the regularized MOE in the commuting-operator setup, though it is unclear in the tensor-product setup. This talk is based on a recent joint work with Benoît Collins.

**Pierre Youssef (NYU Abu Dhabi)**

Title: On the spectrum of Quantum Channels

Abstract: In this talk, we will recall results on the spectrum of classical regular graphs and expanders and introduce their quantum analogues. We will then explore random constructions and study the corresponding spectral properties. In particular, we will show that many generic random constructions of Quantum Channels produce Quantum Expanders, and study the corresponding limiting spectral distribution. Based on joint works with Cecilia Lancien and Patrick Oliveira Santos.