Quantum information theory
Théorie de l'information quantique
(Org: **Jason Crann** (Carleton) and/et **David Kribs** (Guelph))

LI GAO, Technical University of Munich
Complete logarithmic Sobelev inequalities

Quantum Markov semigroups are noncommutative generalization of Markov process, which models the time evolution of dissipative open quantum systems. For both classical and quantum Markov semigroups, modified log Sobolev inequality serves as a powerful tool to study the convergence property via the exponential decay of entropy. In this talk, I'll present some recent progress on complete bounded versions of modified log-Sobelev inequalities for finite dimensional quantum Markov semigroups. This talk is based on a joint work with Cambyse Rouze.

NATHANIEL JOHNSTON, Mount Allison University
Completely positive completely positive maps (and a resource theory for non-negativity of quantum amplitudes)

We examine quantum states which are non-negative mixtures of pure states with non-negative amplitudes (in a fixed basis) and the channels which preserve them. These states are exactly those that are completely positive (CP), and we show how several standard properties of CP matrices, such as the CP-rank, correspond to physical properties of these states. We also introduce the family of quantum channels that preserve CP states, which we call *completely positive completely positive (CPCP)*, since quantum channels are also (very confusingly) called completely positive. We show that CP quantum states and the CPCP maps that preserve them constitute a (physically well-motivated) quantum resource theory analogous to that of quantum entanglement. Finally, we investigate several ways of measuring how resourceful a state is in this theory (which roughly means how far away it is from being CP).

MARTTI KARVONEN, University of Ottawa
Neither contextuality nor non-locality admits catalysts

Bell's theorem rules out local hidden-variable theories of quantum mechanics. This is due to the phenomena of non-locality: given n-parties sharing some quantum states, there is no joint probability distribution on all possible measurements that explains the outcomes observed when each party chooses a fixed measurement. Contextuality can be seen as the same phenomenon (i.e. inability to glue pairwise compatible probability distributions into a joint one) without the assumption of spatial separation.

Non-locality of quantum mechanics is often seen as arising from entanglement, but entanglement and non-locality are not quite the same resource. In this talk we discuss one such discrepancy. Entanglement famously allows for catalysts: there are states that can be used to catalyze an otherwise impossible local transformation. More formally, there are quantum states ρ_1, ρ_2 such that no (LOCC-)transformation $\rho_1 \to \rho_2$ exists but $\psi \otimes \rho_1$ can be transformed to $\psi \otimes \rho_2$.

In this talk we show that such catalysts do not exist for contextuality nor for non-locality. To do so, we first recap what contextuality and non-locality are as features of correlations, and then discuss what does it mean to transform such correlations to others. This lets us formalize the no-catalysis result, which states that if there is a transformation $d \otimes e \to d \otimes f$, then there is a transformation $e \to f$ as well.

JEREMY LEVICK, University of Guelph
Mixed Unitary Rank

We discuss the mixed unitary rank of a mixed unitary channel: the smallest number of unitaries required to express the channel in Choi-Kraus form. We present an upper bound on mixed unitary rank in terms of the Choi rank and the dimension of an associated operator system, and present a class of examples based on mutually unbiased bases which exhibit a large gap between mixed unitary rank and Choi rank.

RAJESH PEREIRA, University of Guelph
Correlation Matrices in Quantum Information Theory

Correlation matrices are positive semidefinite matrices which have all of their diagonal entries equal to one. In this talk, we explore some applications of correlation matrices to topics in quantum information such as quantum channels, coherence and Bell's inequalities. The key common mathematical theme between all of these topics is the interplay between the set of correlation matrices and the subset formed by taking the convex hull of the rank-one correlation matrices.

SARAH PLOSKER, Brandon University
Quantum theoretic aspects of spin unitary matrices

We consider quantum theoretic aspects of spin systems, which are finite sets of anticommuting selfadjoint unitary matrices, and of complete order isomorphisms between the operator systems generated by two spin systems, a concept related to the quantum interpolation problem. We also connect our findings to recent developments on the topic of free spectrahedra and matrix convex sets.

JITENDRA PRAKASH, University of Copenhagen
Constant-sized robust self-tests for states and measurements of unbounded dimensions

We consider correlations, $p_{n,x}$, arising from measuring a maximally entangled state using n measurements with two outcomes each, constructed from n projections that add up to some scalar times an identity. We show that the correlations $p_{n,x}$ robustly self-test the underlying states and measurements. To achieve this, we lift the group-theoretic Gowers-Hatami based approach for proving robust self-tests to a more natural algebraic framework. A key step is to obtain an analogue of the Gowers-Hatami theorem allowing to perturb an "approximate" representation of the relevant algebra to an exact one. As a corollary, we exhibit a constant-size self-test for measurements of unbounded dimension as well as all maximally entangled states with odd local dimension. (This is a joint work with Laura Mančinska and Christopher Schafhauser.)

MIZANUR RAHAMAN, BITS Pilani KK Birla Goa Campus
Bisynchronous Games and Positively Factorizable Maps

Bisynchronous games are a special class of non-local games played by Alice and Bob against a referee where players can use entanglement as a resource to optimize their winning probability. In this talk, I will introduce these games and the corresponding probability densities which we call bisynchronour correlations. We establish a close connection with the theory of quantum permutation groups and these correlations. Moreover, when the number of inputs is equal to the number of outputs, each bisynchronous correlation gives rise to a unital quantum channel which will be shown to be factorizable in the sense of Haagerup- Musat. Motivated from this

finding, we further generalize the concept of factorizability and introduce a new class of quantum channels that we call **positively factorizable**. It turns out that there is a close connection between the convex sets in Euclidian space containing self-dual cones and the existence of these maps. In this context, we

find new examples of matrices that are non-negative but not CPSD (completely positive semidefinite). This talk is based on two separate works with Vern Paulsen and Jeremy Levick.

HADI SALMASIAN, University of Ottawa
Monogamy of Entanglement Games on Unitary Groups

A Monogamy of Entanglement game (MOE) is a tripartite game in which two isolated parties (Bob and Charlie) try to predict the outcome of the measurement done by the third party (Alice) based on the information that they receive about Alice's measurement. The MOE games have recently found a number of applications, e.g. in uncloneable encryption. In this talk we will investigate MOE games in which Alice's measurement is determined by a randomly chosen point on the unitary group. Computing the winning probability thresholds of this MOE game lead to interesting questions involving the Haar measure. This talk is based on a joint work (in progress) with A. Broadbent, A. Mahmoud, and M. Nevins.

IVAN TODOROV,
A quantum sandwich theorem

The classical sandwich theorem in combinatorial optimisation, due to Grötschel, Lovász and Schrijver, is an inclusion chain between three convex corners arising canonically from a given graph, and plays a cornerstone role in classical zero-error information theory. In this talk, based on a joint work with Gareth Boreland and Andreas Winter, I will describe a non-commutative version of this result, suited to the context of zero-error quantum information theory, and based on non-commutative graphs. The viewpoint we employ leads to new quantum versions of the classical Lovász number of a graph and to improved bounds on the zero-error capacity of a quantum channel.

SANG-GYUN YOUN, Seoul National University
Irreducibly SU(2)-covariant quantum channels

Quantum channel is one of the most fundamental objects in quantum information theory, and group symmetry has been considered important resources to analyze quantum channels. Conservation of irreducible group symmetries has been studied for quantum channels in various contexts. In particular, geometric structures of the set of all irreducibly covariant quantum channels have been clarified very recently. The main aim of this talk is to present detailed information-theoretic properties of irreducibly SU(2)-covariant quantum channels of low rank (less than or equal to 3). For example, we present complete characterizations of PPT property, entanglement-breaking property, degradability, Holevo information in this class. Moreover, this approach gives us a new example of additivity violation of the coherent information.