Probabilités et information quantique

- Mizanur Rahaman (ENS Lyon)

  Title: Zero-error communication under iterated quantum channels

  Abstract: Motivated by Shannon's theory of zero-error communication, we study the quantum channel version of the zero-error capacity problem. The long term behaviour of a quantum channel under iterations (i.e. under repeated applications of itself) yields many interesting properties. For example, almost all channels exhibit the property that the one-shot zero-error capacity vanishes when large iterations are applied. This motivates us to investigate the threshold point of a channel, after which no classical message can be sent through the channel without making an error. More precisely, the objective is to find the minimum number of iterations needed for a channel such that the one-shot zero-error capacity becomes trivial. In this talk, I will discuss how mathematical techniques from the theory of operator algebras can be used to provide an upper bound for this threshold point. This is a joint work with Nilanjana Datta (Univ. of Cambridge) and Satvik Singh (Univ. of Cambridge).

- Emily Beatty (INRIA Lyon)

  Title: Order p quantum Wasserstein distances from coupling

  Abstract: Optimal transport provides a powerful mathematical framework with applications spanning numerous fields. A cornerstone within this domain is the p-Wasserstein distance, which serves to quantify the cost of transporting one probability measure onto another. While recent attempts have sought to extend this measure to the realm of quantum states, existing definitions often present certain limitations, such as not being faithful or being restricted to a specific underlying structure. In this talk, we present a new definition of quantum Wasserstein distances. This definition, leveraging the coupling method and a metric applicable to pure states, draws inspiration from a property characterising the classical Wasserstein distance - its determination based on its value on point masses. Subject to certain continuity properties, our definition exhibits numerous attributes expected of an optimal quantum rendition of the Wasserstein distance. In addition, our approach seamlessly integrates metrics familiar to quantum information theory, such as the trace distance, and provides an organic extension for metrics to mixed states with a natural operational interpretation. We show how this definition unveils phase transitions in random states and an application to quantifying the noise of quantum channels.

- Sang-Jun Park (LPT Toulouse)

  Title: Random Covariant Quantum Channels

  Abstract: The group symmetries inherent in quantum channels often make them tractable and applicable to various problems in quantum information theory. In this talk, we introduce natural probability distributions for covariant quantum channels.

Specifically, this is achieved through the application of “twirling operations” on random quantum channels derived from the Stinespring representation that use Haar-distributed random isometries. We explore various types of group symmetries, including unitary covaraince, orthogonal covariance, and diagonal orthogonal covariance (DOC), and analyze their properties related to quantum entanglement based on the model parameters. In particular, we discuss the threshold phenomenon for positive partial transpose and entanglement breaking properties, comparing thresholds among different classes of random covariant channels. Finally, we contribute to the PPT-squared conjecture by showing that the composition between two random DOC channels is generically entanglement breaking. This talk is based on a joint work with Ion Nechita.

- Anna Szczepanek (IMT Toulouse)

  Title: Quantum Trajectories: Dark Subspaces & Invariant Measures

  Abstract: Quantum trajectories are Markov chains modeling the evolution of a quantum system subject to repeated indirect measurements. That is, the system interacts with a probe which is then measured and, due to entanglement, the outcome allows us to learn something about the system. A new probe is then taken and the whole procedure repeated. Extracting information pushes the system towards pure states; it is a renowned result by Kümmerer and Maassen that asymptotically quantum trajectories either purify completely or get trapped inside ‘dark subspaces’ from which no further information can be extracted. It was shown by Benoist et al. that in the case of (irreducible) systems with purification, i.e., without dark subspaces, there exists a unique invariant probability measure for quantum trajectories. In this talk we discuss the classification of invariant measures inside dark subspaces. This is joint work with T. Benoist and C. Pellegrini.