

SEMINAR: Moments of Quantum Channels

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June 26, 2025

12:00 to 13:00

Seminar Room

Moments of ensembles of unitary evolutions play a central role in quantum information theory as they capture the statistical properties of dynamics with some form of randomness. Indeed, concepts such as approximate t -designs arise when comparing how close an associated moment operator of a given ensemble is to that of another, reference, ensemble. Despite their tremendous importance, the analysis of moment operators for quantum channels, which describe noisy quantum circuits, has not been explored. In this work we develop a general theoretical framework to study moment operators for channels, with a special focus on determining ensembles that can be used as points of reference. By studying exactly concatenated moment operators within general Hilbert spaces, for all moment orders t , we give operational meaning to their spectra and norms. We show that such quantities can be used to analyze many ensemble properties, in particular concentration phenomena in noisy quantum circuits. We proceed to perform theoretical and numerical studies which show that different types of noise can decrease the norm of the moment operators (e.g. depolarization), as well as increase it (e.g. amplitude damping). We finish our work with a description of several future research directions based on the developed formalisms that are relevant to error mitigation. This work is done in collaboration with Diego Garcia-Martin and Marco Cerezo at Los Alamos National Laboratory and Zoe Holmes at EPFL.

Hosted by: Prof. Dr. Antonio Acín