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The Quantum Symmetric Simple Exclusion Process

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An alternative title could have been « How to characterise coherences and fluctuations in diffusive out-of-equilibrium many-body quantum systems ? ».
In general, the difficulty to characterise non-equilibrium systems lies in the fact that there is no analog of the Boltzmann distribution to describe thermodynamic variables and their fluctuations. Over the last 20 years, however, it was observed that fluctuations of diffusive transport show universal properties that do not depend on the microscopic details. The general framework to characterise these systems from a macroscopic point of view is now called the Macroscopic Fluctuation Theory. A natural question is whether this framework can be extended to quantum mechanics to describe the statistics of purely quantum mechanical effects such as interference or entanglement in diffusive out-of-equilibrium systems. With this aim in mind, I will introduce the Quantum Symmetric Simple Exclusion Process (QSSEP), a microscopic model system of fluctuating quantum diffusion. I will in particular present the recent observation that fluctuations of coherences in QSSEP have a natural interpretation as free cumulants, a concept from free probability theory, and heuristic arguments why we expect free probability theory to be an appropriate framework to describe coherent fluctuations in generic mesoscopic systems.

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