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Quantum measurements and quantum dynamics

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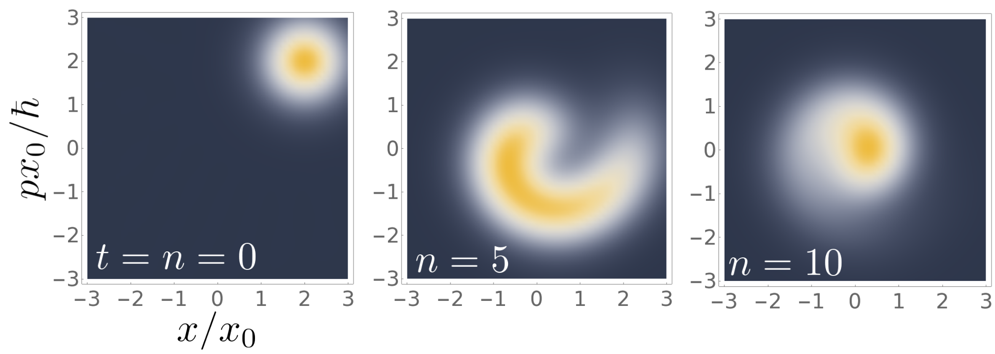

Quantum experiments are generally divided into three stages: initial state preparation, evolution, and readout measurement. If the quantum system is isolated during the evolution, it follows Schrödinger's equation, and the role of the, typically strong, concluding measurement is confined to inform us about the state of the system at the readout time. However, quantum measurements can also take a more active role and be deployed to influence and steer the evolution before the final readout. The quantum Zeno effect, where a rapid sequence of strong measurements can slow down or even freeze the evolution, was among the first compelling demonstrations of such influence. Continuous (weak) measurements, on the other hand, induce quantum jumps at random times, which are registered as "clicks" in the detectors. The resulting, stochastically evolving "quantum trajectories" are, when statistically averaged over many runs at the readout time, described by a deterministic quantum master equation, this way establishing a fundamental relationship between continuous quantum measurements and open quantum systems. However, this averaging instruction over the quantum trajectories effectively discards the knowledge of the occurrence of the jump events. Recently, it was shown that quantum trajectories can also be read out directly following the jump events [1]. The respective statistical average at given jump counts then gives rise to an alternative, discrete deterministic evolution equation, which preserves the knowledge of the jump detections, and which replaces the Lindblad equation for this readout protocol. This jumptime evolution reveals distinct characteristics and, as I will show along familiar examples, thus provides a complementary description of the associated open quantum systems. The graphic displays phase-space snapshots of the jumptime evolution of an (initial) coherent state for a damped harmonic oscillator.

[1] C. Gneiting, A. Rozhkov, F. Nori, Jumptime unraveling of Markovian open quantum systems, arXiv:2001.08929