Stochastic path integral formalism for quantum trajectories of continuously measured systems

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Abstract

There has been increasing interest in continuous quantum measurements and its application both in quantum information processing, as well as towards a theory of quantum thermodynamics. In this talk, I will reformulate the theory of continuous quantum measurement as a stochastic path integral, describing all possible quantum trajectories moving between initial and final quantum states as boundary conditions in time [1]. The introduced stochastic action encodes both the Hamiltonian and measurement dynamics. This formulation is well suited to finding the most-likely quantum path between the boundary conditions via a principle of least action. A diagrammatic expansion approach to calculate correlation functions of trajectory variables and the continuous readout will be discussed. Preliminary results for including feedback as well as two-qubit entangled trajectories will also be presented. Comparison to recent experiments with superconducting transmon qubits shows the theory is able to accurately and quantitatively explain the experimental results [2]. This formalism sheds new light on the conditional dynamics of monitored open quantum systems.

[1] Action principle for continuous quantum measurement, A. Chantasri, J. Dressel, and A. N. Jordan, Phys. Rev. A 88, 042110 (2013).

Mapping the optimal route between two quantum states, S. J. Weber, A. Chantasri, J. Dressel, A. N. Jordan, K. W. Murch, and I. Siddiqi, Nature 511, 570–573 (2014).

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