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Stochastic action principle approach to continuous quantum measurement

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New features in fundamental quantum physics appear in generalized (or weakened) measurements that are no longer simple projections. A sequence of weak measurements can also be made effectively continuous, producing monitored state evolution in the form of a quantum stochastic process. Previous theoretical investigations of this topic have mainly focused on using Langevin-type Stochastic Schrodinger equations to generate and study the quantum trajectories. Here, we reformulate the theory of continuous quantum measurement as a stochastic path integral, describing all possible quantum trajectories moving between initial and final quantum states. In order to do this, an auxiliary set of variables is introduced to impose the intrinsic state disturbance, doubling the state space of the system. The stochastic action encodes both the Hamiltonian and measurement dynamics. This formulation is well suited to finding the most-likely quantum path between chosen boundary conditions on the quantum states separated in time via a principle of least action. This action principle leads to a set of coupled nonlinear ordinary differential equations for the most likely path, structurally similar to Hamilton's equations. I will present predictions for the single and multiple qubit cases. Comparison to recent experiments with superconducting transmon qubits will be discussed. This formalism sheds new light on the conditional dynamics of monitored open quantum systems.