Telling different unravelings apart via non-linear quantum-trajectory averages

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The Gorini-Kossakowski-Sudarshan-Lindblad master equation (ME) [1] governs the density matrix of open quantum systems (OQSs). When an OQS is subjected to weak continuous measurement, its state evolves as a stochastic quantum trajectory, whose statistical average solves the ME [2]. The ensemble of such trajectories is termed an unraveling of the ME. We propose a method to operationally distinguish unravelings produced by the same ME in different measurement scenarios, using nonlinear averages of observables over trajectories. We apply the method to the paradigmatic quantum nonlinear system of resonance fluorescence in a two-level atom [3]. We compare the Poisson-type unraveling, induced by direct detection of photons scattered from the two-level emitter, and the Wiener-type unraveling, induced by phase-sensitive detection of the emitted field. We show that a quantum-trajectory-averaged variance is able to distinguish these measurement scenarios [4]. We evaluate the performance of the method, which can be readily extended to more complex OQSs, under a range of realistic experimental conditions.

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