Noninvasive Quantum Measurement of Arbitrary Operator Order by Engineered Non-Markovian Detectors

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The development of solid-state quantum technologies requires the understanding of quantum measurements in interacting, nonisolated quantum systems. In general, a permanent coupling of detectors to a quantum system leads to memory effects that have to be taken into account in interpreting the measurement results. We analyze a generic setup of two detectors coupled to a quantum system and derive a compact formula in the weak-measurement limit that interpolates between an instantaneous (text-book type) and almost continuous-detector dynamics-dependent-measurement. A quantum memory effect that we term “system-mediated detector-detector interaction“ is crucial to observe noncommuting observables simultaneously. Finally, we propose a mesoscopic double-dot detector setup in which the memory effect is tunable and that can be used to explore the transition to non-Markovian quantum measurements experimentally.
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