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Martin-Siggia-Rose approach to quantum error correction in the presence of time-dependent noise RAFAEL HIPOLITO, PAUL GOLDBART, Georgia Tech — We consider the basic task of obtaining a target unitary operation (quantum gate) via external control fields coupled to a quantum system, while compensating for time-dependent noise. We address this problem by means of a formulation rooted in the MSR approach to noisy, classical, nonequilibrium systems. We express the noisy control problem as a path integral, and integrate out the noise to arrive at an effective noise-free description. To illustrate the approach, we consider a single spin-s degree of freedom (with s arbitrary) in the presence of Gaussian time-dependent noise, though our approach can be generalized to more complicated systems and noise distributions. Success is characterized via a "fidelity," measuring the overlap between the ideal noise-free evolution and the noisy one. To make connection with MSR, we reformulate the fidelity in terms of a Schwinger-Keldysh path integral, with an added twist: "forward" and "backward" branches of the contour are inequivalent with respect to noise. We explore the effective description, and show how to evaluate the path integral to arbitrary order in noise strength. Our approach naturally treats the problem for arbitrary s under a unified protocol, valid from the qbit limit ($s = 1/2$) to the classical limit ($s \to \infty$).

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