Efficient multiqubit characterization and control via finite-frame filter functions

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We study the resource-efficient characterization and control of multiple qubits coupled to realistic non-Markovian noise environments using the recently introduced theoretical framework of finite-frame filter functions [1]. This formalism facilitates the appropriate choice of transfer-filter functions according to the available control capabilities and constraints, offering intrinsic flexibility and a model-reduced description of the open quantum system dynamics. In particular, we show that when we consider a multiqubit system in which spatial constraints in the control are necessary, due to fault-tolerant error correction schemes for example, the use of finite-frame filter functions permits an efficient representation of the overlap integrals between the spatiotemporal noise correlation functions and the elements of the control matrix, allowing us to identify the noise components that are relevant to the dynamics. We therefore demonstrate that the cost required for high-quality multiqubit characterization and control is significantly lower than would be expected using the standard frequency-domain filter-function formalism.

[1] T. Chalermpusitarak, B. Tonekaboni, Y Wang, L.M. Norris, L. Viola, and G. A. Paz-Silva, Frame-based filter-function formalism for quantum characterization and control. *PRX Quantum*, **2**(3), 030315 (2021).