Optimal mitigation of random-telegraph-noise dephasing by spectator-qubit

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Despite advances in techniques for mitigating noise affecting a quantum system, the challenge of suppressing noise sufficiently for scalable quantum computing persists. Recently, the use of spectator qubits (SQ) as a new approach has been proposed [1, 2]. The idea is to obtain noise information by measuring the SQ without touching the data qubit; then, using that information to mitigate the effect of noise by applying appropriate control to the data qubit. Although the proof of principle of SQ has been demonstrated, the optimal measurement and control strategies have not been investigated. To do so, in our recent work [3, 4], we consider dephasing of a data qubit due to a random telegraph process (RTP) [5, 6]. We propose and investigate an *adaptive*-measurement [7] protocol for SQ—see diagram in Fig 1(a). We find a measurement and control strategy to optimally mitigate qubit dephasing. In Fig 1(b), we show our optimal adaptive strategy (maroon circles) improves the decoherence radically in compare to the no-control case (brown solid curve). Our results evident that the SQ—similar to Dynamical Decoupling and Quantum Error Correction—can mitigate noise arbitrarily well in a suitable regime.

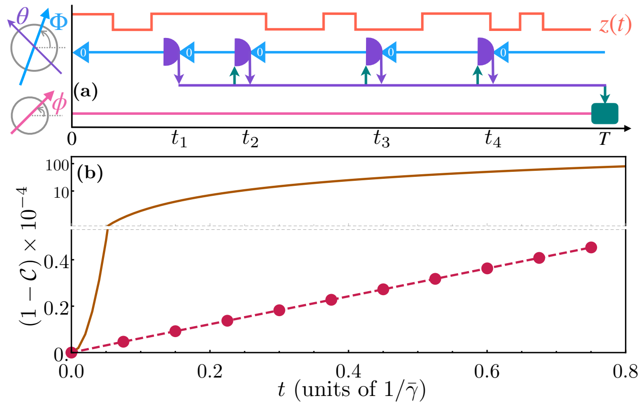

Figure 1: (a) Schema for the SQ protocol, from top to bottom: RTP (orange); SQ (blue) which is reprepared (triangle) after each measurement (purple); measurement record (purple); and data qubit (pink). Teal arrows from measurement record show feedback (upwards for adaptive measurements and downward for final control). (b) Plot of data qubit decoherence $(1-C)$ versus time t for no-control case (solid brown) and the numerical result of our optimal algorithm (maroon).

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