Title: Smallest quantum error correcting codes for amplitude-damping noise

Abstract: Quantum error correction (QEC) is indispensable for achieving reliable quantum computing and to scale up from the current generation of noisy intermediate-scale quantum (NISQ) devices to universal, fault-tolerant quantum computers. If the noise structure of the dominant noise affecting the quantum hardware is known, one can leverage this information to construct resource-efficient quantum codes that are tailored to the noise. Here, we focus on amplitude-damping noise, which is known to be the dominant noise process in many hardware realisations, including superconducting qubits. We demonstrate the existence of a 3-qubit QEC code to correct for amplitude-damping noise, thus addressing a long-standing open question in the field. We generalize this construction to create a family of codes that correct damping noise up to any fixed order. Although the recovery procedure for this code is non-deterministic, our codes are optimal with respect to overheads and outperform existing codes. Finally, we construct a set of universal logical gates for the 3-qubit code, thus providing a potential pathway to fault tolerance in this scheme.
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