Controlling ultra-high-quality microwave cavities using noisy auxiliary qubits

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Three-dimensional microwave cavity resonators can reach lifetimes of the order of a second [1,2,3]. Such cavities represent an ideal platform for quantum computing with bosonic qubits. The effective control of such qubits remains a problem since the large mode volume results in inefficient coupling to nonlinear elements used for their control. Moreover, this coupling introduces additional cavity decay via the inverse Purcell effect which can easily destroy the advantage of long intrinsic lifetime. Here, we discuss conditions and protocols for efficient control of these ultra-high-quality microwave cavities using conventional nonlinear circuits. We show different effective interaction terms between the auxiliary qubit and the storage cavity that can be used to achieve a control rate exceeding the decay rate of the auxiliary. We will explore the necessary trade-offs between increasing the control rate and increasing cavity decay (inverse Purcell effect) associated with increased auxiliary qubit-cavity coupling. Our work explores a potentially viable roadmap towards using ultra-high-quality microwave cavity resonators for storing and processing information encoded in bosonic qubits.

References

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Figures

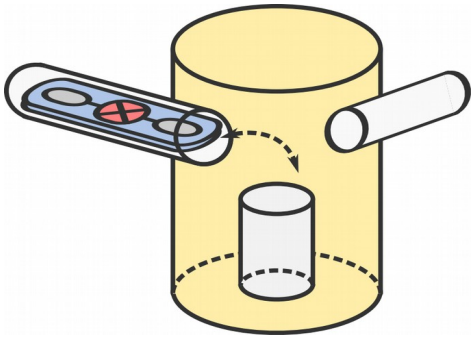

Figure 1: Schematic presentation of the cavity memory and its control.

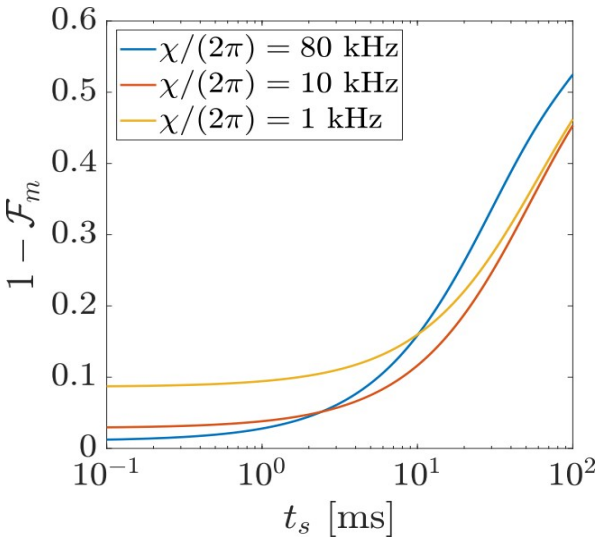

Figure 2: Cat state memory fidelity with different coupling strengths.