# Enhancing the coherent-state lifetime of a Kerr-cat qubit through leakage suppression

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A superconducting Kerr-nonlinear resonator subject to a two-photon drive stabilizes opposite-phase coherent states and their quantum superpositions, the Schrödinger cat states, via Hamiltonian confinement [1]. These states encode a Kerr-cat qubit (KCQ), whose Bloch sphere features one error-protected axis thanks to the intrinsic robustness of the coherent states against noise. This property positions the KCQ as a promising candidate for reducing the hardware overhead of quantum-error-correction codes [2].

However, recent experiments [3] indicate that leakage to excited states outside of the KCQ computational manifold severely restricts the lifetime of the coherent states. Suppressing this leakage is therefore crucial to improving overall qubit performance.

In this talk, we present experimental results that demonstrate coherent control of the excited states and provide a direct measurement of their population. We then introduce dissipation that selectively brings this population back to the KCQ computational manifold. We furthermore explore the KCQ parameter space and identify conditions where this dissipation enhances the coherent-state lifetime. Our results reveal a direct correlation between increased lifetime and reduced excited-state population.

## References

[1] Grimm, A., Frattini, N. E. et al. Nature 584 (2020), 205-209
[2] Darmawan, A. S., et al. Phys. Rev. X Quantum 2 (2021), 030345
[3] Frattini, N. E., Cortiñas, R. G. et al. Phys. Rev. X 14 (2024), 031040

## Figures

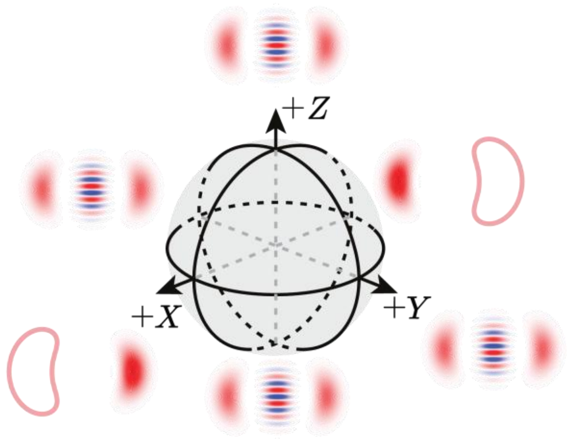


**Figure 1:** Kerr-cat qubit Bloch sphere.

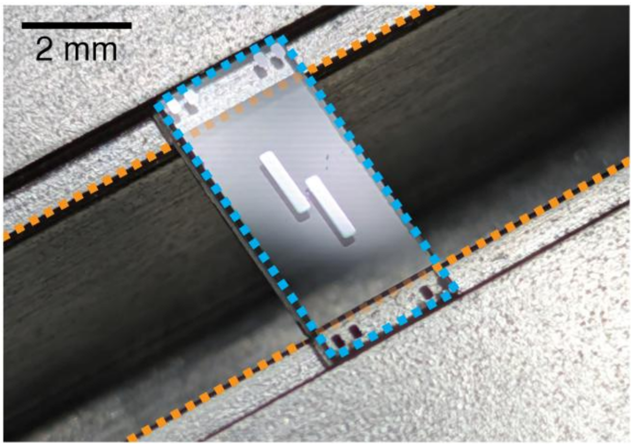


**Figure 2:** Superconducting Kerr-nonlinear resonator (blue) inside a superconducting readout cavity (orange).