Offset Dependence of Measurement Induced State Transitions and TLS lifetime Measurements

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Achieving high-fidelity measurement in superconducting qubits is essential for scalable quantum computing but remains limited by measurement-induced transitions, or qubit ionization, that occur at specific photon populations in the readout resonator. By explicitly controlling and calibrating the offset charge of a transmon qubit, we experimentally reveal the gate-charge dependence of these transitions—even deep in the transmon regime—thus providing new insight into how higher-order excitations and Hamiltonian corrections shape measurement backaction. Building on these improved measurement strategies, we extend our approach to probe the qubit's microscopic environment. Through wideband spectroscopy and correlation analysis, we identify long-lived two-level systems (TLS) coupled to the qubit and perform Stark-shift pump–probe experiments to directly measure their intrinsic lifetimes. Together, these results show how refined understanding and mitigation of measurement-induced effects open the way to resolving and characterizing individual TLS defects that limit qubit coherence.

References

[1] M. Féchant, M. F. Dumas, D. Bénâtre, N. Gosling, P. Lenhard, M. Spiecker, W. Wernsdorfer, B. D'Anjou, A. Blais, and I. M. Pop, Offset charge dependence of measurement-induced transitions in transmons,

Figures

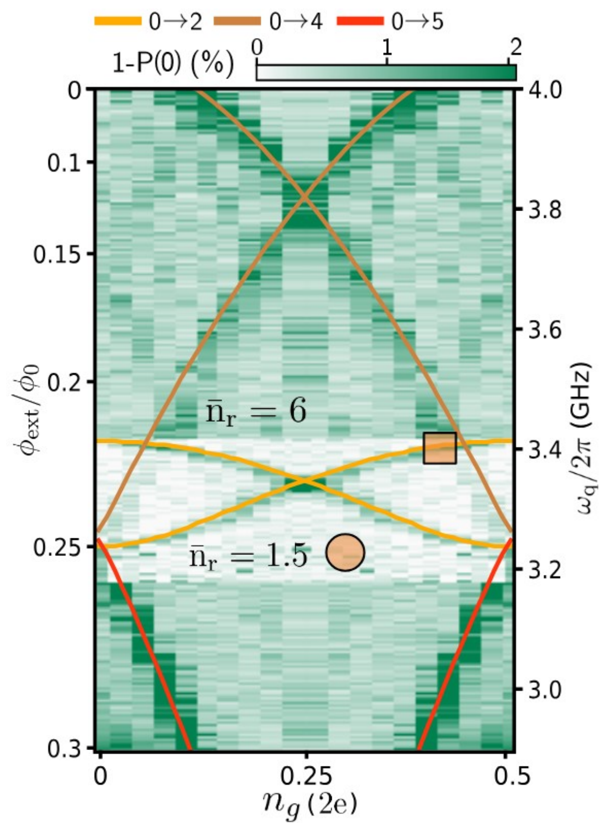

Figure 1: Transition plot of measurement induced state transitions showing clear offset charge dependence

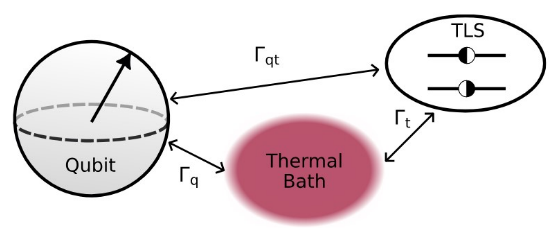

Figure 2: Schematic of TLS-qubit system.