MHz-fluxonium qubit for quantum control of mechanical systems

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Résumé

Beyond their applications in quantum computing, superconducting qubits are a powerful platform to probe various quantum phenomena in the context of hybrid quantum systems (1). However, most of them are confined to the GHz frequency domain, limiting the class of systems they can interact with. Building upon the heavy fluxonium architecture introduced by (2), we have developed a superconducting qubit with an unprecedentedly low transition frequency of 1.8 MHz (3). Notably, we have demonstrated a qubit with a coherence time exceeding 30 μs, a sideband cooling scheme to prepare the qubit in a pure state with 97.7% fidelity, and single-shot readout capability. Moreover, by detecting a weak charge modulation by repeated qubit interrogation, we demonstrate the high-sensitivity of this qubit architecture to a nearly resonant AC-charge drive, proving its potential in a hybrid circuit scenario. We will finally present our recent efforts to achieve the strong coupling regime between this qubit and an ultra-coherent softly-clamped mechanical membrane.
(1) Y. Chu et al. Nature 563, 666 (2018).

(2) H. Zhang et al. Physical Review X 11, 011010 (2021).
(3) Najera et al. Physical Review X, 14, 011007 (2024).

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