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Implementing a Universal Gate Set on a Logical Qubit Encoded in an Oscillator PHILIP REINHOLD, REINIER HEERES, NISSIM OFEK, LUIGI FRUNZIO, LIANG JIANG, MICHEL DEVORET, ROBERT SCHOELKOPF, Yale University — A logical qubit is a subspace of a systems total Hilbert space, carefully chosen so as to minimize the effect of the environment on the encoded information. A side effect of protecting the qubit from the environment is that it is likely to be difficult to control. Controlling the state of a logical qubit generally requires precise and arbitrary control over the entire system. We encode quantum information in the two-level subspace of four-component cat states, and demonstrate a universal set of operations which manipulate this cat qubit with high fidelity. We create these operations with numerically optimized pulse waveforms, which exploits accurate knowledge of the Hamiltonian to manipulate the dispersively coupled oscillator-transmon system. Our results show the power of applying numerical techniques to control linear oscillators and pave the way for utilizing their large Hilbert space as a resource in quantum information processing.

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