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Universal Control of an Oscillator with Dispersive Coupling to a Qubit STEFAN I. KRASTANOV, CHAO SHEN, VICTOR V. ALBERT, REINIER W. HEERES, BRIAN M. VLASTAKIS, ROBERT J. SCHOELKOPF, LIANG JIANG, Yale University — We investigate quantum control of an oscillator mode that dispersively couples to an ancillary qubit. In the strong dispersive regime we can drive the qubit conditioned on the selected number states of the oscillator, which enables selective number-dependent arbitrary phase (SNAP) operation and universal control of the oscillator. Based on our proof of universal control, we provide explicit constructions for arbitrary state preparation and arbitrary unitary operation of the oscillator. Moreover, we present an efficient procedure to prepare the number state $|n\rangle$ using only $O(\sqrt{n})$ operations. We also compare our scheme with known quantum control protocols for coupled qubit-oscillator systems. We point out that this universal control scheme of the oscillator can be readily implemented using superconducting circuits.

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