

Abstract Submitted
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Implementation of a Toffoli Gate with Superconducting Circuits ARKADY FEDOROV, LARS STEFFEN, MATTHIAS BAUR, ETH Zurich, MARCUS DA SILVA, Raytheon BBN Technologies, ANDREAS WALLRAFF, ETH Zurich — The Toffoli gate is an important primitive in many quantum circuits and quantum error correction schemes. Here we demonstrate the implementation of a Toffoli gate with three superconducting transmon qubits coupled to a microwave resonator [1]. Following Ralph *et al.* [2] we used the third energy level of the transmon qubit to significantly reduce the number of elementary gates needed to implement the Toffoli gate in comparison to approaches using two-level systems only. A similar scheme to realize a Toffoli-class gate has independently been devised on a system of three logical qubits encoded in the states of two qubits and a resonator [3]. Our gate fidelity evaluated by both full process tomography and Monte Carlo process certification is $68.5 \pm 0.5\%$. The results reinforce the potential of macroscopic superconducting qubits for implementation of complex quantum operations and point at the possibility to implement quantum error correction schemes [4].

[1] A. Fedorov *et al.*, arXiv:1108.3966.

[2] T. C. Ralph, K. J. Resch, A. Gilchrist, Phys. Rev. A **75**, 022313 (2007).

[3] M. Mariantoni, *et al.* Science **334**, 61 (2011).

[4] M. D. Reed, *et al.*, arXiv:1109.4948.

Arkady Fedorov
ETH Zurich

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