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Nanomechanics and superconducting qubits for quantum information[1]

ANDREW CLELAND, University of California - Santa Barbara

There has been tremendous progress in the capabilities of superconducting quantum circuits, both for fundamental quantum science as well as for applications in quantum information. Superconducting qubits are based on the Josephson junction, which provides the fundamental inductive nonlinearity that affords full quantum control of otherwise quite simple electrical circuits. I will outline how a superconducting qubit can be used to measure and control the quantum state of a nanomechanical system [1], completely control multi-photon states in superconducting resonators [2,3], factor the number 15 using a von Neumann-style computing architecture [4,5], and possibly allow the transfer of a GHz-frequency quantum state to an optical signal.

[1] A.D. O'Connell et al., "Quantum ground state and single-phonon control of a mechanical resonator," Nature 464, 697-703 (2010)
[2] M. Hofheinz et al., "Generation of Fock states in a superconducting quantum circuit," Nature 454, 310-314 (2008)
[3] M. Hofheinz et al., "Synthesizing arbitrary quantum states in a superconducting resonator," Nature 459, 546-549 (2009)
[4] M. Mariantoni et al., "Implementing the quantum von Neumann architecture with superconducting circuits," Science 334, 61 (2011)
[5] E. Lucero et al., "Computing prime factors with a Josephson phase qubit quantum processor," Nature Physics 8, 719 (2012)

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