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Abstract for an Invited Paper
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Superconducting qubit storage and entanglement with nanomechanical resonators¹

MICHAEL GELLER, University of Georgia

I will discuss work done with Andrew N. Cleland on the design of a quantum computing architecture based on the integration of GHz-frequency mechanical or electromagnetic resonators with Josephson junction (JJ) phase qubits. This system is analogous to one or more few-level atoms (the JJs) in an electromagnetic cavity (the resonator), except that here we can individually tune the energy level spacing of each atom, and can control the electromagnetic interaction strength. We show that the quantum state of a JJ can be passed to the resonator and stored there, and later passed back to the original JJ or transferred to a second JJ. Furthermore, memory devices made from resonators with ultrahigh Q factors can be used to effectively extend the coherence of the phase qubits. The resonator can also produce controlled entangled states of the JJs and can mediate quantum logic. We discuss the accuracy of the rotating-wave and adiabatic approximations in this system, and show that these approximations are actually quite poor at predicting the phase of probability amplitudes. Our architecture combines desirable features of both solid-state and cavity-QED approaches, and may make quantum computing possible in a scalable, solid-state environment.

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