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A macroscopic mechanical resonator operated in the quantum limit AARON O'CONNELL, University of California, Santa Barbara - Physics, RADOSLAW BIALCZAK, MICHAEL LENANDER, ERIK LUCERO, MATTEO MARIANTONI, MATTHEW NEELEY, DANIEL SANK, HAOHUA WANG, MARTIN WEIDES, JAMES WENNER, TSUYOSHI YAMAMOTO[1], YI YIN, JOHN MARTINIS, ANDREW CLELAND — The observation of quantum effects in a macroscopic mechanical resonator is hindered by the difficulty in cooling to the quantum ground state, and in making a system that displays adequate coherence times. We are able to meet these challenges in a novel system comprising a superconducting phase qubit coupled to a high frequency (6 GHz) micromechanical dilatational resonator. Using this coupled system, we place an upper bound on the minimum average phonon occupation number of the mechanical resonator $\langle n \rangle < 0.07$, showing that the resonator is in its quantum ground state. Furthermore, we use the qubit to both create and measure a single phonon state in the resonator. Using this ability, the energy decay and phase coherence times of the resonator are extracted. Additionally, we excite the resonator directly with a classical microwave source, demonstrably creating a coherent state in the mechanical resonator.

[1]NanoElectronics Research Laboratories, NEC Corporation, Japan.

Aaron O'Connell
University of California, Santa Barbara - Physics

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