Mechanical resonators in the quantum regime

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I will describe our recent experiments, representing about ten years' development of nanomechanical and quantum circuit technology, which culminated in our formulating and creating a quantum mechanical resonator that could "easily" be prepared in quantum (non-classical) states of mechanical vibration. Key requirements included a mechanical design that supported a microwave-frequency mechanical resonance; using a piezoelectric material in order to achieve very strong electromechanical coupling; and employing a Josephson junction, implemented as a phase quantum bit (qubit), to measure and interact with the mechanical resonator. Operating at 25 mK on the mixing chamber of a dilution refrigerator, this integrated electromechanical system can be cooled to its quantum ground state without additional intervention. Then, employing the extraordinary nonlinearity provided by the Josephson qubit, and the coherent interactions of this qubit and the mechanical resonator, we were able to prepare and measure non-classical mechanical states of motion in the resonator.

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