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Strong electromechanical coupling of an AFM cantilever to a few-electron quantum dot STEVEN D. BENNETT, McGill University, LYNDA COCKINS, YOICHI MIYAHARA, PETER GRUTTER, AASHISH A. CLERK —
Mechanical objects provide extremely sensitive probes to measure quantum electronic systems. The damping of an atomic force microscope (AFM) cantilever capacitively coupled to a quantum dot exhibits Coulomb blockade peaks as a function of bias voltage in much the same way that Coulomb blockade peaks occur in the conductance through a quantum dot. It has long been predicted that level degeneracy in the dot results in asymmetric lineshapes in the Coulomb blockade peaks of the conductance, as well as temperature-dependent shifts of the peak positions. We extend this theory to the case of mechanical damping, and find that the effects of degeneracy are enhanced due to an increased sensitivity to the asymmetry between adding or removing an electron from the dot. Furthermore, by driving the cantilever to large oscillation amplitudes we enter a regime of strong coupling where the lineshape asymmetry is enhanced dramatically. The high sensitivity of the AFM damping to level degeneracy has allowed both the shifts and asymmetric lineshapes of Coulomb blockade peaks to be measured in recent experiments for the first time, showing excellent agreement with theory.

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