Quantum nondemolition measurement of mechanical motion quanta

Abstract

The fields of opto- and electromechanics have facilitated numerous advances in the areas of precision measurement and sensing, ultimately driving the studies of mechanical systems into the quantum regime. To date, however, the quantization of the mechanical motion and the associated quantum jumps between phonon states remains elusive. For optomechanical systems, the coupling to the environment was shown to preclude the detection of the mechanical mode occupation, unless strong single photon optomechanical coupling is achieved. Here, we propose and analyse an electromechanical setup, which allows us to overcome this limitation and resolve the energy levels of a mechanical oscillator. We find that the heating of the membrane, caused by the interaction with the environment and unwanted couplings, can be suppressed for carefully designed electromechanical systems. The results suggest that phonon number measurement is within reach for modern electromechanical setups.

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