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Fachbereich Physik, Universität Stuttgart
Max-Planck-Institut für Festkörperforschung
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Quantum back-action in recent cavity-optomechanics experiments

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Abstract

Quantum limits to precision measurement of an object's displacement, and correspondingly the forces acting on the object, have been well studied since the 1970's. In the case of laser interferometers, quantum fluctuations of the probe laser field set the level of imprecision for displacement sensitivity and also give rise to quantum back-action via radiation pressure shot noise. Recent experiments with much smaller chip-scale devices have for the first time measured the effects of quantum back-action in the context of cavity-optomechanics. I will describe two of these experiments that have been performed at Caltech. The first involves measurement of the relative amplitude of the Stokes and anti-Stokes motional sidebands created on a probe laser field by a mechanical resonator near its quantum ground-state of motion. An asymmetry in the generated motional sidebands, as has been utilized in experiments with trapped ions and atoms, provides a self-calibrated means of measuring the mechanical oscillator's quantum occupancy. An alternative view of such experiments, one from the perspective of continuous position measurement of the mechanical oscillator, provides an interesting twist in interpreting the source of the measured sideband asymmetry. A second experiment, involves the use of strong measurement by a probe laser field to generate, via quantum back-action, squeezed light from a silicon micromechanical resonator.