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Observing quantum phenomena in cavity optomechanics[1]
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— Recent efforts have produced optomechanical systems whose mechanical elements are prepared at or near their quantum ground state. But what manifestly quantum effects can be measured with these new systems? Here we present results from our experiment, using the collective motion of an ultracold atom ensemble as a mechanical oscillator. The motion is driven by shot noise in the light's radiation pressure, allowing us to observe the production of nonclassical states of light by optomechanics – here, quadrature-squeezed light. Notably, this nonlinear optical effect occurs with only 40 pW of pump power. We also measure the quantization of the oscillator, by observing a 3:1 asymmetry in the light it scatters to low- and high-energy optical sidebands. Analyzing the light emitted from the cavity moreover provides a spectroscopic record of the energy exchanged between light and motion, allowing us to directly quantify the necessary diffusive heating of a quantum backaction-limited position measurement.

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