Abstract Submitted
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Nanomechanical motion measured with an imprecision below the standard quantum limit using a nearly shot-noise limited microwave interferometer JENNIFER HARLOW, JOHN TEUFEL, TOBIAS DONNER, MANUEL CASTELLANOS-BELTRAN, KONRAD LEHNERT, JILA, University of Colorado and NIST — Observing quantum behavior of mechanical motion is challenging because it is difficult both to prepare pure quantum states of motion and to detect those states with sufficient precision. We present displacement measurements of a nanomechanical oscillator with an imprecision below that at the standard quantum limit [1]. We infer the motion from the phase modulation imprinted on a microwave signal by that motion. The modulation is enhanced by embedding the oscillator in a high-Q microwave cavity. We achieve the low imprecision by reading out the modulation with a Josephson Parametric Amplifier, realizing a microwave interferometer that operates near the shot-noise limit. The apparent motion of the mechanical oscillator due the interferometer's noise is now substantially less than its zero-point motion, making future detection of quantum states feasible. In addition, the phase sensitivity of the demonstrated interferometer is 30 times higher than previous microwave interferometers, providing a critical piece of technology for many experiments investigating quantum information encoded in microwave fields. [1] J. D. Teufel, T. Donner, M. A. Castellanos-Beltran, J. W. Harlow, K. W. Lehnert, Nature Nanotechnology, doi:10.1038/nnano.2009.343, (2009).

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