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Quadratic Measurement and Conditional State Preparation in an Optomechanical System[1] GEORGE BRAWLEY, MICHAEL VANNER, WARWICK BOWEN, School of Mathematics and Physics, The University of Queensland, SILVAN SCHMID, ANJA BOISEN, Department of Micro- and Nanotechnology, Technical University of Denmark — An important requirement in the study of quantum systems is the ability to measure non-linear observables at the level of quantum fluctuations. Such measurements enable the conditional preparation of highly non-classical states. Nonlinear measurement, although achieved in a variety of quantum systems including microwave cavity modes and optical fields, remains an outstanding problem in both electromechanical and optomechanical systems. To the best of our knowledge, previous experimental efforts to achieve nonlinear measurement of mechanical motion have not yielded strong coupling, nor the observation of quadratic mechanical motion. Here using a new technique reliant on the intrinsic nonlinearity of the optomechanical interaction, we experimentally observe for the first time a position squared (x^2) measurement of the room-temperature Brownian motion of a nanomechanical oscillator. We utilize this measurement to conditionally prepare non-Gaussian bimodal states, which are the high temperature classical analogue of quantum macroscopic superposition states, or cat states. In the future with the aid of cryogenics and state-of-the-art optical cavities, our approach will provide a viable method of generating quantum superposition states of mechanical oscillators.

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