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Mechanical effects of strong measurement: back-action noise and cooling

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Our recent experiments show that it is now possible to prepare and measure mechanical systems with thermal occupation factors of N∼25 and perform continuous position measurements close to the limits required by the Heisenberg Uncertainty Principle (1). I will discuss our back-action measurements with nanomechanical structures strongly coupled to single electron transistors. We have been able to observe the stochastic back-action forces exerted by the SET as well as a cooling effect which has analogies to cooling in optical cavities. Furthermore, I will discuss progress using optical fields coupled to mechanical modes which show substantial cooling using the pondermotive effects of the photons impacting a flexible dielectric mirror (2). Both of these techniques pave the way to demonstrating the true quantum properties of a mechanical device: squeezed states, superposition states, and entangled states.

(1) "Quantum Measurement Backaction and Cooling Observed with a Nanomechanical Resonator," A. Naik, O. Buu, M.D. LaHaye, M.P. Blencowe, A.D. Armour, A.A. Clerk, K.C. Schwab, *Nature* **443**, 193 (2006).
(2) "Self-cooling of a micro-mirror by radiation pressure," S. Gigan, H.R. Boehm, M. Patemostro, F. Blaser, G. Langer, J. Hertzberg, K. Schwab, D. Baeuerle, M. Aspelmeyer, A. Zeilinger, *Nature* **444**, 67 (2006).