

Direct Detection of Small Numbers of Nuclear Spins

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We have developed and studied a nanoelectromechanical system with a radio-frequency nanomechanical resonator tightly coupled to single electron transistor. This system has demonstrated a number of exceptional properties: frequency $f \sim 20$ MHz, quality factor $Q \sim 150,000$, mode noise temperature $T = 25$ mK, displacement resolution 3×10^{-16} m/rtHz, force sensitivity 6×10^{-19} N/rtHz, $Dx/Dx_{\text{sql}} = 5$, $(S_x S_f)^{.5} < 15$ hbar/2. These results were reported in Ref.1 and soon in Ref. 2. We are exploring the possibility to use this system to directly detect nuclear magnetic resonance of a microscopic quantity of nuclear spins, in collaboration with Chris Hammel and Ohio State. I will present our thoughts and ask for ideas from the participants.

[1] "Approaching the Quantum Limit of a Nanomechanical Resonator," M. LaHaye, O. Buu, B. Camarota, K. Schwab, *Science* 304, 74 (2004).

[2] "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, to appear in *Nature* /August 2006