

Abstract Submitted  
for the MAR11 Meeting of  
The American Physical Society

**Super-rolloff electron tunneling transduction of nanomechanical motion using frequency downmixing** MENG KAN, MARK FREEMAN, WAYNE HIEBERT, National Institute for Nanotechnology, National Research Council of Canada and Department of Physics, University of Alberta, Edmonton, Canada — Electron tunneling transduction has high sensitivity for detecting the motion of nanomechanical devices, but the relatively low detection bandwidth of a few 10's of kHz has limited its development. Here we demonstrate a novel downmixing transduction scheme which eliminates the detection bandwidth problem of electron tunneling transduction. With this technique, the high frequency vibration modes ( $\sim 1$  MHz) of a MEMS doubly clamped beam are measured. This measurement is 2 orders of magnitude above the electronic bandwidth of our readout circuitry with no fundamental limitation anticipated up to microwave frequencies. The displacement sensitivity is  $40 \text{ fm/Hz}^{1/2}$  comparable to state-of-the-art low finesse free-space optical interferometry. The back-action force induced by the STM tip on the MEMS device is also explored and is shown to have a small effect on the measurement resonance frequency, causing slight resonance frequency shifts of order 1%.

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Date submitted: 22 Nov 2010

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