SFB/TRR 21 - Kolloquium
6. Mai 2011, Stuttgart

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Strong coupling of single-electron tunneling to nanomechanical motion

Nanoscale resonators that oscillate at high frequencies are potentially exciting candidates for ultra-sensitive mass detectors, as well as for probing the mechanical motion of macroscopic objects in the quantum limit. Here, I will discuss our recent results studying a high-quality mechanical resonator made from a suspended carbon nanotube driven into motion by applying a periodic radio frequency potential using a nearby antenna. A high mechanical quality factor exceeding 10^5 allows the detection of a shift in resonance frequency caused by the addition of a single-electron charge on the nanotube. Single-electron charge fluctuations are found to induce periodic modulations of the mechanical resonance frequency. These single-electron “tuning” oscillations are a mechanical effect that is a direct consequence of single-electron tunneling oscillations. Additional evidence for the strong coupling of mechanical motion and electron tunneling is provided by an energy transfer to the electrons causing mechanical damping, and unusual nonlinear behavior induced by the single electron force. In the absence of external RF driving, we discover that a direct current through the nanotube spontaneously drives the mechanical resonator, exerting an oscillating force that is coherent with the high-frequency resonant mechanical motion.

6. Mai 2011, 14:00 Uhr

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