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Clean carbon nanotubes: From single electron quantum dots to ultra-high quality mechanical resonators

Carbon nanotube devices made using a new ultra-clean fabrication technique offer a unique new platform for studying transport, optics, nanomechanics, and the coupling between them. Motivated by a desire for single electron quantum dots to be used as a spin quantum bit, these clean nanotubes can also act as high efficiency optical emitters, and possess phenomenal mechanical properties as high frequency resonators. In this talk, I will focus on the nanomechanical properties of these devices: here, a suspended nanotube acts as a nanometre sized vibrating beam. The motion of the nanotube is detected by the current through a quantum dot formed in the nanotube itself. The resonator in these clean nanotubes shows a quality-factor of up to 150 000, two orders of magnitude higher than previous nanotube devices. We also find that the mechanical motion is strongly influenced by the quantum dot detector, observed by quantized jumps in the nanotube tension, periodic modulations of the resonance frequency, and spontaneous driving of the mechanical motion by the single electron current.

