Crossover between Quantum and Thermal Regimes in Nanostructures

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Free-standing nanostructures with transverse dimensions on the order of 10 nm may provide a new arena for studying fundamental quantum phenomena at the nanometer scale [*a*]. In terms of applications such structures may play a role in next-generation microelectronics, where small mechanical structures could be combined with conventional semiconductor technology [*b*]. Here we address the quantum aspects of suspended elastic nanostructures under longitudinal compression. We calculate excitation energies and quantum fluctuation amplitudes as a function of applied strain first for a general system, and then we compare results for rectangular silicon beams and carbon nanotubes. We argue that compressing a carbon nanotube at low temperature may cause a crossover between quantum and thermal fluctuation regimes. Experimental progress towards realization of these ideas is discussed.

[a] S.M. Carr et. al., cond-mat/0104039.

[b] see, e.g., P. Collins and P. Avouris, Sci. Am. **283**, 62 (2000); T. Rueckes et. al., Science **289**, 94 (2000).