Nonlinearities in mechanical resonators at the zero-point motion level

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Résumé

An open question in mechanics is whether mechanical resonators can be made nonlinear with vibrations approaching the quantum ground state. This requires engineering a mechanical nonlinearity far beyond what has been realized thus far. In this talk, I will present a mechanism to boost the Duffing (also called Kerr) nonlinearity by coupling the vibrations of a nanotube resonator to single-electron tunneling in a quantum dot and by operating the system in the ultrastrong coupling regime (1). Remarkably, thermal vibrations become highly nonlinear when lowering the temperature. In a second series of experiments, we couple the nanotube vibrations and a double quantum dot qubit, which is readout with a superconducting resonator, enabling us to observe nonlinear vibrations at the zero-point motion level. Our work paves the way for realizing mechanical qubits (2), quantum simulators emulating the electron-phonon coupling, and macroscopic quantum superposition states (3).

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