Nonlinearities in mechanical resonators approaching the quantum regime

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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 and by operating the system in the ultrastrong coupling regime[1]. Remarkably, thermal vibrations become highly nonlinear when lowering the temperature. I will also discuss our progress using mechanical resonators with an embedded double-quantum dots and coupled to a superconducting resonator. Our work paves the way for realizing mechanical qubits[2] and quantum simulators emulating the electron-phonon coupling[3,4] .

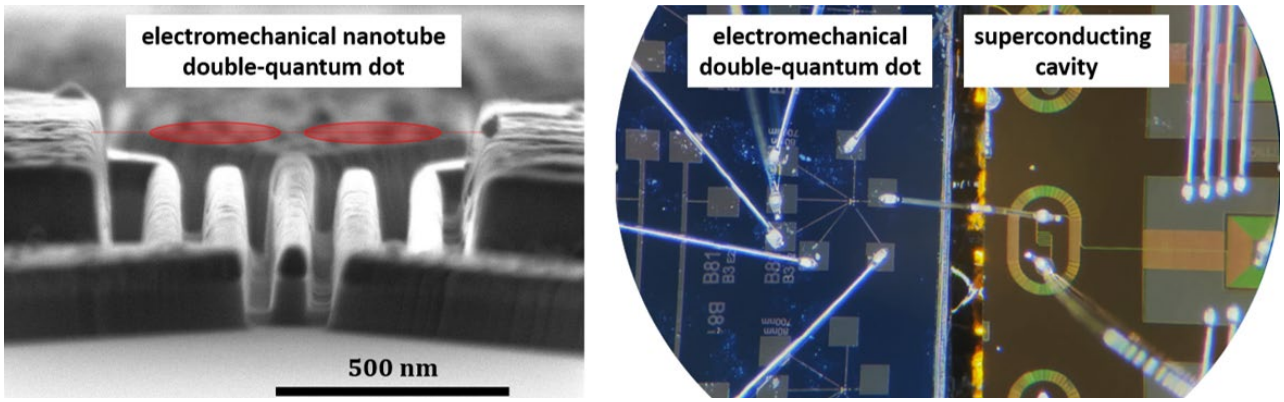

Fig. 1: Electromechanical device consisting of a double-quantum dot (in red) embedded in a suspended carbon nanotube clamped at its two ends. The double-quantum dot is defined by electrostatics means using the five gate electrodes. For the readout, the electromechanical device is dispersively coupled to a superconducting resonator.

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