Electron-vibron coupling in finite suspended carbon nanotubes

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The remarkable electronic and vibronic properties of suspended carbon nanotubes (CNTs) make them very promising for nanomechanical devices. The strong coupling between single electron tunneling in quantum dots and the mechanical vibration of the suspended CNTs have been observed in several experiments. We provide an analytical investigation of the interaction between the stretching vibrational modes and the electronic degrees of freedom in a finite-length CNT in the helical picture. A parity symmetry and the rotational symmetry of the CNT are used in the derivation to simplify the electron-vibron coupling Hamiltonian. Selection rules, which are different for zigzag class and armchair class CNTs, determine which electronic transitions are coupled to distinct vibrational modes.