Master 2 Internship

Title: carbon nanotubes as nano-mechanical qubits

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Project:

The realization of new platform for quantum computing is an important challenge. The main element for quantum computation is the qubit, a two-level system. In order to be used for quantum computation is has to well isolated from the environment, in order to preserve the quantum coherence. Mechanical resonators are known to have very good quality factors, and in this respect could be very interesting as host systems for a qubit. The main difficulty is to convert the equally spaced harmonic oscillator spectrum to that of a non-linear oscillator, in order to manipulate the first two states without populating higher states. Introducing a non-linearity is not trivial, recently we proposed a system formed by a nanotube coupled to a double quantum dot (see figure and reference), that appears to fulfill the requirements for being a qubit.
In this internship, we will study theoretically the dynamics of the system and its behavior in presence of an environment. Protocols for large quantum delocalization of the oscillator will be also investigated.

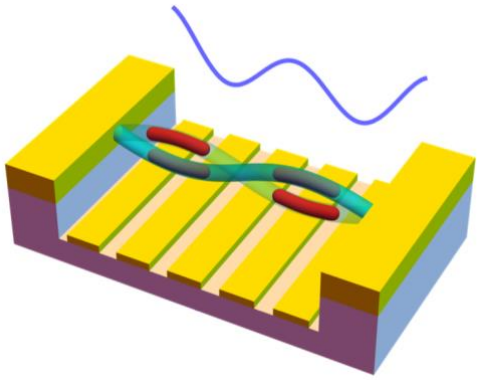

Fig: Schematic of the proposed setup. A suspended carbon nanotube hosting a double quantum dot, whose one- electron charged state is coupled to the second flexural mode. In blue a sketch of the electronic confinement potential.

Reference: Proposal for a nanomechanical qubit, F. Pistolesi, A. Cleland, A. Bachtold, Phys. Rev. X **11**, 031027 (2021).