Master 2 Internship

Title: carbon nanotubes as nano-mechanical qubits

Supervisor(s): F. Pistolesi

Email(s): Fabio.Pistolesi@u-bordeaux.fr

Project:

The realization of a new platform for quantum computing is an important challenge. The main element for quantum computation is the qubit, a two-level system. To be suitable for quantum computation, it must be well-isolated from the environment to preserve quantum coherence. Mechanical resonators are known to have very good quality factors and, in this regard, could be very interesting as host systems for a qubit. The main difficulty lies in converting the equally spaced harmonic oscillator spectrum into that of a non-linear oscillator, allowing manipulation of the first two states without populating higher states. Introducing non-linearity is not trivial. In 2021 we proposed a system consisting of a nanotube coupled to a double quantum dot (see the figure and reference [1]), which appears to meet the requirements for being a qubit. Very recently a strong non-linearity has been observed [2].

During this internship, we will theoretically study how to detect and manipulate such a qubit coupled to a microwave cavity or to a quantum dot.

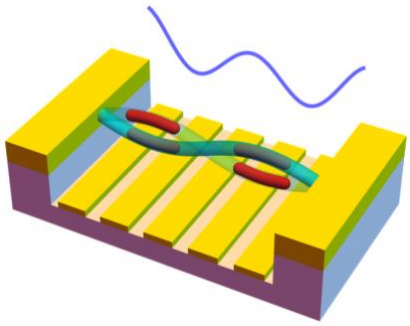

Figure: Schematic of the proposed setup. A suspended carbon nanotube hosting a double quantum dot, whose one-electron charged state is coupled to the second flexural mode. In blue a sketch of the electronic confinement potential.

References:

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

[2] Nonlinear nanomechanical resonators approaching the quantum ground state, C. Samanta, S. L. De Bonis, C. B. Møller, R. Tormo-Queralt, W. Yang, C. Urgell, B. Stamenic, B. Thibeault, Y. Jin, D. A. Czaplewski, F. Pistolesi and A. Bachtold, Nature Physics, **19**, 1340 (2023).