

Master's thesis

Superconducting qubit based on a suspended carbon nanotube

Context and goals:

This project aims to develop a novel type of superconducting qubit based on a single suspended carbon nanotube forming a transparent Josephson junction. A key objective is to explore the relation between Andreev bound states in the nanotube and the qubit's properties.

A natural evolution of the project consists in addressing the mechanical vibration of the nanotube as a new available degree of freedom (phonons). Ultimately, this approach could enable the exploration and generation of exotic quantum states, such as mechanical Schrödinger cat states [1], in which a mechanical resonator occupies a quantum superposition of distinct vibrational states.

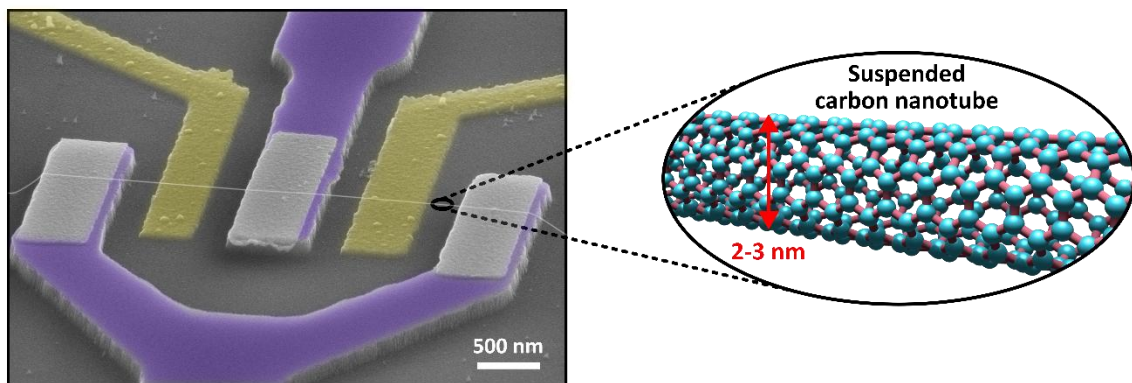


Figure: Example of a home-built nanocircuit [2] comprising two Josephson junctions within a single suspended carbon nanotube (Scanning electron micrograph).

We are looking for a motivated student

with a strong interest in Quantum mechanics, and experimental research.

Project: The project content is flexible and can be adapted to the preferences of the student. Possible activities include:

- Quantum transport and qubit-measurement techniques
- Data analysis (programming, simulations, ...)
- Nanofabrication of superconducting circuit (clean-room techniques).
- Handling our Cryogenic setups (dilution refrigerator).

References:

[1] Schrödinger cat states of a 16-microgram mechanical oscillator
M. Bild, et al., Science 380, 274–278 (2023).

[2] Nano-assembled open quantum dot nanotube devices

T. Althun, T. Cubaynes, A. Auer, C. Sürgers, and W. Wernsdorfer Communications Materials 5, 5 (2024).