

Exploring Quantum States in Carbon Nanotubes and Novel Josephson Junctions

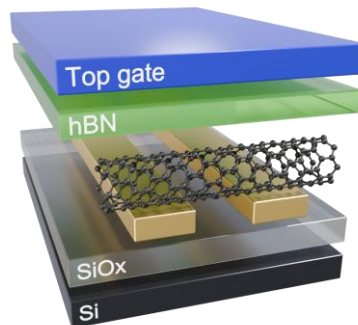
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Project:

The goal of this project is to explore quantum states localized between two superconductors, known as Andreev bound states. One of the specialties of our laboratory is the study of these states in carbon nanotubes (CNTs), where a single molecule can host a single conduction channel. We have already demonstrated supercurrent transport through CNTs [1].

The project will also explore novel types of Josephson junctions made from aluminum, in particular junctions containing pinholes through an insulating barrier [2]. Such junctions provide access to highly transmitting conduction channels and offer a new platform for investigating Andreev bound states and their potential applications in quantum circuits.

A central goal of the project is to achieve coherent control of these quantum states and explore their potential as building blocks for quantum devices. A first step in this direction was recently achieved in our laboratory with the realization of a superconducting qubit based on a CNT [3]. The project will build on this result to investigate the coherent dynamics of Andreev states in both CNTs and novel Josephson junctions.

[1] S. Annabi et al., Phys. Rev. Applied 22, 064035 (2024)

[2] J. Griesmar et al., Phys. Rev. Applied 24, 064065 (2025)

[3] H. Riechert et al., Nat. Commun. 16, 7197 (2025)

Methods : Cryogenics, electronics, microwave measurements, low noise DC measurements, nanofabrication, numerical simulations