NÉEL INSTITUTE Grenoble

PhD Project – Academic year 2024-2025

Quantum capacitance of an anyon box in bilayer graphene

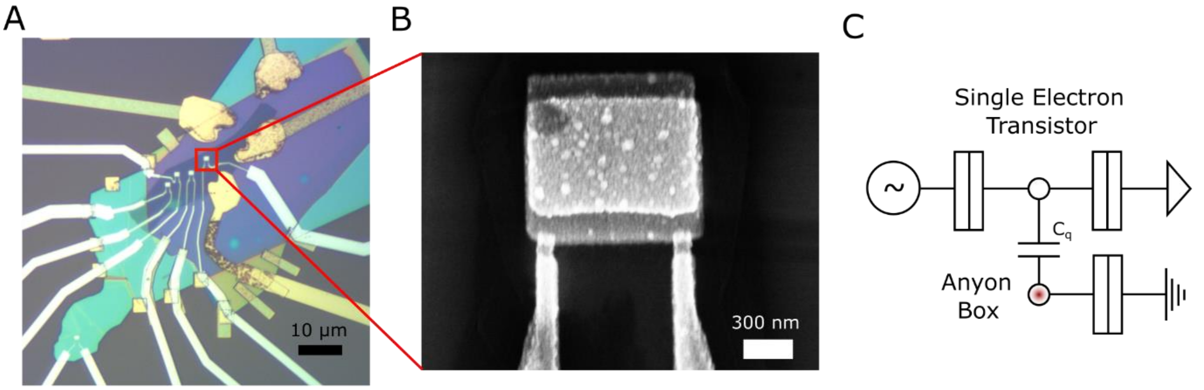
General Scope :

Anyons are a type of quasiparticle that can be generated in low dimensional (d<3), strongly interacting electronic system. The interest of anyons lies in their new quantum statistic, neither bosonic nor fermionic, which make it possible to manipulate the ground state of an electronic system by exchanging the position of its particles. This controlled exchange of the anyon positions, known as braiding, should lead to topological qubits with exceptionally low error rates [1]. In addition, the possibility of exploring a new quantum statistic beyond the fermion-boson dichotomy is of considerable fundamental interest.

[1] "Non-Abelian anyons and topological quantum computation"
C. Nayak et al. Review of Modern Physics (2008).

Research topic and facilities available :

The most promising route to realizing anyons is the fractional quantum Hall effect, where a 2D electron system is subjected to a strong perpendicular magnetic field. Bilayer graphene has recently been shown to be a promising platform for probing anyons, thanks to the large energy gaps reported for its fractional quantum Hall states. The aim of this project is to trap a single anyon around an electrostatic potential well, in order to investigate the capability of such "anyon box" structures for topological quantum computing. The candidate will be involved in the sample fabrication process, where aluminum single electron transistors, capable of detecting a single anyon charging event, are capacitively coupled to the anyon box, as shown in the figures below. She/He will be involved in low noise cryogenic measurements of the anyon box quantum capacitance.



A. Optical image showing multiple single electron detectors (white) capacitively coupled to bilayer graphene equipped with electrostatic gates made of 2D materials. **B.** Scanning electron microscope image of an aluminum single electron transistor realized at the Néel Institute. **C.** Schematic of the measurement showing the anyon box capacitively coupled to the single electron transistor.

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Possible collaboration and networking :
University of California Santa Barbara – Young lab.

Required skills:
Background in condensed matter physics.
Interest in experimental condensed matter physics with quantum electrical circuits, from the circuit fabrication to the low temperature measurements.

Starting date : Flexible.

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