NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2023-2024

Quantum capacitance as a probe of non-abelian anyons in bilayer graphene

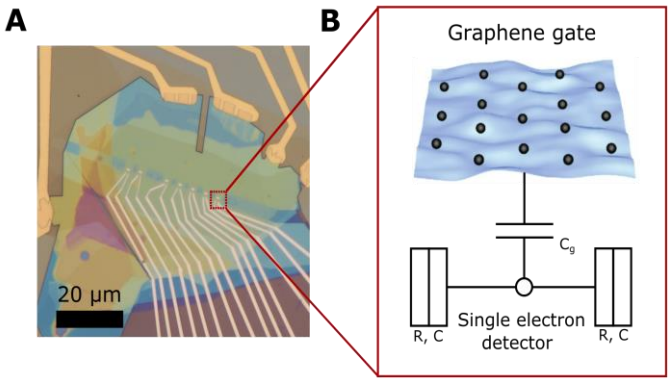
General Scope :

Non-abelian anyons are a type of quasiparticle that can be generated in low dimensional (d<3), strongly interacting electronic system. The interest in such 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 non-abelian 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 these anyons, thanks to its high electron mobility and high degree of tunability. Their detection relies on their non-trivial quantum statistics, which can be inferred from low temperature measurement of the chemical potential. The goal of this internship is to probe the chemical potential in a capacitor geometry in which one of the plates is made of bilayer graphene. The candidate will be involved in the sample fabrication process, where single electron transistors, used as highly sensitive detectors of the chemical potential, are placed on bilayer graphene equipped with electrostatic gates, as shown in the figures below. She/He will be involved in low noise cryogenic measurements of quantum capacitors.



A. Optical image showing multiple single electron detectors (white) capacitively coupled to bilayer graphene equipped with electrostatic gates made of 2D materials. **B.** Schematic of the measurement showing a lattice of anyons (black dots on blue background) capacitively coupled to a single electron transistor.

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

Possible extension as a PhD :
Funding available for extension as a PhD.

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.

Contact : Alexandre Assouline : alex.assouline91@gmail.com