INTERNSHIP PROPOSAL

Laboratory name: C2N, Université Paris-Saclay
CNRS identification code: UMR 9001
Internship director'surname: Frédéric Pierre / Anne Anthore
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Internship location: Centre de Nanosciences et nanotechnologies, 10 bd Thomas Gobert, 91120 Palaiseau (RER B, 'le guichet')

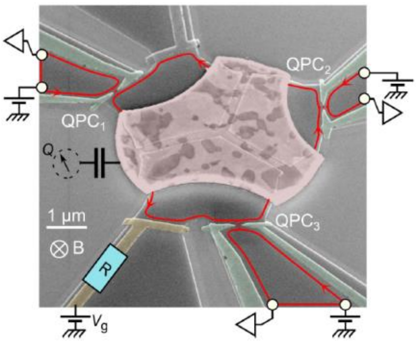
Thesis possibility after internship: YES
Funding: YES **type of funding:** ERC

Entropy in Engineered Quantum Systems

Mesoscopic thermodynamics of correlated quantum states

Quantum systems engineered to host correlated electronic states are of fundamental and technological interest. Often 'exotic' new quasi-particles emerge, such as Majorana fermions, whose inherent topological robustness forms the basis of a promising approach to quantum computation. Thermodynamic probes have been central for characterizing new phases of matter in bulk materials. Whereas low-dimensional quantum systems offer greater opportunities for control, probing their electronic states in a similar way is notoriously difficult, in part because of the small number of electrons involved.

The broad objective of this project, involving also teams in Switzerland, Canada and Israel, is to overcome this challenge and to explore correlated quantum states in low-dimensional systems by measuring thermodynamic quantities. The specific main objective of the present experimental internship/PhD work will be to perform unequivocal observations of exotic states including Majorana fermions and Fibonacci anyons, from their fractional ground state entropy (a fraction of kB ln[2]). These exotic states will emerge from the quantum circuit engineering of Coulomb induced correlations, which will be achieved by developing an approach pioneered in the C2N team (see e.g. Science 360, 1315 (2018), https://arxiv.org/abs/2303.12039). The ground state entropy will be measured by adapting a strategy demonstrated by our Canadian partner for a spin ½ (Nature Physics 14, 1083 (2018)), based on the Maxwell relation dS/dN=-dμ/dT.



The student will get acquainted with a variety of ultra-sensitive measurement techniques (electrical conductance and fluctuations, thermodynamic probes including entropy), cryogenic techniques for millikelvin temperatures, e-beam nanofabrication in the outstanding C2N facilities, and advanced quantum mechanics. The student work will encompass all aspects of the project, including the theoretical work of analysis and modelling which will also benefit from the constant support of our partner theory team in Israel. Opportunities for a 1-3 months visit in the lab of our Swiss or Canadian partner are likely to arise along the PhD.

Condensed Matter Physics:	YES	Soft Matter and Biological Physics:	NO
Quantum Physics:	YES	Theoretical Physics:	NO