

INTERNSHIP PROPOSAL

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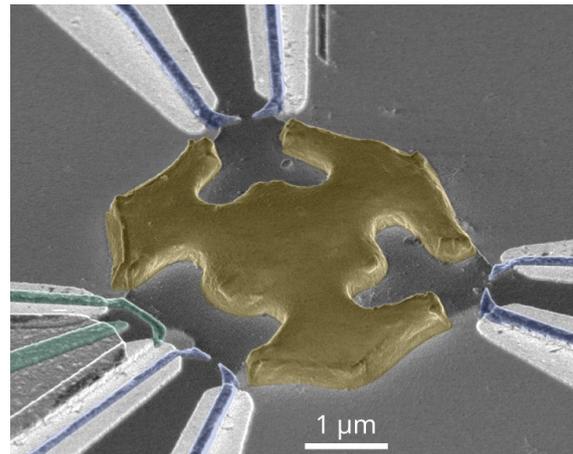
Web page: <https://qpc.c2n.universite-paris-saclay.fr/en/>

Location: Centre de Nanosciences et nanotechnologies, 10 bd Thomas Gobert, 91120 Palaiseau (RER B, 'le guichet')

Circuit engineering and thermodynamics characterization of correlated quantum states

Quantum systems hosting correlated electronic states are of fundamental and technological interest. 'Exotic' new quasi-particles can emerge, such as Majorana fermions, whose inherent topological robustness forms the basis of a promising approach to quantum computation. However, the complexity and reduced control over bulk materials impedes their study. An alternative approach is to engineer electronic correlations by quantum circuit design. Such tunable and well characterized circuits behave as quantum simulators. These can be addressed not only through transport but also using revealing thermodynamic probes that have been central for characterizing new phases of matter in bulk materials.

The broad objective of this project is to engineer quantum circuit behaving as quantum simulators to create and explore new correlated quantum states, and to unambiguously characterize them 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 $k_B \ln[2]$). 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), Nature Communications 14, 7263 (2023)). The ground state entropy will be measured by adapting a strategy demonstrated for a spin $\frac{1}{2}$ (Nature Physics 14, 1083 (2018)), based on the thermodynamic Maxwell relation $dS/dN = -d\mu/dT$.

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.

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