Funded PhD Thesis Proposal on Experimental Quantum Physics

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Funding: Labex Nanosaclay (project QPT)

Quantum phase transitions in electronic circuits

The exotic `quantum critical' physics that develops in the vicinity of quantum (zero temperature) phase transitions is believed to underpin the fascinating behaviors of many strongly correlated electronic materials, such as heavy fermions and high-temperature superconductors. However, in these complex systems identifying the microscopic origins is very challenging and controversial.

During his Phd, the student will explore the quantum critical physics using completely characterized electronic quantum circuits as model systems, allowing an unprecedented direct comparison between the measurements and the quantitative predictions of many-body theoretical methods (renormalization group, conformal field theory, Bethe ansatz…).

The studied quantum circuits are metal-semiconductor hybrids that the student will fabricate using the exceptional nanofabrication facilities of our laboratory (belonging to the French technological research network, with four other facilities). The quantum critical physics will be characterized through transport measurements (electrical and thermal conductance, current fluctuations, charge susceptibility). For this purpose the student will use, and eventually develop further, the team's outstanding low-temperature setup, which holds the 6 mK record temperature in mesoscopic circuits and allows for a resolution on current fluctuations of 10^{-31} A^2/Hz, the present international state of the art in the field. An important part of the PhD is also the theoretical work of bibliography, analysis and modelling. For the most theoretically involved aspects, we will benefit from strong collaborations with several theory teams.

Selection of related publications:

1. Two-channel Kondo effect and renormalization flow with macroscopic quantum charge states. Z. Iftikhar *et al.*, Nature 526, 233 (2015).
2. Tomonaga-Luttinger physics in electronic quantum circuits. S. Jezouin *et al.*, Nature communications 4, 1802 (2013).
3. Quantum limit of heat flow across a single electronic channel. S. Jezouin *et al.*, Science 342, 601 (2013).