Master 2: *International Centre for Fundamental Physics*

INTERNSHIP PROPOSAL

Laboratory names: Laboratoire Pierre Aigrain (ENS) and LPS (Orsay)
CNRS identification code: UMR 8551
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Internship location: ENS Paris & Orsay
Thesis possibility after internship: YES
Funding: YES/NO If YES, which type of funding:

Title: **Theoretical study of quantum Phase transitions in dissipative circuits**

Quantum Phase Transitions (QPT) [1] display fascinating and unconventional scaling properties and are believed to play a prominent role in the correlated physics of High-Tc superconductors or heavy fermions. They are driven by quantum fluctuations rather than thermal fluctuations in contrast with standard phase transitions. Even though QPT occur at zero temperature, their presence dictates exotic finite temperature scaling properties. Quantum mesoscopic circuits offer clean and tunable platforms to precisely and quantitatively analyze quantum phase transitions.

A typical example of quantum phase transition is provided by a quantum dot (an artificial atom) connected to two electronic reservoirs and coupled to a strongly dissipative environment [2]. Embedded in a dissipative environment, electron tunneling is suppressed at low temperature except on resonance where the system displays perfect transparency. Surprisingly, this physics is well described by an impurity in a Luttinger liquid [3,4], which corresponds to a paradigmatic quantum field theory to describe the collective excitations in one-dimensional quantum many-body systems [5].

During this internship, we plan to analyze the dynamical properties near such a quantum phase transition which are for example embodied in the current-current correlation function (also called the noise). We also wish to characterize the transport of heat current near the QPT which constitute another accessible observable. Our aim is to build from these different theoretical predictions a comprehensive overview of criticality in coherent conductors in the vicinity of quantum phase transitions.
These theoretical developments are done in close connection with experimentalists working in that direction in the Paris area.

[1] S. Sachdev, **Quantum Phase Transitions**, *Cambridge university press* (2011).
[2] H.T. Mebrahtu et al., Nature **488**, 61 (2012) ; Nature Physics **9**, 732 (2013).
[3] I. Safi and H. Saleur Phys. Rev. Lett. **93**, 126602 (2004).
[4] J.-R. Souquet, I. Safi, P. Simon, Phys. Rev. B **88**, 205419 (2013).
[5] T. Giamarchi, **Quantum Physics in One Dimension**, *Oxford university press* (2004).

Profile: Condensed matter theory, quantum field theory, many-body physics, transport

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics:	YES	Macroscopic Physics and complexity:	NO
Quantum Physics:	YES	Theoretical Physics:	YES