INTERNSHIP PROPOSAL

(One page maximum)

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CNRS identification code: UMR 9012
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Internship location: Bldg 108, Paris-Saclay University, Orsay Campus, 91400 Orsay

Thesis possibility after internship: YES
Funding: NO (funding application under review) If YES, which type of funding:

Quantum phase transitions in 2D disordered systems

In recent years, low-dimensional materials have been an especially fruitful playground for condensed matter physicists, mainly because these systems are highly sensitive to emerging orders, whether magnetic, topological or superconducting. However, the fundamental understanding of phase transitions in low dimensional systems remains a significant pending question, particularly for **Quantum Phase Transitions** (QPT) where the system ground state (at T=0) is modified by varying a parameter in its Hamiltonian. Studying QPTs offers insights into the relative strength of competing orders, which helps understanding these systems that are now center stage for many quantum engineering and detection applications (Qubits, bolometers, quantum sensors etc...).

A particularly complex example of QPTs is the **Superconductor-to-Insulator Transition** (SIT) in disordered two-dimensional (or quasi-2D) systems, **where superconductivity competes with quantum interferences and Coulomb interactions**. Despite decades of both theoretical and experimental investigations, the SIT is a very active field of research, particularly due to the possibility of exotic phases near the transition. For example, the nature of the insulating phase is still unclear, with experiments indicating signs of Cooper pairing and finite superconducting gaps, leading to theories predicting the presence of preformed pairs or emergent electronic granularity that give birth to superconducting islands embedded in an insulating matrix. Such a phase has been named the **Bosonic insulator** and is associated with the presence of a pseudogap above the transition temperature or in the insulator. Experiments and theories have also raised the possibility of an intermediate anomalous **Boson metal phase** between insulator and superconductor, challenging the accepted notion that a 2D metallic state cannot exist. The existence of this phase is under heavy deliberations nowadays.

This internship project proposes the experimental study of very thin Y_xSi_{1-x} films. The objective is to study the electron-phonon decoupling in this system when submitted to large electric fields. Specifically, we will investigate through electronic transport measurements whether a decoupling between the electronic and the phononic quantum baths can be observed at very low temperatures and close to the SIT, thanks to disorder.

The internship may lead to an experimental thesis focused on a more general study of quantum phase transitions in low-dimensional disordered systems. Depending on the candidate's interest and motivation, the work could focus on various fundamental aspects of these QPTs or their applications in detection, particularly for astroparticle experiments (such as dark matter detection).

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

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