INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: LPS-Orsay
CNRS identification code: UMR 8205
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Internship location: University Paris-Saclay

Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: IRL

Title : **Probing the screening of the electric field in Superconductors at nanoscale**

Summary

Does at nanoscale a superconductor screens an electric field as well a normal metal ?

Recently, a series of experiments have suggested that the electric field penetrates into a superconductor on a length, λ_{TF}, larger than the characteristic length scale observed in metals. This poorer screening has been indicated as a starting point for new superconducting devices for quantum technologies based on the effect of the electric field. Fundamentally, these fundings are particularly intriguing because corrections to λ_{TF} in the superconducting state are expected to be very small (from 10^{-10} to 10^{-6} of λ_{TF} depending on the specific superconductor) and hence they have never been clearly measured.

However, for FeSe which is a superconductor with a critical temperature of 14K, the theory predicts a huge change of λ_{TF} between the superconducting and the normal state. This change might be as big as 50%. The goal of this internship is to verify such a prediction which would open up new routes on the control of superconductivity by electric field including for instance the electrical imaging of magnetic vortices (Abrikosov vortices)

The aim is to measure λ_{TF} in FeSe as function of the temperature across the superconducting transition locally by measuring the change in the capacitance between a FeSe single crystal and a metallic tip located 50 nm about its surface. We will use an Atomic Force Microscope (AFM) working at low temperature in the electrostatic and Kevin probe modes to directly access to the capacitance. The topography of the sample will be also imaged by AFM using the non-contact mode to preserve the tip quality and to de-correlate surface defects from intrinsic screening. The experiment being in essence a measure of the force between the tip and the sample in presence of a voltage bias, we expect to minimize spurious effects from the electromagnetic environnement.

This project is a collaboration with Prof. Bertrand Reulet at the University of Sherbrooke (Canada). It can be followed by a PhD thesis (« co-tutelle » between the University Paris-Saclay and the University of Sherbrooke) and is part of the research objectives of the new International Laboratory (IRL-« Frontières Quantiques ») between the CNRS and the University of Sherbrooke.

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