Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: Institut des NanoSciences de Paris - INSP
CNRS identification code: UMR7588
Internship director'surname: Marie Hervé and Tristan Cren
e-mail: marie.herve@insp.upmc.fr Phone number: 01 44 27 98 04
Web page: http://www.insp.upmc.fr/-Spectroscopie-des-nouveaux-etats-.html
Internship location: campus Jussieu 22-32 2nd floor
Thesis possibility after internship: YES
Funding: YES, ANR funding is obtained

Scanning tunnelling microscopy to investigate low energy magnetic excitations

In condensed matter systems, the investigation of low energy magnetic excitations has been carried out using resonance method such as Electron Paramagnetic Resonance (EPR), Nuclear Magnetic resonance (NMR) or Ferromagnetic Resonance (FMR). Conventional magnetic resonance techniques are based on the inductive detection of an electromagnetic signal induced by the precession of an electron's or nucleus's magnetic moment and require to investigate macroscopic systems. With the development of low dimensional electronics and quantum computing, one challenge in condensed matter physics is to develop radio frequency (rf)-based resonance experiments liable to sense low energy electronic, magnetic and vibronic excitations down to the single atom/molecule limit.

Scanning tunnelling microscopy (STM) is currently the best tool for investigating electronic, magnetic, as well as vibronic excitations of single molecules or atoms on surfaces in the sub-meV range. Excitation spectra can be probe using conventional STM as long as the energy separation between the states is larger than 3.2kbT, i.e., the Fermi-Dirac broadening at finite temperature. To give an example, at a temperature of 300 mK, the STM energy resolution is about 90 µeV. It can be enhanced down to 30 µeV with the use of a superconducting tip. Since a few years a new promising method allows to go much further by exploiting radio-frequency resonances. The recently developed rf-STM, it is liable to address electronic, magnetic and vibronic excitation spectrum down to few neVs resolution at the atomic scale. The possibility to access such a high energy resolution with an STM was demonstrated only recently in the literature and such an experimental setup is currently under construction at INSP.

This new microscope will be used to investigate magnetic excitations in some complex heterostructures. During this internship, we will investigate the growth and magnetic properties of heterostructures with a conventional STM. This work will serve as the building block for the completion of the PhD thesis. Additionally, during this internship, the candidate will have the opportunity to participate the construction of this new rf-microscope.

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