Scientific Area	Quantum Nanodevices
Topic title	Atomic-scale spin sensing using a quantum molecular system at the tip apex of a scanning tunneling microscope
Main host institution	IPCMS www.ipcms.unistra.fr
Supervisor/institution	Laurent Limot www-ipcms.u-strasbg.fr/stmipcms
Co-Supervisor/institution	To be confirmed
Mentor[1]/institution	To be confirmed
Secondment institution	To be confirmed

Topic description

Quantum sensing is expected to boost the performance of a number of practical tasks, including the readout of information from ultra-dense storage devices. Upstream research in this domain relies on perfecting single-spin sensing with scanning probe techniques. We have recently shown that this may be possible by attaching a single nickelocene molecule to the tip apex of a scanning tunneling microscope (STM) (arXiv:1901.04862). A nickelocene-terminated tip has well-defined Zeeman levels that can be monitored with a 0.5 meV energy resolution through electrically driven spin excitations. In the presence of surface magnetism, these Zeeman levels shift and magnetic information may be collected from on-surface objects with atomic-scale spatial resolution. During the four-year Ph.D., we wish to use this spin-sensitive quantum sensor to investigate model spintronic systems. The specific goals are to: 1) Image the spin texture of magnetic surfaces and single atoms, 2) Obtain a magnetic contrast within organometallic molecules directly or indirectly coupled to a magnetic surface, 3) Visualize the spin polarization of organometallic molecules.

The use of a nickelocene-terminated STM tip gives a twofold twist to the significance of this project. Firstly, we intend to validate the concept of using such a tip for an atomic-scale imaging of surface magnetism. This is of great interest given the growing number of studies devoted at improving scanning probe techniques through the use of molecular-probe tips —none have focused so far on spin detection. Secondly, we would like to tackle fundamental aspects of molecular magnetism and spintronics: i) Measure the magnetic intermolecular interaction between the nickelocene tip and several target molecules on a surface. Studies of this kind across a vacuum gap remain very limited worldwide and their demand is strong; ii) Obtain a magnetic contrast and map the spin polarization with intramolecular resolution.

Recommended applicant's profile

The experiments will be carried out in a STM operating in ultra-high vacuum at 2.4 K. We are looking for highly motivated candidate with a Master degree in physics and some experience with surface science, if possible with STM. A good solid background in magnetism is desirable.

[1] Mentor: The primary role of the mentors will be to identify and facilitate specific training objectives, advise on any problems faced by the ESR, including career matters with an external perspective and provide mediation in the case of disputes.

The QUSTEC programme has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement number 847471.