Spécialité de Master « Optique, Matière, Paris »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage

Date de la proposition : 01/03/2015 – 30/06/2015

Responsable du stage / *internship supervisor*:

Nom / *name*:	JACQUES	**Prénom/ *first name*** :	Vincent
Tél :	04 67 14 99 23	**Fax :**	
Courriel / *mail*:	vincent.jacques@umontpellier.fr		

Nom du Laboratoire / *laboratory name*: Laboratoire Charles Coulomb

Code d'identification : UMR 5221 **Organisme** : Université de Montpellier and CNRS

Site Internet / *web site*: http://www.coulomb.univ-montp2.fr

Adresse / *address:* Place Eugène Bataillon, Université de Montpellier, 34000 Montpellier

Lieu du stage / *internship place*: Montpellier

Revealing orbital magnetism in graphene with a single spin microscope

Detecting and imaging magnetic fields with high sensitivity and nanoscale resolution is a topic of crucial importance for a wealth of research domains, from material science, to mesoscopic physics, and life sciences. This is obviously also a key requirement for fundamental studies in nanomagnetism and the design of innovative magnetic materials with tailored properties for applications in spintronics. Although a large number of magnetic microscopy methods have been developed in the last decades, imaging magnetism at the nanoscale remains a challenging task.

It was recently realized that the experimental methods allowing for the detection of single spins in the solid-state, which were initially developed for quantum information science, open new avenues for high sensitivity magnetometry at the nanoscale. In that spirit, it was recently proposed to use the electronic spin of a *single* nitrogen-vacancy (NV) defect in diamond as a nanoscale quantum sensor for scanning probe magnetometry. This approach promises significant advances in magnetic imaging since it provides non-invasive, quantitative and vectorial magnetic field measurements, with an unprecedented combination of spatial resolution and magnetic sensitivity.

The objective of the PhD project is to **exploit the unique performances of scanning-NV magnetometry to detect orbital magnetism in graphene.** This material has attracted tremendous interest over the last years owing to its extraordinary electronic properties. The 'honeycomb' structure of the carbon atom lattice in a graphene monolayer is at the origin of a very peculiar band structure leading to spectacular signatures in transport, such as the quantum Hall regime. Whereas electronic transport has been extensively studied both theoretically and experimentally, orbital magnetism in graphene has not yet been explored experimentally, despite surprising theoretical predictions. Here we will use a scanning-NV magnetometer (i) to map the magnetic susceptibility over a graphene layer with nanoscale resolution and (ii) study its dependence with the Fermi level while applying a gate voltage to the graphene sample. These experiments will likely open a large range of perspectives like imaging spin currents or ferromagnetic defects in graphene spintronics devices.

Recent publications of the host group

J.-P. Tetienne *et al.,* Nature Communications **6**, 6733 (2015).
J.-P. Tetienne *et al.,* Science **344**, 1366 (2014).
L. Rondin, *et al.,* Nature Communications **4**, 2279 (2013)

Website : https://sites.google.com/site/quantumspinsensors/home

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : YES**

Si oui, financement de thèse envisagé/ *financial support for the PhD*: **YES**