Exploring condensed matter physics 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 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 remarkable number of magnetic microscopy techniques have been developed over the last decades, imaging magnetism at the nanoscale still 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, we make use of the electronic spin of a *single* **nitrogen-vacancy (NV) defect in diamond as a nanoscale quantum sensor** for scanning probe magnetometry [Fig. 1]. 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 [1].

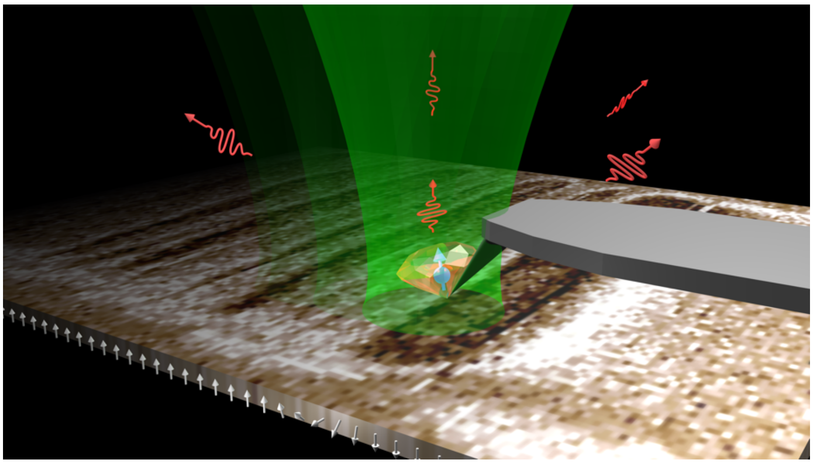

Figure 1 : Schematic representation of a scanning-NV magnetometer mapping the magnetic field distribution over domain walls in an ultrathin ferromagnet.

The objective of the PhD is to **exploit the unique performances of scanning-NV magnetometry to image and control exotic magnetic order in ultrathin antiferromagnet**, such as spin cycloids and magnetic skyrmions, which are currently attracting tremendous interest for the design of innovative spintronic devices [2]. We will first study the physics of antiferromagnetic domains in insulating oxides and then manipulate these domains in order to design artificial spin textures on-demand.

This project will be conducted in collaboration with the Oxytronics group at the CNRS/Thales laboratory, located within Thales Research and Technology in Palaiseau.

[1] L. Rondin *et al., Rep. Prog. Phys.* **77**, 056503 (2014)
[2] P. Wadley *et al., Science* **351**, 587 (2016).

Recent publications of the host group

[3] I. Gross *et al., Nature* **549**, 252 (2017).
[3] A. Hrabec *et al., Nature Communications* **8**, 15765 (2017)
[3] J.-P. Tetienne *et al., Nature Communications* **6**, 6733 (2015).
[4] J.-P. Tetienne *et al., Science* **344**, 1366 (2014).

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