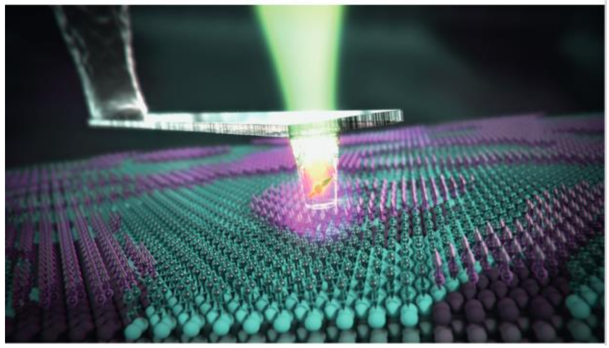
Nitrogen Vacancy Centre Microscopy: Novel *in-situ* Insights into Nanomagnetism

Supervisors : Dr. A Kumar



Summary: In this project, we aim to develop and exploit a recently installed Nitrogen Vacancy Centre (NVC) microscope (currently one of its own kind in British Isles) towards investigation of novel physics in magnetic materials. Nitrogen Vacancy centre microscopy has recently emerged as a revolutionary approach to quantum sensing and is capable of measuring physical properties with unprecedented sensitivities and resolution[1]. NVC is particularly renowned for single spin magnetometry with atomic resolution at room temperature[2]. The magneto-optically active lattice point defect created by substitution of a Nitrogen atom in diamond has exceptionally long coherence time associated with the single-electron-spin quantum state which then is highly sensitive to the local environment. Over the last decade, NVC protocols have been developed to investigate local temperature, electric and magnetic fields with nanometer scale precision. In particular, NVC microscopy is envisioned as a game-changing approach for investigation of novel physics related to nano-magnetism[3]. The potential to investigate time-resolved spin dynamics through adoption of laser pump-probe techniques offers novel dimensionalities to NVC microscopy. The focus of the project will be on three specific strands. First of these will involve imaging of materials with unique ferroic orderings arising from complex spin configurations (spin cycloids in antiferromagnets, ferrimagnets and skyrmionic systems) with the goal to investigate novel aspects of physics associated with them. The second strand will focus on development of tomographic approach with the goal to employ the diamond to remove material with atomic precision and undertake three-dimensional mapping of functional magnetic behaviour in materials of interest. The third and final strand of the project will aim to develop and undertake dynamic stroboscopic experiments to investigate current-driven domain wall motion in ferrimagnetic systems like Heusler compounds, where the NVC microscope will be used to map critical currents and temperatures. The project will also explore collaborative theoretical efforts with teams at QUB for validation of experimental results.

Background reading:

[1] Dolde et al., Nature Physics **7**, 459 (2011).
[2] Grinolds et al., Nature **9**, 215 (2013).
[3] Gross et al., Nature **549**, 252 (2017).

Further Details: Amit Kumar, email: a.kumar@qub.ac.uk ;