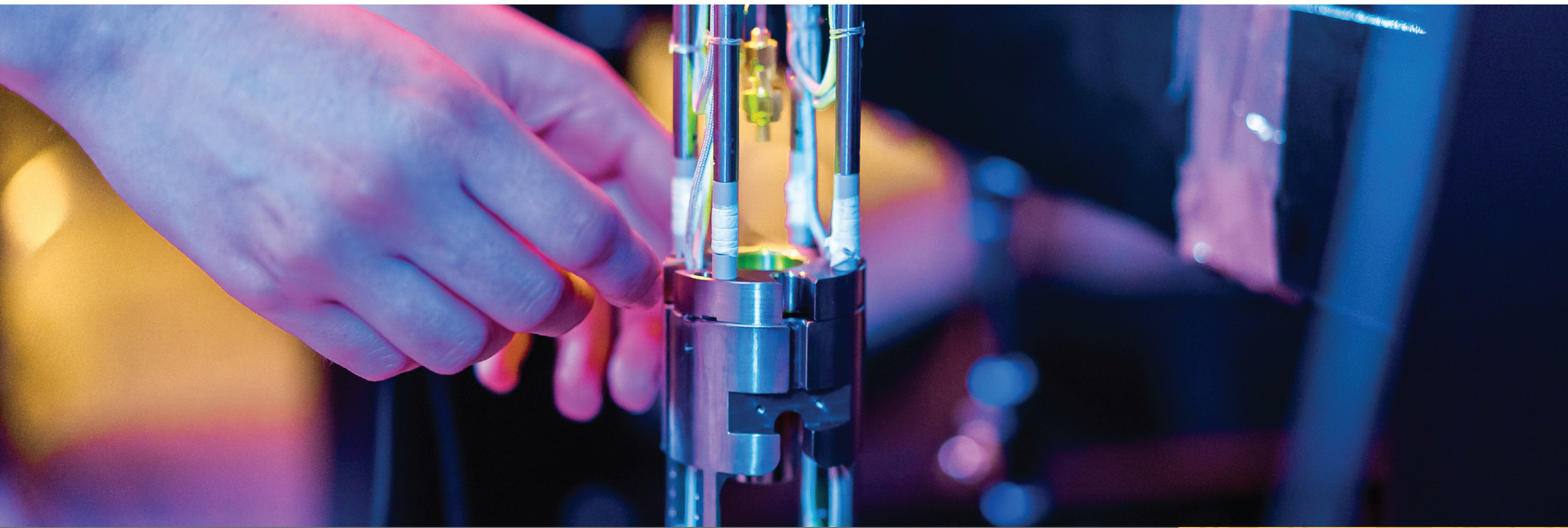
UNIVERSITY OF CAMBRIDGE

ADVANCED MATERIALS RESEARCH & INNOVATION

Scanning NV Centre Magnetometry Study of 2D Magnets

Characterisation of the two-dimensional Van der Waals (vdW) ferromagnet was performed in the Royce Nanoscale Quantum Sensing and Imaging Suite at the University of Cambridge. The study of magnetism in 2D layered materials is crucial for advancing the development of high-speed and low-power spintronic devices, with the potential to revolutionize computer architectures.



The Cambridge Nanoscale Quantum Sensing and Imaging Suite (CANSIS) uses probes containing a single nitrogen-vacancy defect at the tip apex to image ultrasmall variations in local temperature and magnetic field with a 10-nm spatial resolution. The facility:

- utilises a closed-cycle cryogenic atomic force/confocal microscope which can operate at 300K down to 2.8K, and can probe magnetic fields spanning DC to MHz with micro-T magnetic resolution and 10-nm spatial resolution.
- is ideal for imaging emergent magnetic and transport phenomena in low dimensional materials such as skyrmions, magnons, and edge currents, with virtually no perturbation.

University of Cambridge is a Partner of the Henry Royce Institute for advanced materials

ROYCE

THE CHALLENGE

The family of cleavable Van der Waals materials is continuously growing. Although significant progress has been made in this area, the discovery of magnetism in atomically thin crystals of CrI_3 and $CrGeTe_3$ occurred only a few years ago. Characterising these newly discovered 2D magnets is a challenging task due to the low magnetic signal they generate and the experimental conditions required to explore their properties in-depth.

ROYCE SUPPORT

Using the Nanoscale Quantum Sensing and Imaging Suite, diamond quantum microscopy (DQM) detected weak magnetic fields from a few-layer sample. This method imaged ferromagnetic domain propagation in Fe_5GeTe_2, a 2D ferromagnet, under high magnetic fields. Scientists obtained high-resolution information about the magnetic properties at the nanoscale, imaging magnetic domain nucleation and propagation at cryogenic temperatures. The Royce-funded special cantilevers enable future characterisation of magnetic domains and topological spin textures in magnetic Van der Waals heterostructures.

"This Royce-funded collaboration between the Universities of Cambridge and Oxford achieved a significant advancement in the field of 2D materials."

RESULTS

It was found that domains in the material tend to get pinned to defects and impurities, an important consideration for future applications where precise movement of domains and domain walls is desired. This strong pinning effect could potentially hinder desired motion and limit the material's functionality.

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"This Royce-funded collaboration between the Universities of Cambridge and Oxford achieved a significant advancement in the field of 2D materials. It provided insights into the fundamental mechanisms that contribute to ferromagnetism in 2D materials. These are crucial for the development of high-density memory and logic units for beyond-Si technology."

Ryuji Fujita
Postgraduate Researcher, University of Oxford

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