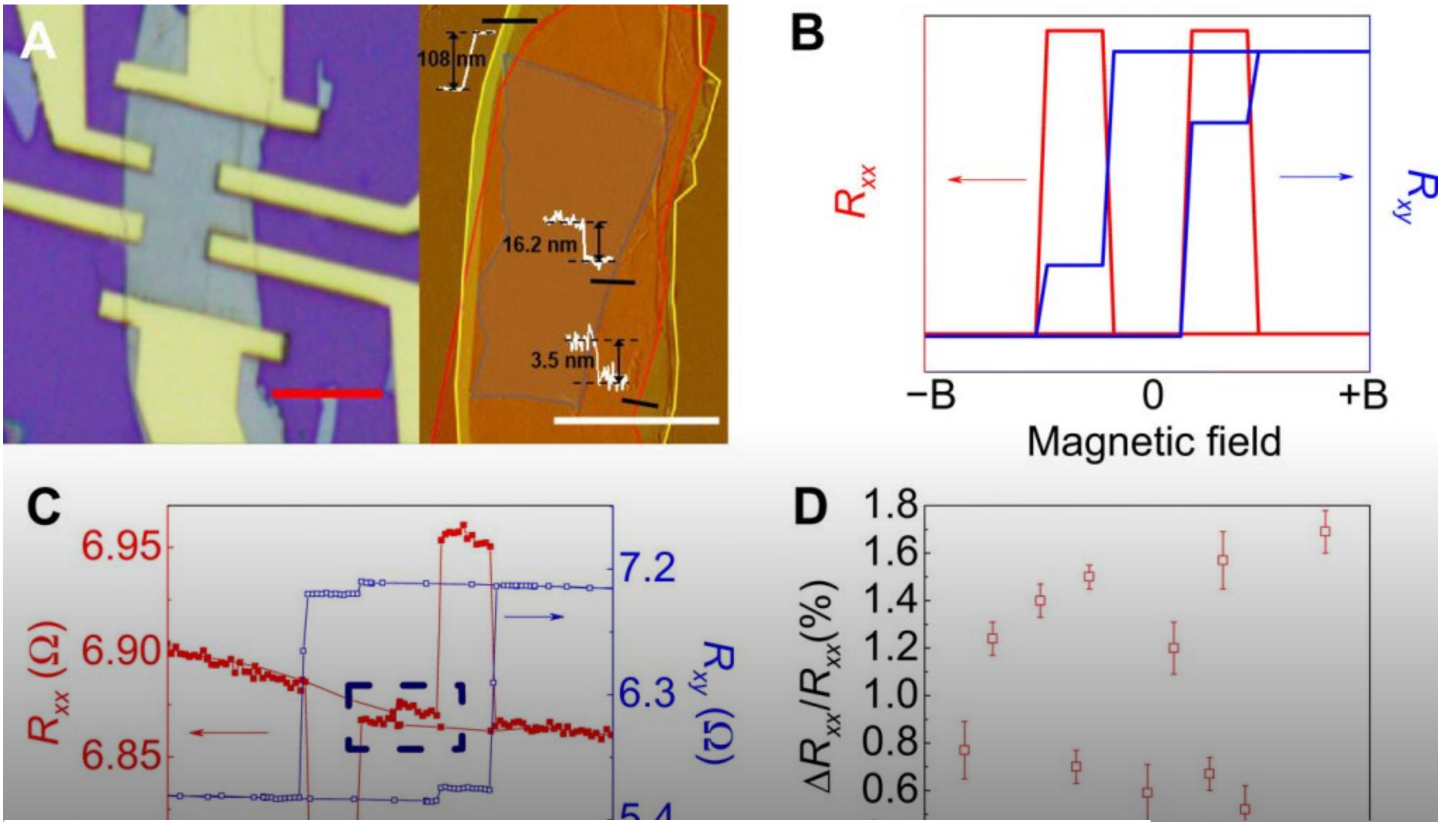

New magnetic properties unlocked for future spintronic applications

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A theoretical-experimental collaboration across two FLEET nodes has discovered new magnetic properties within 2-D structures, with exciting potential for researchers in the emerging field of spintronics.

Spintronic devices use a quantum property known as spin, in addition to the electronic charge of conventional electronics. Spintronics thus promise ultra-high speed low-energy electronic devices with significantly enhanced functionality.

The RMIT–UNSW study discovered never-before-seen magnetic properties in devices known as vdW heterostructures comprising several layers of novel, 2-D materials. The latest results show that vdW spintronics could provide devices with more functionality, comparing with the traditional spintronic approaches. Further research could generate devices with significant industrial applications.

Two-dimensional (2-D) ferromagnetic van der Waals (vdW) materials have recently emerged as effective building blocks for a new generation of spintronic devices. When layered with non-magnetic vdW materials, such as graphene and/or topological insulators, vdW heterostructures can be assembled to provide otherwise unattainable device structures and functionalities.

The scientists studied 2-D Fe_3GeTe_2 (FGT), a metal found to display promising ferromagnetic properties for spintronic devices in a previous FLEET study. "We discovered a previously unseen mode of giant

Unlike the conventional, previously known two GMR states (ie, high resistance and low resistance) that occur in thin-film heterostructures, the researchers also measured antisymmetric GMR with an additional, distinct intermediate resistance state.

"This reveals that vdW ferromagnetic heterostructures exhibit substantially different properties from similar structures," says Sultan. This surprising result is contrary to previously held beliefs regarding GMR. It is suggestive of different underlying physical mechanisms in vdW heterostructures with potential for improved magnetic information storage.

Theoretical calculations indicate that the three levels of resistance are the result of spin-momentum-locking induced spin-polarised current at the graphite/FGT interface. "This work has significant interest for researchers in 2-D materials, spintronics, and magnetism," says co-author FLEET Ph.D. Cheng Tan. "It means that traditional tunneling magnetoresistance devices, spin-orbit torque devices and spin transistors may reward re-investigated using similar vdW heterostructures to reveal similarly surprising characteristics."

The study, "Antisymmetric giant magnetoresistance in van der Waals Fe_3GeTe_2/graphite/Fe_3GeTe_2 tri-layer heterostructures," was published in *Science Advances* this month.

The experiment's detailed electron transport measurements were performed by a collaboration of researchers led by FLEET CI Prof Lan Wang (RMIT) and FLEET Deputy Director Prof Alex Hamilton (UNSW), using heterostructures and devices fabricated by Prof Wang's team at RMIT.

Provided by: FLEET

More information: Sultan Albarakati et al. **Antisymmetric magnetoresistance in van der Waals Fe3GeTe2/graphite/Fe3GeTe2 trilayer heterostructures**. *Science Advances* (2019). DOI: 10.1126/sciadv.aaw0409 On *Arxiv*: arxiv.org/abs/1904.10588

Image: Overview of the MR effect in FGT/graphite/FGT heterostructures. (A) Optical and AFM images of an FGT/graphite/FGT heterostructure. The device number is FPC3. Scale bars, 5 μm. The regions surrounded by the blue line, red line, and yellow line represent the top FGT layer, graphite layer, and bottom FGT layer, respectively. (B) Schematic diagram for the transport behavior of a typical GMR effect. (C) Field-dependent Rxx and Rxy measurements of an FGT/graphite/FGT heterostructure (sample FPC3) at 50 K. A loop surrounded by a dark blue dashed line is shown in the Rxx(B) curve. (D) ΔRxx/Rxx values for samples with various thicknesses of graphite layer. All the data are calculated for measurements at 50 K. The error bars come from the noise of the measurement.
Credit: *Science Advances* (2019). DOI: 10.1126/sciadv.aaw0409