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Revising Magnetic Features in a New 2D vdW Ferromagnet: Fe3GaTe2

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Fe3GaTe2 is a 2D vdW layered material with an intrinsic ferromagnetism identified by above-room temperature Curie temperature (Tc) and a robust large perpendicular magnetic anisotropy (PMA). Previous studies have shown that 2D vdW ferromagnets are promising candidates for many magnetoelectronic devices and next-generation spintronic applications. However, these 2D materials must be stable at room temperature with long range magnetic order for the majority of spintronics applications [1-3]. Theoretically, long-range ferromagnetism hardly exists in 2D materials because of thermal fluctuation and reduced spatial dimensionality but long-range order can be stabilised by the anisotropy-driven spin-wave excitation gap. Despite this, no intrinsic 2D vdW ferromagnetic crystals such as CrI3, Cr2Ge2Te6 and Fe3GeTe2 have ordered magnetic states at room temperature. To date, the 2D vdW ferromagnet with the highest Curie temperature is Fe3GaTe2, which has Tc (~350-380K), a high saturation magnetic moment (40.11 emu/g) and large PMA energy density (~4.79 X 105J/m3) with hexagonal structure of space group P63/mmc (a = b = 3.9860 Å, c = 16.2290 Å, $\alpha = \beta = 90^{\circ}$, $\gamma = 120^{\circ}$) [2].

The study aims to revise magnetic properties of Fe3GaTe2 by investigating its magnetic structure. Initial measurements of polycrystalline samples, obtained by manual grinding of bulk crystals, using neutron powder diffraction (wavelength 2.41Å, Echidna diffractometer at ACNS), revealed a sharp peak near q=0.25Å-1 at 4K, which transitioned into a broad peak at 400K. However, Small Angle Neutron Scattering with Bilby indicated that this peak was an artifact of measurement limitations rather than a genuine magnetic signal. Further investigations using the Thermal Triple Axis Spectrometer with Taipan (wavelength of 2.345 Å) revealed at least one new magnetic peak arising below 100K. To identify different magnetic phases more precisely, single Fe3GaTe2 crystal will be analysed using neutron single crystal Laue diffractometer with Koala later this year.

Topics

Magnetism and Condensed Matter

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