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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 (T_c) 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 Fe₃GaTe₂ have ordered magnetic states at room temperature. To date, the 2D vdW ferromagnet with the highest Curie temperature is Fe₃GaTe₂, which has T_c (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 ($a = b = 3.9860 \text{ \AA}$, $c = 16.2290 \text{ \AA}$, $\alpha = \beta = 90^\circ$, $\gamma = 120^\circ$) [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 $q=0.25 \text{ \AA}^{-1}$ 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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