Real-space evidence for 2D-XY ordering in a van der Waals ferromagnet

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Abstract

Two-dimensional (2D) materials often host emergent physical phenomena in the atomically thin limit. Here, we spatially resolve the magnetization in four-layer (4L) Fe_5GeTe_2, a van der Waals ferromagnet [1], utilizing X-ray photoemission electron microscopy (XPEEM) [2]. Generally, the magnetization is found to be determined by an easy-plane anisotropy. Within 90° domain walls, a quasi-ordered phase (QOP), consisting of a continuous rotation of the in-plane magnetization of approximately 180°, is observed across length scales up to nearly one micron (Figure 1). These quasi-ordered phases also host a vortex and antivortex [3, 4] (Figure 1), which are pinned to the boundaries with the surrounding domain wall. These experimental findings will be presented in the broader context of magnetic textures, topological phase transitions in 2D materials and possible quantum applications.

References

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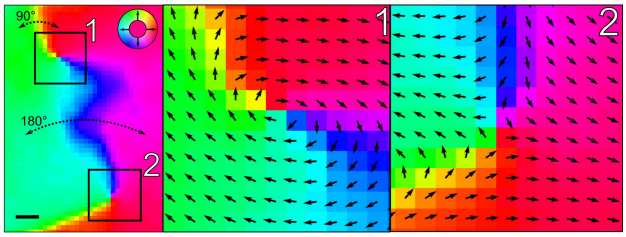

Figure 1. Domain wall topology of 4L Fe_5GeTe_2. The domain wall (shown in yellow) facilitates a ~90° rotation (green → red). The magnetization rotates by ~180° across a quasi-ordered phase (QOP; green → blue → pink). Scale bar = 100 nm. These XPEEM data were acquired at 50 K.

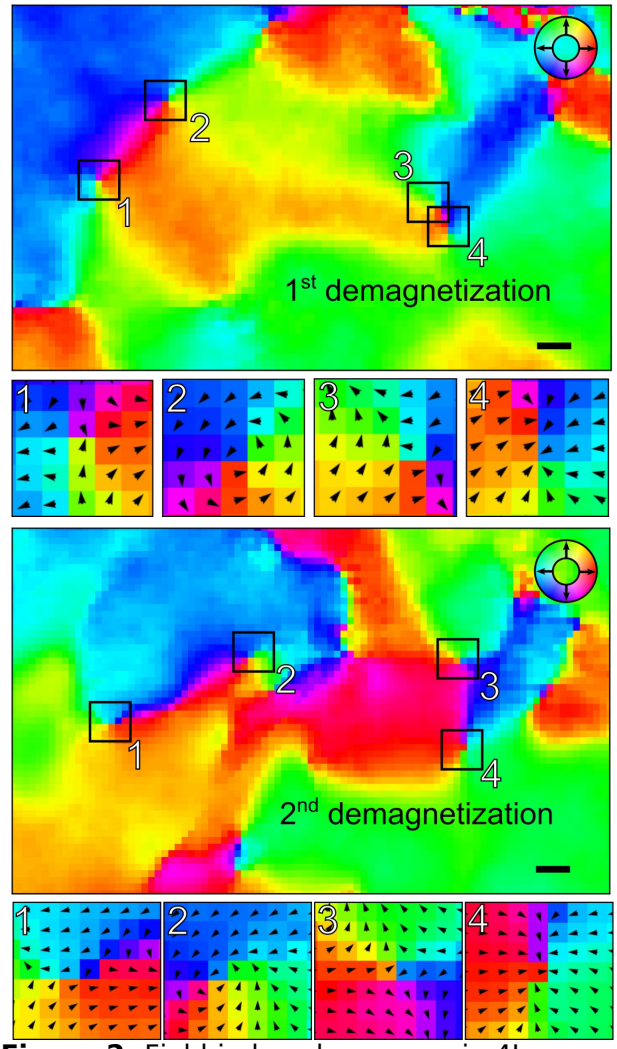

Figure 2: Field-induced response in 4L Fe_5GeTe_2. Field pulses of alternating polarity were applied. In response, textures 2 and 3 move, while textures 1 and 4 remain stationary. Scale bar = 100 nm. These XPEEM data were acquired at 50 K in zero field.