Investigating Phase Transitions in Van Der Waals Magnets using a Quantum Sensor

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Abstract

The advent of two-dimensional magnetic van der Waals(vdW) heterostructures has expanded the boundaries of nano-magnetism and led to novel ideas for information transfer in the field of spintronics[1]. By probing the intrinsic layer-dependent magnetic phases, it is possible to gain fundamental understanding of spin structure and dynamics[2]. We aim to study these exotic magnetic phase transitions using a local, non-invasive scanning magnetometry technique. Our sensor consists of a single nitrogen-vacancy (NV) center in diamond that is attached to an AFM cantilever to enable scanning measurements at cryogenic temperatures[3].

We are particularly interested in studying the magnetic phases of CrSBr, a layered 2D vdW anti-ferromagnet with intralayer ferromagnetic (FM) and interlayer anti-ferromagnetic (AFM) coupling[4]. We quantitatively characterize the FM to AFM phase transition in bilayer CrSBr by directly imaging the FM-AFM phase boundary as it propagates through the sample[5]. Strikingly, we observe the formation of characteristic "cusp-like" features in the FM-AFM phase wall which leads to the creation and propagation of AFM-AFM domain walls. Furthermore, we correlate the interplay between the phase walls and neighboring connected CrSBr multilayers to ultimately decipher the spin configuration of the underlying layers.

References

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Figures

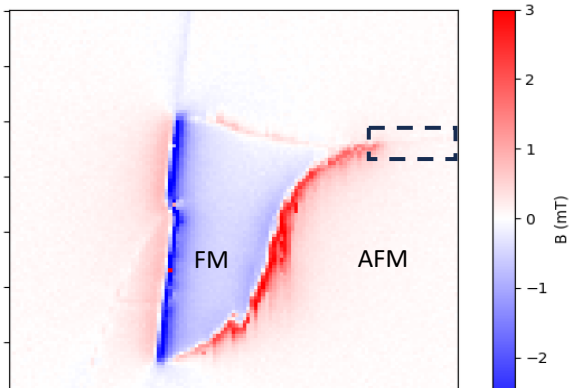

Figure 1: Imaging the FM to AFM phase transition in bilayer CrSBr at 5.2K using scanning NV-magnetometry reveals the presence of a "cusp-like" deformation of the phase boundary. The cusp merges into a line of non-zero stray magnetic field (boxed) traversing across the AFM region, which we associate to an AFM-AFM domain wall.