Magnetic 2D materials: studying and manipulating ordered spins in flatland.

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Layered materials have been at the heart of the field of magnetism since the pioneering observations of antiferromagnetic phase transitions more than a century ago. The manifestation of spontaneous magnetization in two dimensions has thereafter captured the attention of condensed matter physicists. From a theoretical point of view, the Mermin and Wagner theorem demonstrated that long-range ordering in low dimensions is forbidden in an isotropic spin lattice. In order to confirm this theorem, many experiments were performed in the layered magnetic materials as model two-dimensional (2D) spin lattices. However, despite the layered nature, interlayer coupling in bulk systems is not negligible and an approach for the study of true 2D magnetism had been lacking until the avenue of 2D materials. In this talk, I will start by reviewing the long history of magnetism in 2D systems, culminated by the realization of long-range magnetic order in a 2D material with the discovery of the first free-standing ferromagnetic 2D material made out of a single layer of chromium triiodide (CrI_3) [1]. The pioneering experiments on CrI_3 showcase the dramatic layer dependence and non-trivial exchange interactions of the magnetic ground states in atomically-thin van der Waals crystals down to the monolayer. In particular, an intriguing metamagnetic behaviour emerges in CrI_3 as the ferromagnetic bulk is thinned down, which might have its ultimate origin in a unique mesoscopic layer-dependent structural phase transition [2, 3]. Finally, I will highlight the potential of this new class of few-layer magnets for developing efficient magneto-optic [4], magnetoelectric [5], magnetoelastic [6] and spintronic devices [7], and for the study of competing strongly correlated states in two dimensions.

References

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Figures

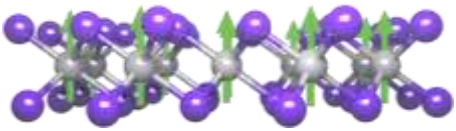

Figure 1: Cartoon representation of single layer CrI_3, portraying the long-range out-of-plane order of the spins in the lattice below the Curie temperature.