Chromium triiodide: intricacies at the mesoscale in a van der Waals magnetic material

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The first van der Waals material to exhibit a sizable spontaneous ferromagnetic hysteresis down to the monolayer was chromium triiodide (CrI_3) [1]. Strikingly, this observation was accompanied by a transition from a layered ferromagnetic to a layered antiferromagnetic order as the thickness of the crystal was reduced to the nanoscale [2]. The discovery of layered-dependent magnetism in CrI_3 posed a longstanding fundamental conundrum that lasts to date, motivating a wealth of fundamental studies seeking the origin of this phenomenon. This effect can be underpinned by the structural differences of bulk and few-layer CrI_3, where different stacking orders result in different types of spin exchange coupling [3, 4]. However, an explanation for the layer-dependent stacking structural transition is still missing and, more interestingly, this effect might be general to other van der Waals materials with layered structures [5, 6]. In addition, the exact crossover thickness from the bulk to the few layer regime appears to lie, surprisingly, in the mesoscale and has not been determined with accuracy. Other controversies regarding the presence of odd features in the in-plane magnetization curve [7] and the coexistence of different structural phases in bulk single crystals of this material [8] have just kept adding layers of complexity to the problem of this archetypal magnetic 2D material. In this talk, I will provide experimental insights regarding a rich coexistence and layer dependence of electronic, magnetic and crystalline phases in CrI_3 beyond the reported monoclinic-rhombohedral stacking dichotomy [9, 10]. With these results I aim to showcase a far more intricate scenario than originally thought and to point out the challenges and opportunities provided by the family of magnetic 2D materials.

References

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