Tunneling Probe of 2D Magnetism

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The recent discoveries of ferromagnetism in single atomic layers have opened a new avenue for two-dimensional (2D) materials research. Not only do they raise fundamental questions regarding the requirements for long-range magnetic order in low-dimensional systems, but they also provide a new platform for the development of spintronic devices. In this talk, I will present a series of studies on the family of layered ferromagnetic semiconductors, CrX_3 (X = I, Br, Cl), in the atomically thin limit. By incorporating these materials as tunnel barriers between graphene electrodes, we are able to achieve extremely large tunnel magnetoresistance as well as robust memristive switching that is tunable with magnetic field. Tunneling spectroscopy further allows for direct observation of their spin wave excitations, or magnons, from which we are able to derive a simple microscopic Hamiltonian for all three spin systems. These results show that strong exchange anisotropy is not necessary to stabilize ferromagnetism in the monolayer limit.