2D Magnets and Heterostructures

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Since the discovery of graphene, the family of two-dimensional (2D) materials has grown to encompass a broad range of electronic properties. However, until recently 2D crystals with intrinsic magnetism were still lacking. Such crystals would enable new ways to study 2D magnetism by harnessing the unique features of atomically-thin materials, such as electrical control for magnetoelectronics and van der Waals engineering for novel interface phenomena. In this talk, I will describe our recent magneto-optical spectroscopy experiments on van der Waals magnets, chromium(III) iodide CrI_3. I will first demonstrate the existence of isolated monolayer semiconductor with intrinsic Ising ferromagnetism. I will then show the layer number-dependent magnetic phases. The magnetic ground state evolves from being ferromagnetic in a monolayer, to antiferromagnetic in a bilayer, and back to ferromagnetic behavior in a trilayer. Lastly, I will discuss the emerging spin phenomena in monolayer WSe_2/CrI_3 ferromagnetic semiconductor heterostructures, including ferromagnetic control of valley pseudospin in WSe_2 via large magnetic exchange field, and optical analog of giant magnetoresistance effect.