Title/ Abstract

Title: Studying 2D magnetism and superconductivity with a Sagnac MOKE microscope

Abstract: In this talk, I will discuss our recent results on 2D magnetism and superconductivity using a scanning Sagnac MOKE microscope, which is based on a Sagnac interferometer technique first developed at Stanford [1], and has achieved unprecedented nanoradian level Kerr and Fraday sensitivity even at DC. In exfoliated Cr2Ge2Te6 (CGT) atomic layers, we report [1] the discovery of intrinsic ferromagnetism in 2D van der Walls crystals, defying the well-known Mermin-Wagner theorem. Unlike 3D magnetism, the ferromagnetic order in this 2D system is stabilized by magnetic anisotropy from the CGT structure, which is not present in graphene. As a result, changing the magnetic anisotropy with a small external magnetic field was found to strongly enhance the Curie temperature, which is a feature unique to 2D magnetism. An emerging alternative route for developing new multifunctional perovskite is by modification of the oxygen octahedral structure. We demonstrate [2] the control of structural oxygen octahedral rotation in ultrathin perovskite SrRuO3 films by the deposition of a SrTiO3 capping layer, which can be patterned to achieve local control. We show an increase in the Curie temperature of SrRuO3 due to the suppression octahedral rotations revealed by the synchrotron x-ray diffraction. In epitaxial Bi/Ni bilayer samples, we report [3] the observation of 2D superconductivity that spontaneously breaks time-reversal symmetry (TRS). Because of strong spin-orbit interaction and lack of inversion symmetry in a Bi/Ni bilayer, superconducting pairing cannot be classified as singlet or triplet. We propose a theoretical model where magnetic fluctuations in Ni induce the superconducting pairing of the dxy ± idx2+y2 orbital symmetry between the electrons in Bi. In this model, the order parameter has a nonzero phase winding number around the Fermi surface, thus making it a rare example of a 2D topological superconductor. We will also discuss a more recent result of realizing a spin-polirized 2D electron gas between two non-magnetic insulators.

1. “Discovery of intrinsic ferromagnetism in 2D van der Waals crystals”, Nature, 546, 265-269 (2017).

2. “Localized Control of Curie Temperature in Perovskite Oxide Film by Capping-layer-induced Octahedral Distortion”, Phys. Rev. Lett. , 119, 177203 (2017).

3. “Time-Reversal-Symmetry-Breaking Superconductivity in Epitaxial Bismuth/Nickel Bilayers”, Science Advances, 3, 3, e1602579 (2017).