Magnetism Modified by Topology

Tao Liu, Mingzhong Wu (Colorado State); Tim Pillsbury, Maria Hilse, Anthony Richardella, Roman Engel Herbert, Nitin Samarth (2DCC, Penn State)

Topological insulators are materials that are insulating in the bulk but have conducting surface states with a helical Dirac dispersion. These properties are created by the combined effects of strong spin-orbit coupling and time-reversal symmetry. When a topological insulator is interfaced with a magnetic insulator, the magnetic interactions across the interface can break time-reversal symmetry, opening a gap at the Dirac point of the topological surface states. Experiments demonstrating the impact of magnetism on topology in this manner have been well documented. An unresolved question is whether the inverse situation is possible: can topological surface states influence magnetism? In a user project led by Mingzhong Wu (Colorado State), 2DCC scientists used molecular beam epitaxy (MBE) to synthesize topological insulator (Bi_2Se_3) thin films on ferrimagnetic insulator $Y_3Fe_5O_{12}$ (YIG) thin film substrates grown by sputtering at Colorado State. Wu's group then used ferromagnetic resonance measurements to show that the magnetic anisotropy, gyromagnetic ratio, and damping of the YIG were modified by interfacing with Bi_2Se_3. To prove that the topological surface states in Bi_2Se_3 are crucial for the observed changes in the magnetic properties, the 2DCC team interfaced YIG with $(Bi,In)_2Se_3$, a "trivial" insulator, and found no significant modification of the ferromagnetic resonance signal.