# Topological Hall Effect in Topological Insulator/Magnetic Insulator Bilayer

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**Project Summary:** The topological Hall effect (THE) is a phenomenon that is a consequence of a Berry phase created by spin textures in real space. Interfacing a topological insulator with a magnetic insulator provides a model platform for studying this phenomenon in a well-controlled manner. This papers reports the first clear evidence for the THE in heterostructures that combine a model topological insulator ($Bi_2Se_3$) with a ferromagnetic insulator ($BaFe_{12}O_{19}$). The key signature of the THE is an "excess" Hall resistance when the perpendicular to the plane magnetization of the ferromagnet is reversed by an external magnetic field. These samples show a conventional anomalous Hall effect (AHE) at high temperature ($T$ > 80 K) but a pure THE develops in the temperature range of $T$ = 2–3 K. Over $T$ = 3–80 K, the two effects coexist but show opposite temperature dependence. Control measurements, calculations, and simulations together suggest that the observed THE originates from skyrmions (spin textured "bubbles") that arise due to a Dzyaloshinskii–Moriya interaction at the interface. The estimated strength of this interaction is substantially higher than that in more conventional heavy metal-based systems widely studied in the spintronics community. Publication: *Nano Lett.* 2021, 21, 1, 84–90

**2DCC Role:** The $Bi_2Se_3$ thin films were grown by MBE in the multi-module MBE system in the 2DCC facility on $BaFe_{12}O_{19}$ substrates provided by the user (Wu). The user and his graduate students have been active participants in 2DCC User Committee meetings and also participated in the reverse site visit for the 2DCC renewal.