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Realization of high-precision and more robust quantum anomalous Hall state in a hard ferromagnetic topological insulator

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The discovery of the integer quantum Hall (QH) effect in 1980 led to the realization of a topological electronic state with dissipationless currents circulating in one direction along the edge of a two dimensional electron layer under a strong magnetic field. The quantum anomalous Hall (QAH) effect shares a similar physical phenomenon as the QH effect, whereas its physical origin is a result of intrinsic spin-orbit coupling of the topological insulator (TI) and when it is in ferromagnetic state. Since the QAH effect does not require an external field and the associated Landau levels, it is believed that this effect has unique potential for applications in electronic devices with low-power consumption. In this talk, we shall describe the experimental observation of the QAH state in V-doped $(Bi,Sb)_2Te_3$ TI films. We find that in zero-field longitudinal resistance decreases to $0.00013 \pm 0.00007\ h/e^2 \sim 3.35 \pm 1.76\Omega$), Hall conductance reaches $0.9998 \pm 0.0006\ e^2/h$ and the Hall angle becoming as high as $89.993 \pm 0.004^\circ$ at T =25mK, thus realizing the anomalous Hall transport with negligible dissipation in the absence of any initial magnetic field. The advantage of this system comes from the fact that it is a hard ferromagnet with a large coercive field (H_c>1.0T) and a relative high Curie temperature. These results were unexpected from the theoretical calculations. This high-precision realization of a more robust QAH state in hard FMTIs is a major step towards dissipationless electronic applications without external applied fields.

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