Quantum Anomalous Hall Edge Channels Survive up to the Curie Temperature

Kajetan M. Fijalkowski
Nan Liu, Pankaj Mandal, Steffen Schreyeck, Karl Brunner, Charles Gould, and Laurens W. Molenkamp
Faculty for Physics and Astronomy (EP3), Universität Würzburg, and Institute for Topological insulators (ITI), Am Hubland, D-97074 Würzburg, Germany
kfijalkowski@physik.uni-werzburg,de

The past couple of decades saw the rise of topology in condensed matter, which led to the discovery of various new quantum states of matter. One of the more prominent examples is the quantum anomalous Hall effect [1], first observed in Cr (as well as V)-doped $(Bi,Sb)_2Te_3$ material. This effect was quickly recognized as a promising platform for potential applications in quantum metrology [2] and for academic investigations of axion electrodynamics [3].

One of the biggest open questions surrounding the quantum anomalous Hall effect in Cr/V-doped $(Bi,Sb)_2Te_3$ is the temperature discrepancy between the thermal breakdown of quantized transport (around 100 mK) and the Curie temperature of bulk ferromagnetism (around 20 K). In the intermediate temperature range, while the material remains robustly ferromagnetic, the electronic transport is no longer quantized. Based on traditional Hall bar measurements it is impossible to rule out that the observed signals originate from the ordinary anomalous Hall effect from thermally activated bulk states, and in the absence of any edge channels. Since it is of paramount importance to increase the operational temperature of the quantum anomalous Hall effect, a natural first step is to verify that the edge channels indeed exist at higher temperatures.

Here, in order to address this question, we move away from a traditional Hall bar, and instead implement a novel multi-terminal Corbino geometry. By physically separating the bulk and edge state current paths, this allows us to investigate a variety of non-local measurement configurations at higher temperatures, where the presence of edge channels produces large unambiguous signals. Indeed our results suggest that the quantum anomalous Hall edge channels survive all the way up to the bulk Curie temperature, and that thermally activated bulk conductance is solely responsible for the quantization breakdown, by electrically shorting the edges of the sample [4]. Our results offer important insights on the nature of the topological protection of these edge channels and provide an encouraging sign for potential applications.

References

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