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Hinge Spin Polarization in Magnetic Topological Insulators Revealed by Resistance Switch

We report on the possibility to detect hinge spin polarization (HSP) [1] in magnetic topological insulators (MTI) [2-4] by resistance measurements. By implementing a three-dimensional model of MTIs [5-7] into a multi-terminal device with ferromagnetic contacts near the top surface, local spin features of the chiral edge modes are unveiled. We find local spin polarization at the hinges that inverts sign between top and bottom surfaces. At the opposite edge, the topological state with inverted spin polarization propagates in the reverse direction. Large resistance switch between forward and backward propagating states is obtained, driven by the matching between the spin polarized hinges and the ferromagnetic contacts. This feature is general to the ferromagnetic (FM), antiferromagnetic (AFM) and canted-antiferromagnetic (c-AFM) phases [8-10], and enables the design of spin-sensitive devices, with the possibility of reversing the hinge spin polarization of the currents.

References

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Figures

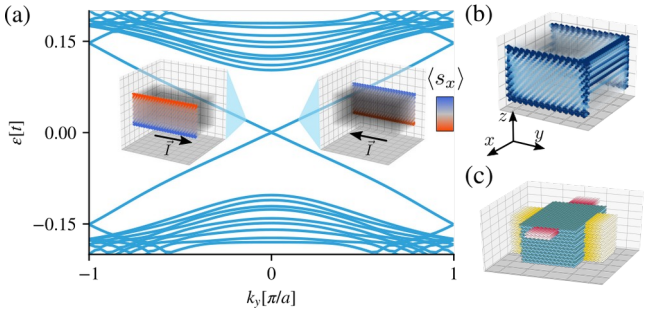

Figure 1: MTI in the FM phase. a) Dispersion relation of a slab infinite in y.The left (right) inset depicts the local spin density of states $\langle s_x \rangle$ of the edge state that covers the side wall of the slab and propagates to the right (left). b) Local density of states of a finite square slab. The edge state circulates around the sample, covers the sidesurfaces perpendicular to x, and propagates along the top or bottom hinges of the side surfaces perpendicular to y. c) Sideview of transport setup geometry: metallic leads connect to the whole walls at both ends of the slab (golden color), and ferromagnetic leads connect to the lateral walls only near top hinge (red color).

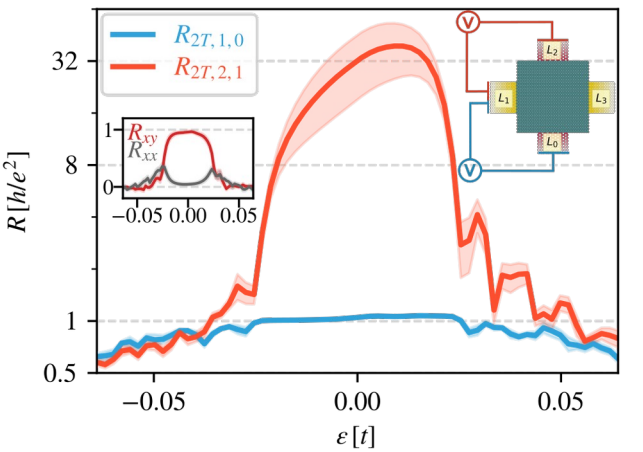

Figure 2: Transport simulations of a FM slab between metallic leads (L1 and L3) and ferromagnetic leads (L0 and L2) with spin down (s_x,↓) polarization. The FM lead L0 matches the top HSP, while L2 has the opposite spin polarization. The matching or mismatching of the spin polarizations is revealed by a large resistance switch and allows us to characterize the HSP.