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Symmetry Protected Josephson Supercurrents in Three-Dimensional Topological Insulators SUNGJAE CHO, BRIAN DELLABETTA, University of Illinois at Urbana-Champaign, ALINA YANG, JOHN SCHNEELOCH, ZHIJUN XU, TONICA VALLA, GENDA GU, Brookhaven National Laboratory, MATTHEW GILBERT, NADYA MASON, University of Illinois at Urbana-Champaign — Coupling the surface state of a topological insulator (TI) to an s-wave superconductor is predicted to produce the long-sought Majorana quasiparticle excitations. However, superconductivity has not been measured in surface states when the bulk charge carriers are fully depleted, i.e., in the true topological regime relevant for investigating Majorana modes. Here, we report measurements of DC Josephson effects in TI-superconductor junctions as the chemical potential is moved through the true topological regime characterized by the presence of only surface currents. We compare our results to 3D quantum transport simulations, and determine the effects of bulk/surface mixing, disorder, and magnetic field; in particular, we show that the supercurrent is largely carried by surface states, due to the inherent topology of the bands, and that it is robust against disorder. Our results thus clarify key open issues regarding the nature of supercurrents in TIs.

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