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Tunable Anomalous Supercurrent in a topological tri-junction SQUID[1] C. KURTER, A.D.K. FINCK, P. GHAEMI, University of Illinois at Urbana Champaign, Y.S. HOR, Missouri University of Science and Technology, D.J. VAN HARLINGEN, University of Illinois at Urbana Champaign — There has been intense interest in realizing Majorana fermions (MFs) in solid-state systems. Circuits of Josephson junctions (JJs) made of closely spaced s-wave superconductors on 3D topological insulators have been proposed to host zero energy Andreev bound states (ABSs) that act like MFs. Here, we present signatures of an anomalous supercurrent carried by topologically non-trivial low energy ABSs in a Nb/Bi_2Se_3/Nb tri-junction SQUID where two of the three superconducting leads are connected by a loop. An electrostatic top gate allows strong modulation of the supercurrent despite a high bulk contribution to the normal state conductance. In response to a magnetic field threading flux within the superconducting loop, we find unconventional SQUID oscillations enclosed by an envelope associated with a clear diffraction pattern, indicating spatially uniform and symmetric JJs. At a critical gate voltage, when the trivial 2DEG at the surface is nearly depleted, we observe a sharp drop in the critical current, signaling a topological phase transition in which the nature of the supercurrent-carrying states is transformed. This transition is accompanied by qualitative changes in the SQUID oscillations, magnetic diffraction pattern, and temperature dependence of the critical current.

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