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Observation of Quantum Spin Hall States in InAs/GaSb Bilayers under Broken Time-Reversal Symmetry[1] LINGJIE DU, Department of Physics and Astronomy, Rice University, IVAN KNEZ, IBM Research - Almaden, GERARD SULLIVAN, Teledyne Scientific and Imaging, RUI-RUI DU, Department of Physics and Astronomy, Rice University — Topological insulators (TIs) are a novel class of materials with nontrivial surface or edge states. Time-reversal symmetry (TRS) protected TIs are characterized by the Z2 topological invariant. The fate of the Z2 TIs under broken TRS is a fundamental question in understanding the physics of topological matter but remains largely unanswered. Here we show, a two-dimensional TI is realized in an inverted electron-hole bilayer engineered from InAs/GaSb semiconductors which retains robust helical liquid (HL) edge states under a strong magnetic field. Wide conductance plateaus of 2e2/h value are observed; they persist to 10T applied in-plane field before transitioning to a trivial semimetal. In a perpendicular field up to 35T, broken TRS leads to a spatial separation of the movers in Kramers pair and consequently the intra-pair backscattering phase space vanishes, i.e., the conductance increases from 2e2/h in strong fields manifesting chiral edge transport. We propose a phenomenological phases diagram, where inside the topological gap the HL transfers into a "canned helical state" driven by perpendicular fields. Our findings suggest that once established, the HL is remarkably resilient and only undergoes adiabatic deformation under TRS breaking.

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