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Phase coherent transport in hybrid superconductor-topological insulator devices[1]

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Heterostructures of superconductors and topological insulators are predicted to host unusual zero energy bound states known as Majorana fermions, which can robustly store and process quantum information. Here, I will discuss our studies of such heterostructures through phase-coherent transport, which can act as a unique probe of Majorana fermions. We have extensively explored topological insulator Josephson junctions through SQUID and single-junction diffraction patterns, whose unusual behavior give evidence for low-energy Andreev bound states. In topological insulator devices with closely spaced normal and superconducting leads, we observe prominent Fabry-Perot oscillations, signifying gate-tunable, quasi-ballistic transport that can elegantly interact with Andreev reflection. Superconducting disks deposited on the surface of a topological insulator generate Aharonov-Bohm-like oscillations, giving evidence for unusual states lying near the interface between the superconductor and topological insulator surface. Our results point the way towards sophisticated interferometers that can detect and read out the state of Majorana fermions in topological systems. This work was done in collaboration with Cihan Kurter, Yew San Hor, and Dale Van Harlingen.

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