Interface-Engineered Topological Quantum Matter

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Topology has emerged as a new paradigm in quantum materials over the past two decades, and a series of topological materials, such as topological insulators (TIs), topological semimetals (TSMs), and topological superconductors (TSCs), have been predicted and subsequently identified experimentally. In these topological materials, even though their topological properties are insensitive to marginal disorders, many of their electronic, such as transport and optical, properties can still be significantly affected by disorders. Moreover, in these materials, the very topological protection mechanism pushes the active carriers to reside on the interfaces and this makes their electronic properties particularly vulnerable to interfacial disorders. Since interfaces generally harbor substantially more disorders than the bulk does, interface control plays a key role in defining the transport and optical properties of many topological materials [1].

Along this line, my group introduced a series of interface engineering schemes over the past decade and uncovered hidden topological quantum signatures such as the quantum Hall effect [2], quantized Faraday/Kerr rotations [3], high-temperature quantum anomalous Hall effect [4], etc., in several topological materials. Furthermore, with similar interface control schemes, we also discovered that the ground state of a Hund metal (FeTe) can be switched from an antiferromagnetic to a superconducting state, showing that small perturbations such as interfaces can be utilized to select one of the competing ground states when the barriers between them are sufficiently small [5].

In this talk, I will overview these findings over the past decade and show how interface engineering schemes have helped discover hidden or unexpected signatures in various topological quantum materials.

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