Interface-Induced Superconductivity in Quantum Anomalous Hall Insulators

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When two different electronic materials are brought together, the resultant interface often shows unexpected quantum phenomena, including interfacial superconductivity and Fu-Kane topological superconductivity (TSC). In this talk, I will first briefly talk about our recent progress on the quantum anomalous Hall (QAH) effect in magnetic topological insulator (TI) multilayers. Next, I will focus on our recent discovery of interfacial superconductivity in QAH/iron chalcogenide heterostructures. We employed molecular beam epitaxy (MBE) to synthesize heterostructures formed by stacking together two magnetic materials, a ferromagnetic TI with the QAH state and an antiferromagnetic iron chalcogenide (FeTe). We discovered emergent interface-induced superconductivity in these heterostructures and demonstrated the trifecta occurrence of superconductivity, ferromagnetism, and topological band structure in the QAH layer, the three essential ingredients of chiral TSC. The unusual coexistence of ferromagnetism and superconductivity can be attributed to the high upper critical magnetic field that exceeds the Pauli paramagnetic limit for conventional superconductors at low temperatures. The QAH/FeTe heterostructures with robust superconductivity and atomically sharp interfaces provide an ideal wafer-scale platform for the exploration of chiral TSC and Majorana physics, constituting an important step toward scalable topological quantum computation.