Condensed Matter Physics Seminar Series

Engineering Topological and Interaction-Driven Quantum Phases in HfTe5

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Quantum materials can host electronic states that do not exist in ordinary solids, many of which are topological and protected by symmetry. In this seminar, I will present $HfTe_5$, a layered van der Waals material whose electronic structure can be tuned in situ to access multiple topological and interaction-driven phases.By applying uniaxial strain, we drive a transition between weak and strong topological insulating states, producing a nearly three-order-of-magnitude increase in resistance and a crossover to surface-state-dominated transport. In the weak topological phase, a magnetic field generates a sequence of Landau levels and one-dimensional Weyl-like modes. At low carrier density, strong Coulomb interactions stabilize a spin-triplet excitonic insulator that we recently discovered. In the strong topological phase, this condensate appears at lower fields and can be tuned through isotope-controlled electron–phonon coupling.When thinned below ~100 nm, $HfTe_5$ becomes increasingly surface dominated and exhibits new correlated behavior, providing a clean platform to study the interplay of topology, dimensionality, and interactions.

In summary, $HfTe_5$ offers an exceptional opportunity to control topological phase transitions, interaction-driven condensates, and symmetry-protected boundary transport within a single material system. Its tunability and rich phase diagram make it a promising platform for spin-based electronics and topologically robust quantum devices.

Friday, March 6th at 11am
4-330 PAB