Condensed Matter Physics Seminar Series

Correlated States in Topological Materials

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Electronic correlations and topological phases represent two central frontiers of condensed matter physics, yet they rarely coexist within the same material system. In this talk, I will present our experimental work on two such rare examples where correlation and topology intertwine in unexpected ways. In the first part, I will introduce the topological excitonic insulator phase realized in $Ta_2Pd_3Te_5$. In this system, electrons and holes bind to form excitons, which subsequently undergo Bose–Einstein condensation, driving the system into an excitonic insulating state. Remarkably, this condensate gives rise to a topological state with distinct boundary modes, realizing the long-sought topological excitonic insulator. In the second part, I will discuss our discovery of a Pomeranchuk instability in the topological surface state of grey arsenic. At and near the Fermi energy, the surface-state Fermi surface spontaneously distorts from a circular to an elliptical shape, signaling a rotational symmetry breaking. This deformation is accompanied by an intra-unit-cell nematic order, providing direct evidence of a Pomeranchuk instability in the topological surface-state Fermi liquid. I will conclude by discussing the broader implications of these results.

1. *Nat. Phys.* **21**, 1250–1259 (2025). 2. arXiv:2410.19636.

Friday, March 13th at 11am
4-330 PAB