

CLARK UNIVERSITY PHYSICS COLLOQUIUM



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“Symmetry protected Dirac fermions in topological crystalline insulators”

ABSTRACT: In Dirac materials such as graphene and topological insulators, electrons behave like relativistic particles with zero mass. This is a direct consequence of the form of the low energy effective Hamiltonian describing these electrons and has important implications for realizing physical properties predicted for high-energy particles, now in condensed matter systems. Topological crystalline insulators are a recently discovered class of topological materials [1,2], in which topology and crystal symmetries intertwine to create relativistic massless electrons. One of the unique characteristics of these systems is that crystalline symmetry breaking is theoretically predicted to impart mass to otherwise massless surface state (SS) Dirac electrons. In this talk, I will discuss our recent experimental and theoretical investigations of a topological crystalline insulator $\text{Pb}_{1-x}\text{Sn}_x\text{Se}$ [3,4]. We acquire and analyze two types of scanning tunneling microscopy (STM) data: Fourier transforms of interference patterns and Landau level spectroscopy. Our experiments reveal the coexistence of zero mass Dirac fermions protected by crystal symmetry with massive Dirac fermions resulting from crystal symmetry breaking. Additionally, we discover that the measured fermion mass scales with alloying composition, which we explain by the evolution of the SS penetration depth [5].

[1] L. Fu, Topological Crystalline Insulators. *Phys. Rev. Lett.* 106, 106802 (2011).

[2] T. H. Hsieh et al., Topological crystalline insulators in the SnTe material class. *Nat. Commun.* 3, 982 (2012).

[3] Y. Okada et al., Observation of Dirac node formation and mass acquisition in a topological crystalline insulator, *Science* 341, 1496-1499 (2013)

[4] Ilija Zeljkovic et al., Mapping the unconventional orbital texture in topological crystalline insulators, *Nat. Phys.* 10, 572577 (2014)

[5] Ilija Zeljkovic et al., Dirac mass generation from crystal symmetry breaking on the surfaces of topological crystalline insulators, *arXiv:1403.4906*

Wednesday, October 15, 2014
4:15 pm – Room S-122, Sackler Sciences Center