Coexistence of Massless and Massive Dirac Fermions in Topological Crystalline Insulators

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Topological crystalline insulators are recently discovered topological materials [1,2] where topology and crystal symmetry intertwine to create massless electrons, which behave like relativistic particles. Among the theoretical predictions for topological crystalline insulators is the possibility of imparting mass to these massless Dirac fermions by breaking crystal symmetry. In this talk I will discuss our recent experimental and theoretical investigations of a topological crystalline insulators, $Pb_{1-x}Sn_xSe$ [3]. We performed scanning tunneling microscopy (STM) studies at low temperatures and as a function of magnetic field. By analyzing two types of STM data: Fourier transforms of interference patterns and Landau level spectroscopy, we reveal the coexistence of zero mass Dirac fermions protected by crystal symmetry with massive Dirac fermions resulting from crystal symmetry breaking. In addition, I will discuss our recent data on the evolution of the mass as well as the Dirac surface states as we go through a quantum phase transition from the topological to trivial regime.

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