Pavan Hosur

Title: Superconductor vortices in Weyl semimetals

Abstract: Vortices in type-II superconductors carry critical information about the parent metal. For example, ordinary metals produce equally spaced levels with finite zero-point energy, whereas massless Dirac metals yield exotic Majorana fermions at precisely zero energy. Weyl semimetals are gapless topological materials defined by accidental band intersections or Weyl nodes in the bulk and a bizarre surface metal composed of open Fermi arcs instead of closed Fermi surfaces. We ask, "what is the spectrum of superconductor vortices in Weyl semimetals?" Restricting to non-magnetic Weyl semimetals and superconductivity that is gapped when uniform, we show that the spectrum is generically gapped and follows from semiclassical quantization of closed orbits consisting of Fermi arcs on opposite surfaces connected by one-way bulk conduits. It is expected to produce a slew of exotic behaviors such as (i) periodic oscillations in the specific heat and tunneling conductance as the vortex is tilted (ii) transmutation between bosonic, fermionic, and supersymmetric statistics (iii) and "magic angles" where the spectrum becomes independent of the slab thickness. Moreover, if the semiclassical orbits are shorted by quantum tunneling in the bulk, surface Majorana modes appear under simple conditions based on the Fermi arc connectivity and bulk Weyl node positions. We propose well-studied materials NbP, TaP, LifeCoAs and FeSeTe for realizing different parts of our proposals.