Chez Pierre

Presents ...

Tuesday, September 24, 2019

12:00pm Noon

MIT Room 4-331

Special Chez Pierre Seminar

Haim Beidenkopf – Weizmann Institute of Science

“Topological protection of Weyl fermions tested on the atomic scale.”

Topological electronic materials host exotic boundary modes, that cannot be realized as standalone states, but only at the boundaries of a topologically classified bulk. Topological Weyl semimetals, whose bulk electrons exhibit chiral Weyl-like dispersion, host Fermi-arc states on their surfaces. The Fermi-arc surface bands disperse along open momentum contours terminating at the surface projections of bulk Weyl nodes with opposite chirality. Such reduction of the surface degrees of freedom by their splitting and segregation to opposite surfaces of the sample, that reoccurs in all topological states of matter and even exhibited by topological defects [1], provides topological protection from their surface elimination. We have confirmed the Weyl topological classification of both the inversion symmetry broken compound TaAs [2] and the time reversal symmetry broken $Co_3Sn_2S_2$ [3] by spectroscopic visualization of their Fermi-arc surface states through the interference patterns those electrons embed in the local density of states. This has allowed us to examine their unique nature and level of protection against perturbations. In TaAs the Fermi arc bands are found to be much less affected by the surface potential compared to trivial bands that also exist on its surfaces. In contrast, in $Co_3Sn_2S_2$ the dispersion of the topological Fermi-arc bands, and even their inter-Weyl node connectivity, are found to vary with the surface termination. This discrepancy seems to elude towards a tradeoff between momentum extended Fermi-arc bands, as those in $Co_3Sn_2S_2$, which have more pronounced experimental signatures but are more susceptible to surface perturbations, to short extent ones, as those in TaAs, which are harder to detect but are more robust.

[1] Abhay Kumar Nayak et al, “Resolving the Topological Classification of Bismuth with Topological Defects” *Science Advances* (in press); arXiv:1903.00880

[2] Rajib Batabyal et al, “Visualizing weakly bound surface Fermi arcs and their correspondence to bulk Weyl fermions” *Science Advances* 2, e1600709 (2016)

[3] Noam Morali et al, “Fermi-arc diversity on surface terminations of the magnetic Weyl semimetal $Co_3Sn_2S_2$” *Science* (in press); arXiv:1903.00509