Visualizing Fermi arcs and coexisting surface states of weak and crystalline topological insulator

Nurit Avraham*[1], Rajib Batabyal[1], Noam Morali[1], Yan Sun[2], Marcus Schmidt[2], Lin Pan[2], Wu Shu-Chun[2], Andrew Norris[3], Ady Stern[1], Claudia Felser[2], Binghai Yan[1], and Haim Beidenkopf[1]

[1]The Weizmann Institute of science – Israel
[2]Max Planck Institute for Chemical Physics of Solids, Dresden – Germany
[3]Institute IMDEA Nanoscience, Madrid – Spain

Abstract

In my talk I will present our recent findings on two topological materials: the Weyl semimetal TaAs and the weak and crystalline topological insulator Bi2TeI.
The correspondence between surface "Fermi-arcs" and bulk Weyl cones in a Weyl semimetal uniquely allows to study the notion of bulk surface correspondence. The surface of tantalum arsenide, similar to that of other members of the Weyl semimetal class, hosts non-topological states that obscure the exploration of the Fermi arc states. We use the spatial structure of the surface states' wave function visualized by scanning tunneling microscopy (STM) to distinguish the surface Fermi arcs and to observe their unique properties and their correspondence with the bulk states [1]. While the non-topological states show strong coupling to the lattice structure, we find that the Fermi arcs are only weakly bound to it. We find that the arcs' energy dispersion shows clear correspondence with the Weyl nodes. We obtain these results using an analysis technique based on the role of the Bloch wave function in shaping quantum electronic interference patterns.

Bi2TeI is a layered material predicted theoretically to be both a weak and a crystalline topological insulator (TI). It's layered structure enables us to study both types of topological surface states on the same material facet. We observe robust 2D gapless states on the top facet, perpendicular to the material mirror planes. These states are observed for all surface terminations and show excellent agreement with theoretical calculations of the mirror protected surface states. On step edges that occur naturally on this surface, we visualize 1D conducting channels which remain decoupled from the mirror protected 2D states. These 1D channels appear only at the edges of "topological terraces" which contain Bi bilayer, and are absent at the edges of "trivial terraces". This indicates their relation with the weak TI states residing on the side surfaces (parallel to the stacking direction).
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*Speaker