Topology – from the materials perspective

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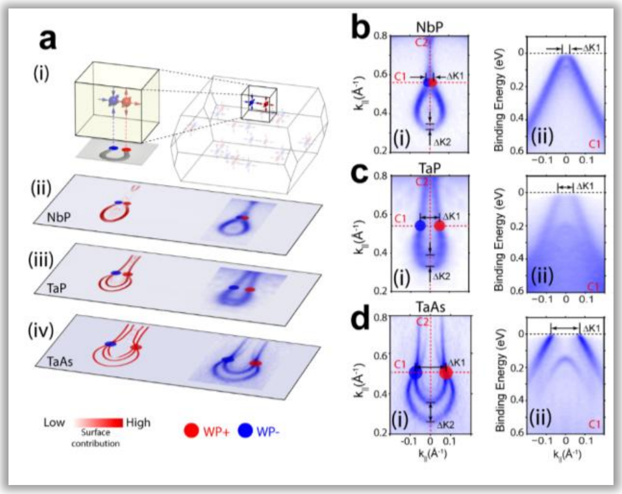
Topological insulators, Weyl and Dirac Semimetals are a new quantum state of matter, which have attracted interest of condensed matter science. Tunable families of compounds such as Heusler compounds, binary phosphides and chalcogenides allows for a design of these new properties and their systematic study. Many known compounds were reclassified through the lens of topology.

Heusler compounds are a remarkable class of materials with more than 1,000 members and a wide range of extraordinary multifunctionalities [1] including tunable topological insulators (TI) [2,3] and Weyl semimetals [4,5]. Many of these ternary zero-gap semiconductors in Heusler compounds (LnAuPb, LnPdBi, LnPtSb and LnPtBi) contain the rare-earth element Ln, which can realize additional properties ranging from superconductivity (for example LaPtBi) to magnetism (for example GdPtBi) and heavy fermion behavior (for example YbPtBi). These properties can open new research directions in realizing the quantized anomalous Hall Effect and topological superconductors. C1b Heusler compounds have been grown as single crystals and as thin films. The band inversion is proven by ARPES [6] and a large anomalous Hall can be explained within a Weyl-Berry curvature scenario.

Binary phoshides are the ideal material class for a systematic study of Dirac and Weyl physics. Weyl points, a new class of topological phases was also predicted in NbP, NbAs. TaP, GdPtBi, MoP and WP_2. [7-10]. New Fermions beyond Weyl and Dirac have been predicted by Bernevig's team and can be classified by space groups and Wyckoff positions [12]. More emerging quantum properties and potential applications will be discussed.



Weyl Semimetals NbP TaPand TaAs and the Fermi arc, calculation vs. Angle Resolved Photoemission (ARPES)

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