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Topology and Chirality

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Abstract

Topology, a mathematical concept, recently became a hot and truly transdisciplinary topic in condensed matter physics, solid state chemistry and materials science. All 200 000 inorganic materials were recently classified into trivial and topological materials: topological insulators, Dirac, Weyl and nodal-line semimetals, and topological metals [1]. The direct connection between real space: atoms, valence electrons, bonds and orbitals, and reciprocal space: bands and Fermi surfaces allows for a simple classification of topological materials in a single particle picture. More than 25% of all inorganic compounds host topological bands, which opens also an infinitive play-ground for chemistry [1,2]. Beyond Weyl and Dirac, new fermions can be identified in compounds that have linear and quadratic 3-, 6- and 8- band crossings that are stabilized by space group symmetries [3]. Crystals of chiral topological materials CoSi, AlPt and RhSi were investigated by angle resolved photoemission and show giant unusual helicoid Fermi arcs with topological charges (Chern numbers) of ±2 [4]. In agreement with the chiral crystal structure two different chiral surface states are observed. A qunatized circular photogalvanic effect is theoretically possible in Weyl semimetals. However, in the multifold fermions with opposite chiralities where Weyl points can stay at different energies, a net topological charge can be generated. This net topological charge can lead to a quantized signal in the circular polarized light-induced injection current, if trivial bands are not to dominant at EF [5]. However, chirality is also of interest for chemists [6], especially because of the excellent catalystic performance of the new chiral Fermions AlPt and PdGa [7]. The open question is the interplay between Berry curvature, chirality, orbital moment and surface states.

References

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