Stacking Dimerized Chains Exhibit Acoustic Type-II Weyl Nodes

Weyl fermions were originally predicted by Weyl in 1929 in the development of quantum field theory, but have not been found as realistic particles (neutrinos were mistakenly thought to be Weyl fermions for decades). Recently, it was found [1] that the electronic low-energy excitations acting as quasiparticles in some novel Weyl semimetals can support the Weyl fermion Hamiltonian. What is beyond the context of traditional Weyl fermions is that, on the platform of a condensed matter system, a new type of Weyl fermion, nowadays classified as a "type-II" Weyl fermion, can emerge at the contact of the electron and hole pockets. This new type of type-II Weyl fermion violates the fundamental Lorentz symmetry in quantum field theory, and thus were actually missed by Weyl in his original studies.

In a recent work [1], Baile Zhang and Zhaoju Yang propose an acoustic version of a type-II Weyl Hamiltonian and clarify its unique features in transportation. They construct a three-dimensional acoustic structure by stacking one-dimensional dimerized chains of acoustic resonators, as presented in Fig. 1(a). The inset shows the schematic of the three-dimensional dimerized cubic lattice. By calculating the band structure, we find the tilted spectrum of the Weyl cone, which indicates the existence of the type-II Weyl point. The right panel displays the non-vanishing density of states, as a distinct feature from a type-I Weyl system. The non-zero chirality of the Weyl points implies the existence of Fermi-arc-like surface states, which can be traced out as shown in Fig. 1(c). The open arcs are a direct analogue of the Fermi arcs discovered recently in Weyl semimetals. Another distinct feature is that the group velocity of the surface states is determined by the tilting spectrum of the type-II Weyl cone rather than the chirality dictated by the Chern number, which is totally different from the type-I Weyl system. This is schematically shown in Fig. 1(d).

References

[1] Yang, Z. and Zhang, B., 2016. Acoustic Type-II Weyl Nodes from Stacking Dimerized Chains. Physical Review Letters, 117(22), p.22430.

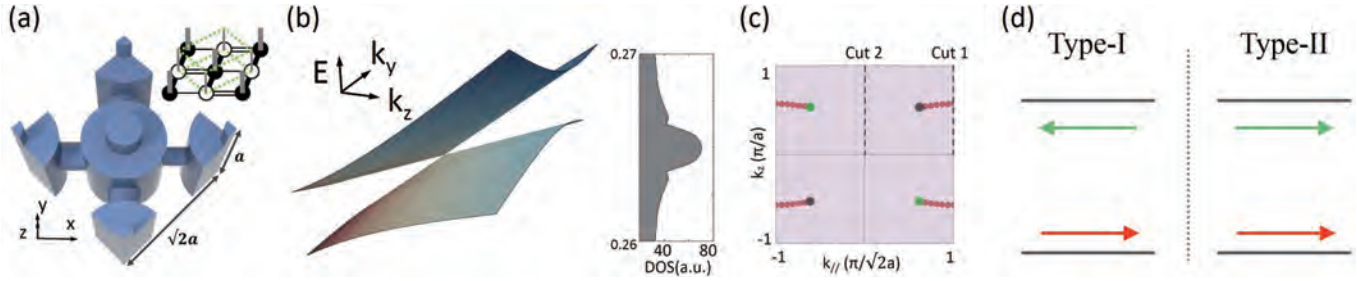

Fig. 1: (a) Acoustic structure. (b) The spectrum of Weyl cone and the density of states. (c) Fermi-arc-like surface states. (d) Transport distinction.

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