**Topological Semimetals: Where the Massless Fermions Are**

Hongming Weng,1,2

*1* *Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China*

*2Collaborative Innovation Center of Quantum Matter, Beijing 100084, China*

email: hmweng@iphy.ac.cn

Topological semimetals (TSMs), characterized by Weyl/Dirac nodes in the bulk and Fermi arcs on their surfaces, are new states of three-dimensional quantum matters. They represent the extension of the topological classification of matters from insulator to metal. The low energy excitation in Dirac/Weyl semimetals (WSM) behaves in the similar way as the massless Dirac/Weyl fermions described by Dirac/Weyl equation. The Weyl fermions have certain chirality and have not been discovered since Hermann Weyl proposed them more than 80 years ago. The recent discovery of their quasiparticles in solids has inspired broad and intensive studies in the field of TSMs. Notably, the Lorentz invariance assumed in high-energy field theory is broken in solids, which leads to more unconventional quasiparticles beyond the traditional classification of fermions of Dirac, Weyl and Majorana. This greatly enriches the quantum states of TSM family, including Node-line semimetal, type-II WSM, multiple-degenerate nodal point semimetal, etc. In this talk, I will briefly introduce the band topology theory firstly, and then show how to extend the topology of electronic states defined on the manifold of whole Brillouin zone in insulators to that defined on closed Fermi surface of partial Brillouin zone. Finally, our theoretical predictions of realistic materials to host these intriguing quantum states, as well as their experimental progresses, are talked about. The TSM family members and their relationship with each other are discussed and summarized.