Nonsymmorphic Dirac and double Dirac semimetals

Benjamin J. Wieder[1], Charles L. Kane[1], Andrew M. Rappe[2], and Youngkuk Kim[2]

[1]*Department of Physics and Astronomy, University of Pennsylvania Philadelphia, Pennsylvania 19104-6323, USA*

[2]*The Makineni Theoretical Laboratories, Department of Chemistry, University of Pennsylvania Philadelphia, Pennsylvania 19104-6323, USA*

Three-dimensional (3D) Dirac semimetals feature a fourfold-degenerate Dirac point at high-symmetric points of the Brillouin zone, protected by nonsymmorphic symmetries of crystals [1]. Here we briefly review the 3D Dirac semimetals and introduce a novel class of Dirac semimetals that feature an eightfold-degenerate double Dirac point [2]. We show that 7 of the 230 space groups can host such Dirac points and, in particular, space group 135 can host an intrinsic double Dirac semimetal with no additional states at the Fermi energy. This defines a symmetry-protected topological critical point, and a uniaxial compressive strain applied in different directions leads to topologically distinct insulating phases. In addition, the double Dirac semimetal can accommodate topological line defects that bind helical modes. Potential materials realizations are discussed.

[1] S. M. Young, S. Zaheer, J. C. Y. Teo, C. L. Kane, E. J. Mele, and A. M. Rappe, Phys. Rev. Lett. **108**, 140405-1 (2012).

[2] Benjamin J. Wieder, Youngkuk Kim, A.M. Rappe, and C.L. Kane, Phys. Rev. Lett. **116**, 186402-1 (2016).