

Topological Semimetals from a High Magnetic Field Perspective

L. Balicas

National High Magnetic Field Laboratory and Physics Department, Florida State University

Topological semimetals such as Weyl and Dirac systems are three-dimensional phases of matter characterized by topology and symmetry protected gapless electronic excitations. These three-dimensional analogs of graphene have generated a lot of interest recently given that their quasiparticles display properties akin to those of relativistic and chiral fermions in particle physics. Their unconventional electronic structures are predicted to lead to protected surface states and to unconventional responses to applied electric and magnetic fields. In the past few years, we have studied a few of these compounds [1-11] under high magnetic fields, with the goal of i) extracting their electronic structure at the Fermi level in order to ii) compare it with theoretical predictions, and of iii) exposing their transport properties which are expected to be unconventional due to their “topological” character. Quantum oscillatory phenomena, such as the de Haas van Alphen-effect (dHvA), provide information about their electronic structure and have a higher energy resolution when compared to angle resolved photoemission spectroscopy (ARPES), which insofar has been the technique of choice for studying these compounds. Here, we will provide an introduction to associated concepts and, time permitting, discuss a few specific examples where measurements under high magnetic fields provide valuable information about the electronic structure at the Fermi level; such as the type-II Weyl semimetals T_d -MoTe₂ [4], WP₂ [5] and NbIrTe₄ [6], and type-II Dirac systems like MAI₃ [8] and (Pt,Pd)Te₂ [9].

References

- [1] D. Rhodes *et al.*, Phys. Rev. B **92**, 125152 (2015).
- [2] Q. Zhou *et al.*, Phys. Rev. B **94**, 121101(R) (2016).
- [3] D. Rhodes *et al.*, Nano Lett. **17**, 1616 (2017).
- [4] See, D. Rhodes *et al.*, Phys. Rev. B **96**, 165134 (2017), and references therein.
- [5] R. Schönemann *et al.*, Phys. Rev. B **96**, 121108(R) (2017).
- [6] R. Schönemann *et al.*, Phys. Rev. B **99**, 195128 (2019).
- [7] K.-W. Chen *et al.*, Phys. Rev. B **97**, 165112 (2018).
- [8] K.-W. Chen *et al.*, Phys. Rev. Lett. **120**, 206401 (2018)
- [9] W. Zheng *et al.*, Phys. Rev. B **97**, 235154 (2018).
- [10] Q. R. Zhang *et al.*, Phys. Rev. B **100**, 115138 (2019).
- [11] Y.-C. Chiu, *et al.*, Phys. Rev. B **100**, 125112 (2019).

Luis Balicas – Research Professor at FSU Physics Department, and Distinguished University Scholar at the National High Magnetic Field Laboratory. He is a Fellow of the American Physical Society and of the Association for the Advancement of Science. Obtained his PhD at the University of Paris XI, Orsay-France. He has co-authored over 240 publications leading to a Hirsh Index of 46 according to ISI.