The robustness of spin-polarized edge states in a two-dimensional semimetal without inversion symmetry

José D. Mella
Luis E. F. Foa Torres
Departamento de física, Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile, Beaucheff 850, Santiago, Chile
jmellariquelme@gmail.com

Three-dimensional topological gapless phases have attracted significant attention due to their unique electronic properties. One of the flagships is the Weyl semimetal, which requires breaking time-reversal or inversion symmetry in three dimensions. Towards two dimensions, the dimensionality reduction requires imposing an additional symmetry, thereby weakening the phase. Like its three-dimensional counterpart, these “two-dimensional Weyl semimetals” present edge states directly related to the Weyl nodes. Since these edge states strongly resemble those in zigzag-like terminated graphene ribbons[2], it is natural to wonder how robust are.

Here we benchmark the robustness of the edge states in two-dimensional Weyl semimetals with those present in zigzag graphene ribbons. To such end we use a Dirac Hamiltonian model proposed by Young and Kane[1], adding new terms for inducing a two-dimensional Weyl semimetal phase and use a scattering picture for the transport calculation. Our results show that despite having a similar electronic bandstructure, the edge states of two-dimensional Weyl semimetal are more robust against vacancies than graphene ribbons[3]. We attribute this enhanced robustness to a crucial role of the spin degree of freedom in the former case.

REFERENCES

[1] S.M. Young and C.L. Kane, Physical Review Letters, 115 (2015) 126803
[2] P.G. Matveeva, D.N. Aristov, D.Meidan, and D.B. Gutman, Physical Review B, 99 (2019) 075409
[3] J. D. Mella, L. E. F. Foa Torres, to be published (2021).