Tunable Circular Dichroism and Valley Polarization in the Modified Haldane Model

Marc Vila,[1,2] Nguyen Tuan Hung,[3] Stephan Roche,[1,4] Riichiro Saito[3]

1 - Catalan Institute of Nanoscience and Nanotechnology (ICN2), CSIC and BIST, Campus UAB, Bellaterra, 08193 Barcelona, Spain.
2 - Department of Physics, Universitat Autònoma de Barcelona, Campus UAB, Bellaterra, 08193 Barcelona, Spain.
3 - Department of Physics, Tohoku University, Sendai 980-8578, Japan.
4 - ICREA - Institució Catalana de Recerca i Estudis Avancats, 08010 Barcelona, Spain.

marc.vila@icn2.cat

Circularly polarized light is at the core of many different and intriguing properties such as circular dichroism [absorption is different between left- and right-handed circularly polarized light (σ_+ and σ_-)] and valley polarization (σ_+ and σ_- are absorbed at a specific valley K/K' in a hexagonal two-dimensional material). In this presentation, I will discuss the optical properties of a recently proposed modification of the Haldane model [1]. We study the polarization dependence of optical absorption for the modified Haldane model, which exhibits protected antichiral edge modes in presence of sample boundaries and is argued to be realizable in Weyl semimetals or in graphene with induced spin-orbit coupling and magnetism [2].
A rich optical phase diagram (Figure 1) is unveiled, in which the correlations between perfect circular dichroism, pseudospin and valley polarization can be tuned independently upon varying the Fermi energy. Importantly, perfect circular dichroism and valley polarization are achieved simultaneously, a feature not yet observed in known optical materials. This unprecedented combination of optical properties suggests some interesting novel photonic device functionality (e.g. light polarizer) which could be combined with valleytronics applications (e.g. generation of valley currents).

References

[1] E. Colomés and M. Franz, Phys. Rev. Lett. 120 (2018) 086603.
[2] M. Vila, N. T. Hung, S. Roche, R. Saito, arXiv:1902.00780 (2019).

Figures

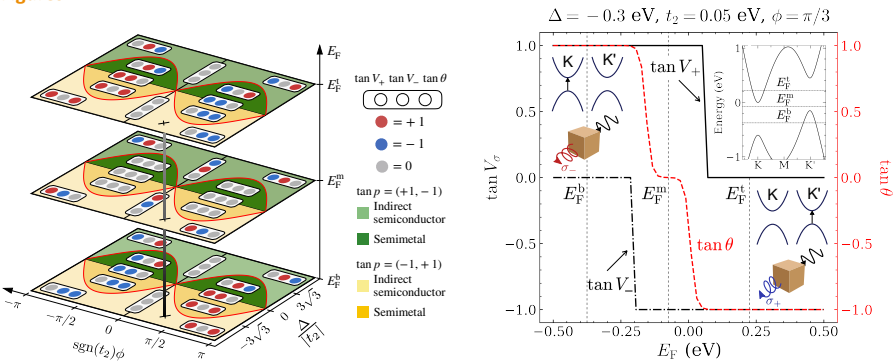

Figure 1: (Left) Optical phase diagram of the modified Haldane model [2]. Circular dichroism, valley polarization and pseudospin polarization is represented by the values $\tan\theta$, $\tan V_\sigma$ and $\tan p$, respectively. **(Right)** Tunability of circular dichroism and valley polarization with varying Fermi energy.