

Emergence of band asymmetry and nonreciprocal transport in the centrosymmetric helimagnet α -EuP₃

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Chiral magnetic textures give rise to unconventional magneto-transport phenomena such as the topological Hall effect and nonreciprocal electronic transport. While the correspondence between real-space magnetic topology/symmetry and such transport phenomena has been well established, a microscopic understanding based on the spin-dependent band structure in momentum space remains elusive. Here we demonstrate using density functional theory calculations how a chiral magnetic structure in real space introduces an asymmetry in the electronic band structure and triggers a nonreciprocal electronic transport in a centrosymmetric helimagnet α -EuP₃[1,2]. The magnetic structure of α -EuP₃ is highly tunable by a magnetic field and closely coupled to its electronic band structure, enabling a systematic study across chiral and achiral magnetic phases on the correspondence between nonreciprocal transport and electronic band asymmetry. Our findings reveal how a microscopic change in the magnetic configuration of charge carriers can lead to nonreciprocal electronic transport, paving the way for designing chiral magnets with desirable properties.

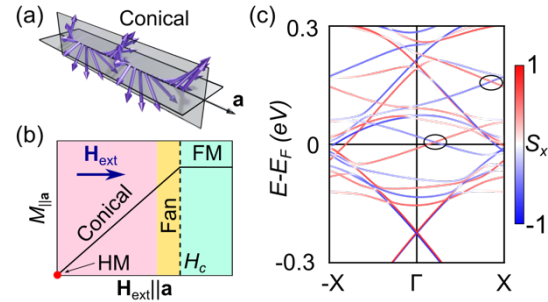


Fig. 1: Figure 1: (a) Illustration of a magnetic spiral in conical phase. (b) Phase diagram of α -EuP₃ in an external field. (c) Asymmetric band structure of α -EuP₃ obtained from DFT in the conical phase.

[1] A. H. Mayo, D.-A. Deaconu, et al. “Band asymmetry-driven nonreciprocal electronic transport in a helimagnetic semimetal α -EuP₃” PNAS, 122(4): e2405839122, 2025.

[2] D.-A. Deaconu, et al. “Field-Driven Band Asymmetry and Nonreciprocal Transport in a Helimagnet” Phys. Rev. Lett. 135, 096701 (2025).