Assessing Nontrivial Topology in Weyl Semimetals by Dichroic Photoemission

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By performing angle-resolved photoemission spectroscopy (ARPES) on the paradigmatic Weyl semimetals Ta(As,P) [1,2] we show the spectroscopic manifestation of topological features and Weyl physics beyond the simple photointensity over a broad range of excitation energies from the vacuum ultraviolet to the soft X-Ray regime and compare the surface to the bulk band structure [3]. Our experimental observations were complemented by state-of-the-art first principle photoemission calculations based on one-step model of photoemission. The determinant criterion confirms the arc character of the spoon features in the constant energy contour close to Fermi level in non-centrosymmetric TaP. We further show the drawbacks of the existing spectroscopic techniques used to determine whether the given material has non-zero Chern number and discuss an improved approach for identifying Fermi arcs by means of differential ARPES measurements, their relation to orbital angular momentum (OAM) as well as the proper final state description. Consequently, we conclude that a more realistic description of the final state is needed to explain dichroism by modeling the photoemission matrix element. It immediately follows that the relation between dichroic ARPES and OAM in the initial state cannot, unlike other ARPES phenomena [4], be explained within the simplified free-electron (FE) final state picture. We also hint a possible combination with new types of linear dichroism [5,6] which further separate the intrinsic and extrinsic contributions into the photoemission.

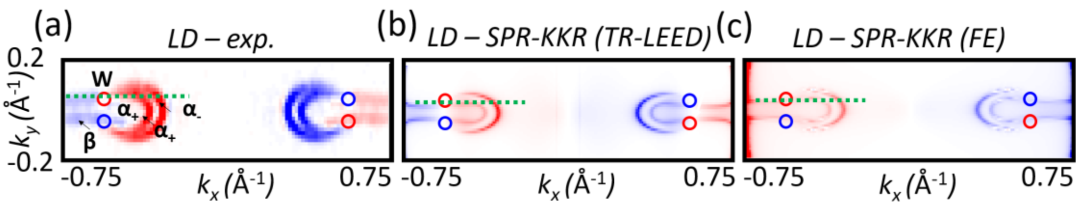

Fig. 1. Linear dichroism (LD) in vacuum ultraviolet regime on TaP. (a) Experimentally measured LD, (b) Calculated LD with the time-reversed low-energy electron diffraction final state (b) and FE final state in (c).

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