# From Initial States to Topology: Dichroism in angle-resolved photoemission spectroscopy

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Dichroism in angle-resolved photoemission is per se a matrix element effect, which depends on the initial and final states as well as on the perturbation by the light field. Although matrix element effects in angle-resolved photoemission spectroscopy (ARPES) such as dichroism are important for addressing properties of the initial state wave functions, the results can strongly depend on experimental geometry or final state effects. Combining experimental data on bulk $WSe_2$ taken at soft x-ray photon energies with state-of-the-art SPR-KKR photoemission calculations, we demonstrate that a dichroic observable called time-reversal dichroism (TRDAD) remains unaffected against variation of photon energy, light polarization, and the angle of incidence [1]. The robustness of this matrix element effect indicates a considerable benefit over other dichroic techniques.
After introducing the novel measurement protocol, we 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 based on differential ARPES measurements, their relation to orbital angular momentum (OAM) as well as the proper final state description.

**Keywords:** Dichroism, Photoemission, ARPES, Topology, SPR-KKR

**Acknowledgement:** Travel support from the Marie Skłodowska-Curie Postdoctoral Fellowship (Horizon Europe, Grant No. 101209345) is gratefully acknowledged. We would also like to thank J. Buck, M. Kalläne, and M. Hoesch for their support during the synchrotron measurements at PETRA III. This work was funded by the Würzburg-Dresden Cluster of Excellence on Complexity and Topology in Quantum Matter – *ct.qmat* (EXC 2147, project-id 390858490) and by the DFG through SFB1170 "Tocotronics" and directly via RE 1469/13-2.

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