**Exploring Approaches to Probe Full Electronic Wave Functions in Solids via Photoemission**

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Access to the full momentum-dependent electronic wave function of solids enables access to the quantum geometric tensor, imaginary part of which is the Berry curvature. In principle, circular-dichroic (CD) and spin-polarized angle-resolved photoemission (spin-ARPES) allow access to these wave functions, however, it is indirect. In this work, we discuss strategies on how to extract the initial state wave functions from the photoemission spectra.

On the example of graphene, we will discuss various contributions to CD-ARPES [1,2] which include phase shifts of the participating partial waves [3], the interatomic phase shifts [4], and the CD due to elastic scattering of an excited electron [5]. Subsequently, we perform similar analysis for $WSe_2$, a material where orbital characters are relatively well-defined.

Finally, a simple interatomic interference model that qualitatively explains asymmetric spin-ARPES spin texture from $WTe_2$ single crystal surface [4] is presented.

Further examples on $PtTe_2$ [6] and selected R166 Kagome compounds will be presented if time allows.

This study aims to explore how CD-ARPES and spin-ARPES techniques can enhance the understanding of quantum materials.

**Keywords:** Berry curvature, spin-polarized ARPES, circular-dichroic ARPES, micro-ARPES.

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[1] Boban et al., PRB 111, 115127 (2025)
[2] Krüger and Matsui, JESRP 258, 147219 (2022)
[3] Moser, JESRP 262, 147278 (2023)
[4] Heider et al., PRL 130, 146401 (2023)
[5] Daimon et al., JJAP 32, L1480 (1993)
[6] Qahosh et al., arXiv:2502.10865 (2025)