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INVITATION to IFP-SEMINAR

Quantum Materials and Magnetic Phenomena Studied by Spin-Resolved ARPES: Theoretical perspectives

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Host: Karsten Held
Date: 12.12.2025, 11:00
Place: TU Wien, Freihaus Building
Wiedner Hauptstraße 8-10, 1040 Wien
Seminar Room DC red 07 (red section, 7. OG)
Zoom: https://tuwien.zoom.us/j/68203025530?pwd=qay8bAoDx8b8RkkbvW6RYaQ5HB1sbs.1

Abstract: Quantum materials exhibit a complex interplay between electronic correlations, topology, and magnetism, placing them at the forefront of condensed matter physics and quantum technology. Understanding these systems requires disentangling spin-orbit coupling, electron-electron interactions, and magnetic fluctuations under realistic conditions, including finite temperatures and structural disorder. Spin- and time-resolved angle-resolved photoemission spectroscopy (STARPES) is a crucial technique for probing electronic and spin structures in magnetic and topological materials. However, quantitative interpretation of spin-ARPES data necessitates advanced theoretical models that accurately capture electronic states, spin textures, and dynamic responses to external fields. I will present a theoretical framework based on the fully relativistic multiple-scattering Green function KKR method [1], effectively modeling spin-dependent photoemission. This approach includes correlation effects via dynamical mean-field theory (DMFT) [2] and describes spin fluctuations using the alloy analogy model [3]. I will also discuss advances in calculating light-induced electronic excitations [4], highlighting their relevance to spin-ARPES studies of topological and magnetic quantum materials. A novel application is the one-step model of photoemission in studying altermagnets and kagome magnetic materials. Altermagnets, exhibiting unconventional time-reversal symmetry breaking without net magnetization, are explored in RuO2 and MnTe [5,6]. Spin-ARPES combined with the one-step model provides insights into lifted Kramers spin degeneracy, revealing their potential for spintronics. In kagome magnetic materials, persistent flat band splitting and selective band renormalization are observed in FeSn thin films [7], highlighting unique correlation effects and topological phenomena. These developments offer a comprehensive framework for exploring magnetic phenomena and spin dynamics in complex quantum materials.

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[4] J. Braun et al., Physics Reports 749, 1 (2018). DOI: 10.1016/j.physrep.2018.02.007
[5] J. Krempaský et al., Nature 626, 517 (2024). DOI: 10.1038/s41586-023-06907-7
[6] O. Fedchenko et al., Sci. Adv. 10, eadj4883 (2024). DOI: 10.1126/sciadv.adj4883
[7] Z. Ren et al., Nature Communications 15, 9376 (2024). DOI:0.1038/s41467-024-53722-3
Acknowledgements: Qu. Materials for Sustainable Techn. project CZ.02.01.01/00/22_008/0004572, cofunded ERDF/MŠMT.

Supported by: FWF Österreichischer Wissenschaftsfonds

Q-M&S Correlated Quantum Materials & Solid State Quantum Systems