

Quantum Materials: Exploring the Interplay of Spin-Based Interactions and Topology

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The competition of spin-dependent interactions, i.e. spin-orbit coupling and exchange interaction is a hallmark feature of quantum materials. The detailed behavior of a quantum material is also determined by a breaking of time-reversal and/or inversion symmetries. Close to the Fermi level, this situation leads to relativistic electronic dispersions associated with Dirac and Weyl points, eventually also leading to complex spin textures in momentum space. These may lead to unusual charge and spin transport phenomena in such materials. In order to understand the physics of quantum materials on a fundamental level, we need to explore these electronic states in detail and disentangle the role of the various interactions. In our experimental approach with spin resolved momentum microscopy we explore a variety of complex 2D and 3D quantum materials and detail the role of the individual interactions and symmetry-breaking mechanisms [1]. However, even the “classical” ferromagnet iron can be turned into a topological ferromagnet under the right conditions, revealing the interplay of spin-based interactions in the behavior of Weyl states and Fermi arcs [2].

[1] Exploring the Mysteries of Topology in Quantum Materials by Spin-Resolved Spectroscopies; C. Tusche, K. Hagiwara, X. L. Tan, Y.-J. Chen, and C. M. Schneider; *J. Vac. Sci. Technol. A* 41 (2023) 042201

[2] Spanning Fermi Arcs by Magnetism Y.-J. Chen, J.-Ph. Hanke, M. Hoffmann, G. Bihlmayer, Y. Mokrousov, S. Blügel, C. M. Schneider, and Ch. Tusche; *Nat. Comm.* 13 (2022) 5309

Bio

Claus Schneider received the Ph.D. in Physics from the FU Berlin in 1990 working in J. Kirschner’s group, and his habilitation in Experimental Physics in 1996 from the Martin-Luther University in Halle-Wittenberg in Germany. From 1990-1992 he was a research scientist at the Institute for Experimental Physics at the FU Berlin, and worked as postdoc from 1992-1993 with Brett Heinrich at the SFU University in Burnaby/Canada. From 1993-1997 he was Group leader “Synchrotron Radiation Research” at the MPI for Microstructure Physics in Halle. From 1997-1998 he was lecturer in Physics at the JGU in Mainz. In 1998-2003 he was Group Leader “thin film systems and nanostructures at the IFW Dresden/Germany. Since 2003 he is the Director at the PGI (PGI-6) at the Research Center Jülich and UAR (University Alliance Ruhr) Professor for Experimental Physics at the University Duisburg-Essen. Since 2018 he is also Adjunct Professor in the Physics Department at UC Davis.

He has received many awards incl the Karl Scheel Award of the DPG in 1990, a NATO Research Fellowship at 1993 to be spent at SFU, the Gay-Lussac Humboldt Award in 2009 and the Japan Society of Vacuum and Surface Science (JVSS) Microbeam Analysis Award in 2022.