GP-Spin Seminar

"From Chiral Electronics to Mottness in Momentum-Space"

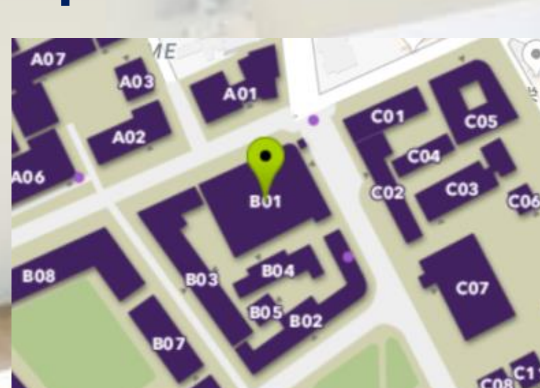
5pm-6:30pm, Monday, November 11, 2024

Dr Niels B. M. Schröter

Max Planck Institute of Microstructure Physics

Venue: Seminar Room, 2nd floor, AIMR Main Building
Katahira Campus, Tohoku University

Katahira Campus North Gate



AIMR Main Building

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Co-hosted by QST AIMR

From Chiral Electronics to Mottness in Momentum-Space

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Abstract: The term chirality is derived from the Greek word for 'hand' χειρ (kheir) and describes objects that are distinct from their mirror image. It is long known that chirality plays a crucial role in nature, providing powerful functionality to chiral molecules in living organisms. By extending this concept from the molecular to the solid state, my group aims to uncover new chirality-enabled phenomena that could form the basis for new technologies.

The focus of my talk will be on chiral topological semimetals, an emerging class of quantum materials at the intersection of structural and electronic chirality. These materials can host new fermionic quasiparticles without analogue in high-energy physics (*1*–*4*), which carry large and controllable topological charges (*5*). We have recently demonstrated that these quasiparticles realize an isotropic Weyl-type parallel spin-momentum locking that can be considered the natural counterpart of Rashba spin-orbit coupling (*6*). Moreover, I will present fingerprints of controllable orbital angular momentum monopoles in these materials (*7*), which could be exploited in memory devices for field-free switching of magnets with perpendicular magnetic anisotropy.

Time permitting, I will also present our investigation of the origin of the magnetic field-induced (*8*) and field-free (*9*) Josephson diode effect. For the latter, we identify a momentum-resolved signature of Mottness that allows us to distinguish band-insulators from unconventional Mott-insulators with an even number of electrons.

1. N. B. M. Schröter *et al.*, *Nat. Phys.* **15**, 759–765 (2019).
2. Z. Rao *et al.*, *Nature*. **567**, 496–499 (2019).
3. D. Takane *et al.*, *Phys. Rev. Lett.* **122**, 076402 (2019).
4. D. S. Sanchez *et al.*, *Nature*. **567**, 500–505 (2019).
5. N. B. M. Schröter *et al.*, *Science*. **369**, 179–183 (2020).
6. J. A. Krieger *et al.*, *Nat Commun*. **15**, 3720 (2024).
7. Y. Yen *et al.*, *Nat. Phys.* (2024) 10.1038/s41567-024-02655-1
8. B. Pal *et al.*, *Nat. Phys.* **18**, 1228–1233 (2022).
9. H. Wu *et al.*, *Nature*. **604**, 653–656 (2022).

Bio: Since 2021, Dr. Niels B. M. Schröter has been leading an independent Max Planck Research Group at the Max Planck Institute of Microstructure Physics in Halle, Germany. He earned his DPhil in Physics from the University of Oxford in 2018, followed by postdoctoral research at the Paul Scherrer Institute in Switzerland. He is the recipient of the 2021 IBM Condensed Matter Physics Award of the Swiss Physical Society for his discovery of chiral topological semimetals, and holds a Starting Grant from the European Research Council (ERC) to further explore this novel material class. His research spans the spectroscopy and synthesis of quantum materials, with a particular focus on structurally chiral materials that exhibit unique chiral electronic, spin, and orbital textures, offering potential applications in next-generation technologies. From 2025, he will be a full Professor (W3) of Experimental Physics at the Martin-Luther University Halle-Wittenberg, while still maintaining his research lab at the Max Planck Institute. He is currently recruiting prospective graduate students and postdocs to work on his ERC funded research. For more information, please visit www.schroeterlab.org