



Thursday, 19th May 2022, 17.15 h
Lecture Hall III, Department of Physics, Garching

Symmetry Principles in Magnetic Systems

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Abstract:

Symmetry principle is the key to understand many exotic phenomena in condensed matter physics. In magnetic systems, the spin pseudovector leads to novel magnetic ordering and electron transports. In this talk, I will give three examples showing how symmetry analysis can help understand and design magnetic materials of interest. First, I will show the prediction of giant perpendicular magnetic anisotropy (PMA) in iron monolayer on top of III-V nitride substrates. The magnitude of PMA is up to 50 meV, in contrast to 1meV in conventional Fe-based thin films. A paradigm shift from second order to first order perturbation of the spin-orbit coupling is the origin of such large PMA. In the second topic, the electron transport in MnTe thin films will be discussed. A zero-field Hall effect was experimentally observed in antiferromagnetic MnTe. I will show how time reversal and its combined symmetries are broken in this material, and how an effective Hamiltonian constructed by theory of invariants successfully describing all transport signatures. Finally, I will discuss how discrete symmetries like time reversal and spatial inversion help us understand the chiral frustration and topological Hall effect addressed in many experiments.

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- [2] G. Yin, J. X. Yu, Y. Liu, R. K. Lake, J. Zang, K. L. Wang, 'Planar Hall effect in antiferromagnetic MnTe thin films', *Physical Review Letters* **122**, 106602 (2019).
- [3] W. T. Hou, J. X. Yu, M. Daly, and J. Zang, 'Thermally driven topology in chiral magnets', *Physical Review B (Rapid Communications)* **96**, 140403 (2017).
- [4] J. Jiang, D. Xiao, F. Wang, J. H. Shin, D. Andreoli, J. Zhang, R. Xiao, Y. F. Zhao, M. Kayyalha, L. Zhang, J. Zang, C. Liu, N. Samarth, M. H. W. Chan, and C. Z. Chang, 'Crossover of Quantum Anomalous Hall to Topological Hall Effects in Magnetic Topological Insulator Sandwich Heterostructures', *Nature Materials* **19**, 732 (2020).
- [5] Z. Li, S. Shen, Z. Tian, K. Hwangbo, M. Wang, Y. Wang, F. M. Bartram, L. He, Y. Lyu, Y. Dong, G. Wan, H. Li, N. Lu, J. Zang, H. Zhou, E. Arenholz, Q. He, L. Yang, W. Luo, and P. Yu. 'Electrical Control of Magnetism with Emergent Topological Hall Effect in SrRuO₃ through Proton Evolution', *Nature Communications* **11**, 1 (2020).

There will be coffee, tea, and cookies in front of the lecture hall at 17.00 h