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Helices, (anti-)skyrmions, and scalar spin chirality in magnets

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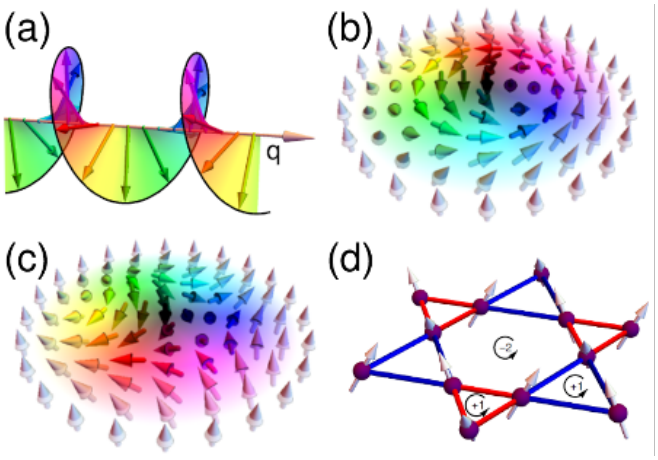

Magnetic textures can establish various orders beyond trivial ferromagnetism, including non-collinear order as in the helical phase, where the magnetization rotates in space in a plane that is defined by some q-vector, see panel (a). Such lamellar phases are interesting from a fundamental perspective but usually considered useless for applications. In turn, non-coplanar textures like skyrmions, panel (b), attracted a lot of attention as they might potentially be useful for storage devices or unconventional computing. Moreover, they give rise to a topological Hall effect as the sum over the solid angles that are spanned by three neighboring spins, dubbed “scalar spin chirality”, is a quantized number.

In my talk, I will present our recent theoretical and experimental studies of these magnetic objects. We opened the field of “helitronics”, showing that helical phases can be combed by electric currents [1] and suggest a new mechanism for detecting defects in the helical order [2]. I will also discuss our recent discovery of a giant skyrmion-induced topological Nernst effect [3], which is the thermal analogue of the Hall effect, our real-space observations of moving skyrmions in thermal gradients [4], static defects in skyrmion-strings [5], and our discovery of a new class of materials that hosts antiskyrmions [6], see panel (c). Finally, I plan to give an outlook how scalar spin chirality can cause a geometrical Hall effect even in the absence of skyrmions in trimerized lattices, see panel (d).

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[3] M. Hirschberger, L. Spitz, …, J. Masell, et al., Phys. Rev. Lett. 125, 076602 (2020)
[4] X. Z. Yu, F. Kagawa, …, J. Masell, et al., preprint DOI: 10.21203/rs.3.rs-156692/v1
[5] X. Z. Yu*, J. Masell*, F. S. Yasin, et al., Nano Lett. 20, 10, 7313-7320 (2020)
[6] K. Karube, L. C. Peng, J. Masell, et al., Nature Materials 20, 335-340 (2021)