On-line SPICE-SPIN+X Seminars

Wednesday, 24th November 2021, 15:00 (CET)

The seminar will be via Zoom (Meeting ID: 847 9742 1715) and live streamed in the SPICE YouTube Channel.

Hariom Jani,

National University of Singapore

Antiferromagnetic Skyrmionics: generating and controlling topological textures

Whirling magnetic textures such as skyrmions, bimerons and their anti-particles could emerge as topologically-protected information bits for next-generation memory and logic. However, their practical exploitation has been inhibited by susceptibility to stray magnetic fields, strong internal dipolar fields, slow speeds or sideway motion. To alleviate these issues, there has been a surge of interest in antiferromagnetic (AFM) analogues, predicted to be robust, scalable and ultra-fast1,2. Even so, experimental progress in this field has been curtailed by magnetic compensation in AFM systems, which makes it difficult to visualize and control AFM textures via standard magnetic techniques.

To this effect, I will firstly discuss a recently-developed AFM vector-mapping technique3,4 exploiting angle-dependent dichroism to image spatial variations of the AFM order. Then, I will present a general field-free approach, employing the Kibble–Zurek transition, that we used to reversibly create a wide multichiral family of topological AFM textures, including exotic merons or antimerons and bimerons5. In the earth-abundant oxide (α-Fe2O3) these nanoscale textures can be nucleated and stabilized at room temperature. Particularly, the presence of widely tunable anisotropy6 and exchange4,5,7 interactions in this system enable unprecedented reversible control over the dimensions and orientation of AFM textures. I will then present how we may realize the hitherto undiscovered AFM skyrmions in α-Fe2O3, by introducing new symmetry breaking interactions. Lastly, I will outline the path ahead for AFM skyrmionics, discussing how our results may be translatable to a broad class of AFM systems – including orthoferrites, orthochromites and layered-ferrates6,8, and sharing how electrical pathways can be exploited to control members of the topological family9-11.

[1] J Barker et al., Physical Review Letters 116, 147203 (2016);
[2] V Baltz et al., Review of Modern Physics 90, 015005 (2018);
[3] NW Price et al., Physical Review Letters 117, 177601 (2016);
[4] FP Chmiel et al., Nature Materials 17, 581 (2018);
[5] H Jani et al., Nature 590, 74 (2021);
[6] H Jani et al., Nature Communications 12, 1668 (2021);
[7] PG Radaelli et al., Physical Review B 101, 144420 (2020);
[8] ZS Lim, H Jani et al., MRS Bulletin, In Press (2021);
[9] L Baldrati et al., Physical Review Letters 123, 177201 (2019);
[10] P Zhang et al., Physical Review Letters 123, 247206 (2019);
[11] Y Cheng et al., Physical Review Letters 124, 027202 (2020);