MA 10: Non-Skyrmionic Magnetic Textures

Time: Monday 15:00–16:45 Location: H47

Invited Talk MA 10.1 Mon 15:00 H47

Magnetic vortices: into the third dimension — •Sebastian Gliga — Swiss Light Source, Paul Scherrer Institute, 5232 Villigen PSI, Switzerland

Vortices are familiar phenomena in fluids and gases. In ferromagnets, they are naturally forming flux-closure states characterized by a curling of the magnetization around a very stable and narrow core. Over the past decades, vortex structures have been extensively studied in laterally confined thin-film elements owing to their rich dynamics [1]. Recently, non-destructive imaging of three-dimensional magnetic structures at the nanoscale has become possible. Using hard X-ray tomography [2], we have uncovered three-dimensional structures forming closed vortex loops in a bulk magnet. Based on magnetic vorticity (a quantity analogous to hydrodynamic vorticity), we identified these configurations as magnetic vortex rings [3]. In contrast to theoretical predictions, the observed vortex rings exist as static configurations, rather than purely dynamic states.
Our results open possibilities for further studies of complex three-dimensional solitons.

[1] R. Hertel, S. Gliga, M. Fähnle, and C. M. Schneider, Phys. Rev. Lett. **98**, 117201 (2007)
[2] C. Donnelly, M. Guizar-Sicairos, V. Scagnoli, S. Gliga, M. Holler, J. Raabe, L. J. Heyderman, Nature **547**, 328-331 (2017)
[3] C. Donnelly, K. L. Metlov, V. Scagnoli, M. Guizar-Sicairos, M. Holler, N. S. Bingham, J. Raabe, L. J. Heyderman, N. R. Cooper, S. Gliga, Nature Physics **17**, 316-321 (2021)

MA 10.2 Mon 15:30 H47

High-Resolution Magnetic Imaging of Surface Magnetic Textures in Synthetic Antiferromagnets Using SEMPA — •Mona Bhukta, Takaaki Dohi, M-A. Syskaki, Robert Frömter, and Mathias Kläui — Institut für Physik, Johannes Gutenberg-Universität Mainz, Staudingerweg 7, 55128 Mainz, Germany

Magnetic skyrmions[1] are twisted spin configurations, which shows a non-zero skyrmion Hall angle when driven by current due to their topological nature[2], which is detrimental for applications. Skyrmions in synthetic antiferromagnet(SAFs), could suppress this effect owing to an overall zero topological charge. Recent observations of skyrmions in SAFs have opened the possibility for using skyrmions as a candidate for logic operations, data storage devices[3]. Here, we investigate different, more exotic spin textures in a SAF consisting of (CoFeB/Ir/CoFeB)n by using scanning electron microscopy with polarization analysis (SEMPA). The unique feature of SEMPA is especially effective on a SAFs enabling us to investigate the topological spin textures even in a fully compensated composition. We report high-resolved vortex-antivortex pairs in the SAF that are stable at zero magnetic fields and room temperature. Micromagnetic simulations of the investigated SAF stacks have been carried out to understand the way stabilize for these exotic spin textures as well as to explore the possible emergence of three-dimensional (3D) spin structures in the SAF multilayer system. [1] K. Everschor-Sitte et al., J. Appl. Phys. 124, 240901 (2018) [2] K. Litzius et al., Nat. Phys. 13, 170 (2017). [3] T. Dohi et al, Nat. Commun. 10, 5153 (2019).

MA 10.3 Mon 15:45 H47

Effects of static magnetic fields in antiferromagnetic ring-shaped spin chains — •Yelyzaveta A. Borysenko[1,2,3], Denis D. Sheka[1], Jürgen Fassbender[2], Jeroen van den Brink[3], Denys Makarov[2], and Oleksandr V. Pylypovskyi[2,4] — [1]Taras Shevchenko National University of Kyiv, Kyiv, Ukraine — [2]Helmholtz-Zentrum Dresden-Rossendorf e.V., Dresden, Germany — [3]IFW Dresden, Dresden, Germany — [4]Kyiv Academic University, Kyiv, Ukraine

While antiferromagnets with the easy axis of anisotropy are considered to be robust against external magnetic fields of a moderate strength, strong-field-driven spin reorientations provide an insight into subtle properties of the material usually hidden by the high symmetry of the ground state. Here, we address theoretically the effects of curvature in the curvilinear antiferromagnetic achiral anisotropic ring-shaped spin chains in strong magnetic fields. We identify the geometry-driven helimagnetic phase transition above the spin-flop field between the vortex and onion states. The spin-flop transition is of the first- or second-order depending on the ring curvature, which is influenced by the geometry-induced Dzyaloshinskii–Moriya interaction. Inhomogeneity of the Néel vector distribution in spin-flop phase generates weakly ferromagnetic response, which lies in the plane perpendicular to the applied magnetic field. Our findings provide an understanding of complex responses of curvilinear antiferromagnets on magnetic fields and allow further experimental study of geometrical effects relying on spin-chain-based nanomagnets.

MA 10.4 Mon 16:00 H47

Screw dislocations in chiral magnets — •Maria Azhar[1], Volodymyr Kravchuk[1,2], and Markus Garst[1] — [1]Karlsruhe Institute of Technology, Germany — [2]Bogolyubov Institute for Theoretical Physics of National Academy of Sciences of Ukraine, Kyiv, Ukraine

The Dyzaloshinskii-Moriya interaction stabilizes helimagnetic order in cubic chiral magnets for a large range of temperatures and applied magnetic field. In this helimagnetic phase the magnetization varies only along the helix axis, that is aligned with the applied field, giving rise to a one-dimensional periodic magnetic texture. This texture shares many similarities with generic lamellar order like cholesteric liquid crystals, for example, it possesses disclination and dislocation defects [1]. Here, we investigate both analytically and numerically screw dislocations of helimagnetic order. Whereas the far-field of these defects is universal, we find that various core structures can be realized even for the same Burgers vector of the screw dislocation. In particular, we identify screw dislocations with smooth magnetic core structures, that close to the transition to the field-polarized phase continuously connect either to vortices of the XY-order parameter or to skyrmion strings. In addition, close to zero fields we find singular core structure comprising a chain of Bloch points with alternating topological charge [2].

[1] P. Schoenherr et al. Nature Physics 14, 465 (2018).
[2] M. Azhar, V. Kravchuk, and M. Garst, Physical Review Letters 128, 157204 (2022).

MA 10.5 Mon 16:15 H47

Chiral response of spin spiral states as the origin of chiral transport fingerprints of spin textures — •Jonathan Kipp[1,2], Fabian Lux[3], and Yuriy Mokrousov[2,3] — [1]Department of Physics, RWTH Aachen University, 52056 Aachen, Germany — [2]Peter Gr\"unberg Institut and Institute for Advanced Simulation, Forschungszentrum J\"ulich and JARA, 52425 J\"ulich, Germany — [3]Institute of Physics, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

To extend the commonly accepted yet simplifying and approximate picture of transport effects taking place in systems with spatially varying magnetization such as skyrmions, domain walls and multi-q states, it is important to understand the transport properties of the homochiral spin-spiral states, which are building blocks for these more advanced textures of different nature and dimensionality. In this work, by referring to phenomenological symmetry arguments based on gradient expansion and explicit calculations within the Kubo framework, we study transport properties of various types of spin-spirals in a two-dimensional model with strong spin-orbit interaction. Specifically, we focus on the contributions to the magnetoconductivity, planar Hall effect and anomalous Hall effect, which are sensitive to the sense of chirality of the spiral states. In particular, we analyze the emergence, symmetry, and microscopic properties of the resulting chiral magnetoconductivity, chiral planar Hall effect and chiral Hall effect in terms of spin-spiral propagation direction, cone angle, spiral pitch and disorder strength.

MA 10.6 Mon 16:30 H47

Single-crystal growth and low temperature properties of ErB_2 — •Christoph Resch[1], Andreas Bauer[1], Georg Benka[2], and Christian Pfleiderer[1] — [1]TU München Physik-Department, 85748 Garching, Germany — [2]Kiutra GmbH, 81369 München, Germany

Single crystals of the hexagonal rare-earth diboride ErB_2 were synthesized by means of the self-adjusted flux travelling solvent optical floating zone technique and metallurgically characterized. The magnetic phase diagram of single crystalline ErB_2 was inferred from measurements of the specific heat, the magnetisation, the ac susceptibility, and the electrical transport for fields applied along major crystallographic axes. We find behavior characteristic of an easy-plane antiferromagnet below $T_{\mathrm{N}} = 14$ K. For magnetic fields applied along the hard out-of-plane axis we observe a spin-flip transition at $B_{\mathrm{N}} = 12$ T. Most notably, the Hall resistivity below T_{N} for fields applied along the hard axis exhibits a large anomalous contribution that does not scale with the uniform magnetization. Possible origins include spin-chirality mechanisms and large Berry curvatures associated with a canted spin structure, or more exotic types of magnetic order.