MA 11: Non-Skyrmionic Magnetic Textures I

Time: Monday 15:00–16:45 Location: POT 6

MA 11.1 Mon 15:00 POT 6

Topological defects in a multiferroic antiferromagnet — •Aurore Finco[1], Angela Haykal[1], Stéphane Fusil[2], Pawan Kumar[1], Pauline Dufour[2], Anne Forget[3], Dorothée Colson[3], Jean-Yves Chauleau[3], Michel Viret[3], Nicolas Jaouen[4], Vincent Garcia[2], and Vincent Jacques[1] — [1]Laboratoire Charles Coulomb, Université de Montpellier, CNRS, Montpellier, France — [2]Unité Mixte de Physique, CNRS, Thales, Université Paris-Saclay, Palaiseau, France — [3]SPEC, CEA, CNRS, Université Paris-Saclay, Gif sur Yvette, France — [4]Synchrotron SOLEIL, Gif-sur-Yvette, France

We report on the formation of topological defects emerging from the cycloidal order at the surface of bulk $BiFeO_3$ crystals [1]. Combining reciprocal and real-space magnetic imaging techniques, we first observe, in a single ferroelectric domain, the coexistence of regions in which the antiferromagnetic cycloid propagates along different wave vectors. We then show that the direction of these wave vectors is not strictly locked to the preferred crystallographic axes but rather rotates continuously. At the junctions between the magnetic domains, we observe topological line defects identical to those found in a broad variety of lamellar physical systems with rotational symmetries. Our work establishes the presence of these magnetic objects at room temperature in the multiferroic antiferromagnet $BiFeO_3$, offering new opportunities in terms of robustness and electrical control towards their use in spintronic devices.

[1] Finco et al, *Phys. Rev. Lett.* 128, 187201 (2022)

MA 11.2 Mon 15:15 POT 6

Domain structures of stressed free-hanging magnetic thin films — Dhavalkumar Mungpara[1], •Alexander Schwarz[1], Federico Maspero[2], Riccardo Bertacco[2], Nicola Manca[3], Leonèlio Cichetto Jr.[3], and Luca Pellegrino[3] — [1]INF, University of Hamburg, Jungiusstr. 11, 20355 Hamburg — [2]CNR-IFN, Piazza Leonardo da Vinci 32, 20133 Milano, Italy — [3]CNR-SPIN Corso F. M. Perrone 24, 16152 Genova, Italy

This work has been conducted as part of the OXiNEMS project, which aims to realize a miniaturized all-oxide hybrid sensor able to detect magnetic fields in the fT-regime. Our envisaged design encompasses a superconducting pick-up loop with a constriction and a magnetically sensitive resonator placed directly above.

To achieve a high sensitivity, the resonator must have a high Q-value, which is accomplished by a large in-plane stress. To obtain magnetic sensitivity, the resonator itself can be magnetic, or a magnetic thin film element is grown on top of a non-magnetic resonator. Of course, the magnetic sensitivity of the whole device depends on the magnetic properties of the resonator. Therefore, we investigated the domain structure of two promising resonator candidates using magnetic force microscopy: 100 nm thick Co rectangles on non-magnetic silicon nitride trampoline resonators and 100 nm thick magnetic $La_{0.7}Sr_{0.3}MnO_3$ trampoline resonators.

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MA 11.3 Mon 15:30 POT 6

Stability and dynamics of SO(3) solitons in magnetically frustrated systems — •Ricardo Zarzuela — Institut für Physik, Johannes Gutenberg Universität Mainz, D-55099 Mainz, Germany

In recent years frustrated magnets have resurged in condensed matter due to their striking spin transport properties [1,2] and ability to host three-dimensional magnetic solitons, such as Shankar skyrmions [3] or Anderson-Toulouse vortices [4]. The latter emerge in the corresponding SO(3)-order parameter (describing the spin-spin correlation of the system), have potential use in topological computing and high-density memory storage, and coexist with those conventional magnetic solitons encoded in the total magnetization field (e.g., domain walls and baby skyrmions). We discuss the stability of these SO(3) solitons for several phenomenological models for a magnetically frustrated platform and, within a collective variable approach, we also explore their dynamics in the presence of spin-transfer torques and topological defects.

[1] N.L. Nair, E. Maniv, C. John, S. Doyle, J. Orenstein, and J.G. Analytis. Nat. Mater. 19, 153 (2020).
[2] R. Zarzuela and J. Sinova, arXiv:2112.06680 (2022).
[3] R. Shankar, J. Physique 38, 1405 (1977).
[4] P.W. Anderson and G. Toulouse, Phys. Rev. Lett. 38, 508 (1976).

15 min. break

MA 11.4 Mon 16:00 POT 6

Interaction of antiferromagnetic domain walls with crystal defects — •Oleksandr V. Pylypovskyi[1,2], Artem V. Tomilo[1], Natascha Hedrich[3], Kai Wagner[3], Brenan J. Shields[3], Tobias Kosub[1], René Hübner[1], Jürgen Fassbender[1], Denis D. Sheka[4], Patrick Maletinsky[3], and Denys Makarov[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf e.V., 01328 Dresden, Germany — [2]Kyiv Academic University, 03142 Kyiv, Ukraine — [3]University of Basel, Basel CH-4056, Switzerland — [4]Taras Shevchenko National University of Kyiv, 01601 Kyiv, Ukraine

Understanding behavior of magnetic texture in antiferromagnetic nanostructures and thin films is crucial for the design of novel magnetic data storage and logic devices. Here, we derive the boundary conditions for the Néel vector in a two-sublattice antiferromagnet (AFM) and apply them to describe the shape of the domain walls [1,2] and skyrmions [2] in confined samples. In general, the surface of a 3D domain wall behaves as an elastic ribbon which bends in response on the topographic features of the single crystal Cr_2O_3 [1]. In presence of the Dzyaloshinskii-Moriya interaction, topologically non-trivial AFM textures possess broadening near the surface. In thin films, the sample's granularity becomes crucial. We present a model of a granular AFM and, by comparison with Nitrogen Vacancy magnetometry of 200-nm-thick Cr_2O_3 films, estimate the inter-grain exchange strength. The grain boundaries act as strong pinning sites for the AFM texture. [1] N. Hedrich et al., Nat. Phys. 17, 574 (2021); [2] O. Pylypovskyi et al., Phys. Rev. B 103, 134413 (2021).

MA 11.5 Mon 16:15 POT 6

Evaluation of phase images obtained by electron holography for three-dimensional spin-textures — •Moritz Winterott[1,2] and Samir Lounis[1,2] — [1]Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich & JARA, D-52425 Jülich, Germany — [2]Faculty of Physics, University of Duisburg-Essen and CENIDE, 47053 Duisburg, Germany

Three-dimensional (3D) spin-textures, similarly to their 2D counterpart (skyrmions), are attracting widespread interest, especially because of their potential application as magnetic bits for energy-efficient storage devices. Thereby, a major challenge is their identification. Here we focus on electron holography, where phase images are reconstructed in order to recognize 3D spin-textures. The phase image consists of an electronic and a magnetic contribution, with the latter being assumed to emerge from the stray field, and thus should vanish for antiferromagnets, while the former is conjectured to be inert to the magnetic texture. Here we demonstrate that the electronic phase image carries non-trivial magnetic information induced by spin-mixing and spin-orbit mechanisms. We calculate and compare systematically the strength of both electronic and magnetic phase images employing the optimized forward model [1] and a tight-binding scheme combined with multiple-scattering theory. We explore the impact of spin-orbit interaction, exchange splitting and hopping.

[1] J. Caron, Model-Based Reconstruction of Magnetisation Distributions in Nanostructures from Electron Optical Phase Images, PhD thesis, RWTH Aachen Uni. (2017).

MA 11.6 Mon 16:30 POT 6

X-ray holographic imaging of magnetic surface spirals in FeGe lamellae — •Luke A. Turnbull[1], Matthew T. Littlehales[1], Murray N. Wilson[1], Max T. Birch[2], Horia Popescu[3], Nicolas Jaouen[3], Joel Verezhak[4], Geetha Balakrishnan[4], and Peter D. Hatton[1] — [1]Department of Physics, Durham University, Durham, DH1 3LE, UK — [2]Max Planck Institute for Intelligent Systems, 70569 Stuttgart, Germany — [3]Synchrotron SOLEIL, Saint Aubin, BP 48 91192 Gif-sur-Yvette, France — [4]Department of Physics, University of Warwick, Coventry, CV4 7AL, UK

Isotropic helimagnets are known to host a diverse range of chiral magnetic states. In 2016, F.N. Rybakov et al. theorized the presence of a surface-pinned stacked spin spiral phase [F.N. Rybakov et al., 2016 New J. Phys. 18 045002], which had yet to be observed experimentally. The phase is characterized by surface spiral periods exceeding the host material's fundamental winding period, L. In this talk we present experimental evidence for the observation of this state in lamellae of FeGe using resonant x-ray holographic imaging data and micromagnetic simulations. We find images of FeGe lamellae, exceeding a critical thickness of 300 nm (4.3L), exhibit contrast modulations with a field-dependent periodicity of x<1.4L, consistent with theoretical predictions of the stacked spiral state. The identification of this spiral state carries significant implications for the stability of other coexisting spin textures in chiral helimagnets, and indicates the utility in considering magnetic systems in three-dimensions.