MA 53: Skyrmions IV

Time: Friday 9:30–10:45 Location: EB 301

MA 53.1 Fri 9:30 EB 301

Putative formation of an antiferromagnetic Skyrmion lattice in J_2-frustrated spinel compounds $MnSc_2X_4$ (X=S, Se) — •Justus Grumbach[1], Mahmoud Deeb[1], Andreas Hauspurg[1,2], Sergey Granovsky[1], Sergei Zherlitsin[2], and Mathias Doerr[1] — [1]Institut für Festkörper- und Materialphysik, Technische Universität Dresden, 01069 Dresden, Germany — [2]Hochfeld-Magnetlabor Dresden (HLD), Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany

Spinels are a superposition of a pyrochlor and a diamond substructure. In the case of $MnSc_2X_4$ the magnetic Mn^{3+}-ions form the diamond substructure with a dominant second nearest neighbour-exchange (J_2>J_1), which leeds to magnetic frustration. New magnetic phase diagrams could be deduced by magnetoelastic measurements for both compounds. For $MnSc_2S_4$ in H||[111] an antiferromagnetic skyrmion-lattice could be found in a broad region between 5T and 8T, up to 2K, confirming former INS-measurements and simulations. Furthermore, the skyrmionic phase could be reproduced by a new simulation based on thermodynamics, connected to the experiments. Otherwise, measurements of $MnSc_2Se_4$ as well as the resulting phase diagram clearly show no hints for a skyrmionic phase.

A comparison of dilatometry measurements and resulting phase diagrams with special consideration of the skyrmion-lattice will be the main message of the talk.

MA 53.2 Fri 9:45 EB 301

Skyrmion Ordering in Geometric Confinements — •Raphael Gruber, Jan Rothörl, Simon Fröhlich, Fabian Kammerbauer, Elizabeth Martín Jefremovas, Peter Virnau, and Mathias Kläui — Institut für Physik, Johannes-Gutenberg Universität Mainz, 55099 Mainz, Germany

Magnetic skyrmions are chiral, quasi-particle spin textures that are considered as promising candidates for data storage, logic and non-conventional computing devices [1]. Furthermore, dense arrangements of skyrmions in thin films allow us to observe 2D phase behavior [2], which significantly differs from 3D systems. In confined geometries, we identify how the patterned structures significantly impact the ordering behavior of the skyrmions. We analyze the characteristic lattice behavior in our system and show how random diffusion and the pinning landscape [3] contribute to the features and capabilities of our system in the context of phase observations and the design of nanodevices.

[1] Zázvorka et al., Nat. Nanotechnol. 14, 658-661 (2019) [2] Zázvorka et al., Adv. Funct. Mater. 30, 2004037 (2020). [3] Gruber et al., Nat. Commun. 13, 3144 (2022).

MA 53.3 Fri 10:00 EB 301

Helical to conical order in M1/3 NbS2 (M=Cr, Mn), detected by Cr, Mn NMR — •Manaswini Sahoo[1,2], Pietro Bonafa[2], Amelia Hall[3], Daniel Mayoh[3], Laura Corredor[1], Bernd Buechner[1], Geetha Balakrishnan[3], Roberto De Renzi[2], and Giuseppe Allodi[2] — [1]Leibniz IFW Dresden,Germany — [2]University of Parma,Italy — [3]Department of Physics, University of Warwick, United Kingdom

Recently, the materials Cr1/3NbS2 have piqued the interest of researchers as rare examples of 2D materials with helical magnetic ordering, thought to occur due to competition between exchange and DMI. When a magnetic field is applied perpendicular to the c-axis, the helical ground state transforms into the chiral soliton lattice (CSL). A chiral conical phase (CCP) emerges when the magnetic field is applied along the c-axis. Both phases are well established in Cr3/NbS2. However, the other member of the family, Mn1/3NbS2 has a similar crystal structure but complex magnetic behavior. Cr single-crystal NMR measurements demonstrate the first-order nature of the helical-to-paramagnetic phase transition and determine the exact boundaries of the conical phase. Similarities with Mn single crystal NMR results are discussed.

MA 53.4 Fri 10:15 EB 301

Current induced nucleation of spin textures in aperiodic multilayers — Riccardo Battistelli[1,2], Kai Litzius[2], Matthieu Grelier[3], •Krishnanjana Puzhekadavil Joy[1,2], Michael Schneider[4], Christian M Günther[5], Kathinka Gerlinger[4], Christopher Klose[4], Daniel Metternich[1,2], Lisa Marie Kern[4], Manas Ranjan Patra[1,2], Tamer Karaman[1,2], Josefin Fuchs[4], Sascha Petz[1], Stefan Eisebitt[4,5], Bastian Pfau[4], Nicolas Reyren[3,6], Vincent Cros[3], and Felix Büttner[1,2] — [1]Helmholtz Zentrum Berlin, Germany — [2]University of Augsburg, Germany — [3]Unité Mixte de Physique, CNRS-Thales, Palaiseau, France. — [4]Max Born Institute,Berlin,Germany — [5]Technische Universität Berlin, Germany — [6]SOLEIL Synchrotron, Gif-sur-Yvette Cedex, France

Magnetic cocoons are ellipsoid-shaped 3D structures, that have been recently observed in aperiodic multilayers where magnetic interactions are varied along the thickness. Here we report the feasibility of the production of these cocoons using nanosecond current pulses in Pt/Co/Al aperiodic multilayer system. The images obtained using Scanning Transmission X-ray Microscopy also show other complex spin textures when stronger pulses are applied. Simulations show that these current pulses heat up the system. It also creates an Oersted field in addition to the applied magnetic field.The magnetic field-temperature phase diagram can be thus obtained from such images. The measurements lead to the conclusion that the magnetic field and temperature aid the system to a fluctuation state where the cocoons are nucleated.

MA 53.5 Fri 10:30 EB 301

Topological spin textures in nominally centrosymmetric van der Waals magnet — •Rana Saha, Holger Meyerheim, and Stuart Parkin — Max Planck Institute of Microstructure Physics, Halle (Saale), Germany

Current spintronics research explores magnetic materials with adjacent non-collinear magnetic moments, giving rise to intricate topological spin textures, notably skyrmions. These nano-objects feature chiral magnetic boundaries and circular shapes, traditionally requiring non-centrosymmetric crystal structures and Dzyaloshinskii-Moriya exchange interactions for their formation. Recently skyrmions have been observed in several centrosymmetric materials [1]. Here we show evidence for skyrmions in CrTe2, a member of the van der Waals (vdW) materials family, which is nominally centrosymmetric. The presence of Cr self-intercalation into vdW gaps, coupled with the development of a three-dimensional long-range ordered superstructure, alters the space group symmetry from centrosymmetric to the acentric. This transformation results from the uneven occupancy of Cr atoms in the two vdW gaps per unit cell, creating an asymmetric environment. Notably, Néel-type skyrmions are directly observed using in-situ Lorentz transmission electron microscopy across a broad temperature range and magnetic fields [2]. This study highlights that self-intercalation in vdW materials offers a novel avenue for generating synthetic skyrmions.

References [1] A. Chakraborty, et al., Adv. Mater. 34 (2022) 2108637. [2] R. Saha, et al., Nat. Commun. 13 (2022) 3965.