MA 46: Magnetic Imaging Techniques II

Time: Thursday 9:30–10:45 Location: POT/0361

MA 46.1 Thu 9:30 POT/0361

Spin-Disorder-Induced Angular Anisotropy in Polarized Magnetic Neutron Scattering — Ivan Titov, •Venus Rai, and Andreas Michels — Department of Physics and Materials Science, University of Luxembourg, 162A Avenue de la Faiencerie, 1511 Luxembourg

We experimentally report a hitherto unseen angular anisotropy in the polarized small-angle neutron scattering (SANS) cross section of a magnetically strongly inhomogeneous material [1]. Based on an analytical prediction using micromagnetic theory, the difference between the spin-up and spin-down SANS cross sections is expected to show a spin-disorder-induced anisotropy. The effect is particularly pronounced in inhomogeneous magnetic materials, such as nanoporous ferromagnets, magnetic nanocomposites, or steels, which exhibit large nanoscale jumps in the saturation magnetization at internal pore-matrix or particle-matrix interfaces. Analysis of the experimental neutron data constitutes a method for determining the exchange-stiffness constant. Our results for the nuclear-magnetic interference terms contained in the polarized magnetic neutron scattering cross section might also be of relevance to other neutron techniques.

[1] I. Titov, M. Bersweiler, M. P. Adams, E. P. Sinaga, V. Rai, Š. Liščák, M. Lahr, T. L. Schmidt, V. M. Kuchkin, A. Haller, K. Suzuki, N.-J. Steinke, D. A. Venero, D. Honecker, J. Kohlbrecher, L. F. Barquín, and A. Michels, Phys. Rev. Lett. **135**, 196706 (2025)

MA 46.2 Thu 9:45 POT/0361

Beam focusing with nested mirror optics(NMO) at RESEDA — •Florian Schönleitner[1,2], Denis Mettus[2], Johanna Jochum[2], and Christian Pfleiderer[1,2] — [1]Physik-Department, Technische Universität München, Germany — [2]Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München, Garching, Germany

The RESEDA(REsonance Spin Echo for Diverse Applications) instrument is a spectrometer that can use the MIEZE(Modulated IntEnsity with Zero Effort) method, a variant of neutron spin echo(NSE) that uses radio frequency(RF) spin flippers instead of static magnetic fields and that can measure samples that depolarise the beam. As a next step for improving the experimental setup it was proposed that nested mirror optics should be integrated to focus the beam at varios components of the instrument. Focusing the beam at the sample might allow measurements of samples with smaller sizes, such as samples in a diamond anvil cell. It also might allow for measurements at higher scattering angles, as it could reduce phase aberrations for the MIEZE method. Focusing the beam at the RF-flippers allows to build smaller AC-coils, leading to higher accessible frequencies, and consequently might lead to a better energy resolution of the spectrometer. In order to create an efficient setup that does not introduce additional artifacts, careful consideration of all effects caused by inserting NMO is necessary. Here we will present preliminary results of the simulations of NMO integration and discuss their potential.

MA 46.3 Thu 10:00 POT/0361

Towards Halbach spheres - Icosahedral symmetry is not just cool anymore — •Ingo Rehberg[1] and Peter Blümler[2] — [1]Experimental Physics, University of Bayreuth, Germany — [2]Institute of Physics, University of Mainz, Germany

Halbach spheres [e.g.1] are an ideal theoretical solution for generating homogeneous magnetic fields. Experimentally, a continuous magnetisation profile is difficult to realise, and the inaccessibility of the sphere's interior favours the use of Halbach rings [2,3]. An alternative is to arrange discrete magnets on the surface of a sphere. Regular polyhedra with a high degree of symmetry are well suited to approximate spherical Halbach configurations [3,4]. Icosahedral symmetry is especially effective at producing uniform magnetic fields (4th order saddle points).

[1] Peter Blümler and Helmut Soltner, Practical Concepts for Design, Construction and Application of Halbach Magnets in Magnetic Resonance. Appl. Magn. Reson. 54, 1701 (2023).

[2] Ingo Rehberg and Peter Blümler, Analytic approach to creating homogeneous fields with finite-size magnets, Phys. Rev. Appl. 23, 064029 (2025).

[3] Ingo Rehberg and Peter Blümler, Halbach two point oh: Optimize uniform fields with clusters and rings of permanent magnets. https://doi.org/10.5281/zenodo. 15006677 (2025).

[4] Ingo Rehberg, Dipole Cluster Inspector - A Duty-Free Python GUI for Exploring 569 Magnetic Configurations. https://doi.org/10.5281/zenodo. 10084573 (2025).

MA 46.4 Thu 10:15 POT/0361

Shaken, not stirred: Using vibrations for sub-10nm resolution scanning X-ray microscopy imaging — •Simone Finizio, Benjamin Watts, Benedikt Rösner, and Jörg Raabe — Paul Scherrer Institut, Villigen PSI, Switzerland

In order to fully exploit the significantly higher coherent photon flux offered by the novel diffraction-limited light sources for high-resolution imaging, scanning microscopy techniques need to tackle imaging overheads and the unavoidable vibrations at the nanometric scales, both hindering the achievement of sub-10nm resolutions in routine conditions.

In most scanning microscopy endstations, significant effort and expense is dedicated to fight these unavoidable vibrations. In this work, we propose to stop fighting vibrations, and instead harness their potential to provide a uniform sampling at the nanoscale. This is achieved by relaxing the positioning precision requirements and sampling the position of the sample with a fast (10 kHz) clock, significantly above the mechanical eigenfrequencies of the sample assembly. An image is then created by binning the recorded positions and photon counts according to a user-defined pixel size. With this method, the routine imaging of sub-10nm features could be demonstrated.

MA 46.5 Thu 10:30 POT/0361

Magnetic interactions and magnetic field distributions in van der Waals heterostructures with Fe_3GeTe_2 — •Joachim Dahl Thomsen[1], Qianqian Lan[1], Eva Duft[1], Zdeněk Sofer[2], Nikolai Kiselev[3], and Rafal Dunin-Borkowski[1] — [1]Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons, Forschungszentrum Jülich, Jülich, Germany — [2]Department of Inorganic Chemistry, University of Chemistry and Technology Prague, Prague, Czech Republic — [3]Peter Grünberg Institute and Institute for Advanced Simulations, Forschungszentrum Jülich, Jülich, Germany

Magnetic van der Waals (vdW) materials are promising for memory and logic applications because their properties are highly tunable and they integrate readily into heterostructures that exploit proximity and interlayer effects. However, depth-resolved imaging of interlayer coupling is challenging in plan-view, where contrast is integrated through the sample. Here we use cross-sectional Fe_3GeTe_2 (FGT)/graphite/FGT heterostructures to probe coupling between vertically stacked FGT layers across separations of 0-110 nm. We use Lorentz TEM and off-axis electron holography to visualize the domain structure and map the magnetic field inside and outside the vdW heterostructures, resolving how the interaction evolves with spacer (graphite) thickness. We find that domain alignment between FGT flakes is set by their separation, and that a weak interaction persists even at a separation of 110 nm. These measurements provide design guidance for vdW heterostructure devices that rely on controlled interlayer interactions between magnetic textures.