MA 15: INNOMAG e.V. Prizes 2023 (Diplom-/Master and Ph.D. Thesis)

Die Arbeitsgemeinschaft Magnetismus der DPG hat einen Dissertationspreis und einen Diplom-/Masterpreis ausgeschrieben, welche auf der Tagung der DPG 2023 in Dresden vergeben werden. Ziel der Preise ist die Anerkennung herausragender Forschung im Rahmen einer Diplom-/Masterarbeit beziehungsweise einer Promotion und deren exzellente Vermittlung in Wort und Schrift. Im Rahmen dieser Sitzung tragen die besten der für ihre an einer deutschen Hochschule durchgeführten Diplom-/Masterarbeit beziehungsweise Dissertation Nominierten vor. Im direkten Anschluss entscheidet das Preiskommittee über den Gewinner des INNOMAG e.V. Diplom/Master-Preises und des Dissertationspreises 2023. Talks will be given in English!

Time: Tuesday 9:30–11:50 Location: HSZ 401

MA 15.1 Tue 9:30 HSZ 401

Cubic magneto-optic Kerr effect in Ni(111) thin films — •Maik Gaerner[1], Robin Silber[2], Tobias Peters[1], Jaroslav Hamrle[3], and Timo Kuschel[1] — [1]Bielefeld University, Germany — [2]IT4Innovations, VŠB - Technical University of Ostrava — [3]Charles University, Prague, Czech Republic

In most studies utilizing the magneto-optic Kerr effect (MOKE), the detected change of polarized light upon reflection from a magnetized sample is supposed to be proportional to the magnetization $\boldsymbol{M}$. However, MOKE signatures quadratic in $\boldsymbol{M}$ have also been identified and utilized, e.g., to sense the structural order in Heusler compounds, to detect spin-orbit torque or to image antiferromagnetic domains.

In our study, we observe a strong anisotropic MOKE contribution of third order in $\boldsymbol{M}$ in Ni(111) thin films, attributed to a cubic magneto-optic tensor $\propto \boldsymbol{M}^3$ [1]. This cubic MOKE (CMOKE) is responsible for a threefold in-plane angular dependence of the magnetically saturated longitudinal MOKE response. We further show that this angular dependence is affected by the amount of structural domain twinning in the sample. The degree of twinning is determined by off-specular X-ray diffraction. Finally, the dependence of the anisotropic CMOKE on the external magnetic field strength is investigated up to nearly 2 T. Our detailed study on CMOKE for two selected photon energies will open up new opportunities for CMOKE applications with sensitivity to twinning properties of thin films, e.g. CMOKE spectroscopy and microscopy or time-resolved CMOKE.

[1] M. Gaerner et al., arXiv: 2205.08298

MA 15.2 Tue 9:50 HSZ 401

Switching of Sublattice Magnetization in Quantum Antiferromagnets Described by Schwinger Bosons — •Katrin Bolsmann — Technische Universität Dortmund

Harvesting magnetic excitations in antiferromagnets for information processing is a promising and fast-growing field in the research of magnetism. One of the main foci is the readout and manipulation of the Néel vector of antiferromagnetic (AFM) materials. We study a theoretical approach to describe the non-equilibrium switching of a two-dimensional AFM magnetization on a square lattice. We recall the use of Schwinger bosons in equilibrium to describe the elementary excitations, of the isotropic and anisotropic AFM square lattice, in mean-field approximation. The Bose-Einstein condensation of Schwinger bosons describes the long-range magnetic order. Then, the Schwinger boson mean-field theory is applied to investigate the switching of the sublattice magnetization on the AFM square lattice via an external magnetic field. In the anisotropic system, there is an increase in energy after switching, which depends on the degree of anisotropy. Furthermore, we find a threshold field, below which switching is no longer possible, and investigate its dependence on the anisotropy. Even for low anisotropy, the threshold for the magnetic field turns out to be too large for standard technical applications. Finally, we discuss possible modifications of the protocol to enable switching of the sublattice magnetization with smaller fields.

MA 15.3 Tue 10:10 HSZ 401

Magnetooptical Investigation of nonreciprocal Phonon-Magnon Interaction — •Yannik Kunz[1], Michael Schneider[1], Moritz Geilen[1], Matthias Küss[2], Manfred Albrecht[2], Philipp Pirro[1], and Mathias Weiler[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, Rheinland-Pfälzische Technische Universität Kaiserslautern-Landau, 67663 Kaiserslautern, Germany — [2]Institut für Physik, Universität Augsburg

The coupling of surface acoustic waves (SAWs) with spin waves (SWs) intrinsically breaks the time-inversion symmetry. The resulting nonreciprocity can be exploited for applications such as miniaturized microwave isolators. SAWs can be efficiently excited and detected by interdigital transducers. Therefore, in experiments the magnetic field dependent transmission induced by the coupling with SWs is commonly detected via electrical methods [1]. However, for the investigation of magnetoelastic interactions with spatial resolution, magnetooptical measurement methods are needed. We employed microfocused Brillouin light scattering spectroscopy and frequency-resolved magneto-optical Kerr effect spectroscopy [2] to map the spatial dependence of the phonon-magnon-coupling on a $LiNbO_3/Co_{40}Fe_{40}B_{20}$(10 nm)/SiN(5 nm)-structure. Our experiments provide direct evidence for coherent and nonreciprocal conversion of phonons to magnons along the SAW propagation path.

We acknowledge the funding by DFG via project No. 492421737.

[1] M. Küß et al., Phys. Rev. Lett. 125, 217203 (2020).
[2] L. Liensberger et al, IEEE Magnetics Letters 10, 5503905 (2019).

MA 15.4 Tue 10:30 HSZ 401

The Turn of the Screw and the Slide of the Skyrmion — •Nina del Ser — Institute for Theoretical Physics, University of Cologne

We explore the non-equilibirum dynamics of chiral magnets driven by oscillating magnetic fields in the GHz regime. Universal activation of the magnets' translational and rotational Goldstone modes invites many exciting applications. Magnetic screws will turn, skyrmions will swim and skyrmion lattices will rotate. The magnetic Archimedean screw opens the door to new transport applications on the nano-scale, and is shown to be a very efficient electron pump even in the presence of disorder. At stronger driving, Floquet spin wave instabilities provoke the formation of a time quasicrystal, where the magnetisation oscillates at new incommensurate spatial and temporal frequencies. We also investigate the role of fractional charge topological charge in magnets. We show that such charges turn up for example in cubic magnets and in the fragments of exploding skyrmions or trapped between symmetry-broken domain walls. We show how their remarkable scattering properties can be used to build a magnon-powered fractional defect engine.

MA 15.5 Tue 10:55 HSZ 401

Imaging vortex pinning and gyration by time-resolved and in-situ Lorentz microscopy — •Marcel Möller — Max Planck Institute for Multidisciplinary Sciences, Göttingen, Germany — 4th Physical Institute - University of Göttingen, Göttingen, Germany

Nanoscopic magnetic textures, including vortices, merons and skyrmions promise future applications three-dimensional memory, logic gates or neuromorphic computing. Studying the control of such textures employing electric, magnetic or optical fields, demands instruments with sufficient spatial and temporal resolution. Ultrafast transmission electron microscopy allows for the study of optically-driven dynamics in materials. Yet, its potential to probe current- or field-driven dynamics of magnetic textures has remained unexplored.

In this work, ultrafast Lorentz imaging is developed to map the time-resolved gyration of vortices in a magnetic nanostructure driven by radio-frequency currents. The tracking of the vortex core with a localization precision of ± 2 nm and a temporal resolution below 3 ps is demonstrated [1]. Moreover, we find a transient change in the frequency and damping of the core orbit, attributed to structural disorder in the sample. Combining time-resolved Lorentz microscopy with bright-field imaging is used to identify the origin of this disorder, indicating grain boundaries in the polycrystalline film to be a major source of pinning [2].

[1] M. Möller *et al.*, Commun Phys 3, 36 (2020).

[2] M. Möller *et al.*, Phys. Rev. Research 4, 013027 (2022).

30 min. discussion break and bestowal of INNOMAG e.V. Diplom-/Master Prize and Ph.D. Thesis Prize