MA 59: Posters Magnetism III

Time: Friday 9:00–12:00 Location: P2/EG

MA 59.1 Fri 9:00 P2/EG

Chiral Magnetic Texture and Spin Dynamics in Magnetic Superlattices — •Luis Flacke[1,2], Valentin Ahrens[3], Simon Mendisch[3], Markus Becherer[3], Lukas Liensberger[1,2], Matthias Althammer[1,2], Hans Huebl[1,2,4], Stephan Geprägs[1], Rudolf Gross[1,2,4], and Mathias Weiler[1,2] — [1]Walther-Meißner Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Physics Department, Technical University of Munich, Garching, Germany — [3]Chair of Nanoelectronics, Technical University of Munich, Munich, Germany — [4]Munich Center for Quantum Science and Technology (MCQST), Munich, Germany

Chiral magnetic textures with topological protection, so called magnetic skyrmions, are attractive for spin-based data storage and processing applications. For such applications, thin-film, all-metallic magnetic heterostructures with chiral magnetic texture stabilized by interfacial Dzyaloshinskii-Moriya interaction are ideally suited. Here, we investigate static and dynamic properties of magnetic superlattices based on the low-damping and high saturation magnetization binary alloy $Co_{25}Fe_{75}$ (CoFe). We confirm the formation of skyrmions in [Pt/CoFe/Ir] superlattices and investigate their and associated GHz-frequency resonance using magnetic force microscopy and broadband magnetic resonance spectroscopy.

We acknowledge financial support by the DFG via project WE5386/5-1.

MA 59.2 Fri 9:00 P2/EG

First-principles study of magnetic interactions in Rh/Co/Fe/Ir multilayers — •Felix Nickel, Sebastian Meyer, and Stefan Heinze — Institute of Theoretical Physics and Astrophysics, University of Kiel

Magnetic skyrmions are promising for the usage in data storage and logic devices. Materials, which can host small diameter skyrmions in zero magnetic field at room temperature, are suitable for such applications. Recently, it has been shown that ultrathin Rh/Co films on Ir(111) exhibit skyrmions with diameters below 10 nm at zero magnetic field [1]. On the other hand, room temperature skyrmions with diameters of 30 nm - 90 nm have been found in magnetic multilayers [2]. An antiferromagnetic coupling between magnetic layers further leads to the stabilisation and fast movement of complex spin structures [3]. Here, we study if properties, such as strong exchange frustration of ultrathin Co films as in Ref. [1] can be transferred to multilayers and how interlayer interactions can be modified. Different transition-metal multilayers consisting of Co, Fe, Ir and Rh layers have been investigated using density functional theory to examine how intra- and interlayer exchange, Dzyaloshinskii-Moriya interaction, and magnetocrystalline anisotropy can be tuned.

[1] Meyer *et al.*, Nat. Commun. **10**, 3823 (2019)
[2] Moreau-Luchaire *et al.*, Nat. Nanotechnol. **11**, 444 (2016)
[3] Parkin *et al.*, Nat. Nanotechnol. **10**, 221 (2015)

MA 59.3 Fri 9:00 P2/EG

Stability of the skyrmion lattice in Fe1-xCoxSi — •Carolina Burger[1], Andreas Bauer[1], Alfonso Chacon[1], Marco Halder[1], Jonas Kindervater[1], Sebastian Mühlbauer[2], André Heinemann[2], and Christian Pfleiderer[1] — [1]Physik-Department, Technische Universität München, D-85748 Garching, Germany — [2]Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München, D-85748 Garching, Germany

We report on the magnetization and susceptibility of single-crystal Fe1-xCoxSi, x = 0.5, complemented by small-angle neutron scattering. In small magnetic fields, this compound hosts a hexagonal lattice of topologically non-trivial skyrmions, that may metastably persist down to lowest temperatures when field-cooled. We show that signatures characteristic of the skyrmion lattice survive field values up to the field-polarized regime as well as field inversion. This stability highlights the topological protection of skyrmions allowing to exploit their unique properties, even when being present only in metastable form.

MA 59.4 Fri 9:00 P2/EG

Atomistic spindynamic simulations on the stability of bilayer skyrmions. — •Hendrik Schrautzer[1], Stephan v. Malottki[1], Pavel F. Bessarab[2,3], and Stefan Heinze[1] — [1]Institute of Theoretical Physics and Astrophysics, University of Kiel — [2]University of Iceland, Reykjavík, Iceland — [3]ITMO University, St. Petersburg, Russia

Future room temperature skyrmionic applications require improved skyrmion stability. Recent experiments showed the possibility of stabilizing skyrmions in multilayered structures which was partly attributed to an increased amount of magnetic material [1]. Besides experimental approaches, a detail understanding of the role of interlayer exchange coupling on skyrmion stability is missing, while it is crucial for the development of skyrmion based racetracks in synthetic antiferromagnets [2]. Here we study the effect of different stackings and various coupling strengths of bilayers on the skyrmion stability using an atomistic spin model parametrized from first-principles, minimum energy path calculations and transition state theory. We investigate the multilayer system $(Rh/Pd/2Fe/2Ir)_n$ concerning skyrmion stability properties with *ab initio*-parameters [3]. For comparison we analyse exemplary stacks of the well investigated Pd/Fe/Ir system [4] for various interlayer coupling strengths and two types of stackings.

[1] Moreau-Luchaire *et al.*, Nat. Nano. **11**, 444-448 (2016)
[2] Zhang *et al.*, Phys. Rev. B **94**, 064406 (2016)
[3] Dupé *et al.*, Nat. Comm. **7**, 11779 (2016)
[4] von Malottki *et al.*, Sci. Rep. **7**, 12299 (2017)

MA 59.5 Fri 9:00 P2/EG

Lifetimes of skyrmionic states with manifold topologies in highly frustrated systems — •Moritz A. Goerzen[1], Stephan v. Malottki[1], Pavel F. Bessarab[2,3], Sebastian Meyer[1], and Stefan Heinze[1] — [1]Institute of Theoretical Physics and Astrophysics, University of Kiel, Germany — [2]University of Iceland, Reykjavík, Iceland — [3]ITMO University, St. Petersburg, Russia

A recent study [1] on a Rh/Co bilayer on Ir(111) shows an interesting energy landscape for noncollinear magnetic states due to a high degree of exchange frustration. In order to determine the suitability of the system for future spintronic technologies, we investigate the lifetimes of skyrmionic states with various topological charges. Based on an atomistic spin model parameterized from density functional theory, we perform spin dynamic simulations using the geodesic nudged elastic band method as well as transition state theory in harmonic approximation [2,3]. In determining the lifetimes of states, special care is taken for the treatment of Goldstone modes.

[1] Meyer, Perini *et al.*, Nature Comm. **10**, 3823 (2019)
[2] Bessarab *et al.*, Sci. Rep. **8**, 3433 (2018)
[3] von Malottki *et al.*, Phys. Rev. B **99**, 060409 (2019)

MA 59.6 Fri 9:00 P2/EG

Observation of compact ferrimagnetic skyrmions in $DyCo_3$ film — •Kai Chen[1], Dieter Lott[2], Andre Philippi-Kobs[3], Markus Weigand[1,4], Chen Luo[1], and Florin Radu[1] — [1]Helmholtz-Zentrum Berlin für Materialien und Energie, Albert-Einstein-Str.15, 12489 Berlin, Germany — [2]Institute for Materials Research, Helmholtz-Zentrum Geesthacht, 21502 Geesthacht, Germany — [3]Deutsches Elektronen-Synchrotron (DESY), Notkestraße 85, 22607 Hamburg, Germany — [4]Max-Planck-Institut für Intelligente Systeme, 70569 Stuttgart, Germany

Owing to the experimental discovery of magnetic skyrmions stabilized by the Dzyaloshinskii-Moriya interaction in chiral magnets and/or dipolar interactions in thin films, there is a recent upsurge of interest in magnetic skyrmions with antiferromagnetic spin ordering which exhibit non-trivial topological spin configurations. Here, we report the observation of compact ferrimagnetic skyrmions in $DyCo_3$ single layer, combining x-ray magnetic scattering, scanning transmission x-ray microscopy and Hall transport techniques. These skyrmions, with an antiparallel aligned Dy and Co magnetic moments and with a characteristic lateral sizes of about ∼40 nm are formed during the nucleation and the annihilation of the magnetic maze-like domains with an obvious topological Hall effect character. Our findings provide a promising route for fundamental research in the field of antiferromagnetic spintronics towards practical applications.

MA 59.7 Fri 9:00 P2/EG

Production of Magnetic Textures in Different Dimensions — •Ross J. Knapman[1], Davi R. Rodrigues[1], Venkata Krishna

Bharadwaj[1], Jairo Sinova[1,2], and Karin Evershor-Sitte[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, Mainz, Germany — [2]Institute of Physics, Academy of Sciences of the Czech Republic, Prague, Czech Republic

Current-induced forces can be exploited to create magnetic textures. In a 1D wire, this mechanism allows for the periodic production of domain walls [1-3] and in 2D it allows for the shedding of skyrmion-antiskyrmion pairs [4-6]. In 1D, it is possible to obtain an analytical solution to the problem which agrees well with micromagnetic simulations. In 2D there are more degrees of freedom. Within numerical simulations, we found that the degree of elasticity in the shedding process results in a change in the periodicity of the shedding, going beyond the previous results. We are constructing a model to capture this effect. Furthermore, we aim to extend our work to the investigation of the shedding of 3D magnetic textures from localised impurities. For this, we will investigate quantitative aspects such as the dependence of critical current and shedding frequency on the nature of the impurity, as well as qualitative aspects such as the nature of the objects shed.

[1] J. Shibata, et. al., PRL 94, 076601 (2005) [2] M. Sitte et. al., Phys. Rev. B 94, 064422 (2016) [3] T. P. Dao et. al., Nano Lett. 19, 5930-5937 (2019) [4] K. Everschor-Sitte, et. al., New J. Phys. 19, 092001 (2017) [5] M. Stier, et. al., PRL 118, 267203 (2017) [6] F. Büttner et. al., Nat. Nanotech. 12, 1040-1044 (2017)

MA 59.8 Fri 9:00 P2/EG

Measurement of magneto-crystalline anisotropies in MnSi by means of torque magnetometry — •Michelle Hollricher, Schorsch Sauther, Vivek Kumar, Andreas Bauer, Marc Wilde, and Christian Pfleiderer — Physik Department, Technische Universität München, D-85748 Garching, Germany

The first observation of a skyrmion lattice was reported a decade ago, in the magnet MnSi [1], stabilized by thermal fluctuations. Recently an independent second skyrmion phase was discovered in a different magnet, Cu_2OSeO_3 [2]. This second novel state can only be observed for fields applied along the <100> axes, highlighting the importance of magneto-crystalline anisotropies. So far, however, further information on the quantitative strength of magnetic anisotropies is scarce [3,4]. We report a comprehensive study of the cubic chiral magnet MnSi using torque magnetometry. We discuss our results in terms of a Ginzburg-Landau description and give an outlook on future studies on related systems.

[1] S. Mühlbauer *et al.*, Science **323**, 915-919 (2009)
[2] A. Chacon *et al.*, Nature Phys. **14**, 936-941 (2018)
[3] A. Bauer *et al.*, Phys. Rev. B **95**, 024429 (2017)
[4] T. Adams *et al.*, Phys. Rev. Lett. **121**, 187205 (2018)

MA 59.9 Fri 9:00 P2/EG

Direct Imaging of Chiral Spin Texture Distortion in Antiferromagnetic/Ferromagnetic Nanodisk structure — •Sri Sai Phani Kanth Arekapudi[1], Benny Böhm[1], Lakshmi Ramasubramanian[3], Fabian Ganss[1], Peter Heinig[1], Ciarán Fowley[3], Kilian Lenz[3], Jürgen Lindner[3], Alina M Deac[3], Manfred Albrecht[2], and Olav Hellwig[1,3] — [1]Institute of Physics, Technische Universität Chemnitz, 09107 Chemnitz, Germany — [2]Institute of Physics, University of Augsburg, Universitätsstraße 1,86159 Augsburg, Germany — [3]Institute for Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstrasse 400, 01328 Dresden, Germany

Chiral magnetic spin textures such as Skyrmions in Ferromagnetic (FM)/Antiferromagnetic (AFM) systems are actively explored for future data storage and signal processing devices [1]. We use an archetype NiFe disk structure which is known to stabilize a half-skyrmionic texture (magnetic vortex state). Due to the topological nature, magnetic vortex core reversal is mediated by the creation and subsequent annihilation of Bloch point singularities. Using high-resolution magnetic force microscopy, we show that the interfacial interactions between the chiral spin structure of the FM and AFM can cause significant distortion of the FM spin structure. These interfacial interactions are further harassed to stabilize phase transformations in chiral nanoscopic spin systems. Experimental observations are further supported by topological arguments and micromagnetic modeling. [1] Albisetti. et al. Commun Phys 1, 56 (2018).

MA 59.10 Fri 9:00 P2/EG

Direct Imaging of the Chiral Spin Texture Distortion in Antiferromagnetic/Ferromagnetic Nanodisk Structures — •Sri Sai Phani Kanth Arekapudi[1], Benny Böhm[1], Lakshmi Ramasubramanian[3], Fabian Ganss[1], Peter Heinig[1], Ciarán Fowley[3], Kilian Lenz[3], Jürgen Lindner[3], Alina M Deac[3], Manfred Albrecht[2], and Olav Hellwig[1,3] — [1]Institute of Physics, Technische Universität Chemnitz, 09107 Chemnitz, Germany — [2]Institute of Physics, University of Augsburg, Universitätsstraße 1,86159 Augsburg, Germany — [3]Institute for Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstrasse 400, 01328 Dresden, Germany

Chiral magnetic spin textures, such as skyrmions in ferromagnetic (FM)/antiferromagnetic (AFM) systems are actively explored for future data storage and signal processing devices [1]. We use an archetype NiFe disk structure which is known to stabilize a half-skyrmionic texture (magnetic vortex state). Due to the topological nature, the reversal of the magnetic vortex core is mediated by the creation and subsequent annihilation of Bloch point singularities. Using high-resolution magnetic force microscopy, we show that the interfacial interactions between the chiral spin structure of the FM and AFM can cause significant distortion of the magnetic vortex structure. These interfacial interactions are further used to stabilize phase transformations in chiral nanoscopic spin systems. Experimental observations are further supported by topological arguments and micromagnetic modeling. [1] Albisetti. et al. Commun Phys 1, 56 (2018).

MA 59.11 Fri 9:00 P2/EG

Symmetry of skyrmion and antiskyrmion dynamics with spin transfer and spin orbital torques — •Mariia Potkina[1,2], Igor Lobanov[1,2], and Valery Uzdin[1,2] — [1]ITMO University, Saint Petersburg, Russia — [2]Saint Petersburg State University, Russia

Lattice models of skyrmions and antiskyrmions in ferromagnetic and antiferromagnetic materials are considered taking into account the Heisenberg exchange, magnetic anisotropy, Dzyaloshinskii-Moriya interaction and interaction with external magnetic field. The skyrmionic and antiskyrmionic states are shown to be in one to one correspondence under certain transformation of spin configurations and vector parameters in the Hamiltonian. Without long range magnetic dipole interaction this transformation conserves the energy of the system and the shape of the energy surface. Therefore activation energies for annihilation of both states and the prefactors in Arrhenius law for lifetime are exactly the same for correspondent structures.

For the current driven dynamics, both spin-transfer and spin-orbit torques are considered and it is demonstrated how the current has to be transformed in both cases to match the dynamics of skyrmions and antiskyrmions. This makes it possible to determine the dynamics of an antiskyrmion if the dynamics of the corresponding skyrmion is known and to predict for which orientation the antiskyrmion moves in the direction of the applied spin polarized current.

This work was funded by the Russian Science Foundation (Grant No. 19-72-10138).

MA 59.12 Fri 9:00 P2/EG

Anisotropic Skyrmion Diffusion — •Klaus Raab[1], Nico Kerber[1,2], Markus Weissenhofer[3], Kai Litzius[1,2], Jakub Zázvorka[1], Ulrich Nowak[3], and Mathias Kläui[1,2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, DE-55099 Mainz, Germany — [2]Graduate School of Excellence Materials Science in Mainz, 55128 Mainz, Germany — [3]Fachbereich Physik, Universität Konstanz, Universitätsstraße 10, DE-78457 Konstanz, Germany

Thermally activated processes are intrinsic effects in every physical system and their understanding key to the underlaying dynamics of such systems. Using skyrmions, magnetic, topologically stabilized spin structures, we investigate the thermal diffusion dynamics in specifically tailored metal-multilayer. We find that for low pinning materials stacks, the thermal diffusion dominates the dynamics and allows for stable skyrmions at room temperature that move by thermal activation [1-3].

These stable Skyrmions allow for a wide range of possible applications in logic, data storage or Brownian token computing devices. In Brownian circuits the control of the skyrmion diffusion and the implementation of certain control is necessary. We show that by applying an in-plane field the skyrmion diffusion becomes anisotropic and controllable, while the absolute values of the diffusion coefficients are also drastically affected. We can analytically and numerically explain the anisotropic diffusion due to an elliptical deformation of the skyrmions by the application of the in-plane field, which leads to a preferential diffusion axis.

MA 59.13 Fri 9:00 P2/EG

Topological Magnetic Textures in Antiskyrmion Hosting Heusler Compounds Mn_xYZ — •Jacob Gayles, Yan Sun, and Claudia Felser — Max Planck Institute for Chemical Physics of Solids, D-01187 Dresden

Recently, the Heusler compounds $Mn_{1.4}PtSn$ and $Mn_{1.4}Pt_{0.9}Pd_{0.1}Sn$ were shown to stabilize an antiskyrmion lattice above room temperature and without an external magnetic field. These Heusler compound forms in a superstructure with the D_{2d} symmetry, which allows for an anisotropic Dzyaloshinskii-Moriya interaction (DMI) perpendicular to the tetragonal axis. Furthermore, many of these compounds show a spin reorientation transition where the topological Hall effect is much larger below the transition than above in the known antiskyrmion regime. We perform density functional theory calculations of Mn_xYZ compounds to extract the relevant exchange interactions that determine the rich phase diagrams in these materials. The exchange interactions are between the large moments on the Mn atoms $\sim 4\mu_B$, which show magnetic states that are non-collinear ferrimagnetic up to the spin reorientation. The major role of the spin-orbit driven DMI is due to the Z ion, either In, Ga, Sn or Sb where the Y ion (Ru, Rh, Pd, Ir, or Pt) *d*-states lowered in energy due to the Jahn-Teller distortion. The content of Mn also plays a large role in the stabilization of the magnetic textures. The electron occupation can be tuned by the Y ion, either In, Sn or Sb. We last calculate the anomalous Hall effect and topological Hall effects in these regimes, to capture the influence of the electronic structure on the Berry curvature.

MA 59.14 Fri 9:00 P2/EG

Topological Defects in Helimagnetic Spin Textures — •Erik Lysne[1,2], Mariia Stepanova[1,2], Peggy Schoenherr[3], Jan Masell[4], Laura Köhler[2,5], Achim Rosch[6], Naoya Kanazawa[7], Yoshinori Tokura[4,7], Markus Garst[8], and Dennis Meier[1,2] — [1]NTNU, Trondheim, Norway — [2]QuSpin NTNU, Trondheim, Norway — [3]ETH Zurich, Zürich, Switzerland — [4]RIKEN , Wako, Japan — [5]Technische Universität Dresden, Dresden, Germany — [6]Universität zu Köln, Köln, Germany — [7]University of Tokyo, Tokyo, Japan — [8]Karlsruhe Institute of Technology, Karlsruhe, Germany

In non-centrosymmetric ferromagnets, the Dzyaloshinskii-Moriya interaction is symmetry-allowed and the magnetic energy can be reduced by canting the spins, resulting in complex spin spiral structures. Examples include transition-metal silicides and germanides, which crystallize in the B20 structure. Among the B20 magnets, the highest known transition temperature is found in FeGe, which also has a remarkably low magnetic anisotropy. Because of this low anisotropy, the orientation of the helix can assume any direction in the surface plane. Most interestingly, completely new types of domain walls emerge between regions with different orientation of the helical structure in the ground state. These novel helimagnetic domain walls have interesting and unusual physical properties, such as non-trivial topology. Furthermore, they bear a striking resemblance to cholesteric liquid crystals, but on a very different length scale. We use magnetic force microscopy to investigate these domain walls and associated defects, with the goal of demonstrating new opportunities for future spintronic applications.

MA 59.15 Fri 9:00 P2/EG

μSR on single crystals of GaV4S8 — •Elaheh Sadrollahi[1,2], Andre Borchers[2], Jochen Litterst[2,3], Isván Kézsmárki[4], Sandor Bordacs[5], Vladimir Tsurkan[4], and Alois Loidl[4] — [1]Institut für Festkörper- und Materialphysik, Technische Universität Dresden, 01062 Dresden, Germany — [2]Institut für Physik der kondensierten Materie, Technische Universität Braunschweig, 38110 Braunschweig, Germany — [3]Centro Brasileiro de Pesquisas Físicas, 22290-180, Rio de Janeiro, RJ, Brazil — [4]Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany — [5]Department of Physics, Budapest University of Technology and Economics, 1111 Budapest, Hungary

The lacunar thio-spinel GaV4S8 possesses a complex magnetic phase diagram with several magnetic phases in zero and applied field, in part with supposed cycloidal, ferromagnetic and/or short-range cycloidal spin structures, eventually even including skyrmion structures in the ferromagnetic phase [1,2]. We have performed muon spin rotation and relaxation (μSR) experiments on oriented single crystals. In zero magnetic field, the spontaneous rotation signals allow to distinguish between the cycloidal (ca. 8-13 K) and the low temperature "ferromagnetic" phase, yet with a smooth continuous transition extending over several degrees, what is interpreted with a spin-reorientation. The observed changes at low temperature and in the applied field indicate that this phase has not simple ferromagnetic character. We will discuss the observed field distribution patterns under various applied fields. [1] I. Kezsmarki et al., Nature Mater. 14, 1116 (2015). [2] S. Widmann et al., unpubl., arXiv 1606.04511 (2016).

MA 59.16 Fri 9:00 P2/EG

Dynamics of non-trivial topological states without the need for Dzyaloshinskii-Moriya interaction — •David Eilmsteiner[1], Levan Chotorlishvili[2], Xi-guang Wang[3], Martin Hoffmann[1], and Arthur Ernst[1,4] — [1]Institute for Theoretical Physics, Johannes Kepler University Linz, 4040 Linz, Austria — [2]Institute of Physics, Martin Luther University Halle-Wittenberg, 06120 Halle, Germany — [3]School of Physics and Electronics, Central South University, Changsha 410083, China — [4]Max Planck Institute of Microstructure Physics, 06120 Halle, Germany

The current interest in topologically non-trivial states in magnetic materials, for instance magnetic skyrmions, arises not only from the fascinating connection between the mathematical concept of topology and phenomena observable in the lab but also from possible future applications of those configurations in technology. The main obstacle towards technological applicability is the limited range of materials in which skyrmions intrinsically occur – for instance the Dzyaloshinskii-Moriya interaction is usually required. Nevertheless, making use of special material combinations, it is possible to induce skyrmions in a much wider range of materials. The aim of our research is to study the dynamics of various non-trivial topological configurations in such systems (e.g. bi-skyrmions in a $La_{0.7}Sr_{0.3}MnO_3$-$SrRuO_3$ bilayer with Co disks on top). Therefore, we use the toolkit of micro-magnetism equipped with parameters such as the exchange stiffness or the magneto-crystalline anisotropy gained from first-principles calculations.

MA 59.17 Fri 9:00 P2/EG

Current-induced instabilities of magnetic skyrmions due to spin-transfer torques; speed limits for skyrmions — Jan Masell[1,2], •Benjamin F. McKeever[3], Davi R. Rodrigues[3], and Karin Everschor-Sitte[3] — [1]Institute for Theoretical Physics, University of Cologne, 50937 Cologne, Germany — [2]RIKEN Center for Emergent Matter Science, Wako, Saitama 351-0198, Japan — [3]Institute of Physics, Johannes Gutenberg-Universität, 55128 Mainz, Germany

Magnetic skyrmions in chiral ferromagnets can be efficiently moved by spin-polarized electric currents, and controllable motion at high speeds is particularly desirable for spintronics applications. Upon increasing the current strength, however, skyrmions deform from their trademark circular shape, which limits their utility. We analyze single skyrmions in motion for different micromagnetic parameters and driving currents, due to spin-transfer torques for smooth magnetic textures, and systematically map out how the skyrmion shape distorts. For compact skyrmions at uniaxial anisotropies far above the critical anisotropy for a uniform ground state, we find that at large current densities the skyrmion assumes a non-circular shape with a tail, reminiscent of a shooting star. For larger, softer, skyrmions closer to the critical anisotropy, we observe a critical current density above which skyrmions become unstable and elongate to an arbitrary extent; however, above a second critical current density the shooting star solution can also be recovered for these skyrmions.

[1] J. Masell, B.F. McKeever et al. (in preparation), (2020)

MA 59.18 Fri 9:00 P2/EG

Double Topological Hall Effect as a signature for Skyrmions and Antiskyrmions — •Pranava Keerthi Sivakumar[1], Börge Göbel[1], Edouard Lesne[1], Anastasios Markou[2], Jyotsna Gidugu[1], James Taylor[1], Hakan Deniz[1], Jagannath Jena[1], Claudia Felser[2], Ingrid Mertig[1,3], and Stuart.S.P. Parkin[1] — [1]Max Planck Institute of Microstructure Physics, Weinberg 2, 06120 Halle, Germany. — [2]Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Strasse 40, 01187 Dresden, Germany. — [3]Institute of Physics, Martin Luther University Halle-Wittenberg, 06120 Halle, Germany.

Topological magnetic textures such as skyrmions and antiskyrmions are typically observed in materials belonging to different symmetry groups where the bulk Dzyaloshinskii-Moriya interaction (DMI) is either isotropic or anisotropic and leads to the stabilization of either skyrmions or antiskyrmions respectively. Recently, both these topological objects were found in the same inverse Heusler crystal, whose D2d symmetry is expected to stabilize only antiskyrmions. In this poster, we report on the observation of two distinct peaks in the topological Hall effect (THE) exhibited by thin films of Mn2RhSn. These features are later shown, phenomenologically and through transport simulations, to be direct signatures of two topologically distinct chiral spin textures, namely skyrmions and antiskyrmions. Utilizing THE studies, we infer that skyrmions are predominantly stabilized at lower temperatures where dipolar interactions dominate, while antiskyrmions are present at higher temperatures over a wide range of magnetic fields.

MA 59.19 Fri 9:00 P2/EG

Edges modes in FM-SC hybrid structures — •Jasmin Bedow[1,2], Eric Mascot[2], Stephan Rachel[3], Dirk Morr[2], and Götz Uhrig[1] — [1]TU Dortmund — [2]University of Illinois at Chicago, Chicago, USA — [3]University of Melbourne

We investigated edge modes in two-dimensional FM-SC hybrid structures, composed of an s-wave superconductor and magnetically ordered adatoms placed on top of the superconducting substrate.

Our results show topological properties for a 3Q-ordered structure of the adatoms' spins. For this ordering, we computed the topological phase diagram and the zero-energy local density of states for islands and ribbons of adatoms. For these, Majorana modes emerge depending on the chosen parameter set and a supercurrent is found along the edge of the magnetic structure.

Furthermore, we investigated different types of magnetic domains, including domains created by shifts in the unit cell, a reversal of the spins' orientation and a reversal of the superconducting order parameter. The emerging edge modes show interesting dispersions and we determined whether they are Majorana modes.

MA 59.20 Fri 9:00 P2/EG

Fast Mapping of Magnetic States in Perpendicular Magnetic Anisotropy Systems — •Ruslan Salikhov[1], Fabian Samad[1], Leopold Koch[2], Benny Böhm[2], and Olav Hellwig[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Chemnitz University of Technology, Chemnitz, Germany

Synthetic antiferromagnets (SAF) with perpendicular magnetic anisotropy (PMA) are hosting a large variety of magnetic states ranging from AF coupled states to ferromagnetic (FM) stripe domain configurations and their mixtures [1]. Magnetic states in SAFs can be conveniently adjusted using the design parameters of the magnetic multilayers (ML), e.g. their individual layer thicknesses and their number of repetitions [1]. The remanent domain state mostly depends on the specific demagnetization routine via an external magnetic field [1-3]. Here we present the fast mapping of magnetic states in SAFs for different demagnetization protocols and ML parameters by means of monitoring the remanent magnetization (RM) during the AC or DC demagnetization process itself and performing magnetic force microscopy (MFM) imaging at intermediate specific states of interest. The aligned stripe domain state is characterized by almost zero RM, whereas bubble domains manifest themselves by an enhanced RM. Our screening protocol allows the fast and convenient detection of magnetic bubble states in all type of PMA systems including SAFs. [1] O. Hellwig, et al., JMMM 319, 13-55 (2007). [2] K. Chesnel, et al., Phys. Rev. B 98, 224404 (2018). [3] L. Fallarino, et al., Phys. Rev. B 99, 024431 (2019).

MA 59.21 Fri 9:00 P2/EG

Interlayer Dzyaloshinskii-Moriya interaction in low-dimensional magnetic structures — •Maria E. Konstantinova, Levente Rózsa, Elena Y. Vedmedenko, and Roland Wiesendanger — Department of Physics, University of Hamburg, Hamburg, Germany

Interfacial Dzyaloshinskii-Moriya interaction (DMI) is responsible for many interesting chiral phenomena in interfacial magnetic multilayer systems. Particularly, it causes a formation of spin spirals within an interfacial plane. Recent theoretical and experimental studies highlighted the role of the interlayer DMI, in addition to the intralayer DMI, in interfacial systems [1-3]. However, it is still not known how the interlayer DMI influences the magnetic texture appearing due to the intralayer DMI. Here, we study analytically and with Monte Carlo simulations the magnetic structure in multilayers with competing interlayer and intralayer DMI. We find that the interlayer coupling changes the relative phase of rotation of the intralayer spin spirals. If the interfacial DM vector in two subsequent layers is opposite, then the spirals become anharmonic due to the intralayer DMI. Additionally, a chiral rotation across the layers appears. The ground states for different ratios of the interlayer and the intralayer DMI will be discussed.

[1] E. Y. Vedmedenko et al., Phys. Rev. Lett. 122, 257202 (2019).
[2] A. Fernández-Pacheco et al., Nat. Mater. 18, 679 (2019).
[3] D. S. Han et al., Nat. Mater. 18, 703 (2019).

MA 59.22 Fri 9:00 P2/EG

Lifetimes of large magnetic structures — •Moritz Sallermann[1,2], Stefan Blügel[1], and Hannes Jónsson[2] — [1]Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany — [2]Science Institute and Faculty of Physical Sciences, University of Iceland, VR-III, 107 Reykjavík, Iceland

The thermal stability of certain spin configurations is of tremendous importance in the design of experimental setups and spintronics devices. In the framework of harmonic transition state theory, this critical property can be estimated. Such a calculation produces the rate of a specific reaction, following a known transition path from the initial configuration to a final state. The reaction rate is determined from local properties of the energy landscape around two designated points along the transition path - the initial state and the saddle point.

Specifically it is required to know the ratio between the determinant of the Hessian matrix at the initial and at the saddle point configuration, which is linked to the entropic bottleneck of the reaction.

As one considers large systems, however, the straightforward approach of computing all eigenvalues of the Hessian, turns out to be much too computationally expensive and therefore not feasible. We explore an alternative avenue of obtaining the transition rate via statistically estimating the entropic contribution, thus avoiding the expensive eigenvalue decompositions. We apply this approach to lifetime estimations for large magnetic structures, modelled as classical atomistic spins with an extended Heisenberg Hamiltonian.

MA 59.23 Fri 9:00 P2/EG

Magnetic structure of Pd/Fe/Ir(111) islands confined by a ferromagnet — •Kathrin Raeker, Jonas Spethmann, Elena Y. Vedmedenko, and Roland Wiesendanger — Departement of Physics, University of Hamburg, Hamburg, Germany

We have employed stochastic Landau-Lifshitz-Gilbert spin dynamics calculations as well as Monte Carlo simulations to study the magnetic structure in laterally confined Pd/Fe/Ir(111) islands interfacing to Co/Fe/Ir(111). Monolayers of Co on Fe/Ir(111) show a strong ferromagnetic signature, whereas ultrathin films of Pd/Fe/Ir(111) form spin spirals at zero magnetic field and skyrmions at finite perpendicular fields [1]. While free-standing Fe/Ir(111) islands have been explored theoretically and experimentally [2], the influence of the interfacing of Co on the magnetic structure of spin spirals in Pd/Fe/Ir(111) is not known yet.

In the field-free regime, we find a strong coupling of the wave vector of the magnetic spiral with the close-packed edges of Fe nanostructures with the spin spiral running perpendicular to the closed-packed edge. If the island is interfaced by Co, the spin spiral is oriented along the island's rim. These numerical findings can be explained by analytical considerations of the spatially dependent energy of the spin texture, and opens new possibilities in the engineering of magnetization states in laterally confined nanostructures.

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[2] J. Hagemeister et al., Phys. Rev. Lett. 117, 207202 (2016).

MA 59.24 Fri 9:00 P2/EG

Floquet Time Crystal in a Chiral Magnet — •Nina del Ser, Lukas Heinen, and Achim Rosch — Insitut für theoretische Physik, Universität zu Köln

We investigate how driving the conical phase of a chiral magnet with a time-periodic magnetic field can lead to the formation of Floquet time crystals: periodic perturbations of the steady-state magnetization in time as well as space. Our model is a 3D cubic spin lattice with Heisenberg and Dzyaloshinskii-Moriya interactions. We first obtain analytical expressions for the time-dependent magnetization of the steady state. We then expand around this time-dependent steady state using the Holstein-Primakoff formalism for bosonic excitations. Calculating the band spectrum requires the use of Floquet theory as it is a time-periodic problem. The Floquet band spectrum suggests the existence of unstable modes at certain resonant frequencies leading to the formations of new Floquet time crystal states, also observed in numerical experiments.

MA 59.25 Fri 9:00 P2/EG

Controlled creation of magnetic stray field landscapes in synthetic antiferromagnets with perpendicular anisotropy by means of focused ion beam irradiation — •Fabian Samad[1,2], Leopold Koch[2], Gregor Hlawacek[1], Sri Sai Phani Kanth Arekapudi[2], Miriam Lenz[1], and Olav Hellwig[1,2] — [1]Helmholtz-

Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Chemnitz University of Technology, Chemnitz, Germany

Recently it was shown that a combination of magnetic field application and focused ion beam irradiation can be employed to create different magnetic stray field landscapes above the surface of exchange bias systems [1]. In our work, instead, we use layered synthetic antiferromagnets with perpendicular anisotropy as a starting state, which exhibits a great variety of magnetic states depending on the specific magnetic energy balance within the system [2]. We are able to stabilize different magnetic states locally and controllably, giving rise to a well-defined stray field landscape. Additionally, we show that the magnetic textures can be modified by an external magnetic field in a controlled way, enabling the post-irradiation modification of the stray field landscapes. These stray fields might be used to stabilize certain magnetic domain formations in a soft-magnetic overlayer deposited on top of the synthetic antiferromagnet, which could be utilized as a spin wave guiding infrastructure. [1] Mitin et al., Nanotechnology 29, 355708 (2018). [2] Hellwig et al., J. Magn. Magn. Mater. 319, 13-55 (2007).

MA 59.26 Fri 9:00 P2/EG

Time-resolved imaging of vortex domain wall motion and chirality rectification in curved nanowires — •Daniel Schönke[1], Robert M. Reeve[1], Hermann Stoll[2], and Mathias Kläui[1] — [1]Institute of Physics, Johannes Gutenberg University Mainz, 55099 Mainz, Germany — [2]Max-Planck-Institut für Intelligente Systeme, 70569 Stuttgart, Germany

Controlling the vortex domain wall (DW) chirality is important for chirality-encoded DW logic and for other devices based on propagating DWs due to chirality-dependent motion behaviour. Among several ideas to control the chirality, spin rectifying corners and end domains have been proposed [1,2]. We investigated domain-wall motion and chirality control in asymmetric $Ni_{80}Fe_{20}$ halfring pairs by time-resolved imaging using a scanning electron microscope with polarization analysis [3]. This method allows us not only to directly observe the dynamics with nanosecond resolution, but also to determine the probabilities of different switching pathways and the associated chirality protection. The experiments were complemented by micromagnetic simulations. The results reveal that the control of chirality by curvature works with very high reliability, whereas the chirality at the wire ends is less reproducible. Furthermore the attractive interaction of vortex DWs in adjacent wires plays a key role in the dynamics with the interaction being stronger for DWs with the same chirality. [1] Omari et al., *Appl. Phys. Lett.* **107**, 222403 (2015) [2] Wilhelm et al., *Appl. Phys. Lett.* **95**, 252501 (2009) [3] Schönke et al., *Rev. Sci. Instrum.* **89**, 083703 (2018)

MA 59.27 Fri 9:00 P2/EG

Magnetic domain wall propagation in periodically modulated wires — •Olga Lozhkina, Robert Reeve, Gerhard Jakob, and Mathias Kläui — Institut für Physik, Johannes Gutenberg- Universität Mainz, 55099 Mainz, Germany

In thin confined wires where the domain structure is governed by the shape anisotropy, for soft magnetic wires domain walls (DWs) can be described as quasiparticles moving under external field so they can be implemented for magnetic field sensing [1-2]. However, DW propagation mechanism has a complex dependence on field and a high stochasticity of pinning depending on the DW spin structure. The periodic modulation of the magnetic wire width was predicted to suppress the Walker breakdown, thus conserving the DW spin structure. A thorough control of the domain wall spin structure can make the propagation reproducible and evades the sensor failure. Our simulations show that wire width modulation with an appropriate amplitude and period fully suppresses the WB. It was also shown that the wire width modulation decouples brunches at the intersection region of the sensor making the DW propagation reproducible [2]. Experiments utilizing short current pulses producing an Oersted field which displaces the DWs in the magnetic wires and Magneto-Optical Kerr Effect for optical detection of the DWs positions were performed to study the influence of the periodic modulation on the DW propagation in soft magnetic wires. [1] M. Diegel et al., IEEE Trans. Magn. 40, 2655 (2004) [2] B. Borie et al., Phys. Rev. Appl. 8, 024017 (2017) [3] E. Semenova et al., J. Appl. Phys. 124, 153901 (2018)

MA 59.28 Fri 9:00 P2/EG

Manipulation of laterally homogeneous vertical AF domain walls in Synthetic Antiferromagnets with Perpendicular Magnetic Anisotropy — •Benny Böhm[1], Lorenzo Fallarino[2] und Olav Hellwig[1,2] — [1]Institute of Physics and MAIN, Chemnitz University of Technology, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Germany

Antiferromagnets (AFs) are of emerging interest due to their wide variety of useful properties at the micro and nanoscale. Despite the macroscopically vanishing magnetic remanent moment and therefore high stability with respect to external magnetic field, AFs may provide other unique magnetic static states as well as promising characteristics for dynamic applications like high domain wall velocities and excitation frequencies into the THz regime.

Synthetic antiferromagnets (SAFs), consisting of AF-coupled ferromagnetic layers via thin non-magnetic spacer layers, maintain the main characteristics of intrinsic AFs. Additionally, SAFs offer a high degree of tunability and easy integration, thus making them interesting for a wide range of applications.

One unique AF phenomenon, which can be efficiently observed in SAFs, is the Surface Spin Flop (SSF). During the SSF-reversal, a laterally homogeneous vertical AF domain is nucleated. Combining the SAF with perpendicular magnetic anisotropy allows to easily manipulate even locally the films magnetic properties. Thereby, the vertical AF domain wall can be stabilized even at remanence, allowing to choose between multiple coexisting remanent states.

MA 59.29 Fri 9:00 P2/EG

Real-time dynamics of classical spins coupled to the boundary of a Kane-Mele model — •Robin Quade and Michael Potthoff — I. Institute of Theoretical Physics, Department of Physics, Universität Hamburg

The real-time dynamics of the two-dimensional Kane-Mele model with a single or several classical impurity spins coupled to the boundary of the electronic system is investigated numerically. To this end, we employ a high-order Runge-Kutta technique to solve the coupled system of equations of motion, i.e., the canonical equations of motion for the classical spin dynamics and the Liouville-type equation for the one-particle reduced density matrix of the electronic system.

At each instant of time, the classical impurity spins act as local magnetic fields and thus, via the Kondo-like exchange coupling, locally break time-reversal symmetry (TRS). We consider the topologically nontrivial phase of the Kane-Mele model and study the impact of the bulk-boundary correspondence and the spin-momentum locking of the TRS-protected surface states on the real-time dynamics of the impurity spins.

MA 59.30 Fri 9:00 P2/EG

Photocurrents in 3D Topological insulators Hall bar and nanowire devices — •Nina Meyer[1], Thomas Schumann[1], Eva Schmoranzerová[2], Kevin Geishendorf[3], Gregor Mussler[4], Jakob Walowski[1], Petr Nemec[2], Andy Thomas[3], Kornelius Nielsch[3], Detlev Grützmacher[4], and Markus Münzenberg[1] — [1]Institute of Physics, University of Greifswald, Greifswald, Germany — [2]Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic — [3]IFW Dresden, Institute for Metallic Materials, Dresden, Germany — [4]Inst. for Semiconductor Nanoelectronics, PGI-9, Forschungszentrum Jülich, Germany

It has been demonstrated experimentally that illuminating a topological insulator (TI) with circular polarized light generates spin-polarized surface currents, since spin-momentum locking is present [1]. In this poster, we will sum up our results on photocurrent measurements on $(Bi, Sb)_2Te_3$ thin film Hall bar structures and Bi_2Se_3 core-shell nanowires. The laser light is moved in a 2D pattern across the sample surface and the photocurrent is measured as a function of the polarisation at every laser position. Therefore, the different contribution to the photocurrent can be displayed as spatially resolved 2D maps. For the Hall bar structure, a lateral accumulation of spin polarization at the TIs edges due to the spin Nernst effect is found [2]. For the nanowires, a constant spin polarized current far off the contacts is found and the edge effects of the Au/TI layer stack are investigated.

[1] J.W. McIver et al., Nature Nanotechnology 7, 96-100 (2012)
[2] T. Schumann et al., arXiv:1810.12799 (submitted)

MA 59.31 Fri 9:00 P2/EG

Interplay of chemical disorder and layer native defects within topological insulators — •Jakub Šebesta and Karel Carva — Charles University, Faculty of Mathematics and Physics, Department of Condensed Matter Physics, Ke Karlovu 5 121 16 Praha 2, The Czech Republic

Material can host several kinds of native defects, which includes chemical defects as well as structural defects. In general, it leads to the modification of their physical properties including magnetic and transport ones. Therefore, in the present work based on ab-initio calculations we focus on the influence of the layer defects, namely the experimentally evidenced twinning planes, on the properties of the well known bismuth chalcogenide topological insulators Bi_2Se_3 and on their interplay with point defects concerning not only the native ones but also magnetic doping. We employ the TB-LMTO-ASA method based on the layered Green's functions, which allows us to treat the chemical disorder efficiently in the framework of the CPA. The distribution of the twinning planes within multilayer sample is discussed together with the dependence of their formation energy in relation to the type of the point defects and their concentration. Furthermore, the interplay between layer defects and magnetic dopants and their magnetism is emphasized. Finally, the impact of the presence of the structure defects on the electron structure, particularly on the surface states and on the surface gap, is estimated.

MA 59.32 Fri 9:00 P2/EG

Static and dynamic magnetic properties of $(MnBi_2Te_4)(Bi_2Te_3)_n$ probed using electron spin resonance technique. — •Alexey Alfonsov[1], Kavita Mehlawat[1], Anna Isaeva[1,2], Alexander Zeugner[3], Anja U. B. Wolter[1], Vladislav Kataev[1], and Bernd Büchner[1,2] — [1]Leibniz Institute for Solid State and Materials Research IFW Dresden, 01069 Dresden, Germany — [2]Faculty of Physics, TU Dresden, 01062 Dresden, Germany — [3]Faculty of Chemistry and Food Chemistry, TU Dresden, 01062 Dresden, Germany

$(MnBi_2Te_4)(Bi_2Te_3)_n$ represents a family of van der Waals materials which exhibit a coexistence of topologically nontrivial surface states with intrinsic magnetism. Such unusual combination of properties renders this natural heterostructures very attractive for investigations since it enables a number of exotic phenomena, which in turn might find potential applications in spintronics. In this work we address static and dynamic magnetic properties of the title material in ordered and disordered states using multifrequency and high field electron spin resonance technique. One example of our finding is the observation in $MnBi_2Te_4$ of surprisingly anisotropic spin dynamics of bulk conduction electrons and Mn localized states which, as we argue, could be responsible for the persistence of the band gap in the topological surface state even above the magnetic ordering temperature.

MA 59.33 Fri 9:00 P2/EG

Magnetic and Anomalous Transport Properties of Hexagonal -$Mn_{3+\delta}$Ge — •Venus Rai, Shibabrata Nandi, Subhadip Jana, Jörg Persson, and Thomas Brückel — Jülich Centre for Neutron Science JCNS and Peter Grünberg Institute PGI, JARA-FIT, Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany

Topological quantum materials have attracted enormous attention since their discovery due to the observed anomalous transport properties, which originate from the non-zero Berry curvature. $Mn_{3+\delta}$Ge has gained special attention because of its large anomalous transport effects that persist starting from Néel temperature (365 K) down to 2 K. Hexagonal - $Mn_{3+\delta}$Ge stabilizes in the range of $\delta = 0.25$ to 0.55. We have observed larger anomalous Hall effect with very small hysteresis (<200 Oe) for high Mn concentration in $Mn_{3+\delta}$Ge. To establish the claim for the existence of Weyl points in $Mn_{3+\delta}$Ge, transverse and longitudinal magneto-resistance (MR) was also performed with field and current applied along several combinations of x, y, z crystallographic axes. Negative MR is observed in some cases even when magnetic field (B) is perpendicular to the current (I) direction. However, in case of I$\|$B$\|x$, negative MR is observed with different slopes below and above 2 T. Angle dependent measurement (between I and B) shows that the negative MR with higher slope (observed below 2 T) is possibly originating due to the chiral anomaly.

MA 59.34 Fri 9:00 P2/EG

GdBiTe: A candidate magnetic topological semimetal — •Paul Gebauer[1], Laura T. Corredor Bohorquez[2], Anja U. B. Wolter[2], Bernd Büchner[2,3], Thomas Doert[1], and Anna Isaeva[2,3] — [1]Faculty of Chemistry and Food Chemistry, Technische Universität Dresden, Dresden, Germany — [2]Institute for Solid State and Materials Research, Leibniz IFW Dresden, Dresden, Germany — [3]Faculty of Physics, Technische Universität Dresden, Dresden, Germany

Interacting topological materieals with a non-trivial topology of the electronic band structure and intrinsic magnetic ordering hold promises for spintronic applications. GdSbTe was reported as an antiferromagnetic nodal-line semimetal [1]. We discover GdBiTe with even stronger spin-orbit coupling. The powder is synthesized by a solid-state reaction of the elements. The crystal structure (space group $P4/nmm$; $a = 436.9(1)$ pm, $b = 924.3(1)$ pm) is determined by single-crystal X-Ray diffraction. The ground state from the first principles calculations is antiferromagnetic with a calculated magnetic moment $7.32\mu_B$ (expected $7.94\mu_B$ for Gd(III), $J = \frac{7}{2}$). Field- and temperature-dependent magnetization and specific heat measurements on polycrystalline samples show an antiferromagnetic state and a metamagnetic transition at 15 K, which nature remains to be eludicated. [1] M. M. Hosen, et al., Sci. Rep. 8, 13283 (2018).

MA 59.35 Fri 9:00 P2/EG

Lattice instability of the novel multiferroic $Cu_9O_2(SeO_3)_4Cl_6$ — •Ksenia Denisova[1,2], Dirk Wulferding[1], Dirk Menzel[1], Olga Maximova[2], Helmuth Berger[3], Jiunn-Yuan Lin[4], Alexander Vasiliev[2], and Peter Lemmens[1] — [1]IPKM, TU-BS, Braunschweig, Germany — [2]Faculty of Physics, MSU, Moscow, Russia — [3]EPFL, Lausanne, Switzerland — [4]NCTU, Hsinchu, Taiwan

Due to the combination of lone-pair ferroelectricity and d-electron magnetism high T_c multiferroicity is observed in many transition metal oxohalides [1,2]. The new type-I multiferroic $Cu_9O_2(SeO_3)_4Cl_6$ exhibits long range magnetic ordering at $T_N = 37$ K and a polar ordering at $T_E = 270$ K [3]. Our Raman study reveals signs of both magnetic and electric phase transitions: spin-phonon coupling below T_N, appearance of new lines of magnetic origin for $T<T^* = 16$ K, and a symmetry lowering for $T<T_E$. Evidence for an additional lattice instability at 100 K is reported. Work supported by NUST "MISiS" Grant No. K2-2017-084. [1] L. Zhao, et al., Sci. Adv. 2, e1600353 (2016). [2] H. C. Wu, et al., PRB 95 125121 (2017). [3] H. C. Wu, et al., PRB in print (2019).

MA 59.36 Fri 9:00 P2/EG

All-Optical Magnetoelectric Memory — •Jakub Vít[1], Alexej Pashkin[2], Vilmos Kocsis[3], Yasujiro Taguchi[4], István Kézsmárki[5], and Sándor Bordács[1] — [1]Budapest University of Technology, Hungary — [2]HZDR Dresden, Germany — [3]IFW Dresden, Germany — [4]RIKEN, Japan — [5]Uni Augsburg, Germany

We demonstrated feasibility of magnetoelectric domain selection by the intense electromagnetic radiation of the FELBE Free Electron Laser. Our experiments showed that among the two magnetic domains, one can be selected in a $LiCoPO_4$ single crystal cooled from the paramagnetic to the antiferromagnetic phase while it was irradiated by the FELBE. The FELBE was the most efficient when 1) its frequency was tuned close to the ME mode at 1.35 THz, 2) the cooling rate was low, and 3) the FEL power was the maximum. In this poster, I discuss possible mechanisms causing domain imbalance.

MA 59.37 Fri 9:00 P2/EG

Dimerization in the commensurate antiferromagnetic phase of $MnWO_4$ and $NaFe(WO_4)_2$ — •Sebastian Biesenkamp[1], Yvan Sidis[2], Navid Qureshi[3], Dmitry Gorkov[1], Karin Schmalzl[4], Wolfgang Schmidt[4], Petra Becker[5], Ladislav Bohatý[5], and Markus Braden[1] — [1]Institute of Physics II, University of Cologne — [2]Laboratoire Léon Brillouin, CEA-CNRS, CEA/Saclay — [3]ILL, Grenoble — [4]JCNS at ILL, Grenoble — [5]Sect. Crystallography, Institute of Geology and Mineralogy, University of Cologne

In multiferoic $MnWO_4$, the relaxation time of the multiferroic domain inversion shows a peculiar temperature dependence. Upon cooling below the multiferroic transition the relaxation time first increases but becomes faster closer to the commensurate low-temperature phase [1]. We investigated anharmonicities in this material as well as in isostructural $NaFe(WO_4)_2$ and propose the enhanced anharmonicities close to the low-temperature magnetic up-up-down-down structure to be responsible for the faster relaxation rates in $MnWO_4$. In both materials there is a similar competition between incommensurate cycloid and commensurate up-up-down-down order, and anharmonic squaring up appears as a precursor in the incommensurate structure [2]. The commensurate magnetic structure is associated with structural dimerization in both materials, that has been quantitatively determined for $NaFe(WO_4)_2$ by a four-circle neutron diffraction experiment. [1]: M. Baum, Phys. Rev. B 89, 144406 (2014) [2]: S. Holbein, Phys. Re. B 94, 104423 (2016)

MA 59.38 Fri 9:00 P2/EG

Direct comparison of magnetization reversal loops and

anomalous Hall resistivity loops of ultra-thin $SrRuO_3$-heterostructures — G. Malsch[1], •D. Ivaneiko[1], P. Milde[1], L. Wysocki[2], L. Yang[2], P. H.M. van Loosdrecht[2], I. Lindfors-Vrejoiu[2], and L. M. Eng[1,3] — [1]Institute for Applied Physics, TU Dresden, 01062 Dresden, Germany — [2]II. Physikalisches Institut, Universität zu Köln, 50937 Köln, Germany — [3]ct.qmat, Dresden-Würzburg Cluster of Excellence - EXC 2147, TU Dresden, 01062

Recently, it was proposed that ultrathin epitaxial layers of $SrRuO_3$/$SrIrO_3$ heterostructures might host magnetic skyrmions. In such thin films unit, skyrmions usually arise due to broken inversion symmetry at interfaces. The resultant interfacial Dzyaloshinskii-Moriya interaction was predicted to become sizeable through large spin-orbit coupling of the transition metals Ru and Ir. The presence of skyrmions is commonly indirectly proven through macroscopic magneto-transport measurements, then indicating the topological nature through hump-like anomalies observed in the Anomalous Hall effect (AHE) resistivity loops. Here, we investigate the structural and magnetic properties of a 4uc-SRO/2uc-SIO heterostructure comparing their physical properties by measurements with various techniques such as MOKE, AHE transport measurements, nc-SFM and MFM. As a result, we prove that local variations within the 4uc-SRO/2uc-SIO layer cause variations in the local switching fields that are the origins of the hump-like anomalies observed in AHE.

MA 59.39 Fri 9:00 P2/EG

Quasiparticle decay induced by spin anisotropies in the frustrated spin ladder system $BiCu_2PO_6$ — •Leanna Müller and Götz S. Uhrig — TU Dortmund

The inorganic compound $BiCu_2PO_6$ contains tubelike structures, which are described magnetically by weakly coupled frustrated spin ladders with a finite gap. The elementary excitations are triplons of which the degeneracy is lifted due to Dzyaloshinskii-Moriya interactions. In certain regions of the Brillouin zone the lifetime of the triplon excitation modes becomes finite due to hybridization of the single-triplon state with two-triplon states. In addition, the dispersions of these triplon modes show peculiar a down-bending before ceasing to exist. In experiment, $BiCu_2PO_6$ shows various types of decay processes, which can be caused by different symmetry breaking interactions. In previous studies, we established a minimal model to include all symmetry-allowed interactions, such as the Dzyaloshinskii-Moriya interaction. Based on this minimal model, we show that isotropic and anisotropic effects are responsible for noticeable quasiparticle decay and certain down-shifts of the single triplon energies. The analyses are based on a deepCUT approach to the isotropic case augmented by a perturbative treatment of the couplings inducing quasiparticle decay at zero temperature.

MA 59.40 Fri 9:00 P2/EG

Calculation of atomistic magnetic interaction parameters in Pb_2MnO_4 from ab-initio — •Roman Kováčik, Ivetta Slipukhina, Marjana Ležaić, and Stefan Blügel — Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany

For an antiferromagnetic Pb_2MnO_4 material [1], with a potential to exhibit complex magnetic textures, we calculate the ground state electronic structure employing the full-potential Korringa-Kohn-Rostoker Green function method [2]. The symmetric Heisenberg and antisymmetric Dzyaloshinskii-Moriya interaction (DMI) exchange parameters are evaluated using the method of infinitesimal rotations [3] and the site-resolved magnetocrystalline anisotropy (MCA) is obtained from the band energy terms. The large leading DMI parameter relative to the Heisenberg exchange as well as the non-trivial single-site MCA are consistent with the experimentally observed non-collinear spin state. Further detailed analysis of the calculated magnetic interaction parameters will be presented. Support from JARA-HPC (jara0182) and DFG (SFB 917) is gratefully acknowledged.

[1] S. A. J. Kimber and J. P. Attfield, J. Mater. Chem. 17, 4885 (2007).
[2] N. Papanikolaou *et al.*, J. Phys. Condens. Matter 14, 2799 (2002), also see: jukkr.fz-juelich.de.
[3] A. I. Liechtenstein *et al.*, J. Magn. Magn. Mater. 67, 65 (1987).

MA 59.41 Fri 9:00 P2/EG

Combined theoretical and experimental investigation of the novel $S = 1$ spin dimer system $K_2Ni(MoO_4)_2$ — •Benjamin Lenz[1,2], Swarup K. Panda[3,2], Silke Biermann[2,4], Bommisetti Koteswara Rao[5,6,7], Rao Kumar[8], Panchanana Khuntia[9], Avinash V. Mahajan[8], Michael Baenitz[9], Kee Hoon Kim[10], and Fang-Cheng Chou[7] — [1]IMPMC, Sorbonne Université, Paris, France — [2]CPHT, Ecole Polytechnique, Palaiseau, France — [3]Bennett University, Greater Noida, Uttar Pradesh, India — [4]Collège de France, Paris, France — [5]IIT Tirupati, Tirupati, India — [6]University of Hyderabad, Hyderabad, India — [7]National Taiwan University, Taipei, Taiwan — [8]IIT Bombay, Mumbai, India — [9]MPI-CPS, Dresden, Germany — [10]Seoul National University, Seoul, South Korea

Spin dimer systems have raised a lot of interest in recent years due to the possibility of studying the Bose-Einstein condensation of their magnetic excitations.
Here, we investigate the novel quantum magnet $K_2Ni(MoO_4)_2$, which has been synthesized recently, by means of different state-of-the-art techniques. Measurements and first principles calculations both establish a S=1 spin dimer ground state of the compound and allow to study its magnetic and thermodynamic properties. Using mean-field theory and quantum Monte Carlo simulations we find the magnetization curve, magnetic susceptibility and specific heat in good agreement with recent experiments.
Our results render this novel quantum magnet a promising candidate for the condensation of magnons under an applied magnetic field.

MA 59.42 Fri 9:00 P2/EG

Phase diagram and linearized dynamics of the classical-spin Kondo model on the triangular lattice — •Michael Lau and Michael Potthoff — I. Institute of Theoretical Physics, Department of Physics, Universität Hamburg

We study the ground-state phase diagram and the linearized real-time dynamics of the Kondo model with classical spins on the half-filled magnetically frustrated two-dimensional triangular lattice. The phase diagram is obtained via a novel technique using an (unphysical) Gilbert damping term to approach the ground state by solving the coupled equations of motion for the classical spins and the reduced one-particle density matrix of the conduction-electron system with a high-order Runge-Kutta method.

We find the classical noncollinear 120° phase in the regime of strong Kondo coupling J as reflected in the spin-structure factor for the classical as well as for the quantum spin-spin correlations by strong peaks at the K-points. At intermediate J, there is a first-order phase transition to a collinear zigzag phase, which exhibits a threefold rotational degeneracy as is again nicely reflected in the spin-structure factor.

The phase diagram sets the stage for subsequent analytical and numerical studies of the real-time dynamics. We compare the full solution of the (physical) equations of motion with the linearized variant in the limit of small excitation energies and study the dispersions of the Goldstone modes and the linearized dynamics close to the critical point.

MA 59.43 Fri 9:00 P2/EG

Temperature dependent, spin-resolved measurements of the electronic structure of Gd — •Josef Ketels[1], Michael Leitner[2], and Christoph Hugenschmidt[1,2] — [1]Physik Department E21, Technische Universität München, 85748 Garching, Germany — [2]Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München, 85748 Garching, Germany

The ferromagnetic rare earth metal gadolinium crystallizes in the hexagonal closed package structure. It is the only rare earth metal ordering ferromagnetically near room temperature with a Curie temperature of 294 K. At $T_{SR} \approx 230$ K a spin reorientation transition occurs, turning the magnetic moment axis away from the c-axis below T_{SR} [1]. The measurement of the two dimensional angular correlation of positron annihilation radiation (2D-ACAR) is a powerful tool to investigate the bulk electronic structure. Based on the spin-polarization of the positrons from a ^{22}Na source, the minority and majority spin-channels can be determined separately. We present recent temperature dependent and spin-resolved 2D-ACAR measurements on Gd, probing the electronic structure at 0 K, 260 K and 305 K.

[1] J. W. Cable and E. O. Wollan, Phys. Rev. 165, 733 (1968)

MA 59.44 Fri 9:00 P2/EG

Exotic magnetism in novel $RE_3Fe_3Sb_7$ compounds — •S. Palazzese[1], S. Chattopadhyay[1], M. Uhlarz[1], S. Yamamoto[1], F. Pabst[3], T. Herrmannsdörfer[1], J. Wosnitza[1,2], and M. Ruck[3] — [1]Hochfeld-Magnetlabor Dresden (HLD-EMFL), Helmholtz-Zentrum Dresden-Rossendorf — [2]Institut für Festkörper-und Materialphysik, TU Dresden — [3]Fakultät für Chemie und Lebensmittelchemie, TU Dresden

Here we present a DC magnetization study of novel $RE_3Fe_3Sb_7$ (RE = Pr, Nd, Sm) compounds with hexagonal crystalline structure $P6_3/m$. Measurements are performed at temperatures from 2 to 400 K and fields up to 7 T by means of SQUID magnetometry on single crystals. We observe a plethora of magnetic phase transitions at temperatures below 390 K. We show that the B-T phase diagram varies with the chemical RE composition of the compound and anisotropic magnetic behavior is observed for different orientations. Below 20 K, we observe a wide magnetic hysteresis loop, while at higher temperatures soft-magnetic behavior is found. Our results suggest strong evidence for the occurence of ferrimagnetic compensation points for each compound.

MA 59.45 Fri 9:00 P2/EG

Topological excitations in the Shastry-Sutherland model compound $SrCu_2(BO_3)_2$ — •Dirk Wulferding[1,2], Peter Lemmens[1,2], Youngsu Choi[3], Kwang-Yong Choi[3], and Hiroshi Kageyama[4] — [1]IPKM, TU-BS, Braunschweig, Germany — [2]LENA, TU-BS, Braunschweig, Germany — [3]Chung-Ang Univ., Seoul, Korea — [4]Chemistry Dept., Kyoto Univ., Japan

In the Shastry-Sutherland model compound $SrCu_2(BO_3)_2$ the ground state is composed of orthogonal spin dimers with low-energy triplon excitations and bound states [1]. In applied magnetic fields of around 1.4 T a topological phase transition is induced, where magnon bands acquire a finite Chern number together with the formation of topologically protected edge states [2,3] - realizing a magnetic analogue of a topological insulator. At higher fields around 27 T a 1/8 magnetization plateau corresponding to the crystallization of triplons appears [4]. Our Raman spectroscopic study at low and high magnetic fields probes the magnetic excitations in the singlet sector through the topological phase transitions. Work supported by QUANOMET NL-4 and DFG LE967/16-1. [1] P. Lemmens, et al., Phys. Rev. Lett. 85, 2605 (2000). [2] J. Romhanyi, et al., Nat. Commun. 6, 6805 (2015). [3] P. A. McClarty, et al., Nat. Phys. 13, 736 (2017). [4] H. Kageyama, et al., Phys. Rev. Lett. 82, 3168 (1999).

MA 59.46 Fri 9:00 P2/EG

Quantum criticality in α-$RuCl_3$ investigated by means of dilatometry — •Vilmos Kocsis[1], Anja U.B. Wolter[1], Sebastian Gass[1], Laura T. Corredor[1], Pedro M. Consoli[2,3], Lukas Janssen[2], Matthias Vojta[2], Paula L. Kelley[4,5], Stephen Nagler[6], David G. Mandrus[4,5], and Bernd Büchner[1,7] — [1]Institute for Solid State and Materials Research, Leibniz IFW Dresden, Germany — [2]Institute for Theoretical Physics, Technical University Dresden, Germany — [3]Instituto de Física de Sao Carlos, Universidade de Sao Paulo, Sao Carlos, Brazil — [4]Materials Science and Engineering Department, University of Tennessee, USA — [5]Materials Science and Technology Division, Oak Ridge National Laboratory, USA — [6]Neutron Scattering Division, Oak Ridge National Laboratory, USA — [7]Institute of Solid State and Materials Physics, Technical University Dresden, Germany

When the antiferromagnetic zigzag phase is suppressed, field-induced quantum criticality was found around B_c 7-8T in the quantum spin liquid candidate α-$RuCl_3$ [1]. We present high-resolution thermal expansion α, magnetostriction λ, and specific-heat (C_p) measurements on α-$RuCl_3$. The extracted Grüneisen parameter $\Gamma = \alpha/Cp$ shows divergence as typical for quantum critical behavior. Our thermodynamic experiments further hint at the existence of a third low-temperature phase in the examined field range in general agreement with former magnetocaloric and neutron diffraction measurements [2]. [1] A. U. B. Wolter et. al., PRB 96, 041405(R) (2017) [2] Christian Balz et al., Phys. Rev. B 100, 060405(R) (2019).

MA 59.47 Fri 9:00 P2/EG

Domain-Superconductivity in Nb/FePd with lateral inhomogeneous magnetization — •Annika Stellhorn[1], Anirban Sarkar[1], Emmanuel Kentzinger[1], Sonja Schröder[1], Grigol Abuladze[1], Markus Waschk[1], Tanvi Bhatnagar[1,2], Patrick Schöffman[3], Zhendong Fu[3], Vitaliy Pipich[3], Kathryn Krycka[4], Juri Barthel[5], and Thomas Brückel[1,3] — [1]Forschungszentrum Jülich GmbH, JCNS-2 and PGI-4, JARA-FIT, Jülich, GERMANY — [2]Forschungszentrum Jülich GmbH, PGI-5, Jülich, GERMANY — [3]Forschungszentrum Jülich GmbH, JCNS@MLZ, Garching, Germany — [4]NIST Center for Neutron Research, NIST, Gaithersburg, USA — [5]Forschungszentrum Jülich GmbH, ER-C 2, Jülich, Germany

We aim at understanding the proximity effects in the superconductor-ferromagnet (S/F) interface of Nb(S)/FePd(F) thin film heterostructures, prepared by MBE growth. Proximity effects at S/F interfaces with an inhomogeneous magnetic field texture result in various effects, like domain-wall superconductivity. To reveal the physical origin of each effect, we compare samples with S/F in direct proximity and S/F decoupled by a thin MgO layer. Measurements of the resistivity and magnetization show striking differences in their critical temperature and the critical field values. According to our results, we ascribe the observed domain-wall and reverse-domain superconductivity to the long-range magnetic interactions. Using polarized neutron scattering techniques, we focus on revealing the lateral magnetic depth profile of the heterostructures as function of temperature.

MA 59.48 Fri 9:00 P2/EG

$CrI_3/NbSe_2/CrI_3$ van der Waals heterostructure: Superconducting spin-valve? — •Chandan K Singh[1] and Mukul Kabir[1,2] — [1]Department of Physics, Indian Institute of Science Education and Research, Pune, India — [2]Center for Energy Science, Indian Institute of Science Education and Research, Pune, India

The proximity of ferromagnetic insulator (FI) and superconductor (S) has attracted the scientific community because of its rich physics and the influence of ferromagnet on the superconductor. Within the first-principles calculations, here we investigate the van der Waals heterostructure of $NbSe_2$ a two-dimensional (2D) superconductor and monolayer CrI_3 a 2D ferromagnetic insulator. Results indicate that magnetism is induced in the $NbSe_2$ layer while the moments in the CrI_3 layers ferromagnetically align. The magnetic moment developed at the Nb-sites decay to zero for antiparallel spin configuration in the CrI_3 layers. Further, we discuss the effects on the metallicity in the $NbSe_2$ layer concerning the relative spin order in the CrI_3 layers and discuss the survival of Ising spin-orbit coupling and nodal topological superconductivity in the $NbSe_2$. These results confirm the theoretical predictions by de Gennes for the thin-film FI/S/FI systems and also indicate the $CrI_3/NbSe_2/CrI_3$ van der Waals heterostructure a possible candidate for superconducting spin-valve.

MA 59.49 Fri 9:00 P2/EG

Large Uniaxial Magnetic Anisotropy of hexagonal Fe-Hf-Sb Alloys — •Maxim Tchaplianka[1], Lukáš Kývala[1,2], Alexander Shick[1], Sergii Khmelevskyi[3], and Dominik Legut[2] — [1]Institute of Physics, Czech Academy of Sciences, Prague, Czech Republic — [2]IT4Innovations and Nanotechnology Centre, VSB - Technical University of Ostrava, Ostrava-Poruba, Czech Republic — [3]Center for Computational Materials Science, Vienna University of Technology, Vienna, Austria

Chemical engineering of the magnetic anisotropy in ferromagnets via element substitution is a promising method of creating permanent magnets. Recent experiments have shown that antimony substitution into Fe_2Hf produces an alloy with the large positive magnetic anisotropy energy necessary for permanent magnets[1]. We investigate the electronic and magnetic properties of Laves phase hexagonal Fe_2Hf and Fe-Hf-Sb alloys making use of the density functional theory. The magnetic moments on individual atoms and the total and projected densities of states are calculated. Fe_2Hf is shown to be metallic and ferrimagnetic with an easy-plane preferential direction. Antimony substitution is found to suppress the planar magnetization direction and favor the uniaxial magnetic anisotropy, in agreement with experimental observations.

[1] D. Goll et al., *Hard Magnetic Off-Stoichiometric $(Fe,Sb)_{2+x}Hf_{1-x}$ Intermetallic Phase.* Phys. Status Solidi RRL, **11**, 1700184 (2017).

MA 59.50 Fri 9:00 P2/EG

Influence of the rapid cooling parameters in an adapted melt spinning process on microstructure and magnetic properties of Nd-Fe-B strip cast alloys — •Franziska Staab, Corinna Müller, Stefan Riegg, and Oliver Gutfleisch — TU Darmstadt, Materialwissenschaft, Alarich-Weiß-Str. 16, 64287, Darmstadt, Germany

High-performance Nd-Fe-B magnets are a main component of the power train in e-mobility. The production of the magnets is based on a powder metallurgical route, for which in the first step strip cast (SC) flakes are produced. The rapid cooling during the SC process results in a microstructure which essentially determines the quality of subsequent production steps such as hydrogen decrepitation, jet milling as well as sintering. A control of the microstructure evolution leads to enhanced magnetic properties of the final magnets. Since the minimum amount of material processed with SC is in the range of 20-50 kg and thus very costly, we investigate the influence of different cooling conditions and additional alloying elements on the microstructure with an own modified setup in a melt-spinner. A typical industrial relevant alloy composition of $(Nd,Pr,Dy,Tb)_{14,6}Fe_{77,9}(Co,Cu,Al,Ga)_{1,7}B_{5,8}$ was used to study the influence of the processing parameters before further elements were added. Scanning electron microscopy reveals a similar microstructure of the melt spun ribbons compared to the strip cast flakes. A detailed characterization and discussion of microstructure and magnetic properties are presented.