MA 40: Poster Magnetism II

Magnetic Domain Walls (non-skyrmionic) (MA 40.1-40.5), Ultrafast Magnetization Effects (MA 40.6-40.12), Magnetic Relaxation and Gilbert Damping (MA 40.13), Magnetic Semiconductors (MA 40.14-40.15), Complex magnetic oxides (MA 40.16-40.20), Frustrated Magnets (MA 40.21-40.27), Thin Films: Magnetic Coupling Phenomena / Exchange Bias (MA 40.28-40.32), Thin Films: Magnetic Anisotropy (MA 40.33-40.34), Magnetic Instrumentation and Characterization (MA 40.35-40.42), Magnetic Particles / Clusters (MA 40.43-40.44), Magnetic Information Technology, Recording, Sensing (MA 40.45-40.48), Micro- and Nanostructured Magnetic Materials (MA 40.49-40.50), Multiferroics and Magnetoelectric Coupling (MA 40.51), Surface Magnetism (MA 40.52-40.55), Cooperative Phenomena: Spin Structures and Magnetic Phase Transitions (MA 40.56-40.58), Topological Insulators (MA 40.59), Topological Insulators (MA 40.60-40.61), Disordered Magnetic Materials (MA 40.62), Focus Session: Altermagnetism: Transport, Optics, Excitations (MA 40.63-40.64), Spin-Phonon Coupling (MA 40.65-40.66)

Time: Thursday 14:00–16:00 Location: P2/EG

MA 40.1 Thu 14:00 P2/EG

The spectrum of localized excitations of spin nanoclusters and their stability in a magnetic field — •Oksana Charkina[1,2], Mikhail Bogdan[2], and Igor Poltavsky[1] — [1]University of Luxembourg, L-1511 Luxembourg City, Luxembourg — [2]B. Verkin ILTPE of NASU, Kharkiv, 61103, Ukraine

Engineering novel materials with predefined spectral and dynamical properties from recently synthesized giant magnetic molecules, permitting well-controlled exchange interaction, is essential for creating memory elements in modern computer technologies. To provide the necessary theoretical basis, we studied the structure and internal dynamics of spin nanoclusters limited by discrete domain walls in ferromagnetic chains placed in a magnetic field. The spin nanoclusters and their spectra of localized excitations are described analytically within the framework of the discrete Takeno-Homma equation [1], which fully accounts for the exchange interaction between spins. Explicit expressions for the internal mode oscillations were found, and the frequency dependences on the parameters of the exchange and the magnetic field were calculated. In addition, a stripe-like stability diagram and the Peierls energy barrier for the noncollinear discrete domain walls were established. We found that the magnetic field can effectively control the localization of information and energy on spin clusters. Our results can be used in developing spin-cluster resonance methods for investigating magneto-optical properties of a new class of low-dimensional metamaterials.

1. Takeno S. and Homma S., J.Phys.Soc.Jpn. 55, 2547 (1986).

MA 40.2 Thu 14:00 P2/EG

Curvature-induced effects in dynamics of domain walls in chiral biaxail nanotubes — •Kostiantyn V. Yershov[1,2] and Denis D. Sheka[3] — [1]Leibniz Institute for Solid State and Materials Research, Dresden, Germany — [2]Bogolyubov Institute for Theoretical Physics, Kyiv, Ukraine — [3]Taras Shevchenko National University of Kyiv, Ukraine

Tubular geometry is paradigmatic example for studying numerous chiral effect. The competition between intrinsic Dzyaloshinskii–Moriya interactions (DMI) and geometry-governed DMI become the source of emergent magnetochiral effects leading to essential modification of critical DMI strength, appearance of new type of domain walls (DWs) [1]. Here, we present a detailed study of static and dynamic properties of DWs in chiral biaxial nanotubes. The easy and hard axises are oriented in azimuthal and radial directions, respectively. (i) First, we considered the static properties of magnetic DWs in nanotubes with different symmetries of DMI. We found that the presence the chiral interaction results in the deformation of the DW profile: for interfacial type of DMI the DW phase has an asymmetrical slope; for bulk type of DMI the DW phase has a linear shift. In both cases deformation is proportional to the strength of DMI (ii) Dynamics of DWs with interfacial DMI results in the linear shift of the Walker field. While, for the case of the a bulk type of DMI we show that the presence of chiral interation results in the emergent magnetochiral effect, i.e. the polarity-helicity coupling. [1] K. Yershov et al, SciPost Phys. **9** (2020), 043.

MA 40.3 Thu 14:00 P2/EG

Dynamics of bound domain walls in the 3D magnetic double helix — •Imelda Pamela Morales Fernandez[1], Sandra Ruiz-Gómez[1], Aurelio Hierro-Rodríguez[2], Simone FInizio[3], Sebastian Wintz[4], Näemi Leo[5], Markus König[1], Claas Abert[6], Dieter Süss[6], Amalio Fernandez-Pacheco[5], and Claire Donnelly[1] — [1]Max Planck Institute for Chemical Physics of Solids — [2]University of Oviedo — [3]Paul Scherrer Institute — [4]Helmholtz Center Berlin — [5]Institute of Nanoscience and Materials of Aragon — [6]University of Vienna

Magnetic domain walls are stable magnetic textures that promise exciting opportunities for advances in technological applications in a wide range of fields. In contrast with their 2D counterparts, DWs in 3D nanosystems can exhibit more complex configurations, with prospects for exotic dynamic behavior. In this framework, double helix nanostructures combine geometrical effects of curvature and chirality with intrinsic exchange and magnetostatic coupling giving rise to a new state consisting of a highly coupled pair of domain walls (head-to-head and tail-to-tail) within the neighboring helices. The cobalt double helix fabricated by the FEBID technique is an ideal platform to experimentally investigate the static and dynamic properties of the coupled domain walls: it is a trustworthy platform to induce the vortex and antivortex textures in the magnetic field of the coupled domain wall state and on the other hand it is a promising system to achieve robust DW motion and synchronous dynamics with ultra-high DW mobilities overcoming the Walker breakdown.

MA 40.4 Thu 14:00 P2/EG

Current-induced creation of domain walls in synthetic antiferromagnets — Robin Msiska[1], •Omer Fetai[1], Raphael Kromin[2], Davi Rodrigues[3], and Karin Everschor-Sitte[1,4] — [1]TWIST group, University of Duisburg-Essen, Germany — [2]Institute of Physics, Johannes Gutenberg University Mainz, Germany — [3]Politecnico di Bari, Italy — [4]Center for Nanointegration Duisburg - Essen (CENIDE)

Improvements in the storage capacity of modern-day memory devices are slowing down and new concepts for storing data are required. A suggestion for a three-dimensional data storage is the racetrack memory which stores information in terms of magnetic domains. The use of synthetic antiferromagnets (SAF), i.e., antiferromagnetically coupled ferromagnetic bilayer systems, accelerates the information access time because the domain walls can be moved up to ten times faster [1]. To obtain a market-ready device, many challenges must be overcome, one of which is integrating a controlled domain wall write process into SAFs. We study the controlled creation of domain walls in SAFs by electrical means. In the case of spin-transfer torques, we find a critical current strength above which antiferromagnetic domain walls are created from an inhomogeneity. In contrast to the ferromagnetic case [2] we show that the critical current density is an order of magnitude higher.

[1] Stuart S. P. Parkin and et. al. Nat.Nanotechnol. 10 (2015)
[2] M. Sitte et al. Phys. Rev. B 94, 064422 (2016)

MA 40.5 Thu 14:00 P2/EG

Imaging the antiferromagnetic domain structure of α-Fe2O3 and its magnetic field dependence — •Julian Skolaut[1], Kai Litzius[2,3], Markus Weigand[4], Olena Gomonay[1], Elizaveta Tremsina[5], Sebastian Wintz[3,4], Norman Birge[6], Geoffrey Beach[5], and Angela Wittmann[1] — [1]Johannes Gutenberg University, Mainz — [2]University Augsburg — [3]MPI Intelligent Systems, Stuttgart — [4]HZB, Berlin — [5]MIT, Cambridge, USA — [6]Michigan State University, East Lansing, USA

In recent years, antiferromagnets have gained increasing attention for spintronics applications due to their favorable properties such as vanishing stray fields. Moreover, the domain structure formation mechanism is different from ferromagnets. Here, we study the canted antiferromagnet hematite α-Fe2O3. The canting of the spins yields a small in-plane magnetization, lifting the degeneracy of the Néel vector orientation w.r.t. an external magnetic field. Our measurements investigate the magnetic domain structure of hematite, specifically the movement of domain walls by application of an external magnetic field. For this, we have imaged the domain structure of α-Fe2O3 by taking x-ray magnetic linear dichroism (XMLD) contrast images of the domain structure of α-Fe2O3 by total electron yield using a scanning x-ray microscope. This method allows imaging of the domain structure within an applied magnetic field and studying the domain structure, as well as the displacement of domain walls as a function of the magnetic field. A thorough analysis of the changes in domain structure will elucidate the underlying mechanisms for the formation of magnetic domains.

MA 40.6 Thu 14:00 P2/EG

Tuning all-optical magnetization switching efficiency by laser pulse wavelength variation — •Marcel Kohlmann[1], Lucas Vollroth[1], Kristýna Hovovřáková[2], Eva Schmoranzerová[2], Robin John[1], Denise Hinzke[4], Peter Oppeneer[3], Ulrich Nowak[4], Markus Münzenberg[1], and Jakob Walowski[1] — [1]Greifswald University, Greifswald, Germany — [2]Charles University, Prague, Czech Republic — [3]Uppsala University, Uppsala, Sweden — [4]Konstanz University, Konstanz, Germany

The relevance of heat-assisted magnetic recording (HAMR) motivates ongoing research and development in magnetization manipulation. We study all-optical helicity-dependent switching (AOHDS) of FePt granular media as a viable alternative method for magnetic writing of HAMR media. The interplay of magnetic dichroism and inverse Faraday effect is currently understood as driving process behind the magnetization reversal. Ab-initio calculations of magnetic dichroism and inverse Faraday effect for the switching rates of single FePt nano particles provided us with a stochastic model for the switching process. We now present data for the wavelength dependent efficiency of the writing process from 800 nm - 1550 nm. We greatly acknowledge the DFG funding within the project "Fundamental aspects of all-optical single pulse switching in nanometer-sized magnetic storage media.

MA 40.7 Thu 14:00 P2/EG

Coherent excitation of spin waves in thin nickel films during ultrafast remagnetization — •Akira Lentfert[1], Anulekha De[1], Laura Scheuer[1], Benjamin Stadtmüller[1,2], Burkard Hillebrands[1], Georg von Freymann[1,3], Martin Aeschlimann[1], and Philipp Pirro[1] — [1]Department of Physics and Research Center OPTIMAS, RPTU Kaiserslautern-Landau, Germany — [2]Institute of Physics, Johannes Gutenberg University Mainz, Germany — [3]Fraunhofer Institute for Industrial Mathematics ITWM, Germany

The remagnetization process after ultrafast demagnetization can be described by relaxation mechanisms between the spin, electron, and lattice reservoirs. The angular momentum transfer between them is the subject of current research, especially the role of collective spin excitations remains comparably unexplored. In our work, we study the pump fluence-dependent excitation of coherent spin waves in thin nickel films. Using the all-optical, time-resolved magneto-optical Kerr-effect (tr-MOKE) technique, we investigate the role of coherent spin waves after the laser-induced demagnetization. We show that the largest spin-wave amplitude is observed close to the fully demagnetized state. Furthermore, the coherence of the system appears to be conserved during de- and remagnetization, even when the magnetization is quenched by up to 90%. Interestingly, the phase of the coherent oscillations relative to the initial laser pulse is strongly dependent on the laser fluence which indicates that the coherent precession is influenced by the demagnetization itself. This research was supported by the DFG through No. TRR 173-268565370 (project B11).

MA 40.8 Thu 14:00 P2/EG

Laser-induced ultrafast magnetization dynamics in Ni|Au heterostructures — •Stephanie Roden[1], Christopher Seibel[1], Marius Weber[1], Martin Stiehl[1], Sebastian T. Weber[1], Martin Aeschlimann[1], Benjamin Stadtmüller[1,2], Hans Christian Schneider[1], and Bärbel Rethfeld[1] — [1]Department of Physics and Research Center OPTIMAS, RPTU, Kaiserslautern, Germany — [2]Institute of Physics, Johannes Gutenberg University Mainz, Germany

Studying the optically induced magnetization dynamics of heterostructures has provided clear insights into the particle and energy transport effects on ultrafast timescales. This understanding leads to new concepts to control the magnetization dynamics by tuning the wavelength of optical excitation [1, 2, 3].

In this contribution we demonstrate how the magnetization dynamics of Ni|Au heterostructures can also be controlled by the thickness of the non-magnetic gold layer. Our conclusions are based on an extended temperature-based μT-model which includes the thickness-dependent absorption profile. We find that thin gold films slow down the demagnetization process of nickel while the demagnetization times decrease again for larger gold film thicknesses. Furthermore we consider transport effects within the gold layer and demonstrate the dependence of the induced spin polarization into the substrate on the considered depth in the substrate.

[1] V. Cardin *et al.*, Phys. Rev. B 101, 054430 (2020)
[2] M. Stiehl *et al.*, Appl. Phys. Lett. 120, 062410 (2022)
[3] C. Seibel *et al*, Phys. Rev. B 106, L140405 (2022)

MA 40.9 Thu 14:00 P2/EG

Optical manipulation of magnetic order parameter in magentic insulators by ultrashort laser pulses — •Paul Herrgen[1], Benjamin Stadtmüller[1,2], and Martin Aeschlimann[1] — [1]Department of Physics and Research Center OPTIMAS, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Institute of Physics, Johannes Gutenberg-Universität Mainz, 55128 Mainz, Germany

Magnetic insulators are highly intriging materials for high performance and sustainable magnetic storage technology. However, the existance of a band gap of several eV makes it rather challenging to optically manipulate these materials on an ultrafast, fs timescale.
Here, we used strong fs laser pulses with high photon energies to optically overcome this bandgap. Using a second ultrashort laser pulse, we were able to measure the dynamics of the magnetic order parameter of this insulator in a time-resolved manner. We find that the optical excitation leads to a fast reduction of the magnetic order on a sub-picosecond time scale. In addition, the remagnetization process takes more than 100ps to fully return to the initial magnetic ground state.

MA 40.10 Thu 14:00 P2/EG

Laser-induced metamagnetic phase transition of FeRh studied by combined UXRD and MOKE experiments — •Maximilian Mattern[1], Jasmin Jarecki[1], Vojtech Uhlir[2], Jon Ander Arregi[2], and Matias Bargheer[1,3] — [1]Institut für Physik und Astronomie, Universität Potsdam, Germany — [2]CEITEC BUT, Brno University of Technology, Czech Republic — [3]Helmholtz-Zentrum Berlin, Germany

We use time-resolved x-ray diffraction (UXRD) and the time-resolved polar magneto-optical Kerr effect (MOKE) to study the laser-induced metamagnetic phase transition in FeRh. The first-order phase transition from an antiferromagnetic (AFM) to a ferromagnetic (FM) phase is accompanied by a gigantic expansion ($\approx$ 0.6%) of the unit cell. While UXRD access the transient FM volume fraction independent of the orientation of the magnetic moment probing the enhanced lattice constant, MOKE is sensitive on the orientation of the magnetization probing the net out-of-plane magnetization.

Our combined UXRD and MOKE experiments access the nucleation, growth and coalescence of the arising FM domains and disentangle their in- and out-of-plane expansion by comparing two samples, with a thickness below and above the optical penetration depth. The thin FeRh film displays a fluence-independent rise time of the FM phase of 8 ps and a much slower rise of the net magnetization within 150 ps starting 10 ps after excitation. For the inhomogeneously excited film, we observe a strong fluence dependence of these rise times originating from an out-of-plane growth of the FM domains by heat transport.

MA 40.11 Thu 14:00 P2/EG

Consequences of Orbital Angular Momentum of Light for Electronic Dynamics — •Marvin Goronczy and Hans Christian Schneider — Physics Department, RPTU Kaiserslautern, 67653 Kaiserslautern

Recent experiments show that the orbital angular momentum (OAM) of laser pulses affects the demagnetization dynamics in ferromagnets by slowing it down or speeding it up depending on the direction of the orbital angular momentum. [1] Motivated by these experiments, we consider here the basic problem of the interaction of OAM-light with electrons in a generic band structure in order to study the effect of OAM-light on the electronic system, without attempting to includemagnetization dynamics yet. We derive the dynamical equations for the reduced electronic density matrix and its Wigner transform. We discuss the role played by different contributions, such as multipole transitions and the inhomogeneities introduced by the beam profile. Finally, we compare our results with earlier approaches to this problem.[2]

[1] E. Prinz, B. Stadtmüller, M. Aeschlimann, arXiv.2206.07502 [2] G. F. Quinteiro, P. I. Tamborenea, EPL 85/47001

MA 40.12 Thu 14:00 P2/EG

Magnetization dynamics in magnetic trilayers with a wedged antiferromagnetic spacer layer at ultrafast timescales — •Jendrik Gördes[1], Ivar Kumberg[1], Chowdhury Awsaf[1], Rahil Hosseinifar[1], Marcel Walter[1], Tauqir Shinwari[1], Sangeeta Thakur[1], Christian Schüssler-Langeheine[2], Niko Pontius[2], and Wolfgang Kuch[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Albert-Einstein-Straße 15, 12489 Berlin

We studied the time-resolved magnetization dynamics of an epitaxially grown heterostructure comprised of an antiferromagnetic (AFM) Mn wedge sandwiched between two ferromagnetic (FM) Co layers on Cu(001). The two FM layers were coupled indirectly by the Ruderman-Kittel-Kasuya-Yosida (RKKY) interaction and directly exchange coupled through the AFM spin structure, leading to parallel or antiparallel alignment of the FM layers, depending on the Mn thickness [1]. Deposition of Mn in a wedge allowed for access to different coupling regimes on the same sample. Magnetization dynamics were observed after excitation with 800 nm laser pulses by X-ray magnetic circular dichroism (XMCD) in resonant soft X-ray reflectivity. We point out the effect an antiferromagnetic spacer layer has on the magnetization dynamics of the FM layers.

[1] Bin Zhang et al., J. Appl. Phys. 115, 233915 (2014)

MA 40.13 Thu 14:00 P2/EG

Anomalous relaxation dynamics of different types of impurity models — •Michael Elbracht and Michael Potthoff — I. Institute of Theoretical Physics, University of Hamburg, Germany

The real-time relaxation dynamics of different types of one-dimensional lattice models with two additional impurities is investigated numerically. We study purely classical, purely quantum mechanical as well as semiclassical systems: (i) a model with two classical spins exchanged coupled to the classical Heisenberg model, (ii) two classical spins exchanged coupled to a tight-binding model of independent electrons, and (iii) a model with the spins replaced by two additional orbitals locally hybridizing with the tight-binding chain.

After an initial local excitation of the impurities, we trace the real-time dynamics by solving the respective fundamental equations of motion. Depending on the exact position of the impurities, the system does or does not fully relax to its local ground state. In all cases, one observes for an even distance between the impurities and after a prerelaxation to a low-energy state, that the system is trapped in a stationary oscillatory mode. Various mechanisms for this incomplete relaxation are considered, including the dynamical emergence of conserved local quantities.

MA 40.14 Thu 14:00 P2/EG

Spin reduction in the covalent chain antiferromagnets $RbFeSe_2$ and $KFeS_2$ — •Z. Seidov[1], H.-A. Krug von Nidda[1], A. Kiiamov[2], M. Kuznetsov[2], V. Tsurkan[2,3], I. Filippova[3], D. Croitori[3], F. Mayr[1], S. Widmann[1], F. Vagizov[2], D. Tayurskii[2], and L. Tagirov[2] — [1]EPV, EKM, Institute of Physics, University of Augsburg, D-86135 Augsburg, Germany — [2]Kazan, Russia — [3]Institute of Applied Physics, MD-20208 Chisinau, Moldova

SQUID susceptibility, Mössbauer and specific-heat measurements show that $RbFeSe_2$ and $KFeS_2$ exhibit antiferromagnetic order below $T_N =$ 248 K and $T_N = 251$ K, respectively. The magnetic specific heat and the spin state of the Fe^{3+} ions in the compounds have been analyzed. Phonon dispersion and phonon density of states (PDOS), were evaluated from first-principles calculations. Analysis of our Mössbauer data, utilizing the calculated Fe PDOS, as well as our optical absorption measurements have shown full agreement with the location of the high-frequency optical-type lattice vibrations within the FeX_4 (X = S, Se) tetrahedra. The phonon contribution to the heat capacity has been calculated from the PDOS and subtracted from the experimental data to extract the magnetic specific heat of the quasi 1D antiferromagnetically correlated Fe^{3+} ion chains. The corresponding magnetic entropy suggests a reduced spin value for the Fe^{3+} ions in both compounds, which seems to be close to an intermediate spin state $S = 3/2$ in $RbFeSe_2$ and to a low-spin state $S = 1/2$ in $KFeS_2$.

MA 40.15 Thu 14:00 P2/EG

Growth optimization and magnetotransport properties of ferromagnetic gadolinium nitride (GdN) thin films — •Raphael Hoepfl[1,2], Manuel Müller[1,2], Johannes Weber[1,2], Matthias Opel[1], Stephan Geprägs[1], Hans Huebl[1,2,3], Rudolf Gross[1,2,3], and Matthias Althammer[1,2] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Technical University of Munich, TUM School of Natural Sciences, Physics Department, Garching, Germany — [3]Munich Center for Quantum Science and Technology (MCQST), München, Germany

Ferromagnetic (FM) semiconductors are of great interest for spintronic devices. Gadolinium nitride (GdN) is one candidate for a FM semiconductor with a Curie temperature T_C=65-70 K [1]. By performing SQUID magnetometry and magnetotransport experiments in a cryogenic environment, we investigate the static magnetic and magnetoresistive properties of GdN thin film heterostructures. Tantalum nitride (TaN)/GdN/TaN trilayers are grown on the thermal oxide of Si substrates using DC magnetron sputtering, where the TaN is used as a electrically conductive seed and top layer. We study the impact of the various deposition parameters, such as deposition pressure, substrate temperature, growth rate and reactive N_2 gas flow on the static magnetic properties of GdN such as T_C and saturation magnetization M_s. For GdN layer stacks grown with our optimized recipe, we perform magnetotransport experiments and identify the origin of magnetoresistance in our heterostructures.

[1] W. B. Mi *et al.*, Appl. Phys. Lett. **102**, 222411 (2013).

MA 40.16 Thu 14:00 P2/EG

Tuning the physical properties of La0.7Sr0.3MnO3-δ via oxygen off-stoichiometry using thermal annealing — •chenyang yin[1], lei cao[1], suqin he[2], tomas duchon[3], yunxia zhou[4], oleg petracic[1], and thomas brückel[1] — [1]Jülich Centre for Neutron Science (JCNS-2) and Peter Grünberg Institut (PGI-4), JARA-FIT, Forschungszentrum Jülich GmbH, Jülich, Germany — [2]Peter Grünberg Institut (PGI-7), JARA-FIT, Forschungszentrum Jülich GmbH, Jülich, Germany — [3]Peter Grünberg Institut (PGI-6), JARA-FIT, Forschungszentrum Jülich GmbH, Jülich, Germany — [4]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany

The oxygen off-stoichiometry in La0.7Sr0.3MnO3-δ (LSMO) thin films on SrTiO3 (STO) substrates has been investigated employing Al-assisted vacuum annealing. The gradual deoxygenation during annealing induces a topotactic phase transition from the as-prepared Perovskite (PV, ABO3) phase to a layered oxygen-vacancy-ordered Brownmillerite (BM, ABO2.5) phase. The structural change is monitored by XRD. A metal-to-insulator and simultaneously a ferromagnetic (FM)-to-antiferromagnetic (AF) transition is found. The variation of the manganese oxidation state is characterized using XAS. The BM phase shows in magnetization vs. temperature curves a peculiar peak above room temperature which cannot be explained within the usual AF ordering at low temperatures. Moreover, to elucidate the role of the strain to the substrate, bulk-like LSMO powder samples were prepared and annealed at similar conditions as the film samples. Also here the PV-BM phase transition is achieved.

MA 40.17 Thu 14:00 P2/EG

Growth and characterization of $Ca_xSr_{1-x}RuO_3$ ($x = 0, 0.3, 0.5, 0.7$) and $Sr_4Ru_3O_{10}$ single crystals — •Zahrasadat Ghazinezhad[1], Akshay Tewari[1], Agustinus Agung Nugroho[2], Kevin Jenni[1], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln, Zülpicher Straße 77, D-50937 Köln, Germany — [2]Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung, Jl. Ganesha 10, Bandung 40132, Indonesia

The Ruddlesden-Popper (RP) series of strontium ruthenates $Sr_{n+1}Ru_nO_{3n+1}$ manifests an interesting variety of phenomena. Here we focus on the crystal growth and on the detailed characterization of the ferromagnetic $SrRuO_3$ (n=∞, 1-1-3) and $Sr_4Ru_3O_{10}$ (n=3, 4-3-10) systems. A peculiar property of the mixed 1-1-3 materials $Ca_xSr_{1-x}RuO_3$ with $x = 0, 0.3, 0.5, 0.7$ concerns the tuning of electronic and magnetic features by substitution of smaller Ca^{2+} ions into the Sr^{2+} sites while not changing the electronic configuration [1].The triple-layer ruthenate compound $Sr_4Ru_3O_{10}$ exhibits a ferromagnetic transition at $T_C = 105K$ followed by an additional magnetic transition at $T_M = 50K$ which remains matter of controversy. This layered material also shows strong anisotropy concerning the application of magnetic fields [2]. Large single-crystals of $Sr_4Ru_3O_{10}$ could be grown by the floating-zone technique and were characterized by structural and magnetization measurements.

[1] K. Yoshimura,et al. Phys. Rev. Lett. **83**, 4397 (1999).
[2] M. Zhu, et al. Scientific reports **8**, 1 (2018).

MA 40.18 Thu 14:00 P2/EG

Analysis of Exchange Bias training effect in Exchange coupled LaFeO3 /NiO nanocomposite — •Priyanka Sharma[1] and Ratnamala Chatterjee[2] — [1]Indian Institute of Technology Delhi, New Delhi 110016, India — [2]Indian Institute of Technology Delhi, New Delhi 110016, India

Existence of exchange bias (EB) resulting from antiferromagnetic/ferromagnetic interface is well known in the literature. EB phenomenon is characterized by the horizontal shift of the magnetic hysteresis loop as the system is cooled through Neel's temperature in presence of an external magnetic field. EB is the backbone of designing magnetic storage devices and is among the modern approaches to spintronics. One of the interesting characteristics of EB is the training effect [1]. In this work, we investigate the EB training effect (TE) in LaFeO3/NiO nanocomposite synthesized by a chemical route. The consecutive measurement of field cooled (60 kOe) magnetic hysteresis loops at 5 K show that the exchange bias field (HE) decreases with the increasing number of cycles of M-H loops (n) confirming the presence of the TE effect in our sample. The experimentally observed trend between HE and n was fitted using the power law and Binek's recursive relation. From the Binek's recursive relation, the obtained value of HE infinity (EB field in the limit of infinite loops) and γ (sample dependent constant) is 1118 Oe & 6.9X10^(-7) (Oe)-2, respectively. Both, the power law and Binek's recursive relation points coincide well with the experimental observations.

[1] C. Binek, Physical Review B 70 (1), 014421 (2004).

MA 40.19 Thu 14:00 P2/EG

Impact of Currents on SDW Order in Sr_2RuO_4 — •Felix Wirth, Thomas Lorenz, and Markus Braden — II. Physikalisches Institut, Köln, Germany

Unconventional superconductivity and magnetic correlations are expected to be closely coupled in Sr_2RuO_4. Ca- and Ti-doped Sr_2RuO_4 exhibit incommensurate (IC) spin density wave (SDW) order below about 20 K appearing at the same wave vector where IC antiferromagnetic spin fluctuations exist in the pure compound. A recent attempt to explain the magnetic order induced by Ti-doping, proposed a potential enhancement of the SDW order by applying an external charge current[1]. To prove this idea Sr_2RuO_4 single crystals doped with 25 % Ca or with 9 % Ti were grown by the optical floating zone technique. The crystal quality was greatly improved during the iterative process of crystal growth. For the investigations of the impact of currents on the SDW order, the MPMS SQUID magnetometer was adapted. No influence of currents on the SDW state was observed that could not be attributed to sample heating issues. Recorded I-U characteristics did not reveal correlations between the SDW and the electronic properties of the system. Thermal expansion shows significant differences for both cases. The thermal expansion of the Ca-doped crystal qualitatively agrees with results for higher Ca concentrations but does not indicate connections to the SDW state. A negative thermal expansion at low temperatures in the Ti-doped crystal may point to a weak correlation to the SDW state but it also resembles the behaviour in pure Sr_2RuO_4. [1]B. Zinkl, et al. Phys. Rev. Res. 3 (2021).

MA 40.20 Thu 14:00 P2/EG

Magnetic phases in the perovskite vanadate ErVO3 — •Elaheh Sadrollahi[1], Jochen Litterst[2], Tobias Ritschel[1], and Jochen Geck[1] — [1]Institut für Festkörper- und Materialphysik, Technische Universität Dresden, 01069 Dresden, Germany — [2]Institut für Physik der Kondensierten Materie, Technische Universität Braunschweig, 38106 Braunschweig, Germany

The perovskite-type vanadium oxide, ErVO3, with Jahn-Teller active t2g electrons at the V site, is a prototypical correlated electron system with orbital degrees of freedom [1-3]. It features an intimate interplay between spin, orbital, and lattice interactions leading to several magnetic transitions. We have performed muSR on the perovskite vanadate ErVO3. Magnetic susceptibility, specific heat, and neutron diffraction measurements on single crystals reveal orbital ordering and orbital-flipping transitions, as well as spin ordering/spin reorientation transitions. Our muSR survey picks up these magnetic transitions and spin freezing of about 20% of the sample volume below 3 K. [1] P. Telang et al, Journal of Crystal Growth 507, 406-412 (2019) [2] P. Bordet et al. J.Solid State Chem. 106, 253 (1993) [3] M. Reehuis et al. Phys. Rev. B 73, 094440 (2006)

MA 40.21 Thu 14:00 P2/EG

Theoretical investigation of magnetic order in crystals with space group $I4_1md$ — •Maurice Colling[1] and Jan Masell[1,2] — [1]Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany — [2]RIKEN CEMS, Wako, Japan

Non-collinear magnetic textures with short ranged modulation in the magnetization exhibit novel transport behavior. Such textures have been proposed to be useful in next generation magnetic memory devices. [1] Materials in the space group $I4_1md$ (#109), such as the Weyl semimetal GdAlSi, are interesting candidates for investigations in this direction because of the many potentially competing interactions. Long-ranged RKKY interaction might stabilize atomic scale spin spirals. Broken inversion symmetry generates an interfacial Dzyaloshinskii-Moriya interaction which favors Néel type spirals. Dipolar interactions, in turn, favor Bloch type helices. We derive a phenomenological Hamiltonian based on symmetry analysis and present the rich phase diagram.

[1] J. Masell, X. Z. Yu, N. Kanazawa, Y. Tokura, and N. Nagaosa, Phys. Rev. B 102, 180402 (2020).

MA 40.22 Thu 14:00 P2/EG

Crystal structural investigations of frustrated 3D spin-$\frac{1}{2}$ system $CuSn(OH)_6$ — •Kaushick Parui[1], Anton Kulbakov[1], Ellen Häussler[2], Thomas Doert[2], Vladimir Pomjakushin[3], Dmytro Inosov[1], and Darren Peets[1] — [1]IFMP, TU Dresden, Germany — [2]Professur f. Anorganische Chemie II, TU Dresden, Germany — [3]LNS, Paul Scherrer Institut, Switzerland

Copper tin hydroxide, $CuSn(OH)_6$ is an A-site-vacant double perovskite with the general stoichiometry $\square_2(BB')(OH)_6$, where B and B' are transition metals. Here, the magnetic Cu^{2+} ions sit on a face-centred sublattice, which makes the system frustrated and is expected to exhibit exotic quantum magnetism. Room-temperature x-ray diffraction performed on polycrystalline samples reveals tetragonal $P4_2/n$ symmetry, possibly with a minor monoclinic distortion. The structure is characterized by the presence of alternating corner-sharing $[Cu^{2+}(OH)_6]$ and $[Sn^{4+}(OH)_6]$ at 4d and 4c sites, respectively. Low-temperature neutron diffraction performed on deuterated powder samples accurately determined hydrogen positions. The positions of other atoms differ significantly from the previously published structure. Our proposed crystal structure of $CuSn(OH)_6$ is consistent with the tilt system $a^+a^+c^-$, as compared to the earlier proposed $a^0b^+b^+$. Magnetization measurements reveal a weak anomaly at 4.1 K suggesting a possible magnetic transition. Surprisingly, magnetic neutron diffraction revealed no long-range order down to 1.6 K. The Curie-Weiss temperature of $-7.1(3)$ K, indicating antiferromagnetic interactions, and a paramagnetic moment of $\approx 2.2\mu_B$ were also determined.

MA 40.23 Thu 14:00 P2/EG

Magnetoelastic Coupling, Grüneisen Scaling and Magnetic Phase Diagram of the Kitaev Material $Na_2Co_2TeO_6$ — •Marius Säubert[1], Jan Arneth[1], Kwang-Yong Choi[2], and Rüdiger Klingeler[1] — [1]Kirchhoff Institute for Physics, Heidelberg University, Germany — [2]Department of Physics, Sungkyunkwan University, Republic of Korea

We report high-resolution thermal expansion and magnetostriction measurements on the Kitaev candidate material $Na_2Co_2TeO_6$ down to low temperatures and up to high magnetic fields. Our data enable us to quantify magnetoelastic coupling and identify dominant energy scales by means of Grüneisen analysis. Combined magnetisation and magnetostriction studies reveal a hitherto unreported, field-induced crossover for $B||c$ accompanied by a sign change of $\partial T_N/\partial B$. For magnetic fields applied parallel to the honeycomb planes, magnetostriction shows that the anomaly in magnetisation at $B_C \simeq 6\,T$, which has recently been speculated to mark the onset of magnetic disorder, is connected to discontinuous lattice changes. Finally, our dilatometric studies allow us to construct the magnetic phase diagram of $Na_2Co_2TeO_6$ which displays strong hysteresis at low temperatures.

MA 40.24 Thu 14:00 P2/EG

Non-Coplanar Magnetic Orders in Classical Square-Kagome Antiferromagnets — •Martin Gembé[1], Heinz-Jürgen Schmidt[2], Ciarán Hickey[1], Johannes Richter[3,4], Yasir Iqbal[5], and Simon

Trebst[1] — [1]Institute for Theoretical Physics, University of Cologne, Germany — [2]Fachbereich Physik, Universität Osnabrück, Germany — [3]Institut für Physik, Otto-von-Guericke-Universität Magdeburg, Germany — [4]Max-Planck-Institut für Physik Komplexer Systeme, Dresden, Germany — [5]Department of Physics and Quantum Centers in Diamond and Emerging Materials (QuCenDiEM) group, Indian Institute of Technology Madras, India

Motivated by the recent synthesis of $KCu_6AlBiO_4(SO_4)_5Cl$, we study the classical Heisenberg model on the square-kagome lattice – also called the squagome or shuriken lattice. This cousin of the kagome lattice exhibits, already on the classical level, a rich phenomenology of frustrated magnetism including residual entropy, order-by-disorder, and non-coplanar ordering tendencies. Having in mind that upon introducing quantum fluctuations, non-coplanar order melts into chiral spin liquids, we explore the multitude of non-coplanar orders including some which break rotational symmetry (possibly leading to nematic quantum orders), for an elementary, classical Heisenberg model on the squagome lattice supplemented by cross-plaquette interations.

MA 40.25 Thu 14:00 P2/EG

Frustrated Low-dimensional Copper Compounds Bluebellite and Rouaite. — •Aswathi Mannathanath Chakkingal[1], Falk Pabst[2], Vladimir Pomjakushin[3], Maxim Avdeev[4], Roman Gumeniuk[5], Darren Peets[1], and Dmytro Inosov[1] — [1]IFMP, TU Dresden, Germany — [2]Professur f. Anorganische Chemie II, TU Dresden, Germany — [3]PSI, Switzerland — [4]ANSTO, Australia — [5]Institut für Experimentelle Physik, TU Bergakademie Freiberg, Germany

The hydrothermal technique is an efficient strategy to synthesize mineralogically inspired structures, including natural and synthetic cuprate minerals with a variety of exciting frustrated magnetic lattices. We report the hydrothermal synthesis of bluebellite ($Cu_6[(IO_3)(OH)_3](OH)_7Cl$) and rouaite ($Cu_2(NO_3)(OH)_3$). Neutron diffraction studies were performed to determine both compound's crystal structure and magnetic structure. $Cu_2(NO_3)(OH)_3$ crystallizes in a monoclinic structure consisting of a ferromagnetic chain and an antiferromagnetic chain of Cu^{2+}. This is similar to the botallackite ($Cu(OH)_3Br$) in which spinon-magnon mixing was recently reported. $Cu_6[(IO_3)(OH)_3](OH)_7Cl$ crystallizes in a trigonal structure, and the magnetic Cu^{2+} forms a distorted maple-leaf lattice. Frustration effects and quantum fluctuations in spin-1/2 maple-leaf lattice antiferromagnets may give rise to interesting phenomena. We report details of the crystal structure, magnetic structure, and the low-temperature magnetic and thermal properties.

MA 40.26 Thu 14:00 P2/EG

Variational iPEPS — •Erik Weerda[1], Jan Naumann[2], Matteo Rizzi[2], Jens Eisert[1], and Philipp Schmoll[1] — [1]Institute for Theoretical Physics, University of Cologne, D-50937 Köln, Germany — [2]Dahlem Center for Complex Quantum Systems and Institute for Theoretical Physics, Freie Universität Berlin, 14195 Berlin, Germany

Tensor networks capture large classes of ground states of phases of quantum matter faithfully and efficiently. Their manipulation and contraction has remained a challenge over the years, however. For most of the history of projected entangled pair states, ground state simulations of two-dimensional quantum lattice systems using (infinite) projected entangled pair states have relied on what is called a time-evolving block decimation. In recent years, multiple proposals for the variational optimization of the quantum state have been put forward, overcoming accuracy and convergence problems of previously known methods. The incorporation of automatic differentiation in tensor networks algorithms has ultimately enabled a new, flexible way for variational simu- lation of ground states and excited states. In this work, we present and explain the functioning of an efficient, comprehensive and general tensor network library for the simulation of infinite two-dimensional systems using iPEPS, with support of different lattice geometries, flexible unit cells, the use of symmetries and GPU calculations.

MA 40.27 Thu 14:00 P2/EG

Charge dynamics in doped frustrated magnets and quantum spin liquids — •Luke Staszewski and Alexander Wietek — Max Planck Institute for the Physics of Complex Systems, 01187 Dresden, Germany

The advent of recent developments in algorithms, namely finite temperature tensor network related algorithms, has opened the doors to a serious numerical testbed for investigating the plethora of interesting phenomenology in strongly interacting electron systems. This testbed is taking us a step closer to understanding an array of systems displaying unconventional superconductivity as well as helping answer questions about the delicate interplay between magnetic correlations and the onset of superconductivity in such materials. This work looks at how the mobility of holes is affected by various magnetic environments and vice versa in the hope to shed some more light on the nature of the mechanisms at play in the resulting phases that have recently been demonstrated both numerically and experimentally. We focus on the role geometric magnetic frustration plays in leading to both unconventional superconductivity, and exotic magnetic order, such as quantum spin liquids.

MA 40.28 Thu 14:00 P2/EG

Micromagnetic simulation of magnetic reversal processes in exchange biased thin film geometries — •Lukas Paetzold, Sapida Akhundzada, Christian Janzen, and Arno Ehresmann — Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Strasse 40, 34132 Kassel, Germany

As first observed by Meiklejohn and Bean [1] and described as a unidirectional anisotropy, the exchange bias is a well-known interface effect between antiferromagnetic and ferromagnetic thin films. Initiated by field cooling [1], sputter deposition [2], or light-ion bombardment [3] the effect appears as a shift of the hysteresis loop and increased coercive fields [4]. Micromagnetic simulations [5,6] are presented for investigating the magnetic reversal processes in exchange biased thin film systems with a polycrystalline uncompensated antiferromagnetic layer. Different geometries like stripes, squares and discs in the micrometer range are simulated and the influence of modified magnetic parameters in the edges is investigated.

[1] W. H. Meiklejohn et al., Phys. Rev. 105, 904 (1956)
[2] A. E. Berkowitz et al., J. Magn. Magn. Mater. 200, 552-570 (1999)
[3] D. Engel et al., J. Magn. Magn. Mater. 293, 849-853 (2005)
[4] J. Nogués et al., J. Magn. Magn. Mater. 192(2), 203-232 (1999)
[5] A. Vansteenkiste et al., AIP Advances 4, 107133 (2014)
[6] J. De Clercq et al., J. Phys. D: Appl. Phys. 49, 435001 (2016)

MA 40.29 Thu 14:00 P2/EG

Magneto-ionic control of magnetic properties in perpendicular magnetized synthetic antiferromagnet stacks — •Maria-Andromachi Syskaki[1], Takaaki Dohi[2,3], Mona Bhukta[2], Jürgen Langer[1], Mathias Kläui[2], and Gerhard Jakob[2] — [1]Singulus Technologies AG, 63796 Kahl am Main, Germany — [2]Institut für Physik, Johannes Gutenberg-Universität Mainz, Staudingerweg 7, 55128 Mainz, Germany — [3]Laboratory for Nanoelectronics and Spintronics, Research Institute of Electrical Communication, Tohoku University, Sendai, Japan

Voltage-controlled spintronic devices are the key to a more energy-efficient way for future storage applications [1]. Electric field effect experiments in this direction reported that the application of a low-power ionic liquid gating technique [2] to nearly compensated synthetic antiferromagnet (SAF) stacks gives rise to high domain wall velocities [3]. In our work, we have grown a SAF stack by magnetron sputtering consisting of two ferromagnetic layers coupled by a non-magnetic spacer layer. The coupling strength is modified by tuning the thickness of the spacer layer to investigate the electric field modulation. With room temperature voltage-controlled magneto-ionic effects, we focus on the modulation of the magnetic properties in this system, i.e., the control of the compensation ratio, the perpendicular magnetic anisotropy, and the antiferromagnetic RKKY coupling strength. [1] T. Nozaki et al., Micromachines 10(5), 327 (2019). [2] C. Leighton et al., Nature Mater 18, 13 (2019). [3] Y. Guan et al., Nat. Commun. 12, 5002 (2021).

MA 40.30 Thu 14:00 P2/EG

Exchange bias in PtMn/Co: New insights into its origin and possibilities for manipulation — •Beatrice Bednarz[1], Maria-Andromachi Syskaki[2], Rohit Pachat[3], Liza Herrera-Diez[3], Armin Kleibert[4], Mathias Kläui[1], and Gerhard Jakob[1] — [1]Johannes Gutenberg-University, Mainz, Germany — [2]Singulus Technology AG, Kahl, Germany — [3]Université Paris-Saclay, Palaiseau, France — [4]Paul Scherrer Institute, Villigen PSI, Switzerland

Exchange bias is fundamental for many spintronic devices as a means of pinning the direction of the ferromagnetic layer [1,2] and for exerting an intrinsic magnetic field for field-free switching [3]. One of the most commonly used antiferromagnets for this purpose is PtMn [4]. It has a CuAu-I type structure with a high bulk Néel temperature of 975 K and high thermal stability [4]. In this study, we report on new insights into its magnetic structure and the effect on the exchange bias. The magnetic domains were imaged for crystalline as well as polycristalline PtMn by x-ray magnetic linear dichroism (XMLD) photo-emission electron microscopy (PEEM). We found that the drastic difference in the exchange bias is not caused by a difference in the domain size but only by differences in the domain orientations. Furthermore, we show that the magnetic properties of the exchange biased system can be reversibly controlled by ionic liquid gating.

[1] A.V. Khvalkovskiy et al., J. Phys. D: Appl. Phys. 46, 074001 (2013). [2] S.S.P. Parkin et al., J. Appl. Phys. 85, 5828 (1999). [3] A. van den Brink et al., Nat. Commun. 7, 10854 (2016). [4] G.W. Anderson et al., J. Appl. Phys. 87, 5726 (2000).

MA 40.31 Thu 14:00 P2/EG

Relaxation behavior of antiferromagnetic grains in polycrystalline exchange-biased bilayers — •Maximilian Merkel, Rico Huhnstock, Meike Reginka, and Arno Ehresmann — Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel

Measuring first-order reversal curves, a prototypical polycrystalline exchange-biased bilayer was found to exhibit a viscous decrease of the ferromagnetic in-plane magnetization upon increasing the external magnetic field. [1] The observed phenomenon is mediated by a rotatable magnetic anisotropy arising from thermally unstable antiferromagnetic grains coupled to the probed ferromagnet. The investigations, performed with the help of angular-resolved vectorial Kerr magnetometry and Kerr microscopy, are further in agreement with a generalized description of polycrystalline exchange-bias systems. The study emphasizes the relevance of understanding minor loop behavior addressing non-saturated magnetic states for systems susceptible to dynamic changes on the hysteresis loop timescale.

[1] Merkel et al., Phys. Rev. B 104, 214406 (2021)

MA 40.32 Thu 14:00 P2/EG

Tailoring the electronic and magnetic properties of the layered antiferromagnet $CrCl_2$ — •Diana Vaclavkova, Vladyslav Romankov, Niéli Daffé, and Jan Dreiser — Swiss Light Source (SLS), Paul Scherrer Institut (PSI), CH-5232 Villigen PSI, Switzerland

The electronic and magnetic properties of two-dimensional van der Waals (vdW) materials differ greatly when comparing mono- and few-layered flakes to their bulk counterparts. In the case of atomically thin single layers the substrate has a profound influence on their properties. $CrCl_2$, belonging to the family of vdW materials, is expected to show a geometrical frustration in the monolayer limit given antiferromagnetic interactions are present [1]. Our preliminary studies involve X-ray magnetic circular dichroism measurements of mono- and few-layered $CrCl_2$ deposited on different materials. Based on the initial interpretation of the experimental data, methods for tailoring the magnetic properties by careful choice of the substrate material will be discussed.

[1] McGuire, M. A. (2017). Crystal and magnetic structures in layered, transition metal dihalides and trihalides. Crystals, 7(5), 121.

MA 40.33 Thu 14:00 P2/EG

Angle dependent FMR studies on YIG films — •Tim Vogel[1], David Breitbach[1], Carsten Dubs[2], Burkard Hillebrands[1], and Philipp Pirro[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, RPTU Kaiserslautern-Landau, Germany — [2]INNOVENT e.V. Technologieentwicklung, Jena, Germany

Yttrium iron garnet (YIG) is a commonly used material in magnonics due to its low spin-wave damping. Previous ferromagnetic resonance spectroscopy (FMR) studies on (111) grown YIG thin films suggested a deviation from the expected sixfold symmetry of the magnetocrystalline anisotropy for large external fields. For more in-depth investigations, we developed a fully automized setup for angle dependent vector-network-analyzer-FMR studies of in-plane magnetized YIG films. We apply this setup to investigate a (111) grown, d=55nm thick LPE YIG film. Our results confirm the expected sixfold symmetry even for high external field values. Further, we apply the setup to quantify the effect of the present anisotropy field. This study contributes to the understanding of YIG thin films and the impact of magnetocrystalline anisotropy for magnonic applications.

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MA 40.34 Thu 14:00 P2/EG

Quantification of anisotropic and magneto-elastic contributions to the SSW excitation in Bi:YIG films via UXRD — •Steffen Peer Zeuschner[1], Xi-Guang Wang[3,4], Marwan Deb[1], Elena Popova[5], Gregory Malinowski[6], Michel Hehn[6], Alexander von Reppert[1], Nils Keller[5], Jamal Berakdar[4], and Matias Bargheer[1,2] — [1]Universität Potsdam, 14476 Potsdam, Germany — [2]Helmholtz-Zentrum Berlin, 12489 Berlin, Germany — [3]Central South University, Changsha 410083, China — [4]Martin-Luther Universität, 06099 Halle/Saale, Germany — [5]Institut de Physique de Rennes (IPR, CNRS) UMR6251 Université Rennes, 35000 Rennes, France — [6]Institut Jean Lamour (IJL, CNRS) UMR 7198, Université de Lorraine, 54506 Vandaeuvre-lès-Nancy, France

The photoexcited standing spin waves (SSWs) in the ferromagnetic insulator Bi:YIG are generated by the ultrafast change of the magnetocrystalline anisotropy and the picosecond strain dynamics via magneto-elasticity. Ultrafast X-ray diffraction (UXRD) quantifies the strain and temperature spatio-temporally which is used as in input to a numerical micromagnetic model to fit the ultrafast time-resolved magneto-optical Kerr-effect (tr-MOKE) data of the thin film which exhibits SSWs. With this, we prove that both mechanisms drive the fundamental mode with opposite phase. Both mechanisms are also substantially active as the relative amplitude of the higher order modes indicates. This is a prime example for the exceptional assistance UXRD offers in the understanding and modelling of ultrafast magnetic phenomena.

MA 40.35 Thu 14:00 P2/EG

Generating small magnetic fields inside an open-end magnetic shielding with a superconducting solenoid magnet — •Lukas Vogl[1,2], Ana Strinc[1,2,3], Franz Haslbeck[1], Rudolf Gross[1,2,3], and Nadezhda Kukharchyk[1,2,3] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Physik-Department, Technische Universität München, Garching, Germany — [3]Munich Center for Quantum Science and Technologies, München, Germany

Quantum memory is an essential part for the development of quantum computers. One of the most promising realisation of quantum memories has been realised for storage of optical photons in rare-earth-doped crystals, reaching a storage time of 6 hours. The long storage time has been achieved due to working at the zero first-order Zeeman shift point (ZEFOZ). At this point, the phase-sensitivity of a spin system to the magnetic field fluctuations is strongly reduced, and thus longer coherence times can be achieved. Such ZEFOZ transitions are present in the hyperfine states of rare earth ions close to zero magnetic fields, which enables the design of quantum memories compatible with the zero-field environments required for superconducting quantum computing curcuits. Here, we present a setup for a highly controllable homogeneous magnetic environment with additional shielding from external background magnetic fields. This environment will allow for precise control of the magnetic field at the sample position, fine tuning to the ZEFOZ transitions, and additional protection of the superconducting quantum circuits from the fields applied to the rare earth spins.

MA 40.36 Thu 14:00 P2/EG

Design and set-up of an optomechanical readout apparatus to characterize magnetic field sensors encompassing high-Q resonators down to 4 K — Torben Hänke, •Dhavalkumar Mungpara, and Alexander Schwarz — Institute of Nanostructure and Solid State Physics, University of Hamburg, Jungiusstr. 11, 20355 Hamburg

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

Here, we present a set-up to characterize the mechanical properties of potential resonators alone or already integrated into the hybrid sensor. To do so, the resonator motion is detected using an all-fiber interferometer inside a dip stick, which can be pumped to pressures below 10^{-6} mbar and cooled down to 4 K. Alignment between fiber and resonator in x-, y- and z-directions is done with remotely operated precision piezomotors. The resonator can be excited using an integrated shaker piezo to record amplitude and phase response curves. Without external excitation the power spectral density can be recorded and to test the performance of the complete hybrid sensor in operation, the frequency change of the resonator can be monitored.

The OXiNEMS project (www.oxinems.eu) has received funding from the European Union's Horizon 2020 research and innovation program under Grant Agreement No. 828784.

MA 40.37 Thu 14:00 P2/EG

Micro-Hall magnetometry for multiscale magnetic measurements — •Bereket Ghebretinsae[1], Charu Garg[1], Martin Lonsky[1], Mohanad Al Mamoori[1], Michael Huth[1], Christian Schröder[2], Priscila Rosa[3], and Jens Müller[1] — [1]Institute of Physics, Goethe University, 60438 Frankfurt (M), Germany — [2]Institute for Applied Materials Research, University of Applied Sciences Bielefeld, Bielefeld 33619, Germany — [3]Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA

Micro-Hall magnetometry is a technique that allows for ultra-sensitive magnetic stray field measurements on macro- to micro- to nanoscaled samples. The magnetometer is a Hall sensor that utilizes the very high electron mobility of a two-dimensional electron gas inside a GaAs/AlGaAs heterostructure to resolve even smallest changes in the sample's stray field almost instantaneously. The technique is unique especially in its versatility. Firstly, the Hall sensor itself can serve as a substrate for the growth of nanoscaled magnetic samples with complex geometries. Secondly, microscopic and even macroscopic samples can be placed directly ontop of the sensor surface such that the stray field emanating from the surface of the sample is captured by the Hall sensor. Here we demonstrate the utility of this technique using (i) 3D ferromagnetic FeCo nanostructures and (ii) single crystalline microsized $Eu_5In_2Sb_6$ with two antiferromagnetic transitions. We present magnetic field- and temperature dependent micro-Hall measurements to explain the details of the technique and prove its usefulness as a tool for the study of multiscale magnetic phenomena.

MA 40.38 Thu 14:00 P2/EG

PUMA: Thermal neutron three axes spectrometer — •Alsu Gazizulina[1], Avishek Maity[2], Jitae Park[2], and Frank Weber[1] — [1]Institute of Quantum Materials and Technologies, Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany — [2]Heinz Maier-Leibnitz Zentrum, Technical University of Munich, Garching, Germany

Thermal neutron three axes spectrometer PUMA is characterized by a very high neutron flux as a result of the efficient use of focusing techniques. An innovative option of the spectrometer is the multi-analyzer/detector system, which allows a unique and flexible type of multiplexing. Using this option, a scattering angle range of 16° can be measured simultaneously and flexible $Q-\omega$ paths can be realized without repositioning the instrument. The typical scientific applications of PUMA are studies of phonons and magnons. Furthermore, a unique feature of the instrument is the possibility to perform stroboscopic, time resolved measurements of both elastic and inelastic signals on time scales down to the microsecond regime. Using this technique, the sample is periodically perturbed by an external variable such as temperature, electric field, etc. The signal is then recorded not only as a function of momentum and energy transfer, but also given a time stamp, relative to the periodic perturbation. Since 2021, the Neutron Scattering Group of the Institute of Quantum Materials and Technologies (IQMT) of the Karlsruhe Institute of Technology (KIT) has been jointly operating the PUMA three-axes spectrometer at MLZ within the framework of a collaboration contract.

MA 40.39 Thu 14:00 P2/EG

Pulse-triggered detection of resonant magnetic small-angle scattering at a laser-driven X-ray source — •Leonid Lunin[1], Martin Borchert[1], Daniel Schick[1], Bastian Pfau[1], and Stefan Eisebitt[1,2] — [1]Max-Born-Institut, Berlin, Germany — [2]Technische Universität, Berlin, Germany

Resonant soft-x-ray scattering methods provide unique possibilities to study nanometer-scale magnetization dynamics on ultrashort timescales. Typically, these experiments are performed at synchrotron-radiation (SR) sources or x-ray free-electron lasers (XFELs) due to the required tunability and intensity of the radiation. While XFELs still offer only limited access, the available time resolution at SR sources on the order of 100 ps is insufficient for many phenomena in ultrafast magnetism. We developed an instrument based on a laser-driven plasma x-ray source to perform resonant x-ray scattering in the wavelength regime between 50 eV and 1500 eV with pulses of 10 ps duration. Specifically, we here present the first resonant small-angle x-ray scattering experiment on a laboratory scale with photon energies in the range of the transition-metal L edges and the rare-earth-metal M edges. In our pilot experiment, we detect scattering from domains forming in a ferrimagnetic Fe/Gd multilayer using an electronically triggered hybrid detector with single-photon sensitivity. Such laboratory-based measurements will allow studying magnetization dynamics with high spatio-temporal resolution in a much more efficient and flexible way than possible today.

MA 40.40 Thu 14:00 P2/EG

Quantitative high sensitivity Magnetic Force Microscopy in vacuum — •Christopher Habenschaden[1], Sibylle Sievers[1], and Andrea Cerreta[2] — [1]Physikalisch-Technische Bundesanstalt, Braunschweig, Germany — [2]Park Systems Europe GmbH, Mannheim, Germany

Magnetic Force Microscopy (MFM) allows the imaging of magnetic samples with spatial resolution of tens of nm and stray field resolution down to the mT range. However, it lacks comparability between measurements, which can be overcome by calibrating the tip, using a magnetic reference sample. This enables the calculation of sample stray fields in A/m, allowing quantitative MFM measurements.

Spatial resolution and field sensitivity can be pushed to several nm and the hundred uT range by measuring in vacuum conditions. This is due to the higher cantilever quality factors Q, that can be achieved in vacuum, directly leading to an increase in measurement signal. However, with increasing signal amplitude, non-linear behavior must be considered. Additionally, advanced feedback techniques are required for stable operation in vacuum.

Here we present an implementation by using phase-locked loops into a commercial Atomic Force Microscope (Park NX Hivac AFM), overcoming non-linearities in measurement signal. This allows stable, transfer function based, quantitative MFM also in vacuum. Advances in resolution and sensitivity are discussed and measurements on samples like skyrmion hosting multilayer stacks are shown and analyzed to demonstrate the feasibility of our measurement approach.

MA 40.41 Thu 14:00 P2/EG

Development of an AC susceptometer for magnetic thin film systems — •Matthias Zetzl, Grace Causer, and Christian Pfleiderer — Physik-Department, Technical University of Munich, D-85748 Garching, Germany

An ongoing challenge in thin film magnetism concerns the need for easy-to-use characterization tools exploiting the response to alternating magnetic fields. We report the development of a bespoke ac-susceptometer comprising a primary and a balanced pair of secondaries specifically tailored for thin film systems. To gauge the performance of the susceptometer we have revisited the properties of epitaxial layers of MnSi in the thick film limit, in which high-resolution measurements of the temperature and field history of the magnetization, complemented by neutron scattering and neutron reflectometry, have recently identified the formation of a cascade of solitonic layers.

MA 40.42 Thu 14:00 P2/EG

Comparison of continuous and pulsed neutron sources for MIEZE witz McStas. — •Korbinian Fellner[1], Johanna K. Jochum[1], Lukas Vogl[1], Lukas Beddrich[1], Jonathan Leiner[1], Christian Franz[2], and Christian Pfleiderer[3] — [1]Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München, Garching, Germany — [2]Jülich Centre for Neutron Science JCNS-MLZ, Germany — [3]Physik-Department, Technische Universität München, Germany

The MIEZE method is a type of the neutron spin-echo technique that uses oscillating neutron intensities to record changes to the energy of a scattered neutron. This allows MIEZE, which is implemented at the spectrometer RESEDA to study magnetic dynamics, quantum phenomena, and molecular diffusion in soft matter, to achieve an energy resolution of neV, taking advantage of a broad wavelength band of $\Delta\lambda/\lambda$=11.6 %. Nonetheless, a significant portion of the neutron beam is discarded by the velocity selector, making MIEZE at pulsed neutron sources increasingly attractive. We have implemented the polarization shaping components of RESEDA in the McStas framework to investigate the feasibility and data reduction of a MIEZE spectrometer at a pulsed neutron source (PNS). The large wavelength spread of a PNS allows for the measurement of the intermediate scattering function over many points in Fourier time, similar to a multi-detector option at a triple-axis spectrometer. Simulations of a quasielastic sample enable a comparison of the performance between a reactor source and a PNS. Additionally, tests of crucial data reduction algorithms that have not been addressed in previous instrument proposals, are discussed.

MA 40.43 Thu 14:00 P2/EG

Characterizing the defocusing behaviour of magnetic microparticles for the application in three-dimensional trajectory tracking — •Nikolai Weidt, Rico Huhnstock, Yahya Shubbak, and Arno Ehresmann — Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel

For the implementation in Lab-on-a-chip systems, superparamagnetic particles can be surface-functionalized to bind to specific analytes [1]. Making use of the transport of particles above magnetically stripe-patterned exchange bias layer systems is a promising approach to achieve a remote-controlled and directed transport of these particles [2]. The trajectories of particles during transport can be evaluated for detection of analyte binding events. To get access to the third dimension in optical microscopy, the image characteristics of particles moving out of the focal plane during transport steps are analyzed [3]. In this work quantization of defocusing is achieved by determining the Tenenbaum gradient of single particle images. Correlation between Tenenbaum gradient and the particle's vertical position is established by moving the particles in z-direction through the focal plane of the microscope defined steps. Here we show Tenenbaum gradient curves for differently composed particles and changing illumination conditions. [1] Rampini et al. (2016) Lab on a Chip, 16(19), pp. 3645-3663. [2] Holzinger et al. (2015) ACS Nano, 9(7), pp. 7323-7331. [3] Tasadduq et al. (2015) Flow Measurement and Instrumentation, 45, pp. 218-224.

MA 40.44 Thu 14:00 P2/EG

Simulation of Interaction and Self-assembly of Magnetically Decorated Particles — Sibylle Gemming, •Maximilian Neumann, and Aaron Steinhäusser — TU Chemnitz, Chemnitz, Germany

Magnetic particles with the ability to self-assemble allow for the creation of complex structures from simple parts while retaining malleability, enabling easy manipulation through external influences (e.g. magnetic fields). By arranging permanent magnets along the edges of particles in specific patterns we can assign (multiple) unique patterns to different species of particles without introducing additional geometric limitations. This kind of magnetic assembly schemes improves the selectivity between different types of particles and promotes fixed orientations between those on assembly. Our work shows different simulations of assembly schemes with a focus on finding optimal parameters to maximize interaction and selectivity.

MA 40.45 Thu 14:00 P2/EG

Giant Magnetic Resistance sensor array directly on board — •Laila Bondzio, Torben Tappe, and Andreas Hütten — Bielefeld University, Germany

GMR multilayer systems of Py/Cu-bilayers exhibit nearly triangular shaped GMR curves with a high sensitivity, which is desirable for sensor applications. With a grid of multiple sensor elements a two dimensional magnetic landscapes can be mapped as changes in a magnetic field. To organize and contact a large number of sensor elements on a wide spread area of few centimeters it might be useful to sputter the structure directly onto contacts on a circuit board. Although the circuit board is not an ideal substrate, it has been shown that such application is feasible.

MA 40.46 Thu 14:00 P2/EG

Multifunctional Magneto-Optical Sensing of Temperature and Magnetic Field — •Michael P. Path, Finn Klingbeil, and Jeffrey McCord — Institute of Materials Science, Kiel University, Germany

Measurements of temperature and magnetic field are vital in laboratory and industry settings. We demonstrate multi-functional magneto-optical measurement schemes to relate magnetic and micromagnetic features to temperature and magnetic field using magneto-optical active iron garnet films. The focus lies upon a dual quadrature polarimetric measurement scheme. A calibration free temperature measurement using the relation of the first and third harmonic of the obtained signal during a magnetic sinusoidal excitation of the garnets is presented. Using the domain wall susceptibility a limit of detection of the magnetic field below 14 $\mathrm{nT}/\sqrt{\mathrm{Hz}}$ is reached. Indirect measurements of current in integrated circuits is demonstrated using spatially resolved magnetic field sensitivity utilizing a direct magneto-optical imaging setup. A connection of field and temperature measurements in magneto-optical imaging is discussed.

We acknowledge the DFG for funding through grant MC 9/20-2.

F. Klingbeil, S.D. Stölting, J. McCord, APL 118, 092403 (2021)

MA 40.47 Thu 14:00 P2/EG

Supervised folding of magnetic origami actuators using highly compliant magnetic field sensors — •Eduardo Sergio Oliveros-Mata[1], Minjeong Ha[1,2], Gilbert Santiago Cañón Bermúdez[1], Jessica A.-C. Liu[3], Benjamin A. Evans[4], Joseph B. Tracy[3], and Denys Makarov[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Gwangju Institute of Science and Technology, Gwangju, South Korea — [3]North Carolina State University, Raleigh, NC, United States — [4]Elon University, Elon, NC, United States

Soft actuators are mechanically active functional systems. Magnetic polymeric composites have been used as grippers, rollers, and walkers responding to applied magnetic fields. Flexible, light and conformal sensory systems are still under research to have on-board control of the actuation of soft systems. Here, we show electronic skins with magnetic field sensors that provide awareness of the folding state of origami-like magnetic foils.

[1] M. Ha, E.S. Oliveros Mata, et al. Adv. Mater. 33, 2008751 (2021)

MA 40.48 Thu 14:00 P2/EG

Single magnetic domain magnetoelectric composites for picotesla field sensing — •Dennis Seidler, Patrick Hayes, Lars Thormählen, Dirk Meyners, Eckhard Quandt, and Jeffrey McCord — Kiel University, Institute for Materials Science, Kaiserstraße 2, 24143 Kiel, Germany

The contactless measurement of biomagnetic signals i.e., magnetocardiography or magnetoencephalography at ambient conditions has gained high interest for medical applications. Magnetoelectric (ME) cantilever-based field sensors have shown promising results in that regard [1]. To achieve the necessary limit of detection (LOD) a minimization of all noise sources has to be performed. Magnetic noise mainly results from magnetic domain wall activity during sensor operation. We demonstrate a single-domain thick magnetic multilayer stack, to minimize the magnetic noise in the ME sensors. The multilayer is prepared via sputter deposition in an applied magnetic field. We utilize a scalable approach based on magneto-statically coupled $(Fe_{90}Co_{10})_{78}Si_{12}B_{10}$ layers, with the magnetic sensitive layer showing single domain behavior while still achieving high field sensitivity. Integrated in converse ME composite sensors, we obtain a LOD of 40 $\mathrm{pT\cdot Hz^{-0.5}}$ at 10 Hz.

This work was funded by the German Research Foundation (DFG) through the Collaborative Research Centre CRC 1261.

[1] P. Hayes, M. Jovičević Klug, S. Toxværd, P. Durdaut, V. Schell, A. Teplyuk, D. Burdin, A. Winkler, R. Weser, Y. Fetisov, M. Höft, R. Knöchel, J. McCord, and E.Quandt, Sci Rep. 9, 16355 (2019)

MA 40.49 Thu 14:00 P2/EG

Spin-transfer torque ferromagnetic resonance in vortex magnetic tunnel junctions — •Johannes Demir, Karsten Rott, and Günter Reiss — Bielefeld University, Germany

We investigate the gyrotropic mode resonance frequency of the vortex as the free layer of a magnetic tunnel junction (MTJ) by means of spin-transfer torque ferromagnetic resonance (STT-FMR) using a two-port vector network analyzer (VNA). In order to obtain a proper resistance-area (RA) product the capping layer of a commercial wafer was mostly etched down to sputter 8.5 nm permalloy as the vortex layer on top of it afterwards. Subsequently, nanopillars of 300 and 600 nm diameter were fabricated using electron-beam lithography. Using a coplanar-waveguide to feed the GHz-range current through the nanopillar the transmission scattering-parameter S_{21} was determined. Resonance frequencies of around 240 and 150 MHz for the 300 and 600 nm diameter samples, respectively, were measured in accordance with literature [1]. We recognize a shift of the frequency with increasing the bias voltage indicating a DC-STT contribution.

[1] V. Novosad et al., Phys. Rev. B **72**, 024455 (2005)

MA 40.50 Thu 14:00 P2/EG

Growth and magnetic properties of Fe/Pt heterostructures with L10-FePt alloyed interface — Laura Scheuer[1] and •Evangelos Th. Papaioannou[2] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, Erwin-Schrödinger-Str. 56, 67663, Kaiserslautern, Germany — [2]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Von-Danckelmann-Platz 3, 06120 Halle, Germany

The growth of Fe/L10FePt/Pt trilayers was achieved by means of electron beam evaporation technique and appropriate annealing. We show the formation of the L10 alloy for the case of Fe(12nm)/Pt (6nm) [1] and we investigate the formation of L10 phase for Fe,Pt thicknesses smaller than 3 nm. Magneto-optical and Squid magnetometry reveal the strong change in the magnetization reversal when the L10 phase appears. Furthermore, ferromagnetic resonance studies show a large enhancement of the gilbert damping parameter for the alloyed interface. Mumax simulations are implemented in order to understand the role of the L10 in the magnetic properties of the heterostructures.

[1] L.Scheuer et al., iScience25, 104319, (2022)

MA 40.51 Thu 14:00 P2/EG

Light-poling of antiferromagnetic domains in a magnetoelectric $LiCoPO_4$ — •Jakub Vit[1,2], Oleksiy Pashkin[3], Vilmos Kocsis[4], Yasujiro Taguchi[5], Istvan Kezsmarki[6], and Sandor Bordacs[1] — [1]Budapest University of Technology and Economics, Hungary — [2]Institute of Physics, Czech Academy of Sciences, Czechia — [3]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [4]Institut für Festkörperforschung, Leibniz IFW-Dresden, Germany — [5]RIKEN Center for Emergent Matter Science (CEMS), Japan — [6]University of Augsburg, Germany

We selected antiferromagnetic domains in a magnetoelectric $LiCoPO_4$ single crystal by illuminating the sample by light while cooling through the Néel temperature. The experimental results and symmetry analysis indicate that the thermal gradient and resulting heat flow are responsible for such a novel effect: Propagation of thermally-activated quasi-particles is nonequivalent in different antiferromagnetic domains. The microscopic mechanism behind the observed effect is not clear at the moment, calling for future theoretical modeling.

MA 40.52 Thu 14:00 P2/EG

Spontaneous nanoscale square vs. hexagonal skyrmion lattices in Fe/Ir(111) — •Mara Gutzeit, Soumyajyoti Haldar, Tim Drevelow, Moritz A. Goerzen, and Stefan Heinze — Institute of Theoretical Physics and Astrophysics, University of Kiel, Leibnizstraße 15, 24098 Kiel, Germany

We investigate the occurrence of spontaneous skyrmion lattices in an Fe monolayer in both fcc and hcp stacking on the Ir(111) surface employing first-principles calculations based on density functional theory (DFT). For fcc-Fe the well-known non-collinear square nanoskyrmion lattice is confirmed as the magnetic ground state [1]. Surprisingly, for hcp-Fe a nearly collinear hexagonal multi-Q state turns out energetically more favourable than the hexagonal skyrmion lattice proposed based on spin-polarized scanning tunneling microscopy experiments [2]. By mapping total DFT energies of a variety of complex magnetic structures to an atomistic spin model we reveal the interplay of pairwise Heisenberg exchange, Dzyaloshinskii-Moriya interaction and higher-order exchange interactions to be responsible for the symmetry and the degree of collinearity of the respective spin lattice.

[1] Heinze *et al.* Nat. Phys. **7**, 713 (2011)
[2] von Bergmann *et al.* Nano Lett. **15**, 3280 (2015)

MA 40.53 Thu 14:00 P2/EG

Temperature dependent μ-ARPES of the exfoliated zigzag-type intralayer antiferromagnet FePS3 — •B. Pestka[1], J. Strasdas[1], A. K. Budniak[2], D. Baranowski[3], N. Leuth[1], H. Boban[3], M. Liebmann[1], V. Feyer[3], L. Pulcinski[3], E. Lifshitz[2], and M. Morgenstern[1] — [1]II Institute of Physics B and JARA-FIT, RWTH Aachen University, Germany — [2]Schulich Faculty of Chemistry, Solid State Institute of Thechnology, Haifa 3200003, Israel — [3]Forschungszentrum Jülich, Peter Grünberg Institute (PGI-6), Germany

The exfoliable intralayer antiferromagnets MPX3 (M: transition metal, P: phosphorus, X: chalcogenide) provide a multitude of spin arrangements such as Néel-, stripe- and zigzag-type. However, the electronic band structure of these semiconductors has barely been probed. Here, we provide micro-scale angle-resolved photoelectron spectroscopy (μ-ARPES) of the exfoliated intralayer antiferromagnet FePS3 above and below the Néel temperature TN. The material exhibits the zig-zag-type spin arrangement consisting of ferromagnetic zig-zag lines that are mutually coupled antiferromagnetically. We find changes of some of the probed bands across TN. Additionally, the changing bands differ in the different Gamma-K directions, if probed below TN, which is likely related to the selected orientation of the ferromagnetic zig-zag stripes. First low-temperature scanning tunneling spectroscopy results obtained with a Cr tip are also presented. The novel access to the electronic band structure will contribute to a detailed understanding of 2D antiferromagnets.

MA 40.54 Thu 14:00 P2/EG

Optimised mechanical exfoliation of antiferromagnetic $MnPS_3$ — •Niklas Leuth — II. Institute of Physics B, RWTH Aachen University, Aachen, Germany

An optimized mechanical exfoliation technique was developed to exfoliate large-area few-layer flakes of the antiferromagnetic van-der-Waals material $MnPS_3$. This was achieved by utilizing the process of oxygen plasma ashing on gold surfaces and making use of the good bonding strength between the gold surface and the sulfur atoms which terminate the individual layers of $MnPS_3$. Furthermore, there is evidence that the gold surface of the substrate gets oxidised by the oxygen plasma. With the optimised technique, it was possible to exfoliate $\sim 100\,\mu m^2$-large mono- and bilayer flakes. Furthermore, a method was developed which characterises the layer thickness of the exfoliated flakes quantitatively based on the optical Michelson contrast.

MA 40.55 Thu 14:00 P2/EG

Dual-pulse-excitation all-optical switching of a $Gd_{26}Fe_{74}$ ferrimagnet — •Rahil Hosseinifar[1], Ivar Kumberg[1], Sangeeta Thakur[1], Sebastien Hadjadj[1], Jendrik Gordes[1], Chowdhury Awsaf[1], Mrio Fix[3], Florian Kronast[2], Manfred Albrecht[3], and Wolfgang Kuch[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Berlin, Germany — [2]Helmholtz-Zentrum Berlin, Albert-Einstein-Straße 15, 12489 Berlin, Germany — [3]Institut für Physik, Universität Augsburg, Universitätsstraße 1, Augsburg, Germany

Individual linearly p-polarized laser pulses of 800 nm wavelength above a specific threshold fluence can reverse the magnetization of ferrimagnetic samples. We study this all-optical toggle switching in $Gd_{26}Fe_{74}$ ferrimagnetic alloys with out-of-plane easy axis of magnetization after dual-pulse excitation by x-ray magnetic circular dichroism photoelectron emission microscopy. The time between the two spatially overlapped pulses is varied. The experiment is done at room temperature and at 70 K, above and below the magnetic compensation temperature of the sample. In both cases, when the time delay is less than 1 ps, the threshold for toggle switching decreases. At $T = 70$ K, all the region in the footprint of the laser pulse above a certain fluence switches deterministically. However, at room temperature, in addition to a region of deterministic switching, another region appears at higher fluences where multi-domain nucleation is observed.

MA 40.56 Thu 14:00 P2/EG

Magnetoelastic coupling and magnetic anisotropy in $LiMnPO_4$ — •Timo Kleinbek[1], Sven Spachmann[1], Martin Jonak[1], Mahmoud Abdel-Hafiez[2], and Rüdiger Klingeler[1] — [1]Kirchhoff Institute for Physics, Heidelberg University, Germany — [2]Department of Physics and Astronomy, Uppsala University, Sweden

We report high-resolution capacitance dilatometry, magnetisation, and high-frequency electron-spin-resonance studies on $LiMnPO_4$ single crystals. Our findings imply sizeable magnetoelastic coupling as demonstrated by large anomalies in the thermal expansion coefficients associated with the evolution of long-range magnetic order at $T_N = 33$ K. We extract the uniaxial pressure dependencies. Existence of short-range magnetic order above T_N is indicated by magnetic entropy changes up to around 70 K. A spin flip for $B||b$-axis is indicative of a Dzyaloshinskii-Moriya-interaction-caused spin-canting in the ground state. The magnetic phase diagrams are constructed for the three crystallographic directions. The field dependence of the magnon branches implies a two-sublattice model of antiferromagnetic resonance with orthorhombic anisotropy. An anomalous magnon branch detected above the spin-flop field is shown to be accountable-for by a rotation of the easy anisotropy axis at the spin-flop field by 6.5° away from the a-axis towards the hard b-axis. With increasing temperature, the two zero-field excitation gaps remain distinct, implying the preservation of the orthorhombic anisotropy.

MA 40.57 Thu 14:00 P2/EG

Magnetoelastic coupling and uniaxial pressure dependencies of AFM ordering in 2D vdW $M_2P_2S_6$(M=Ni & Fe) — •Kranthi Kumar Bestha[1,2], Laura Teresa Corredor

Bohorquez[1], Vilmos Kocsis[1], Sebastian Selter[1], Saicharan Aswartham[1], Bernd Buechner[1,2], and Anja U. B. Wolter[1] — [1]Institute for Solid State Research, Leibniz IFW Dresden, 01069, Dresden, Germany — [2]Institute of Solid State and Materials Physics and Wuerzburg-Dresden Cluster of Excellence ct.qmat, Technical University Dresden, 01062 Dresden, Germany

Two-dimensional van der Waals(vdW) magnets research has been intensified recently due to their myriad of applications. For these applications, an understanding of coupling of the mechanical degrees of freedom to electronic and magnetic order is crucial. In this work, we employed thermodynamic methods to study the magnetoelastic coupling in 2D vdW $Fe_2P_2S_6$ and $Ni_2P_2S_6$. These materials belong to the class of transition metal chalcogenophosphates($M_2P_2S_6$), with XXZ- and Ising type antiferromagnetic order respectively. *M(T)* and $C_p(T)$ on single crystals confirm AFM ordering in both $Fe_2P_2S_6$(T_N=118 K) and $Ni_2P_2S_6$(T_N=158 K). Our thermal expansion studies demonstrate positive thermal expansion coefficient along the crystallographic stacking axis, with signatures of magnetoelastic coupling by the onset of magnetic order for both $Fe_2P_2S_6$ and $Ni_2P_2S_6$ single crystals. We estimated the uniaxial pressure dependence of antiferromagnetic ordering temperature from heat capacity and thermal expansion.

MA 40.58 Thu 14:00 P2/EG

Unconventional Spin State Driven Spontaneous Magnetization in $RE_3Fe_3Sb_7$ — •S. Palazzese[1,2], F. Pabst[3], S. Chattopadhay[1], Sh. Yamamoto[1], T. Herrmannsdoerfer[1], D. Gorbunov[1], E. Weschke[4], O. Prokhnenko[4], H. Nojiri[5], T. Doert[3], B. Lake[4,6], J. Wosnitza[1,2], and M. Ruck[3] — [1]Hochfeld-Magnetlabor Dresden (HLD-EMFL), HZDR, Dresden, Germany — [2]Institut für Festkörperund Materialphysik, Technische Universität Dresden (TUD), Germany — [3]Fakultät für Chemie und Lebensmittelchemie, TUD, Germany — [4]Helmholtz-Zentrum Berlin für Materialien und Energie (HZB), Berlin, Germany — [5]Institute for Materials Research, Tohoku University, Sendai, Japan — [6]Institut für Festkörperphysik, Technische Universität Berlin, Germany

Consolidating a microscopic understanding of magnetic properties is crucial for a rational design of magnetic materials with tailored characteristics. The interplay of $3d$ and $4f$ magnetism in rare-earth transition metal antimonides is an ideal platform to search for such complex behavior. Here we present a detailed magnetization and electrical-transport study of novel $RE_3Fe_3Sb_7$ compounds. $RE_3Fe_3Sb_7$ shows a an emergent spontanoeus magnetization in zero applied field and a kink in the temperature-dependent resistivity, indicating a symmetry breaking at the spin-reorientation transition (SRT). Our XMCD and additional neutron scattering results reveal an unusual antiparallel alignment of Pr and Fe magnetic moments.

MA 40.59 Thu 14:00 P2/EG

2D van-der Waals Heterostructures — •Burak Özer[1], Arthur Veyrat[1], Sebastian Selter[1], Saicharan Aswartham[1], Rudolf Schäfer[2], Ivan Soldatov[2], Bernd Büchner[1,3], and Burak Ozer[1] — [1]Leibniz IFW Dresden, Institute for Solid State Research, 01069 Dresden, Germany — [2]Helmholtzstr 20 — [3]Technische Universität Dresden, Faculty of Physics, 01062 Dresden, Germany

2D materials and their properties are being investigated since 2004 when researchers obtained the monolayer graphene and investigated its excellent electrical properties. To produce down-to-monolayer materials the mechanical exfoliation technique has been used since the very beginning. In 2013, researchers found a technique that allows to build a 3D structure from exfoliated 2D materials like LEGO blocks and control their physical properties, called van-der-Waals (vdW) stacking. Combining 2D materials for the discovery and characterization of new topological phases could pave the way for many opportunities for new and interesting fundamental aspects of physics, also for potential applications. This work shows how to exfoliate and encapsulate different materials, including graphene, hBN and Cr_2 Ge_2 Te_6 (T_c ~62 K) crystal, which is a paramagnetic at bulk; but recently researchers have found out at down-to-monolayer thicknesses, it showed ferromagnetic behavior. The magnetism of Cr_2 Ge_2 Te_6 has investigated at several thicknesses to observe their hysteresis curves by MOKE; to compare the difference between encapsulated with hBN and free-standing CGT behavior, we conducted the magnetic measurement for two different flakes.

MA 40.60 Thu 14:00 P2/EG

Strain control on band topology and surface states in antiferromagnetic EuCd2As2 — •Nayra Alvarez[1], Venkata Bharadwaj[1], Bennet Karetta[1], Rodrigo Jaeschke[1], Adrian Valadkhani[2], Libor Smejkal[1], and Jairo Sinova[1] — [1]Institut fur Physik, Johannes Gutenberg Universitat, Mainz, Germany — [2]Institut für Theoretische Physik, Goethe-Universität, Frankfurt am Main, Germany

We study the effect of strain on EuCd2As2 and the effect on its topological features in different interlayer antiferromagnetic configurations [1]. Magnetic Anisotropy calculations indicate that the modulation of the lattice structure with strain can lead to a change in the direction of the magnetic moment changing the topology of the system [2,3]. We performed band structure calculations for the different strained configurations, applying three different kinds of stress along the x-y plane: volumetric, longitudinal, and shear. In addition, we analyse the surface states at different cleavage surfaces.

[1] J. Ma, H. Wang, S. Nie, et al., "Emergence of nontrivial low-energy Dirac fermions in antiferromagnetic EuCd2As2", Advanced Materials.

[2] G. Hua, S. Nie, et al., "Dirac semimetal in type-IV magnetic space groups", Physical Review B.

[3] E. Gati, S. L. Budko, et al., "Pressure-induced ferromagnetism in the topological semimetal EuCd2As2", Physical Review B.

MA 40.61 Thu 14:00 P2/EG

Strain control of band topology and surface states in antiferromagnetic EuCd2As2 — •Nayra Alvarez[1], Venkata Bharadwaj[1], Bennet Karetta[1], Rodrigo Jaeschke[1], Adrian Valadkhani[2], Libor Smejkal[1], Jairo Sinova[1], and Roser Valenti[2] — [1]Institut fur Physik, Johannes Gutenberg Universitat, Mainz, Germany — [2]Institut für Theoretische Physik, Goethe-Universität, Frankfurt am Main, Germany

We study the effect of strain on EuCd2As2 and the effect on its topological features in different interlayer antiferromagnetic configurations [1]. Magnetic anisotropy calculations indicate that the modulation of the lattice structure with strain can lead to a change in the direction of the magnetic moment changing the topology of the system [2,3]. We performed band structure calculations for the different strained configurations. We consider three different kinds of stress along the x-y plane: volumetric, longitudinal, and shear. In addition, we analyse the surface states at different cleavage surfaces.

[1] J. Ma, H. Wang, S. Nie, et al., "Emergence of nontrivial low-energy Dirac fermions in antiferromagnetic EuCd2As2", Advanced Materials.

[2] G. Hua, S. Nie, et al., "Dirac semimetal in type-IV magnetic space groups", Physical Review B.

[3] E. Gati, S. L. Budko, et al., "Pressure-induced ferromagnetism in the topological semimetal EuCd2As2", Physical Review B.

MA 40.62 Thu 14:00 P2/EG

Influence of disorder and multi-magnon processes on the magnonic properties of ultrathin metallic ferromagnets — •Sebastian Paischer[1], Arthur Ernst[1], Igor Maznichenko[2], David Eilmsteiner[1], Khalil Zakeri[3], and Pawel Buczek[4] — [1]Johannes Kepler University, Linz, Austria — [2]Martin-Luther-Universität Halle-Wittenberg, Halle, Germany — [3]Karlsruhe Intitute of Technology, Karlsruhe, Germany — [4]Hamburg University of Applied Sciences, Hamburg, Germany

Understanding the processes behind the excitation and relaxation of spin excitations in low-dimensional magnetic structures is one of the most intriguing research directions in solid-state physics. A detailed knowledge of the fundamental mechanisms involved in such processes is the key to understanding many different phenomena like ultrafast magnetization reversal. In this poster session we compare different magnon damping mechanisms in ultrathin metallic films. While the Landau-damping is the most dominant channel, we show that a significant contribution of the damping originates from substitutional disorder. Also the influence of multi-magnon processes on the magnonic properties of these materials will be discussed.

MA 40.63 Thu 14:00 P2/EG

Transverse magnetotransport in unconventional antiferromagnet Mn_5Si_3 — •Sebastian Beckert[1], Antonin Bad'ura[2], Miina Leiviskä[3], Eva Schmoranzerová[4], Ismaila Kounta[5], Dominik Kriegner[2], Andy Thomas[1,6], Libor Šmejkal[7], Jairo Sinova[7], Tomáš Jungwirth[2], Lisa Michez[5], Sebastian T. B. Goennenwein[8], Vincent Baltz[3], and Helena Reichlová[1,2] — [1]TU Dresden — [2]IoP ASCR Prague — [3]Spintec Grenoble — [4]Charles University Prague — [5]CINaM Marseille — [6]IFW Dresden — [7]JGU

Mainz — [8]University of Konstanz

Traditional collinear antiferromagnets do not exhibit a spin polarization in the band structure. Therefore, the anomalous Hall and Nernst effect are forbidden in this materials. Recent theory developments predict a new class of magnetically ordered compensated materials with particular crystal and spin symmetries that break the time inversion symmetry in the reciprocal space [1,2]. One experimental demonstration are epitaxially grown Mn_5Si_3 films. In these samples with a (0001) film normal, we observe a robust anomalous Hall effect despite vanishing magnetization [3]. On this poster, we will discuss the magnetothermal transport properties of this compound in more detail and the symmetry of measured signals.

[1] L. Šmejkal et al., Sci. Adv. **6**, aaz8809 (2020).
[2] L. Šmejkal et al., Phys. Rev. X **12**, 031042 (2022).
[3] H. Reichlova et al., arXiv preprint arXiv:2012.15651 (2020).

MA 40.64 Thu 14:00 P2/EG

Magneto-transport measurements in altermagnetic RuO_2 and MnTe — •Ruben Dario Gonzalez Betancourt[1,2,3,4], Jan Zubáč[3,4], Rafael Julian Gonzalez Hernandez[5], Kevin Geishendorf[3], Zbynek Šobáň[3], Gunther Springholz[6], Kamil Olejník[3], Jakub Železný[3], Philipp Ritzinger[3], Joseph Dufouleur[2], Louis Veyrat[2], Teresa Tschirner[2], Simon Moser[7], Libor Šmejkal[8], Tomas Jungwirth[3,9], Sebastian Tobias Benedikt Goennenwein[1,10], Andy Thomas[1,2], Dominik Kriegner[3], and Helena Reichlová[1,3] — [1]IFMP, TU Dresden — [2]IFW Dresden — [3]Institute of Physics, AV ČR, Prague — [4]Charles University, Prague — [5]Universidad del Norte, Barranquilla — [6]JKU Linz — [7]University of Wuerzbug — [8]JGU, Mainz — [9]University of Nottingham — [10]University of Konstanz

In altermagnets [1], spin polarization in both crystal-structure real space and electronic-structure momentum space alternates and, consequently, it enables effects that were believed to be exclusive to ferromagnets. Many of the predicted altermagnetic phenomena [2] await their experimental confirmation. Here, we present a magnetotransport characterization of two altermagnetic materials - semiconducting MnTe [3] and metallic RuO_2. We discuss which contributions to the measured transversal and longitudinal signals can be signatures of the unconventional altermagnetic phase.

[1] L. Šmejkal et al., Phys. Rev. X. 12.031042 (2022) [2] L. Šmejkal et al., Phys. Rev. X. 12.011028 (2022) [3] R. D. Gonzalez Betancourt et al., (2021) arXiv:2112.06805

MA 40.65 Thu 14:00 P2/EG

Tuning of magnetoelastic coupling with acoustic impedance matching techniques — •Johannes Weber[1,2], Manuel Müller[1,2], Stephan Geprägs[1], Rudolf Gross[1,2,3], Hans Huebl[1,2,3], and Matthias Althammer[1,2] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]TUM School of Natural Sciences, Technische Universität München, Garching, Germany — [3]Munich Center for Quantum Science and Technology (MCQST), Munich, Germany

Magnetoelastic coupling and the coherent emission of phonon modes generated by magnon Kittel modes have regained interest because of their potential applications in quantum devices [1]. So far primarily the ferrimagnetic insulator yttrium iron garnet (YIG) grown on single crystal substrates of the paramagnetic insulator gadolinium gallium garnet (GGG) has been used in experiments. However, as YIG requires epitaxial growth, the choice of material combinations is limited. Therefore we studied magnon-phonon coupling in acoustic resonators consisting of polycrystalline magnetic thin-films grown on silicon substrates, as this material platform would allow for the implementation of magnetoelastic coupling effects in existing CMOS-technology. In particular, we investigate whether a tuning of the magnetoelastic coupling between magnetic metal thin films and silicon substrate can be achieved by inserting an intermediated metallic layer, allowing for better acoustic impedance matching [2].

[1] K. An et al., Phys. Rev. X **12**, 011060, (2022).
[2] V. Rathod, Sensors, **20**, 4051, (2020).

MA 40.66 Thu 14:00 P2/EG

Towards shaping picosecond strain pulses via magnetostrictive transducers — Maximilian Mattern[1], Jan-Etienne Pudell[1,2,3], Karine Dumesnil[4], •Alexander von Reppert[1], and Matias Bargheer[1,2] — [1]Institut für Physik und Astronomie, Universität 14476 Potsdam, Potsdam, Germany — [2]Helmholtz-Zentrum Berlin, 12489 Berlin, Germany — [3]European XFEL, 22869 Schenefeld, Germany — [4]Institut Jean Lamour (UMR CNRS 7198), Université Lorraine, 54000 Nancy, France

Using time-resolved x-ray diffraction, we demonstrate the manipulation of the picosecond strain response of a metallic heterostructure consisting of a dysprosium (Dy) transducer and a niobium (Nb) detection layer by an external magnetic field. We utilize the first-order ferromagnetic-antiferromagnetic phase transition of the Dy layer, which provides an additional large contractive stress upon laser excitation compared to its zero-field response. This enhances the laser-induced contraction of the transducer and changes the shape of the picosecond strain pulses driven in Dy and detected within the buried Nb layer. Based on our experiment with rare-earth metals we discuss required properties for functional transducers, which may allow for novel field-control of the emitted picosecond strain pulses.