MA 31: Poster II

Time: Wednesday 17:00–19:30 Location: P1

MA 31.1 Wed 17:00 P1

Near-Room-Temperature Compensation Temperature In Terbium Iron Garnet Thin Films — •Mehak Loyal, Akashdeep Akashdeep, Mathias Kläui, and Gerhard Jakob — Institute of Physics, Johannes Gutenberg University Mainz, Staudingerweg 7, 55128 Mainz, Germany

Rare-earth iron garnets (REIGs) with perpendicular magnetic anisotropy (PMA) have emerged as promising materials for spintronic applications. The compensation temperature (T_{comp}), where the net magnetization for the ferrimagnet becomes zero, plays a crucial role in determining potential application. While bulk REIGs have a T_{comp} well below room temperature, researchers have shown that it can be tuned in thin films. $Tb_3Fe_5O_{12}$ (TbIG) with bulk compensation temperature ~240 K, in particular has gained interest as recent report shows a near-room-temperature T_{comp} for TbIG thin films.

We investigate the factors that tune the compensation temperature (T_{comp}) of TbIG thin films to near-room-temperature. This would have significant implications for the development of spintronics applications, potentially enabling more efficient and stable operation at ambient conditions. PMA TbIG thin films are deposited on (111)-oriented $Gd_3Ga_5O_{12}$ (GGG) substrates using pulsed laser deposition (PLD). The magnetization reversal of TbIG thin films at different temperatures are probed using transverse magneto-resistance measurement. The study contributes to the broader understanding of REIGs and paves the way for integration into practical spintronic applications.

MA 31.2 Wed 17:00 P1

Polarized inelastic neutron scattering studies on magnetic excitations in the SDW ordered state of qasi 2D $Sr_{1.5}Ca_{0.5}RuO_4$ — •Felix Wirth[1], Yvan Sidis[2], Paul Steffens[3], and Markus Braden[1] — [1]II. Physic. Inst., Univ. Cologne, Germany — [2]LLB, CEA Saclay, France — [3]ILL, Grenoble, France

Superconductivity in the layered ruthenate Sr_2RuO_4 emerges near competing magnetic fluctuations. The different d orbitals of Ru^{4+} give rise to the multi-band structure causing spin fluctuations with incommensurate (IC) propagation vector due to fermi-surface nesting. These antiferromagnetic fluctuations are anisotropic and condensate to static spin density wave (SDW) order with moments oriented along c when Sr is replaced by 25 % of isovalent Ca. Only a few realizations of SDW in metals have been studied concerning their magnetic excitations. Cr exhibits strong anisotropy as well as new excitations like the Fincher-Buke mode, while the spin-orbit coupling (SOC) is much smaller than in $Sr_{1.5}Ca_{0.5}RuO_4$. This renders it an ideal material for studying SDW state in the presence of SOC. Our contribution presents inelastic polarized neutron scattering measurements on the IC SDW signal. With scattering vector within the layer, we discriminated between transversal and longitudinal excitations. We see longitudinal or c-polarized spectral weight enhancement at low energy. At the same time, the transversal or in-plane response is suppressed over a broad temperature range and exhibits single-relaxor behavior like in the pure compound. SOC induces strong anisotropy in the magnetic fluctuations in $Sr_{1.5}Ca_{0.5}RuO_4$.

MA 31.3 Wed 17:00 P1

Structural and magnetic properties of Bi-bonded Mn-Al-C-Ti magnets — •Semih Ener, Fernando Maccari, Konstantin P. Skokov, and Oliver Gutfleisch — Functional Materials, Technical University of Darmstadt, Peter-Grünberg-Str. 16, D-64287, Darmstadt, Germany

In this study, the influence of Ti doping on the phase formation and magnetic properties of Mn-Al-C-Ti alloys is investigated. The alloys were synthesized by melt spinning followed by thermal treatment to obtain the ferromagnetic τ-phase, which was determined to be 20 min at 550 °C for all Ti compositions.

However, the Ti-doped samples exhibited β-phase formation due to partial phase decomposition, with TiC precipitates observed at higher Ti concentrations. Doping resulted in an increase in the Curie temperature from 557 K in the undoped sample to 600 K in the Ti-doped samples.

In order to increase the coercivity, a combination of ball milling and hot compaction was used along with the introduction of Bi as a metallic binder. This resulted in an increase in coercivity, from 0.18 T to 0.33 T, as the addition of Bi facilitated the formation of a grain boundary phase, which aided in densification. This work demonstrates how compositional and processing modifications can be used to improve the magnetic properties of Mn-Al based magnets.

[1] J.S. Trujillo Hernández, F. Maccari, J.A. Tabares, K.P. Skokov, G.A. Pérez Alcázar, O. Gutfleisch and S. Ener, J. Magn. Magn. Mater. 610 (2024) 172573.

MA 31.4 Wed 17:00 P1

Comparative study on magenetical and structural properties Mn_3XC (X=Sn,Ga,In,Zn) antiperovskites — •Lennart Endler, Benedikt Eggert, Katharina Oleffs, Mehmet Acet, and Heiko Wende — Faculty of Physics and CENIDE, University of Duisburg-Essen

The family of Mn_3XC antiperovskites shows a wide variety of properties ranging from large magnetocaloric effects, giant magnetoresistance to negative thermal expansion [1], which makes them an interesting material class for researchers and industry. Starting with ternary compounds, we also investigate the effect of multiple elements on the X-site, as done for perovskite oxides in the past, revealing a correlation between Neel temperature and Goldschmidt tolerance factor and therefore the chosen elements [2]. For the chemical, structural and magnetic characterisation, we have used EDX, X-ray diffraction, magnetometry and if possible ^{119}Sn Mössbauer spectroscopy. Based on the analysis of the ternary compounds prepared by solid state reaction, the foundation for a comparison to medium and high entropy Mn-antiperovskites is held to further explore and potentially control their properties.

We acknowledge the financial support through the Deutsche Forschungsgemeinschaft wihtin the framework of the CRC/TRR270 HoMMage (Project 405553726-TRR270).

[1] Y. Wang, Adv. Mater. 32, 1905007 (2020)
[2] R. Witte, Phys. Rev Mat. 3, 034406 (2019)

MA 31.5 Wed 17:00 P1

Effect of Ni addition to Fe-B-Si-Nb alloy on magnetic and thermal properties — •Purbasha Sharangi[1], Uma Rajput[2], Amirhossein Ghavimi[2], Ralf Busch[2], Isabella Gallino[3], Gabriele Barrera[1], Enzo Ferrara[1], and Paola Tiberto[1] — [1]INRIM, Istituto Nazionale di Ricerca Metrologica, Strade delle Cacce, 5, 10135 Torino, Italy. — [2]Saarland University, Chair of Metallic Materials, Campus C6.3 66123, Saarbrücken, Germany — [3]Technical University of Berlin, Chair of Metallic Materials, Ernst-Reuter Platz 1, 10587 Berlin, Germany

The next generation of electrical equipment, such as motors and generators, and power electronics, depend heavily on soft magnetic materials. It has been reported that the addition of Ni to Fe-Si-B-Nb BMGs has shown significant improvements in both their soft magnetic properties and plasticity. Fe-based BMGs that incorporate Ni exhibit a good glass forming ability (GFA), reasonable soft magnetic properties and improved mechanical performance. In this work we have investigated the effect of Ni addition and annealing on the microstructural, thermal and magnetic properties of Fe-B-Si-Nb alloy. It has been observed that the GFA is improved from 800 μm to almost 1000 μm upon the addition of 2 to 5 at. % Ni. A slight increment in saturation magnetization and reduction in coercive field have been observed with increasing the Ni% for the as cast ribbons. Further, the soft magnetic properties improve significantly in the form of reduced coercivity and energy losses after annealing the ribbons at 320 °C for 2 hours due to the relief of frozen-in stresses.

MA 31.6 Wed 17:00 P1

A materials library for cryogenic magnetocaloric cooling — •T. Gottschall, E. Bykov, M. Strassheim, T. Niehoff, C. Salazar-Mejía, and J. Wosnitza — Helmholtz-Zentrum Dresden-Rossendorf, Dresden High Magnetic Field Laboratory (HLD), Dresden, Germany

Magnetic cooling is a refrigeration technique that is based on the so-called magnetocaloric effect, the change of temperature caused by a magnetic field. It can be utilized to construct environmentally friendly cooling devices, air conditioners, and heat pumps. Originally, magnetic cooling was used to achieve ultra-low temperatures near absolute zero.

Recently, low temperatures have once again become the focus of attention as an area of application for magnetocaloric cooling namely for efficient hydrogen liquefaction. In this contribution, we will present our materials library for cryogenic applications. The basis for this is our research infrastructure at the Dresden High Magnetic Field Laboratory, which includes both static and pulsed fields. Our aim is to gain a better understanding of the magnetocaloric materials required for the cooling process, to provide consistent data sets for simulations, and to drive magnetic hydrogen liquefaction forward making it an energy efficiency alternative to conventional technology.

MA 31.7 Wed 17:00 P1

Inverse magnetocaloric effect in Tb_3Ni: So hot right now — •T. Niehoff[1,2], B. Beckmann[3], K. Skokov[3], A. Herrero[4], A. Oleaga[5], M. Strassheim[1,2], T. Wosnitza[1,2], and T. Gottschall[1] — [1]Dresden High Magnetic Field Laboratory (HLD-EMFL), HZDR, Dresden, Germany — [2]Institut für Festkörper- und Materialphysik, TU Dresden, Dresden, Germany — [3]Institut für Materialwissenschaft, TU Darmstadt, Darmstadt, Germany — [4]Departamento de Física Aplicada, UPV/EHU, Vitoria-Gasteiz, Spain — [5]Departamento de Física Aplicada, UPV/EHU, Bilbao, Spain

The magnetocaloric effect (MCE) is a cornerstone of promising, environmentally friendly cooling technologies, particularly for cryogenic applications. In this presentation, we use Tb_3Ni as a case study, previously reported to exhibit a strong inverse MCE at very low temperatures based on magnetization measurements. By comparing these findings with other techniques, we show that neither Tb_3Ni nor similar materials with metamagnetic transitions from antiferromagnetic to ferromagnetic exhibit the predicted inverse effect. To support our claims and further investigate the MCE, we conducted specific-heat measurements and direct T_{ad} in pulsed-field experiments. These reveal no effects, while the pulsed-field data even show a significant positive effect, which we attribute to dissipative heating. Our findings highlight the importance of using complementary measurement techniques to accurately characterize the MCE and fully understand the behavior of these materials.

MA 31.8 Wed 17:00 P1

Design of Cr_xFe_{1-x}MnCoNiGeSi high-entropy alloy with large barocaloric effect — •Yong Guo[1,2], Yuanyuan Gong[1], Tingting Zhang[1], Zhishuo Zhang[1], Bin Chen[1], Fenghua Chen[3,4], Zhengyi Jiang[4], Feng Xu[1], and Luana Caron[2,5] — [1]MIIT Key Laboratory of Advanced Metallic and Intermetallic Materials Technology, School of Materials Science and Engineering, Nanjing University of Science and Technology , Nanjing 210094, PR China — [2]Faculty of Physics, Bielefeld University, Bielefeld 33501, Germany — [3]School of Materials Science and Engineering, Taiyuan University of Science and Technology, Taiyuan 030024, PR China — [4]School of Mechanical, Materials, Mechatronic and Biomedical Engineering, University of Wollongong, Wollongong, NSW 2522, Australia — [5]Helmholtz-Zentrum Berlin für Materialien und Energie, 12489 Berlin, Germany

This paper presents a high-entropy system exhibiting a large barocaloric effect. Experimental results confirm that equiatomic FeMnCoNiGeSi and CrMnCoNiGeSi are high-entropy solid-solutions with hexagonal and orthorhombic structures at room temperature, respectively. Further tuning Fe/Cr ratio in Cr_xFe_{1-x}MnCoNiGeSi establishes a thermal-induced hexagonal-orthorhombic structural transformation. For the alloy with $x = 0.44 - 0.50$, the structural transformation occurs at room temperature and can be induced by hydrostatic pressure. The barocaloric effect reaches -30.6 J/kgK for a pressure change from 5 to 0 kbar, and the entropy change per kbar is comparable to widely studied intermetallic compounds.

MA 31.9 Wed 17:00 P1

Collective out-of-plane stripe domain magnetization reversal via a single point of irreversibility — •Peter Heinig[1,2], Ruslan Salikhov[2], Fabian Samad[1,2], Lorenzo Fallarino[2,3], Attila Kákay[2], Nikolai S. Kiselev[4], and Olav Hellwig[1,2] — [1]Chemnitz University of Technology — [2]Helmholtz-Zentrum Dresden-Rossendorf — [3]CIC energiGUNE — [4]Forschungszentrum Jülich

Periodic stripe domain structures in thin films with perpendicular magnetic anisotropy are well-studied, however, the detailed field reversal of such systems in the transition regime between in-plane (IP) and out-of-plane (OOP) magnetization remains intriguing, with unexpected effects. In particular, the $[Co(3.0\ nm)/Pt(0.6\ nm)]_X$ multilayer system undergoes this transition[1]. We examine samples with $X = 10$ and $X = 11$ repetitions, which display a remanent state with both significant OOP as well as IP magnetization components, here referred to as the "tilted" stripe domain state[1,2]. Using vibrating sample magnetometry, magnetic force microscopy, and micromagnetic simulations, we analyze the unusual OOP field reversal behavior, which is characterized by a single point of irreversibility and parallel stripe domains at remanence. While these two characteristics seem at first sight mutually exclusive, we will reveal how they still can evolve simultaneously. In addition to the unusual OOP reversal, we also observe a significant IP angular dependence of the susceptibility around remanence induced by the parallel stripe domain alignment.

[1][L. Fallarino et al., Phys. Rev. B 99, 024431 (2019)]
[2][P. Heinig et al., Phys. Rev. B 110, 024417 (2024)]

MA 31.10 Wed 17:00 P1

Epitaxy and Magnetic Properties of Fe films on GaAs(001) in Dependence of the Electrodeposition Procedure — •Danny P. Quint[1], Raphael Kohlstedt[2,3], Olav Hellwig[2,3], and Karin Leistner[1] — [1]Institute of Chemistry, TU Chemnitz — [2]Institute of Physics, TU Chemnitz — [3]Research Center MAIN, TU Chemnitz

Epitaxial Fe/GaAs heterostructures are of great interest for spintronic devices.[1] The quality of the epitaxial growth is crucial for the functionality. While MBE is traditionally used to fabricate Fe/GaAs structures, electrodeposition (ED) offers a cost-efficient alternative. [2,3] We systematically examined the impact of an initial voltage pulse during ED of Fe films (approx. 20 nm thick) on GaAs(001) on their epitaxy and magnetic behavior. We compare depositions without a pulse (A), with a pulse after immersion in the electrolyte (B), and with a pulse during immersion in the electrolyte (C). The angle-dependent ferromagnetic resonance field, remanence and coercivity of the deposited films were analyzed by in-plane FMR and MOKE, respectively. The results show an enhanced fourfold anisotropy for the films prepared with the pulsed routines, with method C approaching the expected behavior for dominating cubic magnetocrystalline anisotropy in epitaxial Fe(001) films. The quality of epitaxial growth is investigated by X-ray diffraction. This work highlights the importance of optimizing the ED procedure to achieve epitaxial Fe films on GaAs and opens pathways for the broader application of ED in spintronic materials research. [1] Wastlbauer et al., Adv. Phys., 54, 2005, 137. [2] Liu et al., ESL, 7, 2004, D11. [3] Guo et al., Nano Lett., 22, 2022, 4006.

MA 31.11 Wed 17:00 P1

Pt-catalyzed hydrogen magneto-ionics in Co/Pd multilayers — •Felix Engelhardt[1,2], Rico Ehrler[1,2], Olav Hellwig[1,2], Karin Leistner[1,2], and Markus Gössler[1] — [1]Chemnitz University of Technology, D-09107 Chemnitz, Germany — [2]Research Center MAIN, D-09126 Chemnitz, Germany

Magneto-ionics, which is the electrochemical reconfiguration of magnetic materials at low gating voltages, offers a highly energy-efficient method to control magnetism. One major issue of this mechanism, however, is its response time, which is limited by the timescale of the electrochemical reactions. Here, we demonstrate that the hydrogen-based magneto-ionic effect in sputtered Co/Pd multilayers [1] can be accelerated catalytically via an additional Pt layer at the surface.

We investigate how the thickness of such a Pt overlayer affects the magneto-ionic effect strength and hydrogen insertion kinetics in the Co/Pd multilayer system. To analyze these effects, we use in-situ MOKE microscopy to monitor the magneto-ionic behavior, while flow-cell coulometry measurements are carried out to quantify the hydrogen concentration in the multilayers.

Our findings reveal that a Pt overlayer with a thickness of 0.5-2 nm significantly enhances the strength of the magneto-ionic effect by a factor of 2, while also reducing the time required for hydrogen insertion by a factor of 10. Our results highlight a route towards faster switching speeds in magneto-ionic devices, which is crucial for future magnetic memory applications.

[1] M. Bischoff et al., Adv. Funct. Mater., **34**, 2405323 (2024)

MA 31.12 Wed 17:00 P1

Investigating Micromagnetic Structures in Dy-Fe Ferrimagnetic Thin Films — •Pranati Parui[1], Tamer Karaman[1], Felix Büttner[1,2], and Manfred Albrecht[1] — [1]University of Augsburg, Augsburg, Germany — [2]Helmholtz-Zentrum Berlin, Berlin, Germany

Ferrimagnetic thin films present a unique platform for studying emergent spin textures and magnetic phenomena due to the interplay between the transition-metal and rare-earth sublattices. Here, we investigate ferrimagnetic Dy-Fe alloy thin films, which exhibit a broad spectrum of magnetic properties that are highly sensitive to composition and temperature. Despite their potential, a systematic investigation of Dy-Fe thin films remains unexplored. This work focuses on the sputter deposition of thin films with varying compositions and employs comprehensive characterization techniques, including SQUID magnetometry, magneto-optical Kerr effect (MOKE) measurements, magnetic force microscopy (MFM), and Lorentz transmission electron microscopy (LTEM), to unravel their micromagnetic structures, domain patterns, and domain wall chirality.

MA 31.13 Wed 17:00 P1

Detecting correlation between surface and interface magnetism of Mn/Fe thin film heterostructures on the atomic scale — •Toshio Miyamachi[1,2], Shuhei Nakashima[1], Yasumasa Takagi[3], Toshiohiko Yokoyama[3], and Fumio Komori[1] — [1]ISSP, The University of Tokyo, Japan — [2]IMaSS, Nagoya University, Japan — [3]Institute for Molecular Science, Japan

The magnetic coupling between ferromagnetic (FM) and antiferromagnetic (AFM) layers has been the focus of interest for magnetic multilayer devices. The fundamental magnetic properties of FM/AFM magnetic multilayers, e.g., magnetic moment, magnetic anisotropy rely much on their interfacial structural and electronic properties. In this work, we investigated structural, electronic and magnetic properties of AFM/FM Mn/Fe thin film heterostructures grown on Cu(001) by spin-polarized scanning tunneling microscopy (Sp-STM) and x-ray absorption spectroscopy/x-ray magnetic circular dichroism (XAS/XMCD) [1]. With the help of surface sensitivity of SP-STM and element specificity of XAS/XMCD, electronic and magnetic properties of surface Mn and interface Fe layers were separately investigated. Sp-STM measurements revealed a new type of surface magnetic structures of Mn layers, which could be interpreted in term of the magnetic coupling with underlying Fe layers.

[1] S. Nakashima et al., Adv. Funct. Mater. 29, 1804594 (2019).

MA 31.14 Wed 17:00 P1

Integration of a dual broadband characterization setup for time-resolved magneto-optical spectroscopy — •Richard Leven, Sophie Bork, David Gutnikov, Umut Parlak, and Mirko Cinchetti — Department of Physics, TU Dortmund, 44227 Dortmund, Germany

We present a recently developed setup for broadband ultrafast magneto-optical pump-probe spectroscopy, optimized for operation at low temperatures and high magnetic fields. The setup utilizes a broadband supercontinuum (white light) probe beam, spanning wavelengths from the near UV to the near IR region. Two independent CMOS detector arrays enable simultaneous data acquisition across all available wavelengths, providing comprehensive insights into transient reflectivity ($\Delta R/R$) and polarization rotation ($\Delta\theta$) measurements in a single experiment. The system operates at variable repetition rates, ranging from <10 kHz to ∼100 Hz, combining the precision of a femtosecond laser source with high sensitivity for low-light conditions. To validate the setup, we conduct experiments on the semiconducting antiferromagnet CrSBr, ensuring the spectrum encompasses the material's bandgap and exciton excitation energies. This poster will detail the technical specifications of the setup, its characterization results, and its performance benchmarks, highlighting its potential for studying ultrafast dynamics in a variety of magnetically ordered systems.

MA 31.15 Wed 17:00 P1

Element-resolved study of antiferromagnetic/ferromagnetic magnetization dynamics in epitaxial CoO/Fe bilayer — •Chowdhury Shadman Awsaf[1], Sangeeta Thakur[1], Markus Weissenhofer[2], Jendrik Gördes[1], Marcel Walter[1], Niko Pontius[3], Christian Schüssler-Langeheine[3], Peter Oppeneer[2], and Wolfgang Kuch[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin — [2]Department of Physics and Astronomy, Uppsala University — [3]Helmholtz-Zentrum Berlin für Materialien und Energie

We examine the transient AFM spin structure in an epitaxial Fe/CoO bilayer on an Ag(001) single-crystal substrate after excitation by 60 fs laser pulses of 800 and 400 nm wavelength, below and above the CoO band gap, respectively, by evaluating the time-resolved x-ray magnetic linear dichroism in reflectivity at the Co L2 edge. The findings are compared to time-resolved x-ray magnetic circular dichroism measurements at the Fe L3 edge. Both layers exhibit a fast drop in magnetic order within 300 fs. Simulating an atomistic two-temperature model, coupled with the stochastic Landau Lifshitz-Gilbert equation for the spin degrees of freedom, indicates a direct energy transfer from hot Fe electrons to CoO spins in the case of 800 nm excitation. For demagnetization at 400 nm pump, above-band-gap excitation in CoO has to be assumed in the simulation to reproduce the experimental result [1].

[1] C. S. Awsaf et al., arXiv:2408.14360.

MA 31.16 Wed 17:00 P1

Laser-induced magnetostriction in Gd, Tb and Dy probed by UXRD — •Florian Baltrusch[1], Alexander von Reppert[1], Steffen P. Zeuschner[1], Maximilian Mattern[1], Matthias Rössle[2], Florin Boariu[2], Karine Dumesnil[3], and Matias Bargheer[1,2] — [1]Institut für Physik und Astronomie, Universität Potsdam, Potsdam, Germany — [2]Helmholtz-Zentrum Berlin, Berlin, Germany — [3]Institut Jean Lamour, Universite Lorraine, Nancy, France

In ultrafast X-ray experiments, we compare the laser-induced magnetostriction in Gd, Tb and Dy upon femtosecond laser excitation at temperatures above and below the magnetic ordering temperatures. These rare earths exhibit giant spontaneous magnetostriction and consequently negative thermal expansion (NTE). The coupling between magnetic order and the lattice below the Curie temperature leads to a competition between the expansive stresses from electrons and phonons and the contractive stress due to magnetic order. Thus, upon femtosecond laser excitation, the ultrafast dynamics show a variety of interesting results, such as transforming a typical bipolar strain wave into a unipolar pulse. By comparing equilibrium thermal expansion and heat capacities, we separate electronic, phononic, and magnetic stress contributions using an extended Grüneisen model based on energy densities in each of the three subsystems. This enables fitting ultrafast strain dynamics and identifying subsystem coupling constants.

MA 31.17 Wed 17:00 P1

Towards ultrafast time-resolved SHG imaging of ferroic materials — •Andrin Caviezel, Gerrit Horstmann, Thomas Lottermoser, and Manfred Fiebig — Department of Materials, ETH Zurich, Zurich, Switzerland

Ferroic materials enable the storage and manipulation of information within their domain structures, a fundamental property underpinning their technological potential. Second-harmonic generation (SHG) imaging is a well-established method for probing ferroic domain patterns at equilibrium, while optical excitation with femtosecond laser pulses holds promise for achieving ultrafast domain switching. However, studying the non-equilibrium dynamics of ferroic domains demands an imaging technique that offers both high temporal and spatial resolution. In this work, we present an ultrafast time-resolved SHG imaging setup designed specifically to investigate non-equilibrium dynamics in ferroic materials. By utilizing the high pulse energies of an amplified laser system, our setup enables direct wide-field imaging of ferroic structures. Additionally, the ability to tune the laser wavelength and employ sequences of pump pulses provides precise control over optical excitation conditions. This approach allows us to study ultrafast processes both in bulk ferroics with microscopic domain structures and micrometer-sized flakes of van der Waals ferroics under cryogenic conditions, advancing our understanding of their dynamic behavior.

MA 31.18 Wed 17:00 P1

Influence of defects on the ultrafast orbital Hall effect in metallic nanoribbons — •Theresa Albrecht, Franziska Ziolkowski, Oliver Busch, Börge Göbel, Ingrid Mertig, and Jürgen Henk — Institut für Physik, Martin-Luther-Universität, D-06099 Halle

The time-dependent orbital Hall effect, which is generated by a femtosecond laser pulse, called the ultrafast orbital Hall effect (UOHE) is investigated. We present the influence of different types of defects on the UOHE in a Cu nanoribbon. The laser-driven electron dynamics is numerically calculated by our theoretical framework Evolve based on a real-space tight-binding approach for finite systems and the solution of the von Neumann equation for the calculation of the occupation numbers [1]. As a result we discuss charge redistribution and charge currents as well as orbital angular momenta and their currents with atomic resolution in the time domain. The role of defects is analysed quantitatively which is particularly important to compare with experiments.

[1] O. Busch *et al.*, Physical Review Research **6**, 013208 (2024)

MA 31.19 Wed 17:00 P1

Ultrafast magneto-elastic phenomena in highly magnetostrictive materials with systematic variation of anisotropy —

•Constantin Walz[1], Fried Weber[1], Karine Dumesnil[2], Alexander von Reppert[1], and Matias Bargheer[1,3] — [1]Institut für Physik und Astronomie, Universität Potsdam, Germany — [2]Institut Jean Lamour, Université Lorraine, Nancy, France — [3]Helmholtz-Zentrum Berlin, Germany

Highly magnetostrictive Rare Earth-Iron compounds ($REFe_2$ with RE = Tb, Dy, $Tb_{0.3}Dy_{0.7}$) are well known for their giant (inverse) magnetostriction, with more than 10^{-3} lattice constant change when applying a magnetic field. Because of that they are widely used as ultrasonic transducers in the MHz regime. Their laser-induced magnetization dynamics are less explored, though they have potential as field-tunable magneto-acoustic transducers in the GHz regime or even for strain driven magnetization switching. Here we compare polar transient magneto-optical Kerr effect (trMOKE) data on three (110)-oriented $REFe_2$. The rare-earth ion influences the cubic magnetocrystalline anisotropy energy, leading to nontrivial demagnetization and precession responses with opposing signs for Dy and Tb. We discuss nonresonant strain-driven magnetization dynamics that follow the lattice deformation with a delay. Glass-capped $TbFe_2$ films help to disentangle signal contributions from unipolar strain pulses, quasi-static strain and spin disorder.

MA 31.20 Wed 17:00 P1

Controlling Spin periodicity in a Helical Heisenberg Antiferromagnet — •Hyein Jung[1,2], Abeer Arora[2], Deeksha Gupta[3], Franziska Walther[4], Kristin Kliemt[4], Victoria C. A. Taylor[2], Túlio de Castro[2], Hanqian Lu[1,2], Christian Schüssler-Langeheine[3], Niko Pontius[3], Urs Staub[5], Cornelius Krellner[4], Laurenz Rettig[2], Ralph Ernstorfer[1,2], and Yoav W. Windsor[1,2] — [1]Technische Universität Berlin, Berlin, Germany — [2]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin, Germany — [3]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany — [4]Goethe-Universität Frankfurt, Frankfurt, Germany — [5]Paul Scherrer Institut, Villigen, Switzerland

Manipulating antiferromagnetic spin structures is a promising route to new spintronics functionality. This is particularly desirable on ultrafast time scales due to the growing demands for device speeds. Here we investigate the chiral antiferromagnet EuCo2P2 using resonant X-ray diffraction and manipulate the periodicity of its spins under three distinct conditions: (a) femtosecond laser pulse excitation, (b) applied magnetic fields, and (c) heating. These represent fundamentally distinct microscopic routes for manipulation, and their combination can provide an essential basis for achieving precise control of antiferromagnetic spin structures.

MA 31.21 Wed 17:00 P1

Ultrafast demagnetization via 4f-multiplet excitations in Terbium investigated by tr-ARPES — •Timo Dully, Gaurav Kshetry, Xinwei Zheng, Christian Strüber, and Martin Weinelt — Freie Universität Berlin

The magnetic properties of rare earth metals are governed by the localized electrons in the partially filled 4f electron shell and the interaction with the itinerant 3d electrons. Spin polarization of the 4f electrons decreases much faster in Terbium than in Gadolinium [1]. This has been attributed to enhanced coupling to the lattice caused by the anisotropic shape of the electronic wavefunction in Terbium. However, recent XMCD and RIXS experiments demonstrate an additional excitation pathway that is involved in drastically increasing the response of the magnetic system to optical excitation [2]. Scattering of optically excited 5d electrons with the 4f-subsystem allows for an efficient excitation of the 4f-multiplet.

In our time- and angle-resolved photoemission spectroscopy (tr-ARPES) setup using a hemispherical energy analyzer we measure the demagnetization of Tb as a function of time and fluence. We observe transient changes to the 4f photoemssion signal indicating a substantial excitation of the 4f-multiplet by energy transfer from the 5d valence electrons.

[1] B. Frietsch et al. Sci. Adv. 6(2020) eabb1601
[2] Nele Thielemann-Kühn et al., Sci. Adv. 10 (2024) eadk9522

MA 31.22 Wed 17:00 P1

Probing magnetic dimensional crossover in CrSiTe3 through picosecond strain pulses — •Anjan Kumar Naralapura Manohara[1,2], Soumya Mukherjee[2], Abhirup Mukherjee[2], Ajinkya Punjal[3], Shubham Purwar[4], Thirupathaiah Setti[4], Shriganesh Prabhu[3], Siddhartha Lal[2], and Natarajan Kamaraju[2] — [1]Institute of Solid State and Materials Physics, TUD Dresden University of Technology, Dresden, Germany, 01069 . — [2]Department of Physical Sciences, Indian Institute of Science Education and research, Kolkata, West Bengal, India, 741246. — [3]Department of Condensed Matter Physics and Materials Science, Tata Institute of Fundamental research, Mumbai, Maharashtra, India, 400005. — [4]Department of Condensed Matter and Materials Physics, S. N. Bose National Centre for Basic Sciences, Kolkata, West Bengal, India, 700 106.

Two-dimensional van der Waals materials provide a unique platform to investigate the evolution of magnetic order from short-range 2D intraplanar to long-range 3D interplanar configurations. Employing nondegenerate pump-probe spectroscopy, we have generated and detected picosecond acoustic strain pulses in CrSiTe3. By analysing the distinct signatures of these pulses, we have elucidated a multi-stage pathway for the magnetic dimensional crossover. Furthermore, our study reveals novel insights into the intricate interplay between spin dynamics and lattice vibrations, as manifested in both picosecond strain pulses and ultrafast carrier dynamics.

MA 31.23 Wed 17:00 P1

Low-temperature XPEEM to study functional properties of magnetic 2D materials — •Shubhada Patil[1], Alevtina Smekhova[2], and Florian Kronast[3] — [1]Helmholtz-Zentrum Berlin für Materialien und Energie, Albert-Einstein-Straße 15, 12489 Berlin, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Albert-Einstein-Straße 15, 12489 Berlin, Germany — [3]Helmholtz-Zentrum Berlin für Materialien und Energie, Albert-Einstein-Straße 15, 12489 Berlin, Germany

Two-dimensional (2D) magnetic van der Waals materials are particularly promising for electronic and spintronic devices. They exhibit novel electronic and magnetic properties that are ideally suited for investigation with surface-sensitive X-ray photoemission electron microscopy (XMCD-PEEM). In this poster, the experimental capabilities of the low-temperature PEEM facility at BESSY II are presented, including the possibility to study responses to optical excitations of a femtosecond laser system.

The results presented will focus on investigations of the magnetic properties of 2D heterostructures prepared by mechanical exfoliation of FexGeTe2 crystals (x=3, 4 or 5) with a thickness of up to a few monolayers on gold-coated Si/SiO2 substrates with h-BN capping layer in an inert atmosphere. Element-specific low-temperature imaging in XPEEM with a special sample environment is used to identify the magnetic domain configurations and their dynamic response to optical excitation with fs laser pulses.

MA 31.24 Wed 17:00 P1

Magnon-phonon scattering on ultrafast timescales — •Nabil Makadir, Kai Leckron, and Hans Christian Schneider — Physics Dept, University of Kaiserslautern-Landau (RPTU), Kaiserslautern, Germany

In the ultrafast demagnetization of ferromagnets, electron-magnon scattering likely plays an important role. Recently it has been shown in the framework of a two-band Stoner model (arXiv:2304.14978) that electron-magnon scattering processes lead to the creation of nonequilibrium magnons at large wave vectors on ultrafast time scales. In this contribution, we investigate how a large density of high-q magnons, as it is created during the demagnetization process, relaxes due to magnon-phonon and magnon-electron interactions. Treating phonons as bosons, we solve the dynamical equations for the magnon and phonon distributions including the relevant interactions at the level of Boltzmann scattering integrals. From the numerical results, we draw conclusions for the remagnetization process.

MA 31.25 Wed 17:00 P1

Ultrafast spin flop in Fe/Gd bilayers — Dominic Lawrenz[1], Tim Amrhein[1], Jonathan Weber[1], Wibke Bronsch[1], Niko Pontius[2], Christian Schüssler-Langeheine[2], Nele Thielemann-Kühn[1], and •Martin Weinelt[1] — [1]Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Helmholtz-Zentrum Berlin, Albert-Einstein-Str. 15, 12489 Berlin, Germany

Using time-resolved X-ray magnetic circular dichroism in reflection (XMCD-R) at the femtoslicing facility of BESSY II (Helmholtz-Zentrum Berlin) we studied ultrafast magnetization dynamics in an Fe(5 nm)/Gd(11 nm) bilayer on W(110). Structural and magnetic depth profiles of the bilayer were characterized by static $\Theta/2\Theta$ XMCD-R scans. The magnetization $\vec{M}$ lies in-plane with antiparallel alignment of $\vec{M}_{Fe}$ and $\vec{M}_{Gd}$ at the Fe/Gd interface. At 300 K, Gd is magnetized only at the interface. Upon optical excitation Gd demagnetizes within 2 ps reaching a transient ferromagnetic state for $\sim$ 20 ps, comparable to simulations for Co/Gd in [1]. Close to the compensation temperature of 235 K, $\vec{M}_{Fe} = -\vec{M}_{Gd}$ are oriented nearly perpendicular to the external field and twisted into the field direction with increasing distance to the interface. Upon optical excitation we observe a transient spin flop by 6° of the Gd magnetization within 300 fs. This is attributed to spin-transfer torque caused by ultrafast spin currents [2] and may hint to spin vacuum switching [3].

[1] M. Beens et al., Phys. Rev. B **100**, 220409(R) (2019).
[2] B. Liu, H. Xiao, M. Weinelt, Sci. Adv. **9**: eade0286 (2023).
[3] E. I. Harris-Lee et al., Sci. Adv. **10**: eado6390 (2024).

MA 31.26 Wed 17:00 P1

Setting up current-induced spin-wave Doppler shift experiments — •Linda Nesterov, Julian Strassburger, Johannes Demir, Karsten Rott, and Timo Kuschel — Universität Bielefeld, Germany

The coupling of coherent spin waves with incoherent spin transport, such as spin-polarized electrons, results in the transfer of angular momentum via spin-transfer torque, enabling the so-called spin-wave Doppler shift [1]. Our research aims to deepen the understanding of this fundamental process, which plays a significant role in the development of next-generation memory devices and other spintronic applications. Propagating spin-wave spectroscopy is used to detect a possible Doppler shift in spin waves generated by charge currents in a 20 nm thick $Ni_{81}Fe_{19}$ strip. The experiments are conducted using a vector network analyzer with both in-plane and out-of-plane magnetic fields applied perpendicular to the direction of the propagating spin wave, which is excited with the use of a coplanar waveguide design. In contrast to published works [1,2], this study uses Ta_2O_5 as an insulating material, chosen for its high permittivity, leading to a different impedance matching within the system.

[1] V. Vlaminck, M. Bailleul, Science 322, 410 (2008)
[2] J. Lucassen et al., Appl. Phys. Lett. 115, 012403 (2019)

MA 31.27 Wed 17:00 P1

Angle-dependent pumping of magnon Bose-Einstein condensates — •Franziska Kühn[1], Matthias R. Schweizer[1], Georg von Freymann[1,2], Alexander A. Serga[1], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, RPTU Kaiserslautern-Landau, 67663 Kaiserslautern, Germany — [2]Fraunhofer Institute for Industrial Mathematics ITWM, Fraunhofer Platz 1, 67663 Kaiserslautern, Germany

Our work focuses on the generation and behavior of magnon Bose-Einstein condensates (BEC) in yttrium-iron-garnet films. To create a magnon BEC, the magnon gas must be populated above the thermal level by external injection of magnons. Conventionally, this is done by parallel parametric pumping, where magnons are injected into spin-wave modes at half the pumping frequency. This work aims to optimize the pumping configuration by changing the direction of the microwave pumping field relative to the external magnetic field. This concept of oblique pumping promises higher efficiency and easier manipulation of the magnon BEC. The measurements are performed using a vector magnet for the rotation of the external magnetic field and Brillouin light scattering spectroscopy as an optical detection method for magnons. First results promise lower thresholds for the pumping power and thus easier excitation of magnons leading to a magnon BEC. This research was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation)-TRR 173/3-268565370 Spin+X (Project B04)

MA 31.28 Wed 17:00 P1

Towards Aharonov–Casher effect based nonreciprocal electrical control of the magnon phase in a perpendicularly magnetised YIG film — •Gabriel Schwöbel[1], Alexander A. Serga[1], Vitaliy I. Vasyuchka[1], Rostyslav O. Serha[2], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, RPTU, 67663 Kaiserslautern — [2]Faculty of Physics, University of Vienna, 1090 Vienna

Modulation of phase and amplitude of spin waves plays a crucial role in the realization of ultra-low power magnon-based computing. Therefore, we study the magnon phase change, induced by an applied electric field, in yttrium iron garnet (YIG), which has favourable magnetic properties such as a very low spin wave damping.

Recent studies [1] performed in in-plane magnetized single crystal YIG films have allowed us to evaluate different contributions to this phase change and to provide experimental evidence for the theoretically predicted magnonic Aharonov–Casher effect. This effect describes the accumulation of a geometric phase when a magnon passes through an electric field. In our new setup, which provides a more homogeneous and stable magnetic field, we investigate the non-reciprocal effects of magnon phase accumulation when a tangential electric field is applied to an out-of-plane magnetized YIG film.

[1] R.O. Serha et al., *Towards an experimental proof of the magnonic Aharonov–Casher effect*, Phys.Rev. B **108**, L220404 (2023)

MA 31.29 Wed 17:00 P1

Towards magnetically controlled phononic crystals — •Philipp Knaus, Maximilian Alexander Thiel, Kaya Gauch, and Mathias Weiler — Fachbereich Physik and Landesforschungszentrum Optimas, RPTU Kaiserslautern, Germany

Phononic crystals (PnCs) are materials with periodic modulations in their elastic properties that allow precise tuning of the phonon dispersion relation, enabling control of phonon propagation, including bandgaps, waveguiding and confinement. Recent advances have focused on 2D PnCs, which support innovative applications such as nanoscale information processing, optomechanical systems and thermal management [1]. This work represents a first step towards magnetically controlled PnCs based on surface acoustic waves, where the phononic properties of the material can be tuned. We study a magnetically controlled PnC based on Lithium Niobate $LiNbO_3$/CoFeB heterostructure. We characterize our prototype by electrical transmission measurements using a vector network analizer and optical measurements based on Brillouin Light Scattering and the time-resolved magneto-optic Kerr effect. Based on our results, we discuss potential applications and device optimization.

[1] M. Sledzinska et. al, Adv. Funct. Mater. 8, 30 (2020)

MA 31.30 Wed 17:00 P1

Spin Hall driven spin-wave emission in Ga:YIG/Pt heterostructures — •Moritz Bechberger[1], David Breitbach[1], Björn Heinz[1], Carsten Dubs[2], and Philipp Pirro[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, RPTU Kaiserslautern-Landau, 67663 Kaiserslautern, Germany — [2]INNOVENT e.V. Technologieentwicklung, Jena, Germany

The development of a DC driven and scalable spin-wave source that exhibits a self-adaptive frequency is desirable. In particular, spin currents can be used for these spin-wave sources, but instead of radiating energy in the form of propagating spin waves, localized oscillations occur in most systems due to the underlying negative nonlinear frequency shift. Here, a heterostructure consisting of an yttrium iron garnet thin film substituted with gallium atoms (Ga:YIG), which exhibits a perpendicular magnetic anisotropy, and a thin layer of platinum is employed. The heterostructure allows studies in the positive nonlinear frequency shift regime for in-plane magnetization. A spin current is locally injected into the Ga:YIG film via the spin Hall effect by applying a direct current to the platinum pad. This allows for the study of the spin-wave emission into the adjacent Ga:YIG waveguide. The emission of spin waves was found to be partially decoupled from the auto-oscillation and is restricted to a narrow frequency and wave-vector range. This work provides a proof-of-concept and the fundamental basis for the development of spin-wave emitters utilizing this mechanism. This research is funded by the DFG - Project No. 271741898, TRR 173-268565370 (B01), and the ERC Grant No. 101042439 CoSpiN.

MA 31.31 Wed 17:00 P1

Controlling the Bi/Fe ratio in bismuth iron garnet thin films deposited by confocal magnetron sputtering for enhanced Faraday rotation — Gajendra L. Mulay[1,2], •Shraddha Choudhary[3], Bhagyashree A. Chalke[1], Rudheer D. Bapat[1], Jayesh B. Parmar[1], Manish B. Ghag[1], Vilas J. Mhatre[1], Shriganesh Prabhu[1], Ashwin A. Tulapurkar[2], and Venu Gopal Achanta[1,4] — [1]TIFR, Mumbai, 400005, India. — [2]IIT Bombay, Mumbai, 400076, India. — [3]Institute of Physics, University of Münster, Wilhelm-Klemm-Str. 10, Münster, 48149, Germany. — [4]On lien at CSIR-NPL, New Delhi, 110012, India.

Among all known garnet films bismuth-iron-garnet (BIG;$Bi_3Fe_5O_{12}$) films not only demonstrate the highest Faraday rotation in visible light but also exhibit minimal optical losses. We have successfully deposited high-quality BIG epitaxial thin films on single-crystal gadolinium-gallium-garnet (GGG;$Gd_3Ga_5O_{12}$) (111) substrates via Radio frequency confocal sputtering, utilizing separate bismuth and iron oxide sputtering targets and optimized thermal treatments. The Bi/Fe ratio in the deposited BIG thin films can be varied by controlling the sputter process parameters. These deposited thin films exhibit homogeneity and surface root mean square roughness of less than 2 nm. The epitaxial film quality is confirmed by X-ray diffraction and Transmission electron microscopy. Moreover, the films demonstrate low optical loss and a magneto-optical Faraday rotation as high as $-34^o \pm 1^o/\mu$m at a wavelength of 535 nm for a BIG thin film with a Bi/Fe ratio of 0.7 and an annealing temperature of 510^oC.

MA 31.32 Wed 17:00 P1

Ultrafast dynamics in photoexcited antiferromagnets — •Katja Sophia Moos[1], Yun Yen[2], Arnau C. Romaguera[3], Hiroki Ueda[3], and Michael Schüler[1,2] — [1]Department of Physics, University of Fribourg, 1700 Fribourg, Switzerland — [2]PSI Center for Scientific Computing, Theory and Data, 5232 Villigen PSI, Switzerland — [3]PSI Center for Photon Science, 5232 Villigen PSI, Switzerland

State-of-the-art time-resolved probes provide unprecedented access to the dynamics of interacting quasiparticles in solids on their natural time scales. Although a significant body of work exists on the dynamics of electrons and phonons, much less is known about the ultrafast response of magnetic moments. Here, we study pump-induced out-of-equilibrium magnetism in the Mott insulator CuO, combining measurements of resonant magnetic X-ray scattering with quantum-kinetic simulations. In particular, the diffuse scattering reveals time-dependent magnetic correlations, which we interpret in terms of interacting magnons. For quantitative insights, we solve the time-dependent quantum Boltzmann equation to study magnon-magnon scattering. The calculations are consistent with experimental observations and provide a detailed picture of magnetic dynamics in terms of non-thermal magnons and their subsequent thermalization.

MA 31.33 Wed 17:00 P1

Investigating Spin Cherenkov Radiation in Magnetic Materials Using MuMax3 Simulations — •Kawa Noman, Matthias Schweizer, Vitaliy Vasyuchka, and Mathias Weiler — Fachbereich Physik and Landesforschungszentrum OPTIMAS, RPTU Kaiserslautern-Landau, 67663 Kaiserslautern, Germany

Spin Cherenkov Radiation (SCE) is a groundbreaking mechanism that enables the emission of spin waves (magnons) in ferromagnetic materials when an external perturbation surpasses the minimum phase velocity of these spin waves. In this study, we employ MuMax3 micromagnetic simulations to investigate SCE induced by high-amplitude Surface Acoustic Waves (SAWs) in Yttrium Iron Garnet (YIG) thin films. Our simulations reveal that SAWs propagating at velocities exceeding the spin wave phase velocity efficiently excite coherent spin wave modes, exhibiting characteristic Cherenkov like conical wavefronts. Through comparative analysis with Cobalt Iron Boron (CoFeB), we affirm the universal nature of SCE across diverse ferromagnetic materials, thereby highlighting its significant potential for advanced applications in magnonic and spintronic devices. This study not only establishes spin Cherenkov Radiation as a fundamental physical phenomenon but also paves the way for innovative technologies that leverage controlled spin wave emission.

MA 31.34 Wed 17:00 P1

Excitation of spin waves via surface acoustic waves in complex magnetic domain structures — •Mohammad Javad Kamali Ashtiani[1], Alexandre Abbass Hamadeh[2], Ephraim Spindler[1], Mathias Weiler[1], and Philipp Pirro[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, RPTU Kaiserslautern-Landau, 67663 Kaiserslautern, Germany — [2]Center de Nanosciences et de Nanotechnologies, CNRS, Universite Paris-Saclay, 91120, Palaiseau, France

We investigated the interaction of surface acoustic waves (SAWs) with spin waves (SWs) in micrometer-sized cobalt-iron-boron (CoFeB) dots on a piezoelectric –ScAlN– substrate. These dots exhibit particular domain structures leading to complex magnon-phonon coupling. SAWs, generated using interdigital transducers across a broad GHz frequency range, were observed to excite SWs in the CoFeB structures. The dynamics were characterized using micro-focused Brillouin light scattering (*BLS) spectroscopy, allowing direct detection of SAW and SW excitations. Nitrogen-vacancy magnetometry provided high-resolution insights into the magnetic domain arrangement. Also, Mumax3 simulations confirmed the complex domain textures. The response of SWs at specific resonance magnetic fields was observed and shifted across different frequencies. Our findings highlight the potential of hybrid phonon-magnon systems for tunable magnonic devices, advancing wave-based information processing technologies. This research was supported by DFG under TRR 173/3 - 268565370 Spin+X (Project B01).

MA 31.35 Wed 17:00 P1

All-Magnonic Frequency Multiplication in Ferromagnetic Microstructures — •Alexandra Schrader[1], Chris Körner[1], Rouven Dreyer[1], Niklas Liebing[2], and Georg Woltersdorf[1] — [1]Martin-Luther-Universität Halle-Wittenberg — [2]Fraunhofer Institute for Electronic Nano Systems ENAS, Chemnitz

We have observed all-magnetic frequency multiplication and a six-octave frequency comb in polycrystalline NiFe thin films [1]. At low bias fields, magnetic ripples cause local magnetization tilting, and MHz-range excitation induces rapid switching and high-harmonic spin wave emission. To enable practical applications, it is essential to miniaturize active components and optimize the frequency multiplication efficiency, aiming to generate GHz-range spin waves using MHz rf excitation in minimal-sized elements.

Recently, frequency multiplication has also been observed in extended CoFeB layers [2]. This motivates us to investigate the effect in both thin films as well as microstructures of CoFeB. Using micromagnetic simulations, we analyze how various parameters - such as saturation magnetization, anisotropy, static bias field and the shape, size and thickness of micrometer-sized CoFeB elements - influence generation efficiency. These numerical results are then compared to experimental measurements performed via NV magnetometry and SNS-MOKE techniques on actual samples.

[1] Koerner et al., Science 375, 6585 (2022)
[2] Wu et al., npj Spintronics 2, 30 (2024)

MA 31.36 Wed 17:00 P1

Magnetoacoustic coupling in Yttrium Iron Garnet / Aluminium Scandium Nitride heterostructures — •Kevin Künstle[1], Kaya Gauch[1], Yannik Kunz[1], Agne Žukauskaite[2,3], Stephan Barth[2], and Mathias Weiler[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, Rheinland-Pfälzische Technische Universität Kaiserslautern-Landau, 67663 Kaiserslautern, Germany — [2]Fraunhofer Institute for Electron Beam and Plasma Technology FEP, 01277 Dresden, Germany — [3]Institute of Solid State Electronics, Technische Universität Dresden, 01062 Dresden, Germany

The magnetoelastic coupling between surface acoustic waves (SAWs) and spin waves (SWs) has garnered significant attention in recent years. Magnetoelastic excitation of SWs is particularly appealing in ferrimagnets with low magnetic damping, such as yttrium iron garnet (YIG). To enable the electrical excitation of SAWs, a piezoelectric layer is required. We have demonstrated that ZnO is a suitable choice [1]. In this study, a novel heterostructure comprising a YIG/GGG bilayer covered by a piezoelectric AlScN thin film is investigated to explore this coupling. The interaction of SAW and SW is characterized using micro-focused Brillouin light scattering (BLS) spectroscopy and vector network analyzer (VNA) measurements. Additionally, the observed magnetoelastic coupling is benchmarked against the coupling in the more established ZnO/YIG/GGG heterostructure.

[1] Ryburn et al., arXiv 2403.030006 (2024)

MA 31.37 Wed 17:00 P1

Efficient all-magnonic frequency multiplication in nanoscale devices — •Chris Körner[1], Anna Kiefel[1], Rouven Dreyer[1], Alexandra Schrader[1], Niklas Liebing[2], and Georg Woltersdorf[1] — [1]Martin-Luther-Universität Halle-Wittenberg, Institut für Physik, Von Danckelmann Platz 3, 06120 Halle (Saale) — [2]Fraunhofer-Institut für Elektronische Nanosysteme ENAS, Technologie-Campus, 3 09126 Chemnitz

We recently have observed all-magnonic frequency multiplication and the generation of a 6-octave spanning frequency comb within an extended polycrystalline NiFe layer [1]. At low bias fields the magnetization locally tilts due to a magnetic ripple effect in the film. Driving the magnetization with frequencies far below ferromagnetic resonance, i.e. in the MHz range, causes rapid synchronous switching and leads to high harmonic spin wave emission. To make use of this effect in an actual device it is necessary to shrink the dimensions of the active components and to enhance the efficiency of the frequency multiplication process. The aim is to generate spin waves in the range of up to 10 GHz most efficiently in elements as small as possible, just from r.f. excitation with MHz frequencies. We employ micromagnetic simulations to investigate how the generation efficiency is influenced by external parameters, such as bias field and the shape, size, and thickness of micrometer sized NiFe elements. We find that the comb generation process can still be efficient even if we scale down the elements to just a few microns and compare these results to NV-center and SNS-MOKE measurements. [1] Koerner et al. Science, 375 (6585) 2022.

MA 31.38 Wed 17:00 P1

Realization of Inverse-Design Magnonic Logic Gates — •Fabian Majcen[1,2], Noura Zenbaa[1,2], Claas Abert[1,3], Florian Bruckner[1,3], Norbert Mauser[3,4], Thomas Schrefl[3,5], Qi Wang[6], Dieter Süss[1,3], and Andrii Chumak[1,3] — [1]University of Vienna, Faculty of Physics, Vienna 1090, Austria — [2]University of Vienna, Vienna Doctoral School in Physics, Vienna 1090, Austria — [3]Research Platform MMM "Mathematics-Magnetism-Materials", University of Vienna, Vienna 1090, Austria — [4]Faculty of Mathematics, University of Vienna, Vienna 1090, Austria — [5]Center for Modelling and Simulation, Donau-Universität Krems, Wiener Neustadt, 2700, Austria. — [6]School of Physics, Hubei Key Laboratory of Gravitation and Quantum Physics

The field of Magnonics, which utilizes magnons, the quanta of spin waves, for energy-efficient data processing, has made significant advancements through the application of inverse design. A universal magnonics processor has been developed, utilizing a 7x7 array of independent current loops to generate local inhomogeneous magnetic fields, thereby scattering spin waves in an Yttrium-Iron-Garnet film to achieve various functionalities. In this system, binary data ('0' and '1') is encoded in the spin-wave amplitude, and by making use of the nonlinearity of spin waves and applying the inverse-design process, logic gates including NOT, OR, NOR, AND, NAND, and a half-adder have been successfully created.

MA 31.39 Wed 17:00 P1

Yttrium iron garnet nanostructures for spin-wave computing — •Jannis Bensmann[1], Ahmad El Kadri[1], Dmitrii Raskhodchikov[1,2], Kirill O. Nikolaev[3], Robert Schmidt[1], Johannes Kern[1], Shraddha Choudhary[1], Vladislav E. Demidov[3], Steffen Michaelis de Vasconcellos[1], Wolfram H. P. Pernice[1,2,4], Sergej O. Demokritov[3], and Rudolf Bratschitsch[1] — [1]University of Münster, Institute of Physics and Center for Nanotechnology, 48149 Münster, Germany — [2]University of Münster, Center for Soft Nanoscience, 48149 Münster, Germany — [3]University of Münster, Institute of Applied Physics, 48149 Münster, Germany — [4]Heidelberg University, Kirchhoff-Institute for Physics, 69120 Heidelberg, Germany

The ever-increasing demand for computing power, particularly driven by the recent advances in the field of artificial intelligence, has triggered research into novel system architectures to improve the performance of current computing technology. Here, spintronics appears as a promising candidate, as spin waves are energy-efficient, broadband (up to THz), and can have wavelengths down to the nanometer scale. In order to realize hardware-based spin-wave computing, we employ nanofabrication techniques to create devices from 100-nm-thick films of yttrium iron garnet (YIG), a material well known for its exceptional low-damping. We evaluate the performance of individual building blocks using optical measurements such as Brillouin light scattering, which provides detailed insights into the spin-wave propagation.

MA 31.40 Wed 17:00 P1

Manipulation of spin waves in YIG/FM heterostructures — •Julien Schäfer, Akira Lentfert, Björn Heinz, and Philipp Pirro — Department of Physics and Research Center OPTIMAS, RPTU Kaiserslautern-Landau, 67663 Kaiserslautern, Germany

The concept of using spin waves as data carriers is a promising alternative to existing communication standards with the potential for energy efficient data transfer. In magnonics, communication building blocks, such as time-delay lines for phase modulation, can be realized by exploiting the magnetic field-dependent spin-wave group velocities in e.g. yttrium-iron-garnet (YIG). In particular, the spin wave propagation in Damon-Eshbach geometry can be modified by the deposition of an additional ferromagnetic layer, leading to a strong frequency nonreciprocity induced by dipolar interaction. Here, we report an on-chip configurable magnonic frequency filter/phase shifter device consisting of a YIG transmission line with iron stripes deposited on top. These stripes act as Fabry-Pérot (FP) resonators due to the spin-wave reflections at the boundaries. Destructively interfering spin waves are filtered by such a resonator, while the transmitted spin waves accumulate an additional phase due to the altered dispersion relation in the bilayer region. We present micromagnetic studies investigating the tunability of these FP resonators by means of external parameters such as local magnetic fields and the stripe magnetization configuration. This research is funded by the European Union within HORIZON-CL4-2021-DIGITAL-EMERGING-01 (No.101070536, MandMEMS).

MA 31.41 Wed 17:00 P1

Mapping of the Morin Transition in alpha-Fe2O3 using Surface Acoustic Waves — •Katharina Lasinger[1,2], Florian Kraft[1], Yannik Kunz[1], Kevin Künstle[1], Finlay Ryburn[2], John F. Gregg[2], and Mathias Weiler[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, RPTU Kaiserslautern-Landau, Germany — [2]Clarendon Laboratory, Department of Physics, University of Oxford, United Kingdom

Antiferromagnets (AFMs) hold great potential for applications due to their insensitivity to external magnetic fields, the absence of associated stray fields and and their ability to host fast spin dynamical phenomena [1,2]. While AFMs interact only weakly with external magnetic fields, their magnetic order couples to elastic deformation. We investigate the manipulation of AFMs using magnetoelasticity and demonstrate both the possibility to probe changes in the static magnetization as well as map out the Morin transition of alpha-Fe2O3 through concurrent modification of its elastic properties. To achieve this, surface acoustic waves (SAWs) are launched in an alpha-Fe2O3 | ZnO heterostructure while magnetic field sweeps are performed. We observe significant changes in SAW group velocity and amplitude depending on the angle of the external magnetic field relative to the crystallographic c-axis and the SAW propagation direction. A temperature-dependent study around the Morin transition reveals the critical fields at each temperature required for the antiferromagnetic phase transition to occur.

[1] A. V. Chumak, et al., Nature Physics 11, 453 (2015).
[2] S. M. Rezende, et al., J. Appl. Phys. 126, 151101 (2019).

MA 31.42 Wed 17:00 P1

Interlayer coupling in Co/Pd multilayers with perpendicular magnetic anisotropy — •Raphael Kohlstedt[1,2], Rico Ehler[1,2], Peter Heinig[1,2], and Olav Hellwig[1,2,3] — [1]Chemnitz University of Technology, D-09107 Chemnitz, Germany — [2]Research Center MAIN, D-09126 Chemnitz, Germany — [3]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, D-01328 Dresden, Germany

Antiferromagnetically (AF) coupled perpendicular magnetic anisotropy (PMA) multilayers (MLs) are widely utilized in magnetic devices. In Co/Pd MLs with PMA, the coupling is implemented via non-magnetic spacer layers like Ru or Ir. Using Pd itself as a spacer would be beneficial, since purely-Pd-based systems are promising candidates for applications in magneto-ionics, as demonstrated in recent reports [1-3]. In sputtered Co/Pd/Co trilayers, aging under ambient conditions induces a transient coupling effect, leading to a transition from ferromagnetic to antiferromagnetic coupling [4]. Building onto these experiments, we investigate the coupling behavior in Co/Pd/Co trilayers and Co/Pd MLs separated by a thicker Pd spacer. In our samples, we observe AF coupling as well as distinctly time-dependent effects, differing from those reported previously.

[1] A. E. Kossak et al., Sci. Adv., 9(1), 2023
[2] A. E. Kossak et al., Adv. Funct. Mater., 34(46), 2024
[3] M. Gößler et al., Adv. Funct. Mater., 34(40), 2024
[4] F. S. Wen et al., J. Appl. Phys., 110(4), 2011

MA 31.43 Wed 17:00 P1

Magnetometry of Buried Co-based Nanolayers by Hard X-ray Photoelectron Spectroscopy — •Andrei Gloskovskii[1], Christoph Schlueter[1], and Gerhard Fecher[2] — [1]Photon Science / DESY, Hamburg — [2]Max Planck Institute for Chemical Physics of Solids, Dresden

Magnetic circular dichroism (MCD) effect has a cos (θ) dependence where θ is the angle between light polarization and sample magnetization. This yields direct information about the magnetization direction with respect to the polarization of the synchrotron X-ray beam for both ferromagnetic and antiferromagnetic materials. In the hard X-ray regime, the beam polarization can be conveniently modified utilizing the phase shift produced by a diamond phase plate in the vicinity of a Laue or Bragg reflection. Extracting quantitative information about absolute values of local magnetic moments is very challenging, because of the complicated structure of photoelectron spectra. For example, the 4eV Co satellite cannot be explained by the solid-state calculations. The satellite obviously exhibits strong dichroism.

The electronic and magnetic properties of CoFe, CoFeB and Co-based Heusler nanolayers were studied using MCD. Both the polarization-dependent spectra and the dichroism indicate that the lines of the multiplet extend over the entire spectral range. It is demonstrated that MCD in HAXPES is an effective and powerful technique to perform element- and depth-specific magnetometry of deeply buried ferromagnetic and antiferromagnetic magnetic materials.

MA 31.44 Wed 17:00 P1

Kerr Microscopy Studies of Magnetic Domains in proximity-coupled 3d FM-EuO Heterostructures — •Katharina Wehrstein, Seema Seema, Pia Maria Düring, and Martina Müller — FB Physik, Universität Konstanz, 78457 Konstanz

Europium monoxide (EuO) is a promising material for future spintronic applications as it is an insulator with a similar band gap to silicon, is ferromagnetic (FM) up to a Curie temperature (T_c) of 69 K and shows good spin-filter qualities. Since the low T_c is limiting for applications, methods to increase T_c are actively investigated. For this purpose, it is important to understand the magnetic behavior of EuO below, near and above T_c. One possible option to increase T_c is the proximity coupling of EuO with room temperature (RT) FM such as Fe or Co. Here, the temperature- and thickness-dependent magnetization of EuO thin films and 3d FM coupled EuO heterostructures synthesized by molecular beam epitaxy was investigated using magneto-optical Kerr microscopy. Systematic temperature- and thickness-dependent investigations on one hand revealed that the magnetic domain structure in Fe undergoes significant modifications in the presence of EuO, compared to Co. On the other hand, coercivity gets more affected due to the presence of Co than Fe. Such observations could lead to tuning thickness of EuO and overlayer choice in proximity-coupled heterostructures with T_c close to RT for applications.

MA 31.45 Wed 17:00 P1

Phase Modulation of Spin Waves via Surface Acoustic Waves — •Tim Vogel, Björn Heinz, and Philipp Pirro — Fachbereich Physik and Landesforschungszentrum OPTIMAS, RPTU Kaiserslautern-Landau

The interaction of spin waves and surface acoustic waves (SAWs) offers promising opportunities for advanced spintronic and magnonic applications. This study investigates the feasibility of using low-frequency SAWs in the MHz range to modulate the phase of high-frequency spin waves in the GHz range. Using micromagnetic simulations with mumax3, we investigate the dynamic coupling mechanisms and conditions necessary for effective phase manipulation of propagating spin waves.

While the primary focus is theoretical, this work also provides a framework for potential experimental validation to elucidate key factors such as coupling efficiency, propagation dynamics and system geometry. These results will contribute to a deeper understanding of magnon-phonon interactions.

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MA 31.46 Wed 17:00 P1

Antiferromagnetic coupling in Co/Au/Co tri-layers — Lokesh Rasabathina[1], Rico Ehrler[1], Markus Gössler[1], Karin Leistner[1], Georgeta Salvan[1,2], and •Olav Hellwig[1,2,3] — [1]Chemnitz University of Technology, Chemnitz, Germany — [2]Center for Materials, Architectures and Integration of Nanomembranes (MAIN), Chemnitz University of Technology,Chemnitz, Germany — [3]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

Magnetic thin film systems are of great interest for many applications, such as magnetic memory, storage, sensor devices, etc. Specifically synthetic antiferromagnets (SAFs) with perpendicular magnetic anisotropy are of interest in the fabrication of nanomagnetic and spintronic devices[1]. In reference to earlier studies[2], we fabricate thin films consisting of $Au_{seed}/Co_{(1)}/Au_{interlayer}/Co_{(2)}/Au_{cap}$ layer stack using magnetron sputtering in ultra-high vacuum conditions. Varying the $Au_{interlayer}$ thickness the $Co_{(1)}$ and $Co_{(2)}$ layers either reverse separately at different switching fields or jointly at the same switching field. We investigate if the interaction between the two cobalt layers originates from RKKY coupling, orange-peel coupling or through growth induced asymmetry between the two cobalt layers[3]. The Au_{seed} layer thickness also seems to affect the observed reversal behaviour. For our sample characterization, we use different types of magnetometry and magnetic microscopy techniques.

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[2] M. Matczak et al., J. Appl. Phys., vol. 114, no. 9 (2013)
[3] V. Grolier et al, Phys. Rev. Lett. 71, 3023 (1993)

MA 31.47 Wed 17:00 P1

Site-selective substitution effects on the magnetic phase diagram of multiferroic $Fe_2Mo_3O_8$ — Lilian Prodan[1], •Dorina Croitori[2], Irina G. Filippova[2], Sergiu Shova[3], Vladimir Tsurkan[1,2], and Istvan Kezsmarki[1] — [1]University of Augsburg — [2]Moldova State University — [3]Romanian Academy

Antiferromagnetic materials hold great promise for the design of ultrafast and energy-efficient spintronic devices. Therefore, understanding the robustness of crystals, their magnetic structures, and their manipulation is of high importance. Here, we report the effect of site-selective substitution of Zn^{2+} for Fe^{2+} ions on the crystal structure, magnetic and thermodynamic properties of the multiferroic $Fe_2Mo_3O_8$. We found the strong preference of Zn to occupy the tetragonal positions for substitution concentrations $\mathbf{0 \geq x \leq 1.3}$. This contrasts the previously reported results for related system $Co_2Mo_3O_8$ [1]. Site-selective substitution affects the magnetic phase diagram of $Fe_2Mo_3O_8$ influencing both the intra and inter-layer exchange interactions. This leads to the stabilization of the FiM phase for $\mathbf{x \geq 0.2}$ and to the decrease of T_C with increasing the Zn content. [1]. L. Prodan, I. Filippova, et al. Phys Rev B 106 (2022) 174421.