MA 35: Poster 2

Topics: Magnonics (35.1-35.14), Magnetic Domain Walls (non-skyrmionic) (MA 35.15-35.17), Ultrafast Magnetization Effects (MA 35.18-35.33), Magnetic Relaxation and Gilbert Damping (MA 35.34-35.36), Magnetic Semiconductors (MA 35.37-35.38), Magnetic Heuslers (MA 35.39-35.40), Complex Magnetic Oxides (MA 35.41), Frustrated Magnets (MA 35.42-35.44), Thin Films: Magnetic Coupling Phenomena / Exchange Bias (MA 35.45-35.48), Thin Films: Magnetic Anisotropy (MA 35.49-35.51), Bulk Materials: Soft and Hard Permanent Magnets (MA 35.52), Magnetic Instrumentation and Characterization (MA 35.53-35.59), Magnetic Particles / Clusters (MA 35.60-35.61), Magnetic Information Technology, Recording, Sensing (MA 35.62), Micro- and Nanostructured Magnetic Materials (MA 35.63-35.65), Multiferroics and Magnetoelectric Coupling (MA 35.66-35.67), Surface Magnetism (MA 35.68-35.71), Cooperative Phenomena: Spin Structures and Magnetic Phase Transitions (MA 35.72), Topological Insulators (MA 35.73-35.75), Weyl Semimetals (MA 35.76).

Time: Thursday 16:00–18:00 Location: P4

MA 35.1 Thu 16:00 P4

Magnetic Coupling in Y3Fe5O12/Gd3Fe5O12 Heterostructures — Sven Becker[1], Zengyao Ren[1,2,3], •Akashdeep Akashdeep[1], and Gerhard Jakob[1,2] — [1]Institute of Physics, Johannes Gutenberg-University Mainz, Staudingerweg 7, Mainz 55128, Germany — [2]Graduate School of Excellence *Materials Science in Mainz* (MAINZ), Staudingerweg 9, Mainz 55128, Germany — [3]School of Materials Science and Engineering, University of Science and Technology Beijing, Beijing 100083, China

Ferrimagnetic Y3Fe5O12 (YIG) is the prototypical material for studying magnonic properties due to its exceptionally low damping. By substituting the yttrium with the temperature-dependent magnetic moment of gadolinium, we can introduce an additional spin degree of freedom in form of a magnetic compensation point. Here, we study the magnetic coupling in epitaxial Y3Fe5O12/Gd3Fe5O12 (YIG/GIG) heterostructures grown by pulsed laser deposition. The XRD patterns show Laue oscillations and a narrow rocking curve indicating a smooth surface and interface. From bulk sensitive magnetometry and surface-sensitive spin Seebeck effect and spin Hall magnetoresistance measurements, we determine the alignment of the heterostructure magnetization as a function of temperature and external magnetic field. We show that we can control the magnetic properties of the heterostructures by tuning the thickness of the individual layers. These bilayer devices could potentially control the magnon transport analogously to electron transport in giant magnetoresistive devices[1].

[1] H. Wu et.al.; Phys. Rev. Lett. 120, 097205 (2018).

MA 35.2 Thu 16:00 P4

GHz frequency layered antiferromagnets for novel Magnonic computing applications — •Sally Lord and John Gregg — Clarendon Laboratory, Department of Physics, University of Oxford, Parks Road, Oxford, OX1 3PU, United Kingdom

Magnonic computing is a novel computing paradigm that exploits the unusual behaviour of magnons to develop faster, more efficient devices, that have the potential to rival existing CMOS technologies. Antiferromagnetic materials are a prime candidate for such applications, primarily due to their typical THz resonant frequencies, which offer the possibility of creating devices with faster operating speeds. However, studying the THz frequencies of these materials, using conventional electronic methods, is challenging. Layered antiferromagnetic materials offer a promising solution to this challenge, since the weak interlayer coupling results in resonant frequencies that exist in the easily accessible microwave range. Furthermore, these materials can be artificially created by coupling two ferromagnetic layers via a non-magnetic spacer layer to create synthetic antiferromagnet. In this contribution, we report on the experimental setup designed to explore the magnetic properties of such materials.

MA 35.3 Thu 16:00 P4

Towards Integration: On-chip Excitation of Spin Waves using Meander Antennas tailored to practical Applications — •Johannes Greil[1], Martina Kiechle[1], Matthias Golibrzuch[1], Ádám Papp[2], György Csaba[2], and Markus Becherer[1] — [1]Technical University of Munich (TUM), Germany — [2]Pázmány Peter Catholic University, Budapest, Hungary

Albeit spin-wave (SW) computation principles are understood well, integrating SW-based devices makes an efficient excitation of SWs inevitable. Electrical measurements are performed most conveniently with inductive antennas that transfer radio frequency (RF) power into the SW system and pick up the output signals.

We demonstrate the realization of broadband efficient excitation of SWs with meander antennas in a chip-on-platform system. The platform is a PCB that carries the RF signal to a 100nm thin YIG film with metallized bond pads and meander antennas on top. Despite the lower spectral bandwidth of meander antennas compared to CPW structures they have better impedance matching over a wide frequency range and thus provide efficient SW excitation.

We also demonstrate a new design for a dual-wavelength spin wave antenna that consists of a meander structure with two linewidths and gap sizes. Feeding the antenna with two RF frequencies enables for simultaneous excitation of SWs with two wavelengths at one magnetic bias field. Thus, it can be seen as a first realization of purely SW frequency modulation or as the basis for SW-based frequency-division multiplexing (FDM) with two sub-bands.

MA 35.4 Thu 16:00 P4

Non-linear spin waves at low bias fields in $Ni_{80}Fe_{20}$ elements — •Matthias Volz, Rouven Dreyer, and Georg Woltersdorf — Martin Luther University Halle-Wittenberg, Institute of Physics, Von-Danckelmann-Platz 3, 06120 Halle (Saale), Germany

Magnetic rf fields can be used to excite non-linear spin waves in $Ni_{80}Fe_{20}$ elements at low bias fields. At a certain rf threshold field, spin waves oscillating at odd half-integer multiples of the driving frequency can be excited [1]. Here, the $\frac{3}{2}\omega$ mode is investigated with frequency resolved magneto-optical Kerr microscopy [2]. Specifically we determine the dynamical response at $\frac{3}{2}$ multiple of the driving frequency. By simultaneously detecting real and imaginary parts of the response at $\frac{3}{2}$ of the driving frequency, we reveal phase stable regimes for these $\frac{3}{2}\omega$ non-linear spin wave modes. These modes are investigated as a function of the pump power level, the bias field, and the $Ni_{80}Fe_{20}$ element thickness. We show that a phase stable non-linear regime can be established for $Ni_{80}Fe_{20}$ thicknesses between 10 nm and 20 nm.

[1] H. G. Bauer et al., Nat. Commun. 6:8274 (2015)
[2] R. Dreyer et al., Phys. Rev. Materials 5.6 (2021)

MA 35.5 Thu 16:00 P4

Sensing of magnetic excitations in 2D-materials with NV-spins — •Hossein Mohammadzadeh, Dominik Maile, and Joachim Ankerhold — ICQ and IQST, University of Ulm, Ulm, Germany

Magnetism in two-dimensional (2D) van der Waals (vdW) materials has recently emerged as one of the most promising areas in condensed matter research, with many exciting emerging properties and significant potential for applications ranging from topological magnonics to low-power spintronics, quantum computing, and optical communications [1]. The nitrogen-vacancy (NV) center in diamond is an excellent platform to detect nanoscale signatures in magnetic materials [2]. The spin state of the NV center can be easily initialized and read out in the optical domain and coherently manipulated with microwave fields. Motivated by and in collaboration with recent experimental activities in this direction [3], in this poster we describe the general strategy and first theoretical results. The latter is based on a description of low energy magnetic excitations in terms of a Kitaev-Heisenberg model and the coupling of magnons in the trivial and in the topological phase to single NV-electronic spins.

[1] Qing Hua Wang et al., ACS Nano, 16, 5, 6960-7079 (2022)
[2] Francesco Casola, Toeno van der Sar, and Amir Yacoby. Nat Rev Mater 3, 17088 (2018)
[3] Jörg Wrachtrup et al. Nat Commun 12, 1989 (2021)

MA 35.6 Thu 16:00 P4

Microwave Control of Magnon Transport in Nanostructures — •Franz Weidenhiller[1,2], Janine Gückelhorn[1,2], Manuel Müller[1,2], Hans Huebl[1,2,3], Matthias Althammer[1,2], and Rudolf Gross[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 Technology, München, Germany

Magnon transport in magnetically ordered insulators is of great interest for the implementation of magnonic devices. We here present our results on the diffusive magnon transport signal in yttrium iron garnet (YIG) due to the simultaneous excitation of magnons with electromagnetic microwaves. Using E-beam lithography, we pattern two platinum strips on top of the YIG for the injection and detection of magnons. The Pt strips are electrically insulated from an aluminum microwave antenna, which covers both strips and the gap in between. Via the antenna, microwave driven generation of magnons in the active device area through ferromagnetic resonance is possible. We investigate how these microwave injected magnons affect the magnon transport between the two Pt strips. We compare these results to spin pumping experiments using the two Pt strips as electrical detectors. Finally, we discuss relevant magnon relaxation mechanisms in our experiments.

MA 35.7 Thu 16:00 P4

Unidirectional spin wave propagation mediated by $Co_{25}Fe_{75}$-nanogratings — •Christian Mang[1,2], Monika Scheufele[1,2], Manuel Müller[1,2], Johannes Weber[1,2], Vincent Haueise[1,2], Hans Huebl[1,2,3], Matthias Althammer[1,2], Stephan Geprägs[1], and Rudolf Gross[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 Technology (MCQST), München, Germany

Unidirectional spin wave propagation adds additional functionalities to magnonic devices and their potential application in communication technology. We report the fabrication of $Co_{25}Fe_{75}$-nanogratings via electron beam lithography and DC magneton sputtering on yttrium iron garnet (YIG) thin films. The dipolar magnetic interactions between the $Co_{25}Fe_{75}$-nanogratings and the YIG-film give rise to a finite non-reciprocity of the spin wave propagation in the YIG-film for a collinear magnetization configuration of the $Co_{25}Fe_{75}$-gratings and the YIG-film [1]. By performing spin wave spectroscopy, we study the coupled spin wave modes of the $Co_{25}Fe_{75}$-nanogratings and the YIG thin films in the Damon-Eshbach geometry using a vector network analyzer.

[1] J. Chen et al., Phys. Rev. B **100**, 104427, (2019)

MA 35.8 Thu 16:00 P4

Spontaneous emergence of spin-wave frequency combs mediated by vortex gyration — •Christopher Heins[1], Katrin Schultheiss[1], Lukas Körber[1,2], Attila Kákay[1], Tobias Hula[1,3], Mauricio Bejarano[1,2], Vadym Iurchuk[1], Jürgen Lindner[1], Jürgen Fassbender[1,2], and Helmut Schultheiss[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Fakultät Physik, Technische Universität Dresden, Dresden, Germany — [3]Institut für Physik, Technische Universität Chemnitz, Chemnitz, Germany

We present experimental investigations of the spin-wave frequency comb formation in a confined system, a magnetic vortex. The magnetic vortex shows rich spin-wave dynamics like the formation of whispering gallery magnons and non locally induced three-magnon scattering, all with frequencies in the GHz range. Additionally, there is the low frequency gyration of the vortex core itself. The combination of these dynamics on two different time scales inside magnetic vortices, results in the generation of spin-wave frequency combs with their spacing given by the vortex gyration frequency.

Using Brillouin light scattering microscopy, we show that large amplitude excitations of spin waves purely in the GHz range can induce a gyration of the vortex core, which leads to the formation of frequency combs. Analyzing the mode profiles of the sidebands by micromagnetic simulations, shows that the comb is generated via three magnon scattering under conservation of energy and angular momentum.

The authors acknowledge financial support from the Deutsche Forschungsgemeinschaft within program SCHU 2922/1-1.

MA 35.9 Thu 16:00 P4

Magnetooptical Investigation of non-reciprocal Phonon-Magnon interaction — •Yannik Kunz[1], Michael Schneider[1], Moritz Geilen[1], Torben Pfeifer[1], Matthias Küss[2], Manfred Albrecht[2], Philipp Pirro[1], and Mathias Weiler[1] — [1]Fachbereich Physik und OPTIMAS, TU Kaiserslautern — [2]Institut für Physik, Universität Augsburg

Surface acoustic waves (SAWs) are employed to achieve miniaturization of telecommunication devices, as they live in the Gigahertz-regime with wavelengths on the micrometre scale. The coupling of SAWs with spin waves (SWs) leads to nonreciprocal SAW-propagation, induced by symmetry breaking coupling mechanisms [1]. We investigated the coupling of SAWs, excited by Interdigital Transducers (IDTs), with SWs in a $LiNbO_3/Co_{40}Fe_{40}B_{20}$(10 nm)/SiN(5 nm)-structure using well-established micro-focused Brillouin Light Scattering Spectroscopy and the novel microfocused frequency-resolved magneto-optical Kerr effect with phase resolution, empowered by vector network analysis [2]. We model the magnetic field and angle-dependent SAW-SW- coupling using an extended theoretical model for continuous, viscoelastic Rayleigh-mode SAWs [3] as well as a theoretical model to describe the magneto-elastic coupling [4]. We acknowledge the funding by DFG via project No. 492421737.

[1] M. Küß et al., Phys. Rev. Lett. 125, 217203 (2020).
[2] L. Liensberger et al. IEEE Magn. Lett. 10, 5503905 (2019).
[3] P.K. Currie et al., Q. Appl. Math. 35, (1977).
[4] M. Küß et al., Phys. Rev. Applied 15, 034060 (2021).

MA 35.10 Thu 16:00 P4

Magnon Bose–Einstein condensates in microscopic thermal landscapes — •Franziska Kühn, Matthias R. Schweizer, Georg von Freymann, Alexander A. Serga, and Burkard Hillebrands — Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, Kaiserslautern, Germany

This contribution is focused on the behavior of a magnon Bose–Einstein condensate (BEC) in artificial magnetization landscapes at the scale of the wavelengths of condensed magnons. In our work, the magnon condensate is created by overpopulation of a magnon gas using microwave parametric pumping. By combining a heating laser with a microscopic phase-based wave front modulation technique, a temperature pattern is imprinted on the yttrium-iron-garnet film sample. Accordingly, the saturation magnetization, on which the dispersion relation of the magnons depends, is shifted. The corresponding spatial variation of the condensate frequency, acting as an artificial potential for the BEC, affects its dynamics and propels magnon supercurrents and Bogoliubov waves. Since the size of these patterns is small compared to the area of BEC formation, it is possible to investigate the BEC in two-dimensional thermal landscapes. In the experiment, by utilizing microfocused Brillouin light scattering spectroscopy, we study the anisotropy of the two-dimensional density distribution of a magnon BEC and the possibility of interference effects between Bogoliubov waves.

Funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – TRR 173 – 268565370 (project B04).

MA 35.11 Thu 16:00 P4

Optical characterisation of direct write 3D nanoarchitectures for magnonics — •Sebastian Lamb-Camarena[1,2], Sabri Koraltan[3], Qi Wang[1], Fabrizio Porrati[4], Sven Barth[4], Michael Huth[4], Michal Urbanek[5], Dieter Suess[3], Andrii Chumak[1], and Oleksandr Dobrovolskiy[1] — [1]University of Vienna, Nanomagnetism and Magnonics, Boltzmanngasse 5, 1090 Vienna, Austria — [2]University of Vienna, Vienna Doctoral School in Physics, Boltzmanngasse 5, 1090 Vienna, Austria — [3]University of Vienna, Physics of Functional Materials, Boltzmanngasse 5, 1090 Vienna, Austria — [4]Physikalisches Institut, Goethe-Universität, Max-von-Laue-Str. 1, 60438 Frankfurt am Main, Germany — [5]CEITEC BUT, Brno University of Technology, Brno 61200, Czech Republic

Major directions in magnonics are the extension of magnonic conduits into the third dimension, and operations with short wavelength, fast moving exchange magnons. Both are addressed by direct write nanoarchitectures fabricated by focused electron beam induced deposition (FEBID). Characterisation results of 2D and 3D magnetic FEBID nanostructures by Brillouin light scattering (BLS) spectroscopy and ferromagnetic resonance (FMR) measurements are presented, including a structure with 3D hemicylindrical protrusion along the top face of the rectangular waveguide. The FEBID nanostructures exhibit strong magnetic response to quasi-static and dynamic external magnetic stimuli. Further characterisation of the material properties is foundational for advancing research into spin wave dynamics and geometric curvature induced effects on signal propagation.

MA 35.12 Thu 16:00 P4

VSM and EPR characterization of GGG at ultralow temperatures — •R. O. Serha[1], S. Knauer[1], D. Schmoll[1], K. Davidkova[3], Q. Wang[1], B. Budinská[1], O. V. Dobrovolskiy[1], V. E. Demidov[2], M. Urbánek[3], S. O. Demokritov[2], and A. V. Chumak[1] — [1]University of Vienna, Faculty of Physics, Boltzmanngasse 5, A-1090 Vienna, Austria — [2]Boltzmanngasse 5Institute for Applied Physics and Center for Nonlinear Science, University of Muenster, Corrensstrasse 2-4, D-48149 Muenster, Germany — [3]CEITEC BUT, Brno University of Technology, Purkynova 123, 612 00 Brno, Czech Republic

Magnons, the quanta of spin-waves, also exist in paramagnetic materials and are known as paramagnons. Paramagnon properties are governed by the exchange interactions, which do not vanish above Curie/Neel temperature and the dipolar interactions. Here we present our results on the investigation of electron paramagnetic resonance (EPR) spectroscopy in gadolinium gallium garnet (GGG) and DPPH bulk slabs in a wide range of temperatures down to 20 mK. GGG is one of the materials of choice, as Gd^{3+} ions have a large spin S = 7/2 and its saturation magnetization is about $M_s = 800$ kA/m. Millikelvin temperatures allow reaching the saturation of the GGG magnetization, by applying magnetic fields of hundreds mT. However, the EPR linewidth of GGG is strongly influenced by the phenomenon of dipolar broadening, while DPPH is known to have a very narrow resonance line. These studies form an initial step toward investigations of long-propagating paramagnons.

MA 35.13 Thu 16:00 P4

Aharonov-Casher effect in spin-wave refraction — •Andrii Savchenko[1,2], Vladimir Krivoruchko[2], and Stefan Blügel[1] — [1]Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich, D-52425 Jülich, Germany — [2]Donetsk Institute for Physics and Engineering, National Academy of Sciences of Ukraine, 03028 Kyiv, Ukraine

It has been shown that in a homogeneous magnetic film there is a possibility of electric field control on the reflection and refraction of spin waves at the interface formed by regions under the effect of different electric fields. Under these conditions, the critical angles for Snell's law, the positive or negative refraction of the spin waves, and their non-reciprocity with respect to the incident angle are determined by the electric field. This is possible due to the electrically induced Aharonov-Casher phase shift of the spin-wave phase, that is equivalent to adding a Dzyaloshinskii-Moriya-like interaction between the spins of neighboring ions.

MA 35.14 Thu 16:00 P4

Ring-shaped multi-bandpass spin wave filter — •Takuya Taniguchi, Michael Lindner, Christian Riedel, and Christian Back — Technische Universität München

Spin waves (SWs) are fundamental collective excitations of magnetic order and their wave character makes it possible to potentially realize next generation logic devices. As one of the possible logic devices, multi-bandpass filters are desired in order to forbid certain frequency bands of SWs. In this work, we design a SW wave-guide, which has a ring shape attached to the middle of a stripe. In the device, SWs (SW1s) travel through the stripe part and are split to the ring part and the stripe part at the middle of the stripe. The SWs traveling through the ring (SW2s) interfere with the SW1s after traveling one round and SW1s are suppressed when the phase difference between SW1s and SW2s is pi. We fabricate devices from 200-nanometer-thick YIG films and observe SW propagation using Brillouin light scattering (BLS). Since the phase difference depends on the wavelength of the SWs, we control the wavelength by varying the SW excitation frequency and evaluate the filtering effect. In the presentation, we report the efficiency of the ring-shaped SW filter and provide some key parameters for determining the forbidden frequencies of SWs.

MA 35.15 Thu 16:00 P4

Orientation and Shape of 180° Magnetoelastic Domain Walls in Antiferromagnets — •Bennet Karetta, Olena Gomonay, and Jairo Sinova — Institut für Physik, Johannes Gutenberg Universität Mainz, D-55099 Mainz, Germany

Antiferromagnets are potential candidates to be used in the future for active spintronics elements as they are faster and more stable than the ferromagnets in recent devices. However, without a net magnetization it is more difficult to manipulate their magnetic state. Recent studies suggested that the magnetoelastic coupling can be used to overcome this problem. Thus, it is essential to understand the interaction between the strains in the antiferromagnet and the Néel vector. In this study, we investigate the 180° antiferromagnetic domain wall and the influence on it from the strains. It is known that non-180° domain walls have preferred alignments in antiferromagnets since strains in the respective domains are incompatible for certain orientations. We show, that there is a similar anisotropy for the orientation of 180° domain walls, which now is induced by incompatibilities at the domain wall itself. We further investigate this anisotropy to determine how magnetoelasticity affects the shape of the closed 180° domain wall loop in the antiferromagnet. With this, we demonstrate that the shape of the loop significantly changes in comparison to a purely magnetic system and thus verify the strong influence of the magnetoelastic coupling on the equilibrium domain structure.

MA 35.16 Thu 16:00 P4

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]Faculty of Physics, University of Duisburg-Essen, Duisburg, Germany — [2]Institute of Physics, Johannes Gutenberg University Mainz, Mainz — [3]Politecnico di Bari, 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] S. Parkin, S-H. Yang, Nat. Nanotechnol. 10, 195 (2015)
[2] M. Sitte et al. Phys. Rev. B 94, 064422 (2016)

MA 35.17 Thu 16:00 P4

Magnetization patterns in biaxial Fe32Co68 core-shell nanostructures with hexagonal cross-section — •Anastasiia Korniienko[1], Alexis Wartelle[2], Matthias Kronseder[3], Michael Foerster[4], Miguel Ángel Niño[4], Sandra Ruiz-Gomes[4], Muhammad Waqas Khaliq[4,5], and Christian H. Back[1] — [1]Technical Univ. of Munich, Garching, Germany — [2]Univ. Grenoble Alpes, Grenoble, France — [3]Univ. of Regensburg, Regensburg, Germany — [4]Alba Synchrotron Light Facility, CELLS, Barcelona, Spain — [5]Univ. of Barcelona, Barcelona, Spain

We fabricate nanostructures with a Fe32Co68 shell on GaAs nanorods with hexagonal cross-section. Such a FeCo alloy, deposited on the (110) GaAs planes (the rod's facets), shows a thickness-dependent spin-reorientation transition [1]. At a thickness of 32 monolayers, we expect our tube walls to feature a biaxial behavior, with distinct azimuthal components of magnetization. Here we use Photoemission Electron Microscopy in combination with X-ray Magnetic Circular Dichroism (XMCD-PEEM) to image the magnetic configuration of individual nanostructures [2]. The XMCD-PEEM imaging was done at remanence, between applications of magnetic fields and for different angles between the x-rays and the tube axis. Some of our nanostructures feature a large number of unexpectedly persistent magnetic domains. We observed a switching between almost longitudinal and azimuthal magnetization for some domains, confirming system's biaxial behavior.

[1] Muermann et al., J. Appl. Phys., 103, 07B528 (2008).
[2] Wyss et al., PRB 96, 024423 (2017).

MA 35.18 Thu 16:00 P4

Exploring transient ferromagnetism in $La_{0.9}Sr_{0.1}MnO_3$ thin films — •Karen P. Stroh, Tim Titze, Henrike Probst, Stefan Mathias, Daniel Steil, and Vasily Moshnyaga — I. Physikalisches Institut, Georg-August-Universität Göttingen

In perovskite manganites such as $La_{1-x}Sr_xMnO_3$ (LSMO), complex phase diagrams with different magnetic, electric, and structural phases are obtained as a function of chemical doping. Whilst $x = 0.33$ is referred to as optimal doping, underdoped LSMO with $x \sim 0.1 - 0.15$ is close to a PM-I/FM-M phase boundary for T>T_C [1] and thus a suitable candidate for photo-induced transitions. Ultrafast laser pulses may photoionize electrons from Mn^{3+} to Mn^{4+}, establishing a double exchange interaction and a FM state, so that the compositional phase boundary might temporarily also be crossed via "optical" doping [2].

Underdoped LSMO/$SrTiO_3$(100) thin films were epitaxially grown by metalorganic aerosol deposition (MAD) and investigated by time-resolved magneto-optical Kerr effect (MOKE) and pump-probe reflectivity (PPR). Temperature-, fluence-, and magnetic field-dependent measurements have been performed on timescales from femtoseconds to nanoseconds using a pulsed fs laser setup. Our results indicate a possibility to optically drive a paramagnetic-insulating LSMO into a transient ferromagnetic state above T_C on a sub-ps timescale.

Financial support by the DFG via Project 399572199 and within the SFB 1073 (TP A02) is acknowledged.

[1] Hemberger et al., Physical Review B 66, 094410 (2002)
[2] Matsubara et al., Physical Review Letters 99(20), 207401 (2007)

MA 35.19 Thu 16:00 P4

Influence of metallic substrates on the OISTR effect in permalloy thin films — •Martin Anstett[1], Simon Häuser[1], Jonas Hoefer[1], Laura Scheuer[1], Philipp Pirro[1], Burkard Hillebrands[1], Benjamin Stadtmüller[1,2], and Martin Aeschlimann[1] — [1]Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Institute of Physics, Johannes Gutenberg University Mainz, 55128 Mainz, Germany

Optical manipulation of magnetic materials on extremely short, sub-100 fs timescales can be achieved either by generation and injection of optically induced (ballistic) spin currents or by direct excitation of the spin system, for instance by the optically induced spin transfer (OISTR) effect as shown in [1, 2].

In this work, we aim to reveal the mutual interplay of these spin-transfer effects on ultrafast timescales. Therefore, we investigate the ultrafast demagnetization of a thin $Fe_{20}Ni_{80}$ alloy on a non-magnetic Au substrate and how it is influenced by the spin-dependent charge transport into the Au substrate. As an element-resolved probe of the spin dynamics, we employ time-resolved Kerr spectroscopy with fs-XUV radiation in transversal geometry to disentangle the spectroscopic signatures of the OISTR and ballistic spin transport in this material. Our results will be compared to the magnetization dynamics of a $Fe_{20}Ni_{80}$ film on an insulating substrate.

References: [1] Dewhurst et al.; Nano Lett., 2018; 18: 1842*1848 [2] Hofherr et al., Sci. Adv., 2020; 6: eaay8717

MA 35.20 Thu 16:00 P4

Ultrafast magnetization dynamics in perovskite manganites — •Maren Schumacher, Henrike Probst, Mariana Brede, Christina Möller, Karen Stroh, Tim Titze, Cinja Seick, Sabine Steil, Marcel Reutzel, G. S. Matthijs Jansen, Daniel Steil, Vasily Moshnyaga, and Stefan Mathias — 1. Physikalisches Institut, Göttingen, Germany

Correlated manganese oxides are promising materials to realize new functionalities in spintronic applications, which are enabled by strong correlations between electrons, lattice, and spins. Femtosecond time-resolved spectroscopy has proven to be a powerful probe of these interactions. Here, we study demagnetization dynamics in thin-film perovskite manganites using magneto-optical Kerr spectroscopy (MOKE) in the visible and extreme ultraviolet (XUV) range of the spectrum. This allows us to study the samples as a function of temperature (T=10 - 400 K), magnetic field (up to B=1 T), and, in the case of using XUV probe light, with element-specificity. We will show first results of element-specific HHG-MOKE data on high-quality manganite thin film of LSMO and compare it to standard visible-MOKE.

MA 35.21 Thu 16:00 P4

Wide spectral range ultrafast pump-probe magneto-optical spectrometer at low temperature, high-magnetic and electric fields — •Fabian Mertens[1], Marc Terschanski[1], David Mönkebüscher[1], Stefano Ponzoni[1], Davide Bossini[1,2], and Mirko Cinchetti[1] — [1]Department of Physics, TU Dortmund University, Otto-Hahn-Straße 4, 44227 Dortmund, Germany — [2]Department of Physics and Center for Applied Photonics, University of Konstanz, Germany.

We developed a table-top setup to perform magneto-optical pump-probe measurements with the possibility to independently tune the photon-energy of both pump and probe beams in the 0.5 eV - 3.5 eV range[1]. Our apparatus relies on a commercial turn-key amplified laser system, able to generate light pulses with duration shorter than or comparable to 100 fs throughout the whole spectral range. The repetition rate of the source can be modified via the computer in the 1 kHz - 1 MHz range. A commercial balanced detector is connected to a high-frequency digitizer, allowing for a highly-sensitive detection scheme: rotations of the probe polarization as small as 70 μdeg can be measured. Additionally, a DC magnetic field as high as 9 T and voltages in the kV regime can be applied on the sample. A cryostat allows us to precisely set the temperature of the sample in the 4 K - 420 K interval. We test the performance of our setup by measuring the ultrafast demagnetization of a cobalt crystal as a function of a wide variety of experimental parameters.

[1] F. Mertens et al., *Review of Scientific Instruments* **91** (2020)

MA 35.22 Thu 16:00 P4

Integration of a supercontinuum probe line in a setup for time-resolved magneto-optical spectroscopy — •Sophie Bork, Richard Leven, Marc Terschanski, Fabian Mertens, Umut Parlak, and Mirko Cinchetti — Department of Physics, TU Dortmund University, Otto-Hahn-Straße 4, 44227 Dortmund, Germany

We have recently developed a setup for wide spectral range ultrafast pump-probe magneto-optical spectroscopy at low temperature, high-magnetic and electric fields [1]. Here we present an upgrade of this setup that allows to measure the transient reflectivity (ΔR/R) in a broad spectral range and with femtosecond time-resolution. To this end, we have generated a broadband supercontinuum (white light) probe beam that covers the wavelengths from the near UV to the near IR region. The detection of the white light spectrum reflected or transmitted from the sample is achieved by a 1D-array of CMOS detectors that allow for simultaneous data acquisition of all available wavelengths. This upgraded setup can work at high repetition rates (< 100 kHz) and allows to perform measurements with high temporal and spectral resolution. This is particularly useful, for example, to fully map the photo-driven transient evolution of the band gap energy in magnetically ordered semiconducting systems and to assess whether it is linked to the magnetization dynamics [2]. In this poster contribution we will present all technical details of the setup together with first characterization measurements to specify its performance.

[1] Mertens et al., Rev. Sci. Instrum. 91, 113001 (2020)
[2] Bossini et al., Phys. Rev. B 104, 224424 (2021)

MA 35.23 Thu 16:00 P4

All-optical switching of magnetically hard CoPt and $L1_0$-FePt in contact with a Gd-layer — •Johannes Seyd[1], Julian Hintermayr[2], Manfred Albrecht[1], and Bert Koopmans[2] — [1]Institute of Physics, University of Augsburg, 86159 Augsburg, Germany — [2]Department of Applied Physics, Eindhoven University of Technology, 5600 MB Eindhoven, The Netherlands

All-optical switching (AOS) by single femtosecond laser pulses promises to be an ultrafast, energy-efficient alternative to conventional writing in magnetic recording using magnetic fields. $L1_0$-FePt is a magnetic material with high perpendicular magnetic anisotropy (PMA), which makes it an interesting candidate for future ultrahigh-density magnetic recording applications, and for which helicity-dependent multi-shot AOS has already been confirmed [1].

Thermally-induced single-shot AOS is not only possible in ferrimagnetic alloys with a compensation temperature near room temperature, but also in synthetic ferrimagnets consisting of a ferromagnetic (multi-) layer in contact with a Gd layer, as shown for Co and Co/Ni [2]. These results suggest the possibility of reproducing the same kind of switching in other magnetic thin films, which in the case of L10-FePt would circumvent the problem of writing the magnetically hard material in magnetic recording applications.

We show the most recent results on the thermally-induced AOS behaviour of thin CoPt and $L1_0$-FePt films in contact with a Gd layer.

[1] R. John et al., Scientific Reports 7, 4114 (2017)
[2] M. Beens et al., Physical Review B 100, 220409(R) (2019)

MA 35.24 Thu 16:00 P4

Magnetic field-dependent ultrafast control of an antiferromagnet — •A. Arora[1,4], Y.W. Windsor[6], S.E. Lee[1], J. Sarkar[1], K. Kliemt[3], Ch. Schüssler-Langeheine[2], N. Pontius[2], C. Krellner[3], D.V. Vyalikh[5], and L. Rettig[1] — [1]FHI der MPG, Berlin — [2]HZB für Materialien und Energie GmbH, Berlin — [3]Phy. Inst., Goethe-Uni., Frankfurt am Main — [4]Fach. Phy., FU Berlin — [5]DIPC, Basque, Spain — [6]IOAP, TU Berlin

Antiferromagnets, due to their zero net magnetization, offer faster manipulation of spins and more robust devices. But this also makes the interaction with magnetic order challenging. One way to achieve this is to utilize the magnetic anisotropy to manipulate the spin arrangement which we demonstrated recently using ultrafast optical excitation [1]. For practical applications, understanding the interaction of this effect with external magnetic fields is of strong interest. To this end, we perform time-resolved resonant soft X-ray diffraction in the prototypical A-type antiferromagnet $GdRh_2Si_2$. Consistent with our previous study, we observe a coherent rotation of the antiferromagnetic (AF) arrangement of Gd 4f spins followed by oscillations of the AF order as a consequence of a light-induced change in the anisotropy potential. Surprisingly, upon increasing magnetic field, the frequency of the oscillations as well as the extent of demagnetization upon photoexcitation increases. These observations indicate a change in the magnetic anisotropy potential and may offer a new way towards deterministic control of spin order using combined electromagnetic and magnetic fields. [1] Windsor et al. Commun Phys 3, 139 (2020)

MA 35.25 Thu 16:00 P4

Studying double pulse toggle switching of GdFe — •Rahil Hosseinifar[1], Ivar Kumberg[1], Sangeeta Thakur[1], Evangelos Golias[1], Sebastien Hadjadj[1], Jendrik Gördes[1], Jorge Torres[1], Florian Kronast[2], Mario Fix[3], Manfred Albrecht[3], and Wolfgang Kuch[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14,14195 Berlin, Germany — [2]Helmholtz-Zentrum Berlin, Albert-Einstein-Straße 15, 12489 Berlin, Germany — [3]Institut für Physik, Universität Augsburg, Universitätsstraße 1, 86159 Augsburg, Germany

Switching of magnetization without the help of a magnetic field by using an ultra-fast laser pulse is a popular topic for both applied and fundamental research. We study the effect of double-pulse optical excitation on all-optical toggle switching in $Gd_{26}Fe_{74}$ ferrimagnetic alloys with perpendicular magnetic anisotropy by X-ray magnetic circular dichroism photoelectron emission microscopy. Varying the temporal separation of the two pulses and their intensities reveals a lowering threshold for toggle switching compared to a single pulse, and the formation of three areas in the footprint of the laser pulses for time delays below 1 ps. First, an area is located at lower fluences that does not switch. The second area is at higher fluences where multi-domain nucleation is observed, and the third area is in between and switches deterministically. The experiment is done starting from either a saturated state or in presence of magnetic domains. In both cases, a deterministically switching area is observed which would be desirable for many applications.

MA 35.26 Thu 16:00 P4

Magneto-optical study of proximity effects at the EuO/Co interface — •David Mönkebüscher[1], Paul Rosenberger[1,2], Davide Bossini[1,2], Umut Parlak[1], Martina Müller[2], and Mirko Cinchetti[1] — [1]Department of Physics, TU Dortmund University, Germany — [2]Department of Physics, University of Konstanz, Germany

Europium monoxide has shown great potential as a magnetic insulator and was succesfully employed in various spintronic applications as a spin filter with nearly 100% spin polarized currents [1]. For the use in practical applications, an increase of its relatively low Curie temperature ($T_C = 69\,K$) is necessary. One approach relies on proximity effects, i.e. the coupling with a high T_C ferromagnetic layer [2]. Following this approach, we prepared YSZ/EuO/Co multilayers using molecular beam epitaxy (MBE) [3], and studied them using the magneto-optical setup described in Ref. [4]. First, we measured static hysteresis to gain insight about the nature of the proximity-induced coupling of the two magnetic sublattices. Then we used that the pump-probe experimental scheme to manipulate this coupling by varying the pump laser fluence and the delay between the pump and the probe beam.

[1] T. Santos et al., Phys. Rev B **69**, 241202 (2004)
[2] S. Pappas et al. Sci Rep **3**, 1333 (2013).
[3] P. Rosenberger et al. Phys. Rev. Mater. **6**, 044404 (2022).
[4] F. Mertens et al. Rev. Sci. Instrum. **91**, 113001 (2020).

MA 35.27 Thu 16:00 P4

Wavelength-dependent 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 Baerbel Rethfeld[1] — [1]Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, Kaiserslautern, Germany — [2]Institute of Physics, Johannes Gutenberg University Mainz, Mainz, Germany

For a long time, the ultrafast magnetization dynamics of ferromagnets has predominantly been studied for optical excitation using only one photon energy. However, recent experiments have shown that the dynamics of the demagnetization and remagnetization process can be altered by the wavelength of the exciting laser pulse [1, 2].

In this contribution, we extend the temperature-based μT-model to investigate the ultrafast magnetization dynamics of Ni|Au heterostructures. Our model is based on realistic densities of states of both materials and includes energy and spin transfer at the interface. Thereby, we explicitly consider the wavelength- and layer-dependent absorption profile within multilayer structures. This allows us to show the influence of the wavelength-dependent excitation on the magnetization dynamics [3], which is also affected by the substrate thickness.

References:

[1] V. Cardin *et al.*, Phys. Rev. B 101, 054430 (2020)
[2] U. Bierbrauer *et al.*, JOP: Cond. Mat. 29, 244002 (2017)
[3] C. Seibel *et al.*, arXiv:2112.04780 (2021)

MA 35.28 Thu 16:00 P4

Optical manipulation of the antiferromagnetic order in a Pt/NiO bilayer system by ultrafast energy transfer — •Paul Herrgen[1], Stephan Wust[1], Christopher Seibel[1], Hendrik Meer[2], Christin Schmitt[2], Lorenzo Baldrati[2], Rafael Ramos[3], Takashi Kikkawa[4], Eiji Saitoh[4], Olena Gomonay[2], Jairo Sinova[2], Yuriy Mokrousov[2], Hans Christian Schneider[1], Mathias Kläui[2], Baerbel Rethfeld[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 — [3]CIQUS, Departamento de Química-Física, Universidade de Santiago de Compostela, Santiago de Compostela, Spain — [4]Department of Applied Physics, The University of Tokyo, Tokyo 113-8656, Japan

Antiferromagnets are promising materials for future spintronic devices due to their resilience against external magnetic fields and their high frequency magnon modes. Here, we explore the subpicosecond magnetization dynamics of the antiferromagnet NiO after strong optical excitation with fs light pulses. We find a clear reduction of the magnetic order for a Pt/NiO bilayer systems on sub-picosecond timescales. Our observations are discussed in the framework of an extended μT model. We conclude that the ultrafast loss of antiferromagnetic order in the Pt/NiO bilayer system is mediated by a highly efficient energy transfer between the hot Pt electrons and the NiO spins.

MA 35.29 Thu 16:00 P4

Spin-transport-driven ultrafast magnetization dynamics in a ferrimagnetic Gd/Fe bilayer — •Huijuan Xiao, Bo Liu, and Martin Weinelt — Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, 14195, Berlin

Laser-induced spin transport has been proven to be a key ingredient in ultrafast spin dynamics, such as femtosecond demagnetization and all-optical switching (AOS). We use time- and spin-resolved photoemission spectroscopy of the gadolinium surface state to study spin dynamics in a ferrimagnetic Gd/Fe bilayer. This prototype system for AOS was epitaxially grown on W(110). Our findings suggest that spin transport between the antiferromagnetically coupled gadolinium and iron layers leads to an ultrafast drop of the spin polarization and an increased exchange splitting at the Gd surface. The Gd surface state shows an ultrafast decrease of the spin polarization by 20% within the first ~ 100 fs and a subsequent slower decrease by about 5% on the picosecond timescale. The increase of the exchange splitting counterbalances the overall demagnetization of the Gd layer. In contrast, the pure Gd/W(110) film shows a constant spin polarization and a reduced exchange splitting of the surface state upon optical excitation. These findings are corroborated by the transient electron temperature. Our results provide clear evidence that magnetization dynamics in the Gd/Fe bilayer can be driven by spin transport. We see distinct signatures in the spin-dependent electronic structure that allow us to gain microscopic insights into ultrafast spin dynamics (supported by SFB/TRR 227 Ultrafast Spin Dynamics).

MA 35.30 Thu 16:00 P4

Ultrafast demagnetization of 2d ferromagnets — •Nele Stetzuhn[1,2], Felix Steinbach[1], Martin Borchert[1], Abhijeet Kumar[2], Denis Jagodkin[2], Clemens von Korff Schmising[1], Stefan Eisebitt[1], and Kirill Bolotin[2] — [1]Max-Born-Institut, Max-Born-Straße 2 A, 12489 Berlin — [2]Fachbereich Physik der Freien Universität Berlin, Arnimallee 14, 14195 Berlin

Two-dimensional ferromagnets are one of the latest additions to the family of 2d materials and offer a new platform to study ultrafast magnetic phenomena. When combining 2d ferromagnets with other 2d materials such as transition metal dicalchogenides (TMDs), the absence of lattice mismatch between layers also makes the resulting heterostructures promising for high-performance spintronic devices. Here, we measure the ultrafast demagnetization of 2d ferromagnets with the structure Fe_xGeTe_2 ($x = 3, 5$) after excitation by a pump laser using time-resolved MOKE. The usually low Curie temperature of Fe_xGeTe_2 ($x = 3, 5$) can be increased above room temperature, e.g. by doping with Ni, allowing us to do element-resolved demagnetization measurements at the free-electron laser facility FERMI. This can give insight into effects such as optical inter-site spin transfer (OISTR) in the material.

MA 35.31 Thu 16:00 P4

Heat capacities and Curie curve in the Stoner and Heisenberg models — •Nabil Makadir, Stephanie Roden, Sanjay Ashok, Sebastian T. Weber, Felix Dusabirane, H. Christian Schneider, and Baerbel Rethfeld — Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, Germany

The excitation of a metallic ferromagnet with an ultrashort laser pulse leads to a demagnetization on the femtosecond timescale. The response of the material is governed by macroscopic properties, like the heat capacities and the equilibrium magnetization (Curie curve). They can be calculated for instance with either the Stoner model or the Heisenberg model. The former attributes the change of magnetization to the shifting of the spin-resolved density of states. The latter describes the reduction of the magnetization through collective angular oscillation of the individual magnetic moments.

In this contribution, we derive the temperature-dependent heat capacities and the Curie curves for Nickel. We compare the results of the Stoner and the Heisenberg model and analyze the advantages and drawbacks of both approaches. Finally, we investigate the transition between Stoner and Heisenberg excitations.

MA 35.32 Thu 16:00 P4

Hybrid simulation tracing non-equilibrium spin-dynamics and -transport — •Lukas Jonda, Johan Briones, Sebastian T. Weber, Christopher Seibel, Sanjay Ashok, and Baerbel Rethfeld — Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, Germany

We simulate the complex phenomena arising in a magnetic film after femtosecond laser irradiation with help of a hybrid model. This model consists of a combination of two methods: The μT model [1] and a kinetic Monte Carlo method [2]. The former treats the low-energetic electrons as an ensemble, tracing spin resolved temperatures and chemical potentials, as well as their gradients [3]. The latter traces individual high-energetic non-equilibrium electrons, including spin-dependent scattering processes and spin-flip probabilities. We present first investigations of how non-equilibrium electrons influence the magnetization dynamics for Nickel.

The long-term perspective of this project is to develop a model that can describe both the transport of the electron ensemble and individual high-energetic super-diffusive electrons. This allows to study the different types of non-equilibrium transport and their effects on magnetization dynamics.

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[2] J. Briones, H.C.Schneider, B.Rethfeld, J. Phys, **6**, 035001 (2022).
[3] S. Ashok et al., Appl. Phys. Lett. **120**, 142402 (2022).

MA 35.33 Thu 16:00 P4

Ultrafast Tunnel Magnetoresistance — •Thomas Jauk[1], Kazma Komatsu[1], Hana K. Hampel[1], Jana Kredl[2], Jakob Walowski[2], Florian Lackner[1], Sangeeta Sharma[3], Markus Münzenberg[2], and Martin Schultze[1] — [1]Institute of Experimental Physics, Graz University of Technology, Graz, Austria — [2]Institute of Physics, University of Greifswald, Greifswald, Germany — [3]Max Born Institute, Berlin, Germany

Magnetic tunnel junctions (MTJ) have been arousing ongoing interest due to their peculiar spin-transfer mechanism since the discovery of the large tunnel magnetoresistance. However, a complete microscopic understanding of the underlying physics is still lacking. We put the spotlight on the interface between a MgO-based tunnel barrier and a CoFeB wedge-like electrode in order to disentangle intertwined phenomena which come along with ultrafast demagnetization. By employing circularly-polarized visible light pulses and utilizing magnetic circular dichroism in a two-photon-photoemission (2PPE) experiment we establish a direct route to the buried interface, providing insight into the spatial arrangement and the electronic behaviour of the magnetic pattern near the Fermi level. Beside the typical demagnetization curve we observe a light-induced increase in magnetic moment for specific energy/momentum intervals. Together with DFT calculations we try to shed light on the microscopic processes involved in the ultrafast demagnetization and, especially, emphasize on the peculiarity of MTJs acting as an energy- and spin-filter.

MA 35.34 Thu 16:00 P4

Ferromagnetic resonance study of spin pumping in epitaxial Fe/Rh bilayers — •Jonas Wiemeler, Ali Can Actas, Michael Farle, and Anna Semisalova — Faculty of Physics and CENIDE, University of Duisburg-Essen, 47057 Duisburg, Germany

The alloy FeRh has been studied extensively for structural, electrical and magnetic properties. On the other hand spin dynamics in a Fe/Rh thin film bilayer system in detail has not been addressed yet. In this work, 5 nm Fe films capped with Rh of thicknesses (0, 1, 2, 3, 5, 10, 15) nm were grown on GaAs(100) substrates using molecular beam epitaxy (MBE). Ferromagnetic resonance (FMR) experiments at room temperature, utilising both angular X-Band and frequency dependence (1-40GHz), were used to characterise the magneto dynamic properties of these bilayers. The growth characteristics of Rh on a 5 nm substrate Fe layer have been investigated using Auger electron spectroscopy (AES) measurements during the Rh growth. It was found, that Rh grows epitaxially on Fe in a layer-by-layer manner. The thickness dependence of the magnetisations precession damping, measured using FMR, shows an exponential behaviour which was analysed in terms of a spin pumping effect. We found, that the spin pumping efficiency of Rh is comparable to Pt, while the spin flip rate compares to that of Pd.

Funding by DFG Project No. 392402498 (SE 2852/1-1 | AL 618/37-1) and helpful discussion with R. Meckenstock and T. Strusch are acknowledged.

MA 35.35 Thu 16:00 P4

Magnetization dynamics of γ-Fe_2O_3 thin films with reduced effective magnetization — •Monika Scheufele[1,2], Manuel Müller[1,2], Janine Gückelhorn[1,2], Luis Flacke[1,2], Andreas Haslberger[1,2], Mathias Weiler[3], Hans Huebl[1,2,4], Stephan Geprägs[1], Rudolf Gross[1,2,4], and Matthias Althammer[1,2] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Physik-Department, Technische Universität München, Garching, Germany — [3]Fachbereich Physik und Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, Kaiserslautern, Germany — [4]Munich Center for Quantum Science and Technology (MCQST), München, Germany

Magnetic insulators (MI) are of key importance in the emerging fields of magnonics and spin-caloritronics. In this respect, the room-temperature MI γ-Fe_2O_3 is a promising candidate offering a variety of application perspectives. Here, we report on the static and dynamic magnetic properties of pseudomorphic-grown γ-Fe_2O_3 thin films on MgO (001). We find a strain-induced small effective magnetization M_{eff}, showing a sign change at 200 K. In addition, we also observe the impact of slowly relaxing impurities to the ferromagnetic resonance (FMR) field and the linewidth as a function of temperature. Moreover, above 150 K we detect an increase of the FMR linewidth, which we attribute to valence-exchange damping induced by Fe^{2+}-ions in γ-Fe_2O_3 [1].

[1] M. Müller *et al.*, arXiv:2204.11498.

MA 35.36 Thu 16:00 P4

Spin pumping in embedded lateral nanostructures in Fe60Al40 — Tanja Strusch[1], Ralf Meckenstock[1], Rantej Bali[2], Jonathan Ehrler[2], Kay Potzger[2], Kilian Lenz[2], Jürgen Lindner[2], Michael Farle[1], and •Anna Semisalova[1] — [1]Faculty of Physics and CENIDE, University of Duisburg-Essen, Duisburg, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Dresden, Germany

The magnetic properties of an Fe60Al40 (FeAl) alloy are tailorable from paramagnetic (PM) to ferromagnetic (FM) state by variation of the structure through ion beam irradiation, making it a promising material for the fabrication of magnetic landscapes and magnonic crystals. Here, we report on ferromagnetic resonance (FMR) detected spin pumping in FeAl/Pd and Py/FeAl bilayers and laterally patterned nanostructures and show that FeAl can be used as spin source and as spin sink. Using FMR, we estimate the spin pumping efficiency and find a spin-mixing conductance of g_FeAl=2.1(+/-0.2) nm^(-2) and a spin diffusion length of λ_FeAl=11.9(+/-0.2) nm for paramagnetic FeAl, and g_Pd=3.8(+/-0.5) nm^(-2) and λ_Pd=9.1(+/-2.0) nm for Pd. Further, we investigate the spin pumping in laterally patterned FeAl nanostructures representing 500 nm wide FM strips separated by PM strips of different width (100-400 nm) produced in a 40 nm thick FeAl film. We find an enhancement of the damping parameter with decreasing width of the PM FeAl areas due to an increase of the number of FM/PM interfaces. Financial support from DFG is gratefully acknowledged (project No. 392402498 (SE 2852/1-1 | AL 618/37-1)).

MA 35.37 Thu 16:00 P4

Growth optimization of ferromagnetic gadolinium nitride (GdN) thin films for magnon transport phenomena — •Raphael Hoepfl[1,2], Manuel Müller[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]Physik-Department, Technische Universität München, Garching, Germany — [3]Munich Center for Quantum Science and Technology (MCQST), München, Germany

Ferromagnetic (FM) semiconductors are of great interest for spintronics devices. Gadolinium nitride (GdN) is one candidate for a semiconducting ferromagnet with a Curie temperature T_C of 65-70 K [1]. In this study, we investigate the static and dynamic properties of FM GdN thin films by SQUID magnetometry and broadband ferromagnetic resonance experiments in a cryogenic environment. In detail, we prepare tantalum nitride (TaN)/GdN/TaN thin films on thermally oxidized Si substrates using DC magnetron sputtering, where the TaN is used as seed and protective top layer. Here, we discuss the impact of the various deposition parameters, such as deposition pressure, temperature, rate and reactive N_2 gas flow on the static and dynamic magnetic properties of GdN.

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

MA 35.38 Thu 16:00 P4

Spin polarized band engineering for spin-photocatalyst in ZnO nanowires — Hua Shu Hsu[1], Jun-Xiao Lin[1], •Jutathip Thaomonpun[1], Wei-Jhong Chen[1], Shih Jye Sun[2], and Zdenek Remeš[3] — [1]No. 4-18, Minsheng Road, PIngtung City, 90044, Taiwan (R.O.C.) — [2]700, Kaohsiung University Rd., Nanzih District, Kaohsiung 811, Taiwan(R.O.C.) — [3]Na Slovance 1999/2, Praha 8, Czech Republic

Transition metal-doped oxides with spin-polarization energy bands have been expected as potential materials for semiconductor spintronics applications. In our work, we found that through surface-doped Co/ZnO nanowires (NWs), the generation of spin-polarized energy bands can be confirmed in the ultraviolet (UV) region by magnetic circular dichroism measurements. Because ZnO itself can be applied in the UV photocatalytic material. Therefore, the magnetic field-enhanced photocurrent and magnetic field-enhanced photocatalytic effect due to modulation of the spin-polarized energy band can be observed. And spin-polarized energy band engineering can be extended to non-magnetic ion-doped ZnO NWs. The realization of these spin photocatalytic effects will also provide new opportunities for the study of spin-polarized energy bands in semiconductors.

MA 35.39 Thu 16:00 P4

Electric transport properties of Ni-Mn-In alloy exposed to external stimuli — •Sergiy Konoplyuk[1] and Alexandr Kolomiets[2] — [1]Institute of magnetism of NASU and MESU, Kyiv, Ukraine — [2]Department of Physics, Lviv Polytechnic National University, Lviv, Ukraine

The polycrystalline Ni45.4Mn40In14.6 Heusler alloy was studied to find dominant factors affecting its electric transport behavior in austenitic and martensitic phases. Analysis of three main contributions into temperature dependent resistivity has shown that prevalent mechanisms of carrier scattering in the austenitic phase are scattering on structural and magnetic disorders rather than on thermal fluctuations.

In spite of the small transformation volume effect of 0.09 %, application of hydrostatic pressure of 2 GPa results in almost threefold rise in the longitudinal resistivity and twofold rise in the Hall resistivity due to the pressure-induced martensitic transformation. The measurements of the ordinary Hall resistivity have shown that main charge carriers in both phases are holes whose mobility is ten times as high in the austenitic phase as in the martensitic one.

The anomalous Hall resistivity (AHE) of the Ni45.4Mn40In14.6 reaches significant magnitude of 20 microOhm*cm in the martensitic phase. Unusual scaling relation between AHE and the longitudinal resistivity is discussed.

MA 35.40 Thu 16:00 P4

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

The intensity and shape of photoelectron lines of magnetic materials depend on the relative orientation of the sample magnetization, the X-ray beam polarization and the spectrometer axis, i.e. the electron emission direction. 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. A single-stage in-vacuum phase retarder is installed and commissioned in 2020 at the HAXPES beamline P22 at PETRA III (Hamburg) [1].

The electronic and magnetic properties of CoFe and Co-based Heusler nanolayers were studied using the linear and circular magnetic dichroism in the angular distribution of photoelectrons. The layers were remanently magnetized in-situ and Co $2p_{1/2}$ and $2p_{3/2}$ core levels were probed at room temperature [2-3]. Both the polarization-dependent spectra and the dichroism indicate that the lines of the multiplet extend over the entire spectral range. In particular, the dichroism does not vanish between the two main parts of the spin-orbit doublet.

References [1] C. Schlueter et al., AIP conference proceedings 2054(1), 040010 (2019).[2] G.H. Fecher et al., SPIN 04, 1440017 (2014). [3] P. Swekis et al., Nanomaterials 11, 251 (2021).

MA 35.41 Thu 16:00 P4

Ultrafast optical Spectroscopy of $LaMnO_3/SrMnO_3$ Superlattices — •Tim Titze, Leonard Schueler, Jannik Brumm, Vitaly Bruchmann-Bamberg, Vasily Moshnyaga, Daniel Steil, and Stefan Mathias — I. Physikalisches Institut, Goettingen, Germany

We investigate photoinduced dynamics of a $LaMnO_3/SrMnO_3$ superlattice, using transient reflectivity $\Delta R/R$ at various temperatures. The superlattice exhibits a low-T_C ferromagnetic (FM) phase below $T_{C,LMO} = 200$ K with a bulk-LMO-like behavior. Further, Keunecke *et al.* reported on a high-T_C interfacial quasi-2D FM phase below $T_{C,2D} = 350$ K that results from an LMO to SMO charge transfer during sample growth [1].

By studying the system response on timescales from fs to ns we aim to determine whether the 2D interfacial phase shows a distinctly different response to an ultrafast optical stimulus than the bulk FM phase. We find that on the sub-ps timescale the T-dependent dynamics mimic the static M(T)-curve, i.e., both ferromagnetic phases seem to contribute to the ultrafast system response. On the 100 ps timescale spin-phonon coupling leads to an additional component in $\Delta R/R$ within the bulk FM phase, which is not observed for the high-T_C quasi-2D FM phase. An additional signature in the T-dependent relaxation time on a ns timescale around 300 K is tentatively attributed to the vanishing of the 2D FM phase already below its $T_{C,2D}$ due to optical excitation.

Financial support by the DFG within the CRC 1073 is acknowledged.

Ref.: [1] M. Keunecke *et al.*, doi: 10.1002/adfm.201808270

MA 35.42 Thu 16:00 P4

Frustrated triangular magnetism in new copper based single crystals. — •Aswathi Mannathanath Chakkingal[1], Chloe Fuller[2], Dmitry Chernyshov[2], Maxim Avdeev[3], Marein Christopher Rahn[1], Falk Pabst[4], Yiran Wang[4], Darren Peets[1], and Dmytro Inosov[1] — [1]IFMP, TU Dresden, Germany — [2]ESRF, Grenoble, France — [3]ANSTO, Sydney, Australia — [4]Professur f. Anorganische Chemie II, TU Dresden, 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 single crystals of a new material $Cu_4(SO_4)(OH)_6$. Single-crystal x-ray and neutron diffraction studies performed to determine the crystal structure reveal the presence of three copper layers which stack in an ABACABAC pattern in the crystal, which results in a large b lattice constant of 25Å. Seemingly-distorted and -expanded $SO_4{}^{2-}$ tetrahedra in the system are likely attributable to vacancies and structural disorder. The Cu^{2+} copper ions are arranged in buckled sheets consisting of ribbons of edge-sharing and corner-sharing octahedra, and form a heavily distorted triangular lattice. Diffuse scattering measured with synchrotron x-rays also reveals strong stacking-fault disorder in this system. We report details of the crystal structure and its low temperature magnetic properties.

MA 35.43 Thu 16:00 P4

High-pressure crystal growth and the magnetic phase diagram of hexagonal $GdInO_3$ — •Ning Yuan, Ahmed Elghandour, Lukas Gries, Waldemar Hergett, and Rüdiger Klingeler — Kirchhoff Institute for Physics, Heidelberg University, Germany

$GdInO_3$ is hexagonal structured system which exhibits strong geometrical frustration and improper geometric ferroelectricity [1,2]. We report the growth of macroscopic $GdInO_3$ single crystals which are used to study magnetization, specific heat, and thermal expansion in magnetic field up to 16 T. The data are used to construct the magnetic phase diagram. Anomalies in the specific heat confirm the evolution of long-range magnetic order at $T_N = 2.1$ K. At the antiferromagnetic phase boundary, anomalies in thermal expansion and magnetostriction imply significant spin-lattice coupling. A modest net magnetic moment points along the crystallographic c axis in the ground state. The magnetic phase diagrams for B$\|c$ and B$\|ab$ are presented for temperatures down to 400 mK and magnetic fields up to 14 T. Isothermal magnetization curves indicate a narrow 1/3 magnetization plateau as well as a sharp anomaly at about 5 T.

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MA 35.44 Thu 16:00 P4

Spin Excitations, Accidental Soft Modes, and Phase Diagram of the Triangular-Lattice t-t'-U Hubbard Model — •Josef Willsher[1], Hui-Ke Jin[1], and Johannes Knolle[1,2,3] — [1]TUM, Munich, Germany — [2]MCQST, Munich, Germany — [3]Imperial College London, London, UK

The structure factor is an important probe of quantum magnets but due to numerical limitations it remains a challenge to make theoretical predictions beyond linear spin wave calculations of Heisenberg-like models. In this work we study the excitation spectrum of the triangular lattice Hubbard model including next-nearest neighbour hopping within a self-consistent random phase approximation. Starting from the 120-degree and stripe magnetic orders we compute the relevant magnon spectra and discuss connections to recent experiments on triangular lattice compounds. In addition, we show that the condensation of accidental soft-modes allows us to construct the phase diagram of the model, which is consistent with previous results of the variational cluster approximation. We discuss the implications of our findings for unconventional magnon spectra and even for the presence of quantum disordered phases without long range order.

MA 35.45 Thu 16:00 P4

Exchange Enhancement of Ferromagnetic Resonance in Mn_2Au/Py — •Tobias Wagner and Olena Gomonay — Johannes Gutenberg-University Mainz, Germany

In the future, AFMs as active components will bring favourable advantages to spintronics: Robustness to external magnetic fields, temperature stability of the Néel ordered state and lack of stray fields. Therefore, AFMs are suitable for ultrafast and ultra high density spintronics. Recently, strong exchange coupling between Mn_2Au and thin layers of Permalloy ($Ni_{80}Fe_{20}$) has been shown [1]. As a consequence, the coercive field of Mn_2Au/Py was reported to be 5000 Oe, which is high compared to 200 Oe in CuMnAs/Fe [1]. High coercive fields lead to long term stability at room temperature. Due to strong exchange coupling, the AFM Néel vector and the FM magnetisation rotate coherently, when an external field is applied to the FM. Ferromagnetic resonance spectroscopy revealed two distinct frequencies for the coupled bilayer system, both of which lie above the resonance frequency of Permalloy. We model these findings using a phenomenological model. Our model enables us to demonstrate how the interfacial exchange coupling enables tuning of the ferromagnetic resonance frequency by variation of the thickness of the ferromagnetic layer.

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MA 35.46 Thu 16:00 P4

Voltage induced magneto-ionic interactions controlling magnetic properties of synthetic antiferromagnets — •Maria-Andromachi Syskaki[1,2], Takaaki Dohi[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

Voltage control of magnetic properties in spintronic devices is one of the most promising device-compatible and energy-efficient ways for future storage applications [1]. This approach can be ideally realized with the advantages of a synthetic antiferromagnet (SAF) system, which provides higher thermal stability and a wide dynamic range, e.g. high domain wall velocities for nearly compensated SAFs [2] when integrated into MRAM devices. In our work, we have grown a SAF stack by magnetron sputtering consisting of two ferromagnetic layers coupled by a non-magnetic spacer layer. A thermodynamically stable skyrmion state at elevated temperatures is achievable in this stack [3]. With room temperature voltage-controlled magneto-ionic effects, we focus on the modulation of the magnetic properties in this system, i.e., the voltage control of the compensation ratio between the layers, the perpendicular magnetic anisotropy, and the antiferromagnetic RKKY coupling strength. [1] T. Nozaki et al., Micromachines 10(5), 327 (2019). [2] Y. Guan et al., Nat. Commun. 12, 5002 (2021). [3] T. Dohi, et al., Nat. Commun 10, 5153 (2019).

MA 35.47 Thu 16:00 P4

Micromagnetic simulation of magnetic reversal processes in exchange biased micro stripes — •Lukas Paetzold, Sapida Akhundzada, Christian Janzen, Michael Vogel, 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

Exchange bias, being first observed by Meiklejohn and Bean [1] and described as a unidirectional anisotropy, 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 micro stripes with a polycrystalline uncompensated antiferromagnetic layer. Special focus is put on the nucleation processes occurring in the microscopic range depending on the stripe width.

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MA 35.48 Thu 16:00 P4

Exchange-spring behavior at magnetic perovskite oxide interfaces — •Antonia Rieche, Martin Michael Koch, Michael Enders, Aurora Diana Rata, and Kathrin Dörr — Martin-Luther-Universität Halle-Wittenberg

Advances in ultrathin film deposition allow the investigation of exceptional properties at interfaces which significantly differ from those of bulk materials. A particular kind of interface coupling between magnets is the exchange spring, whose magnetic switching is distinctly different from that of exchange-bias coupling. To explore exchange springs in oxides, high quality $SrRuO_3/La_{0.7}Sr_{0.3}MnO_3$ (SRO/LSMO) and $La_{0.7}Sr_{0.3}CoO_3$ (LSCO/LSMO) bilayers were grown by pulsed laser deposition on different substrates with systematically varied layer thicknesses. Strong antiferromagnetic Mn-O-Ru or ferromagnetic Mn-O-Co exchange coupling connects the magnetic moments at the interface. An exchange spring resembling a Bloch wall is formed in the hard magnet due to a striking reduction of the magnetocrystalline anisotropy near the interface and return to bulk behavior further away from the interface. The thickness-dependent switching is analyzed to derive the exchange and anisotropy energies of the spring, its length and field-temperature „phase diagram". We discuss the impact of such interfacial spin textures on magnetic switching as well as on further properties which are important for spintronics applications.

MA 35.49 Thu 16:00 P4

Effect of laser annealing on the magnetic properties of Co/Pt based multilayers — •Lokesh Rasabathina[1], Apoorva Sharma[1], Sandra Busse[3], Benny Böhm[1], Fabian Samad[1,2], Georgeta Salvan[1], Alexander Horn[3], and Olav Hellwig[1,2,4] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstraße 400, 01328 Dresden, Germany — [3]Laserinstitut Hochschule Mittweida, Schillerstraße 10, 09648 Mittweida, Germany — [4]Center for Materials, Architectures and Integration of Nanomembranes (MAIN), Chemnitz University of Technology, 09107 Chemnitz, Germany

Two modes of laser annealing, namely, Continuous Wave (CW) and Pulsed Wave (PW) mode, are used for modifying the magnetic properties of perpendicular magnetic anisotropy (PMA) multilayers in a controlled manner. For this we compare two types of samples - a PMA $(Co/Pt)_{10}$ multilayer and an antiferromagnetically interlayer exchange coupled PMA $(Co/Pt)_4/Co/Ir/(Co/Pt)_5$ multilayer. Room temperature hysteresis loops using polar MOKE magnetometry are measured for the different laser annealing modes. Thus, a relationship between the applied laser parameters and the magnetic properties is extracted, which provides an opportunity to alter magnetic properties of PMA multilayer systems locally with high spatial resolution on demand.

MA 35.50 Thu 16:00 P4

Anisotropic spin dynamics in $Mn_2Au/Ni_{80}Fe_{20}$ thin-film bilayers — •Gutenberg Kendzo[1], Hassan Al-Hamdo[1], Vitaliy Vasyuchka[1], Philipp Pirro[1], Yaryna Lytvynenko[2], Olena Gomonay[2], Mathias Kläui[2], Martin Jourdan[2], and Mathias Weiler[1] — [1]Fachbereich Physik und Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, Kaiserslautern, Germany — [2]Institut für Physik, Johannes Gutenberg-Universität Mainz, Mainz, Germany

Ferromagnets and antiferromagnets host qualitatively different spin dynamics. At the ferromagnet/antiferromagnet interface we thus expect coupled spin dynamics of hybrid character. We experimentally investigate the anisotropic coupling of spin dynamics in antiferromagnetic/ferromagnetic ($Mn_2Au/Ni_{80}Fe_{20}$) thin-film heterostructures by ferromagnetic resonance spectroscopy. To this end, we carried out measurements on two samples Mn_2Au(40nm)/$Ni_{80}Fe_{20}$(10nm; 7,5nm) as a function of the orientation of the static external magnetic field. For each orientation, the ferromagnetic resonance frequency at fixed magnetic field magnitude was measured. We find a pronounced anisotropy of the $Ni_{80}Fe_{20}$ ferromagnetic resonance. This finding is attributed to coupling of the $Ni_{80}Fe_{20}$ magnetization to the Mn_2Au Néel vector in conjunction with the Mn_2Au crystalline anisotropy.

Funding by DFG via CRC/TRR 173 "Spin+X", projects A01, A05, B12 & B13 is gratefully acknowledged.

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MA 35.51 Thu 16:00 P4

Magnetic Anisotropies and Large Exchange Bias of Ultrathin Ni0.95Fe0.05/NiFeO Multilayers — Dimitrios Anyfantis[1], Camillo Ballani[2], Nikolaos Kanistras[2], Alexandros Barnasas[1], Georg Schmidt[2], •Evangelos Th. Papaioannou[2], and Panagiotis Poulopoulos[1] — [1]Department of Materials Science, University of Patras, 26504 Rio, Patras, Greece — [2]Institute of Physics, Martin-Luther University Halle-Wittenberg, 06120 Halle, Germany

Magnetic anisotropy at metal/oxide interfaces has played a significant role in the development of technological applications in recording, spintronics, sensors and actuators over the years[1]. In this work we present a novel method to produce high quality Ni(0.95)Fe(0.1)/NiFeO multilayers with the aid of the natural oxidization procedure and with the help of a single magnetron sputtering head [2]. Doping of Ni by only 5% Fe results in enhanced layering quality as X-ray reflectivity reveals. Due to magnetostatic anisotropy, the multilayers were found to be in-plane magnetized. Mild thermal annealing (T = 525 K) results in the enhancement of perpendicular magnetic anisotropy, mainly due to an increase in the uniaxial volume anisotropy term. Temperature-dependent hysteresis measurements between 4-400 K revealed considerable enhancement of coercivity and appearance of strong exchange bias effect.

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MA 35.52 Thu 16:00 P4

Additive Manufacturing of (Pr,Nd)-Fe-Cu-B Permanent Magnets using functionalized microparticles — •Jianing Liu[1], Lukas Schäfer[1], Holger Merschroth[2], Jana Harbig[2], Ying Yang[3], Anna Ziefuss[3], Matthias Weigold[2], Stephan Barcikowski[3], Oliver Gutfleisch[1], and Konstantin Skokov[1] — [1]Functional Materials, Technical University of Darmstadt, Germany — [2]Alarich-Weiss-Str. 16 — [3]Technical Chemistry I, University of Duisburg-Essen, Germany

Additive Manufacturing (AM) of permanent magnets is an upcoming and challenging task in material science and engineering. A microstructure with engineered grain boundaries and grain sizes necessary for high coercivity is not easily obtainable, especially when using Laser Powder Bed Fusion (L-PBF) to obtain fully dense magnets. In order to achieve the desired microstructure and hard magnetic properties after printing, we proposed Pr-Fe-Cu-B based alloy as a useful alloy system and compare this with its Nd-based counterpart. Our studies describe the Pr-Fe-Cu-B alloys and their annealing optimization for L-PBF. In order to achieve an improved flowability and refined microstructure, the grain boundary engineering with nanoparticles shows great potential. The nanoparticle functionalized Pr-Fe-Cu-B powder was being validated as a precursor for AM. During L-PBF, the hypothesis of heterogeneous nucleation induced by NP inoculums during resolidification is explored with the goal of grain refinement and realizing more uniaxial growth. We acknowledge the support of the Collaborative Research Centre/Transregio 270 HoMMage.

MA 35.53 Thu 16:00 P4

In-situ rotation of sample in the magnet with a rotator — •M. Safiri, P. Y. Portnichenko, M. Siegel, and D. S. Inosov — TU Dresden, Germany

Field-induced collective excitations in f-electron systems with multipolar order parameters were recently shown to exhibit significant anisotropy in field space even in structurally cubic systems, such as CeB6 [P. Y. Portnichenko et al., Phys. Rev. X 10, 021010 (2020)]. However, following such changes in the excitation spectrum in a neutron scattering experiment currently requires a tedious and time-consuming sample realignment for every field direction. To enable a much faster in-situ rotation of the sample inside a cryomagnet, we have designed and manufactured a compact piezo-driven rotator with a diameter of 32 mm that is compatible with cryomagnets used on the time-of-flight or triple-axis neutron spectrometers, up the maximum field of 10 T. This new piece of sample environment will allow us to change the sample orientation within 360° by rotating it precisely around the momentum transfer **Q** at low temperatures, which corresponds to a rotation of magnetic field in the vertical plane orthogonal to **Q**. This is supposed to add a new dimension to neutron-spectroscopy measurements, facilitating continuous scans vs. magnetic field angle that contain crucial information about magnetic anisotropy and other spin-orbit coupling effects.

MA 35.54 Thu 16:00 P4

MIASANS at the longitudinal neutron resonant spin echo spectrometer RESEDA — •Jonathan Leiner[1,2], Christian Franz[1,2,3], Johanna Jochum[1,2], and Christian Pfleiderer[1] — [1]Technical University of Munich, Garching, Germany — [2]Heinz Maier-Leibnitz Zentrum (MLZ), Garching, Germany — [3]JCNS at MLZ, FZ Jülich GmbH, Garching, Germany

The RESEDA (Resonant Spin-Echo for Diverse Applications) instrument has been optimized for neutron scattering measurements of quasielastic and inelastic processes over a wide parameter range. One spectrometer arm of RESEDA is configured for the MIEZE (Modulation of Intensity with Zero Effort) technique, where the measured signal is an oscillation in neutron intensity over time prepared by two precisely tuned radio-frequency (RF) flippers. With MIEZE, all of the spin-manipulations are performed before the beam reaches the sample, and thus the signal from sample scattering is not disrupted by any depolarizing conditions there (i.e. magnetic materials and fields). The MIEZE spectrometer is being further optimized for the requirements of small-angle neutron scattering (MIASANS), a versatile combination of the spatial and dynamical resolving power of both techniques. We present the current status of (i) newly installed superconducting solenoids as part of the RF flippers to significantly extend the dynamic range and (ii) development and installation of a new detector on a translation stage within a new larger SANS-type vacuum vessel for flexibility with angular coverage and resolution.

MA 35.55 Thu 16:00 P4

An Efficient Magnetic Hyperthermia Setup for Controlled Nanoparticle Heating — •Daniel Kuckla, Julia-Sarita Brand, Vinzenz Jüttner, and Cornelia Monzel — Heinrich-Heine-Univerity,Düsseldorf,Germany

Magnetic hyperthermia is a promising approach to enable a remote and localized heating of magnetic nanoparticles (MNPs) with various applications in condensed matter or biomedical physics. The MNPs may be positioned precisely in space and act as hot spots by increasing the temperature in the nanometer vicinity of the particle while causing minimal effects on the macroscopic environment. The heat dissipation arises from energy delivered to the nanoparticle in the form of an alternating magnetic field with ∼100kHz frequency and 50mT magnetic flux density. A particular challenge is to realize an efficient magnetic hyperthermia setup and to image the localized heating. Here, we present such setup consisting of an electromagnet in a resonance circuit and exhibiting a small form factor to be implemented under a microscope. We provide a profound characterization of the different components of this setup - the electromagnet and electric circuit, essential improvements to reduce power loss arising from electromagnetic induction as well as strategies to directly record thermal changes. We demonstrate efficient heating/cooling cycles using well-defined MNP samples in suspension and create MNP lithographically structured substrates. Our setup may be used to create localized hot spots in condensed matter samples, to create thermofunctional switches or to study heat-sensitive molecules in biophysics, among other examples.

MA 35.56 Thu 16:00 P4

Investigation of de Haas-van Alphen oscillations under temperature modulation in Bi — •Michelle Hollricher, Christian Pfleiderer, and Marc A. Wilde — Physik-Department, Technical University of Munich, D-85748 Garching, Germany

The properties of Bi have become the drosophila of studies of the electronic structure and the Fermi surface of metals [1-4]. An inherent constraint of present-day detection techniques of quantum oscillations concerns the separation of signal components associated with large differences of the effective charge carrier masses. We report the development of a detection technique for measurements of the de Haas-van Alphen (dHvA) effect by means of an inductive signal pick-up that is driven by temperature oscillations of the sample [1]. Resulting in an effective convolution of the oscillatory signal components with the derivative of the effective charge carrier mass with respect to temperature, our setup permits to discriminate elegantly light from heavy masses, and allows in-situ determination of the charge carrier effective masses. We have revisited the dHvA effect in Bi, focusing on the nature and character of the electron pockets.

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MA 35.57 Thu 16:00 P4

Visualization of Exchange Spin Coupling Constants — •Lawrence Rybakowski[1,2], Torben Steenbock[2], and Carmen Herrmann[1] — [1]Institut for Inorganic and Applied Chemistry, Luruper Chaussee 149, Hamburg, Germany — [2]Institut for Physical Chemisrtry, Luruper Chaussee 149, Hamburg, Germany

Most current methods for calculating the magnetic exchange interactions can calculate coupling constants for two and multi-spin systems, but a single number, the exchange spin coupling constant, is often poorly informative about the origins of the coupling. With our method, footing on nonrelativistic first-principle electronic structure calculations, the coupling constant can be decomposed into atomic and basis function contributions, which allows to plot a three-dimensional density distribution of the coupling constant weighted by the atomic orbital basis contributions and thus to analyze the influences of ligands and coordinations on the coupling behavior of different magnetic ions. In addition, exchange–correlation functional dependencies and influences of structure distortions on the strength and character of the exchange coupling constant can be investigated.

We can show that in complex compounds with competing exchange pathways, individual ligand classes can be associated with characteristic contributions to the total coupling constant. Furthermore, the inclusion and enhancement of exact exchange in the exchange-correlation functional induces an alternating contribution of neighboring atomic orbitals, having a direct impact on the calculated exchange coupling constants.

MA 35.58 Thu 16:00 P4

A Sacrificial Magnet System for Flux Dependent Surface Science Studies — •Danyang Liu[1], Jens Oppliger[1], Aleš Cahlík[1], Catherine Witteveen[1,2], Fabian O. von Rohr[2], and Fabian Donat Natterer[1] — [1]Department of Physics, University of Zurich, Winterthurerstrasse 190, CH-8057 Zurich, Switzerland — [2]Department of Quantum Matter Physics, University of Geneva, 24 Quai Ernest-Ansermet, CH-1211 Geneva, Switzerland

Here we describe the design and characterization of a NbFeB permanent magnet system that can be retrofitted to the sample holders of existing STM. Our design produces a magnetic field of up to 400 mT that is compatible with high temperature sample cleaning routines above the Curie point of the magnet frequently used in UHV experiments. We characterize the flux density using superconducting vortices in NbSe2 and BSCCO and demonstrate the life-cycle of the magnet from sample preparation to characterization. Our magnet is an accessible way to flux-dependent surface science, ranging from vortices in high-temperature superconductors to STM-enabled electron spin resonance.

MA 35.59 Thu 16:00 P4

DC-Mode Background Subtraction for the MPMS3 SQUID Magnetometer by Quantum Design — •Börge Mehlhorn[1], Anja Wolter[1], and Bernd Büchner[1,2] — [1]Leibniz IFW Dresden, D-01069 Dresden, Germany — [2]Institute for Solid State and Materials Physics and Würzburg-Dresden Cluster of Excellence ct.qmat, TU Dresden, D-01062 Dresden, Germany

Due to vibrating-sample SQUID magnetometry becoming more common in magnetization studies, the software satisfying the needs of slow linear DC mode became rather sparse. As one example raw-voltage background subtraction software is no longer supplied with the instruments, but is needed, whenever the background signal becomes large compared to the intrinsic magnetization signal of the sample.

As a response a handful of scientists began developing their own solutions. Most commonly known is the open source software published by M. J . Coak et al.[1] at the universities of Warwick and Cambridge free for academic use and based on *MathWorks MATLAB*.

The solution presented here is an independent work published as free (as in freedom) open source software. It is founded on the ecosystem of scientific software in the Python programming language. Therefore, it does not only allow frictionless future contributions by the scientific community, but also makes use of the countless human hours invested in that open source ecosystem in the past.

As an interesting scientific example the software will be demonstrated on a low-moment small-size 2D van-der-Waals crystal mounted on a horizontal rotator.

MA 35.60 Thu 16:00 P4

Mössbauer study of anisotropic magnetic nanoparticle systems — •Juri Kopp[1], Joachim Landers[1], Soma Salamon[1], Robert Müller[2], Sarah Essig[3], Silke Behrens[3], and Heiko Wende[1] — [1]Faculty of Physics and Center for Nanointegration Duisburg-Essen (CENIDE), University of Duisburg-Essen — [2]Leibniz Institute of Photonic Technology — [3]Institute of Catalysis Research and Technology (IKFT), Karlsruhe Institute of Technology

Liquid crystalline (LC) systems have a wide range of applications as they combine the properties of a liquid and orientability in electric fields. In turn, if magnetic nanoparticles are added to such systems, we obtain magneto-responsive liquid crystals. Barium ferrite particles can be considered as possible candidates for use in such magneto-responsive LC systems. Accordingly, this work is geared towards the study of doped and undoped anisotropic barium ferrite nanoparticles using magnetic field and temperature dependent Mössbauer spectroscopy. In pure barium ferrite samples, the five different sublattice positions could be resolved and reorientation in magnetic fields was observed. In the doped samples an asymmetry in the Mössbauer lines as well as partial overlap of the individual sublattices' contributions was visible, which points towards altered environments of the iron atoms. In particular, the 2b site with its relatively high quadrupole level shift provides information about the magnetic orientation relative to the crystal structure. These results enable us to analyze orientation phenomena in future barium ferrite based magnetic liquid crystalline systems.

MA 35.61 Thu 16:00 P4

Fe3N nanoparticles as alternative material for magnetic fluid hyperthermia — •Yevhen Ablets, Imants Dirba, and Oliver Gutfleisch — Technical University of Darmstadt, Darmstadt, Germany

Magnetic fluid hyperthermia (MFH) is one of the modern individual and adjuvant methods for cancer treatment. Usually, iron oxide nanoparticles (IONP) are used for this purpose due to their chemical stability, non-toxicity, well-established and cost-effective production, well-known metabolism of iron in the human body. However, the heating performance of IONP is limited due to moderate values of saturation magnetization and magnetocrystalline anisotropy. Using particles with enhanced magnetic properties will enable more effective tumor treatment, and within AC magnetic field amplitude (H) and frequency (f) conditions of the so-called Brezovich-Atkinson criteria (H*f = 5x10^8 A/m*s), which leads to less discomfort for the patients.

In this work, a new synthesis method of crystalline Fe3N nanoparticles is demonstrated. Metal-organic compound iron pentacarbonyl is thermally decomposed in the presence of polyisobutylene succinimide under continuous ammonia flow. Varying gas flow concentrations and type of surfactant (oleic acid, oleylamine) Fe3O4 and Fe homogeneous spherical particles were obtained with an average diameter of 14 nm. Fe3N particles show better magnetic properties and heating performance than Fe3O4 and better chemical stability compared to Fe particles. First stage biocompatible studies are ongoing.

MA 35.62 Thu 16:00 P4

Origin of magnetic loss and noise in magnetoelastic magnetic field sensors — •Elizaveta Golubeva[1], Benjamin Spetzler[2], Franz Faupel[1], and Jeffrey McCord[1] — [1]Kiel University, Kiel, Germany — [2]Technical University Ilmenau, Ilmenau, Germany

Magnetoelastic magnetic field sensors based on the delta-E effect have proven their high potential for detecting small-amplitude and low-frequency magnetic fields. The concept of such sensors evolves from the dependency of the stiffness tensor on the applied magnetic field and can be utilized in various device configurations, including surface acoustic wave sensors and composite cantilevers. Previous research has shown that the main factor limiting the performance of such sensors comes from the sensor's intrinsic noise. However, the challenge of quantifying different noise sources has not been resolved yet. In this work, we suggest a general methodology for estimating the magnetic noise in magnetoelectric delta-E-effect sensors. Here, we present a complete physical device model and experimental analysis at the example of a millimeter-sized cantilever sensor. In this case, the magnetic noise associated with the hysteresis loss dominates the sensor performance and determines a minimal detectable field for the sensor of about 300 pT/Hz^1/2 @ 10 Hz. The described principles can also be applied to other magnetoelastic magnetic field sensors.

This work was funded by the German Research Foundation (DFG) through the Collaborative Research Centre CRC 1261 "Magnetoelectric Sensors - From Composite Materials to Biomagnetic Diagnostics" and the Carl-Zeiss Foundation via the Project MemWerk.

MA 35.63 Thu 16:00 P4

Giant and Tunneling Magnetic Resistance sensor elements based on Focused Ion Beam methods and chemical synthesis — •Laila Bondzio, Björn Büker, Nadine Fokin, Pierre Piel, and Andreas Hütten — University of Bielefeld, Germany

Common GMR and TMR sensors are based on sputter deposited multilayer stacks. Structuring these thin films using lithography can be expensive and time consuming, thus alternative ways of structuring are explored such as nanoparticle synthesis or high-precision milling via ion beam.

A dual-beam Focused Ion Beam (FIB) microscope can be used for Focused Electron Beam Induced Deposition (FEBID) to deposit small Co dots as nanoparticles, which are afterwards covered with a slightly conductive material to fill the gaps, so that a granular highly ordered, 2 dimensional GMR array is created in a bottom-up method. Alternatively, the ion beam can be used for a top-down approach by milling grid-like structures into a deposited magnetic layer to create rectangular particles. In spite of successful proof of concept measurements, higher particle densities are needed to produce a sufficiently high effect for sensor applications.

With chemical nanoparticle synthesis arrays of randomly arranged nanoparticles can be created representing the ferromagnetic layers. The organic ligand shells of e.g. oelic acid create the isolated TMR barrier between the particles. Measurements on these otherwise untreated random, 3 dimensional particle arrays have shown a broad TMR curve for high fields.

MA 35.64 Thu 16:00 P4

Two-photon lithography as a fabrication tool for 3D curved magnetic thin film arrays — •Christian Janzen[1], Sapida Akhundzada[1], Arne Vereijken[1], Michał Matczak[2], Piotr Kuświk[2], Arno Ehresmann[1], and Michael Vogel[1] — [1]Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, DE — [2]Institute of Molecular Physics, Polish Academy of Science, ul. Mariana Smoluchowskiego 17 60-179 Poznań, PL

Fabrication of 3D magnetic nanostructures of complex geometry is a challenging task not easily achievable by standard lithography techniques. Two-photon lithography exploits the non-linear absorption properties of the utilized resist to initialize its polymerization at the volume of highest intensity, called voxel. By manipulating the three-dimensional position of the voxel, it is possible to prepare microstructures with varying Gaussian curvature (e.g., torus), being used as templates for the deposition of magnetic thin films. For preparing high-quality thin films, minimal surface roughness is required. Hence, the latter was investigated by atomic force microscopy depending on process parameters. By spatially separating the curved template from the substrate surface with an additional spacer, the magnetostatic interaction between the magnetic cap and the flat full film becomes negligible. Individual template structures are written with variable spacing to their nearest neighbors, enabling the magnetostatic interaction via strayfields as a tunable parameter of the interaction within the magnetic array.

MA 35.65 Thu 16:00 P4

Applications of 3D Nano-Lithography in Magnetism — •Jana Kredl[1], Christian Denker[1], Cornelius Fendler[2], Robin Silber[3], Hauke Heyen[1], Tristan Winkel[1], Finn-F. Stiewe[1], Nina Meyer[1], Tobias Tubandt[1], Neha Jha[1], Jakob Walowski[1], Marcel Kohlmann[1], Julia Betune[1], Chris Badenhorst[1], Alena Rong[1], Mark Doerr[1], Raghvendra Palankar[1], Mihaela Delcea[1], Uwe T. Bornscheuer[1], Robert Blick[2], Swadhin Mandal[4], Alexander Paarmann[5], and Markus Münzenberg[1] — [1]University of Greifswald, Germany — [2]Universität Hamburg, Germany — [3]VŠB-Technical University of Ostrava, Czech Republic — [4]Indian Institute of Science Education and Research Kolkata, India — [5]Fritz Haber Institute of the Max Planck Society, Berlin, Germany

3D 2-Photon-Lithography, originally developed for 3D photonic crystals, opens a wide range of new possible applications in many fields, e.g. life sciences, micro-optics and mechanics. We will present our recent applications of 3D 2-Photon-lithography and show 3D evaporation masks for in-situ device fabrication using different deposition angles, infra-red laser light focusing lenses directly fabricated on optical fibers, tunnel structures for guiding growth of neurons [1], pillars for investigation of cell mechanics and master-mold fabrication for Polydimethylsiloxane (PDMS) micro-fluidic channels. Based on our experience we will discuss possible applications in magnetism. [1] C. Fendler et al., Adv. Biosys. 5 (2019) doi: 10.1002/adbi.201970054

MA 35.66 Thu 16:00 P4

Monte-Carlo study of commensurate-incommensurate phase transtion of YBaCuFeO5 — •Mukesh Sharma and Tulika Maitra — Indian Institute of Technology Roorkee, Roorkee Uttrakhand, India

Type-II multiferroic materials where ferroelectricity is driven by magnetic order are highly sought after these days. Intense research is being carried out to increase the transition temperature of multiferroicity to near room temperature. YBaCuFeO5(YBCFO) is one such rare material where it has been reported that incommensurate spiral magnetic ordering is stable upto temperatures higher than room temperature even though the presence of ferroelectricity is still debated. Motivated by the recent experimental evidence of tuning commensurate-incommensurate magnetic phase transition temperature in this system via Fe-Cu disorder, we have studied the role of anisotropic exchange and Fe-Cu site disorder on this transition. Using various exchange interactions obtained from density functional theory, our Monte-Carlo simulations show that both anisotropic exchange and site disorder play significant roles in giving rise to spiral magnetic ordering at lower temperatures.

MA 35.67 Thu 16:00 P4

Formation, effects and suppression of M-Type hexaferrite in barium titanate-spinell ferrite multiferroic composites — •Daniil Lewin, Sofia Shamsulbahrin, Vladimir V. Shvartsman, and Doru C. Lupascu — Institute for Materials Science and Center for Nanointegration Duisburg-Essen (CENIDE), University of Duisburg-Essen, Germany

The combination of a ferroelectric barium titanate-based perovskite with a magnetic ferrite is a common approach for creating multiferroic composites. In some cases, however, a hexagonal phase, usually identified as barium ferrite (BaFe12O19, BaM), appears during sintering. As a noticeable difference exists in the optimal sintering temperature for both phases, it may become a challenge to create an electrically well insulating ceramic. Confronted with strong formation of BaM at high sintering temperatures (1270 °C), we investigate efficient ways to suppress its formation for combinations of barium titanate with cobalt ferrite or nickel ferrite. We show that by using a reducing atmosphere, the formation of BaM is heavily suppressed, while addition of extra cobalt oxide or nickel oxide during the synthesis can further improve the magnetoelectric coefficient while minimizing the remaining amount of BaM. A clear correlation between the amount of BaM and the polarizability and magnetoelectric coupling of the composites is established.

MA 35.68 Thu 16:00 P4

Transport properties of systematically disordered Cr_2AlC films — •Joao S. Cabaco[1], Ulrich Kentsch[1], Jurgen Lindner[1], Jurgen Fassbender[1], Christoph Leyens[2,3], Rantej Bali[1], and Richard Boucher[2] — [1]Institute of Ion Beam Physics and Materials Research, Helmholz Zentrum, Dresden-Rossendorf, Germany — [2]Institute for Materials Science, TU Dresden, Germany — [3]Fraunhofer Institute for Material and Beam Technology IWS, Dresden, Germany.

Nano-lamellar composite materials, known as MAX-phases, can possess a combination of ceramic and metallic properties. A prototype compound is Cr_2AlC, formed from a unit cell of Cr_2C sandwiched between atomic planes of Al.

In this work we study the modifications to the structural, transport and magnetic behavior of 500 nm thick Cr_2AlC after irradiation with Co^+ ions, and Ar^+ noble gas ions as control. X-ray diffraction shows that ion-irradiation induces a suppression of the 0002 reflection, indicating a deterioration of the crystal structure. Increasing the ion fluence leads to an increase of the saturation magnetization at 1.5 K, whereby both Ar^+ and Co^+ cause an increased magnetization, respectively to 150 kA.m^{-1} and 190 kA.m^{-1}, for the highest fluences used. At Co^+ fluences of 5×10^{13} ions.cm^{-2} the magnetoresistance (MR) shows a 2-order of magnitude increase, up to 3% (10 T) at 100 K. A similar effect also occurs for 5×10^{12} ions.cm^{-2} Ar^+ irradiated films, however, with a smaller MR-increase. The disordering of MAX phase films may reveal interesting spin-related transport phenomena.

MA 35.69 Thu 16:00 P4

A Floquet Green's Function technique to study ESR spectra — •Jose Reina Galvez — Center for Quantum Nanoscience, Ewha University, Seoul, Republic of Korea

This poster presents a theoretical framework to describe experiments directed to controlling single-atom spin dynamics by electrical means using a scanning tunneling microscope. The model consists of a quantum impurity connected to electrodes while an electrical time-dependent bias is applied. The quantum impurity consists of a localized electronic state, with a Coulomb repulsion U term, connected magnetically to a localized spin S.

Applying the Heisenberg picture, in the limit of weak coupling between the impurity and the electrodes, Born-Markov approximation, a quantum master equation can be obtained. The rates in this equation are derived by the non-equilibrium Green's function formalism. The Floquet theorem is used to transform the differential equation into algebraic one.

We show results in two cases. The first case is just a single atomic orbital subjected to a time-dependent electric field, and the second case consists of a single atomic orbital coupled to a second spin-1/2. This first case reproduces the main experimental features Ti atoms on MgO/Ag (100) but in a sequential tunneling regime and for different U values. The second case directly addresses the experiments on two Ti atoms.

These calculations permit us to explore the effect of different parameters to reproduce experimental fingerprints of the ESR technique.

MA 35.70 Thu 16:00 P4

Characterization of thin MgO layers grown on Fe(100) and Fe(100)-p(1x1)O — •Mira Arndt, David Janas, Giovanni Zamborlini, and Mirko Cinchetti — Department of Physics, TU Dortmund University, Otto-Hahn-Straße 4, 44227 Dortmund, Germany

In the field of spintronics, thin magnesium oxide (MgO) interlayers play a major role as dielectric tunneling barriers in magnetic tunnel junctions. As the most prominent example, MgO enhances the tunneling magnetoresistance of Fe/MgO/Fe heterolayers. Crucially, exposing Fe to oxygen results in rapid oxidation of the surface, which in turn highly influences the MgO growth process and makes it less reproducible, eventually, changing the device performances. This problem can be overcome by controlled passivation of the Fe surface with oxygen prior to MgO deposition. In this contribution we present the characterization of the growth of MgO layers with variable thickness on the clean Fe(100) and the passivated Fe(100)-p(1x1)O surface. The studies have been performed by employing various surface sensitive techniques, such as Auger electron spectroscopy, low energy electron diffraction (LEED), reflective medium energy electron diffraction (MEED), and photoelectron spectroscopy (PES). Our data show that, despite evident differences in the growth behavior, the electronic properties of the two interfaces are very similar.

MA 35.71 Thu 16:00 P4

Correlation of Magnetism and Disordered Shiba bands in Fe Monolayer Islands on Nb(110) — Julia J. Goedecke[1], Lucas Schneider[1], Yingqiao Ma[3], •Khai Ton That[1], Dongfei Wang[2], Jens Wiebe[1], and Roland Wiesendanger[1] — [1]Department of Physics - University of Hamburg, Hamburg, Germany — [2]CIC Nanogune, Donostia - San Sebastian, Spain — [3]Institute of Chemistry - Chinese Academy of Sciences, Beijing, China

Two-dimensional (2D) magnet-superconductor hybrid systems are intensively studied due to their potential for realizing 2D topological superconductors with Majorana edge modes. It is theoretically predicted that this quantum state can occur in spin-orbit coupled ferromagnetic or skyrmionic 2D layers in proximity to an s-wave superconductor. However, recent examples suggest, that the requirements for topological superconductivity are complicated by the multi-orbital nature of the magnetic components and disorder effects.

Here, we investigate Fe monolayer islands grown on a surface of the s-wave superconductor with the largest gap of all elemental superconductors, Nb, with respect to magnetism and superconductivity using spin-resolved scanning tunneling spectrosopy. We find three types of Fe monolayer islands which significantly differ by their reconstruction, by the magnetism and the disordered Shiba bands, without any signs of topological gaps or edge states.

Our work illustrates, that a reconstructed growth mode of magnetic layers on superconducting surfaces is detrimental for the formation of 2D topological superconductivity.

MA 35.72 Thu 16:00 P4

Suppression of Weak Ferromagnetic Order in $SrRuO_3$ under Pressure — •Anh Tong[1], Pau Jorba[1], Marc Seifert[1], Stefan Kunkemöller[2], Kevin Jenni[2], Markus Braden[2], James S. Schilling[1], and Christian Pfleiderer[1] — [1]Technical University of Munich, Garching bei München, Germany — [2]University of Cologne, Cologne, Germany

In the Ruddlesden-Popper perovskite series, $Sr_{n+1}Ru_nO_{3n+1}$, intense experimental and theoretical efforts have been dedicated to unravel the nature of unconventional superconductivity in single-layer $Sr_2RuO_4(n=1)$ as well as a putative electronic nematic phase masking the quantum critical endpoint in the double-layer itinerant metamagnet $Sr_3Ru_2O_7$ ($n=2$). We report an experimental study of the zero temperature ferromagnetic-to-paramagnetic transition under pressures up to 20GPa in high quality single crystals of the infinite layer itinerant ferromagnet $SrRuO_3(n=\infty)$. Electrical transport measurements in Bridgman anvil high pressure cells, as well as neutron depolarization measurements in diamond anvil cells were performed on $SrRuO_3$. Our study aims to investigate quantum criticality in $SrRuO_3$ and reconcile the properties of $Sr_3Ru_2O_7$ and Sr_2RuO_4 with the generic temperature-pressure-magnetic field phase diagram of itinerant ferromagnets.

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MA 35.73 Thu 16:00 P4

Magneto-transport in (Bi,Sb)Te nanostructures — •Titouan Charvin[1,2], Felix Hansen[2], Silke Hampel[2], Joseph Dufouleur[2], Bernd Büchner[2,3], and Romain Giraud[1,2] — [1]Université Grenoble Alpes, CNRS, CEA, IRIG/Spintec, F-38000 Grenoble, France — [2]Leibniz Institute for Solid State and Materials Research Dresden, Helmholtzstrasse 20, D-01069 Dresden, Germany — [3]Institut für Festkörperphysik, TU Dresden, D-01062 Dresden, Germany

The investigation of Dirac fermions surface states in binary 3D topological insulators, such as Bi_2Te_3 or Sb_2Te_3, is limited by their large bulk-carrier densities. This shift of the Fermi level, away from the bulk band gap, is caused by a high density of point defects, acting as donors or acceptors. With the aim to achieve a bulk-charge compensation, we grew $(Bi_xSb_{1-x})_2Te_3$ nanostructures by chemical vapor transport, with different stoichiometries, in order to vary both the band structure and the relative contributions of different types of point defects. From magneto-transport measurements, we infer the bulk and surface carrier densities and mobilities. Although the bulk contribution to the conductivity can be reduced for some stoichiometries, all samples show a metallic-like behavior of their conductivities, with coexisting bulk and surface states contributions.

MA 35.74 Thu 16:00 P4

Electrical and thermal hall transport in compensated topological insulator BiSbTeSe$_2$ — •Rohit Sharma, Mahasweta Bagchi, Oliver Breunig, Yoichi Ando, and Thomas Lorenz — II. Physikalisches Institut, Universität zu Köln, Zülpicher Straße 77, D-50937 Köln, Germany

The existence of puddles in $BiSbTeSe_2$ at low temperature (T < 50K) has been detected using optical conductivity measurements, where DC electrical conductivity data shows an insulating behaviour, but above 50K, optical and transport results agree well with each other due to evaporation of charge puddles with increasing T[1]. By comparing thermal conductivity κ_{xx} and thermal hall effect κ_{xy} data with the electrical counterparts (σ_{xx} & σ_{xy}), we study a possible influence of charge puddles on thermal transport. Electrical hall conductivity (σ_{xy}) shows hole like (p-type) behaviour at elevated T, which changes to multi-band behaviour at low T. From the electrical transport data electronic contribution to thermal transport κ_e was calculated by using Wiedemann-Franz law and then compared with the measured thermal transport data where it was found that both κ_{xx} and κ_{xy} shows phonon dominated behaviour. When compared κ_{xy} and κ_e, data matches well with each other above 50K. In contrast, below 50K κ_{xy} shows a sign change and evolves to a large thermal hall signal, whereas κ_e has no sign change and smoothly decreases. Possible reason for large thermal hall effect in $BiSbTeSe_2$ will be discussed.

Funded by the DFG via CRC 1238 Projects A04 and B01

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MA 35.75 Thu 16:00 P4

Topology and DC quantum transport in Floquet-driven systems — •Aya Abouelela and Johannes Kroha — University of Bonn

Recently, several works have investigated the topological properties emerging in periodically driven systems, where a periodic drive is used to engineer the band structure such as to support topologically stabilized edge modes. The topological phases of periodically driven systems have been classified across all dimensions in the periodic table of Floquet topological insulators. The Floquet multiplicity of bands implies the emergence of anomalous edge states which cross bulk gaps that do not occur in static systems. Here, we present our studies on the non-interacting topological Qi-Wu-Zhang (QWZ) model under the influence of a periodic drive, and analyze its drive-induced edge modes, using the Floquet formalism. Investigating two regimes of the driving frequency , higher or lower than the static bandwidth, the latter is shown to support anomalous edge modes. For the experimental detection of edge states, we calculate the dI/dV spectra at non-zero DC bias voltage V, using the Keldysh-Floquet formalism. We predict quantized conductance plateaus when the transport voltage is within a normal gap (V centered around $V = 0$, normal edge mode) or within an anomalous gap (V centered around $V = \pm\Omega/2$, anomalous edge mode). We also perfom a spatially resolved computation of the chiral tranmission channels of the finite- size system with finite bias applied, showing that the transport is along an edge and that it is spatially modulated corresponding to the wave number π of the (anomalous) edge mode.

MA 35.76 Thu 16:00 P4

Effects of the chiral anomaly on charge and heat transport in Weyl semimetals — •Alina Wenzel[1,2], Annika Johansson[1], and Ingrid Mertig[2] — [1]Max Planck Institute of Microstructure Physics, Halle, Germany — [2]Martin Luther University Halle-Wittenberg, Halle, Germany

The chiral anomaly in Weyl semimetals, which corresponds to nonconservation of chiral charge if a magnetic field is applied nonorthogonal to an electric field or a temperature gradient, leads to unconventional contributions to longitudinal charge and thermal transport, strongly depending on the external magnetic field [1-3]. We calculate the thermoelectric transport properties for Weyl systems by solving the semiclassical Boltzmann equation including a temperature gradient. To analytically calculate the transport coefficients the Sommerfeld expansion is used. The isotropic Weyl Hamiltonian [2] and an anisotropic, more realistic model to describe pairs of Weyl points [4,5] are discussed. Using the latter, Weyl semimetals with either broken time reversal or inversion symmetry are simulated and the influence of symmetry on the electric and thermal transport properties is discussed.

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