MA 21: Poster I

Time: Tuesday 9:30–13:00 Location: Poster A

MA 21.1 Tue 9:30 Poster A

Topological Hall effect in asymmetric all-oxide perovskite superlattices? — •Lena Wysocki, Jörg Schöpf, Ramil Mirzaagheyev, Rolf Versteeg, Paul H. M. van Loosdrecht, and Ionela Lindfors-Vrejoiu — Universität zu Köln, II. Physikalisches Institut

Interactions at coherent interfaces in all-oxide superlattices may result in spectacular physical effects. The presence of interfacial Dzyaloshinskii-Moriya interaction at the interface between a ferromagnetic oxide layer and a heavy 5d metal oxide may generates chiral magnetic order in the ferromagnetic layers, possibly even leading to a skyrmionic phase. Here we study the effects of interfacing a ferromagnetic 4d transition metal oxide, SrRuO3, with non-magnetic insulating 4d and 5d transition metal oxides. Asymmetric superlattices combining SrRuO3 and 5d perovskite oxides were grown by pulsed-laser deposition and studied by SQUID magnetization, magneto-optical Kerr effect, and Hall effect experiments. The Hall resistivity measurements of the superlattices showed, besides the usual ordinary and anomalous contributions, a clear contribution hinting to the occurrence of a topological Hall effect, and hence to the occurrence of topological magnetic textures in the SrRuO3 layers. These results open the gateway to engineered all-oxide heterostructures hosting non-trivial magnetic structures such as skyrmions.

MA 21.2 Tue 9:30 Poster A

Signatures of toroidal order — •Oliver Busch[1], Börge Göbel[2], and Ingrid Mertig[1,2] — [1]Institut für Physik, Martin-Luther-Universität, D-06120 Halle — [2]Max-Planck-Institut für Mikrostrukturphysik, D-06120 Halle

Magnetic moments that form a closed planar ring exhibit a toroidal moment. Ferrotoroidic order, i. e., the periodic arrangement of uniform toroidal moments, changes its sign upon application of space or time inversion and gives rise to a magnetoelectric effect of electrons [1]. Effective Hamiltonians allow a simplified description of toroidal order on honeycomb lattices and a prediction of the magnetoelectric effect, as well as a strongly diminished anomalous Hall effect in the presence of toroidal order [2].

We report on tight-binding calculations of a full *sp* Hamiltonian with toroidal order on a square-octagon lattice, in which toroidal moments are formed by the four spins of the square plaquettes. The band structure of electrons on this lattice without toroidal order shows a symmetric shift in reciprocal space due to spin-orbit coupling. Applying toroidal order leads to an asymmetric shift along the direction of the toroidal moment, as for the honeycomb lattice [2]. We present a band-resolved analysis to obtain deeper understanding of the above effects.

[1] N. Spaldin et al., J. Phys.: Condens. Matter **20**, 434203 (2008).
[2] S. Hayami et al., Phys. Rev. B **90**, 024432 (2014).

MA 21.3 Tue 9:30 Poster A

Spin-resolved inelastic electron scattering by spin-waves in non-collinear magnets — •Flaviano José dos Santos, Manuel dos Santos Dias, Filipe S.M. Guimarães, Juba Bouaziz, and Samir Lounis — Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich & JARA, D-52425 Jülich, Germany

So far, no experimental technique has attempted to probe large wave-vector spin-waves in non-collinear low-dimensional systems. In this work, we explain how inelastic electron scattering, being suitable for investigations of surfaces and thin films, can detect the collective spin-excitation spectra of non-collinear magnets. We propose a measurement protocol to reveal the particularities of spin-waves in such non-collinear samples, by utilizing spin-polarized electron-energy-loss spectroscopy augmented with a spin-analyzer. With the spin-analyzer detecting the polarization of the scattered electrons, four spin-dependent scattering channels are defined, which allow to filter and select specific spin-wave modes. We take as examples a topological non-trivial skyrmion lattice, a spin-spiral phase and the conventional ferromagnet. Then we demonstrate that, counter-intuitively and in contrast to the ferromagnetic case, even non spin-flip processes can generate spin-waves in non-collinear substrates.

Work supported by the Brazilian agency CAPES under Project No. 13703/13-7 and the European Research Council under ERC-consolidator Grant No. 681405-DYNASORE.

MA 21.4 Tue 9:30 Poster A

Spin wave dynamics in the chiral magnet $Fe_{50}Ge_{50}$ — •Nicolas Josten[1], Benjamin Zingsem[1,2], Detlef Spoddig[1], Iliya Radulov[3], Ralf Meckenstock[1], Thomas Feggeler[1], Michael Farle[1], and Oliver Gutfleisch[3] — [1]Faculty of Physics and Center for Nanointegration (CENIDE), University Duisburg Essen, Duisburg, 47057, Germany — [2]Ernst Ruska Centre for Microscopy and Spectroscopy with Electrons and Peter Grünberg Institute, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — [3]Department of Material- and Geosciences, Functional Materials, Technische Universität Darmstadt

We use X-band ferromagnetic resonance (FMR) spectroscopy inside an R-Type micro-resonator [1] to investigate polycrystalline micron sized samples of $Fe_{50}Ge_{50}$, a chiral magnet, with a B20 crystal structure. Unusual dynamics in confined chiral magnets were, for example, predicted in [2], showing that additional resonance modes are expected in confined chiral systems as opposed to achiral systems. Indeed, besides the uniform main mode, we observe a multitude of resonances at high fields (200-900 mT), identified as spin wave modes, which cannot be explained within the standard model of FMR and are tailorable in wedge-shaped samples due to the special geometric boundary conditions. Furthermore, we find a unidirectional anisotropy for the spin waves, which does not affect the uniform main mode.

[1] R. Narkowicz, D. Suter, and I. Niemeyer. Rev. of Sci. Instr., 79(8):084702, 2008. [2] B. Zingsem, M. Farle, R. Stamps, R. Camley. arXiv:1609.03417

MA 21.5 Tue 9:30 Poster A

Resonant Soft X-Ray Scattering Ferromagnetic Resonance in the chiral magnet Cu_2OSeO_3 — •Simon Pöllath[1], Aqeel Aisha[1], Chen Luo[1,2], Hanjo Ryll[2], Florin Radu[2], and Christian Back[1] — [1]Department of Physics, University of Regensburg, Universitätsstrasse 31, 93053, Regensburg, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Albert-Einstein Str. 15, 12489, Berlin, Germany

We report on X-ray Ferromagnetic Resonance (X-FMR) in scattering geometry in the skyrmion hosting chiral magnet Cu_2OSeO_3. Using a detector system which provides vertical and horizontal scanning capability mounted within the magnet bore, the diffraction patterns of the helical, conical and skyrmion phases are obtained. Through mapping of the magnetic scattering around the forbidden structural (001/2) Bragg peak, in resonant scattering at the Cu L_3 edge, we can distinguish and probe individually each of the helical, conical and skyrmion magnetic configurations. The system is excited via microwaves which at the resonant frequencies is directly as magnetic scattering contrast. The measurements were performed at the VEKMAG end station.

MA 21.6 Tue 9:30 Poster A

generation of dzyaloshinskii-moriya interaction in three-dimensional topological insulators beyond linear indirect exchange interaction — •Mahroo Shiranzaei[1,2], Jonas Fransson[2], Hosein Cheraghchi[1], and Fariborz Parhizgar[2] — [1]School of Physics, Damghan University, P.O. Box 36716-41167, Damghan, Iran — [2]Department of Physics and Astronomy, Uppsala University, Box 516, SE-751 21, Uppsala, Sweden

The Dzyalosinski-Morya (DM) interaction which is a cause of spin-orbit coupling in materials becomes a rapidly growing topic in the field of spintronics. This anisotropic interaction results in exotic phases such as skyrmions, and chiral domain walls. In dilute magnetic semiconductors, the magnetic impurities interact indirectly via the itinerant electrons and the magnetic properties can be controlled by tuning the electronic properties. Although the surface states of three-dimensional topological insulators resemble a pure Rashba Hamiltonian, the DM term takes zero magnitude at the Dirac point. Furthermore, impurities modify the electronic structure by inducing new local states in the material. These new states become important when they occur at energies with vanishing (inside band gap) or low density of electron states (e.g., near Dirac point). In our survey, we go beyond the well-known RKKY interaction within the linear response theory and consider effects of these impurity states on the indirect exchange interaction. We studied the effect of these new states on the different terms of the RKKY interaction and found that the DM term takes large values while the collinear parts reduce and even can change sign in some cases.

MA 21.7 Tue 9:30 Poster A

Spin textures in Fe/Rh/Ir(111) investigated by spin-polarized STM — •Andre Kubetzka, Kirsten von Bergmann, and Roland Wiesendanger — Department of Physics, University of Hamburg, Germany

We employ low temperature spin-polarized STM to investigate heterogeneous bilayer films on the heavy substrate Ir(111). While Pd/Fe/Ir(111) shows a magnetic spin spiral of 6 nm, which forms a skyrmion lattice in an applied field of 1.5 Tesla [1], exchanging Pd with Rh results in spiral periods of only 1-1.5 nm in Rh/Fe/Ir(111) [2]. Here, we investigate the magnetism of the reversed system, Fe/Rh/Ir(111), where the Fe layer is moved away from the heavy substrate. Depending on the stacking of the Fe layer (hcp or fcc), we find a spiral of period 1.1 nm and a hexagonal spin texture with a period of 1.3 nm. The magnetic periods are surprisingly close to the reversed system, Rh/Fe/Ir(111), but interestingly, the stacking of the Fe layer alone determines whether the spin texture is one- or two-dimensional.

[1] N. Romming *et. al*, Writing and deleting single magnetic skyrmions, Science **341**, 636 (2013).
[2] N. Romming *et. al*, Spin spirals in ultra-thin films driven by frustration of exchange interactions: Rh/Fe/Ir(111), arXiv:1610.07853 (2016).

MA 21.8 Tue 9:30 Poster A

Stripe and bubble domain formation and transformation in Ni/Fe/Cu(001) — •Thomas Meier, Matthias Kronseder, and Christian Back — Institut für experimentelle und angewandte Physik, Universität Regensburg, Deutschland

In ultrathin ferromagnetic films with perpendicular magnetic anisotropy a spin-reorientation transition from out-of-plane to in-plane magnetization may occur. The competition of the domain wall energy and the dipole interaction leads to a rich variety of domain patterns in the vicinity of this spin reorientation transition. We investigate chiral magnetic domain patterns stabilized by the Dzyaloshinskii-Moriya interaction (DMI) in Cu- and Pt- capped Ni/Fe/Cu(001) samples with different DMI-constants depending on effective anisotropy, temperature and external magnetic fields. Phase diagrams of the magnetic domain pattern are recorded for both sample types and by scaling the magnetic field a universal phase diagram for perpendicularly magnetized systems depending only on the stripe domain width in zero field and the external magnetic field is obtained. By real-time imaging of the domain pattern using a high-speed camera we investigate the transition between bubble and stripe domain patterns dependent on external magnetic field and temperature. We found that due to the chiral nature of the domain walls merging and splitting of stripe segments may be strongly suppressed at room temperature depending on the stripe width, whereas a larger temperature of approx. 90°C allows the transformation from bubbles to stripes and vice versa in an experimentally accessible time scale.

MA 21.9 Tue 9:30 Poster A

Modification of perpendicular anisotropy synthetic antiferromagnets by local ion irradiation — •Fabian Samad[1], Leopold Koch[1,2], Phani Arekapudi[1], Miriam Lenz[2], and Olav Hellwig[1,2] — [1]Institute of Physics, Chemnitz University of Technology, Germany — [2]Institute for Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, Germany

By using local ion irradiation we modify the magnetic microstructure of perpendicular anisotropy synthetic antiferromagnets (AF) consisting of [(Co/Pt)Co/Ru] multilayers. The systems magnetic energy balance between AF interlayer exchange and dipolar energy has been tuned such that its room temperature ground state exhibits a laterally correlated and vertically anti-correlated magnetic microstructure (single domain antiferromagnet) [1]. In our study we locally altered this energy balance with focused ion beam irradiation with different ion fluences and area shapes, giving rise to a variety of laterally coexisting magnetic phases and 3D-magnetic textures. Extensive studies of their interaction as well as their field reversal behavior were performed with in-field high resolution magnetic force microscopy.

[1] O. Hellwig, J. B. Kortright, A. Berger and E. E. Fullerton, J. Magn. Magn. Mater. 319, 13-55 (2007).

MA 21.10 Tue 9:30 Poster A

Surface acoustic wave mediated magneto elastic investigation of magnetic thin film systems — •Matthias Küss[1], Michael Heigl[2], Andreas Hörner[1], Manfred Albrecht[2], and Achim Wixforth[1] — [1]Lehrstuhl für Experimentalphysik I, Universität Augsburg, — [2]Lehrstuhl für Experimentalphysik IV, Universität Augsburg

Magnetostriction describes the geometrical deformation of a magnet, caused by an applied magnetic field. The effect vice versa is named inverse magnetostriction. This mechanism in combination with surface acoustic strain waves (SAW) enables the manipulation of the magnetization on short time scales ($\sim$ ns) and on micrometer distances. Since the SAW and magnonic modes are typically excited in the same radio frequency regime, both degrees of freedom have the potential to become strongly or even resonantly coupled. Therefore, not only the magnetization, but also the properties of the SAW itself are characteristically changed. This can be easily measured in a delay line setup, made up of two interdigital transducers (IDT).

Besides highly magnetostrictive ferrimagnetic TbFe thin films, exchanged-biased CoFeB/CoO, consisting of a soft ferromagnet CoFeB and an antiferromagnetic CoO layer, are studied. Because the Néel temperature of the antiferromagnet is at about 160K, it is possible to probe the impact of the exchange bias effect on the magnetoacoustic interaction below and above the blocking temperature. First results obtained on magnetization reversal at room temperature as a function of sample orientation show good accordance with the theory of elastically driven ferromagnetic resonance.

MA 21.11 Tue 9:30 Poster A

Interfacial ferromagnetism in $LaMnO_3/SrMnO_3$ superlattices — •Jan Philipp Bange[1], Marius Keunecke[1], Vladimir Roddatis[2], and Vasily Moshnyaga[1] — [1]Erstes Physikalisches Institut, Georg-August-Universität-Göttingen, Germany — [2]Institut für Materialphysik, Georg-August-Universität-Göttingen, Germany

Transition-metal-oxide perovskite heterostructures show unusual electrical and magnetic properties originated from the so called “emergent phases” at the interfaces [1]. Their behaviour is shown to be governed by interfacial charge transfer, driven by polar mismatch and orbital reconstruction, which can be as well influenced by epitaxy stress. The metalorganic aerosol deposition (MAD) technique was employed to grow digital $[(SrMnO_3)_n/(LaMnO_3)_m]_{10}$ superlattices (SL) on $SrTiO_3$(100) substrates with layer thicknesses n,m=3,4,5,6 u.c. Structural characterization reveals chemically sharp and symmetric interfaces as well as atomically smooth surface morphology. A complex magnetic behaviour with coexisting high- and low-temperature ferromagnetic phases with $T_{C,1}$=270-350 K and $T_{C,2}$=150-280 K, respectively, was observed and assigned to the interfacial ($T_{C,1}$) and LMO-like ($T_{C,2}$) contributions. Magnetic properties were found to be controlled by the SL design, i.e. by the SMO/LMO thickness ratio ($n/n+m$), thus, pointing out the importance of crystal structure and MnO_6 octahedral distortions onto the manifestation of the emergent high-T_C interfacial magnetism. [1] Hwang, H.Y., Iwasa, Y., Kawasaki, M., Keimer, B., Nagaosa, N. and Tokura, Y. “Emergent phenomena at oxide interfaces” *Nat. Mater.* **11**, 103 (2012).

MA 21.12 Tue 9:30 Poster A

Optical detection of magnetic excitations in ferromagnets via photoluminescence in nearby diamond NV centers — •Chris Körner[1], Martin Wagener[2], Niklas Liebing[1], and Georg Woltersdorf[1] — [1]Martin Luther University Halle-Wittenberg — [2]Johannes Gutenberg University Mainz

We detect magnetic resonance in ferromagnetic layers by means of optical photoluminescence (PL) measurements using nanoscale diamonds containing nitrogen-vacancy (NV) centers. In magnetic layers exposed to RF- and static bias fields, different modes can be excited. These modes become visible in the PL signal of nearby NV centers, as previously observed by Wolfe et al. [1,2]. However, the physical origin of the cross coupling between magnetic excitations and the photoluminescence of NV centers is still not revealed. There are some approaches conceivable, namely spin-transport, magnetostriction, and magnetic stray fields [3]. Our work intends to identify the physical mechanism of the spin-wave induced change in the PL signal by measuring the dependence on the excited modes in various magnetic materials at different RF-frequencies and bias fields. Additionally, we investigate the influence of different spacer layer materials and thicknesses, as well as various surface structures.

[1] C. S. Wolfe et al. Phys. Rev. B 89, 180406 (2014)
[2] C. S. Wolfe et al. ArXiv 1512.05418v2 (2016)
[3] A. Yacoby et al. Science 257, 6347 (2017)

MA 21.13 Tue 9:30 Poster A

X-ray magnetic linear dichroism as a probe for non-collinear magnetic state — •Chen Luo[1,2] and Florin Radu[2] — [1]Department of Physics, University of Regensburg, Universitätsstrasse 31, 93053, Regensburg, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Albert-Einstein Str. 15, 12489, Berlin, Germany

We report on exploiting the X-ray magnetic linear dichroism (XMLD) contrast for probing the non-collinear states in $DyCo_5$ ferrimagnetic thin film. From the X-ray magnetic circular dichroism measurements, an anomalous 'wing shape' hysteresis loop is observed slightly above its compensation temperature. This bear the chracterisitcs of an intrinsic exchange bias effect, referred to as *atomic exchange bias*. This effect is assumed to be mediated by the formation of an the out-of-plane domain wall formation from the surface towards the bulk. By taking advantage of the strong linear dichroism of the Dy element at the M_5 absorption edge, the formation of domain walls during the hysteresis measurements is directly observed via XMLD measurements.

MA 21.14 Tue 9:30 Poster A

Novel method of setting exchange bias in tunnel magnetoresistance devices with laser annealing — •Apoorva Sharma[1], Maria Almeida[1,2], Sandra Busse[3], Mathias Müller[3], Patrick Matthes[2], Horst Exner[3], Stefan E. Schulz[2], Dietrich R.T. Zahn[1], and Georgeta Salvan[1] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Fraunhofer ENAS, 09126 Chemnitz, Germany — [3]Laserinstitut Hochschule Mittweid, Schillerstraße 10, 09648 Mittweida, Germany

Magnetic field sensors have become indispensable in a vast variety of modern devices, with applications ranging from basic research to industrial equipment. The so-called spintronic magnetoresistive effects, in particular the tunnel magnetoresistance can provide larger signal yields and sensitivities compared to well-established Hall and Anisotropy magnetoresistance technologies. The selective orientation of the magnetization depending on setting an exchange bias in micron size sensors, however, still represents a challenge. This can be achieved by laser annealing in conjunction with the suitable magnetic field. We investigated micromagnetic properties of IrMn/CoFeB/MgO/CoFeB tunnel junctions upon localized annealing with a 1064 nm IR laser, focusing on the magnetic properties of the exchanged coupled IrMn/CoFeB bilayers, namely the magnetization, coercivity, and exchange bias field. These were evaluated with SQUID-VSM and MOKE-magnetometry, as well as with a 4-point probe magnetoresistance measurement method. The exchange field set with laser-field-cooling was observed to be comparable with conventional methods.

MA 21.15 Tue 9:30 Poster A

Influence of Bulk and Interface Defects in the Antiferromagnetic Layer for the Exchange- Bias Effect — •Tauqir Tauqir[1], M. Yaqoob Khan[2], Ikram Ullah[2], M. Sajjad[2], Izran Ullah[2], Yasser A. Shokr[1], and Wolfgang Kuch[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Kohat University of Science and Technology, Kohat 26000, Khyber Pakhtunkhwa, Pakistan

A series of experiments is carried out to identify the fundamental mechanisms leading to the exchange bias effect in ultrathin epitaxial bilayer samples ferromagnetic/antiferromagnetic (FM/AFM) on a $Cu_3Au(001)$ substrate. The studied samples are bilayers of single-crystalline antiferromagnetic $Ni_{25}Mn_{75}$ and ferromagnetic Co layers, deposited under UHV, in which structural or chemical defects are deliberately introduced by Ar^+ ion bombardment for short times at the FM/AFM interface or at a certain depth of the AFM layer. The approach is to influence both the interface coupling as well as the pinning sites inside the AFM material by the controlled insertion of disorder. Comparison of the magnetic properties measured by magneto-optical Kerr effect then allows a precise determination of the influence of the Ar^+ ion bombardment of the AFM layer. We find that the interfacial and sandwiched defects result in decrease and increase of the exchange bias field (H_{eb}), respectively. We interpret this as, within the AFM layer, sandwiched defects leading to the formation of domains, which in turn give rise to uncompensated pinned moments that are responsible for the increased H_{eb} as predicted in the domain-state model.

MA 21.16 Tue 9:30 Poster A

Interface coupling between $3d$-$La_{0.67}Sr_{0.33}MnO_3$ and $5d$-$SrIrO_3$ — •Lukas Bergmann, Diana Rata, and Kathrin Dörr — MLU Halle-Wittenberg, Halle, Germany

The magnetic anisotropy (MA) is a fundamental property of magnetic materials. Especially the perpendicular magnetic anisotropy (PMA) is important for new spintronic devices. We investigate how the interface coupling between $3d$-$La_{0.67}Sr_{0.33}MnO_3$(LSMO) and $5d$-$SrIrO_3$ (SIO) can influence the MA in the ferromagnetic LSMO. SIO is a paramagnet with a strong spin-orbit coupling [1], which can induce Dzyaloshinskii-Moriya interactions at the interface with another oxide.

Heterostructures of LSMO and SIO with different layer thickness are grown by the pulsed laser deposition (PLD). We are using TiO_2 terminated (100) $SrTiO_3$ as substrate. The structure characterization is done by X-Ray diffraction (XRD). The magnetic and electrical properties are investigated by SQUID and transport measurements. The results of this study and ongoing work will be presented.

[1] A. Biswas, K.-S. Kim, and Y. Jeong, Journal of Magnetism and Magnetic Materials, 400 (2015)

MA 21.17 Tue 9:30 Poster A

Ferromagnetic Resonance of Co_2MnGa Thin Films — •Peter Swekis[1,2], Anastasios Markou[1], Yi-Cheng Chen[1], Jörg Sichelschmidt[1], Stefan Klingler[3,4], Mathias Weiler[3,4], Sebastian T.B. Gönnenwein[2], and Claudia Felser[1] — [1]Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Straße 40, 01187 Dresden, Germany — [2]TU Dresden, Institute of Solid State Physics, Helmholzstr. 40, 01069 Dresden, Germany — [3]Walther Meißner Institute, Walther-Meißner-Straße 8, 85748 Garching, Germany — [4]TU München, Physics-Department, 85748 Garching, Germany

Heusler compounds are a widely studied class of materials interesting for spintronic applications due to a number of magnetic and electronic properties, such as high spin polarization and elevated Curie temperatures. The dynamic response to gigahertz frequencies becomes particularly interesting and has to be investigated in relevant structures. We studied Co_2MnGa thin films of various thicknesses (10-80 nm) with cavity FMR (X-Band) as well as broadband FMR to determine damping, g-factor, effective magnetization and anisotropy constants. First results show a trend of all parameters with changing thickness. Furthermore, we observed unusual oscillating behavior of the broadband FMR linewidth with frequency as well as 8-fold symmetry of the anisotropy in cavity FMR in-plane measurements.

MA 21.18 Tue 9:30 Poster A

XRMR study of ultrathin magnetite films on MgO and $SrTiO_3$ substrates — •Tobias Pohlmann[1], Karsten Küpper[1], Timo Kuschel[2], and Joachim Wollschläger[1] — [1]Osnabrück University, Osnabrück, Germany — [2]Bielefeld University, Bielefeld, Germany

Magnetite thin films are frequently discussed as material for spintronic devices, such as magnetic tunnel junctions. For such multilayer devices, understanding the magnetic interface effects can be significantly important. While x-ray magnetic circular dichroism (XMCD) – the main technique to investigate the magnetic properties in an element resolved fashion – is sensitive to the entire film volume, x-ray magnetic reflectometry (XRMR) allows for the probing of the magnetic moment depth distribution and even of buried interfaces. Recently, it has been found that the easy axis of magnetite films depends on the substrate, switching from [110] in Fe_3O_4/MgO(001) to [100] in $Fe_3O_4/SrTiO_3(001)$ [1]. To clarify the origin of this behaviour, we have grown magnetite ultrathin films on MgO(001) and $SrTiO_3(001)$ substrates by molecular beam epitaxy. We employ XMCD together with XRMR to obtain magnetic depth profiles of these samples. By selecting the Fe $L_{2,3}$ resonances, the impact of the subtrate choice on magnetite's differently coordinated Fe ions can be resolved. Magnetite's large saturation moment of 4 $\mu_B/f.u.$ leads to asymmetry ratios of the XRMR signals as high as 60% at the resonances, demonstrating the capability of this method for the study of magnetite.

[1] K. Küpper et al., PRB **94**, 024401 (2016)

MA 21.19 Tue 9:30 Poster A

Magnetization profile at the interface between CoFeB and MgO determined by XRMR — •Eberhard Goering, Daan Boltje, and Gisela Schuetz — Max-Planck-Institut für Intelligente Systeme, 70569 Stuttgart

Sputtered CoFeB films sharing an interface with MgO play a key role in out-of-plane magnetized magnetic tunnel junctions STT-MRAM devices, based on perpendicular magnetic anisotropy (PMA). It is possible to switch the magnetic configuration using an electric field, directly affecting the PMA in the CoFeB layer [1].

Detailed information on the chemical dependant near the interface magnetic profile still lacks. We have performed x-ray resonant magnetic reflectometry (XRMR) and related x-ray magnetic circular dichroism (XMCD) experiments on the CoFeB-MgO system [2]. We obtain magneto optical properties and corresponding chemical and magnetic profiles for Co and Fe separately.

Partial oxidation of Fe during microfabrication is reported, where the oxidation state is reversibly controlled by an electric field [3]. Similarly, we find a 1 nm iron dead layer at the MgO interface and a 0.4 nm thick dead layer for cobalt at both interfaces of the CoFeB. Our results provide more information on the changes in magnetization profile due to oxidation.

[1] Wang *et al.*, Nature Materials **11**, 64 (2012).
[2] Macke *et al.*, JoP: Condensed Matter **26**, 363201 (2014).
[3] Bonell *et al.*, Applied Physics Letters **102**, 152401 (2013).

MA 21.20 Tue 9:30 Poster A

Magnetic exchange coupling in Fe_3O_4/CoO bilayers on MgO(001) — •Kevin Ruwisch, Jari Rodewald, and Joachim Wollschläger — Fachbereich Physik, Universität Osnabrück, Barbarastr. 7, 49079 Osnabrück

Spintronics is a rising field of research in physics. Magnetite as a ferrimagnet and cobaltoxide as an antiferromagnet have become more important for industrial applications in spintronics over the years. For instance, magnetite is used in magnetoresistive random-access memory (MRAM) consisting of magnetic tunnel junctions (MTJ). Thus, improving the magnetic properties of ferrimagnetic films and ferrimagnetic/antiferromagnetic bilayers for spintronic devices is very important since antiferromagnetic films serve as pinning layers due to exchange bias.

Hence, in this work CoO and Fe_3O_4/CoO bilayers, grown by reactive molecular beam epitaxy (RMBE) on MgO(001), are investigated temperature-dependent via vibrating sample magnetometry (VSM). Furthermore, cubic magnetic anisotropy (CMA) measurements are performed. The composition as well as the surface structure have been characterized by in-situ x-ray photoelectron spectroscopy (XPS) and low-energy electron diffraction (LEED), respectively.

One approach of characterizing the magnetic features of CoO and Fe_3O_4/CoO is to evaluate the impact of CoO towards coercivity, remanence, magnetocrystalline anisotropy and especially the exchange bias.

MA 21.21 Tue 9:30 Poster A

Quantum Hall Ferromagnetism in Two-Dimensional Atomic Lattices — Angelika Knothe[1], Thierry Jolicoeur[2], and •Vladimir Fal'ko[1] — [1]National Graphene Institute, The University of Manchester, Manchester M13 9PL, United Kingdom — [2]Laboratoire de Physique Théorique et Modèles Statistiques (LPTMS), Université Paris-Sud, 91405 Orsay, France

Since the seminal discovery of graphene, two-dimensional (2D) atomic crystals have proven to be an exciting playground for investigating novel quantum Hall (QH) phenomena. Besides mono- and bilayer graphene [1,2] this includes 2D surface states of crystals such as the (111) surface of elemental bismuth [3] or heterostructures such as graphene on hexagonal boron nitride [4].

We theoretically investigate these novel QH systems focussing on the multiple discrete degrees of freedom the electrons may carry. Within the framework of QH ferromagnetism, i.e, treating the electronic degrees of freedom as spins and isospins, different aspects of the systems are explored by analysing the resulting spin and isospin structure. Hartree Fock theory is employed to study the influence of electronic interactions in these multicomponent spin and isospin system on the mean field level [5].

[1] A.Knothe, T. Jolicoeur, PRB 92, 165110 (2015), [2] A. Knothe, T. Jolicoeur, PRB 94, 235149 (2016), [3] B. E. Feldman, Ali Yazdani, et al., Science 354, 316-321 (2016) [4] Xi Chen, J. R. Wallbank, V. I. Fal'ko, et al., PRB 89, 075401 (2014) [5] A. Knothe, Ph.D. Thesis, University of Freiburg (2017)

MA 21.22 Tue 9:30 Poster A

Characterization of a synchrotron-based spin-resolved ARPES set-up — •Laura Kugler, Henning Sturmeit, Davide Bossini, Stefano Ponzoni, and Mirko Cinchetti — Experimentelle Physik 6, Technische Universität Dortmund, 44227 Dortmund

Spin-resolved ARPES (angle-resolved photoelectron spectroscopy) is one of the most powerful, yet almost unexplored, method to study the spin properties of metal-organic interfaces. In particular, by analyzing the angular dependence of the spin resolved photoemission yield, it is possible to understand the complex interaction between organic adsorbates and metallic surfaces, and its influence on the spin properties of the interface [1].

In this contribution we will present the characterization of the spin-ARPES set-up at the Beamline 5 at Delta, the synchrotron light source at the Technical University of Dortmund. To characterize the performance of the system, we have performed measurements of the well-known Cu(111) surface and of Co thin films on Cu(100).

[1]M. Cinchetti, A. Dediu, and L. Hueso. Nature Materials 16, 507*515, (2017).

MA 21.23 Tue 9:30 Poster A

First-principles study of the magnetic properties of 4*d*/Fe bilayers on W(001) — •Nanning Petersen, Sebastian Meyer, and Stefan Heinze — Institute of Theoretical Physics and Astrophysics, Christian-Albrechts-Universität zu Kiel, Leibnizstrasse 15, 24098 Kiel

The magnetic ground state of an Fe monolayer (ML) can be tuned by growth on different 4*d*- and 5*d*-transition metal substrates due to hybridization at the interface. In particular, it has been shown that an Fe ML on the Pd(001) surface is ferromagnetic while it becomes antiferromagnetic on W(001) [1]. Here, we use density functional theory as implemented in the FLEUR code [2] to investigate the magnetic properties of composite systems of 4*d*/Fe bilayers on the W(001) surface varying the 4*d* transition-metal from Nb to Pd. Since W is a heavy transition-metal with large spin-orbit coupling, significant Dzyaloshinskii-Moriya (DM) interaction is expected. We calculate the energy difference between the ferro- and the antiferromagnetic state for 4*d*/Fe bilayers on W(001). Spin spiral calculations are performed to obtain the exchange and the DM interaction. We first focus on model systems of freestanding 4*d*/Fe/W trilayers as well as the Fe/W bilayer and compare these calculations with those for film systems such as Pd/Fe/W(001).

[1] P. Ferriani *et al.*, Phys. Rev. B **72**, 024452 (2005)
[2] www.flapw.de

MA 21.24 Tue 9:30 Poster A

Realization of a Microstructured Spin-Wave Majority Gate — •Martin Kewenig[1], Thomas Brächer[1], Carsten Dubs[2], Philipp Pirro[1], and Andrii Chumak[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, Kaiserslautern, Germany — [2]INNOVENT e.V. Technologieentwicklung Jena, 07745 Jena, Germany

Spin-wave logic devices offer large advantages compared to modern CMOS-based elements. For example spin waves promise a significant reduction of Joule heating since they avoid Ohmic losses. An example for such a logic element is the spin-wave majority gate, in which the logical output is given by the majority of the logical inputs. Besides, a spin-wave majority gate is suitable for the construction of all-magnonic circuits. In this contribution, we present the fabrication and investigation of a microstructured spin-wave majority gate device made from a 80 nm thick YIG film. We investigate the operation of the device by means of microwave techniques and performed additional measurements to examine the spin-wave propagation and transmission by using Brillouin light scattering microscopy. This research has been supported by: DFG SFB/TRR 173 Spin+X, Project B01, ERC Starting Grant 678309 MagnonCircuit, and DFG (DU 1427/2-1).

MA 21.25 Tue 9:30 Poster A

Unidirectional excitation and interference of caustic-like spin-wave beams — •Frank Heussner, Matthias Nabinger, Milan Ender, Alexander A. Serga, Burkard Hillebrands, and Philipp Pirro — Fachbereich Physik and Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, D-67663 Kaiserslautern, Germany

Caustic-like spin-wave beams can be used to steer spin-wave energy in 2D magnetic structures. Hence, they are promising candidates to expedite the development of 2D magnonic logic chips in which interference effects are expected to play an important role for data processing.

Caustic-like beams are formed due to the superposition of different spin-wave modes, which cover a broad range of wavevectors. Consequently, their interference can lead to complex phenomena.

In this work, we present a detailed study of the interference of caustic-like spin-wave beams in 2D magnetic media by utilizing micromagnetic simulations. General laws regarding the control of the observed interference effects are deduced and exemplified. In addition, based on these findings, a method for unidirectional excitation and phase-dependent steering of caustic-like spin-wave beams is revealed. Our results open doors to new possibilities for the technical application of spin waves in 2D microstructures.

Financial support by DFG within project SFB/TRR 173 Spin+X is gratefully acknowledged.

MA 21.26 Tue 9:30 Poster A

Non-reciprocal spin-wave dispersion in a NiFe/Ni bilayer — •Moritz Geilen[1], Morteza Mohseni[1], Thomas Brächer[1], Yves Henry[2], Damien Louis[2], Matthieu Bailleul[2], Florin Ciubotaru[3], Burkard Hillebrands[1], and Philipp Pirro[1] — [1]FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, Germany — [2]Institut de Physique et Chimie des Matériaux de Strasbourg, UMR 7504, CNRS and Université de Strasbourg, B.P. 43, F-67037 Strasbourg Cedex 2, France — [3]Imec, B-3001 Leuven, Belgium

Surface spin waves have an imaginary wave-vector component $k_\perp$ across the film thickness, which leads to a localization of this mode to one surface of the film and the highly non-reciprocal propagation behaviour. This component is proportional to the in-plane wave-vector component $k_\parallel$, which is perpendicular to the magnetization. But as long as both surfaces of the film are equal and the film itself has homogenous material parameters across its thickness the frequency of spin waves with wave vectors $+k_\parallel$ and $-k_\parallel$ are degenerate. This symmetry is broken in a magnetic bilayer system leading to frequency shift between counter-propagating spin waves.

We present the investigation of the spin wave spectrum of a Ni (25 nm) / NiFe (25 nm) bilayer film employing wave-vector resolved Brillouin light scattering spectroscopy and micromagnetic simulations. We find that the dispersion relation can be manipulated effectively, which is an important property for future magnonic computing devices.

MA 21.27 Tue 9:30 Poster A

Modulation of spin-wave propagation with time-varying magnetic fields — Nana Nishida[1], •Peter Matthies[1,2], Kai Wagner[1,2], Katrin Schultheiss[1], and Helmut Schultheiss[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Dresden, Germany — [2]Technische Universität Dresden, Dresden, Germany

We investigated spin-wave propagation under the influence of nanosecond magnetic field pulses in a 2 μm wide spin-wave waveguide made from NiFe. A coplanar waveguide serves as an antenna for spin waves. The spin wave conduit is magnetized perpendicular to its long axis by an external magnetic field. In order to modulate the amplitude of the internal field, we apply 20 ns long current pulses to a gold conductor that was fabricated below the spin-wave waveguide.

The spin-wave intensity was measured using time-resolved Brillouin light scattering microscopy while applying current pulses with amplitudes that both increase and decrease the effective magnetic field. Depending on the applied microwave frequency, the initial magnetic field and the direction of the pulsed magnetic field different phenomena are observed: First, short spin-wave packets can be created when starting the field sequence off resonance. Second, a pulse induced shift of spin-wave frequencies is detected when starting at resonance, i.e., when propagating spin waves feel a time dependent magnetic field.

MA 21.28 Tue 9:30 Poster A

Injection locking of constriction based Spin-Hall nano-oscillators — •Tillmann Weinhold[1,2], Toni Hache[1,3], Sri Sai Phani Kanth Arekapudi[1,3], Olav Hellwig[1,3], and Helmut Schultheiss[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institut für Ionenstrahlphysik und Materialforschung, Abteilung Magnetismus — [2]Faculty of Physics, Technische Universität Dresden, 01062 Dresden, Germany — [3]Institut für Physik,Technische Universität Chemnitz, D-09107 Chemnitz

Spin-Hall nano-oscillators (SHNOs) are modern auto-oscillation devices. Their simple geometry allows for an optical characterization by Brillouin-Light-Scattering microscopy at room temperature. Here we report on the observation of dc-driven auto-oscillations in constriction based SHNOs under the forcing influence of an added microwave current. We show the possibility of *injection locking* between the applied external signal and the auto-oscillations driven by a direct current. Within the locking range the frequency of the auto-oscillations is forced to the external stimulus. Furthermore, the intensity of the oscillations is strongly increased and the linewidth decreases. Due to the controllability of the auto-oscillations of the magnetization, injection locking can be used to influence the properties of future communication technologies, e.g. based on synchronized constriction based Spin-Hall nano-oscillator arrays.

MA 21.29 Tue 9:30 Poster A

Stokes- /Anti-Stokes signal dependance on polarization in BLS measurements on thin magnetic films — •Tobias Jost, David Breitbach, Thomas Meyer, Moritz Geilen, Burkard Hillebrands, and Philipp Pirro — FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, Germany

To investigate magnetoelastic phenomena in thin films, Brillouin light scattering can be used to detect excitations of both the lattice (phonons) and the magnetization (magnons). Depending on the selected plane of polarization of the backscattered light, the signal contains either strong contributions of the phonon- or magnon-signal, respectively or a mixture of both. For a clear distinction of these two signal sources in the analysis of experimental data, one has to know the behavior of either of them separately.
In this work, the Stokes- and Anti-Stokes signals in dependence of the plane of polarization were investigated on a thin permalloy film, in which spin waves were excited by a coplanar wave guide. Contrary to expectations the magnon-signal did not drop to zero for any plane of polarization which indicates that the backscattered photons are not completely linear polarized. In addition the Stokes- and Anti-stokes amplitudes did not reach their respective maximum and minimum at the same polarization configuration.

MA 21.30 Tue 9:30 Poster A

Backscattering-Immune Spin-Wave Modes for Protected Magnon Transport — •Morteza Mohseni, Qi Wang, Burkard Hillebrands, and Philipp Pirro — Fachbereich Physik and Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany.

Protected transport of energy and particles has been an intensive subject of research during the last decade. It has stimulated a lot of interest in the field of topological insulators. The idea of protected transport transferred into the realm of magnonics by considering different types of magnonic crystals. Indeed, protected magnon transport would constitute a major breakthrough in reducing the losses, which are associated with, e.g., defects and inhomogeneities in magnonic networks for data processing. Here, we show that in homogeneous magnetic thin films, backscattering-immune spin-wave modes exist. Using micromagnetic simulations, we show that in an in-plane magnetized film with relatively small thickness, non-reciprocal waves which propagate perpendicular to the static magnetization can be robust against even large inhomogeneities and defects. Such robust and non-reciprocal spin waves open the possibility for designing highly efficient magnonic elements. In addition, their strong protection should stimulate further investigation of the topology of those waves.

MA 21.31 Tue 9:30 Poster A

Spin-Wave Reciprocity in the Presence of Néel Walls — •Lukas Körber, Kai Wagner, Attila Kákay, and Helmut Schultheiss — Helmholtz-Zentrum Dresden - Rossendorf, Bautzner Landstraße 400, 01328 Dresden, Germany

We report on the reciprocity of channeled spin waves in a 180° Néel wall with special focus on the in-plane curling of the magnetization. In particular, the dispersion relation, phase fronts and frequency-dependent spin-wave intensites where studied by means of micromagnetic simulations. Despite the strong curling of the magnetization at the center of the Néel wall, non-reciprocity is only found in the domains whereas the wall acts as a reciprocal channel.

Corresponding paper: L. Körber, K. Wagner, A. Kákay, H. Schultheiss "Spin-wave reciprocity in the presence of Néel walls" IEEE Magnetic Letters PP, 99 (2017), DOI: 10.1109/LMAG.2017.2762642

MA 21.32 Tue 9:30 Poster A

Investigation of spin wave modes in laterally confined Yttrium-Iron-Garnet (YIG) thin films — •Philipp Geyer, Maximilian Paleschke, Philip Trempler, and Georg Schmidt — Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Von-Danckelmann-Platz 3, 06120 Halle(Saale)

Magnonics is promising for the realization of low power information storage and processing, by excitation of the spin lattice rather than by moving electrons. In confined structures the propagation and damping of spin waves strongly depends on the geometry. For example shape anisotropy fields can change the dispersion in different directions. Different geometries thus lead to fundamentally different resonance characteristics. In contrast to a rather complicated analytical description for example by using Green functions theory, micromagnetic simulations provide an easy way to examine different structures theoretically. We have performed micromagnetic simulations of magnetic nanostructures with mumax3 [1] which we can compare to experimental results. For the experiments arrays of identical nanostructures were investigated by ferromagnetic resonance. The structures were fabricated from thin YIG films with very low damping [2]. The results show numerous standing spin wave modes including edge modes. Besides rectangular shapes also other geometries like triangles were successfully investigated.

[1] "The design and verification of mumax3", AIP Advances 4, 107133 (2014)
[2] C. Hauser et. al., Scientific Reports 6, 20827 (2016)

MA 21.33 Tue 9:30 Poster A

On-chip magnetic field bias for magnon-resonator experiments — •Stefan Eisele[1], Tomislav Piskor[1], Marco Pfirrmann[1], Andre Schneider[1], Hannes Rotzinger[1], Alexey V. Ustinov[1,3], and Martin Weides[1,2] — [1]Karlsruhe Institute of Technology, Germany — [2]Johannes Gutenberg University Mainz, Germany — [3]Russian Quantum Center, Moscow, Russia

Today, spin waves are considered as promising candidates for classical and quantum information processing. Their propagation properties are conventionally controlled through an external magnetic field bias to the ferromagnetic materials, generally generated by coils or permanent magnets. The high inductances of coils make manipulations on a short timescale impossible. Furthermore, the unconfined magnetic fields require shielding to avoid cross-bias of neighboring magnonic cells. In this work, we develop an on-chip magnetic field bias to overcome these constraints. For application in a cryogenic environment, i.e., in liquid helium at 4.2 K, very low heat dissipation is mandatory. Our system consists of a superconducting niobium feedline with a magnetic film deposited on top. The magnetic bias field is provided by the superconducting current. For on-chip ferromagnetic resonance measurements, an additional niobium feedline is added on top of the magnetic structure. Due to the small inductance of the biasing component, current variations on short timescales are achievable. This work enables combining novel compact magnonic circuits with electrical quantum circuits to process microwave signals in cryogenic environments.

MA 21.34 Tue 9:30 Poster A

Controlling the phase in coupled magnon-photonic circuits — •Christine Dörflinger[1], Isabella Boventer[1,2], Marco Pfirrmann[1], Tomislav Piskor[1], Alexey Ustinov[1], Mathias Kläui[2], and Martin Weides[1,2] — [1]Karlsruhe Institute of Technology, Physikalisches Institut, Karlsruhe, Germany — [2]Johannes-Gutenberg University, Institute of Physics, Mainz, Germany

Polaritons are quasiparticles describing hybridized states resulting from light-matter interactions. They offer new perspectives for applications in information processing technology. In this work, we focus on magnon-photon-polaritons (MPPs) describing electromagnetic coupling between collective spin excitations of a magnetically ordered material and photons. Our interest is to study the MPP's anticrossing spectrum when such a system features a relative phase shift between a resonator mode and the uniform spin precession of the Kittel mode. Experimentally, we introduce an additional drive of adjustable phase compared to standard experiments. Therefore we utilize a sandwich design consisting of a lambda/2 microwave resonator, a YIG film and a microstrip line. Both the resonator and the middle segment of the microstrip line are aligned parallel to an external static magnetic field and are driven by the same source but variably shifted in phase. With this setup we aim to measure the phase dependency of the transmission and reflection spectra and discuss the influences on the MPP line shape. Tuning the anticrossing gap could offer new possibilities for applications such as amplifiers and interferometers.

MA 21.35 Tue 9:30 Poster A

Magnon Bandstructure of strongly dipolar-coupled nanoparticle chains — •Benjamin Zingsem[1,2], Thomas Feggeler[1], Alexandra Terwey[1], Sara Ghaisari[3], Detlef Spoddig[2], Damien Faivre[3], Ralf Meckenstock[1], Michael Farle[1], and Michael Winklhofer[4] — [1]Faculty of Physics, University of Duisburg-Essen, 47057 Duisburg, Germany. — [2]Ernst Ruska Centre for Microscopy and Spectroscopy with Electrons and Peter Grünberg Institute, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — [3]Department of Biomaterials, Max Planck Institute of Colloids and Interfaces, Potsdam, Germany — [4]School of Mathematics and Science, University of Oldenburg, 26129 Oldenburg, Germany.

We present Ferromagnetic Resonance (FMR) spectroscopy on individual chains of magnetic nanoparticles. The chains consist of 10-20 magnetite crystals with a crystal size of about 30 nm. Our measurements reveal intriguing properties regarding the formation of magnonic band gaps, as well as an unusual curvature of angular dependent resonance lines. We show that through modification of the geometric arrangement of these particles, i.e. by introducing defects or kinks, the magnonic properties of these chains can be tailored, yielding potential applications for nano-sized magnon-logic and spintronic devices. In addition to the measurements, we performed high performance GPU accelerated micromagnetic simulations, which provide further insight into the unusual magnon band structure. These simulations are in good agreement with the measured spectra and allow us to identify the connection between spatial and spectral features.

MA 21.36 Tue 9:30 Poster A

Design of a spin-wave flat lens — •Mateusz Zelent[1], Paweł Gruszecki[1], Marina Mailian[2], Oksana Gorobets[2], Yuri Gorobets[2,3], Maciej Krawczyk[1], and Vishal Vashista[1] — [1]Faculty of Physics, Adam Mickiewicz University in Poznan, Umultowska 85, Poznan, 61-614, Poland — [2]Faculty of Physics and Mathematics, National Technical University of Ukraine *Igor Sikorsky Kyiv Polytechnic Institute*, 37 Peremogy Avenue, Kyiv, 03056, Ukraine — [3]Institute of Magnetism, National Academy of Sciences of Ukraine, 36-b Vernadskogo Street, Kyiv, 03142, Ukraine

The focusing of plane spin waves propagating in a thin ferromagnetic film by designed phase-shift on a metasurface formed by the ultranarrow interface was studied. We demonstrated with micromagnetic simulations and analytical model, that the effect exists for the exchange spin waves propagating in thin Co film in transmission through the interface, where interlayer exchange interactions are present. The phase shift of transmitted spin waves is achieved by introducing ultrathin nonmagnetic metallic spacer, with a width much smaller than the spin wave wavelength. Due to RKKY interaction, the change of the metal width allows to modify interfacial exchange coupling, which determine the phase of the transmitted spin waves. We combine this phase-shift dependency along the interface with the lens equation to design a spin wave flat lens based on magnonic matasurface. Funded from the EU Horizon 2020, G.A. No. 644348.sign a spin wave flat lens based on magnonic matasurface.

MA 21.37 Tue 9:30 Poster A

Spin Wave Propagation in Thin Films with Perpendicular Magnetic Anisotropy — •Matías Grassi[1], Yves Henry[1], Michel Hehn[2], Thibaut Devolder[3], and Matthieu Bailleul[1] — [1]Institut de Physique et Chimie des Matériaux de Strasbourg, CNRS, Université de Strasbourg, B.P. 43, 67034 Strasbourg Cedex 2, France. — [2]Institut Jean Lamour, CNRS, Université de Lorraine, B.P. 70239, F-54506 Vandoeuvre-lès-Nancy Cedex, France — [3]Centre de Nanosciences et de Nanotechnologies, CNRS, Univ. Paris-Sud, Université Paris-Saclay, C2N-Orsay, 91405 Orsay Cedex, France.

We present a study of the spin wave (SW) dynamics in thin films with perpendicular magnetic anisotropy. The interactions between the SW and different magnetic textures were studied by a dynamic matrix approach using a custom developed code [1]. In particular, we analyze the spin wave propagation in samples with a stripe domain structure and its dependence as function of the applied magnetic field. We focus on two particular questions: how the evolution of spin wave dispersions in the saturated state could explain the formation of the stripes domains; and how the domain walls within the stripe structure can be used as waveguides for SW —the so-called Domain Wall Channeled Spin Waves (DWCSW). These simulations are used to design Propagating Spin Wave Spectroscopy experiments, allowing one to measure the SW frequencies within a determined wave length range.

[1] Y. Henry, O. Gladii and M. Bailleul, https://arxiv.org/abs/1611.06153

MA 21.38 Tue 9:30 Poster A

Nano-scaled magnon transistor based on three-magnon splitting — •Qi Wang, Philipp Pirro, Thomas Brächer, and Andrii Chumak — Fachbereich Physik, Technische Universitaet Kaiserslautern, Kaiserslautern, Germany.

Spin waves and their quanta magnons open up a promising branch of high-speed and low-power information processing. The realization of single-chip all-magnon information systems demands for the development of circuits in which magnon currents can be manipulated by magnons themselves. In our previous study, we presented and tested experimentally a proof-of-concept magnon transistor. Here we use micromagnetic simulations to propose a conceptually different approach for the realization of a nano-scaled magnon transistor. In this device, a three- rather than a four-magnon scattering process is utilized. Source magnons interact with the gate magnons boosting a three-magnon scattering process in which one gate magnon scatters into one new source magnon and into one idle magnon. As a result, the number of the source magnons at the drain is increased and the transistor acts as an amplifier of magnon signals. Financial support by the ERC Starting Grant "MagnonCircuits" is gratefully acknowledged.

MA 21.39 Tue 9:30 Poster A

Spin Wave Propagation in Thin Films with Perpendicular Magnetic Anisotropy — •Matías Grassi, Yves Henry, and Matthieu Bailleul — Institut de Physique et Chimie des Matériaux de Strasbourg, CNRS, Université de Strasbourg, B.P. 43, 67034 Strasbourg Cedex 2, France.

We present a study of the spin wave (SW) dynamics in thin films with perpendicular magnetic anisotropy. The interactions between the SW and different magnetic textures were studied by a dynamic matrix approach using a custom developed code [1]. In particular, we analyze the spin wave propagation in samples with a stripe domain structure and its dependence as function of the applied magnetic field. We focus on two particular questions: how the evolution of spin wave dispersions in the saturated state could explain the formation of the stripes domains; and how the domain walls within the stripe structure can be used as waveguides for SW —the so-called Domain Wall Channeled Spin Waves (DWCSW)[2]. These simulations are used to design Propagating Spin Wave Spectroscopy experiments, allowing one to measure the SW frequencies within a determined wave length range.

[1] Y. Henry, O. Gladii and M. Bailleul, https://arxiv.org/abs/1611.06153
[2] SWANGATE ANR-16-CE24-0027-01

MA 21.40 Tue 9:30 Poster A

Propagating spin waves spectroscopy of YIG magnonic crystal — •Hugo Merbouche, Martin Collet, Lucile Soumah, Paolo Bortolotti, Vincent Cros, and Abdelmadjid Anane — Unité Mixte de Physique, CNRS, Thales, Univ. Paris-Sud, Université Paris-Saclay, 91767 Palaiseau, France

The propagation of Damon-Eshbach spin waves in a magnonic crystal (MC) is studied. The MC consists of periodically nanostructured waveguides (WGs) made out of 20 nm thick YIG film. We observe a 25MHz transmission gap at 1.3GHz. Fifty parallel 2.5μm wide WGs are designed, using laser lithography. Two gold antennas are deposited on top, 30μm apart. Using electron beam lithography and dry ion etching, 150nm wide grooves, orthogonal to the WGs principal axis, are etched. The period corresponds to a Bragg k-vector of 1μm^{-1} and the depth is incremented from 0 to 20nm in 6 steps.

The propagation properties are then measured using a VNA based all-inductive method: Propagating Spin Wave Spectroscopy (PSWS). For un-etched WGs, a good agreement with theoretical expectations is observed. For MCs with grooves depth greater than 5nm, a 25MHz transmission gap at 1.3GHz is measured, corresponding to a decrease by a factor 2.4 of the output signal. Transmission outside the frequency gap is unaffected by the grooves till a depth of about 10nm. Nevertheless, the signal remains strong even when the YIG film becomes discontinuous.

MA 21.41 Tue 9:30 Poster A

Phase-modulated Fresnel zone plate for spin waves in bulk and thin-film geometry — •Piotr Graczyk[1], Irina Tukavkina[2], Mateusz Zelent[1], Oksana Gorobets[2,3], and Maciej Krawczyk[1] — [1]Faculty of Physics, Adam Mickiewicz University in Poznan, Umultowska 85, 61-614 Poznan, Poland — [2]National Technical University of Ukraine, "Igor Sikorsky Kyiv Polytechnic Institute", 37 Peremogy Ave., 03056, Kyiv, Ukraine — [3]Institute of Magnetism, National Academy of Sciences of Ukraine, 36-b Vernadskogost., 03142, Kyiv, Ukraine

We present results of investigation on the metasurface designed to effectively focus spin wave by means of diffraction. The boundary conditions [1] for the interlattice exchange and surface anisotropy were introduced at the interface of two ferromagnetic media to form phase-modulated Fresnel zone plate. The problem was treated analytically and supported by the numerical simulations. We extended the investigation to the case of the interface in a thin-film geometry with dipolar interactions included. It is shown, that proper tuning of the anisotropy at the interface keeps the tramsmittivity at a high level while the exchange between adjacent materials is weak, leding to the significant phase shift. We keep parameters of our model close to the realistic values, providing a way for experimental realization.

[1] V.V. Kruglyak, O.Y. Gorobets, Y.I. Gorobets, and A.N. Kuchko, J. Phys. Condens. Matter 26, 406001 (2014).

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MA 21.42 Tue 9:30 Poster A

Electronic transport through a one dimensional vacuum barrier using Greens functions — •Max Götzler, Michael Czerner, and Christian Heiliger — Institut für theoretische Physik, Justus-Liebig-Universität Gießen, Heinrich-Buff-Ring 16, 35392 Gießen

We study the electronic transport through a one dimensional vacuum barrier, using a tight-binding approximation and the method of Greens funtions for solving the Schrödinger equation. We calculate the transmission function and electron density in the equilibrium case. We then solve the poisson equation for the non interacting charge distribution and try to self-consistently calculate the new charge distribution with respect to electrostatic interactions. This is repeated for small applied voltages, using a steady state Keldysh-formalism. We calculate the current and the new electron density, then compare the results to the equilibrium case.

MA 21.43 Tue 9:30 Poster A

Ultrafast magnetization and spin dynamics driven by terahertz radiation pulses — •Julius Heitz[1], Lukáš Nádvorník[1], Tom Seifert[1], Martin Wolf[2], and Tobias Kampfrath[1,2] — [1]Freie Universität Berlin, Arnimallee 14, 14195 Berlin — [2]Fritz-Haber-Institut der Max Planck Gesellschaft, Faradayweg 4-6, 14195 Berli

Magnetization reversal, spin transfer torque, giant magnetoresistance [1] and the emission of terahertz (THz) radiation [2] are intriguing spintronic applications, each of which relies on well-controlled generation and manipulation of spin currents. The established methods to generate spin currents are the anomalous and spin Hall effects (AHE, SHE), whose inverse were demonstrated recently up to THz frequencies [3]. This makes them excellent candidates to extend the bandwidth of spin information processing into the THz range. However, so far no direct observation of AHE-related ultrafast spin accumulation at sample interfaces has been reported.

In this contribution, we study the interaction of ultrashort intense THz pulses with magnetic thin films. In our experiment, the strong THz electric field (up to ~0.5 MV/cm) is used to drive ultrafast charge currents in the plane of the structure. By using the magnetooptic Kerr effect, we investigate how such excitation and the AHE currents can lead to ultrafast spin and charge redistribution in thin films.

1. C. Chappert, A. Fert, Frédéric Nguyen Van Dau, Nature Materials 6, 813-823 (2007) 2. T. Kampfrath et al., Nature Nanotech. 8, 256 (2013). 3. T. Seifert, M. Wolf, T. Kampfrath et al., Nature Photon. 10, 483 (2016).

MA 21.44 Tue 9:30 Poster A

Terahertz Spin Currents and Spin Hall Effect in β-Tungsten and Au_xPt_{1-x} Alloys — •Oliver Gueckstock[1], Mohammadreza Rouzegar[1], Tom Seifert[1], Sebastian Dapper[2], Satya Prakash Bommanaboyena[2], Björn Gliniors[2], Lukas Liensberger[3], Martin Wolf[1], Mathias Weiler[3], Markus Meinert[2], and Tobias Kampfrath[1,4] — [1]FHI der MPG, Berlin — [2]U Bielefeld, Bielefeld — [3]WMI, Garching — [4]FU Berlin, Berlin

The efficient conversion of spin into charge currents by spin-orbit interaction (SOI) will be important for future spin-based electronics [1]. Recently, much effort has been devoted to the identification of new large-SOI materials. One promising material is β-tungsten, for which large spin Hall angles (SHA) have been reported [2]. In our experiments, we employ femtosecond optical pulses to trigger ultrafast spin transport in magnetic thin-film stacks. Due to SOI, this spin current is partially converted into a transverse charge current which is monitored by detecting the concomitantly emitted THz electromagnetic radiation [3,4]. In particular, we study THz emission from bilayers of cobalt-iron-boron (CoFeB) and β-tungsten with varying oxygen concentration and bilayers of CoFeB and Au_xPt_{1-x} alloys. By additionally measuring the THz conductivity of these films, we can separate the influence of the spin Hall conductivity and the longitudinal conductivity to the SHA.

References: [1] S.A. Wolf et al., Science 294.5546 (2001), [2] K. Demasius et al., Nature Comm. 7, 10644 (2016), [3] T. Kampfrath et al., Nature Nanotech. 8, 256 (2013), [4] T. Seifert et al., Nature Phot. 10, 483 (2016)

MA 21.45 Tue 9:30 Poster A

Launching magnons at the terahertz speed of the spin Seebeck effect — Tom Seifert[1,2], Joel Cramer[3], Joe Barker[4], Samridh Jaiswal[3], Gerhard Jakob[3], Martin Wolf[2], Georg Woltersdorf[5], Piet W. Brouwer[1], Mathias Kläui[3], and •Tobias Kampfrath[1,2] — [1]FU Berlin — [2]FHI Berlin — [3]JGU Mainz — [4]Tohoku University, Japan — [5]MLU Halle

We study the initial steps of the spin Seebeck effect with 10 fs time resolution in prototypical bilayers of the ferrimagnet yttrium iron garnet and platinum. Following excitation of the metal with an ultrashort laser pulse, the spin Seebeck current j_s is measured all-optically using the inverse spin Hall effect and terahertz electrooptic sampling. The current rises on the ~ 200 fs time scale on which the electrons in the metal approach a Fermi-Dirac distribution. This observation is a hallmark of the assumption that the spin transfer arises from conduction electrons scattering off the magnetic interface. Model-supported analysis shows that j_s follows the dynamics of the metal electrons quasi-instantaneously because their spins have a correlation time of only ~ 4 fs and deflect the ferrimagnetic moments without inertia. Promising applications for material characterization, interface probing, spin-noise detection and terahertz spin pumping come into reach.

MA 21.46 Tue 9:30 Poster A

Terahertz writing of an antiferromagnetic memory — •Tom Seifert[1], Kamil Olejník[2], Tomas Jungwirth[2,3], and Tobias Kampfrath[1] — [1]Fritz Haber Institut der MPG, Berlin, Germany — [2]Academy of Sciences of the Czech Republic, Prague, Czech Republic — [3]University of Nottingham, Nottingham, United Kingdom

The electrical switching of the magnetic order of antiferromagnets (AFMs) using Néel spin-orbit torques (NSOT) paved the way for AFM-based memory applications [1]. Importantly, in AFMs the frequencies of long-wavelength magnons are strongly enhanced by the exchange interaction opening up the potential for terahertz (THz) switching speeds [2]. Previous studies showed the feasibility of electrical writing of AMFs with pulse lengths from milliseconds to hundreds of picoseconds [3].

Here, we further reduce the current duration down to the picosecond time scale employing an all-optical writing scheme based on free-space THz pulses. With these picosecond laser pulses [4], we observe the analogous switching phenomenology of epitaxial CuMnAs films as with millisecond and nanosecond current pulses. Our results suggest that the current-induced NSOT switching mechanism for AFMs is also operative in the THz range.

The presented results were obtained in close collaboration with the groups of R.P. Campion, P. Gambardella, P. Kuzel, P. Nemec, J. Sinova and J. Wunderlich.

[1] P. Wadley et al., *Science* **351** (2016). [2] T. Kampfrath et al., *Nat. Phot.* **5** (2011). [3] K. Olejník et al., *Nat. Commun.* **8** (2017). [4] K. Olejník et al., arXiv:1711.08444 (2017).

MA 21.47 Tue 9:30 Poster A

Spin to charge current conversion in transition metal dichalcogenide — •Lukáš Nádvorník[1], Lukas Braun[2], Bin Cui[3], Tom Seifert[1], Oliver Glückstock[2], Martin Wolf[2], Stuart Parkin[3], and Tobias Kampfrath[1,2] — [1]Freie Universität, Berlin, Germany — [2]Fritz-Haber-Institut der MPG, Berlin, Germany — [3]Max Planck Institute of Microstructure Physics, Halle, Germany

In the last decade, transition metal dichalcogenides (TMDCs) have attracted considerable attention for their unique mechanical, electronic and spin properties [1]. By sharing a similar honeycomb crystal structure with graphene, they allow for optical generation of the valley polarization. Unlike graphene, they also exhibit a large spin-orbit coupling. This feature and the recently observed valley Hall effect [2] makes TMDCs ideal candidates for spintronic and valleytronic applications.

In this contribution, we report on the observation of an ultrafast injection of in-plane-polarized electron spins and the inverse spin Hall effect (iSHE) in metallic TMDC NbSe2 at terahertz (THz) frequencies. By excitation of an adjacent ferromagnetic layer by an ultrashort optical pulse, we launch a spin-polarized current into the TMDC where it is converted to a charge current via the iSHE. This ultrashort charge current burst acts as a source of an ultrashort THz electromagnetic pulse [3] whose measurement allows us to estimate the efficiency and dynamics of the spin-to-charge-current conversion.

[1] S. Manzeli et al., Nature Reviews 2, 17033 (2017). [2] K.F. Mak et al., Science 344, 1489 (2014). [3] T. Kampfrath et al., Nature Nanotech. 8, 256 (2013).

MA 21.48 Tue 9:30 Poster A

Determining the spotsize of a microlense to build a THz emitter — •Nina Meyer[1], Finn Lietzow[1], Jakob Walowski[1], Christian Denker[1], Tom Seifert[2], Tobias Kampfrath[2], and Markus Münzenberg[1] — [1]Institute of Physics, Greifswald University, Greifswald, Germany — [2]Fritz Haber Institut, MPG, Berlin, Germany

So far Terahertz (THz) spectroscopy has been used as a characterization method, since the intermolecular bonding energies of larger molecules (4 to 400 meV) are in the THz range (1 to 100 THz). The excitation energy for phonons or plasmons in solids lies in the same range. Therefore, THz radiation can be used for probing and driving such low-energy excitations. To lower costs and to simplify analysis smaller THz emitters and detectors are needed. Here we present our first attempts towards micrometer sized spintronic THz emitters. We start with fabricating microlenses on glass substrates using 3D 2-photon-lithography. By this we were able to focus a 1560 nm laser beam with 100 fs pulselength on a CMOS Chip. We measured a spotsize smaller than 10 μm at the focus length for a microlens with a radius of 300 μm. We also fabricated microlenses on a fiber to guide the laser beam directly onto the microlens. The next step is to use the microlens on a fiber to generate THz radiation. To accomplish this, we are going to include a thin film of a ferromagnetic layer and a non-magnetic cap layer. By focusing a femtosecond laser pulse onto the thin film THz radiation is generated. For large scales, this approach has been demonstrated by Seifert et al. [1].

[1] T. Seifert et al., Nat. Photon. 10 (2016) 483.

MA 21.49 Tue 9:30 Poster A

Spintronic terahertz emitters based on epitaxially grown Fe/Pt, Ta/Fe, Ta/Fe/Pt multilayers — •Laura Scheuer[1], Garik Torosyan[2], Sascha Keller[1], René Beigang[1], and Evangelos Th. Papaioannou[1] — [1]TU Kaiserslautern, Fachbereich Physik and Landesforschungszentrum OPTIMAS, Germany — [2]Photonic Center Kaiserslautern, Germany

We demonstrate the efficient generation of pulsed broadband terahertz radiation utilizing the inverse spin Hall effect in Fe/Pt, Ta/Fe and Ta/Fe/Pt multilayers grown epitaxially on MgO and sapphire substrates. The emitter was optimized with respect to layer thickness, growth parameters, substrates and geometrical arrangement [1]. The experimentally determined optimum layer thicknesses were in qualitative agreement with simulations of the spin current induced in the ferromagnetic layer. Our model takes into account generation of spin polarization, spin diffusion and accumulation in Fe and Ta, Pt and electrical as well as optical properties of the bilayer samples. The general performance makes the spintronic terahertz emitters compatible with established emitters based on optical rectification in nonlinear crystals.

[1] G. Torosyan et al., arxiv.org/abs/1707.08894 (2017)

MA 21.50 Tue 9:30 Poster A

Implementation of a self-consistent NEQ scheme in the KKR formalism — •Alexander Fabian, Michael Czerner, and Christian Heiliger — Institut für theoretische Physik, Justus-Liebig-Universität Gießen, Heinrich-Buff-Ring 16, 35392 Gießen

Todays need for even more efficient and faster nano sized devices requires a decent understanding of the behavior of nanostructured materials under applied fields. However, most common approaches rely on the equilibrium properties of the material and use approximations to describe the non-equilibrium behavior. Since crucial assumptions have to be made, these descriptions do not always describe all of the properties correctly and one needs an exact description to calculate non-equilibrium properties. The Keldysh formalism can be used to describe the non-equilibirum properties within the framework of an ab initio theory. We implemented a self-consistent scheme in our multi-scattering DFT code based on the KKR method. To calculate non-equilibrium properties, we use a steady state Keldysh formalism with non-equilibrium Green's functions. The electronic density is calculated by splitting the energy contour in two parts according to the applied voltage. In the first part, the density is calculated with equilibrium tools while the second part is calculated with the actual Keldysh formalism. Summing the two parts the resulting density is used to solve the system self-consistently in the non-equilibrium steady state. Charge displacement due to the applied voltage and the behavior of the voltage in the underlying system are extracted from the self-consistent values.

MA 21.51 Tue 9:30 Poster A

Insights into spin and anomalous Hall effect induced charge and spin currents through ferromagnetic/nonmagnetic interfaces — •Albert Hönemann[1], Christian Herschbach[1], Martin Gradhand[2], and Ingrid Mertig[1,3] — [1]Martin Luther University Halle-Wittenberg, Halle, Germany — [2]University of Bristol, Bristol, United Kingdom — [3]Max Planck Institute of Microstructure Physics, Halle, Germany

Transport phenomena caused by spin-orbit coupling such as spin Hall effect (SHE) [1] and anomalous Hall effect (AHE) [2] are highly relevant topics of current research. In ferromagnetic/nonmagnetic heterostructures the interplay of spin-orbit and exchange interaction enables new phenomena as for example spin-orbit torques [3].

We use an *ab initio* approach, a relativistic Korringa-Kohn-Rostoker method, [4] and solve the linearized Boltzmann equation to describe the electronic transport [5]. We investigate the AHE-induced charge current as well as the SHE-induced spin current perpendicular to the interface in a Co/Cu superlattice alloyed with Bi. We are particularly interested in the spatial distribution of charge and spin current with respect to the interface. The presented results help to understand the underlying microscopic mechanism of charge and spin transport through interfaces.

[1] Sinova *et al.*, Rev. Mod. Phys. **87**, 1213 (2015); [2] Nagaosa *et al.*, Rev. Mod. Phys. **82**, 1539 (2010); [3] Gambardella *et al.*, Phil. Trans. R. Soc. A (2011) **369**, 3175-3197; [4] Gradhand *et al.*, PRB **80**, 224413 (2009); [5] Gradhand *et al.*, PRL **104**, 186403 (2010);

MA 21.52 Tue 9:30 Poster A

Non-local magnetoresistance in normal metal|yttrium iron garnet heterostructures — •Birte Cöster, Matthias Althammer, Tobias Wimmer, Stephan Geprägs, Hans Huebl, and Rudolf Gross — Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany

Pure spin currents, i.e. the flow of angular momentum without an accompanying charge current, represent a new paradigm in state-of-the-art spintronics. In conventional electrical conductors pure spin currents are transported via mobile charge carriers. In contrast, in a magnetically ordered insulator pure spin currents are based on the flow of quantized excitations of the spin structure. Normal metal (NM)/ferromagnetic insulator (FMI) heterostructures allow to study pure spin current transport by utilizing the direct and inverse spin Hall effect in the normal metal.

In our experiments, we investigate NM/FMI heterostructures using YIG as FMI. For the NM layer we use different materials, which are deposited via UHV sputtering technique. We employ nanolithography to pattern NM stripe structures on the LPE-YIG thin films grown on GGG substrates. In the non-local magnetotransport experiments, we apply a charge current through one strip while measuring the resulting electrical potential difference of an adjacent strip. We discuss the results obtained for different NM materials and deposition conditions. Moreover, the comparison of the different materials allows us to extract the relevant pure spin current transport properties.

Financial support via NIM is gratefully acknowledged.

MA 21.53 Tue 9:30 Poster A

Ab initio calculations of magneto crystalline anisotropy in magnetic tunnel junctions — •Philipp Risius, Carsten Mahr, Michael Czerner, and Christian Heiliger — Institut für Theoretische Physik, Universität Gießen, Germany

Spin-orbit effects play an important role in current spintronics research. One effect due to spin-orbit coupling is the magneto crystalline anisotropy (MCA) and the control of this effect by a bias voltage. Using density functional theory in combination with non-equilibrium Green's function method we calculate the bias voltage dependence of MCA for the case of a V/Fe/X/MgO/V. Thereby, X is a very thin layer of a high spin-orbit material as Bi and Pt. Further, we discuss the dependence of MCA and of the tunneling anisotropic magneto resistance (TAMR) on the Fe and MgO slab thicknesses. Further, we show the voltage dependence of spin-torque originated in these tunnel junctions and clarify the connection to the MCA. All our results are compared to recent experimental results in the same junctions.

MA 21.54 Tue 9:30 Poster A

Non-local magnon transport in ferrimagnetic insulators — •Tobias Wimmer[1,2], Kathrin Ganzhorn[1,2], Stefan Klingler[1,2], Nynke Vlietstra[1,2], Stephan Gepraegs[1], Rudolf Gross[1,2,3], Hans Huebl[1,2,3], and Sebastian T. B. Goennenwein[1,2,3,4] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Physik-Department, Technische Universität München, Garching, Germany — [3]Nanosystems Initiative Munich (NIM), Schellingstraße 4, München, Germany — [4]Institut für Festkörperphysik, Technische Universität Dresden, Dresden, Germany

Pure spin currents are the key ingredient for information processing in spintronic devices. Recent experiments in ferromagnetic insulator (FMI)/Pt heterostructures show that information can be carried by diffusing thermal magnons in Yttrium-Iron-Garnet (YIG) as well as Gadolinium-Iron-Garnet (GdIG). These non-equilibrium magnons are generated electrically at the FMI|Pt interface using a dc charge current and are detected as a non-local voltage signal in a second electrically isolated Pt strip. Here, we study this so-called magnon-mediated magnetoresistance (MMR) in detail as a function of the injector and detector separation, temperature and magnetic field. Based on our findings, we have implemented a magnonic majority gate consisting of a 4-strip YIG|Pt device. We furthermore present the MMR effect in the compensated ferrimagnet GdIG, offering intriguing insights into the transport behavior of different magnon branches.

MA 21.55 Tue 9:30 Poster A

Current induced Néel-order switching in magnetron sputtered antiferromagnetic Mn_2Au — •Dominik Graulich and Markus Meinert — Center for Spineletronic Materials and Devices, Bielefeld University, Germany

Antiferromagnets which fulfill certain symmetry properties allow for an intrinsic relativistic Nèel-order spin-orbit torque (NSOT) driven by an electrical current [1]. In tetragonal Mn_2Au the two antiferromagnetically coupled sublattices are inversion partners and therefore experience a staggered spin orbit field caused by the inverse spin galvanic effect (iSGE) resulting in a NSOT, which can reorient the Nèel vector **L** perpendicular to the applied charge current [2]. Applying the current in two orthogonal directions and readout of the two states by the planar Hall effect (PHE) or anisotropic magnetoresistance (AMR) could allow for manufacturing novel antiferromagnetic memory devices that are extraordinarily robust against external magnetic influences [3] with the state of **L** being long-term stable at room temperature [4]. Here, we report on our experiments on the electrical switching of **L** using short current pulses in expitaxial grown, magnetron sputtered Mn_2Au. Our findings support the hypothesis of a thermally activated switching process [4].

[1] J. Železný et al., Phys. Rev. Lett. **113**, 157201 (2014)
[2] P. Wadley et al., Science **351** 587 (2016)
[3] T. Jungwirth et al., Nat. Nanotechn. **11** 231 (2016)
[4] M. Meinert et al. arxiv.org/abs/1706.06983 (2017)

MA 21.56 Tue 9:30 Poster A

Particle-in-Cell Model for Electronic Transport in Metallic Heterostructures — •Marius Weber, Dennis Michael Nenno, and Hans Christian Schneider — University of Kaiserslautern, Kaiserslautern, Germany

Ultrafast demagnetization dynamics triggered by ultrashort laser excitation can be influenced decisively by hot carrier transport in ferromagnet-metal heterostructures [1]. Motivated by recent experiments [2,3], we investigate the transport behavior of excited electrons in Gold. In our model, the electronic dynamics of "hot" electrons is described using the Boltzmann Transport Equation (BTE) and includes the generation of secondary electrons by scattering processes. We use a particle-in-cell (PIC) approach to solve the BTE and calculate the diffusion coefficient. We demonstrate that this approach reproduces the generalized diffusion coefficient as found in Ref. [4] and study the electronic dynamics in a single metal layer in detail. We also show that interfaces in metallic sandwich structures can play a crucial role in electronic spin transport.

[1] D. Rudolf et al., Nature Communications 3, 1037 (2012)

[2] A. Melnikov et al., Physical Review Letters 107, 076601 (2011).
[3] N. Bergeard et al., Physical Review Letters 117, 147203 (2016).
[4] M. Battiato, K. Carva, and P. M. Oppeneer, Physical Review B 86, 024404 (2012).

MA 21.57 Tue 9:30 Poster A

Structural characterization of hexagonal Mn_3X (X = Ga, Ge, Sn) thin films — •Philipp Zilske[1], Jungwoo Koo[1], Samer Kurdi[2], and Günter Reiss[1] — [1]Center for Spinelectronic Materials and Devices, Bielefeld University, Germany — [2]Department of Materials Science and Metallurgy, University of Cambridge, United Kingdom

In the last decade, antiferromagnetic spintronics has established as an important field for future magnetic storage devices [1]. Recently, non-collinear antiferromagnets received much attention due to their promising electronic properties. Theoretical calculations as well as first experimental results show large anomalous Hall effect for hexagonal non-collinear antiferromagnets Mn_3X (X = Ga, Ge, Sn). However, such properties are only studied for single crystalline bulk samples [2-4].

Here, we report on the structural analysis of Mn_3X (X = Ga, Ge, Sn) thin films. Epitaxial Mn_3X films were grown via magnetron co-sputtering. The dependence of the crystalline quality on the deposition temperature and the stoichiometry, as well as the influence of the buffer layer was investigated by X-ray diffraction measurements.

Furthermore, we discuss the transport properties of several samples.

[1] T. Jungwirth *et al.*, Nature Nanotech. **11**, 231 (2016)
[2] Y. Zhang *et al.*, Phys. Rev. B **95**, 075128 (2017)
[3] S. Nakatsuji *et al.*, Nature **527**, 212 (2015)
[4] N. Kiyohara *et al.*, Phys. Rev. Appl. **5**, 064009 (2016)

MA 21.58 Tue 9:30 Poster A

Effect of interlayer insertion on the spin pumping properties in $Co_{40}Fe_{40}B_{20}$/X/Pt,Ta heterostructures — •Matthias Schweizer, Andrés Conca, Sascha Keller, Evangelos Papaioannou, and Burkard Hillebrands — FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, Germany

Spin pumping is highly sensitive to the interface properties and composition of a given material system and in particular to the magnetic proximity effect (MPE). In order to optimize the spin transport across the interface, it is important to understand the different influences of these factors. In many spin pumping experiments, Pt and Ta are used to detect a spin current indirectly via the inverse spin Hall effect (ISHE). However, Pt has been shown to also exhibit MPE, which could have a substantial impact on the interface transparency and damping parameter. In this work, we investigate $Co_{40}Fe_{40}B_{20}$/X/Pt and $Co_{40}Fe_{40}B_{20}$/X/Ta multilayer systems, where X is Al, Ta or Cr with varying thicknesses. Contact between $Co_{40}Fe_{40}B_{20}$ and Pt gives rise to the MPE in Pt whereas this effect is not expected in Ta. In any case, even a thin NM spacing layer suppresses the MPE completely. We present VNA-FMR data on these systems and angle-resolved ISHE measurements, where spin rectification is separated from the spin pumping signal.

Support by M-era.Net and HEUMEM is acknowledged.

MA 21.59 Tue 9:30 Poster A

Spin Hall effect in amorphous W-Zr and W-Hf alloys — •Katharina Fritz and Markus Meinert — Center for Spinelectronic Materials and Devices, Department of Physics, Bielefeld University, Germany

In search for materials with large spin Hall effect, we investigated the binary alloys W-Zr and W-Hf. Thin films were prepared across the full range of stoichiometries for both alloys by magnetron co-sputtering. Due to the linear relation between the spin Hall angle and the resistivity, alloy compositions with high resistivity are expected to show a large spin Hall angle.

In both stoichiometry series we found peak values of the spin Hall angle accompanied with a significant increase of the resistivity. X-ray diffraction measurements connect these observations to a transition from a bcc solid solution to an amorphous material at this concentration. In the W-Zr series, the maximum spin Hall angle of $\Theta = -0.31$ is found at a tungsten content of 65 %, whereas in the W-Hf series the maximum spin Hall angle of $\Theta = -0.23$ appears at a tungsten content of 70 %. For lower tungsten content, the spin Hall angle decreases in both stoichiometry series. In the W-Hf series we find a linear relation between the spin Hall conductivity and the tungsten content irrespective of the structural phase transition.

MA 21.60 Tue 9:30 Poster A

Optimizing the spin Hall angle in ultrathin metallic films — •Christian Herschbach[1], Dmitry Fedorov[2], Martin Gradhand[3], and Ingrid Mertig[1,4] — [1]Martin Luther University Halle-Wittenberg, Halle, Germany — [2]University of Luxembourg, L-1511 Luxembourg, Luxembourg — [3]University of Bristol, Bristol, United Kingdom — [4]Max Planck Institute of Microstructure Physics, Halle, Germany

The spin Hall effect (SHE) is one of the key effects in modern spintronics creating pure spin currents in nonmagnetic materials. The spin Hall angle (SHA) being the ratio of the transverse spin conductivity to the longitudinal charge conductivity serves as a good quantity for the effect's strength. During the last years, reported experimental and theoretical values of the SHA increased. While measurements on Pt-doped Au samples yielded a SHA of about 10% introduced as giant SHE [1], a SHA of 24% was published for thin-film Cu(Bi) alloys [2].

In this work we theoretically investigate Bi-doped ultrathin noble-metal films by means of an *ab initio* approach using density functional theory and linearized Boltzmann equation. We study various possibilities to optimize the SHE and forecast colossal SHAs slightly below 100% [4]. Furthermore, we identify systems with a strong anisotropy of the in-plane transport properties that lead to SHAs above 100%.

[1] Seki *et al.*, Nat. Mater. **7**, 125 (2008); [2] Niimi *et al.*, Phys. Rev. Lett. **109**, 156602 (2012); [3] Gradhand *et al.*, Phys. Rev. Lett. **104**, 186403 (2010); [4] Herschbach *et al.*, Phys. Rev. B **90**, 180406(R) (2014);

MA 21.61 Tue 9:30 Poster A

Probing the spin Hall effect in YIG/$Cu_{1-x}Ir_x$ bilayers at DC and terahertz frequencies — •Joel Cramer[1,2], Tom Seifert[3], Alexander Kronenberg[1], Felix Fuhrmann[1], Franziska Martin[1], Gerhard Jakob[1], Martin Jourdan[1], Tobias Kampfrath[3], and Mathias Kläui[1,2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55128 Mainz, Germany — [2]Graduate School of Excellence Materials Science in Mainz, 55128 Mainz, Germany — [3]Abteilung Physikalische Chemie, Fritz-Haber-Institut der Max-Planck-Gesellschaft, 14195 Berlin, Germany

The effective generation and detection of pure spin currents is a crucial ingredient for next-generation spintronic applications. The spin Hall effect and its inverse are in the focus of research, as they allow for an interconversion of charge and spin currents [1]. We investigate the inverse spin Hall effect of $Cu_{1-x}Ir_x$ thin films on yttrium iron garnet for a large range of Ir concentrations ($0.05 \leqslant x \leqslant 0.7$) [2]. Spin currents are triggered through the spin Seebeck effect, either by a DC temperature gradient or by ultrafast optical heating of the metal layer. The generated spin Hall current is detected by electrical contacts or measurement of the emitted THz radiation. With both approaches, we observe the same complex, non-monotonous concentration dependence. The coinciding results obtained for DC and ultrafast stimuli show that the studied material allows for efficient spin-to-charge conversion even on ultrafast timescales, thus enabling a transfer of established spintronic measurement schemes into the terahertz regime. [1] Sinova *et al.*, Rev. Mod. Phys. **87**, 1213 (2015) [2] Cramer *et al.*, arXiv:1709.01890

MA 21.62 Tue 9:30 Poster A

The influence of the Hall-bar geometry on the apparent spin Hall angle in harmonic Hall voltage measurements — •Lukas Neumann and Markus Meinert — Center for Spinelectronic Materials and Devices, Faculty of Physics, Bielefeld University, D-33501 Bielefeld, Germany

We investigate the influence of the Hall-bar geometry on the apparent spin Hall angle (SHA) in harmonic Hall voltage measurements which is a well established method to determine the SHA of a nonmagnetic metal/ferromagnet bilayer structure like Ta/CoFeB. Tantalum is a heavy metal with large spin-orbit coupling such that an in-plane current generates a substantial spin-orbit torque acting on the magnetization orientation of the ferromagnetic layer. The samples are patterned into Hall bars using electron beam lithography. Being located in an in-plane magnetic field an AC current through the Hall-bar generates a Hall-voltage whose second harmonic gives the apparent SHA. In the simplest model, the influence of the voltage pickup arms is neglected. Obviously, the current density distribution in the vicinity of the voltage pickup arms is not homogeneous and depends on the width of these arms. To systematically investigate this effect we varied the pickup arm width and observe a strong change of the apparent SHA as the pickup arm width is increased. In a symmetric Hall cross with fourfold rotational symmetry, the apparent SHA is reduced by about 30% with respect to the maximum value at narrow pickup arm width. We compare the measured values with simulations of the current density distribution.

MA 21.63 Tue 9:30 Poster A

Perpendicular magnetic anisotropy in magnetic insulator thin films — •Shilei Ding[1,2,3], Andrew Ross[2,3], Sven Becker[2], Joel Cramer[2,3], Jinbo Yang[1], Mathias Kläui[2,3], and Gerhard Jakob[2,3] — [1]State Key Laboratory for Mesoscopic Physics, School of Physics, Peking University, Beijing 100871, China — [2]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — [3]Graduate School of Excellence Materials Science in Mainz, 55128 Mainz, Germany

Rare earth iron garnets (RIG) are drawing great interest in recent years due to their excellent performance in the field of spintronics because of the low Gilbert damping and long spin diffusion length. RIG/normal metal heterostructures have been widely used to study Spin Hall magnetoresistance, spin seebeck effect phenomena which are mainly induced by a spin current through the interface. One of the more attractive possibilities effect is the current induced control of magnetization in perpendicular magnetic anisotropy (PMA) RIG by spin orbit torque (SOT). Here we present the successful growth of thulium iron garnet (TmIG) and gadolinium iron garnet (GIG) by pulsed laser deposition. PMA is induced by lattice strain between films and substrate. The obtained PMA garnet films show low coercivity ($<$ 5 mT) with thickness under 10 nm, which will benefit the study of magnetic moment switching with low current density.

MA 21.64 Tue 9:30 Poster A

Néel vector readout by spin Hall magnetoresistance in NiO/Pt thin films — Lorenzo Baldrati[1], •Andrew Ross[1,2], Tomohiko Niizeki[3], Christoph Schneider[1], Rafael Ramos[3], Joel Cramer[1,2], Olena Gomonay[1], Mariia Filianina[1,2], Tatiana Savchenko[4], Daniel Heinze[1], Armin Kleibert[4], Eiji Saitoh[3,5], Jairo Sinova[1], and Mathias Kläui[1,2] — [1]Institute of Physics, Johannes Gutenberg-University Mainz, Germany — [2]Graduate School of Excellence Materials Science in Mainz, Germany — [3]Advanced Institute for Materials Research, Tohoku University, Japan — [4]Swiss Light Source, PSI, Switzerland — [5]Institute for Materials Research, Tohoku University, Japan

Electrically reading the orientation of the Néel vector is fundamental for the development of antiferromagnetic (AFM) spintronics. Here, we report on spin Hall magnetoresistance (SMR) measurements of a AFM, thin film epitaxial nickel oxide (NiO)/platinum (Pt) heterostructure on MgO (001). We find that the resistance of the Pt film depends on the angle θ between an injected charge current $\mathbf{J}_c$ and the Néel vector of the NiO, **N**. It exhibits the characteristic $\sin^2(\theta)$ dependence for SMR signals, but with a 90 ° shift as compared to SMR signals obtained for insulating ferrimagnets. The strength of the SMR signal increases for increasing field, with an onset of the signal at 1-3 T[1] and we propose a model based on the movement of magnetoelastic domains. From the observed SMR ratio, we estimate the spin mixing conductance at the NiO/Pt interface to be greater than 1x10^{14} Ω^{-1} m^{-2}. [1]Baldrati et al, arXiv:1709.00910 (2017)

MA 21.65 Tue 9:30 Poster A

Unidirectional spin Hall magnetoresistance and thermal effects in Pt/Co, Ta/Co and multilayer systems — •Anastasiia Moskaltsova, Daniel Meier, Timo Kuschel, Jan-Michael Schmalhorst, and Günter Reiss — CSMD, Department of Physics, Bielefeld University, Germany

Recently, the unidirectional spin Hall magnetoresistance (USMR) has been found in ferromagnetic (FM)/heavy metal (HM) bilayer systems [1]. Magnetoresistive (MR) effects, like anisotropic magnetoresistance and spin Hall magnetoresistance are usually symmetric with the current polarity and proportional to m^2, while by using USMR one can detect a change in resistance by reversing current or magnetization direction. This is related to the spin accumulation at the FM/HM interface induced by spin Hall effect. This effect can be potentially used in applications for sensing and multi-state memory devices [2]. In this work we present harmonic measurements of angular dependences in Pt/Co, Ta/Co and multilayer systems. By varying the FM/HM layer order and stack repetitions we can extract the information about the interface influence on USMR as well as other MR effects. It was found that variation of the FM/HM layer order can give rise to a more complex second harmonic signal, which can be explained by additional thermoelectric contributions. Thus, the layer thickness and ordering play significant role and can change the contribution of the thermal effects, while keeping the magnitude of the USMR constant.

[1] C. O. Avci et al., Nat. Phys. 11, 570 (2015)
[2] C. O. Avci et al., Appl. Phys. Lett. 110, 203506 (2017)

MA 21.66 Tue 9:30 Poster A

The structural and magnetic properties of Fe-Sn ferromagnetic compounds — •Bahar Fayyazi, Konstantin Skokov, Tom Faske, and Oliver Gutfleisch — Technische Universität Darmstadt, Germany

Uniaxial ferromagnets with high anisotropy composed of earth-abundant elements are of interest for development of new permanent magnets. Potentially, high values of anisotropy energy are possible in 3d compounds. The Fe-Sn system contains 3 ferromagnetic compounds, namely Fe3Sn, Fe5Sn3, and Fe3Sn2 [1]. In this work, the intrinsic magnetic properties such as spontaneous magnetization, anisotropy field and Curie temperature were obtained for the Fe-Sn compounds by measurements on single crystals. The magnetic measurements were performed along 3 crystallographic directions [001], [100] and [120] of the hexagonal structure in a temperature range of 5-600K. The change of anisotropy with temperature and occurrence of spin reorientation transition will be discussed. Additionally, the structural properties of them measured on single crystal diffractometer will be reported.

[1] Fayyazi, B., et al., Bulk combinatorial analysis for searching new rare-earth free permanent magnets: Reactive crucible melting applied to the Fe-Sn binary system. Acta Materialia, 2017. 141: p. 434-443.

MA 21.67 Tue 9:30 Poster A

Additive Manufacturing of Permalloy: Magnetic and Structural Properties — •Hanna Schönrath, Stefan Kilian, Jan T. Sehrt, Marina Spasova, Gerd Witt, and Michael Farle — Universität Duisburg-Essen, Germany

Permalloy (Fe21.5 at.-%, Ni78.5 at.-%) exhibits remarkable soft magnetic properties [1]. Thus it finds its application for example in sensors or inductive devices. In conventional manufacturing methods, several drawbacks include a degradation of magnetic properties [2], geometrical limitations and a waste of material due to post-processing. An alternative approach is the use of Additive Manufacturing (AM) technologies. In particular, Laser Beam Melting (LBM) allows the fabrication of metallic parts with individualized near net shaped structures and complex geometries, which cannot be manufactured with other techniques [3].

We report the manufacturing of LBM-cubes with an edge length of 5 mm using a magnetic powder blend with 21.5 at.-% Fe and 78.5 at.-% Ni. For high energy input during the production, Energy-dispersive X-ray Spectroscopy revealed a line-shaped segregation of Fe and Ni at the surface of the cubes and a $FeNi_3$ phase in the bulk material. Additionally Magnetometry indicated an increase of the saturation magnetization of the bulk material with increasing energy input.

[1] Jiles, D.C. Acta Mater. **51** (2003) 5907.
[2] Fenineche, N.E., et al. Mater. Lett. **58** (2004) 1797.
[7] Frazier, W.E. JMEPEG **23** (2014) 1917.

MA 21.68 Tue 9:30 Poster A

Large uniaxial magnetostriction with sign inversion at the first order phase transition in Mn_2GaC films — Iuliia Novoselova[1], •Ruslan Salikhov[1], Andrejs Petruhins[2], Arni Ingason[2], Johanna Rosen[2], Ulf Wiedwald[1], and Michael Farle[1,3] — [1]Faculty of Physics and CENIDE, University of Duisburg-Essen, Germany — [2]Department of Physics, Linköping University, Linköping, Sweden — [3]Center for Functionalized Magnetic Materials, Immanuel Kant Baltic Federal University, Kaliningrad, Russia

$M_{n+1}AX_n$ (n = 1,2,3) phases are a family of inherently nanolaminated hexagonal compounds. The new Mn_2GaC MAX phase was synthesized as hetero-epitaxial films containing Mn as the exclusive M-element [1]. Here, we present a comprehensive study of magnetic phase transitions in the Mn_2GaC films. The Néel temperature is $T_N \sim 507$ K, at $T_t = 214$ K the material undergoes a first order phase transition from antiferromagnetic (AFM) above T_t to a non-collinear AFM spin structure. Both states show large uniaxial c-axis magnetostriction of 450 ppm. Remarkably, the magnetostriction changes sign, being compressive (negative) above T_t and tensile (positive) below the T_t. The sign change of magnetostriction coefficient across the phase transition is a consequence of the layered structure and competing AFM and FM exchange interactions between magnetic atomic layers. The sign change of the magnetostriction is accompanied by a sign change in the magnetoresistance indicating a coupling between the spin, lattice and electrical transport properties. The work is supported by DFG Grant SA 3095/2-1. [1] Dahlqvist, M. et al. Phys. Rev. B 93, 014410 (2016).

MA 21.69 Tue 9:30 Poster A

Real-time dynamics of the Kosterlitz-Thouless transition in a magnetic layer on a metallic system — •Simon Michel and Michael Potthoff — I. Institut für Theoretische Physik, Universität Hamburg

A theoretical approach is developed to study the real-time dynamics of topological excitations of a two-dimensional anisotropic magnetic layer which is coupled to a metallic substrate. To this end, we solve the equations of motion for three-component classical spins on the square lattice which mutually interact via a direct in-plane exchange. In addition there is a local exchange coupling to the local magnetic moments of a system of noninteracting conduction electrons.

As a first step we consider the spin-subsystem only and study the vortex-unbinding Kosterlitz-Thouless transition in the equilibrium phase diagram. Within the real-time approach, this is done by starting from a random initial state, followed by a fictitious dissipative dynamics using a Gilbert damping term to generate a typical equilibrium state with given total energy. Thermodynamical expectation values are given as time averages. Here, we discuss the temperature dependence of the spin correlations, of the vortex density and of the average vortex-antivortex distance.

Eventually, our goal is to understand, on an atomic level, how to control topological excitations with the tip of a scanning-tunnelling microscope. In our model approach, this shall be done by computations of the real-time dynamics of the spin-electron hybrid system which is initiated by a strong local perturbation.

MA 21.70 Tue 9:30 Poster A

Magnetic Majorana fermions observed in the diluted Kitaev materials α-Ru1-xIrxCl3 — •Youngsu Choi[1,2], Dirk Wulferding[1,3], Peter Lemmens[1,3], Seunghwan Do[2], and Kwang-Yong Choi[2] — [1]IPKM, TU-BS, Braunschweig, Germany — [2]Chung-Ang Univ., Seoul, Korea — [3]LENA, TU-BS, Braunschweig, Germany

A Kitaev honeycomb lattice is a paradigmatic model that hosts Kitaev spin liquid and Majorana fermions. However, their experimental identification remains elusive in real Kitaev materials as non-Kitaev terms often induce a magnetically ordered state. We introduce spin vacancies to overcome this deadlock. In the diluted Kitaev materials α-Ru1-xIrxCl3, Raman scattering measurements uncover that moderate spin vacancies destabilize the zigzag antiferromagnetic order towards a short-range ordered state, while well-defined Majorana fermion excitations emerge under sizable dilutions. Furthermore, a structural evolution with Ir content is characterized by studying phonon modes.

Work supported by the Quantum- and Nanometrology initiative QUANOMET within project NL-4, the NTH School Contacts in Nanosystems and Korea NRF Grants (No. 2012-046138).

MA 21.71 Tue 9:30 Poster A

Magnetic properties of chain antiferromagnets $KFeS_2$ and $RbFeSe_2$ — •Zakir Seidov[1,2], Vladimir Tsurkan[3], Hans-Albrecht Krug von Nidda[1], Irina Filipova[3], Dorina Croitori[3], Axel Günther[1], Airat Kiiamov[4], Lenar Tagirov[4,5], Farit Vagizov[4], Tatyana Gavrilova[5], and Alois Loidl[1] — [1]EP V, EKM, University of Augsburg, D-86135 Augsburg — [2]Institute of Physics, ANAS, AZ-1143 Baku — [3]Institute of Applied Physics, Academy of Sciences of Moldova, MD-20208 Chisinau — [4]Institute of Physics, Kazan Federal University, RUS-420008 Kazan — [5]E.K.Zavoisky Physical-Technical Institute, RAS, RUS-420029 Kazan

The ternary iron chalcogenides $KFeS_2$ and $RbFeSe_2$ consisting of chains of edge-sharing FeX_4 (X = S, Se) tetrahedra have been investigated by means of magnetic susceptibility, specific heat, Mössbauer, and ESR measurements. The single crystals exhibit collinear antiferromagnetic (AFM) order with strongly reduced moments below 252 K and 248 K, respectively. For both compounds the small anomaly in $C(T)$ and the corresponding low value of entropy at T_N indicate a significant spin reduction and the existence of AFM fluctuations even far above T_N. Mössbauer parameters determined in the entire temperature range indicate that iron in $RbFeSe_2$ is in ferric (trivalent) state having strong covalent bonding to selenium ligands. The measured hyperfine field of 216 kOe at 4.2 K is quite reduced as compared to that in high-spin ferric compounds corroborating the strong spin reduction of Fe^{3+}. The high-temperature susceptibility data of $KFeS_2$ and $RbFeSe_2$ suggest a one-dimensional metallic character along the chains.

MA 21.72 Tue 9:30 Poster A

Magnon-phonon coupling in hybrid-nanostructures — •T. Luschmann[1,2], D. Schwienbacher[1,2,3], R. Gross[1,2,3], M. Weiler[1,2], and H. Huebl[1,2,3] — [1]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Physik-Department, Technische Universität München, Garching, Germany — [3]Nanosystems Initiative Munich, München, Germany

Phononic crystals are ideal candidates for localizing phonons up to GHz frequencies in phononic cavities [1]. Combining these structures with magnetic materials with similar magnetic resonance frequencies should allow for resonant, artificial magnon-phonon coupling. We present a finite element study for the realization of phononic cavities in SiN mechanical resonators and discuss the magnon-phonon coupling in these devices. In addition, we will present first samples and measurements.

[1] M. Eichenfield et al. Optomechanical Crystals, Nature **462** (2009).

MA 21.73 Tue 9:30 Poster A

Magneto-resistance measurements in para- and ferromagnetic $Fe_{60}Al_{40}$ nanowires — Vico Liersch[1], •Alexander Schmeink[1], Benedikt Eggert[2], Tobias Warnatz[1], Sebastian Wintz[1,3], Jonathan Ehrler[1], Roman Böttger[1], Gregor Hlawacek[1], Kay Potzger[1], Jürgen Lindner[1], Jürgen Fassbender[1], Artur Erbe[1], Heiko Wende[2], and Rantej Bali[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]CENIDE & Universität Duisburg-Essen, Duisburg, Germany — [3]Paul Scherrer Institut, Villigen PSI, Switzerland

Paramagnetic (PM) B2 $Fe_{60}Al_{40}$ can be disordered into the ferromagnetic (FM) A2 structure using light noble gas ions.[1] The transition can be adjusted using the ion fluence and reversed via annealing thus providing a tunable magnetic material.

Using a focused Ne^+ ion beam of ∼2 nm spot-size it is possible to locally induce disorder in thin films of such a material, creating FM regions in PM surroundings.[2] This enables patterning of FM|PM|FM structures in the current-perpendicular-to-plane geometry.

FM stripes of ∼100 nm widths with PM spacings down to 50 nm were written onto 40 nm thick B2 $Fe_{60}Al_{40}$. The reversal fields of the patterned FM stripes are adjustable via the stripe width, enabling multiple magnetic configurations. Magneto-transport properties of the ion-patterned structures as well as the effect of joule heating on the stability of A2 $Fe_{60}Al_{40}$ are reported.

[1] E. Menéndez *et al.* New J. Phys. **10** 103030 (2008).
[2] F. Röder *et al.* Sci. Rep. **5** 16786 (2015).

MA 21.74 Tue 9:30 Poster A

A nanoscale approach in wireless power transfer — •Marius Wodniok and Sonja Schöning — University of Applied Sciences Bielefeld, Bielefeld, Germany

Inductive applications become an every day tool in electronics and electronic parts as for example in phones and cars. In that matter the wireless power transfer needs to get optimized in concerns of speed, efficiency and (more important) displacement tolerance. Therefor it is essential to guide the magnetic field lines and form a focused stray field. In heating applications power transfer shall additionally occur homogenous corresponding to flat receivers like cooking dishes.

To realize these demands and make a nanoscale approach a material study for surrounding and receiving parts is performed to determine the key material characteristics for an optimized wireless power transfer. Beforehand simulations using COMSOL Multiphysics are run for a simplified system of an induction stove to predefine key characteristics and narrow down the selection of suitable materials. The material study itself includes measurements of the magnetic, electric and thermal properties in correlation to the power transfer. Following these investigations, nanoparticles and thin films will be tailored for an optimized wireless power transfer.

MA 21.75 Tue 9:30 Poster A

Magnetic coupling effects in ordered arrangements of magnetite nanoparticles — •Nils Neugebauer[1], Matthias T. Elm[1,2,3], and Peter J. Klar[1,2] — [1]Institute of Experimental Physics I, Heinrich-Buff-Ring 16, 35392 Gießen, Germany — [2]Center for Materials Research (LaMa), Heinrich-Buff-Ring 16, 35392 Gießen, Germany — [3]Institute of Physical Chemistry, Heinrich-Buff-Ring 17, 35392 Gießen, Germany

Fabrication of magnetic nanoparticle arrangements have attracted great interest for modern research due to their potential for various applications such as recording tapes, spintronic and magnetoresistive random access memory (MRAM). The influence of the distance between magnetic arrangements on the behavior of the macroscopic properties has not been sufficiently investigated yet. The knowledge of these properties is of enormous significance, e.g. for increasing the storage density of memory devices. The present study is performed to determine the distance dependence of the coupling between magnetic nanoparticle arrangements. By using electron-beam lithography and the meniscus force deposition method, structures with defined size and controlled spacing down to a few tens of nanometers can be assembled. Those structures were filled with magnetite (Fe_3O_4) nanoparticles with diameters of 20 nm. Ferromagnetic resonance measurements (FMR) are used to characterize the properties of those arrangements. It is revealed that there is a critical distance where coupling occurs, and that the nature of the interaction is also dependent on the spatial arrangement of the nanoparticle arrangements.

MA 21.76 Tue 9:30 Poster A

Tuning of the Ni:Fe ratio of flexible thin-film giant magnetoimpedance sensors — •Gregor Büttel and Uwe Hartmann — Institute of Experimental Physics, Saarland University, P. O. Box 151150, D66041, Saarbrücken, Germany

Permalloy-based giant magnetoimpedance (GMI) sensors have been integrated onto Si cantilevers to investigate their potential for the detection of strain and as flexible sensors. The devices allow to apply compressive and tensile strain and to record images of the corresponding magnetic domains by magneto-optical Kerr wide-field microscopy. By tuning the Ni:Fe ratio to a negative magnetostriction constant a strain-gauge factor of nearly 200 is reached in the ferromagnetic resonance regime of the GMI effect [1].

In case of nearly zero magnetostriction the effective anisotropy field remains stable under large applied tensile/compressive strain and no broadening/narrowing of the hysteresis and impedance curve occurs. However, in the low-field and MHz regime a significant modification of the impedance curve was found, which is attributed to domain-wall resonance and a corresponding change of permeability/impedance.

[1] Buettel, G. et al., APL, in press

MA 21.77 Tue 9:30 Poster A

Application of 3D Lithography — •Christian Denker[1], Cornelius Fendler[2], Julia Bethune[4], Nina Meyer[1], Tobias Tubandt[1], Finn-F. Lietzow[1], Neha Jha[1], Chris Badenhorst[3], Alena Rong[5], Jakob Walowski[1], Mark Doerr[3], Raghvendra Plankar[4], Mihaela Delcea[5], Uwe T. Bornscheuer[3], Robert Blick[2], Swadhin Mandal[6], and Markus Münzenberg[1] — [1]Institut für Physik, Universität Greifswald, Germany — [2]Institut für Nanostruktur- und Festkörperphysik, Universität Hamburg, Germany — [3]Institut für Biochemie, Universität Greifswald, Germany — [4]Institute of Immunology and Transfusion Medicine, University Medicine Greifswald, Germany — [5]Centre for Innovation Competence - Humoral Immune Reactions in Cardiovascular Diseases, Universität Greifswald, Germany — [6]Indian Institute of Science Education and Research Kolkata, India

3D 2-Photon-Lithography, originally developed for 3D photonic crystals, opens a wide range of new possible applications in many other fields, e.g. life sciences, micro-optics and mechanics [1]. 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 elongated cells, pillars for investigation of cell mechanics and master-mold fabrication for Polydimethylsiloxane (PDMS) micro-fluidic channels.

[1] J. K. Hohmann et al., Adv. Optical Mater. 3 (2015) 1488

MA 21.78 Tue 9:30 Poster A

Electronic transport in van der Waals layered Kagome lattice Nb3X8 Cluster Compound — •Edouard Lesne[1], Jiho Yoon[1], John P. Sheckelton[2], Chris Pasco[2], Tyrel M. McQueen[2], Stuart S. P. Parkin[1], and Mazhar N. Ali[1] — [1]Max Planck Institute of Microstructure Physics, Halle (Germany) — [2]Johns Hopkins University, Baltimore (USA)

Geometrically frustrated materials based on a Kagome lattice have been long studied as promising Quantum Spin-Liquid candidates. Of particular interest are metallic spin liquids * theorized to host exotic transport properties including high temperature superconductivity [1].

Recently, the 2D van der Waals cluster compound Nb3Cl8, which has a Nb Kagome lattice, has been reported as a potential spin liquid material [2]. Due to its insulating behavior, electronic transport properties and their link to the exotic magnetism have not been investigated.

Here we report on electronic transport measurements in 10-100nm thin flakes of Nb3X8 (X= Cl, Br) in Hall bar geometries, fabricated via standard micromechanical exfoliation techniques combined with photolithography and ion-beam sputtering deposition. We further resort to electrostatic doping in a back-gate geometry, and to top-gating via ionic liquid to metallize the compound and probe a prospective metallic spin liquid state.

[1] P. W. Anderson, Science 235, 1196 (1987) [2] J. P. Sheckelton et al., Inorg. Chem. Front. 4, 481 (2017)

MA 21.79 Tue 9:30 Poster A

Downscaling of planar Hall effect sensors for optical transparency and small volumes — •Luca Marnitz, Karsten Rott, Karl-Josef Dietz, Dario Anselmetti, and Günter Reiss — Bielefeld University

Magnetic field sensors based on the Planar Hall Effect (PHE) have been used to sense the stray field of magnetic nanoparticles induced by the self-field of the sensor current. Prior reports either use the shape anisotropy of the sensor to induce effective single domain behaviour [1] or use exchange-biased ferromagnets for example in a PHE Bridge (PHEB) layout [2].

However, these sensors either have a large surface area of up to several mm^2 [1], which is problematic for small sample volumes and/or are optically non-transparent due to their relatively large thickness.

In this work we prepared μm-sized optically transparent PHE-sensors for magnetic nanoparticle detection and simultaneous optical observation in an optical microscope.

Both the effects of downscaling the area and the thickness of the active sensors are analyzed regarding their feasibility for detecting the particle-surface distance in an optical microscope equipped with a magnetic tweezer. This technique could allow the use of smaller particles and tailored particle shapes to analyze the stretching and twisting of biomolecules.

[1] Mor et al., JAP 111, 07E519 (2012)
[2] Henriksen et al., JAP 119, 093910 (2016)

MA 21.80 Tue 9:30 Poster A

Efficient numerical relaxation of antiferromagnetic spin textures — •Andrew Fingers, Hristo Velkov, Matthias Sitte, Helen Gomonay, Daniele Pinna, Jairo Sinova, and Karin Everschor-Sitte — Johannes Gutenberg-Universität, Mainz, Germany

The literature is plentiful of both open source and commercial software for the analysis of ferromagnetic dynamics. Current approaches to antiferromagnetic systems simply modify the existing codes by either altering the sign of the exchange constant or only covering the dynamics of the staggered field in the large coupling limit. For antiferromagnetic systems, however, the situation is more complex due to the different energy and time scales involved. As an example, just modifying the sign of the exchange constant can lead to nontrivial numerical errors. Already the relaxation of an antiferromagnetic texture on its own is a complex task and the algorithms cannot just be transferred from the ferromagnetic case. We are developing a suite of solvers tailored for antiferromagnetic systems. We demonstrate a relaxation solver and apply it to the specific example of an antiferromagnetic skyrmion.

MA 21.81 Tue 9:30 Poster A

Inverse Coil Design by Simulation based Optimization — •Lennart Weber, Simon Bekemeier, and Christian Schröder — Bielefeld Institute for Applied Materials Research (BIfAM), Computational Materials Science and Engineering (CMSE), University of Applied Sciences Bielefeld, Department of Engineering Sciences and Mathematics, Interaktion 1, D-33619 Bielefeld

Inductive power transfer is nowadays a widely used technology. One example is inductive heating, where the used coils are usually planar with homogeneous winding distances. With regard to energy efficiency, comfort and electromagnetic compatibility it is desirable to start from an optimal magnetic field distribution and derive the necessary coil geometry from it. Such an approach requires inverting the Biot-Savart law, which poses an ill-posed problem. This can usually be addressed by so-called target-field methods. Here, we propose a different approach, namely a direct approach using a parametric representation of the coil geometry. Based on this we solve the forward problem, i.e. calculate the magnetic field and optimize the parameters of the coil by Simulated Annealing in order to minimize the difference between the present field and the target field. Furthermore, we examine machine learning algorithms and other optimization techniques, beside Simulated Annealing, to speed-up our calculations and improve our approach.

MA 21.82 Tue 9:30 Poster A

A target field approach for the design of non-conventional 3-D coils — •Assja Laas and Christian Schröder — Bielefeld Institute for Applied Materials Research (BIfAM), Computational Materials Science and Engineering (CMSE), University of Applied Sciences Bielefeld, Department of Engineering Sciences and Mathematics, Interaktion 1, D-33619 Bielefeld

The design of coils for high-frequency applications in the area of inductive energy or information transfer is a challenging task. For efficiency and energy reasons the geometry and topology of the coils needs to be adapted to the corresponding application. In our study we focus on the design of three dimensional induction heating coils by an inverse methodology. Induction hubs are operating at frequencies where a time-harmonic representation of the Maxwell equations can be used to determine the axial component of the magnetic field B(r). A target field is specified over a certain region and an approximation of the current density through a Fourier series expansion is derived which generates the desired field. Because of the ill-posed nature of this problem, a Tikhonov regularization with a minimum gradient term is used to calculate the unknown parameters of the Fourier series expansion. Based on this, the coil windings are usually determined using a stream function approach. However, because of the three dimensionality of the problem this is not possible. Instead, we generate a current density map, from which the winding patterns can be derived.

MA 21.83 Tue 9:30 Poster A

Motion Characteristics of Exchange Bias Capped Janus Particles in Dynamic Magnetic Stray Field Landscapes — •Andreea Tomiţa, Rico Huhnstock, Meike Reginka, Dennis Holzinger, and Arno Ehresmann — Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel

Transport systems and self-propelled particles offer interesting prospects for research in a wide spectrum of applications like biomedicine, sensors and lab-on-a-chip devices. The system that we propose takes a novel approach by combining the multifunctionality of Janus particles with the strict control and confinement of their locomotion in an artificial magnetic field landscape. The Janus particles are fabricated to have a magnetic cap made of an exchange bias thin film system and a non-magnetic material respectively, in this case the later being silica, a material with high functionalization potential. This allows for the distinct study of the Janus particles' coupled translational-rotational transition and motion dynamics when exposed to dynamically changing magnetic stray field landscapes. The asymmetry of the particles, combined with the magnetic field landscape of the substrate, creates the possibility of a tailored assembly of several particles pointing in a direction dictated by the power-balance of the forces acting on them.

MA 21.84 Tue 9:30 Poster A

Size effect of exchange interaction parameters for FePd nanoparticles — •Svitlana Ponomarova, Iurii Koval, and Oleksandr Ponomarov — Institute for Metal Physics the NAS of Ukraine

Magnetic properties of materials are measured by various types of external influences. From this prospective FePd bulk and nano alloys show interesting features: increase of high magnetic anisotropy in the ordered L10 phase, Invar effect, and martensitic transformation at low temperatures.

In this paper we calculated exchange interaction parameters - exchange integrals - in FePd magnetic nanomaterials for Fe-Fe, Pd-Pd, Fe-Pd atom pairs within a nanoparticle under different conditions.

The Heisenberg model for the system of randomly located spins concerning their slowly-relaxing arrangement was updated for binary solid solution with two magnetic components. Magnetic properties (Curie temperature, etc.) may be easily varied by nanoparticle size. For this readon size effect is additional control factor which was taken into consideration for nanoparticles.

Basically we focused on analysis of:

1. the correlation between exchange interaction parameters and characteristics of martensitic transformation;

2. influence of an external pressure and an atomic ordering effect on exchange integrals.

MA 21.85 Tue 9:30 Poster A

Monte-Carlo simulation studies on interacting 3D nanoparticle supercrystals — •Mauricio Cattaneo, Michael Smik, Oleg Petracic, and Thomas Brückel — Jülich Centre for Neutron Science JCNS and Peter Grünberg Institut PGI, JARA-FIT, Forschungszentrum Jülich GmbH, 52425 Jülich

The assembly of magnetic nanoparticles into large 3D structures constitutes a novel way of fabricating artificial materials that show properties that are not found in conventional systems. A detailed understanding of the magnetic properties is impeded by the huge number of contributing parameters as well as the difficulty in probing the internal magnetic structure in situ. Monte-Carlo Simulations offer the possibility to predict numerically possible magnetic low energy states. Sufficiently small nanoparticles can be considered as single domain, which may be modelled as an effective superspin. In contrast to atomic spins, the dominating inter-particle interaction is the dipole-dipole interaction. We simulated iron oxide nanoparticles in a fcc superlattice structure with various lattice constants in order to tune the interaction strength. An Onsager-like mean-field approach has been implemented in order to increase the performance of the basic Metropolis scheme. In the limit of vanishing magnetocrystalline anisotropy, several low-energy states but no unique ground state have been observed.

MA 21.86 Tue 9:30 Poster A

Synthesis and study of magnetic nanoparticle systems of iron oxide, cobalt and their mixtures — •Svetlana Klimova, Nadine Fokin, Inga Ennen, Daniela Ramermann, and Andreas Hütten — Bielefeld University, Bielefeld, Germany

Magnetic nanoparticles (NPs) have potential for various applications such as sensors, ferro*uidics, high-frequency electronics, high performance permanent magnets, magnetic refrigerants, and catalytic systems. For producing and using magnetic NPs there are three key issues, which dominate the magnetic properties of magnetic NPs and their ensembles: *nite size effects, surface effects, interparticle interactions. Reducing the size leads to quantum con*nement and modi*es the properties at the nanoscale. Exchange bias like hysteresis shifts can be observed in ferromagnetic NPs, in which the surface behaves like a spin glass, which is formed due to *nite-size and surface effects. Furthermore, surface effects are related to the symmetry breaking of the crystal structure at the boundary of each magnetic NP. This work focuses on the synthesis of systems of iron oxide, cobalt and NP mixtures of different sizes and different magnetic phases. Comparing structural with magnetic characterization will reveal the magnetic interactions. Moreover, the resulting magnetic transport properties will be presented and discussed.

MA 21.87 Tue 9:30 Poster A

Fabrication and Magnetic characterization of exchange-biased Janus Particles — •Meike Reginka[1], Andreea Tomita[1], Rico Huhnstock[1], Thomas Kusserow[1], Kai Arstila[2], Dennis Holzinger[1], and Arno Ehresmann[1] — [1]Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel — [2]Department of Physics, University of Jyväskylä, Suorvontie 9, FI-40014 Jyväskylä

Research in the field of point-of-care technology requires bio-functionalized particles, that allow for remotely controllable actuation in microfluidic processes, e.g. via external magnetic fields. In order to magnetically address the particles' degrees of motion, an exchange bias layer system was introduced on top of silica microspheres resulting in magnetic Janus particles. The sputter-deposited exchange bias system exhibits an unidirectional anisotropy, and thus, giving rise to a pinned magnetization distribution within the spherical half shell. For experimental verification the magnetic properties of the designed particles were investigated by Magnetic Force Microscopy and Kerr magnetometry besides other imaging methods on the nanometer scale, namely Helium Ion Microscopy, Focused Ion Beam and Scanning Electron Microscopy. Additionally, the addressability of the particles is shown in dynamic microfluidic experiments under externally applied rotational magnetic fields.

MA 21.88 Tue 9:30 Poster A

Temperature behavior of specific heat of hexagonal spin ice models with different interaction radius — Yuriy Shevchenko[1,2], •Aleksandr Makarov[1,2], Petr Andriushchenko[1,2], and Konstantin Nefedev[1,2] — [1]Department of Computer Systems, School of Natural Sciences, Far Eastern Federal University, Vladivostok, Russian Federation — [2]Institute of Applied Mathematics of Far Eastern Branch, Russian Academy of Science, 7 Radio Str, Vladivostok, Russian Federation

By Wang-Landau method the problems of temperature behavior of specific heat were solved for hexagonal lattice models with dipole short-range, as well as long-range interaction and free boundary conditions. We observe an anomalous behavior of specific heat for such lattices. It is established that systems of a finite number of Ising spins with long-range dipole interactions can have unusual thermodynamic properties that are characterized by the presence of several peaks of the specific heat in the absence of an external magnetic field. There is no phase transition in the model with the nearest-neighbor interaction on a hexagonal lattice, while the temperature behavior of the specific heat exhibits a singularity in the same model for long-range interaction.

MA 21.89 Tue 9:30 Poster A

Scanning electron microscopy with polarization analysis on ex-situ sputter-deposited ultrathin Ir\Co\Pt films — •Susanne Kuhrau, Fabian Kloodt-Twesten, Jochen Wagner, Robert Frömter, and Hans Peter Oepen — Center for Hybrid Nanostructures, Universität Hamburg, Germany

Scanning electron microscopy with polarization analysis (SEMPA) is a magnetic imaging technique with the capability to measure two components of the magnetization simultaneously. Due to its surface sensitivity, samples studied with SEMPA are usually prepared in situ. Ex-situ prepared samples are generally capped to prevent oxidation during transfer. It is commonly assumed that capping with non-magnetic material in the range of nm will deteriorate the magnetic contrast, particularly with strong spin scatterer as Pt. Before the SEMPA measurement the capping layer is either removed by sputtering or dusted by Co or Fe to establish magnetic contrast. However, both methods influence the properties of the sample, either due to intermixing of the upper layers or adding additional magnetic material. By means of a wedge shaped Pt capping layer we have investigated the magnetic contrast of $\{Ir\backslash Co\backslash Pt\}_n$ ($n = 1, 2$) samples. Magnetic domains can be imaged up to the maximum Pt thickness of 2 nm. A contrast reduction due to oxidation as well as capping has been analyzed as a function of Pt thickness. The maximum of the magnetic contrast found around 1 nm Pt thickness, yielding 30% of the pure Co contrast.

MA 21.90 Tue 9:30 Poster A

Room-temperature antiferromagnetic order in individual goethite nanoparticles — •David M. Bracher[1], Tatiana M. Savchenko[1], Marcus Wyss[2], Giorgia Olivieri[3], Matthew A. Brown[3], Frithjof Nolting[1], Martino Poggio[2], and Armin Kleibert[1] — [1]Swiss Light Source, Paul Scherrer Institut, CH-5232 Villigen, Switzerland — [2]Department of Physics and Astronomy, University of Basel, CH-4056 Basel, Klingelberstrasse 82, Switzerland — [3]Laboratory for Surface Science and Technology, Department of Materials ETH Zürich, CH-8093,HCI G543

Nanoscaled antiferromagnets are of profound interest for future spintronic devices and novel materials. The absence of effective magnetic moments renders the investigation of antiferromagnetic material at the nanoscale very challenging. We tackle this issue by combining temperature- and orientation-dependent X-ray linear dichroism (XLD) spectromicroscopy by means of X-ray photoemission electron microscopy with scanning electron microscopy (SEM). The temperature dependen XLD signal of the individual goethite (α-FeOOH) nanoparticles suggest a mostly reversible magnetic phase transition around the Néel temperature (TN=400 K) of bulk goethite despite of the polycrystalline structure of nanoparticles. Comparing the spatially resolved XLD spectra with SEM images allows us to correlate the magnetic properties with the morphology of individual goethite nanoparticles.

MA 21.91 Tue 9:30 Poster A

Characterization of a Fresnel Zone Plate for magnetic imaging with high harmonic radiation — •Tobias Heinrich[1], Sergey Zayko[1], Ofer Kfir[1,2], and Claus Ropers[1] — [1]University of Göttingen, 4th Physical Institute, Göttingen, Germany — [2]Physics Department, Technion - Israel Institute of Technology, Haifa 32000, Israel

The development of bright circularly polarized high harmonic radiation [1,2] has recently enabled nanoscale magnetic imaging with sub-50-nm resolution using x-ray magnetic circular dichroism [3]. Here, we explore possibilities of enhancing this imaging approach utilizing a Fresnel zone plate (FZP). Such a setup will provide the opportunity for a direct and robust real-space image acquisition or can be used in a combination with lensless techniques to increase the irradiance at the sample.

In this work, a Fresnel zone plate suitable for use in a high-harmonic setup was designed and characterized. The resulting wave front was analyzed using a 3-D caustic measurement. By employing a pinhole scan, wave fronts of different diffraction orders were identified and separately evaluated. Using coherent diffractive imaging, the complex exit wave of the FZP was retrieved, yielding a focal spot size of 160 nm. A total first order diffraction efficiency of 4.5 % was estimated. With such an upgrade, the high-harmonic imaging setup will benefit from the opportunity for spatially resolved x-ray photoelectron spectroscopy in a scanning geometry. [1] Fleischer *et all.*, Nature Photonics **8**, 543-549 (2014) [2] O. Kfir *et all.*, Nature Photonics **9**, 99-105 (2015) [3] O. Kfir, S. Zayko *et all.*, arXiv:1706.07695

MA 21.92 Tue 9:30 Poster A

Steps toward a new imaging method in biological systems — •Gerhard Wolff, Simon Schmitt, Christian Osterkamp, Liam McGuinness, Boris Naydenov, and Fedor Jelezko — Institute for Quantum Optics, University Ulm, Germany

In the last century NMR established itself as key technology for non-destructive investigation of molecules and chemical reactions. As traditional NMR is reaching its limits in sensitivity and in spatial resolution new ways a new approach is needed ti reach behind these limitations.

In the last decades quantum sensors have attracted more and more attention. One such quantum sensor is the nitrogen Vacancy (NV) center in diamond for which research groups recently showed nanoscale NMR spectroscopy using single molecule confocal microscopes.

Widefield microscopy has the advantage over single NV experiments that it allows one to increase the signal and reduce measurement time, thus increasing frequency sensitivity. The reduced spatial resolution is still sufficient for imaging of single cells.

However several challenges still remain, such as homogeneous magnetic fields over several hundred micrometers while still being adjustable in arbitrary directions as well as the generation of homogeneous microwave fields for coherent control of the NV ensemble.

This work seeks to develop recent groundbreaking experiments and establish a new imaging method for biological systems.

MA 21.93 Tue 9:30 Poster A

Improving X-ray Magnetic Microscopy at MAXYMUS — •Markus Weigand[1], Iullia Bykova[1], Michael Bechtel[1], Bartel VanWaeyenberge[2], Hermann Stoll[1], and Gisela Schütz[1] — [1]MPI for Intelligent Systems, Stuttgart, Germany — [2]Gent University, Gent, Belgium

MAXYMUS is a UHV Scanning Transmission X-ray Microscope (STXM) operated by the MPI for Intelligent Systems at a dedicated soft X-ray undulator beamline at Bessy II, which is a world leading instrument for time resolved magnetic microscopy.

It allows users to pump samples with a wide range of excitation types and frequencies and directly image the response of the sample with our self-build single photon detection and counting system, yielding resolutions of down to 20ps and 20nm in time and space. This capability can combined with a vector field system and UHV capability for concurrent surface and bulk measurements.

We will present a number of upgrades being made to the microscope to enhance the capabilities, including a helium cryostat and compatible high frequency sample holders for dynamic imaging <30K, improvements for higher excitation bandwidths above 30GHz as well as a high repetition rate synchronized laser being developed in cooperation with the Max-Born-Institute to allow optical pumping, both for thermal excitation as well as triggering of Austin switches for very fast dynamic imaging.

MA 21.94 Tue 9:30 Poster A

Ptychographic imaging of magnetic materials at MAXYMUS X-ray microscope — •Iuliia Bykova, Markus Weigand, Kahraman Keskinbora, Umut Sanli, Joachim Gräfe, Eberhard Goering, Hermann Stoll, Gunther Richter, and Gizela Schütz —

Max-Planck-Institute for Intelligent Systems, Stuttgart, Germany

The size of magnetic features in modern magnetic materials can be scaled far below 100 nm that requires imaging with advanced resolution capabilities. Ptychography is the combination of diffraction imaging and scanning transmission microscopy that provides images of extended sample areas with wavelength limited resolution. Utilizing iterative reconstruction algorithms it provides phase and amplitude information about studied specimens. With possibility to use circular negative and positive polarized X-ray light these technique would allow to gain insight into the domain configuration of the magnetic structures, their shape and stability.

MAXYMUS X-ray microscope was upgraded with a fast in-vacuum CCD camera (PNSensor) with high readout speed up to 450 Hz, quantum efficiency >70% (for E>300eV) and RMS noise per pixel less than 3e-. Implementation of a fast CCD camera and in-house produced IBL FZPs at MAXYMUS allowed introduction of ptychographic imaging and, as a result, drastic improvement of imaging resolution. We are going to present latest results of ptychographic imaging of samples with magnetic contrast obtained at MAXYMUS microscope.

MA 21.95 Tue 9:30 Poster A

Unconvnetional X-ray Optics — •Kahraman Keskinbora, Umut T. Sanli, Margarita Baluktsian, and Gisela Schütz — Max Planck Institute for Intelligent Systems, 70569 Stuttgart, Germany

First optic that comes to mind in any discussion of focusing X-rays, is just a binary Fresnel zone Plate with rectangular zone profiles. However, focusing X-rays with high efficiency or shaping the phase front with high fidelity necessitates more elegant and sophisticated micro/nano-structures. Here, we will discuss some of these unconventional X-ray optical devices useful for various X-ray beam-shaping scenarios.

MA 21.96 Tue 9:30 Poster A

Multilayer Fresnel zone plates — •Umut T. Sanli, Margarita Baluktsian, Markus Weigand, Iuliia Bykova, Gisela Schütz, and Kahraman Keskinbora — MPI for Intelligent Systems, Stuttgart, Germany

Multilayer type (ML) Fresnel zone plates (FZP) were first suggested 35 years ago and drew incredible attention in X-ray community as they can achieve very high aspect ratios which makes it theoretically possible to focus a very broad range of X-rays including very hard X-rays down to around 20 nm. Because of the needed high precision in zone positioning, circularity and the needed low zone roughness, ML-FZPs have suffered from lower than optimum efficiencies and lens aberrations. With our new insight into the fabrication method, which utilizes atomic layer deposition (ALD) technique to deposit the multilayer zones of the ML-FZP, we were able to fabricate high quality ML-FZPs and achieved astigmatism-free direct imaging with high diffraction efficiency for the first time in ML-FZP history [1], and resolved 15.5 nm structures, the world record direct imaging resolution achieved by an ML-FZP. With our ALD fabricated Multilayer Fresnel zone plates we aim for sub 10 nm imaging resolution.

MA 21.97 Tue 9:30 Poster A

Laser-assisted local magnetization switching across the spin reorientation transition in $DyCo_5$ antidots — •Jaime Sánchez-Barriga, Chen Luo, Sergio Valencia, and Florin Radu — Helmholtz-Zentrum Berlin für Materialien und Energie, Elektronenspeicherring BESSY II, Albert-Einstein-Str. 15, 12489 Berlin, Germany

The miniaturization required to achieve ultrahigh areal bit densities leads to new fundamental challenges in both growth of magnetic nanostructures and control of magnetic properties of ferrimagnets in low dimensions. Using photoelectron emission microscopy in combination with x-ray magnetic circular dichroism, we demonstrate the use of $DyCo_5$ ferrimagnetic antidot arrays for heat-assisted magnetic recording. This is achieved by exploiting the reorientation of the magnetic anisotropy which occurs just above room temperature, and by using trains of laser pulses down to a single-photon shot. This allows us to drive the system into a fully controllable final magnetic state of nanoscale bits. We further characterize the efficiency of the process as a function of laser fluence, and find that heat accumulation is the driving mechanism responsible for the switching.

MA 21.98 Tue 9:30 Poster A

Low frequency noise in TMR based vortex spin torque nano-oscillators — •Steffen Wittrock[1], Kay Yakushiji[2], Akio Fukushima[2], Hitoshi Kubota[2], Shinji Yuasa[2], Paolo Bortolotti[1], Enrico Rubiola[3], and Vincent Cros[1] — [1]Unité Mixte de Physique CNRS/Thales, Univ. Paris-Sud, 91767 Palaiseau, France — [2]National Institute of Advanced Industrial Science and Technology (AIST), Spintronics Research Center, Tsukuba, Ibaraki 305-8568, Japan — [3]Time-Frequency department, CNRS FEMTO-ST, Université de Franche Comté, 25030 Besançon, France

With their very rich static and dynamical properties, magnetic vortex dynamics excited by a spin polarized current represent not only a model system to study the physical mechanisms of spin transfer phenomena but could also give birth to a new generation of multifunctional microwave spintronic devices. The key property of spin-torque nano-oscillators (STNOs) is their high nonlinearity which gives rise to manifold phenomena as well as to their relatively poor spectral coherence and coupled noise behavior. While the noise distribution for offset frequencies far from the carrier frequency is reasonably well understood and described by the general nonlinear autooscillator theory, low frequency noise remains under investigation as it limits the frequency stability of the oscillator. Extensively studied in GMR and TMR sensors, this work addresses the low frequency noise of a TMR-based spin-torque vortex oscillator. We investigate the noise dependence on the active magnetic volume of the oscillation under various field and current conditions as well as its link to nonlinearity.

MA 21.99 Tue 9:30 Poster A

Torque-detected electron spin resonance and torque magnetometry — •Alexey Alfonsov[1], Vladislav Kataev[1], and Bernd Büchner[1,2] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden, IFW Dresden, D-01171 Dresden, Germany — [2]Technische Universität Dresden, D-01062 Dresden, Germany

Magnetic anisotropy is a key property of many materials, which has been under a great interest of scientists from around the world. The magnetic anisotropy is defined by the complex interplay of different degrees of freedom, such as spin or/and orbital moments, charge and lattice. One of the most appropriate methods to study magnetic anisotropies, and related properties is high field and multifrequency electron spin resonance (HF-ESR), complemented by a torque magnetometry. Unfortunately samples of many new materials interesting for the investigation are available in very small sizes: in some cases it is complicated to synthesize large crystals, in other cases, the size is a key property of the material itself. This all rises a problem of the detection of the ESR signal from such a small sample, especially in the case of a multifrequency ESR spectrometer, where in order to increase the sensitivity one has to apply restrictions on the microwave frequency, strength and orientation of magnetic field. To overcome this problem we develope a multifrequency cantilever-based (torque-detected) ESR spectrometer, which is capable to perform torque magnetometry measurememnts as well.

MA 21.100 Tue 9:30 Poster A

Ab initio characterisation of skyrmion induced effects in MTJs — •Jonas Friedrich Schaefer, Michael Czerner, and Christian Heiliger — Institut für theoretische Physik, Justus-Liebig-Universität Gießen, Heinrich-Buff-Ring 16, 35392 Gießen

Since interfaces and stacked layers offer a great variety of suitable systems for skyrmions, a deeper understanding of non-collinear effects in these surroundings becomes desirable. Using our KKR Code and the therein implemented Keldysh formalism we investigate the electronic transport properties of such systems with and without self-consistency. We show that this effort is necessary in order to get accurate results and to reveal the underlying physics.

MA 21.101 Tue 9:30 Poster A

In-Operando HAXPES Band Alignment Studies Of Complex Oxide Heterostructures: $Au/NiFe_2O_4/SrTiO_3$ — •Ronja Anika Heinen[1], Mai H. A. Hamed[1], Patrick Lömker[1], Andrei Gloskovskii[2], Wolfgang Drube[2], and Martina Müller[3] — [1]Forschungszentrum Jülich GmbH, PGI-6, Jülich — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg — [3]Technische Universität Dortmund, Experimentelle Physik I, Dortmund

Transition metal (TM) oxides exhibit a variety of physical properties due to their high tunability of spin, orbital and charge degrees of freedom. The initial way to tailor these properties is a precisely controlled growth process of single-crystalline thin film heterostructures. Thus, not only the intrinsic physical properties of the complex oxides but also the electronic conditions at the interface of functional multilayers can give raise to new paths for future applications.

In our experiments, we investigate ultrathin films of the ferrimagnetic inverse spinel $NiFe_2O_4$ (NFO) grown on the perovskite $SrTiO_3$ (STO) substrates. We use in-operando hard X-ray photoelectron spectroscopy at a photon energy of E= 6000 eV and apply in-situ bias voltages of up to U= ±8 V in order to analyse the the chemical fingerprints and simultaneously the potential barrier profile of Au/NFO/STO heterostructures. The results provide insight into the interfacial band arrangement and bias-dependent chemical reactions of ultrathin TM oxides on a microscopic scale.

MA 21.102 Tue 9:30 Poster A

Spin transport through a contacted Heisenberg chain — •Florian Lange, Satoshi Ejima, and Holger Fehske — Institut für Physik, Ernst-Moritz-Arndt Universität Greifswald, D-17489 Greifswald, Germany

We use the density-matrix renormalization group and time-evolving block decimation algorithms to simulate the spin transport through a short Heisenberg spin chain sandwiched between two noninteracting leads under a spin bias. By using total system sizes up to 200 sites, we can accurately estimate the spin current in the steady state. The dependence of the current-voltage characteristic on the chain length and exchange anisotropy is examined. For the spin-1/2 XXZ chain, we find an activated behavior similar to the charge transport through a Mott-insulating Hubbard chain. In the high spin-voltage regime, a negative differential conductivity due to the finite band width of the leads is observed.

MA 21.103 Tue 9:30 Poster A

Hard X-ray spectroscopy of magnetic thin films for spintronic devices — •Andrei Gloskovskii[1], Gerhard H. Fecher[2], and Wolfgang Drube[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg — [2]Max Planck Institute for Chemical Physics of Solids, Dresden

High tunnel magneto-resistance is a characteristic of high quality magnetic tunnel junctions (MTJs) indicating a high spin polarization and epitaxial interfaces. We have studied the electronic properties of buried thin films promising as base electrodes for MTJs. In particular, the influence of the stoichiometry and annealing on the shape of the core levels and the valence band was investigated.

The main method used is Hard X-ray Photoelectron Spectroscopy where the excitation by hard X-rays in the range of typically 3-10 keV produces energetic photoelectrons which carry electronic structure information from well below the sample surface (10-30 nm) making it a powerful tool for studies of complex materials, buried nano-structures and multi-layered structures relevant for device applications. The experiments were carried out at PETRA beamline P09.

MA 21.104 Tue 9:30 Poster A

ALD growth of Fe_2O_3 thin films using Ferrocene and Ozone as precursors — •Michaela Lammel[1,2], Andy Thomas[1], and Kornelius Nielsch[1,2,3] — [1]Leibniz Institute for Solid State and Materials Research Dresden (IFW Dresden), Institute for Metallic Materials, 01069 Dresden, Germany — [2]Technische Universität Dresden, Institute of Applied Physics, 01062 Dresden, Germany — [3]Technische Universität Dresden, Institute of Materials Science, 01062 Dresden, Germany

Antiferromagnetic spintronics is currently one of the main research topics in magnetism due to the robustness of antiferromagnets against disturbances by external fields. Fe_2O_3 is a promising material system to study the magnetization dynamics in antiferromagnets. Fe_2O_3 exists mainly in two phases: antiferromagnetic α- and ferrimagnetic γ-Fe_2O_3.

We fabricate Fe_2O_3 thin films on Si/SiO_2 substrates by atomic layer deposition (ALD) using ferrocene and ozone as precursors. X-ray reflectometry was used to extract the thickness of the Fe_2O_3 films. Furthermore, the composition of the films was determined by EDX measurements. In our studies, we identified the best parameters to maximize the growth rate per cycle. In a next step, the attention will first be focused on the growth of phase-pure α- and γ-Fe_2O_3. Afterwards, we plan to perform a reduction of the Fe_2O_3 thin films into ferromagnetic Fe_3O_4 as already reported in Ref. [1]. Using ALD not only allows us to deposit thin films, but it also enables us to get conformal coatings of 3D-templates with magnetic materials.

[1] Zierold *et al.*, Journal of Physics D, Vol 47, 485001 (2014)

MA 21.105 Tue 9:30 Poster A

Spin pumping through Fe_3O_4 nano–oxide at the Fe/Pt interface — •Laura Mihalceanu, Sascha Keller, Andrés Conca, Burkard Hillebrands, and Evangelos Th. Papaioannou — TU Kaiserslautern, Erwin-Schrödinger Str. 56, 67663 Kaiserslautern

The spin current generation via spin pumping is a prominent method for the establishment of potential spin-current-generating devices. An indirect detection of this effect is provided by measuring the inverse spin Hall effect (ISHE) voltage. Various experiments have been performed in order to probe the interface properties of such bilayer systems by inserting different insulating interlayers at the FM–NM interface. Some examples are Py/MgO/Pt, $Y_5Fe_5O_{12}$/insulating barrier (Sr_2GaTaO_6,$SrTiO_3$, Sr_2CrNbO_6)/Pt structures and Fe/MgO/Pt. In our previous work on Fe/MgO/Pt we have shown the impact of an MgO tunneling barrier on the spin-pumping effect: spin currents are still inducing an ISHE voltage for very thin MgO tunneling barriers. Here, we reveal the impact of nanosized Fe_3O_4 particles at the interface of thin epitaxial Fe(12 nm)/Pt(10 nm) layers.

We show that Fe_3O_4 nanoparticles at the Fe/Pt interface significantly increase the fourfold anisotropy compared to a pure Fe/Al reference. In FMR and spin-pumping experiments a very broad linewidth of the FMR peak is revealed. The voltage generated by spin pumping is steadily detectable over a wide external magnetic field range ΔH.

In collaboration with T. Kehagias, Department of Physics, Aristotle University of Thessaloniki, Thessaloniki 54124, Greece

MA 21.106 Tue 9:30 Poster A

Interplay between localization and magnetism in (Ga,Mn)As and (In,Mn)As — Ye Yuan[1,2], Chi Xu[1,2], René Hübner[1], Rafal Jakiela[3], Roman Böttger[1], Manfred Helm[1,2], Maciej Sawicki[3], Tomasz Dietl[3,4,5], and •Shengqiang Zhou[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Technische Universität Dresden, Dresden, Germany — [3]Institute of Physics, Warsaw, Poland — [4]International Research Centre MagTop, Warsaw, Poland — [5]WPI-Advanced Institute for Materials Research, Sendai, Japan

Ion implantation of Mn combined with pulsed laser melting is employed to obtain two representative compounds of dilute ferromagnetic semiconductors (DFSs):GaMnAs and InMnAs. In contrast to films deposited by the widely used molecular beam epitaxy, neither Mn interstitials nor As antisites are present in samples prepared by the method employed here. Under these conditions the influence of localization on the hole-mediated ferromagnetism is examined in two DFSs with a differing strength of p-d coupling. On the insulating side of the transition, ferromagnetic signatures persist to higher temperatures in InMnAs compared to GaMnAs with the same Mn concentration x. This substantiates theoretical suggestions that stronger p-d coupling results in an enhanced contribution to localization, which reduces hole-mediated ferromagnetism.

MA 21.107 Tue 9:30 Poster A

High TMR at Room Temperature in Magnetic Tunnel Junctions with Phenalenyl-molecule Tunnel Barriers — •Neha Jha[1], Christian Denker[1], Anand Paryar[2], Pavan K. Vardhanapu[2], Heba Mohamad[1], Ulrike Martens[1], Christiane Helm[1], Swadhin Mandal[2], and Markus Münzenberg[1] — [1]Institut für Physik, Universität Greifswald, Germany — [2]Department of Chemical Sciences, IISER, Kolkata, India

Phenalenyl (PLY) based molecules, which can be regarded as Graphene fragments are promising candidates for spintronic applications. Attempts to use open shell PLY molecules have been unsuccessful due to their instability. We investigated a new closed shell molecule, PLY with a Copper complex, for its spintronics suitability. TMR in various samples of PLY-Cu MTJs was determined by measuring the resistance across the MTJ under a high magnetic field during parallel and antiparallel configurations of the ferromagnets (FMs). Preliminary results show outstanding Magnetoresistance (MR) at room temperature. Our works demonstrate convincingly that spin-polarized currents can be injected into organic materials with reasonably high efficiency, providing strong evidence of spin polarized tunneling as the dominant transport mechanism in PLY-Cu based magnetic tunnel junctions, and the use of PLY-based molecules as a viable and scalable platform for building molecular-scale quantum spin memory and processors for technological development.

MA 21.108 Tue 9:30 Poster A

Magnetocaloric effect of magnetic molecules with single-ion-

anisotropy — •Julian Ehrens, Christian Beckmann, and Jürgen Schnack — Universität Bielefeld, PF 100131, D-33501 Bielefeld

The magnetocaloric effect can fundamentally be described as the change of temperature when materials are exposed to changing magnetic fields in e.g. adiabatic processes. Along this line, magnetocaloric properties of isotropic spin systems, that are modeled by a Heisenberg Hamiltonian augmented with a Zeeman term, have been investigated extensively [1]. Magnetic molecules with single-ion-anisotropy such as Mn_{12}, whose ground state multiplet can be approximated as the multiplet of a single giant spin with dominating easy axis, enable the use of rotating magnetic fields or rotating samples to exploit the magnetocaloric effect. Here we report investigations being made for giant spin models with various spin quantum numbers employing several thermodynamic cycles including the successive rotation around different axes in order to find the maximum entropy difference for best cooling performance.

[1] J.W. Sharples, D. Collison, E.J.L. McInnes, J. Schnack, E. Palacios, M. Evangelisti, Nature Communications 5 (2014) 5321

MA 21.109 Tue 9:30 Poster A

Investigation of decoherence in 2-qubit systems realized as magnetic molecules — •Patrick Vorndamme and Jürgen Schnack — Universität Bielefeld, PF 100131, D-33501 Bielefeld

Magnetic molecules are considered as promising constituents of quantum simulators or quantum computers. At low temperatures the magnetic levels of molecular nanomagnets enable the use as qubits. For such an application the investigation and understanding of decoherence caused by external and internal effects is very important. Here we aim at a better understanding of the diverse aspects of decoherence by investigating experimentally relevant notions of decoherence in unitary time evolutions of finite-size closed systems of interacting electronic as well as nuclear spins. We examine the behavior of the qubits and related observables as a function of the considered interactions (SU(2) symmetric or dipolar) and the properties of the nuclear spin bath.

MA 21.110 Tue 9:30 Poster A

Fundamental thermodynamic processes investigated for anisotropic magnetic molecules — •Christian Beckmann and Jürgen Schnack — Universität Bielefeld, Universitätsstr. 25, 33615 Bielefeld

The theoretical understanding of time-dependence in magnetic quantum systems is of great importance in particular for cases where a unitary time evolution is accompanied by relaxation processes. This is of special interest for the realization of fundamental thermodynamic processes.

In this contribution we investigate how fundamental thermodynamic processes, such as Carnot, Otto or Stirling, can be performed with finite velocity on an anisotropic magnetic molecule by rotation of the applied magnetic field.

MA 21.111 Tue 9:30 Poster A

Giant magnetic hyperfine field, spin dynamics and colossal transverse field sensitivity in the single-atomic magnet $Li_2(Li_{1-x}Fe_x)N$ with $x \ll 1$ — •Sascha Albert Bräuninger[1], Sirko Kamusella[1], Rajib Sarkar[1], Manuel Fix[2], Stephan Jantz[2], Anton Jesche[2], Andre Zvyagin[3], and Hans-Henning Klauss[1] — [1]Institute of Solid State and Materials Physics, TU Dresden, D-01069 Dresden, Germany — [2]Institute of Physics, University Augsburg, D-86135 Augsburg, Germany — [3]Max-Planck-Institute for the Physics of Complex Systems, Nöthnitzer Str., 38, D-01187 Dresden, Germany

We present ^{57}Fe Mössbauer studies on large single crystals of diluted Fe ions in $Li_2(Li_{1-x}Fe_x)N$ which forms a hexagonal symmetric α-Li_3N crystal matrix. The homogeneity of the nanoscale distributed isolated Fe centers is shown. The isolated Fe centers, e.g. for $x = 2.5(1)\%$, exhibit a giant magnetic hyperfine field of $B = 70.22(1)$ T parallel to the largest principle axis $V_{zz} = -154.10(19)$ V/Å^2 of the electric field gradient at 2 K, same for other $x \ll 1$. The magnetic hyperfine field fluctuates between 50 K and 300 K probed by Mössbauer spectroscopy described by a two-level relaxation model. The spin dynamics is similar to a behavior known from single-molecule magnets. An Arrhenius frequency plot $\nu = \nu_0 e^{-E_A/k_B T}$ yields a thermal activation barrier of $E_A = 542(8)$ K and $\nu_0 = 216(22)$ GHz which consistent with magnetization investigations. An applied transverse magnetic field study up to 5 T at 70 K shows a sensitivity two orders of magnitude higher than expected from the conventional theory of nanomagnets.

MA 21.112 Tue 9:30 Poster A

Chemical doping of Fe_4 single molecule magnets on surfaces — •Vivien Enenkel, Fabian Paschke, Philipp Erler, Luca Gragnaniello, and Mikhail Fonin — Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany

Single molecules magnets are promising candidates for future applications in the field of molecular spintronics or ultra-dense information storage. Here we investigate the effect of chemical doping by alkali metals on Fe_4H molecules on graphene/Ir(111) and Au(111) surfaces. Submonolayers of intact Fe_4H molecules in form of close-packed islands are prepared on surfaces via the electrospray ionization method [1,2]. The subsequent deposition of dopant atoms (Li, Na) leads to appearance of a new molecular configuration appearing bright and slightly asymmetric compared to the rest of the molecules. We assume that in this configuration a dopant atom resides on the Fe_4H molecule, which leads to the direct electron transfer from Li (Na) to one of the Fe atoms. STS spectra on doped species show a shift in the energetic positions of molecular orbitals as well as further electronic states emerging in the conduction gap as compared to undoped molecules. By means of x-ray absorption spectroscopy, we observe that doping leads to substantial changes in the line shape of the Fe L-edge indicating the reduction of Fe^{3+} to Fe^{2+} in the molecular core.

[1] P. Erler et al., Nano Lett. 15, 4546 (2015). [2] L. Gragnaniello et al., Nano Lett., 2017, in press.

MA 21.113 Tue 9:30 Poster A

Element-selective magnetic properties of mixed 3d - 4f metallacrowns — •Ahmed Alhassanat[1], Alexey A. Sapozhnik[1], Christoph Gamer[2], Angeliki Athanasopoulou[2], Lara Völker[2], Chen Luo[3], Hanjo Ryll[3], Florin Radu[3], Eva Rentschler[2], and Hans-Joachim Elmers[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz — [2]Institut für Anorganische und Analytische Chemie, Johannes Gutenberg-Universität Mainz — [3]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin

Single molecular magnets comprising rare earth metals are of high interest because the unquenched orbital moments of the rare earth ions result in a large energy barrier for magnetization reversal. We investigate polynuclear $4f$ - $3d$ metallacrowns using X-ray magnetic circular dichroism at low temperatures. The element-selective spin and orbital moments of the rare earth ions hint to a large magnetic anisotropy of up to 6 meV. The magnetic moments of some $3d$ transition metal ions can be controlled by chemical means upon changing the corresponding ligand field.

MA 21.114 Tue 9:30 Poster A

High-frequency AC susceptometry on Lanthanide-containing molecular magnets — •Léo de Souza, Krunoslav Prsa, and Oliver Waldmann — Physikalisches Institut, Universität Freiburg, Germany

We present details on the adaptation of a high-frequency (f_{max} = 100 kHz) AC-susceptometer. Lanthanide-based molecular magnets display fast relaxation rates and in order to distinguish between different involved mechanisms it is necessary to use a large frequency range. We describe the steps taken to improve the existing home-made AC-setup towards reliable routine operation. A key aspect is calibration, especially the treatment of phase shifts. We show measurements done over a large span of frequencies and temperatures on a known paramagnetic sample used as a calibration standard and discuss the developed calibration techniques. In addition, preliminary results on a mixed transition metal-lanthanide molecular magnet are presented.