MA 55: Poster II

Magnetic Heuslers / Multiferroics / Spin Transport Phenomena and Spintronics/ Spin- and Magnetization Dynamics / Spin Structures and Phase Transitions / Magnetic Thin Films / Electronic Structure (Theory) / Topological Insulators

Time: Friday 10:30–13:30 Location: P2

MA 55.1 Fri 10:30 P2

Ferroelectric and magnetic properties of doped $BiFeO_3$ and $BiFeO_3/BaTiO_3$ composite and multilayer thin films — •Peter Schwinkendorf[1], Michael Lorenz[1], Vera Lazenka[2], Holger Hochmuth[1], and Marius Grundmann[1] — [1]Universität Leipzig, Institut für Experimentelle Physik II, Linnéstraße 5, 04103 Leipzig — [2]Institute for Nanoscale Physics and Chemistry, KU Leuven

$BiFeO_3$ is to date the most widely studied single phase material concerning potential application as multiferroic in the development of upcoming new computer memory technologies. This is due to its unique combination of room temperature ferroelectricity (polarization values of up to $60\,C\,cm^{-2}$) and ferromagnetism [1].

However, single phase $BiFeO_3$ films often suffer from high leakage currents. In order to overcome this problem and possibly modify the basic ferroelectric and magnetic properties we show here multiferroic composite thin films and multilayers consisting of $BiFeO_3$ and $BaTiO_3$ as well as doping of $BiFeO_3$ films with rare earth ions [2].

As expected, an increasing $BaTiO_3$ content in the samples decreases the leakage current but maintains a high ferroelectric polarization. We furthermore found that multilayers exhibit considerably enhanced magnetic properties compared to single phase films. The same is observed for Gd-doped films while La-doping causes smoothening of the film surface [2]. Magnetoelectric coupling in the composites was investigated via two different methods.

[1] J. Wang, Science 299, 1719 (2003)
[2] V. Lazenka, J. Phys. D: Appl. Phys. 46 175006 (2013)

MA 55.2 Fri 10:30 P2

Magnon Bose Einstein Condensate moving in real space — •Patryk Nowik-Boltyk, Oleksandr Dzyapko, Vladislav E. Demidov, and Sergej O. Demokritov — Institute of Applied Physics, University of Muenster, Muenster, Germany

Magnon Bose-Einstein condensation, created by microwave pumping in Yttrium-Iron-Garnet films, is a spectacular room-temperature macroscopic quantum phenomenon, which is under extended investigation since recently [1]. Temporal [2] and spatial [3] coherence of the condensate have extensively been studied in the past 5 years. As a mBEC is located at the ground state of the magnon system its group velocity is zero, therefore the condensate is not moving in real space and occupies the same area are for a long time if kept in flow equilibrium. We demonstrate a way to create a moving condensate by applying a pulsed magnetic field localized in real space. As a result of the pulsed field the condensate gains a group velocity that is determined by the amplitude of the localized magnetic field. The space, time and frequency dependent magnon density has been determined using a space, time and frequency resolved Brillouin light scattering technique. [1] S.O. Demokritov et al. Nature 443, 430 (2006) [2] V.E. Demidov et al. Phys. Rev. Lett. 100, 047205 (2008) [3] P. Nowik-Boltyk et al. Nature Sci. Rep. 2, 482 (2012)

MA 55.3 Fri 10:30 P2

Long-term magnetic stability of single atoms: a group-theoretical viewpoint — •Timofey Balashov, Christopher Bresch, and Wulf Wulfhekel — Physikalisches Institut, Karlsruhe Institute of Technology, Wolfgang-Gaede-Str. 1, 76131 Karlsruhe, Germany

The recent observation of extremely long lifetimes in single Holmium atoms on Pt(111) [1] can be explained by a careful consideration of the inherent symmetries of the system; namely, the rotation symmetry of the adsorption site, the total angular momentum symmetry of the atom and the time reversal symmetry of the whole system. Here, we describe the model in more detail and demonstrate its robustness against perturbations. We also apply this model to other rare earths to identify promising systems for future research.

[1] T. Miyamachi et al, *Nature* **503**, 242 (2013)

MA 55.4 Fri 10:30 P2

Material and bias dependence of the tunnel magnetoresistance and spin-transfer torque in magnetic tunnel junctions — •Christian Franz, Michael Czerner, and Christian Heiliger — I. Physikalisches Institut, Justus Liebig University, Giessen, Germany

We investigate magnetic tunnel junctions with $Fe_{1-x}Co_x$ alloys as ferromagnetic layers and a MgO barrier. We calculate *ab initio* the tunnel magnetoresistance (TMR) and spin-transfer torque (STT) for zero and finite bias voltage and analyze their dependence on the concentrations [1]. The transport properties are obtained using a non-equilibrium Green's function method. The FeCo alloys are described by the coherent potential approximation (CPA) including vertex corrections [2].

The disorder scattering, which is included by the CPA description, leads to diffusive currents. These lead to a drop in the TMR at zero bias from large values for the pure materials to around 2000% at finite concentrations. At a large bias we find that the TMR decreases with the Co concentration as a result of the band filling. Likewise, the TMR decreases much faster with increasing bias voltage for pure Co leads than for smaller Co concentrations. The in-plane and out-of-plane STT show linear and quadratic voltage dependence at small bias for all concentrations. The linear slope of the in-plane STT is independent of the concentration. At large bias voltages, we find strong deviations from this dependence for high Co concentrations.

[1] C. Franz et. al, Phys. Rev. B 88, 094421 (2013)
[2] C. Franz et. al, J. Phys.: Condens. Matter 25, 425301 (2013)

MA 55.5 Fri 10:30 P2

Evaluating the Gilbert damping in individual $Co_2Mn_{0.6}Fe_{0.4}Si$ microstructures via parametric amplification — •T. Sebastian[1,2], T. Bräcker[1,3], P. Pirro[1], Y. Kawada[4], H. Naganuma[4], A.A. Serga[1], M. Oogane[4], Y. Ando[4], and B. Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Institut für Ionenstrahlphysik und Materialforschung, Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [3]Graduate School Materials Science in Mainz, 67663 Kaiserslautern, Germany — [4]Department of Applied Physics, Graduate School of Engineering, Tohoku University, Sendai 980-8579, Japan

Recent experiments on spin dynamics in microstructures made of the Heusler compound $Co_2Mn_{0.6}Fe_{0.4}Si$ (CMFS) yielded promising results in the linear and nonlinear regime [1,2]. These results were attributed to the low Gilbert damping that was observed with standard ferromagnetic resonance (FMR) technique on homogeneous thin films. However, a quantitative analysis of the damping in CMFS microstructures is still lacking. We present an alternative method to evaluate the damping in individual CMFS microstructures using parametric amplification [3] and show that the low damping is preserved on the microscale.

We acknowledge support by the DFG Research Unit 1464 and the Strategic Japanese-German Joint Research from JST: ASPIMATT.

[1] T. Sebastian, et al., Appl. Phys. Lett. **100**, 112402 (2012).
[2] T. Sebastian, et al., Phys. Rev. Lett. **110**, 067201 (2013).
[3] H. Ulrichs, et al., Phys. Rev. B **84**, 094401 (2011).

MA 55.6 Fri 10:30 P2

Investigation of Pt growth on Yttrium Iron Garnet — •Sabine Pütter[1], Stephan Geprägs[2], and Rudolf Gross[2] — [1]Jülich Centre for Neutron Science JCNS, Forschungszentrum Jülich GmbH, Outstatation at MLZ, 85747 Garching, Germany — [2]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany

For spintronics, heterostructures of ferromagnetic insulators and non-magnetic conductors are very interesting as e.g. the spin Seebeck or the spin Hall effect can be studied. Pt/Yttrium Iron Garnet ($Y_3Fe_5O_{12}$,YIG) is currently in focus [1]. Only recently, it has been found that the quality of the Pt/YIG interface is crucial [2-4].

We performed a detailed growth study of Pt on YIG single crystals. The samples have been studied in-situ by Auger-Electron-Spectroscopy and Reflection High/Low Energy Electron Diffraction and ex-situ by X-ray reflectivity. Pt was thermally evaporated utilizing the JCNS

molecular beam epitaxy system which is also open to users in the framework of neutron experiments performed at the MLZ (www.mlz-garching.de).
[1] Y. Sun et al. Phys. Rev. Lett. 111, 106601 (2013) and references therein, H. Nakayama et al., Phys. Rev. Lett. 110, 206601 (2013), M. Weiler et al., Phys. Rev. Lett. 108, 106602 (2012).
[2] F. D. Czeschka et al., Phys. Rev. Lett. 107, 046601 (2011)
[3] M. B. Jungfleisch et al., Appl. Phys. Lett. 103, 022411 (2013)
[4] Z. Qiu et al. Appl. Phys. Lett. 103, 092404 (2013)

MA 55.7 Fri 10:30 P2

Pure spin current-induced domain wall motion probed by localized spin signal detection — Nils Motzko[1], Björn Burkhardt[1], Robert Reeve[1], Alexander Pfeiffer[1], •Mathias Kläui[1], Piotr Laczkowski[2], Williams Savero Torres[2], Laurent Vila[2], and Jean-Philippe Attane[3] — [1]Institut für Physik, Johannes Gutenberg Universität Mainz, 55099 Mainz, Germany — [2]INAC, CEA Grenoble, 17 av. des Martyrs, 38054 Grenoble, France — [3]INAC, CEA Grenoble, 17 av. des Martyrs, 38054 Grenoble, France and Universite Jospeh Fourier, BP 53, 38041 Grenoble, France

We demonstrate the displacement of domain walls by pure diffusive spin currents, using a non-local spin valve geometry without any applied external fields. We detect the position of the domain wall by non-local spin valve measurements at both sides of the spin conduit, thereby detecting the domain wall position that is moving across the area below the spin conduit when a spin current is applied. We find that it is possible to displace a transverse wall without any external field with a spin current density of
$6 \cdot 10^9 \mathrm{A/m^2}$, and a charge current density of $4 \cdot 10^{11} \mathrm{A/m^2}$, which is lower than what is required for conventional spin-polarized charge current-induced domain wall motion. The spin polarisation of permalloy was calculated to 31 % and the spin diffusion length to 349 nm. The observed efficiency of $10^{-12}\mathrm{T\ m^2/A}$ is the highest ever obtained for domain walls in permalloy demonstrating that this method is advantageous for low power domain wall manipulation.

MA 55.8 Fri 10:30 P2

Enhancement of spin currents by three-magnon splitting — Oleksandr Dzyapko[1], Hidekazu Kurebayashi[2], Vladislav E. Demidov[1], •Michael Evelt[1], and Sergej O. Demokritov[1] — [1]Institute for Applied Physics, University of Muenster, Germany — [2]Cavendish Laboratory, University of Cambridge, United Kingdom

The effect of spin-pumping offers a perfect possibility to generate pure spin currents in a layered system of ferromagnetic and normal metals by excitation of spin precession in the ferromagnet. Vice versa, detecting the spin current using the inverse spin-Hall effect (ISHE) allows investigation of magnetic dynamics.
Here we report on the examination of the spin pumping in yttrium iron garnet (YIG)/Pt bilayers for different thickness of YIG. We show that the efficiency of the spin-current generation can be significantly enhanced by three-magnon splitting in YIG. This is only allowed for particular intervals of applied magnetic fields depending on the thickness of the ferromagnetic film (energy conservation). Our results show that for all samples with allowed three-magnon splitting an enhancement of the spin current generation is observed in a certain frequency region. The cut-off frequencies characterizing the region of the enhancement correlate perfectly with the theoretically predicted frequency for the latter process, confirming the experimental claims [1,2] that three-magnon splitting is responsible for the observed amplification.
[1] H. Kurebayashi, O. Dzyapko, et al, Nature Mater. 10, 660 (2011)
[2] O. Dzyapko, H. Kurebayashi, et al, Applied Physics Letters 102, 252409 (2013)

MA 55.9 Fri 10:30 P2

Absence of an induced magnetic moment in Pt on $Y_3Fe_5O_{12}$ — Stephan Geprägs[1], •Matthias Opel[1], Sibylle Meyer[1], Fabrice Wilhelm[2], Katharina Ollefs[2], Andrei Rogalev[2], Sebastian T.B. Goennenwein[1], and Rudolf Gross[1,3] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]European Synchrotron Radiation Facility (ESRF), Grenoble, France — [3]Physik-Department, TU München, Garching, Germany

The investigation of pure spin currents in ferromagnetic insulating $Y_3Fe_5O_{12}$ (YIG) is usually based on their conversion to charge currents in an adjacent metallic Pt layer via the inverse spin Hall effect. Recently, magnetotransport experiments in Pt/YIG heterostructures revealed a magnetoresistance (MR) effect in Pt which is interpreted controversially in terms of a novel spin-Hall MR [1] or a magnetic proximity MR [2]. To clarify this issue, we study the X-ray magnetic circular dichroism (XMCD) at the Pt $L_{2,3}$ edges in Pt/YIG [3]. Our data unambiguously show a negligible induced magnetic moment below (0.003 ± 0.001) Bohr magnetons per Pt atom, in contrast to [2]. This suggests that a magnetic proximity effect cannot be responsible for the observed MR in Pt/YIG. Our data instead are fully consistent with the spin-Hall MR interpretation. – This work was supported by the ESRF via HE-3784, the Deutsche Forschungsgemeinschaft (DFG) via SPP 1538, and the German Excellence Initiative via NIM.
[1] H. Nakayama *et al.*, Phys. Rev. Lett. **110**, 206601 (2013).
[2] Y.M. Lu *et al.*, Phys. Rev. Lett. **110**, 147207 (2013).
[3] S. Geprägs *et al.*, Appl. Phys. Lett. **101**, 262407 (2012).

MA 55.10 Fri 10:30 P2

Iron Garnet Thin Films for Spin Current-Based Experiments — •Francesco Della Coletta[1], Sibylle Meyer[1], Matthias Opel[1], Sebastian T. B. Goennenwein[1], Stephan Geprägs[1], and Rudolf Gross[1,2] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany — [2]Physik-Department, Technische Universität München, 85748 Garching, Germany

The generation and detection of pure spin currents are in the focus of present research. In ferromagnetic insulator (FMI)/non-magnetic metal (NM) bilayers, the (inter)conversion of spin and charge currents via the (inverse) spin Hall effect in the NM leads to a spin Hall magnetoresistance (SMR), resulting from reflection or absorption of spin current at the interface. The effect manifests itself in the dependence of the electrical resistivity of the NM on the magnetization orientation of the FMI. Candidates for room-temperature FMI layers are iron garnet $A_3Fe_5O_{12}$ (AIG) thin films with $A = \mathrm{Y, Gd}$. Using pulsed laser deposition, we fabricated epitaxial AIG thin films on $Gd_3Ga_5O_{12}$ and $Y_3Al_5O_{12}$ substrates. From X-ray diffractometry, we do not detect any secondary phases. Furthermore, a high structural quality and a low mosaic spread is demonstrated. Using SQUID magnetometry, a ferrimagnetic hysteresis with a saturation magnetization close to the bulk value of $A_3Fe_5O_{12}$ ($A = \mathrm{Y, Gd}$) is observed at room-temperature. Additionally, in case of $A = \mathrm{Gd}$, a compensation temperature of around 290 K, where the remanent magnetization changes its sign, is detectable. — This work is supported by the DFG via SPP 1538.

MA 55.11 Fri 10:30 P2

Spin Seebeck effect induced by resistive Joule heating — M. Schreier[1], N. Roschewsky[1], E. Dobler[1], S. Meyer[1], •R. Roesslhuber[1], R. Gross[1,2], and S.T.B. Goennenwein[1] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Germany — [2]Physik-Department, TUM, Germany

The spin Seebeck effect can be observed by applying a thermal gradient on a ferromagnet/normal metal hybrid structure, thus creating a thermal nonequilibrium state at the interface. As a result a pure spin current perpendicular to the interface is induced and converted into a charge current in the normal metal via the inverse spin Hall effect. So far, the thermal gradient was applied either by clamping the sample between two thermal reservoirs or by using local laser beam heating. Both techniques require a dedicated setup. Here we present a new and simple technique [1] for the generation of the thermal gradient wherein the normal metal layer itself is used as a resistive heater enabling spin Seeback experiments in standard magneto-transport cryostats. We show that the spin Seebeck effect can be recovered from the raw data by simply adding the voltage signals recorded for positive and negative current polarity. We performed measurements as a function of the external magnetic field strength and its orientation and show that the effect scales linearly with the applied power, as expected for a thermal effect. Supported by the DFG via SPP 1538 “Spin Caloric Transport” (project GO 944/4-1) and the German Excellence Initiative via the Nanosystems Initiative Munich (NIM).
[1] Schreier *et al.*, arXiv:1309.6901, accepted for publication in APL

MA 55.12 Fri 10:30 P2

Co thickness and temperature dependent anomalous Nernst and Hall effect in Co/Pd multilayers — •Tristan Matalla-Wagner, Vedat Keskin, Daniel Meier, Jan-Michael Schmalhorst, Timo Kuschel, and Günter Reiss — Thin Films and Physics of Nanostructures, Bielefeld University, Germany

The anomalous Hall effect (AHE) describes a charge voltage generated by spin-orbit-scattering of electrons in solid states. This voltage depends on the applied electric current and on the magnetization in the

investigated material. Due to the dependence on the magnetization the voltage describes a magnetization curve which is antisymmetric with respect to the external magnetic field. The same antisymmetric shape of the magnetization curve can be obtained for the anomalous Nernst effect (ANE). Here, the driving force is a temperature gradient instead of an electric current. Therefore, the conclusion could be, that the ANE is a thermally generated AHE.

In Co/Pd multilayers the AHE depends on the Co thickness and temperature [1]. In this work, the impact of varying these parameters on the AHE as well as ANE is studied. The different behavior of AHE and ANE is discussed in context of spin Seebeck effect investigations.

[1] Keskin *et al.*, Appl. Phys. Lett. **102**, 022416 (2013)

MA 55.13 Fri 10:30 P2

Spin-wave control by thermal gradients — •Thomas Langner, Marc Vogel, Vitaliy Vasyuchka, Andrii Chumak, Alexander Serga, Georg von Freymann, and Burkard Hillebrands — TU Kaiserslautern and Landesforschungszentrum OPTIMAS

Spin waves, excitations of the spin system in a ferromagnetic material, show a high potential to transport information in form of spin angular momentum. In order to code and process data with spin waves one has to provide suitable means of manipulation. Magnonic crystals, magnetic media with periodic variation of the magnetic properties, provide a possibility to create a spin wave filter in analogy to photonic crystal based filters for light. In this work we investigate possibilities to create laser induced magnonic crystals. 532 nm continuous-wave laser-light patterns are generated by a spatial light modulator and imaged onto a spin-wave waveguide. The optically heated areas have a different saturation magnetization influencing the spin-wave propagation. First we study transmission and reflection of spin waves through a single thermally induced barrier. We then increase the number of light fringes focused to investigate the formation of a magnonic crystal and its influence on spin-wave transport. Controlling the laser power, heating time and distance between the fringes provides us with full control of all magnonic crystal parameters without the need to fabricate several samples.

We acknowledge financial support by the Deutsche Forschungsgemeinschaft (DFG) within priority program 1538 (Spin Caloric Transport).

MA 55.14 Fri 10:30 P2

Large tunnel magneto-Seebeck effect in Co2FeSi Heusler compound — •Alexander Boehnke[1], Marvin Walter[2], Christian Sterwerf[1], Michael Czerner[3], Karsten Rott[1], Andy Thomas[1], Christian Heiliger[3], Markus Münzenberg[2], and Günter Reiss[1] — [1]Thin Films and Physics of Nanostructures, Bielefeld University, Germany — [2]I. Physikalisches Institut, Georg-August-Universität Göttingen, Germany — [3]I. Physikalisches Institut, Justus-Liebig-Universität Gießen, Germany

Heusler compounds are promising candidates for magnetic tunnel junctions (MTJ) as their potential high spin polarization leads to high tunnel magnetoresistance (TMR) ratios. Recently the tunnel magneto-Seebeck effect (TMS), that occurs when a temperature gradient is applied to an MTJ, has gained much interest. Our measurements show that Heusler compounds can give a good thermoelectric readout contrast, which is beneficial for future applications in, e.g., green information technology.

We investigated $Co_2FeSi/MgO/Co_{70}Fe_{30}$ MTJs. Interestingly, the TMS ratio (96 %) is comparable to the TMR ratio (101 %). Similar effects were found for Al_2O_3 barrier MTJs, but both observations differ from CoFeB/MgO/CoFeB MTJs, where the TMS is much smaller than the TMR. This reveals a strong influence of the contributing transport bands on the TMS, basically different from the TMR. Further ab initio calculations are pending to gain a proper understanding of these fundamental effects.

MA 55.15 Fri 10:30 P2

Investigations on the cation distribution of sputtered $NiFe_2O_4$ thin films with high resistivity — •Christoph Klewe[1], Markus Meinert[1], Karsten Kuepper[2], Elke Arenholz[3], Arunava Gupta[4], Jan-Michael Schmalhorst[1], Timo Kuschel[1], and Günter Reiss[1] — [1]University of Bielefeld, Germany — [2]University of Osnabrück, Germany — [3]Advanced Light Source, Lawrence Berkeley National Laboratory, CA 94720, USA — [4]University of Alabama, Tuscaloosa Alabama, USA

Oxidic compounds of the ferrite class have attracted a lot of attention due to their potential insulating and ferro(i)magnetic properties. One promising candidate for a wide range of spintronic and spincaloric applications is the inverse spinel ferrite $NiFe_2O_4$.

We investigated the optical and electronic properties of $NiFe_2O_4$ thin films prepared by reactive dc magnetron co-sputtering. From conductivity measurements a high resistivity was deduced, while the temperature dependence revealed a significantly low activation energy, which is about one order of magnitude smaller than the gap energy determined by optical spectroscopy. X-ray photoelectron spectroscopy (XPS) studies gave information about the cation distribution of the sputtered films. X-ray absorption spectroscopy (XAS) and both x-ray magnetic circular dichroism (XMCD) and linear dichroism (XMLD) allowed to determine the element specific moments and gave additional information on the cation distribution. The results display a full structural inversion and a high structural quality for the investigated films, promoting a utilization in spincaloritronic devices.

MA 55.16 Fri 10:30 P2

Thermoelectrical effects and magnetic anisotropy in GaMnAs thin films — •Ivan Soldatov[1], Nadezda Panarina[1], Rudolf Schäfer[1,2], Christian Hess[1], Sibylle Meyer[2], Wolfgang Limmer[3], Wladimir Schoch[3], and Ludwig Schultz[1,2] — [1]IFW-Dresden, Institute for Solid State Research, D-01171 Dresden, Germany — [2]Institute for Materials Science, TU Dresden, Mommsenstraße 9, D-01069 Dresden, Germany — [3]Universität Ulm, D-89081 Ulm, Germany

We performed a comprehensive investigation of thermoelectric (with temperature gradient) and galvanomagnetic (with charge current) effects in magnetic thin films, where the spin Seebeck effect was observed. Thermoelectric measurements were performed using the steady-state technique, The transverse electric signal on the deposited Pt strips (transverse spin Seebeck configuration) was registrated. Signal was registered directly on the GaMnAs. It suggests planar Nernst (PNE), as an origin of the magneto-electric effects observed in the thin ferromagnetic film of GaMnAs. Besides PNE we measured the anomalous Nernst effect (ANE), applying out-of-plane temperature gradient. From those data the anomalous Nernst coefficient was calculated to be not greater then 500*V/K in saturation. The planar Hall effect (PHE) measured in the sample provided us an opportunity to determine the directions of easy axes and temperature dependence of the ratio between the cubic and uniaxial anisotropies in the system. These data are in agreement with conclusions made from observation of the domain structure of the magnetic layer with use of Kerr-microscopy.

MA 55.17 Fri 10:30 P2

Ferromagnetic resonance and anomalous Nernst effect in an individual magnetic nanotube with GaAs core — •Johannes Mendil[1], Daniel Rüffer[2], Florian Heimbach[1], Florian Brandl[1], Tobias Stückler[1], Eleonora Russo-Averchi[2], Anna Fontcuberta i Morral[2], and Dirk Grundler[1,3] — [1]Physik Department E10, TU München, Garching, Germany — [2]LMSC, EPFL, Lausanne, Switzerland — [3]STI, EPFL, Lausanne, Switzerland

Nanomagnetism and magnetic domain walls play a key role in new visionary concepts, such as the racetrack memory [1]. We present a comprehensive study on ferromagnetic nanotubes (NTs) that allow to study vortex wall formation while avoiding the Bloch point structure existing in magnetic nanowires [2]. For this, a few 10 nm thick ferromagnetic shell (CoFeB or Ni) was deposited on a 10-to-20-μm-long GaAs nanowire. Anisotropic magnetoresistance data show well distinguishable signatures of magnetization switching. Under local laser heating we observe spike-like voltages that we attribute to the anomalous Nernst effect and an NT segment with an azimuthal magnetization. Following this, the chirality of a vortex state can be reconstructed during reversal. Additionally, electrically detected ferromagnetic resonance experiments reveal a series of spin-wave resonances. We will compare our results on individual CoFeB NTs to recently considered Ni NTs [3,4]. The work was supported by GR1640/5-1 in SPP 1538.
[1] S.S.P. Parkin et al., Science 320, 190 (2008); [2] R. Hertel et al., J. Magn. Mater. 278, L291 (2004); [3] D. Rüffer et al., Nanoscale 4, 4989 (2012); [4] A. Buchter et al., Phys. Rev. Lett. 111, 067202 (2013)

MA 55.18 Fri 10:30 P2

Thermal spin transfer torque in vortex state structures — •Michael Vogel[1], Ajay Gangwar[1], Susanne Brunner[1], Stefan Günther[1], Jean-Yves Chauleau[1], Claudia Mewes[2], Tim Mewes[2], Georg Woltersdorf[3], and Christian Back[1] — [1]U Regensburg, Regensburg, Germany — [2]U Alabama, Tuscaloosa, USA — [3]MLU Halle, Halle, Germany

It has recently been proposed that temperature gradients in magnetic structures can induce a thermal spin transfer torque (thermally induced STT) [J.C. Slonczewski, Phys. Rev. B 82, 054403 (2010)].

We study thermally induced spin-currents in lateral devices. In particular we will address the motion of a magnetic vortex core in a ferromagnetic square in the Landau state when subjected to a temperature gradient. We have modified our open source micromagnetic simulation package (M3) to include thermal spin transfer torque as suggested in [K.M.D. Hals, A. Brataas, and G.E.W. Bauer, Solid State Communications 150, 461-465 (2010)]. To test this simulator we compare the magnetization dynamics induced in a nanometer sized Permalloy square subjected to voltage driven STT [M. Najafi, et al., J. Appl. Phys. 105, 113914 (2009)] and thermally driven STT. We have also studied the dependence of the vortex motion as a function of the applied temperature gradient and the size of the Permalloy sample. The motion of the core can be compared to analytic approximations [B. Krüger, et al., Phys. Rev. B 76, 224426 (2007)] Further we have investigated the behavior of such vortex cores at the MAXYMUS scanning transmission X-ray microscopy (STXM) beam line at Bessy, Berlin.

MA 55.19 Fri 10:30 P2

***Ab initio* investigation of the tunneling magneto Seebeck effect** — •Christian Franz, Michael Czerner, and Christian Heiliger — I. Physikalisches Institut, Justus Liebig University, Giessen, Germany

The Seebeck coefficient describes the thermoelectric voltage induced in a junction by a temperature gradient. In a magnetic tunnel junction the Seebeck coefficient depends on the relative orientation of the magnetizations. This is termed tunneling magneto-Seebeck effect (TMS) or magneto-thermoelectric power. It is defined in analogy to the tunnel magnetoresistance and belongs to the research field of spin caloritronics. The TMS has been predicted theoretically [1] and confirmed experimentally [2].

In this contribution we show *ab initio* results for the TMS in $Fe_xCo_{1-x}/MgO/Fe_xCo_{1-x}$ tunnel junctions [3]. We use a non-equilibrium Green's function method for the transport properties and the coherent potential approximation with vertex corrections to describe the alloys [4]. We investigate the TMS for varying alloy composition, barrier thickness, and temperature. We find that the TMS depends sensitively on the parameters, in particular the alloy composition. This behavior can be traced back to the respective dependence of the transmission function.

[1] M. Czerner et. al, Phys. Rev. B 83, 132405 (2011)
[2] M. Walter et. al, Nat. Mater. 10, 742 (2011)
[3] C. Franz et. al, Phys. Rev. B 88, 094421 (2013)
[4] C. Franz et. al, J. Phys.: Condens. Matter 25, 425301 (2013)

MA 55.20 Fri 10:30 P2

Spin-dependent hot electron lifetimes of 3*d* ferromagnets — •Marko Wietstruk[1], Kristian Döbrich[2], Cornelius Gahl[1], Andreas Goris[1,2], and Martin Weinelt[1] — [1]Freie Universität Berlin, FB Physik — [2]Max-Born-Institut, Berlin

Hot electrons excited few 100 meV above the Fermi energy (E_F) play a major role in, e.g., spin injection and optically induced magnetization dynamics. Also spin-dependent transport relies on the difference in hot electron lifetimes of majority and minority electrons. While theory proposes large lifetime asymmetries near E_F, only very few experimental evidence is given.

In time- and spin-resolved two-photon photoemission experiments (2PPE) we investigated laser induced hot electrons of the 3*d* ferromagnets Fe, Co and Ni. Their lifetimes were determined by simulations using optical Bloch equations.

In contrast to the theory we found a significantly smaller difference between majority and minority lifetimes that decreases even further when approaching E_F. This discrepancy can be explained by considering secondary electrons as well as exchange scattering [1].

[1] A. Goris *et al.*, Phys. Rev. Lett. **107**, 026601 (2011)

MA 55.21 Fri 10:30 P2

Temperature dependent sign change in tunnel magnetoresistance of magnetic tunnel junctions with one magnetite electrode — •Luca Marnitz[1], Karsten Rott[1], Stefan Niehörster[1], Christoph Klewe[1], Daniel Meier[1], Matthäus Witziok[2], Andreas Krampf[2], Olga Schuckmann[2], Tobias Schemme[2], Karsten Kuepper[2], Joachim Wollschläger[2], Günter Reiss[1], and Timo Kuschel[1] — [1]Bielefeld University, Germany — [2]Osnabrück University, Germany

Due to its high spin polarization and Curie temperature, magnetite (Fe_3O_4) is a promising material for room temperature applications in spintronics. Despite these promising features, MTJs using magnetite have not yet shown a large TMR value, the largest being -27% in $CoFe/Al_2O_3/MgO/Fe_3O_4/Al_2O_3$ (001) junctions[1]. Magnetite grown on MgO shows signs of an interdiffusion of Mg from the substrate through the magnetite at temperatures between 250 and 350°C[2].

We have studied this effect by annealing $CoFeB/MgO/Fe_3O_4/MgO$ (001) MTJs at different temperatures and observed a sign change from a negative TMR to a positive TMR. Additionally, MTJs with magnetite thin films treated by Ar etching showed a vastly increased TMR value of up to -12% for an annealing temperature of 230°C from a starting value of about -1%. A good foundation for further research is provided, including MTJs with two magnetite electrodes with an additional NiO pinning layer and different barrier materials.

[1] T. Kado, Appl. Phys. Lett. 92, 092502 (2008)
[2] Y. Gao et al., J. Mater. Res. 13, 2003 (1998)

MA 55.22 Fri 10:30 P2

Field and temperature dependence of spin fluctuations in $ZrZn_2$ — •Pascal Reiss, Yang Zou, Gilbert G. Lonzarich, and F. Malte Grosche — Cavendish Laboratory, University of Cambridge, JJ Thomson Avenue, Cambridge, CB3 0HE, United Kingdom

$ZrZn_2$ is a low temperature band ferromagnet ($T_c \approx 28$ K), which displays non-Fermi liquid transport properties over a wide temperature range: above $T_{FL} \approx 1$ K and up to T_c, the electrical resistivity follows a power-law temperature dependence with an exponent 5/3, whereas the electronic contribution to the thermal resistivity is linear in temperature. This has been explained in terms of a a magnetic fluctuation model, which includes a self-consistent renormalisation for the magnetic susceptibility [1, 2].

Applied magnetic fields up to 8 T have been observed to increase the cross-over temperature T_{FL} to ~ 6 K. Previous calculations did not include effects of magnetic fields. Here, we will present the results of an extended calculation, which accounts for the role of applied field, allowing a comparison between high field resistivity measurements and the predictions of a magnetic fluctuation model.

[1] G. G. Lonzarich and L. Taillefer, J Phys C: Solid State Phys **18**, 4339-4371 (1985)
[2] R. Smith et al., Nature **455**, 1220-1223 (2008)

MA 55.23 Fri 10:30 P2

Spin-orbit torques in FePt/Pt films from first principles — •Guillaume Géranton, Frank Freimuth, Stefan Blügel, and Yuriy Mokrousov — Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany

Spin-orbit torques in ordered FePt/Pt thin films are investigated from Kubo linear response theory based on the first-principles electronic structure obtained within density functional theory (DFT). FePt/Pt thin films are identified as good candidates for spintronics applications for two reasons: First, large magnetocrystalline anisotropy values were reported in FePt. This suggests that the spin-orbit interaction is strong in this alloy. Thus, breaking of structural inversion symmetry in FePt/Pt films gives rise to relatively large spin-orbit torques (SOTs) on the magnetization. Second, FePt films grow pseudomorphically on Pt(001) substrate. The atomistic structure of FePt/Pt films can thus be well controlled and a high level of reproducibility is possible with respect to magnetic properties. In order to understand the mechanisms underlying the SOTs in FePt/Pt films, we compute the atom-resolved torkance and atom-resolved spin current flux for both even and odd parts of the torkance.

MA 55.24 Fri 10:30 P2

Parametric excitation of spin wave dynamics in a Permalloy nanoellipse — •Philipp Seibt[1], Henning Ulrichs[1], Vladislav Demidov[1], Sergej Demokritov[1], and Sergei Urazhdin[2] — [1]Institut für Angewandte Physik, Universität Münster, Corrensstraße 2-4, 48149 Münster, Germany — [2]Department of Physics, Emory University, Atlanta, GA 30322, USA

The excitation of spin waves with a desired spatial structure is of both fundamental interest and key importance for designing devices utilizing spin dynamics. Parametric excitation is a non-linear process that can access a wide range of spin wave modes. Here we investigate using micro-focus Brillouin light scattering spectroscopy parametrically excited spin waves in a Permalloy nanoellipse. We show that modes

localized at the edges of the ellipse have an anomalous spatial distribution and a significantly higher excitation threshold compared to modes localized at the center. We are able to qualitatively explain these results using micromagnetic simulations. Our work demonstrates that certain spin wave modes are highly sensitive to small deviations in sample properties such as saturation magnetization and thickness.

MA 55.25 Fri 10:30 P2

Determination of the Spin Hall Angle using Time and Spatially Resolved Ferromagnetic Resonance in Metallic Bi-layers — •Martin Decker[1], Christian Back[1], and Georg Woltersdorf[2] — [1]Department of Physics, University of Regensburg, 93053, Germany — [2]Department of Physics, MLU Halle-Wittenberg, 06099, Germany

We investigate the spin Hall effect in different ferromagnet(FM)/normal(NM) metal bi-layers and determine the spin Hall angle of the normal metal. Ferromagnetic Resonance (FMR) measurements are performed on a micro-structured bi-layer. The linear response of the magnetization to ac magnetic fields in the GHz range, created by a microstructured coplanar waveguide, is measured using time and spatially resolved Kerr microscopy. A dc current is applied to the bi-layer and causes the injection of a spin current from the normal metal (NM) into the ferromagnet (FM). This spin current induces a spin torque acting on the magnetization which in turn modifies the linewidth of the FMR signal. Measurements of the linewidth as a function of the applied current provide access to the spin Hall angle of the NM [1, 2]. In contrast to the widely used technique of spin pumping, our method also allows to study normal metals that do not have a large spin mixing conductance. We determine the Spin Hall angle of Platinum, Gold and Tantalum, using Permalloy as a ferromagnet.

[1] K. Ando et al., PRL 101, 036601 (2008).
[2] V.E. Demidov et al., APL 99, 172501 (2011).

MA 55.26 Fri 10:30 P2

Collective GHz excitations of Skyrmions and spin helices — •Ioannis Stasinopoulos[1], Thomas Schwarze[1], Andreas Bauer[2], Helmuth Berger[3], Johannes Waizner[4], Markus Garst[4], Christian Pfleiderer[2], and Dirk Grundler[1,5] — [1]Physik-Department E10, TU München, Garching, Germany — [2]Physik-Department E21, FG Magnetische Materialien, TU München, Garching, Germany — [3]EPFL, Institut de physique de la matiere complexe, Lausanne, Switzerland — [4]Institute for Theoretical Physics, Univ. Köln, Köln, Germany — [5]STI, EPFL, Lausanne, Switzerland

Skyrmions are topologically stable spin textures with the spins pointing in all directions wrapping up a sphere. They emerge in chiral-magnets, e.g. MnSi, at approximately 28K and arrange in a hexagonal lattice with typical lattice constants of several tens of nm. Due to spin transfer torque coupling of the Skyrmion lattice with electrical currents a tunable chiral-magnet based device could thus be obtained. Our group uses an all-electrical microwave spectroscopy setup based on a vector analyzer and lithographically fabricated coplanar waveguides to excite and simultaneously probe the Skyrmion states in MnSi. We study the temperature dependence and dispersion of the dynamics both in the ordered phases and above T_c. This investigation opens the way towards Skyrmion-GHz devices. Financial support by the DFG via TRR80 and NIM is acknowledged.

MA 55.27 Fri 10:30 P2

Chiral magnetic resonances of Skyrmions and helices — •Johannes Waizner[1], Markus Garst[1], Achim Rosch[1], Ioannis Stasinopoulos[2], Thomas Schwarze[2], Andreas Bauer[3], Helmuth Berger[4], Christian Pfleiderer[3], and Dirk Grundler[2,5] — [1]Institute for Theoretical Physics, Univ. Köln, Köln, Germany — [2]Physik Department, E10, TU München, Garching, Germany — [3]Physik Department, FG Magnetische Materialien, TU München, Garching, Germany — [4]EPFL, Institure de physique de la matière complexe, Lausanne, Swizerland — [5]STI, EPFL, Lausanne, Switzerland

Chiral magnets realize skyrmionic and helical magnetic textures. We study theoretically their microwave excitations driven by an oscillating magnetic or electric field. Extending the theory for ferromagnetic resonance (FMR) to the present case, we determine the position and the weight of the resonance frequencies including the effect of demagnetization fields and dipolar interactions. In contrast to the single Kittel mode present in polarized ferromagnets, we find multiple modes within the helical and skyrmion lattice phase with a characteristic dependence on the direction of both the applied static as well as the ac fields. Our theory is in quantitative agreement with recent experimental results.

MA 55.28 Fri 10:30 P2

Current induced domain wall nucleation and motion in an out-of-plane magnetized CoFeB-MgO nanowire — •Tomek Schulz[1], Tim Zacke[1], Su Jung Noh[1], Berthold Ocker[2], Capucine Borrowes[3], Dafiné Ravelsona[3], and Mathias Kläui[1] — [1]Institut of Physics, Johannes Gutenberg-Univesity Mainz, Germany — [2]Singulus Technologies AG, Kahl am Main, Germany — [3]Laboratoire de Physique des Solides, Universite Paris-sud, France

For a racetrack device, an appropriate material composition which is compatible with high TMR MgO-based barriers for readout has been developed. We report on transport measurements on a magnetic nanowire structure consisting of a Ta/CoFeB/MgO-multilayer with a perpendicular magnetic anisotropy. By applying single short current pulses through a gold wire on top of the nanowire it is possible to nucleate domain walls only by the generated Oersted field. After the nucleation, we investigated the spin torque properties of this multilayer stack for current induced domain wall motion using the current-field equivalence method [1]. Another approach to determine the acting torques is using the 2nd Harmonics signal of an alternating current [2].

[1] J. Heinen et al., Appl. Phys. Lett. 96, 202510 (2010) [2] U. H. Pi et al., APL, 97, 162507 (2010)

MA 55.29 Fri 10:30 P2

A novel approach on imaging current-induced spinwave dynamics — •Johannes Stigloher, Jean-Yves Chauleau, Hans Bauer, Helmut Körner, Georg Woltersdorf und Christian Back — Department of Physics, Universität Regensburg, D-93040 Regensburg, Germany

The spin transfer torque (STT) has been an active field of experimental and theoretical research for the last 15 years. STT is accessed by evidencing the consequences of an applied electric current on different magnetic textures such as domain walls, vortex cores or magnetostatic spinwaves. The latter, evidenced by the pioneer work of Vlaminck and Bailleul (Science 320, 410 (2008)), has shown the ability of determining the parameters in a self-consistent way on a single sample. After addressing this subject using time-resolved scanning Kerr microscopy (TRMOKE), we present a preliminary work on an alternative approach of optical detection of current-induced spinwave dynamics. The principle of the approach is the modulation at a low frequency of the applied current, associated to a dual Lock-in amplifier detection. It allows a substantial noise reduction and a direct access to the effect of spin-polarized currents on spinwave characteristics. Subsequently, this approach would open the possibility to spatially resolved STT in more complicated spinwave profiles.

MA 55.30 Fri 10:30 P2

Bose-Einstein condensation of exchange magnons — •Peter Clausen[1], Dmytro A. Bozhko[1], Vitaliy I. Vasyuchka[1], Alexander A. Serga[1], Gennadii A. Melkov[2], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, Germany — [2]Faculty of Radiophysics, Taras Shevchenko National University of Kyiv, Ukraine

The technique of parallel parametric pumping is widely used to inject magnons in ferri- and ferromagnetic films. However, the physics of the evolution of a parametrically pumped magnon gas is still under investigation. We report on this evolution by four-magnon scattering of a non-equilibrium magnon gas in time and wavevector space.

The measurements were performed using a combined microwave and Brillouin light scattering (BLS) setup.

We find two groups of magnons at different positions in time and wavevector space. We identify them with the parametrically pumped magnons and the magnon Bose-Einstein-condensate at the bottom of the magnon spectrum. However, there is a 25 ns long gap between those two magnon groups where no BLS signal is observed.

Our model shows, that this gap in the BLS signal can be explained solely by multi-stage four-magnon scattering from energy minima to minima of high longitudinal BVMSW thickness mode mainly outside of the wavevector detection window of $(0 - 12) \cdot 10^4$ rad/cm from the experimental setup.

Support by the DFG within the SFB/TRR 49 is gratefully acknowledged.

MA 55.31 Fri 10:30 P2

Femtosecond demagnetization of Nickel/Gold: rotation

vs. ellipticity — •Jurij Urbancic, Oliver Schmitt, Moritz Barkowski, Steffen Eich, Jingyi Mao, Sakshath S, Daniel Steil, Mirko Cinchetti, Stefan Mathias, and Martin Aeschlimann — Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

Using femtosecond time-resolved MOKE to study ultrafast demagnetization is today a standard experimental approach. However, there is still an ongoing debate on the so called optical artifacts in the signal, and when and how true magnetization dynamics is extracted. In our measurements of ultrafast demagnetization of Ni/Au, we have the peculiar situation that the MOKE rotation & ellipticity signals differ by demagnetization constants of a factor of two. In order to distinguish demagnetization from non-magnetic effects, we study this system with different fs-techniques and for varying material compositions.

MA 55.32 Fri 10:30 P2

Ultrafast magnetic and structural dynamics in antiferromagnetic Europium-Telluride — •Christoph Trabant[1,2,3,6], Niko Pontius[1], Karsten Holldack[1], Enrico Schierle[1], Eugen Weschke[1], Torsten Kachel[1], Rolf Mitzner[1], Martin Beye[1], Gunther Springholz[4], Georgi Dakovski[5], Joshua J Turner[5], Stefan Möller[5], Tianhan Wang[5], Alex Gray[5], Markus Hantschmann[5,1], Hermann Dürr[5], Michael Minitti[5], W.S. Lee[5], Yi-De Chuang[5], Zuman Hussain[5], Z.X. Shen[5], Matias Bargheer[3], Daniel Schick[3], Alexander Föhlisch[1,3], and Christian Schüssler-Langeheine[1] — [1]Helmholtz-Zentrum Berlin — [2]II. Physikalisches Institut, Universität zu Köln — [3]Institut für Physik und Astronomie, Universität Potsdam — [4]Institute of Semiconductor and Solid State Physics, Johannes Kepler Universität Linz, Austria — [5]SLAC RSXS collaboration, USA — [6]present address: Institut für Experimentalphysik, FU Berlin

We studied the laser induced ultrafast magnetic and structural dynamics of a metallic 4f semiconductor and antiferromagentic EuTe thin film. The dynamics were mapped using the strong resonant x-ray scattering signal of the antiferromagnetic (001/2) superstructure and (001) structural reflection. Here we show how different excitation scenarios have similiar but at certain delays crucially different influence on the ultrafast magnetic and structural dynamics. The optical pump xray probe measurements have been performed in one experiment at the SXR-beamline of LCLS. Supported by the BMBF through contract 05K10PK2.

MA 55.33 Fri 10:30 P2

Transport effects in metals driven by the nonequilibrium in electron temperatures and chemical potentials — •Linda Thesing, Benedikt Y. Mueller, and Baerbel Rethfeld — Department of Physics and Research Center OPTIMAS, University of Kaiserslautern, Germany

By exciting a metal sample with an ultrashort laser pulse, not only the electron temperature but also the chemical potential are spatially disturbed. We developed a μT model for a metallic slab which determines the dynamics of electron and phonon temperatures. In addition, we trace the chemical potential explicitly as an dynamic quantity. Thus, our model allows for additional transport effects, like Seebeck or Peltier effect, which would not be accessible with an ordinary two temperature model (2TM) [1]. The μT model is based on a reformulation of the 2TM and the heat and particle fluxes are determined by the Boltzmann equation within a relaxation approach. Our model also promises insights in the magnetization dynamics, when spin-up and spin-down electrons are considered separately. Spin-flip scattering processes driven by different chemical potentials [2,3] can then be traced simultaneously with transport effects.

[1] Anisimov et al., Sov. Phys.-JETP 39, 375 (1974)
[2] Mueller et al., PRL 111, 167204 (2013)
[3] Mueller et al., NJP 13, 123010 (2011)

MA 55.34 Fri 10:30 P2

Single NV center spin driven by resonant and near-resonant microwave field — •Ganesh Rahane[1], Andrii Lazariev[1], Perunthiruthy Madhu[2], and Gopalkrishnan Balasubramanian[1] — [1]Max Planck Research Group "Nanoscale Spin Imaging", Max Planck Instiute for Biophysical Chemistry, Goettingen, Germany — [2]Dept. of Chemical Sciences, TIFR, Mumbai, India

Optical initialization and detection of nitrogen-vacancy(NV) center spin state at room temperature makes NV center system suitable for variety of applications. The dressed state transitions are important for polarization transfer from NV center spin to surrounding spin bath under Hartmann Hahn condition. The resonant and near-resonant field driving for two-level system corresponding to single quantum transition from single NV center ground state is studied. The Autler-Townes effect and Multi-photon processes are observed. The dependence of Autler-Towenes and Multi-photon transitions on strength and detuning of resonant and near-resonant field is studied.The single quantum transition in NV center ground state is good candidate for qubit because simulation performed for bichromatically driven two level-system matches closely with the experimental result.

MA 55.35 Fri 10:30 P2

Ultra low magnetic damping in half metalic CrO_2 — •Markus Härtinger[1], Tim Mewes[2], Arunava Gupta[2], Georg Woltersdorf[1,3], and Christian Back[1] — [1]Department of Physics, Universität Regensburg, 93040 Regensburg, Germany — [2]University of Alabama, Tuscaloosa, U.S.A. — [3]Department of Physics, Martin-Luther-Universität Halle, 06099 Halle(Saale), Germany

Chromiumdioxide (CrO_2) is one of the most interesting half-metallic ferromagnets with a large spin polarization and a high Curie temperature. It was studied for a long time and used for various magnetic storage devices. Since few years it is possible to grow high quality single crystalline CrO_2 films by chemical vapour deposition (CVD).

We report on the magnetic properties and anisotropies of a 29 nm thick CrO_2 (100) layer grown on a TiO_2 (001) substrate. The magnetic properties are determined by performing ferromagnetic resonance (FMR) measurements in a large frequency range covering 2 to 40 GHz. We find extremely narrow resonance lines corresponding to a very small Gilbert damping constant of approximately $\alpha \approx 0.0002 - 0.0004$. Our angular dependent measurements also show that two magnon scattering dominates the relaxation when the magnetization lies in the sample plane.

MA 55.36 Fri 10:30 P2

Ion Beam Induced Periodic Surface Defects: The Transition from a Thin Film to a Magnonic Crystal — •Manuel Langer[1,2], Rodolfo A. Gallardo[3], Anja Banholzer[1,2], Andreas Jansen[1,2], Tobias Schneider[1,2], Kai Wagner[4], Vladislaw Demidov[5], Sergej O. Demokritov[5], Pedro Landeros[3], Kilian Lenz[1], Jürgen Lindner[1], and Jürgen Fassbender[1,2] — [1]HZDR, 01328 Dresden — [2]TU Dresden, 01069 Dresden — [3]UTFSM Valparaíso, Chile — [4]University Duisburg-Essen, 47057 Duisburg — [5]University Münster, 48149 Münster

Periodic arrays of magnetic stripe defects are fabricated by Cr^+ ion implantation on a 30 nm permalloy film. Modifying the mean ion penetration depth, the defect height can be controlled, which allows an investigation of the gradual transition from a magnetic thin film towards a magnonic crystal.

Spin wave dispersion and two-magnon scattering are studied using brillouin light scattering (BLS) as well as broadband ferromagnetic resonance (FMR). The obtained results are corroborated by theoretical calculations based on a perturbation theory.

MA 55.37 Fri 10:30 P2

Ultrafast magnetization dynamics probed by Lorentz microscopy with temporally structured illumination — •Jan Gregor Gatzmann[1], Vladyslav Zbarsky[2], Markus Münzenberg[2], Sascha Schäfer[1], and Claus Ropers[1] — [1]IV. Physikalisches Institut, Universität Göttingen — [2]I. Physikalisches Institut, Universität Göttingen

Combining transmission electron microscopy (TEM) with ultrashort sample excitation allows for the observation of ultrafast dynamics at the nanoscale. Whereas ultrafast laser-pump/ electron-probe experiments were recently developed, the benefits of temporally structured illumination with femtosecond pulse trains in a conventional TEM remain rather unexplored. Here, we use Lorentz microscopy to study the irreversible magnetization dynamics in iron thin-films triggered by femtosecond optical pulses. At low excitation fluence, we observe a laser-induced switching of ripple domains, with characteristic patterns shaped by pinned domain walls. At a well-defined fluence threshold, the generation of magnetic vortex-antivortex networks is initiated. The dynamical nature of these processes is investigated utilizing femtosecond pulse pairs with variable delay times.

MA 55.38 Fri 10:30 P2

Ultrafast magnetization dynamics of Copper-doped FePt thin films for different Copper contents and fluences. — •Oliver

Schmitt[1], Daniel Steil[1], Sabine Alebrand[1], Stefan Mathias[1], Mirko Mirko[1], Martin Aeschlimann[1], Fabian Ganss[2], Christoph Brombacher[2], and Manfred Albrecht[2] — [1]Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany

Future magnetic data storage devices require high density information packing. A typical material is an FePt thin film with high perpendicular magnetic anisotropy [1]. It is chemically ordered in the L10 phase. Here we investigate this material doped with different Cu contents from 15 to 25 percent using the femtosecond time-resolved magneto-optical Kerr-Effect. For all samples the speed of demagnetization increases very strongly for the highest magnetization quenchings. This behaviour has been proposed for 3d ferromagnets like Ni oder Co [2]. Moreover, we find for the FePt:Cu sample with 25% Cu a transient ferromagnetic-like state on ultrafast and picosecond timescales.

[1] S. H. Sun, C. B. Murray, D. Weller, L. Folks and A. Moser, Science 287, 1989 (2000). [2] B. Koopmans, G. Malinowski, F. Dalla Longa, D. Steiauf, M. Fähnle, T. Roth, M. Cinchetti and M. Aeschlimann, Nature Materials 9, 259*265 (2010)

MA 55.39 Fri 10:30 P2

Spin current in a ferromagnetic chain — •Seyyed Ruhollah Etesami[1,2], Levan Chotorlishvili[2], Alexander Sukhov[2], and Jamal Berakdar[2] — [1]Max Planck Institute of Microstructure Physics, Halle, Germany — [2]Martin Luther University Halle-Wittenberg, Halle, Germany

The long-range thermal injection of the spin current from a ferromagnet (FM) to the adjacent normal metal (NM), known as spin Seebeck effect (SSE), has paved the way for developing more efficient thermoelectric devices. Since the FM-NM interface plays the key role in SSE, the focus of the studies mainly is on the FM-NM interface and the ferromagnet is modeled just as a single domain. But in order to understand SSE the knowledge of spin current generated in the ferromagnet is also indispensable, although it's not yet well understood. In this study we were interested to turn our focus on the generated spin current in the ferromagnet part. We modeled ferromagnet part as a chain of magnetic moments under a temperature gradient. We used the stochastic Landau-Lifshitz-Gilbert (LLG) equation to describe the dynamic of the ferromagnet chain. The generated spin current along the chain at different circumstances was studied. Finally,the FM-NM interface effect was studied by adding the spin pumping and spin-transfer torques to the LLG equation.

MA 55.40 Fri 10:30 P2

Element-specific magnetization dynamics in Gd doped Ni81Fe19 films — •Ruslan Salikhov[3], Radu Abrudan[1], Florian Römer[3], Florin Radu[2], Ralf Meckenstock[3], Hartmut Zabel[1], and Michael Farle[3] — [1]Ruhr-Universität Bochum, Germany — [2]Helmholtz Zentrum Berlin, Germany — [3]Universität Duisburg-Essen, Germany

We have studied magnetization dynamics in Ni81Fe19 films doped by Gd with different concentrations (5, 9 and 13 at.%) using ferromagnetic resonance (FMR) [1] and time-resolved x-ray resonant magnetic scattering (tr-XRMS) implemented at the Helmholtz Zentrum Berlin [2]. At room temperature two antiferromagnetically coupled sublattices Fe (Ni) and Gd show identical response after magnetic field pulse excitation, having similar Landau-Lifshitz (LL) relaxation rate (λ) and precessional frequency (f). The FMR dimensionless damping parameter α increases with increasing Gd content. However, λ obtained from the tr-XRMS shows the opposite trend with increasing Gd concentration. At low temperatures (100 and 50 K) we have found that Fe and Gd sublattices precess noncollinear (with different precessional angles in respect to initial state). Noncollinear precession of the Fe and Gd magnetic moments accompanied with increase in both λ and f. Our results will be discussed in the frame of the "s-d exchange model" [3] and the "slow relaxing" impurity model [4].

[1] F. Römer et al., APL. 100, 092402 (2012). [2] R. Salikhov et al., PRB 86, 144422 (2012). [3] B. Heinrich et al., Phys. Stat. Sol. 23, 501 (1967). [4] G. Woltersdorf et al., PRL. 102, 257602 (2009).

MA 55.41 Fri 10:30 P2

Femtosecond demagnetization of Nickel/Gold: rotation vs. ellipticity — •Jurij Urbancic, Oliver Schmitt, Moritz Barkowski, Steffen Eich, Jingyi Mao, Sakshath Sadashivaiah, Daniel Steil, Mirko Cinchett, Stefan Mathias, and Martin Aeschliman — Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, DE

Using femtosecond time-resolved MOKE to study ultrafast demagnetization is today a standard experimental approach. However, there is still an ongoing debate on the so called optical artifacts in the signal, and when and how true magnetization dynamics is extracted. In our measurements of ultrafast demagnetization of Ni/Au, we have the peculiar situation that the MOKE rotation & ellipticity signals differ by demagnetization constants of a factor of two. In order to distinguish demagnetization from non-magnetic effects, we study this system with different fs-techniques and for varying material compositions.

MA 55.42 Fri 10:30 P2

DC-Inverse Spin Hall Effect in Permalloy/Normal Metal Bilayers — •Martin Obstbaum[1], Markus Härtinger[1], Hans G. Bauer[1], Thomas Meier[1], Fabian Swientek[1], Christian H. Back[1], and Georg Woltersdorf[1,2] — [1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg,93040 Regensburg, Germany — [2]Physik, Martin Luther-Universität Halle, von Danckelmann-Platz 3, 06120 Halle

We present a study of the dc-voltage generation by the inverse spin Hall effect (ISHE) and the anisotropic magnetoresistance (AMR) in permalloy/normal metal bilayers at ferromagnetic resonance (FMR). We use a coplanar waveguide (CPW) structure implementing different excitation geometries. At FMR spin currents with a small dc-component are injected into the normal metal layer due to the spin pumping effect. Measurements of permalloy/platinum and permalloy/gold show that the ISHE and the AMR effect can only be separated for certain conditions. Furthermore, we point out that a conductive layer (e.g. Pt, Au) attached to the permalloy layer generates a significant additional Oersted field in experiments using a CPW. Our study provides a robust experimental basis in the quest for materials showing a large spin Hall angle. We present a reliable determination of spin Hall angles for platinum and gold and a study of ISHE in tantalum, tungsten and metal alloys such as copper-bismuth. Moreover, the contributions to voltages measured at FMR have been studied as a function of temperature and the results are compared to theoretical models.

MA 55.43 Fri 10:30 P2

Microscopic spin dynamics with coupling to a phonon bath — •Svenja Vollmar[1,2], Alexander Baral[1], and Hans Christian Schneider[1] — [1]Department of Physics and Research Center of OPTIMAS, University of Kaiserslautern — [2]Graduate School of Excellence Materials Science in Mainz

To describe different aspects of magnetization dynamics, from magnetization precession to demagnetization dynamics, phenomenological models are used with considerable success. These usually include the spin-orbit interaction and treat certain interactions involving the spin degrees of freedom by introducing baths. Here we investigate different aspects of a s-d(f) model that explicitly includes itinerant charge carriers with spin, the spin-orbit coupling, and the exchange coupling to a localized spin system. Importantly, the interaction with the phonon bath is derived microscopically.

First, we focus on the interaction between antiferromagnetically coupled itinerant carriers and a macroscopin. We calculate the microscopic spin dynamics including a Rashba spin-orbit coupling and the coupling to a phonon bath. Additionally, we extrapolate dephasing and magnetization times.

Next, we investigate the intrinsic spin dynamics of a Heisenberg model coupled to a bath. We derive equations of motion for the excitations in the spin system (magnons) in order to study their relaxation dynamics. The coupling to a phonon bath is described by using a Lindblad-operator formalism.

MA 55.44 Fri 10:30 P2

Magnetic Damping: Domain Wall Dynamics vs. Local Ferromagnetic Resonance — •Tobias Weindler, Hans Bauer, Robert Islinger, Benedikt Boehm, Jean-Yves Chauleau, and Christian Back — Department of Physics, Universität Regensburg, D-93040 Regensburg, Germany

The damping coefficient (α) is a crucial quantity for any magnetization dynamics study. It plays a major role especially in domain wall (DW) dynamics where DW displacement is directly related to relaxation effects. For DWs submitted to magnetic fields, the domain wall mobility in the steady state regime is inversely proportional to α whereas it is proportional in the steady precessional regime. For current-induced DW motion, the mobility in the steady state regime is proportional to

the ratio between the non-adiabaticity and the relaxation. However significant discrepancies have been reported for values of α measured in extended magnetic layers by ferromagnetic resonance (FMR) and when is used as an adjustment parameter in micromagnetic simulation of DW motion in magnetic stripes. In our study, we experimentally address this issue by consistently assessing α in Ni80Fe20 (Permalloy) from two different approaches on the same nanostructure. On one hand we use time-resolved scanning Kerr microscopy (TRMOKE) to perform local FMR on single Ni80Fe20 nanostripes. On the other hand, in the same nanostripes, domain walls are injected and field-driven displacements are evidenced and analysed by wide-field Kerr microscopy.

MA 55.45 Fri 10:30 P2

Time-resolved soft X-ray microscopy of magnetic nanostructures at the P04 beamline of PETRA III — •Philipp Wessels[1], Johannes Ewald[2], Marek Wieland[1], Thomas Nisius[2], Gennaro Abbati[2], Stefan Baumbach[2], Jens Viefhaus[3], Thomas Wilhein[2], and Markus Drescher[1] — [1]Institute for Experimental Physics, University of Hamburg, Germany — [2]Institute for X-Optics, RheinAhrCampus Remagen, Germany — [3]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

We present first time-resolved measurements obtained with a new transmission microscope at the soft X-ray beamline P04 of the high brilliance synchrotron radiation source PETRA III.

A nanostructured magnetic permalloy ($Ni_{80}Fe_{20}$) sample can be excited either by making use of a mobile synchronized femtosecond laser system or by a 250 ps electric current pulse via a coplanar waveguide. The full-field soft X-ray microscope successively probes the time evolution of the magnetization in the sample via XMCD spectromicroscopy in a pump-probe scheme. Static and transient magnetic fields are available in the sample plane by permanent magnets and coils to reset the system and to provide external offset fields.

The microscope generates a flat-top illumination field of 20 μm diameter by using a grating condenser and the sample plane is directly imaged by a micro zone plate with < 65 nm resolution onto a 2D gateable X-ray detector to select one particular bunch in the storage ring that probes the dynamic information.

MA 55.46 Fri 10:30 P2

Dispersive Magnon Excitations in $Ca_3Co_2O_6$ — •Pavlo Y. Portnichenko[2], Anil Jain[1], Hoyoung Jang[1], Alexandr Ivanov[3], Bernhard Keimer[1], and Dmytro S. Inosov[2] — [1]Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, 70569 Stuttgart, Germany. — [2]Institut für Festkörperphysik, TU Dresden, Zellescher Weg 16, D-01069 Dresden, Germany. — [3]Institut Laue-Langevin, 6 rue Jules Horowitz, BP 156, 38042 Grenoble Cedex, France.

The geometrically frustrated trigonal cobaltate $Ca_3Co_2O_6$ is considered to be a model system for a one-dimensional Ising-like antiferromagnet. Its crystal structure represents a hexagonal arrangement of one-dimensional chains, which consist of alternating nonmagnetic CoO_6 octahedra and CoO_6 trigonal prisms with a large magnetic moment.

Using inelastic neutron scattering, we have observed a quasi-one-dimensional dispersive magnetic excitation in the frustrated triangular-lattice spin-2 chain oxide $Ca_3Co_2O_6$. At the lowest temperature ($T = 1.5$ K), this magnon is characterized by a large zone-center spin gap of ~ 27 meV, which we attribute to the large single-ion anisotropy, and disperses along the chain direction with a bandwidth of ~ 3.5 meV. In the directions orthogonal to the chains, no measurable dispersion was found. With increasing temperature, the magnon dispersion shifts towards lower energies, yet persists up to at least 150 K, indicating that the ferromagnetic intrachain correlations survive up to six times higher temperatures than the long-range interchain antiferromagnetic order.

MA 55.47 Fri 10:30 P2

Majorana spin liquid and dimensional reduction in Cs_2CuCl_4 — Tim Herfurth[1,2], •Simon Streib[1], and Peter Kopietz[1,2] — [1]Institut für Theoretische Physik, Universität Frankfurt, Max-von-Laue Strasse 1, 60438 Frankfurt, Germany — [2]Department of Physics, University of Florida, Gainesville, Florida 32611, USA

The low-temperature behavior of the magnetic insulator Cs_2CuCl_4 can be modeled by an anisotropic triangular lattice spin-1/2 Heisenberg antiferromagnet with two different exchange couplings J and $J' = J/3$. We show that in a wide range of magnetic fields the experimentally observed field dependence of the crossover temperature T_c for spin-liquid behavior can be explained within a mean-field theory based on the representation of spin operators in terms of Majorana fermions. In the spin-liquid regime, the Majorana fermions can only propagate along the direction of the strongest bond, which implies that we are dealing with a quasi-one-dimensional spin-liquid phase. Next, we investigate the coupling of the spin degrees of freedom to phonons for a one-dimensional spin-liquid. To this end, we consider the one-dimensional spin-1/2 Heisenberg antiferromagnet with nearest neighbor exchange interaction and include the magneto-elastic coupling by expanding the exchange interactions up to second order in powers of the phonon coordinates. We present theoretical results for the magnetic field and temperature dependence of the elastic constants and the ultrasonic attenuation rate in the one-dimensional spin-liquid phase.

MA 55.48 Fri 10:30 P2

10th order high-temperature expansion for the susceptibility and the specific heat of spin-s Heisenberg models with arbitrary exchange patterns: Application to pyrochlore and kagome magnets — •J. Richter[1], A. Lohmann[1], and H.-J. Schmidt[2] — [1]University Magdeburg, Germany — [2]University Osnabrueck, Germany

We present the high-temperature expansion (HTE) up to 10th order of the specific heat C and the uniform susceptibility χ for Heisenberg models with arbitrary exchange patterns and arbitrary spin quantum number s. We encode the algorithm in a C++ program available at `http://www.uni-magdeburg.de/jschulen/HTE/` which allows to get explicitly the HTE series for concrete Heisenberg models. We apply our algorithm to pyrochlore and kagome magnets. For the pyrochlore FM we use the HTE to estimate the Curie temperature T_c as a function of the spin quantum number s. We find that T_c is smaller than that for the simple cubic lattice, although both lattices have the same coordination number. For the kagome AFM the influence of the spin quantum number s on χ as a function of renormalized temperature $T/s(s+1)$ is rather weak for temperatures down to $T/s(s+1) \sim 0.3$. On the other hand, the specific heat as a function of $T/s(s+1)$ noticeably depends on s. The characteristic maximum in $C(T)$ is monotonously shifted to lower values of $T/s(s+1)$ when increasing s.

[1] H.-J. Schmidt, A. Lohmann, and J. Richter, Phys. Rev. B 84, 104443 (2011). [2] A. Lohmann, H.-J. Schmidt, and J. Richter, arXiv:1309.0940.

MA 55.49 Fri 10:30 P2

Structural and magnetic phase transitions in antiferromagnetic $PrCaFeO_4$ — •Navid Qureshi[1], Martin Valldor[1,2], Lisa Weber[1], Anatoliy Senyshyn[3], Yvan Sidis[4], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln — [2]MPI für Chemische Physik fester Stoffe — [3]Technische Universität München, FRM-II — [4]Laboratoire Léon Brillouin, C.E.A. Saclay

We present a comprehensive study on $PrCaFeO_4$ using macroscopic methods, neutron and x-ray diffraction as well as inelastic neutron scattering. Two single crystals have been grown which exhibit two structural and one magnetic phase transition as seen from single differential thermal analysis and neutron diffraction. In contrast, the very closely related compound $LaSrFeO_4$ stays tetragonal ($I4/mmm$) throughout the whole temperature range [1]. The transition temperature and especially the transition regime of the spin reorientation from an in-plane configuration (like in $LaSrFeO_4$) to the c axis is strikingly different between the two samples suggesting a strong influence of the crystal quality on the magnetic properties. Inelastic neutron scattering reveals a smaller anisotropy gap in the low-temperature magnetic phase, whereas the coupling constants only change for the interplane interaction between the two phases. The spin reorientation and the decreasing gap result from an interplay between magnetostriction and spin-orbit coupling closely connected to the temperature-induced structural changes of lattice constants and octahedral tilts.

[1] N. Qureshi et al., Phys. Rev. B 87, 054433 (2013).

MA 55.50 Fri 10:30 P2

Metamagnetic transitions in U_2Ni_2Sn probed by high-field magnetization and acoustic measurements — •S. Yasin[1], A.V. Andreev[2], Y. Skourski[1], S. Zherlitsyn[1], and J. Wosnitza[1] — [1]Dresden High Magnetic Field Laboratory, Helmholtz-Zentrum Dresden-Rossendorf, 01314 Dresden, Germany — [2]Institute of Physics ASCR, Na Slovance 2, 18221 Prague 8, The Czech Republic

Uranium intermetallic compounds are subjects of intensive fundamental research. The competition between exchange interactions, crystal-field and hybridization effects plays a major role in the formation of

$5f$ magnetic moments and the magnetic ordering. We report on magnetization and ultrasound measurements on antiferromagnet (T_N = 25 K) U_2Ni_2Sn single crystal in pulsed magnetic fields up to 62 T. At T = 1.5 K, three metamagnetic transitions were observed at 30, 40, and 52 T for the magnetic field applied along the c axis. No sign of saturation up to the highest fields was found. Interestingly, the magnetization reaches a value of 1.5 μ_B/f.u. at 60 T which is higher than the uranium magnetic moments (1.05 μ_B at 1.5 K) reported by powder neutron-diffraction. This observation suggests that additional magnetic moments of delocalized electrons are induced by the applied magnetic field. All three metamagnetic transitions are accompanied by pronounced anomalies in the acoustic characteristics. Moreover, in zero magnetic field the sound velocity exhibits an anomaly at T_N. Our results evidence the important role of complex magneto-elastic couplings in this material. The magnetization processes and spin-strain couplings are discussed.

MA 55.51 Fri 10:30 P2

Critical magnetic fluctuations in Heisenberg antiferromagnets — •Kuo Feng Tseng[1], Andrew Walters[1], Thomas Keller[1,2], Sibel Bayrakci[1], and Bernhard Keimer[1] — [1]Max-Planck-Institut für Festkörperforschung, Heisenbergstrasse 1, D-70569 Stuttgart, Germany — [2]Max Planck Society Outstation at the Forschungsneutronenquelle Heinz Maier-Leibnitz (FRM-II), D-85747 Garching, Germany

We have performed elastic and inelastic neutron scattering measurements in classical Heisenberg antiferromagnets MnF_2 (3D) and Rb_2MnF_4 (2D) with a Néel temperature T_N of 67.4 and 38.4 K respectively. We utilized high resolution spin-echo and Larmor diffraction techniques at the TRIple axis resonance SPin echo spectrometer (TRISP). By appropriately choosing field geometries at TRISP, we are able to separate the longitudinal and transverse correlations of the critical fluctuations close to T_N with the advantages of neutron ray-tracing method. Determinations of the longitudinal and transverse linewidths (=inverse lifetime) on MnF_2 and Rb_2MnF_4 were obtained at TRISP with extremely high resolution in a micronelectron-volt range. The results and technique open up a new avenue for a re-investigation of underlying physics in the critical phenomena.

MA 55.52 Fri 10:30 P2

Orphan spins on the checkerboard lattice — •Jorge Rehn, Arnab Sen, Alexei Andreanov, and Roderich Moessner — MPIPKS, Dresden, Germany

Geometrically frustrated systems having a Coulomb phase, i.e., a system with a macroscopically degenerate ground state with power law decaying correlations, exhibit interesting low temperature excitations, e.g., in spin ice effectively described by interacting magnetic monopoles, which are created once the ice rules constraints are violated.

The consideration of disorder in systems with a Coulomb phase, such as the effects of dilution of non-magnetic impurities in the composite SCGO, leads to a similar effective picture: the ice rules constraints are violated because a "Orphan Spin" is left alone with non-magnetic impurities as neighbours.

An effective low temperature theory for such system describes the interactions among the Orphan Spins in terms of the correlations in the ground state of the pure system. In this project we show that the effective interactions of Orphan Spins on the checkerboard lattice must be of logarithmic form, if the temperatures are low enough. Monte Carlo simulations have been carried on to investigate the possibility of a spin glass phase. The main numerical results supporting the presence of a spin glass phase transition in this system are shown.

MA 55.53 Fri 10:30 P2

Electron holography on ripple-shaped magnetic permalloy thin films — •Falk Röder[1], Michael Körner[2,3], Monika Fritzsche[2,3], Kilian Lenz[2], Jürgen Lindner[2], Jürgen Fassbender[2,3], and Hannes Lichte[1] — [1]Triebenberg Laboratory, Institute of Structure Physics, Technical University of Dresden, 01062 Dresden, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Bautzner Landstr. 400, 01328 Dresden, Germany — [3]Technical University of Dresden, 01062 Dresden, Germany

By means of off-axis electron holography, we study the distribution of the magnetic induction within and around a poly-crystalline permalloy ($Ni_{81}Fe_{19}$) thin film. Its deposition on a silicon substrate with a given periodic surface morphology emerging through concerted Xe^+ ion beam erosion introduces a ripple shape to the permalloy thin film. The created ripple morphology is expected to modify the magnetization distribution within the permalloy and to induce dipolar stray fields. Micro-magnetic simulations estimate those stray fields in the order of only 10 mT. Consequently, their experimental determination at nanometer spatial resolution is highly demanding and requires advanced acquisition and reconstruction techniques such as electron holography. The reconstructed magnetic phase images show magnetized thin films, in which the magnetization direction follows the given morphology. Furthermore, a closer look to the permalloy/carbon interface reveals stray fields at the detection limit of the method in the order of 10 mT, which agrees well with micro-magnetic simulations.

MA 55.54 Fri 10:30 P2

Growth, ferromagnetism and electronic properties of the magnetic oxide EuO on conductive SrTiO3 — •Patrick Lömker[1], Bernardus Ziljstra[1], Christian Caspers[1], Michael Hoppe[1], Andrei Glosovskij[2], Wolfgang Drube[2], Claus M. Schneider[1,3], and Martina Müller[1,3] — [1]Peter-Grünberg-Institut (PGI-6), Forschungszentrum Jülich — [2]Petra III, DESY, Hamburg — [3]Fakultät für Physik, Universität Duisburg-Essen

The spin-filter tunnelling effect, which occurs in magnetic insulators like EuO, is an efficient route to generate highly spin-polarized electron currents for spintronic applications. However, only theoretical studies exist for single-crystalline magnetic oxide tunnel barriers, in which band-structure dependent properties are taken into account.

In this regard, we propose a model system based on EuO epitaxially stabilized on Nb-doped SrTiO3(001) (Nb-STO). We succeeded to grow epitaxial ultrathin films ($d = 1 - 15$ nm) of stoichiometric EuO on Nb-STO(001) using oxide molecular beam epitaxy. The structural properties have been analysed by in situ RHEED and LEED, showing a single crystalline growth mode. SQUID measurements display bulk-like ferromagnetic properties ($T_C = 69$ K) for $d > 4$ nm, whereas a reduction of T_C is observed for $d < 4$ nm. Hard X-ray photoelectron spectroscopy experiments reveal the chemical properties and homogeneity of the EuO/Nb-STO heterostructures.

Finally, transport measurements are envisioned to reveal spin filtering in fully epitaxial Euo/STO tunnel junctions.

MA 55.55 Fri 10:30 P2

Behavior of MnSi thin films under hydrostatic pressure — •Josefin Engelke[1], Dirk Menzel[1], Hiroyuki Hidaka[2], Taisei Seguchi[2], and Hiroshi Amitsuka[2] — [1]IPKM, TU Braunschweig, Mendelssohnstr. 3, 38106 Braunschweig, Germany — [2]Graduate School of Science, Hokkaido University, Sapporo 060-0810, Japan

Recently, thin films of the B20 compound MnSi became subject of great interest, since the magnetic properties of bulk MnSi can be modified by inducing uniaxial anisotropy. In comparison to the bulk the critical fields are enhanced and the skyrmion phase is found to be enlarged within the magnetic phase diagram [1],[2]. Furthermore the ordering temperature of 43 K is considerably higher than in bulk ($T_{ord,bulk}$ = 29 K).

Under applied hydrostatic pressure the ordering temperature of bulk MnSi decreases with increasing pressure, and a non-Fermi liquid behavior for pressures exceeding 12 kbar occurs. At 14.6 kbar the magnetic order is completely suppressed [3].

We present resistivity measurements on MnSi thin films under applied pressure of up to around 40 kbar. Qualitatively, the behavior is similar to bulk MnSi. However, the critical pressure is considerably enhanced. Non-Fermi liquid behavior evidenced by a $T^{3/2}$ behavior of the resitivity is observed, when the pressure reaches 33 kbar.

[1] J. Engelke et al., J. Phys. Soc. Japn. 81, 124709 (2012). [2] M. N. Wilson et al., Phys. Rev. B 86, 144420 (2012). [3] C. Pfleiderer et al., Phys. Rev. B 55, 8331 (1997).

MA 55.56 Fri 10:30 P2

Spin-reorientation transition and domain structure in Ni_xPd_{1-x} alloys — •Daniel Gottlob[1,2], Ingo Krug[1], Hatice Doğanay[1], Florian Nickel[1], Stefan Cramm[1], and Claus Schneider[1,2] — [1]Forschungszentrum Juelich, 52425 Juelich — [2]Fakultaet fuer Physik, Universitaet Duisburg-Essen, 47057 Duisburg

We chose the model system Ni_xPd_{1-x} to investigate different mechanisms involved in (inverse) spin-reorientation transitions (iSRTs). The 3d-4d hybridization between Ni and Pd and the strain variation by composition offer a way to tune the magnetic anisotropy. Aberration-corrected LEEM-PEEM with its high spatial resolution is the ideal tool to investigate the magnetic domain-structure and do composition-

gradient dependent studies on microwedges and thin films. By alloying Palladium into Nickel the epitaxial strain of a thin film may be varied and the critical film thickness at which an (i) SRT occurs can be controlled. We prepared microwedged and continuous NiPd thin films in situ by molecular beam epitaxy. Both elements have been co-deposited using an aperture-shadowing technique to create a thickness wedge on the sample. We present a study by aberration corrected LEEM-PEEM at the FZ Jülich Beamline UE56/1-sgm at BESSY, mapping the SRTs and magnetic phases via the domain structures of NiPd alloy films between 10 and 100 monolayers.

MA 55.57 Fri 10:30 P2

Vortex state free layer tunnelmagnetoresistance-sensors — •Frederick Casper[1,2], Ronald Lehndorff[3], Johannes Paul[3], and Mathias Kläui[2] — [1]Johannes Gutenberg University, Institute for Inorganic and Analytical Chemistry, D-55099 Mainz, Germany — [2]Johannes Gutenberg University, Institute for Physics, D-55099 Mainz, Germany — [3]Sensitec GmbH, D-55131 Mainz, Germany

Within the last years magnetoresistive sensors based on the tunnel magneto resistance (TMR) effect have gained a great deal of attention for industrial application. One of their advantages compared to other magnetic sensors is a large signal amplitude, which allows for a reduction of read-out electronics. Here we present a concept for a vortex state free layer TMR sensor. These vortex states are used to linearize the output signal and also have a very narrow hysteresis. Therefore they seem to be ideal for position measurement application. The samples were made on a thermally oxidized 5" silicon wafer by dc magnetron sputtering using a conventional TMR stack: Ta/Ru seed /IrMn 8.9 nm/ CoFe 3 nm/ Ru 0.74 nm/ CoFeB 3.1 nm/ MgO X nm/ CoFeB 3.2 nm / NiFe 15 nm/ Ta cap. The films were annealed in an applied magnetic field of 10 kOe for 1h at 265°C. Circular junctions with a diameter of 2 μm were formed using photo lithography. A sensor element compromises 20 of such junctions. The sensors show a large linear range of arond 10 Oe, a good thermal stability, a low hysteresis and a low area footprint, making them superior to conventional MR sensors.

MA 55.58 Fri 10:30 P2

Study of material parameters of YIG films with ferromagnetic resonance techniques — •Stefan Klingler[1], Andrés Conca[1], Andrii Chumak[1], Burkard Hillebrands[1], Behrouz Khodadadi[2], and Tim Mewes[2] — [1]FB Physik und Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Center for Materials for Information Technology, University of Alabama, Al, USA

The developement of spintronics is aiming to a replacement of the electron charge as information carrier. In this emerging field the electron spin is used as information carrier which can be manipulated without current and therefore without the limitations due to heating. In this context the material parameters of YIG are of crucial importance for the application in magnonics and spintronics.

Here, we present measurements of the saturation magnetization M_s and the exchange constant A of liquid phase expitaxy (LPE) grown YIG films. The films were grown on (111) Gadolinium Gallium Garnet (GGG) substrates with a thickness of 0.91, 1.6 and 2.6 μm and a size of 3×3 mm. The YIG samples were investigated with a waveguide ferromagnetic resonance (FMR) setup in a frequency range from 5 to 40 GHz in in-plane and out-of-plane configuration. A and M_s were determined using the first perpendicular standing spin wave modes (PSSW) and the method of Schreiber and Frait [1]. The results for both configurations are compared and thereby an angular dependence was detected.

[1] Phys. Rev. B, **54**, 6473 (1996)

MA 55.59 Fri 10:30 P2

Magnetic correlations in an Fe monolayer on Rh(001) — András Deák and •László Szunyogh — Department of Theoretical Physics, Budapest University of Technology and Economics, Budapest, Hungary

Motivated by recent experiment of Takada et al. [1] we studied the magnetic thin film system consisting of a monolayer of Fe deposited on a Rh(001) surface using a classical spin Hamiltonian with parameters obtained from ab initio calculations. The ground state magnetic configuration is estimated using the mean field spin susceptibility and zero-temperature Landau–Lifshitz–Gilbert spin dynamics simulations. We find that model parameters obtained from a ferromagnetic and a disordered local moment reference state result in significantly different configurations, but both show strong frustration and a sensitive dependence on layer relaxations. Our simulations lead to a complex spin-structure different as proposed from SP-STM results, which might be attributed to the influence of multiple-spin interactions missing from our model.

[1] M. Takada, P. L. Gastelois, M. Przybylski, J. Kirschner: A complex magnetic structure of ultrathin Fe films on Rh (001) surfaces J. Magn. Magn. Mater. 329, 95 (2013)

MA 55.60 Fri 10:30 P2

Growth modes and epitaxy of FeAl thin films on a-cut sapphire prepared by ion beam assisted and pulsed laser deposition — •Xiang Yao[1], Ulf Wiedwald[1,2], Moritz Trautvetter[1], and Paul Ziemann[1] — [1]Institut für Festkörperphysik, Universität Ulm, Albert-Einstein-Allee 11, 89069 Ulm, Germany — [2]Fakultät für Physik, Universität Duisburg-Essen, Lotharstraße 1, 47057 Duisburg, Germany

FeAl in the B2 phase shows paramagnetism. Thin films prepared at ambient temperature, however, usually exhibit the A2 phase, accompanied by ferromagnetism. We investigate this structural phase transition by subsequent annealing in highly textured films. FeAl thin films are grown on a-cut Al_2O_3 substrates using ion beam assisted sputter deposition (IBAD) and pulsed laser deposition (PLD) at 300K. In all cases, a strong [110] out-of-plane texture exists while in-plane orientations differ significantly as revealed by XRD pole figures. IBAD-grown films possess at least three in-plane orientations while PLD-grown films show high quality epitaxial relation with Al_2O_3 substrate. The formation of the two configurations is attributed to the existence of an intermediate metastable crystalline orientation, as concluded from the non-assisted sputter deposition at elevated temperatures. Magnetic properties were tracked by SQUID-magnetometry. For IBAD-grown films, we find an abrupt transition to paramagnetic behavior at 300 K after annealing at $T_A = 300$°C for 1h while PLD-grown films show a gradual decrease for T_A up to 500°C. We thank the Baden-Württemberg Stiftung for financial support.

MA 55.61 Fri 10:30 P2

Cubic magnetocrystalline anisotropies in ultrathin epitaxial magnetite films on MgO(001) — •Andreas Krampf[1], Nico Pathé[1], Tobias Schemme[1], Timo Kuschel[2], and Joachim Wollschläger[1] — [1]Department of Physiys, Osnabrück University, Germany — [2]Department of Physics, Bielefeld University, Germany

Ultrathin films of magnetite (Fe_3O_4, thickness 10 nm−100 nm) are deposited on lattice matched MgO(001) substrates either by reactive molecular beam epitaxy (RMBE, Fe evaporation in molecular oxygen atmosphere) or by oxidation of previously deposited ultrathin epitaxial Fe films. Both the structure and stoichiometry of the films have been controlled by surface sensitive and bulk sensitive techniques while magnetic properties are characterized by MOKE. In both cases, the magnetite films show in-plane magnetization due to the shape anisotropy. In addition, the easy axes point in Fe_3O_4<110> directions as determined from the coercive fields for different crystallographic directions. This result is in agreement with the well-known easy axes <111> of bulk magnetite if projected on the planar magnetite film.

Alternatively, magnetite films are formed via a two-step growth process. First, Fe films are epitaxially grown. Thereafter, Fe_3O_4 has been deposited by RMBE. The result of this procedure is that the Fe film is completely consumed during growth of the additional magnetite film. The entire film has Fe_3O_4 structure. Surprisingly, the coercive fields are drastically enhanced and the easy axes are rotated by 45° so that they point into Fe_3O_4<100> directions. The mechanism of this effect is still under discussion.

MA 55.62 Fri 10:30 P2

Preparation and characterisation of TiN thin films — •Alessia Niesen[1], Manuel Glas[1], Daniel Ebke[2], Jan Schmalhorst[1], and Günter Reiss[1] — [1]Thin Films and Physics of Nanostructures, Bielefeld University, Germany — [2]Max-Planck-Institute for Chemical Physics of Solids, Dresden, Germany

The preparation of TiN thin films was investigated. The thin films were prepared by RF magnetron sputtering in an UHV sputtering system. To achieve epitaxial (001)-oriented thin films, MgO (001) and SiO_2 (001) substrates were used. During the deposition, the substrate temperature ranged between room temperature and 900°C. X-ray diffraction (XRD) and reflection (XRR) measurements were carried out to determine the crystallographic and surface properties. In addition, atomic force measurements (AFM) were performed to verify the XRR

data. Samples deposited on MgO substrate showed a crystalline ordering over the full deposition temperature range, whereas no visible crystallinity was seen for thin films sputtered on SiO_2 substrates. The surface roughness decreases with increasing deposition temperature for samples on MgO. Furthermore the out-of-plane lattice constant and the resistivity reached the theoretical predicted values of 4.242 Å and 20 $\mu\Omega$cm (300 K) with increasing deposition temperature. The in-situ deposition on heated substrate will be compared to an ex-situ annealing process. Finally, the suitability of TiN as seed layer for ferromagnetic materials like Iron and Heusler compounds, e. g. Co_2FeAl or $Mn_{3-x}Ga$, will be discussed.

MA 55.63 Fri 10:30 P2

Ferromagnetic resonance of perpendicular magnetic anisotropy MgO/CoFeB based tri-layers — •Yuriy Aleksandrov[1,4], Ciaran Fowley[1], Kerstin Bernert[1,4], Volker Sluka[1], Ewa Kowalska[1,4], Michael Farle[2], Jürgen Lindner[1], Berthold Ocker[3], Jürgen Fassbender[1,4], and Alina M. Deac Deac[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, P.O. Box 510119, 01314 Dresden, Germany — [2]Universität Duisburg-Essen Fakultät für Physik Experimentalphysik - AG Farle Lotharstr. 1 47057, Duisburg, Germany — [3]Singulus Technologies AG, Hanauer Landstrasse 103, 63796 Kahl am Main, Germany — [4]Institute for Physics of Solids, TU Dresden, Zellescher Weg 16, 01069 Dresden, Germany

In this report we use the ferromagnetic resonance technique to investigate the magnetic properties of a CoFeB layer sandwiched by Ta and MgO layers. Samples were annealed in N2 environment for 30 minutes at temperatures between 150 and 250°C in steps of 50°C. FMR measurements are performed at room temperature using a microwave cavity. Thin films are also investigated by standard magnetometry measurements in a SQUID/VSM and also by the extraordinary Hall effect to extract the saturation magnetization and effective anisotropy. Through FMR we are able to simultaneously extract the out-of-plane anisotropy, the effective magnetization and the damping co-efficient, as a function of annealing temperature. Our results show that post-annealing systematically shifts the magnetic easy axis from in-plane to out-of-plane direction. As the annealing temperature is increased the effective magnetization also increases.

MA 55.64 Fri 10:30 P2

Optimization of the growth of $Ni_{81}Fe_{19}$ and $Co_{40}Fe_{40}B_{20}$ thin films for an all-optical characterization of micron-sized elliptical elements — •Ana Ruiz-Calaforra[1], Thomas Brächer[1,2], Tobias Fischer[1], Andres Conca[1], Britta Leven[1], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Graduate School Materials Science in Mainz, Gottlieb-Daimler-Strasse 47, 67663 Kaiserslautern, Germany

The optimization of the growth of thin ferromagnetic films is decisive for their future application in spintronic devices. Magnetic properties such as the damping or the spin polarization, which have a large impact on the operation efficiency of these devices, depend strongly on the metallic layers which compose them. We present an optimization of the growth of $Ni_{81}Fe_{19}$ and $Co_{40}Fe_{40}B_{20}$ thin films with different underlayers, aiming for a smooth topography, a controlled magnetic anisotropy and magnetic softness and a large magneto-optical signal. By structuring of micron-sized elliptical elements out of the films, the influence of the shape anisotropy and the magnetic anisotropy of the films on the overall magnetic anisotropy has been studied.

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MA 55.65 Fri 10:30 P2

Relation between spin and orbital magnetism in excited states of ferromagnetic materials — •Leonid Sandratskii — Max Planck Institute of Microstructure Physics, Halle, Germany

Modern experiments are able to disentangle the time dynamics and temperature dependences of the atomic spin and orbital moments. The results appear to be strongly system dependent. The properties of the orbital moments are closely connected with the properties of the magnetic anisotropy that is the physical quantity of enormous practical importance. And again the experiments on the temperature dependence of the magnetic anisotropy of the itinerant-electron magnets show strongly system dependent behavior and the absence of any universal behavior. By studying the properties of excited states of Fe, Co, CoPd, FePt films and uncapped and capped Co/Pd(001) we shed the light on the origin of the diversity of behavior.

MA 55.66 Fri 10:30 P2

Time Resolved Spin Seebeck Effect Experiments as a Probe of Magnon-Phonon Thermalization Time — Niklas Roschewsky[1], Michael Schreier[1], Akashdeep Kamra[1,2], Felix Schade[1], •Kathrin Ganzhorn[1], Sibylle Meyer[1], Hans Huebl[1], Stephan Gepraegs[1], Rudolf Gross[1,3], and Sebastian T. B. Goennenwein[1] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Kavli Institut of Nanoscience, Delft University of Technology, Delft, The Netherlands — [3]Physik-Department, TU München, Garching, Germany

We investigate magnon-phonon interaction times in the ferrimagnetic insulator yttrium iron garnet by means of time-resolved spin Seebeck effect experiments at room temperature [1]. We use an intensity modulated laser beam to dynamically generate a temperature gradient across yttrium iron garnet/normal metal thin film stacks, and record the ensuing spin Seebeck voltage. Our measurements show no intrinsic frequency dependence of the spin Seebeck voltage up to laser modulation frequencies corresponding to timescales of a few nanoseconds. These results put an upper limit to the magnon-phonon interaction time constant relevant for the spin Seebeck effect at room temperature, suggesting that small wavenumber k magnons, with magnon-phonon interaction times of a few hundred nanoseconds, do not play an important role for the spin Seebeck effect in these structures.

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[1] N. Roschewsky *et al.*, arXiv 1309:3986.

MA 55.67 Fri 10:30 P2

Dependence of Ferromagnetic Resonance Behaviour on Chemical Disorder in $Fe_{60}Al_{40}$ Thin Films — •Rantej Bali[1], Tobias Schneider[1,3], Jakob Gollwitzer[1], Simon Rupp[1], Falk Meutzner[1,2], Richard Boucher[2], Kay Potzger[1], Jürgen Bauch[2], Jürgen Fassbender[1,3], Kilian Lenz[1], and Jürgen Lindner[1] — [1]Institut für Ionenstrahlphysik und Materialforschung, Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]Institut für Werkstoffwissenschaft, Technische Universität Dresden, 01069 Dresden, Germany — [3]Institut für Festkörperphysik, Technische Universität Dresden, 01069 Dresden, Germany

We report on the influence of chemical disorder in $Fe_{60}Al_{40}$ thin films on their ferromagnetic resonance. Chemical disorder leads to increased nearest neighbour Fe-Fe magnetic interactions and plays a crucial role in inducing ferromagnetism. The saturation magnetization increases from 20 kAm^{-1} for the chemically ordered film to 780 kAm^{-1} for disordered films. Disorder was induced by irradiation of Ne^+ ions, and the depth-distribution of disorder was controlled by adjusting the ion-energy and -fluence. For moments aligned within the film plane, the resonant linewidth decreases with increasing ion-energy in the range from 2.5 to 30 keV, for a fixed ion-fluence. In-plane magnetic anisotropy is negligible in all cases. The linewidths for in-plane moment alignment are much larger than in materials that do not exhibit disorder induced ferromagnetism. These results may be explained by enhanced two-magnon scattering due to the presence of random defects, and help in preparing thin films with tailored spin-wave dynamic properties.

MA 55.68 Fri 10:30 P2

Magneto-Crystalline Anisotropy of X-Ray Magnetic Linear Dichroism in Reflection and Fluorescence at the Fe 2p1/2, 2p3/2 Edges — •Christine Jansing[1], Marc Tesch[1], Markus Gilbert[1], Hans-Christoph Mertins[1], Andreas Gaupp[2,1], Dominik Legut[3], Peter Oppeneer[4], Daniel Bürgler[5], Claus Schneider[5,6], and Ulf Berges[7] — [1]FH Münster, Stegerwaldstr. 39, D-48565 Steinfurt — [2]HZB, D-12489 Berlin — [3]Nanotech. Centre, Ostrava, Czech Rep. — [4]Depart. of Physics, Uppsala Uni., Uppsala, Sweden — [5]FZ Jülich, PGI-6, D-52425 Jülich — [6]Fak. f. Physik+CeNIDE, Uni Duisburg-Essen, D-47048 Duisburg — [7]DELTA, D-44227 Dortmund

We present first experimental results on the magneto-crystalline anisotropy of X-ray magnetic linear dichroism signals detected on single crystalline bcc Fe films at the 2p edge by measurements in reflection (XMLD-R) and fluorescence (XMLD-F) using linearly polarized undulator radiation at BESSY and DELTA. First XMLD measurements at the Fe 2p edge [1] used total electron yield (TEY) detection. In contrast to TEY XMLD-R and XMLD-F spectroscopy is unaffected by

the applied magnetic field and hence allows also for the investigation of buried layers. The XMLD-R and XMLD-F spectra depend on the orientation of the crystal axes, i.e. the magnetic easy and medium axes, with respect to the polarization vector of the light and show strong changes of up to 100 percent. Comparing the experimental results with our ab initio calculations allows to distinguish between competing models of the electronic band structure.

[1] F. Nolting, D. Legut, J. Rusz et al., Phys. Rev. B 82,184415(2010)

MA 55.69 Fri 10:30 P2

Thin Films of *M*-Type Magnetoelectric Hexaferrites — •Bastian Stibbe[1], Stephan Geprägs[1], Matthias Opel[1], and Rudolf Gross[1,2] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Physik Department, TU München, Germany

Room-temperature magnetoelectric materials, which exhibit a cross-coupling between electric and magnetic order parameters, have attracted widespread interest over the last years, since they provide new opportunities in designing low-power spintronic devices. Among this class of materials, magnetoelectric hexaferrites are promising candidates, since they show large magnetoelectric effects at room temperature and low magnetic fields [1]. In particular, large electric field-induced changes of the magnetization were reported in the polycrystalline *M*-type hexaferrite $SrCo_2Ti_2Fe_8O_{19}$ [2].

Here, we report on the deposition of epitaxial $SrCo_2Ti_2Fe_8O_{19}$ thin films on Al_2O_3 (0001) single crystalline substrates by laser-MBE. To optimize the structural and magnetic properties, a series of $SrCo_2Ti_2Fe_8O_{19}$ thin films was fabricated varying the substrate temperature, the oxygen partial pressure as well as the laser fluence of the ablation process. The thin films are analyzed using high-resolution x-ray diffractometry, atomic-force microscopy, and SQUID magnetometry. Furthermore, converse magnetoelectric effects in terms of electric-field induced changes of the magnetization are discussed.

[1] T. Kimura, Annu. Rev. Condens. Matter Phys. **3**, 93 (2012).
[2] L. Wang *et al.*, Sci. Rep. **2**, 223 (2012).

MA 55.70 Fri 10:30 P2

Spin-liquid phase and order-by-disorder on the frustrated swedenborgite-lattice — •Stefan Buhrandt[1] and Lars Fritz[2] — [1]Institut für theoretische Physik, Universität zu Köln, Zülpicher Straße 77, 50937 Köln, Germany — [2]Institute for Theoretical Physics, Utrecht University, Leuvenlaan 4, 3584 CE Utrecht, The Netherlands

Geometrical frustration is the phenomenon that not all antiferromagnetic exchange interactions in a system can be completely satisfied simultaneously due to the geometry of the underlying lattice. A lattice exhibiting a very unusual and interesting exchange topology is formed by the magnetic ions in compounds of the swedenborgite family, where the magnetic ions reside on alternating stacked triangular and Kagomé layers. While in general there are four distinct next neighbor exchange interactions allowed by symmetry on this lattice, a simplified model with only two distinct interactions, J_1, describing the exchange inside the Kagomé layers and J_2, accounting for the exchange between the Kagomé and triangular layers, is widely used and has proven to be sufficient to reproduce experimental findings. Depending on the ratio J_2/J_1, the ground state of the model is either unique or highly degenerated. In the latter case, coplanar ground states are eventually selected by an entropic order-by-disorder transition at low temperatures. The presence of soft modes in these ground states reduces the specific heat per spin in the limit $T \to 0$ from 1 to 15/16. Additionally, we find a broad spin-liquid regime over a wide range of parameters and temperatures, which might persist even in the presence of small additional interactions.

MA 55.71 Fri 10:30 P2

The mechanisms of the Dy Grain Boundary Diffusion Process in sintered NdFeB permanent magnets — •Konrad Löwe[1], Christoph Brombacher[2], Matthias Katter[2], and Oliver Gutfleisch[1] — [1]TU Darmstadt, Materials Science, 64287 Darmstadt, Germany — [2]VACUUMSCHMELZE GmbH & Co. KG, 63450 Hanau, Germany

We investigated the mechanisms of Dy diffusion in Nd-Fe-B permanent magnets. At optimum annealing conditions the Dy processed magnets yield a total coercivity increase of 4.5 kOe and a roughly constant remanence. The switching field distribution along the diffusion direction was measured with a hall probe. For an application of 0.3 wt% Dy and annealing at 900°C an increased coercivity was found up to a depth of about 3 mm. Microstructure analysis by WDX and TEM EDX revealed an enhanced Dy concentration in the surface region of the individual Nd-Fe-B grains. The Dy concentration in these so-called "shells" decreased exponentially from 6.0 at% at the surface of the magnet to about 1.8 at% after a diffusion depth of 0.4 mm. The mechanism of Dy-shell formation was reasoned to be melting/solidification of a rare earth rich intermediate phase during high-temperature annealing. This assumption is based on the fact that a constant Dy concentration over the width of a shell was found. With EBSD no orientation difference between the Nd-Fe-B grains and the surrounding shells has been found, which points to an epitaxial solidification of the melt on the grains.

MA 55.72 Fri 10:30 P2

Analysis of Magnetic Flux in non–oriented Electrical Sheet — •Anna Brunner, Rudolf Schäfer, and Ludwig Schultz — IFW Dresden, Institut for Metallic Materials, Dpt. Magnetic Microstructures, Helmholtzstr. 20, D-01069 Dresden

Although non–oriented bulk magnetic material like electrical steel is traditionally used in motors, generators or other inductive applications, the mechanisms of flux propagation are so far unexplored. In this presentation we adapt a quasi domain model to describe flux propagation, especial across grain boundaries which are in general obstacles for the magnet flux. We wrote a program to calculate the quasi–domain combination with the smallest grain boundary charge for a given grain orientation towards a grain boundary. The grain orientation of the non–oriented iron–silicon samples was determined by EBSD (Electron BackScatter Diffraction). The domain movement at charged and uncharged grain boundary areas was observed with Kerr–microscopy. The examinations are exemplified at three grain boundaries (one between two grains of slight misorientation with respect to the surface, another one between two grains of strong misorientation with respect to the surface and a last one between a strongly and a slightly misoriented grain).

MA 55.73 Fri 10:30 P2

structure and magnetocaloric effect of Gd-based compound — •Guangcun Shan[1,2], JiLiang ZHANG[1], and Chan-Hung SHEK[1] — [1]Department of Physics and Materials Science, City University of Hong Kong, Hong Kong — [2]Max-Planck-Institut für Chemische Physik fester Stoffe

Gd-based compound was synthesized successfully, and the compound shows good soft magnetic behavior at room temperature with a Curie temperature ~ 350 K. The compound exhibits non Curie-Weiss behavior in a large temperature range above Curie temperature, and slightly enhanced Gd moment at low temperature. The elevated Curie temperature and slightly enhanced Gd magnetic moment were interpreted using Ruderman-Kittel-Kasuya-Yosida model, based on measured electronic structure and density functional theory (DFT) simulation results. The magnetocaloric effect was also measured in terms of the maximum magnetic entropy change of -4.3 J*Kg-1K-1 at 50 kOe and -2.3 J*Kg-1K-1 at 20 kOe.

MA 55.74 Fri 10:30 P2

Multiferroic $Ni_3V_2O_8$ measured in THz range at low temperatures and in high magnetic fields — •Malte Langenbach[1], Komalavalli Thirunavukkuarasu[1], Iván Cámara Mayorga[2], Joachim Hemberger[1], and Markus Grüninger[1] — [1]II. Physikalisches Institut, Universität zu Köln, Köln, Germany; — [2]Max-Planck-Institut für Radioastronomie, Bonn, Germany;

THz spectroscopy in high magnetic fields is an important technique to probe materials with strong magneto-electric coupling. Here, we report on transmission measurements on the Kagomé-staircase compound $Ni_3V_2O_8$. The triangle-based lattice gives rise to frustration of the short-range antiferromagnetic couplings. This causes a rich phase diagram at low temperatures [1]. Below T_N=9.8 K, an incommensurate phase with collinear sinusoidal spin structure is established. This phase is followed by a cycloidal spin structure which is accompanied by the onset of ferroelectricity. Finally, below 3.9 K, the structure changes to a commensurate canted antiferromagnetic phase [2]. We report on elementary excitations in the THz range observed between 2 K and 50 K in fields up to 8 T.

Work supported by the DFG through SFB 608.

[1] M. Kenzelmann et al., Phys. Rev. B 74, 014429 (2006)
[2] G. Lawes et al., Phys. Rev. Lett. 95, 087205 (2005)

MA 55.75 Fri 10:30 P2

Magnetic and orbital order in the system $Fe_{1-x}Cu_xCr_2S_4$ ($0 \leq x \leq 0.9$) studied by Mössbauer spectroscopy — •Elaheh Sadrollahi[1], Mathias Kraken[1], Nicole Christiane Schmidt[1], F. Jochen Litterst[1], Vladimir Tsurkan[2], Alois Loidl[2], and G. Michael Kalvius[3] — [1]IPKM, Technische Universität Braunschweig — [2]Experimentalphysik V, Universität Augsburg — [3]Physik Department, Technische Universität München

Cr based thiospinels of the type $Fe_{1-x}Cu_xCr_2S_4$ ($0 \leq x \leq 1$) have attracted considerable attention due to a variety of interesting electronic and magnetic properties. We have performed a systematic Mössbauer spectroscopic study of the spinel system $Fe_{1-x}Cu_xCr_2S_4$ with $0 \leq x \leq 0.9$ between 4 and 300 K. We could follow the gradual transformation from Fe^{+2} to Fe^{+3} in dependence on Cu doping and the related changes in magnetic ordering.

At low temperatures we find for low Cu doping changes in nuclear electric quadrupole interaction due to changes in the crystalline electric field connected with orbital ordering. Dynamic line broadening related with magnetic orbital dynamics will be discussed.

MA 55.76 Fri 10:30 P2

Magnetic property of Mixed valent Sodium Sequioxide (Na2O3) — •Shivakumara Giriyapura, Sergiy Medvediev, Martin Jansen, and Claudia Felser — MPI-CPFS, 01187, Dresden

It is well-known that compounds containing mixed diatomic oxygen species (superoxide (O2-) is magnetic and peroxide (O22-) diamagnetic) can be stabilized in different forms of A2O2 , A2O3, AO2 and AO2-x [1,3] (A = alkaline metals). Consequently, it is been realized that alkali superoxides (A+O2-) containing magnetic diatomic O2-ions behave like strongly correlated transition metal compounds, where the displacive Jahn-Teller distortion lifts the degeneracy and leads to the reorientation of diatomic anions (O2-) with corresponding orbital ordering (OO) [2][3]. Similarly, mixed valent A4O6 reveals a mixture of superoxide O2- and peroxide O22- with different valency which can lead to a charge ordered state in the lattice. Charge order (CO) is known to be in competition with superconductivity. Accordingly, its been synthesized the Sodium sesquioxide (Na2O3) and discussed the structural and magnetic studies of this compound in comparison with the magnetic end member NaO2 and rest of the alkali sesquioxide(A4O6. [1] W. Hesse, M. Jansen and W. Schnick, Prog. Solid St. Chem. Vol. 19, pp. 47-110. 1989.[2] S. Riyadi, B. Zhang, R. A de Groot, A. Caretta, P.H.M. van Loosdrecht, T. T. M. Palstra and G.R.Blake, Phys. Rev. Lett. 108, (2012) 217206.[3] S.Riyadi, S.Giriyapura, R.A. de Groot, A.Caretta, P.H. M. van Loosdrecht, T. T. M. Palstra, and G. R. Blake. Chem. Mater. 2011, 23, 1578*1586.

MA 55.77 Fri 10:30 P2

Enhancement of Faraday Rotation in BiIG optical resonators — •Felix Spitzer[1], Sören Kreinberg[1], Lars E. Kreilkamp[1], Ilya Akimov[1,2], Vladimir I. Belotelov[2,3,4], Mohammed Nur-E-Alam[5], Mikhail Vasiliev[5], Kamal Alameh[5], and Manfred Bayer[1] — [1]Experimentelle Physik II, TU Dortmund, D-44221 Dortmund, Germany — [2]Ioffe Physical-Technical Institute, Russia Academy of Sciences, 119991 Moscow, Russia — [3]Russian Quantum Center, 143025 Moscow, Russia — [4]Prokhorov General Physics Institute, Russian Academy of Sciences, 119991 Moscow, Russia — [5]Electron Science Research Institute, Edith Cowan University, 6027 Joondalup, WA, Australia

We study the spectral dependence of Faraday Rotation in μm-thin bismuth iron garnet (BiIG) films under illumination by a white light source.

By applying a thin layer of Ag the Faraday Rotation can be enhanced due to the longer optical path length within the sample. With a silver layer on both sides, the sample acts as an optical resonator thus leading to resonant behavior of the Faraday Rotation and its enhancement by up to one order of magnitude depending on the parameters of the structure

MA 55.78 Fri 10:30 P2

In-situ Polarised Neutron Reflectometry during Thin Film Growth by DC Magnetron Sputtering — •S. Mayr[1], W. Kreuzpaintner[1], B. Wiedemann[1], A. Schmehl[2], T. Mairoser[2], A. Herrnberger[2], J.-F. Moulin[3], J. Stahn[4], P. Korelis[4], M. Haese-Seiller[3], M. Pomm[3], A. Paul[1], P. Böni[1], and J. Mannhart[5] — [1]Technische Universität München — [2]Universität Augsburg — [3]Helmholtz Zentrum Geesthacht — [4]Paul Scherrer Institut Villigen — [5]Max Planck Institut Stuttgart

Since thin magnetic layers are used in many magneto-electronic devices the understanding of their texture and the coupling between them is essential to improve functionality. As these parameters are likely to change during the deposition process, in-situ polarised neutron reflectometry (PNR) is used to monitor the development of the structural and magnetic properties of thin films while they are grown. We routinely carry out in-situ PNR measurements using either the horizontal Time-of-Flight reflectometers REFSANS at FRM II or AMOR at PSI with a specially designed sputtering chamber as sample environment combined with modern neutron optical elements. In this contribution, the epitaxial growth of Fe and Cr on a Cu(100)/Si(100) substrate and the observed onset and evolution of the magnetic properties as a function of film thickness will be presented. Initially, after each monolayer deposition step, the reflectivity of polarised neutrons was measured during a short period of time. After approximately 100 Å, the deposition process was adapted and Fe/Cr-bilayers were grown to investigate the evolution of exchange coupling effects in a Fe/Cr heterostructure.

MA 55.79 Fri 10:30 P2

Conventional and inverse magnetocaloric effects at magnetostructural transitions in Mn-based compounds — •Franziska Scheibel[1], Öznur Cakir[2], Atakan Tekgül[3], Mehmet Acet[1], and Michael Farle[1] — [1]Faculty of Physics and CENIDE, Universität Duisburg-Essen, D-47048 Duisburg, Germany — [2]Physics Department, Yildiz Technical University, Davutpasa, Istanbul, Turkey — [3]Physics Department, Akdeniz University, Antalya, Turkey

One key factor for efficient magnetic refrigeration is reversibility in the temperature-change on applying and removing the external magnetic field to the active magnetic refrigeration material. At magnetostructural transitions, where large entropy changes can occur, this occurs only in systems with sufficiently narrow thermal hysteresis at the transition. To understand how reversibility is related to hysteresis, entropy-changes and corresponding adiabatic temperature-changes are studied in Mn-rich Heusler alloys, anti-perovskites, and pnictides. We study the magnetization and the adiabatic temperature-change in the temperature range $5 \leq T \leq 380$ K in magnetic fields up to 5 T using a SQUID magnetometer and a calorimeter, respectively. The structural properties are further investigated by x-ray diffraction. The results indicate that the occurrence of long range ferromagnetism in any one of the phases below or above the magnetostructural transition in the systems mentioned above is unfavorable for a reversible temperature change. In contrast, the presence of ferrimagnetism or enhanced paramagnetism leads to a narrow thermal hysteresis of the transition.
Work supported by the Deutsche Forschungsgemeinschaft (SPP 1599)

MA 55.80 Fri 10:30 P2

High Resolution Imaging of Spin Current-driven Magnetization Manipulation in Nanoscale Structures using SEMPA — •Pascal Krautscheid, Robert M. Reeve, and Mathias Kläui — Institut für Physik, Johannes Gutenberg-Universität, 55128 Mainz, Germany

The utilization of the electron spin degree of freedom, instead of its charge, was proposed to manipulate the magnetic state of a system including the domain wall spin configuration. The interaction between a spin current and the magnetic moments of a system can be described by the implicit Landau-Lifshitz-Gilbert equation [1]. However, the origin of the non-adiabatic spin torque and its relation to the damping is not well understood and several theoretical predictions exist, which can only be distinguished by experiments. We consider a magnetic vortex state within a permalloy-disk and measure the vortex core displacement to gain information about the non-adiabatic spin torque [2]. By altering the damping, e.g. using a rare earth element as a dopant [3] the relation between the damping and the non-adiabatic spin torque can be derived. The vectorial magnetization information within the plane of our nanoscale structure is measured by a scanning electron microscope with polarization analysis, which offers the necessary high-resolution magnetic imaging.

References
[1] A. Thiaville et al., Europhys. Lett. 69, 990 (2005).
[2] B. Krüger et al., Phys. Rev. Lett. 104, 077201 (2010).
[3] T. A. Moore et al., Phys. Rev. B 80, 132403 (2009).

MA 55.81 Fri 10:30 P2

magnetic properties of (Fe,Co)2B alloy with uniaxial magnetocrystalline anisotropy — •Hong Jian[1,2], Konstantin Skokov[1], Michael Kuzmin[1], and Oliver Gutfleisch[1] — [1]Department of Materials Science, TU Darmstadt, Petersenstr. 23, 64287 Darmstadt,

Germany — [2]Department of Materials Science and Engineering, Zhejiang University, Zheda Road. 38, 310027 Hangzhou, China

The high cost of rare earth elements has driven scientists to search for rare-earth-free magnets with high magnetocrystalline anisotropy. Uniaxial magnetocrystalline anisotropy in the (Fe,Co)2B system has been reported, where K1 of ˜410 kJ/m3 at room temperature was obtained in (Fe0.7Co0.3)2B. However, the possibilities for practical application of this alloy system are by no means explored. Furthermore, (Fe,Co)2B system also provides a good model to study the origin of magnetocrystalline anisotropy in 3d elements. In this work, we investigated the intrinsic magnetic properties of (Fe,Co)2B alloy on single crystal and also extended measurements to high temperatures up to 873K. It is expected that this alloy can be used as a semi-hard magnet.

MA 55.82 Fri 10:30 P2

Electronic strcuture, magnetism and chemical bonding in hydrides of transition metal — •Abdesalem Houari[1] and Volker Eyert[2] — [1]Theoretical ḧyics Laboratory, Dpt. Phyics, University of Bejaia, Bejaia, Algeria — [2]Center for Electronic Correlations and Magnetism, Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany

Based on density functional theory calculations, we present an *ab initio* study of the structural stability of the palladium-hydrogen (Pd-H) and platinum-hydrogen systems. Here, we first investigate two ideal stoichiometries: the monohydride Pd $(Pt)_1H_1$ and dihydride Pd $(Pt)_1H_2$. The formers was considered in different types of structures (faces centered cubic *fcc*-rocksalt, *fcc*-zincblende, and hexagonal symmetry), while the latters was considered in two cubic ones which are fluorite and pyrite. Energy versus volume calculations were carried out in all structures and theoretical equilibrium properties (lattice constant, bulk modulus ...etc) are thus obtained. By evaluating and comparing total energies, the ground state crystal structure is found, and it agree with the experimental finding. While the monohydride is energetically more stable than dihydride in Pd-H, the inverse is expected in Pt-H. On the other hand, the whole systems are found to be non magnetic at theoretical equilibrium. We have studied some experimentally synthesized vacancy-defect phase such as Pd_3H_4 compound. The obtained results (equilibrium lattice constant) are in perfect agreement with experimental

MA 55.83 Fri 10:30 P2

Magnetic properties in hydrogenated Li doped ZnO microwires — •Israel Lorite[1], Carlos Ivan Zalandazini[2], Silvia Perez[2], and Pablo Esquinazi[1] — [1]Division of Superconductivity and Magnetism, Institute for experimental Physics II, Fakultät für Physik und Geowissenschaften, Linnéstrasse 5, 04103 Leipzig, Germany — [2]Laboratorio de Física del Sólido, Dpto. de Física, FCEyT, Universidad Nacional de Tucumán, 4000 Tucumán, Argentina

We have studied the magneto-transport properties of ZnO and Li doped ZnO treated with H plasma at room temperature, ZH and ZLH respectively. After plasma treatment a negative magnetoresistance, in perpendicular configuration, of ˜1% and ˜3.5% at 8T applied field is measured at 10K for ZH and ZLH, respectively. The magneto resistance can be well explained by a semi empirical model taking into account local magnetic moments and the s-d exchange interaction. A comparison with parallel configuration indicates possible anisotropy in the magneto resistance indicative of the appearance of magnetic order, further observed by SQUID. Finally, it has been found a minimum of magneto-resistance at 125 K for ZLH sample. It can be interpreted by means of two different parallel contributions: due to the VRH mechanism, below 125 K, and due to exchange interaction contribution above 125 K.

MA 55.84 Fri 10:30 P2

Preparation and structural and magnetic characterisation of transition metal-doped ZnO thin films. — •Vasantha Venkataraman[1], Verena Ney[1], Katharina Ollefs[2], Fabrice Wilhelm[2], Andrei Rogalev[2], and Andreas Ney[1] — [1]Division of Solid State Physics, Johannes Kepler University, Linz, Austria — [2]European Synchrotron Radiation Facility (ESRF), Grenoble, France

Numerous experimental studies have surfaced involving doping of ZnO thin films with transition metals (TM:ZnO). Though neither Cu, nor its oxides are ferromagnetic, reports of ferromagnetic Cu:ZnO can be found [1]. By DC reactive magnetron sputter deposition, we have prepared Cu:ZnO films on c-plane sapphire. By varying the proportions of the reactant (O_2) and carrier (Ar) gases, we have a series of samples and have found three separate regimes. The regimes show a marked difference in terms of their apparent colour. Using x-ray absorption spectroscopy at the Cu-K edge, we have probed the series in order to establish an interrelation between the observed magnetic behavior and the local atomic positioning of dopant Cu atoms and the valence [2]. The XANES point to the oxidation states in the different regimes and XLD in turn indicates the substitution of the Zn atom sites by Cu as being unfavourable. SQUID magnetometry on the series has revealed paramagnetic behavior irrespective of regime.

[1] T. S. Herng et al., Phys. Rev. Lett. 105, 207201 (2010)
[2] J. L. DuBois et al., J. Am. Chem. Soc. 122, 5775 - 5787 (2000)

MA 55.85 Fri 10:30 P2

Adiabatic and dynamic spin-wave spectra in the homogeneous electron gas — •Maximilian Kulke and Arno Schindlmayr — Department Physik, Universität Paderborn, 33095 Paderborn, Germany

Spin-wave spectra of itinerant ferromagnets can be calculated from a variety of ab initio methods, such as the adiabatic frozen-magnon approximation, time-dependent density-functional theory or many-body perturbation theory. A quantitative comparison for real materials is not straightforward, however, because practical implementations of these schemes typically rely on different numerical approximations. To avoid such difficulties and allow a clearer assessment, we study spin waves in the spin-polarized homogeneous electron gas, where an almost completely analytic evaluation of these methods is possible. Within the adiabatic approximation we seek self-consistent solutions of the static Kohn-Sham equations with a constraint that enforces a noncollinear spin-spiral configuration with a given wave vector. As an alternative, we obtain the spin-wave dispersion from the poles of the dynamic transverse spin susceptibility within time-dependent density-functional theory. The same exchange-correlation functional, the (adiabatic) local-spin-density approximation, is used in both cases. Besides a comparison of the calculated spin-wave energies over a large range of wave vectors, we specifically focus on the spin-wave stiffness, which corresponds to the leading parabolic dispersion coefficient in the limit of long wave lengths.

MA 55.86 Fri 10:30 P2

Electronic strucure and finite-temperature magnetic properties of FeRh — •Sergiy Mankovsky[1], Svitlana Polesya[1], Jan Minar[1], Catherine Bordel[2], Cristian Back[3], and Hubert Ebert[1] — [1]Dept. Chemie/Physikalische Chemie, Universität München, D-81377 München, Deutschland — [2]Department of Physics, University of California, Berkeley, California 94720, USA — [3]Department of Physics, Universität Regensburg, 93040 Regensburg, Deutschland

The temperature-induced magnetic phase transitions in FeRh, AFM→FM ($\approx 340K$) and FM→PM ($\approx 670K$) have been investigated by Density Functional Theory (DFT) electronic structure calculations using the fully relativistic Korringa-Kohn-Rostoker Green function (KKR-GF) method. First-principles exchange coupling parameters, J_{ij}, have been used to determine the temperature dependent magnetic properties of FeRh within Monte Carlo simulations based on Heisenberg model. The Gilbert damping parameter calculated for the FM state as a function of temperature is in a good agreement with the experimental results. Separate calculations with temperature-induced structure disorder only as well as structure and magnetic disorder accounting for together allow to make a conclusion about the role of spin fluctuations for the Gilbert damping. The temperature dependent magnetic anisotropy has been investigated for FeRh films grown on two different substrates. The calculations demonstrate the strain induced spin-reorientation transition for both FeRh films across the AFM-FM phase transition, that is in a good agreement with experiment.

MA 55.87 Fri 10:30 P2

Dzyaloshinskii-Moriya interaction in the Kondo lattice model — •Kathrin Höfner and Wolfgang Nolting — Institut für Physik, Humboldt-Universität zu Berlin, Germany

In the recent years much research has been focused on magnetic systems with low symmetry or low dimensionality that exhibit interesting non-collinear spin structures.

A popular explanation for these structures is the Dzyaloshinskii-Moriya (DM) interaction, an effective anisotropic and antisymmetric coupling between localized spins. While successful in describing the magnetic properties of various systems, the justification of the interaction itself depends on the specific electronic structure of the considered

material.

We therefore relate the DM-interaction to the electronic structure of a multi-band Kondo lattice model. The RKKY formalism is generalized to allow the inclusion of spin-orbit coupling in a non-perturbative manner. We show that this procedure leads to Heisenberg-, Ising-, and Dzyaloshinskii-Moriya-like terms. The obtained exchange integrals and the resulting magnetic structure are discussed.

MA 55.88 Fri 10:30 P2

Dual Boson Approach to Collective Magnetic Excitations in the Hubbard Model — •Friedrich Krien[1], Erik van Loon[2], Hartmut Hafermann[3], Mikhail Katsnelson[2], Alexei Rubtsov[4], and Alexander Lichtenstein[1] — [1]Dep. of Physics, University of Hamburg, Jungiusstrasse 9, 20355 Hamburg, Germany — [2]Institute for Molecules and Materials, Radboud University of Nijmegen, 6525 AJ Nijmegen, The Netherlands — [3]IPhT, CEA, CNRS, 91191 Gif-sur-Yvette, France — [4]Dep. of Physics, Moscow State University, 119992 Moscow, Russia

The recently developed dual boson approach is a generalization of the dual fermion theory to study collective excitations in systems of the extended Hubbard model type.

Here we present the implementation scheme that is currently under testing and development by the authors. We reason why its account of collective excitations is also expected to improve the understanding of such in the simpler Hubbard model. We outline the steps to take full account of charge and magnetic excitations within the extended Hubbard model in the future.

MA 55.89 Fri 10:30 P2

Characterization of epitaxial Ni-Mn-Sn thin films with out-of-plane composition gradient — •Niclas Teichert[1], Lars Helmich[1], Svetlana Klimova[1,2], Anna Behler[3], Christian Behler[3], Anja Waske[3,4], Walid Hetaba[1,5], and Andreas Hütten[1] — [1]Bielefeld University, Department of Physics, Thin Films and Physics of Nanostructures, 33615 Bielefeld, Germany — [2]Saratov State University, Department of Nano- and Biomedical Technology, 410012 Saratov, Russia — [3]IFW Dresden, Institute for Complex Materials, 01069 Dresden, Germany — [4]TU Dresden, Institut für Festkörperphysik, 01062 Dresden, Germany — [5]Vienna University of Technology, Universitäre Service-Einrichtung für Transmissionselektronenmikroskopie (USTEM), Wiedner Hauptstraße 8-10, A-1040 Wien, Austria

Ni-Mn-Sn is a ferromagnetic shape memory alloy and a promising magnetocaloric material. In this study we investigate epitaxial Ni-Mn-Sn thin films with out of plane gradient of e/a from 8.05 to 8.12. The gradient is applied in order to expand the temperature range of the martensitic transition. The films are prepared by magnetron cosputtering on MgO(001) substrates. The composition gradient is realized by variation of the Sn rate during the sputter process. We see a widening of the transition range without widening of the thermal hysteresis. We compare films with increasing and decreasing e/a from substrate to surface. The applied methods to study the martensitic transition are temperature dependent resistivity and magnetization measurements, X-Ray Diffraction, and Transmission Electron Microscopy.

MA 55.90 Fri 10:30 P2

Zero Field ^{55}Mn NMR study of Ni-Mn-Sn Heusler alloys — •Maria Eleni Belesi[1], Ahmad Omar[1], Sabyasachi Pramanick[2], Subham Majumdar[2], Bernd Büchner[1,3], and Sabine Wurmehl[1,3] — [1]Leibniz Institute for Solid State and Materials Research, Dresden, Helmholtzstrasse 20, 01069 Dresden, Germany — [2]Department of Solid State Physics, Indian Association for the Cultivation of Science, 2A and B Raja S. C. Mullick Road, Jadavpur, Kolkata 700 032, India — [3]Institute for Solid State Physics, TU Dresden, D-01069, Germany

We present a nuclear magnetic resonance (NMR) study of the Heusler alloys $Ni_2Mn_{1+x}Sn_x$, which are known to exhibit shape memory effects, exchange bias, inverse magnetocaloric and giant magnetoresistance in certain stoichiometry regimes. The x=0 member of the family, Ni_2MnSn, is a ferromagnetic Heusler alloy with a Curie temperature of T_C=349 K and cubic $L2_1$ structure. For $0.35 < x < 0.47$ these compounds manifest a structural transition to the so-called martensitic phase, which has lower crystal symmetry than the parent cubic state and is dominated by a complex strained structure. To probe this structure as well as the accompanied modification of the local magnetic properties through the martensitic transition, we perform zero-field ^{55}Mn NMR experiments on $Ni_2Mn_{1+x}Sn_x$ samples prepared by arc melting. These experiments provide local information for the evolution of the structural and magnetic properties with stoichiometry and as we vary the temperature through the martensitic transition.

MA 55.91 Fri 10:30 P2

Thin film synthesis of the semiconducting Heusler compound Fe2TiSi — •Markus Meinert[1], Manuel Patrice Geisler[1], Jan Michael Schmalhorst[1], Günter Reiss[1], and Elke Arenholz[2] — [1]Center for Spinelectronic Materials and Devices, Bielefeld University, Germany — [2]Advanced Light Source, Berkeley, CA, USA

From band structure calculations, Fe_2TiSi is predicted to be a semiconductor with a narrow gap (about 0.3 eV) and a possible use for thermoelectric applications has been pointed out. [1]

We have synthesized $L2_1$ single-phase thin films of Fe_2TiSi on MgO substrates by DC and RF magnetron co-sputter deposition. The films have a resistivity of $1700\mu\Omega$cm at room temperature, reaching $4700\mu\Omega$cm at 2K. The carrier density is about $5 \cdot 10^{20}\mathrm{cm}^{-3}$ independent of temperature. These results are similar to earlier results on the pseudogap system Fe_2VAl. [2] The resistivity follows a logarithmic temperature dependence up to room temperature, which indicates Kondo scattering off magnetic impurities as the governing mechanism.

A band gap of about 0.4 eV is observed in optical absorption spectra and the general shape of the absorption and reflectance curves agrees with density functional theory calculations. Thus, Fe_2TiSi is in fact the first semiconducting full-Heusler compound reported to date.

[1] S. Yabuchi et al., Appl. Phys. Express 6, 025504 (2013). [2] H. Okamura et al., Phys. Rev. Lett. 84, 3674 (2000).

MA 55.92 Fri 10:30 P2

Photoresponse of $La_{0.7}Ce_{0.3}MnO_3$ films revisited – dominating role of the $SrTiO_3$ substrate — •Andreas Thiessen, Elke Beyreuther, and Lukas M. Eng — Institut für Angewandte Photophysik, Technische Universität Dresden, D-01062 Dresden, Germany

Cerium-doped $LaMnO_3$ films, which have been discussed as an electron-doped counterpart to the common hole-doped mixed-valence lanthanum manganites, were analysed regarding their manganese valence, conductivity and magnetoresistance under illumination. While oxygen-reduced $La_{0.7}Ce_{0.3}MnO_3$ films had shown a large photoconductivity effect as well as a light-induced recovery of the metal-insulator transition in the past [Beyreuther et al., PRB 80, 075106 (2009)], whose microscopic origins remained uncertain, the present study finds strong evidence for the determining role of the photoconductive $SrTiO_3$ substrate by the systematic investigation of a broad set of films with varied thickness, oxygen content, and degree of CeO_2 phase segregation.

MA 55.93 Fri 10:30 P2

Growth and magnetic properties of Heusler alloy type Ru2MnZ (Z=Ge, Si) thin films — •Jan Balluff, Markus Meinert, and Günter Reiss — University of Bielefeld

It has been shown by theory and experiment that the Heusler alloy type compounds Ru2MnZ (Z=Ge, Si) show antiferromagnetic phases. Thin films of these alloys were grown to examine their magnetic properties. Due to their antiferromagnetic order they are in particular interesting for many potential applications in the field of spintronics, i.e. using the Exchange Bias. We will show different growth approaches on MgO and thermally oxidized Si substrates. Furthermore, we will discuss magnetic properties of the compounds including the Exchange Bias.

MA 55.94 Fri 10:30 P2

Double Perovskite La_2CoMnO_6 thin films grown by Metalorganic Aerosol Deposition (MAD) — •Sebastian Hühn[1], Markus Jungbauer[1], Sebastian Merten[1], Ricardo Egoavil[2], Jo Verbeeck[2], and Vasily Moshnyaga[1] — [1]I. Physikalisches Institut, Georg-August-Universität, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Electron Microscopy for Materials Science (EMAT) , Groenenborglaan 171, 2020 Antwerp, Belgium

Some ordered double perovskites (DP) with the general formula $A_2BB'O_6$ exhibit halfmetallic-ferrimagnetic behavior with high Curie temperature $T_C > 400$ K and 100% spin polarization [1]. Therefore these DP are interesting for room-temperature applications. High B-site ordering is a prerequisite for full saturation magnetization and high T_C. As a proof of concept we show that it is possible to grow highly ordered La_2CoMnO_6 thin films on $SrTiO_3$ (111) by metalorganic aerosol deposition [2], a chemical deposition technique in ambient atmosphere.

B-site ordering is confirmed by XRD, TEM-EELS and Raman spectroscopy. The saturation magnetization of $M_{sat} = 6\,\mu_B$/f.u. and Curie point of $T_C = 230$ K agree with the values of highly ordered bulk samples. Financial support from EU FP 7, IFOX (interfacing oxides) project is acknowledged.
[1] Serrate, De Teresa and Ibarra J. Phys.: Condens. Matter 19 (2007) 023201
[2] Moshnyaga et.al. Appl. Phys. Lett. 74, 2842 (1999)

MA 55.95 Fri 10:30 P2

Time evolution of laser-induced changes in electric transport of manganites — •Manuel Mchalwat, Bernd Damaschke, Vasily Moshnyaga, Markus Münzenberg, and Konrad Samwer — 1. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Manganites show structural phenomena at a variety of spatial and time scales ranging from nanometers and picoseconds for single polarons up to microns and seconds for the electronic phase separation. Many of these influence physical properties, e. g. the metal-insulator transition, which is accompanied by a change of the crystal structure and believed to be driven by the formation of correlated polarons near the transition temperature.

By exciting the sample near the transition by short laser pulses we induce or destroy the electronic correlations, i. e. the correlated polarons, and investigate their time development by looking at the electronic transport properties, especially the third harmonic contribution, which is sensitive to the density of polarons.

The work has been supported by the DFG through SFB 1073 TP B01 and by Femtolasers.

MA 55.96 Fri 10:30 P2

Detection of ultra-low magnetic fields based on the planar Hall effect in manganite thin films — •Eduard Unger, Camillo Ballani, Markus Jungbauer, Markus Michelmann, Sebastian Hühn, Danny Schwarzbach, and Vasily Moshnyaga — I.Physikalisches Institut, Universität Göttingen

The anisotropic magnetoresistance (AMR) is widely used for sensing of both direction and absolute value of magnetic fields. Thin epitaxial manganite films, e.g. $La_{0.7}(Sr_{1-y}Ca_y)_{0.3}MnO_3$, show large AMR ratios at temperatures slightly below T_C.[1] For a special AMR geometry, called "planar Hall effect", the measured transverse voltage is sensitive to the direction of the sample magnetization, thus allowing one to investigate magnetization processes like rotation and flops of single magnetic domains driven by an applied field H. Magnetization change and, therefore, the field sensitivity of the transverse voltage was observed to be largest close to the coercitive field H_C, which is about several Oe at room temperature for the investigated films. With the goal to achieve low H_C and high AMR ratios yielding a high detectivity of magnetic fields, we have grown thin manganite films ($La_{0.7}Sr_{0.3}MnO_3$ and $La_{0.6}Ba_{0.4}MnO_3$) on $SrTiO_3$ substrates with orientations (100), (110) and (111) by metalorganic aerosol deposition (MAD) technique and studied the dependence of the planar Hall effect on the temperature and applied magnetic field as well as film thicknesses (5 nm to 30 nm) and Hall bar structure dimensions (Hall bar width from 10 μm to 300 μm). Financial support from EU FP 7 Project IFOX is acknowledged. [1] J. Appl. Phys. 93, 6354 (2003)

MA 55.97 Fri 10:30 P2

Gilbert damping in Co_2-based Heusler compounds — •Daniel Ebke[1], Olga Meshcheriakova[1], Albrecht Köhler[1], Lukas Wollmann[1], Steffen Hausdorf[1], Andreas Kehlberger[2], Günter Reiss[3], Gerhard Fecher[1], and Claudia Felser[1] — [1]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [2]Johannes Gutenberg University, Institute of Physics, Mainz, Germany — [3]Thin Films and Physics of Nanostructures, Bielefeld University, Germany

To reach a low critical current threshold for spin torque switching devices, materials with a low Gilbert damping constant were in the focus of many research groups in the past years. On the other side, a high Gilbert damping is indispensable to realize short switching times in devices such as read heads for hard disk drives. To realize high TMR or GMR ratios, materials with a high spin polarization P are needed. Layer structures that contain Heusler compounds are excellent candidates due to their extraordinary good tunability of their physical properties to meet all criteria upon request.

In this work we have investigated the influence of atomic ordering and crystal structure to the Gilbert damping constant of Co_2-based Heusler compound thin films. The damping constant was determined by FMR measurements as function of post annealing temperature and film thickness.

MA 55.98 Fri 10:30 P2

A_2[FeX_5(H_2O)] a new family of multiferroic and linear magnetoelectric materials — •Matthias Ackermann[1], Sebastian Salm[2], Thomas Lorenz[2], Petra Becker[1], and Ladislav Bohatý[1] — [1]Institut für Kristallographie, Universität zu Köln, Germany — [2]II. Physikalisches Institut, Universität zu Köln, Germany

Magnetoelectric coupling phenomena, such as the linear magnetoelectric effect, have attracted considerable interest during the last decade, especially after the discovery of spin-driven multiferroicity in magnetically frustrated systems. Recently, we indentified $(NH_4)_2[FeCl_5(H_2O)]$ as new multiferroic material with a strong magnetoelectric coupling and with rather complex magnetic field versus temperature phase diagrams [1]. It belongs to the family of erythrosiderite-type compounds $A_2[FeX_5(H_2O)]$, where A stands for an alkali metal or ammonium ion and X for a halide ion. The magnetic properties of the family have been subject of various investigations in the past. Almost all members studied so far have been identified as collinear antiferromagnets [2]. In this contribution now we present a detailed investigation of the linear magnetoelectric properties and their anisotropy of the alkali compounds $K_2[FeCl_5(H_2O)]$, $Rb_2[FeCl_5(H_2O)]$ and $Cs_2[FeCl_5(H_2O)]$. Detailed magnetic field versus temperature phase diagrams are presented.

This work was supported through the Institutional Strategy of the University of Cologne within the German Excellence Initiative.
[1] Ackermann M et al. 2013 *New J. Phys.* (in press, arXiv:1308.0285)
[2] Carlin R L et al. 1985 *Coord. Chem. Rev.* **65** 141

MA 55.99 Fri 10:30 P2

Microscopic and macroscopic studies on the magnetoelectric coupling in chiral multiferroics — •Tobias Cronert[1], Jonas Stein[1], Jeannis Leist[3], Joachim Hemberger[1], Petra Becker-Bohatý[2], Ladislav Bohatý[2], Agung Nugroho[4], Karin Schmalzl[5], Götz Eckold[3], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln — [2]Institut für Kristallographie, Universität zu Köln — [3]Institut für Physikalische Chemie, Universität Göttingen — [4]Institut Teknologi Bandung — [5]JCNS at Institut Laue-Langevin Grenoble

In the chiral magnets $MnWO_4$ and $RMnO_3$ ferroelectric polarisation is directly induced by the non-collinear magnetic structure. We present microscopic neutron scattering studies and macroscopic measurements of the ferroelectric polarisation and of the magnetic structure in these materials. Using a stroboscopic method the control of the chiral magnetism by an external electric field is determined by polarised neutrons while the switching of ferroelectric order can be directly followed in the time-domain with a sawyertower-like circuit. $MnWO_4$ exhibits rather long rise times of 10ms and strong asymmetries that depend on the cooling history. Relaxation times and hysteresis curves of $DyMnO_3$ in dependence of electric field, temperature and thickness were also recorded indicating a non regular behavior.

MA 55.100 Fri 10:30 P2

DFT investigations of $BiFeO_3$ phases: bandgap and dielectric function — •Sebastian Schwalbe, Torsten Weissbach, Cameliu Himcinschi, and Jens Kortus — TU Bergakademie Freiberg, Institute of Theoretical Physics, D-09596 Freiberg, Germany

$BiFeO_3$ (BFO) is the most extensively studied multiferroic material. Recently it has been shown that BFO can adapt to different crystal structures in strained thin films. Raman and optical measurements on strained BFO films on different substrates ($LaAlO_3$, $TbScO_3$) found a change in band gap and dielectric function. Here we present a density functional study using different approaches (LDA + U, hybrid functionals, mBJ [1]) to determine the bandgap for a variety of strained crystal structures of BFO. A proper description of the band gap and the calculation of the dielectric function is the focus of our work. The results are compared to experimental optical spectroscopy data.

[1] F. Tran and P. Blaha, Phys. Rev. Lett. 102, 226401 (2009).

MA 55.101 Fri 10:30 P2

Quantum heat engine operating with multiferroic chain working substance — •Maryam Azimi[1], Levan Chotorlishvili[1], Sunil Kumar Mishra[2], Teimuraz Vekua[3], Wolfgang Hübner[4], and Jamal Berakdar[1] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, 06120 Halle, Germany — [2]Department of Physics, Indian Institute of Technology, Banaras Hindu University, Varanasi -

221005, India — [3]Institut für Theoretische Physik, Leibniz Universität Hannover, 30167 Hannover, Germany — [4]Department of Physics and Research Center OPTIMAS, University of Kaiserslautern, PO Box 3049, 67653 Kaiserslautern, Germany

In this work we study the quantum Otto engine[1,2] with the working substance of frustrated ferromagnetic spin-1/2 chain[3,4]. The presence of the finite spin chirality in the working substance allows driving a cycle by the external electric field. We observe a direct connection between chirality, entanglement and the efficiency of the engine and find the existence of a threshold temperature above which the pair correlations in the system quantified by thermal entanglement decay to zero. We also find a direct correlation between threshold temperature of pair entanglement, with the spin chirality and the minimum of the fidelities related to the electric and magnetic field. The efficiency of the quantum Otto cycle shows a saturation plateau with the increase of the electric field amplitude. [1]H. T. Quan et al., Phys. Rev.E. 76, 031105 (2007). [2]R. Wang et al., Phys. Rev. E. 86,021133 (2012). [3]M. Mostovoy, Phys. Rev. Lett. 96, 067601 (2006). [4]M. Menzel et al., Phys. Rev. Lett. 108, 197204 (2012).

MA 55.102 Fri 10:30 P2

Strain and interface effects on magnetic order of La0.7Ca0.3MnO3/SrTiO3 superlattices — •Sujit Das[1,2], Andreas Herklotz[1,2], Er Jia Guo[2,1], and Kathrin Doerr[2,1] — [1]IFW Dresden, Postfach 270116, 01171 Dresden, Germany — [2]Institute for Physics, MLU Halle-Wittenberg, 06099 Halle, Germany

We explore the strain-induced changes of magnetic order in epi- taxially grown [La0.7 Ca0.3 MnO3 (2.6nm)/SrTiO3 (6.3nm)]15 superlattices (SLs). SLs are simultaneously grown by Pulsed Laser Deposition (PLD) on (100)-oriented SrTiO3 (STO), LaAlO3 (LAO) and piezoelectric 0.72Pb (Mg1/3Nb2/3)3-0.28PbTiO3 (PMN-PT) substrates in order to obtain different residual strain states. Structural characterization by X-ray diffraction (XRD) shows coherent growth on STO and non-coherent growth with two different residual strain states of the SLs on LAO and PMN-PT. The La0.7 Ca0.3 MnO3 layers are under increasing tensile strain (ϵ) from the SL on LAO (ϵ=1.0%) via that on STO (ϵ=1.7%) to that on PMNPT (ϵ=1.8%). Both, Tc and the magnetization decrease with increasing tensile strain. Application of reversible biaxial compression using the PMN-PT substrate reveals the direct strain effect on magnetic order. Comparing the latter with the magnetic data obtained for the three substrates reveals the importance of both, the elastic strain and a second parameter related to the interface structure.

MA 55.103 Fri 10:30 P2

The High-Field Multiferroicity of $GdMnO_3$ and $DyMnO_3$ explored by Resonant Soft X-Ray Scattering — •Enrico Schierle[1], Victor Soltwisch[1], Sven Landsgesell[1], Fabiano Yokaichiya[1,2], Detlef Schmitz[1], Andrej Maljuk[1,3], Ralf Feyerherm[1], Dimitri Argyriou[1,4], and Eugen Weschke[1] — [1]Helmholtz-Zentrum Berlin — [2]Laboratrio Nacional de Luz Sincrotron, Brasil — [3]IFW, Dresden — [4]ESS, Lund, Sweden

Some of the orthorhombic REMnO3 oxides are prototype single-phase multiferroic compounds characterized by a strong coupling of ferroelectric (FE) and magnetic order. This allows for magnetic control of FE polarization P [1] and magnetic response to applied electric fields [3]. The zero-field multiferroic phases, characterized by P along c, are well understood. Here, magnetic Mn cycloids induce P [3] but also RE order has been shown to have significant contributions[3-5]. Only little is known about the magnetic high field phases of these materials with FE P switched to show along a. We employed Resonant Soft X-Ray Scattering to explore the electronic ordering of the RE-4f and Mn-3d and its relation to ferroelectricity. We will compare the behavior observed for the P_a phases of $DyMnO_3$ and $GdMnO_3$ which show surprising differences. The study has been performed using the High-Field-Diffractometer operated at the UE46-PGM-1 beam line at BESSY II. [1] Kimura et al., Nature 426, 55-58 (2003) [2] Kenzelmann et al., PRL 95, 087206 (2005) [3] Schierle et al., PRL 105, 167207 (2010) [4] Feyerherm et al., Journal of Physics: Conference Series 200, 012032 (2010)[5] Walker et al., Science 333, 1273 (2011)

MA 55.104 Fri 10:30 P2

Investigation of Binding Energies in Multiferroic Layer Systems — •Martin Welke[1], Paula Huth[1], Kathrin Dabelow[2], Karl-Michael Schindler[2], Angelika Chassé[2], and Reinhard Denecke[1] — [1]Wilhelm-Ostwald-Institut für Physikalische und Theoretische Chemie, Universität Leipzig — [2]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg

The work presented deals with the electronic structure of ferroelectric $BaTiO_3$ (BTO) and additional ferrimagnetic layers on top. BTO has several phase transitions while the biggest change occurs during the phase transition from tetragonal to cubic where the electrical polarization disappears. In conventional XPS measurements, there are spontaneous shifts in core-level binding energies while heating or cooling through that last mentioned phase transition. That observation was proposed to be a surface effect.[1] In order to check this property, different photon energies ranging from 2000 to 6000 eV have been used to excite photoelectrons with higher kinetic energy to probe the sample in greater depths. Core levels of all contained elements were studied showing shifts in binding energy as well. Therefore, we assume it is not a plain surface effect but might occur throughout the whole bulk of the ferroelectric material. Additionally, layers of $CoFe_2O_4$ and $NiFe_2O_4$ on BTO prepared by PLD have been investigated showing these shifts in binding energies as well. Theoretical simulations were performed in order to obtain a detailed understanding of the influence of the crystal lattice of $BaTiO_3$ and of the shifts observed in binding energies.

[1] L. Makhova et al., Phys. Rev. B, 2011, 83, 115407

MA 55.105 Fri 10:30 P2

Spin density wave ordering in $Ca_{0.5}Sr_21.5RuO_4$ studied by neutron scattering — •Stefan Kunkemöller[1], Agung Nugroho[2], Yvan Sidis[3], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, D-50937, Germany — [2]Faculty of Mathematics and Natural Sciences, Jl. Ganesa 10 Bandung, 40132, Indonesia — [3]Laboratoire Léon Brillouin, C.E.A./C.N.R.S., F-91191 Gif sur Yvette CEDEX, France

The families of layered ruthenates have attracted strong interest mostly due to the appearance of unconventional superconductivity in pure Sr_2RuO_4. The question wether the magnetic fluctuations are relevant for the superconducting pairing in Sr2RuO4 and if so which ones remains an interesting open issue. The spin density wave ordering in $Ca_{0.5}Sr_{1.5}RuO_4$ is studied by polarized and unpolarized neutron diffraction experiments. It exhibits quasistatic correlations below 20 K at the incommensurate wave vector at which Sr_2RuO_4 shows strong inelastic fluctuations driven by Fermisurface nesting. The magnetic character of the signal and the orientation of the ordered moments along the c direction can be ascertained by neutron polarization analysis. The magnetic ordering at low temperatures is very similar to that found upon minor Ti doping of Sr_2RuO_4 underlining, that this incommensurate SDW is the dominant magnetic instability of the unconventional superconductor Sr_2RuO_4.

MA 55.106 Fri 10:30 P2

Influence of shuttered growth vs. co-deposition on magnetic depth profile of [La2/3Sr1/3]n±1[Mn]n[O]3n±1/SrTiO3 — •Alexandra Steffen[1], Sabine Pütter[1], Jürgen Schubert[3], Willi Zander[3], Stefan Mattauch[1], and Thomas Brückel[1,2] — [1]Jülich Centre for Neutron Science JCNS, Forschungszentrum Jülich GmbH, Outstation at MLZ, Lichtenbergstr. 1, 85748 Garching — [2]Jülich Centre for Neutron Science JCNS and Peter Grünberg Institut PGI, JCNS-2, PGI-4: Scattering Methods, Forschungszentrum Jülich GmbH, 52425 Jülich — [3]Peter Grünberg Institut PGI, PGI-9: Semiconductor Nanoelectronics, Forschungszentrum Jülich GmbH, 52425 Jülich

In transition metal oxide thin films the precise control of stoichiometry can explain phenomena like ferromagnetism or superconductivity at interfaces, e.g. LaAlO3/SrTiO3 [1]. Here, we grew [La2/3Sr1/3]n±1[Mn]n[O]3n±1 layers on SrTiO3 by Oxide Molecular Beam Epitaxy. In our study we compared the influence of deposition methods, co-deposition and shuttered growth on the magnetic depth profile of different [La2/3Sr1/3] to Mn ratios. During growth, RHEED oscillations [2] were constantly monitored to observe the structural quality. The samples were characterized structurally (LEED, XRR, XRD) and magnetically (SQUID). The stoichiometry was further checked via RBS. The relation of different deposition methods and depth-dependent distribution of magnetic moments was achieved via Polarized Neutron Reflectometry at TREFF@MLZ.

[1] M. Warusawithana et al., Nat. Commun. 4, 2351 (2013)
[2] J. Neave and B. Joyce, Appl. Phys. A 31, 1 (1983)

MA 55.107 Fri 10:30 P2

Hybridization between surface and bulk electronic structure of the topological insulator Sb_2Te_3(0001) — •Henriette Maass[1,2], Christoph Seibel[1,2], Hendrik Bentmann[1,2], Kazuyuki

Sakamoto[3], Kenya Shimada[4], and Friedrich Reinert[1,2] — [1]Experimentelle Physik VII, Universität Würzburg, D-97074 Würzburg — [2]Gemeinschaftslabor für Nanoanalytik, Karlsruher Institut für Technologie KIT, D-76021 Karlsruhe — [3]Graduate School of Advanced Integration Science, Chiba University, Chiba 263-8522, Japan — [4]Hiroshima Synchrotron Radiation Center, Hiroshima University, Higashi-Hiroshima 739-0046, Japan

We investigated the surface band structure of the topological insulator $Sb_2Te_3(0001)$ with respect to bulk and surface contributions using photon energy dependent angle-resolved photoelectron spectroscopy (ARPES) and spin-resolved ARPES. Our results render direct evidence for a spin-orbit split trivial surface state which shows a Rashba-type character for small $k_{\|}$ but develops an unusual connecting behavior with bulk states for larger $k_{\|}$ in accordance with theoretical predictions. Our findings on the topological surface state (TSS) indicate a coexistence with bulk states in the valence band regime without considerable hybridization, unlike previous results on the isostructural materials $Bi_2Se_3(0001)$ and $Bi_2Te_3(0001)$. On the other hand we find a photon energy dependance of the TSS at higher binding energies which points to a $k_{\perp}$-dispersion and an increasing bulk character.
[1] Seibel *et al.* PRB 86, 161105(R) (2012)

MA 55.108 Fri 10:30 P2

Thin film preparation of the topological insulator Bi_2Te_3 by co-sputtering — •Mike Gotzmann[1], Christian Sterwerf[1], Jan-Michael Schmalhorst[1], Günter Reiss[1], and Gregor Mussler[2] — [1]Thin Films and Physics of Nanostructures, Bielefeld University, Germany — [2]Peter Grünberg Institute Semiconductor Nanoelectronics (PGI-9), Jülich, Germany

Topological insulators are a new class of promising materials for spintronic devices. Due to their bulk band gap, they show an ordinary insulating behavior in the bulk, whereas on the surface the conducting properties and in particular the spin direction, are conserved.[1]

Thin epitaxial Bi_2Te_3 films were prepared by dc and rf magnetron co-sputtering and molecular beam epitaxy from elemental targets onto various substrates such as BaF_2, Si and Al_2O_3. To achieve a high bulk resistivity, the films were doped with Sn. The crystallographic properties of the Bi_2Te_3 films were investigated by x-ray diffraction and reveal a high degree of structural order. Resistance measurements were performed down to 15K to determine the electronic behavior of the films.

[1] M. Hasan and C. Kane (2010). Reviews of Modern Physics, 82(4), 3045–3067.

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Pyrochlore Iridates: Possible Candidates for the Realization of Weyl Nodes — •Andreas Wörfel[1], Matthias Opel[1], Stephan Geprägs[1], and Rudolf Gross[1,2] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany — [2]Physik-Department, Technische Universität München, 85748 Garching, Germany

Pyrochlore iridates $A_2Ir_2O_7$ (A =Y or a rare-earth ion) offer a promising system for studying the interplay of strong spin-orbit coupling, electronic correlations, and band topology effects. Novel phases such as axial or topological insulators, and Weyl semimetals have been predicted in these compounds [1]. In particular, $Nd_2Ir_2O_7$ is proposed to exhibit Weyl semimetal nodes, where two non-degenerate bands touch each other creating a local linear dispersion. These nodes are topologically protected making Weyl states absolutely robust to perturbations.

Here, we report on a detailed study of the structural, magnetic, and magnetotransport properties of bulk samples as well as thin films of $Nd_2Ir_2O_7$. Epitaxial $Nd_2Ir_2O_7$ thin films were deposited on single-crystalline Y:ZrO_2 (111) substrates using laser-MBE, whereas polycrystalline bulk $Nd_2Ir_2O_7$ samples were fabricated by a standard solid state reaction. These samples show a metal to insulator transition (MIT) at around $T_{\mathrm{MIT}} \simeq 33\,\mathrm{K}$. The MIT is accompanied by a bifurcation of the magnetic susceptibility in field-cooled (FC) and zero-field-cooled (ZFC) conditions, suggesting the existence of a magnetic long-range ordered state for temperatures $T < T_{\mathrm{MIT}}$.

[1] X. Wan *et al.*, Phys. Rev. B **83**, 205101 (2011).

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THz spectroscopy on the topological insulator Bi2Te3 — •Nick Borgwardt[1], Gregor Mussler[2], Malte Langenbach[1], Joachim Hemberger[1], and Markus Grüninger[1] — [1]II. Physikalisches Institut, Universität zu Köln, Cologne, Germany — [2]Peter Grünberg Institute (PGI-9), Forschungszentrum Jülich, Germany

Topological insulators are one of the most discussed areas of current research in condensed matter physics. Bi_2Te_3 is a 3D topological insulator with the advantage of a relatively large band gap (∼0.2 eV) and a reduced bulk conductivity. Thin films of Bi_2Te_3 with thicknesses between 9nm and 30nm were grown on high-resistance Si (111) wafers using MBE. By means of cw-THz spectroscopy based on photomixing in combination with far-infrared Fourier spectroscopy, we studied the transmission in the frequency range from 3 cm^{-1} to 700 cm^{-1} as a function of temperature. The goal is to distinguish between surface conductance and bulk conductivity.

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Thin films of the topological Half-Heusler compound YPtBi — Alexander Kronenberg, Hans Joachim Elmers, Mathias Kläui, and •Martin Jourdan — Institut für Physik, Johannes Gutenberg-Universität Mainz, Staudingerweg 7, 55128 Mainz

Half-Heusler materials of the family LaPtBi are predicted to show 3D-topological order [1] i.e. to present topologically protected electronic surface states. Additionally, according to band structure calculations, a bulk band gap can be opened around the Fermi level by lateral strain [2]. The planned in situ spin-resolved ARUPS on epitaxial thin films is the ideal tool to investigate the electronic structure including surface states of thin films of this. We present first results on the preparation of thin films of the YPtBi compound. Crystalline quality as checked by x-ray diffraction and morphology investigated by atomic force microscopy are compared for films deposited by RF-magnetron sputtering from a stoichiometric compound target as well as from three separate elementary sputtering sources. [1] Chadov et al. Nature Materials 9, 541 (2010) [2] Zhang et al. Appl. Phys. Lett. 99 071901 (2011)

MA 55.112 Fri 10:30 P2

***Ab-initio* calculations and ARPES measurements for the bulk topological insulators Bi_2Se_3 and Bi_2Te_3** — •I. Aguilera[1], I.A. Nechaev[2], M. Michiardi[3], R.C. Hatch[3], M. Bianchi[3], D. Guan[3], C. Friedrich[1], J.L. Mi[3], B.B. Iversen[3], V.E. de Carvalho[4], L.O. Ladeira[4], N.G. Teixeira[4], E.A. Soares[4], Ph. Hofmann[3], E.V. Chulkov[5], and S. Blügel[1] — [1]Forschungszentrum Jülich — [2]Tomsk State University — [3]Aarhus University — [4]Universidade Federal de Minas Gerais — [5]Universidad del Pais Vasco

Most theoretical studies of topological insulators were so far based on model Hamiltonians, parameter-dependent tight-binding descriptions, and density functional theory employing either the local-density (LDA) or generalized gradient approximation. But recently, many-body calculations within the *GW* approximation were attracting much attention in the study of these materials. In this work, we have performed LDA and *GW* calculations for bulk Bi_2Se_3 and Bi_2Te_3 within the all-electron FLAPW formalism. We present a detailed comparison of the calculations to angle-resolved photoemission spectroscopy (ARPES) data obtained over a wide range of photon energies. We find that the *GW* corrected bands agree much better with experiment than the LDA bands. In particular, the characteristic "camelback" shape of the valence band around the Γ point flattens in *GW* in the case of Bi_2Te_3 and disappears for Bi_2Se_3, in accordance with experiments.

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Spin dynamics and magnetic interactions of Mn dopants in the topological insulator Bi_2Te_3 — •S. Zimmermann[1,2], V. Kataev[1], Huiwen Ji[3], R.J. Cava[3], and B. Büchner[1,2] — [1]IFW Dresden, Germany — [2]TU Dresden, Germany — [3]Department of Chemistry, Princeton University, USA

Doping of a topological insulator (TI) with magnetic elements can break the time reversal symmetry and thus open a gap in the protected spin polarized conducting surface states, driving the system into a quantum spin Hall regime [1]. Understanding of the interactions between localized magnetic moments of dopants via delocalized electrons that give rise to ferromagnetism in TIs is therefore of significant interest. Electron Spin Resonance (ESR) spectroscopy is a sensitive local technique that can probe interactions of localized spins with conduction electrons as well as spin-spin interactions in semiconductors and metals [2]. In this contribution we report an ESR study of the Mn spin dynamics and magnetic interactions in high-quality single crystals of the Mn doped 3-dimensional TI Bi_2Te_3 [3]. We have observed a well-defined ESR signal from Mn spins and have studied the

temperature dependences of the ESR parameters for a set of Bi_2Te_3 crystals with different Mn doping levels. The experimental ESR data will be presented in detail. In addition the results from magnetization and transport measurements are taken into account to discuss the Mn spin relaxation via conducting states and the establishment of ferromagnetic order. [1] R. Yu et al., Science **369**, 61 (2010); [2] S. E. Barnes, Adv. Phys. **30**, 801 (1981); [3] Y.S. Hor et al., PRB **81**, 195203 (2010)