# MA 48: Poster Session II

Magnetization Dynamics, Spin-Torque and -Transport Phenomena,Topological Insulators, Micromagnetic simulations

Time: Thursday 15:00–18:00 Location: Poster B1

MA 48.1 Thu 15:00 Poster B1

**Multi-Scale Magnetic Vortex Core Switching** — •Andrea De Lucia, Mathias Kläui, and Benjamin Krüger — Johannes Gutenberg Universität, Mainz, Germany

Simulations of magnetization dynamics in a multi-scale environment enable rapid evaluation of the Landau-Lifshitz-Gilbert equation in a mesoscopic sample with nanoscopic accuracy in the regions where such accuracy is needed. Here a multi-scale magnetization dynamics simulation scheme was developed and applied to systems with special spin structures and properties. To achieve this, the MicroMagnum simulator was used as a starting point and then expanded to include a multi-scale solving routine. The software selectively simulates different regions of a ferromagnetic sample according to their properties in order to employ the most suitable discretization and model for each. The method was used to investigate the effect of unipolar magnetic pulses for reliable switching of the core of a magnetic vortex. The switching was simulated for a Permalloy disk with a radius of 100 nm. The parameter range for switch of this device is shown. The core switching is mediated by the creation of a vortex-antivortex pair and the following annihilation of the original vortex with the antivortex. This process can be shown with unprecedented accuracy due to the multi-scale nature of the simulator. The presented results show that magnetic vortices can be reliably switched between two energetically degenerate, stable, polarization states by pulses with certain combinations of width and intensity that we determine with an unprecedented accuracy due to the multi-scale approach.

MA 48.2 Thu 15:00 Poster B1

**Magnetic properties of $Ce^{3+}$ ions in Nb-doped cerium dioxide** — •Olga Gornostaeva[1] and Taras Kolodiazhnyi[2] — [1]Donetsk National University, Vinnytsia, Ukraine — [2]National Institute for Materials Science, Tsukuba, Japan

Dilute magnetic oxides are currently attracting much attention in view of their potential for applications in spintronics and magneto-optical devices. In particular, it relates doped cerium dioxide. We have performed theoretical and experimental studies of crystal-field effects on magnetic properties of Nb-doped $CeO_2$. Using the crystallographic data for the abovementioned compound and the modified crystal-field theory, a novel computational approach, we have calculated energy levels of the $Ce^{3+}$ ions and $g$-factor values. It was found that the $\Gamma_8$ ground state is separated from the overlying $\Gamma_7$ state by 173 $cm^{-1}$ in good agreement with the optical transmission data. With the $g$-factor value and related experimental data, we found the Curie-Weiss constant and get a percentage of $Ce^{3+}$ ions in a mole of the substance. Comparison of calculated and experimentally measured temperature dependences of the magnetic susceptibility in Nb-doped and undoped cerium dioxide allowed us to estimate the contribution of $Ce^{3+}$ ions to the magnetism of the dilute magnetic oxide.

MA 48.3 Thu 15:00 Poster B1

**Tunable magnetism in metal organic frameworks** — •Sebastian Schwalbe[1], Kai Trepte[2], Gotthard Seifert[2], and Jens Kortus[1] — [1]TU Bergakademie Freiberg, Institute for Theoretical Physics, Germany — [2]Technische Universität Dresden, Theoretical Chemistry, Germany

We present a density functional theory based guideline how to combine local magnetism represented by single molecule magnets (SMMs), with the three-dimensional nature of metal organic frameworks (MOFs). Recently, the electronic and magnetic structure of the flexible MOF DUT-8(Ni) was described by Trepte et al. [1]. Based on our previous work we performed a screening of the metal centers in a model system, which is a good approximation for the secondary building unit (SBU) of DUT-8(Ni). The main result of these calculations is, that the electronic structure of this SBU is mainly determined and influenced by the metal centers (3d metals). By varying the metal centers we are able to tune the magnetic properties and obtain stable non-magnetic, ferromagnetic, anti-ferromagnetic or eventually even metallic SBU.

[1] K. Trepte, S. Schwalbe and G. Seifert, PhysChemChemPhys, vol. 17, pp. 17122-17129, 2015

MA 48.4 Thu 15:00 Poster B1

**Theoretical investigations of $^{129}$Xe NMR in UiO-66 and UiO-67** — •Kai Trepte[1], Jana Schaber[2], Eike Brunner[2], and Gotthard Seifert[1] — [1]Technische Universität Dresden, Theoretical Chemistry, Germany — [2]Technische Universität Dresden, Bioanalytical Chemistry, Germany

The chemical shift of the isotope $^{129}$Xe inside the metal organic frameworks (MOFs) UiO-66/UiO-67 (UiO - University of Oslo) has been investigated using density functional theory. Those structures are known for their high thermal and chemical stability [1]. Both MOFs form two types of pores (tetrahedral (T) and octahedral (O) ones), which provide different chemical environments for absorbed Xe atoms. The mentioned isotope of Xe has several advantages in NMR (nuclear magnetic resonance) investigations, as it tends to be mononuclear, chemically inert and has a nuclear spin of $I = 1/2$. T. Ito and J. Fraissard [2] described the Xe shift inside zeolites as a composition of different influences. Some of these influences are interatomic interactions like Xe-Xe and Xe-surface effects, which can be summed up to gain the total shift. Several model systems have been generated to reduce calculation time and verify this additive behaviour. Additionally, theoretical investigations of Xe inside the crystalline systems allow a separation of the shift as introduced by the different pores. Our results are compared to experimental values to get a deeper insight into the effects on the Xe shift and explain the experimentally observed chemical shift.

[1] Chavan et al., PhysChemChemPhys, 2012, vol.14, pp.1614-1626
[2] T. Ito and J. Fraissard, J. Chem. Phys., vol.76, pp.5225-5229, 1982

MA 48.5 Thu 15:00 Poster B1

**Atomistic spin dynamics simulations of chiral spin structures at surfaces** — •Stephan von Malottki, Bertrand Dupé, and Stefan Heinze — Institut für Theoretische Physik und Astrophysik der Christian-Albrechts-Universität zu Kiel, Leibnizstr. 15, 24118 Kiel, Germany

Chiral magnetic structures on surfaces such as domain walls or skrymions are promising candidates for spintronic devices [1]. Therefore, it is of great interest to understand the formation, stability and motion under external stimuli of such spin structures. In order to study these issues, we perform atomistic spin dynamics simulations, based on a numerical solution of the Landau-Lifshitz-Gilbert-equation. We consider the interplay of exchange and Dzyaloshinskii-Moriya interaction in spin structures at surfaces as well as the magnetocrystalline anisotropy. We treat exchange interactions beyond an effective exchange coupling, allowing to tackle systems in which frustration due to competing ferro- and antiferromagnetic coupling is important [3]. Additionally, higher order exchange interactions, namely the 4-spin and biquadratic interaction, are considered. We study the dynamics of chiral spin structures under external magnetic or electric fields, as well as with spin polarized electrical currents.

[1] A. Fert *et al.*, Nature Nanotech **8** (2013). [2] J. H. Mentink *et al.*, J. Phys.: Condens. Matter **22** (2010). [3] B. Dupé *et al.*, arXiv:1503.08098 (2015).

MA 48.6 Thu 15:00 Poster B1

**A General Analytic Description of the Ferromagnetic High Frequency Susceptibility** — •Benjamin Zingsem, Michael Winklhofer, Ralf Meckenstock, and Michael Farle — Faculty of Physics and Center for Nanointegration (CENIDE), University Duisburg-Essen, 47057 Duisburg, Germany

We present a general analytic solution of the ferromagnetic high frequency susceptibility tensor in ferromagnetic systems with arbitrary free energy landscapes. In contrast to conventional approaches found throughout literature, we do not solve the Landau-Lifshitz-Gilbert-equation as a linear system of equations. Instead we employ the jacobian of the system in the perturbation to obtain the tensor with the well known Polder Ansatz. Thus we do not need to make assumptions on the entries of the tensor and the form of the free energy is left arbitray. This complete tensor allows for accurate and fast calculations of the high frequency susceptibility as a function of the applied field angle and amplitude as well as the frequency or any other physical parameter. Furthermore it allows for the description of asymetric lineshapes as well as lineshapes in non extremal magnetic directions. We also tackle the problem of finding the equilibrium states of the magnetization that are necessary in the calculation of the tensor in an unconventional way, suggesting a trajectory dependent second order newton algorithm. In addition to this we are able to calculate the magnon dispersion in reciprocal space as a density function, by applying the Suhl ansatz and including the diploar and the exchange contibution in the energy landscape.

MA 48.7 Thu 15:00 Poster B1

**Static and dynamic magnetization of $Fe_3O_4$ nano cubes** — •Thomas Feggeler, Zi-An Li, Alexandra Terwey, Michael Winklhofer, Ralf Meckenstock, and Michael Farle — Faculty of Physics and Center for Nanointegration (CENIDE), University Duisburg-Essen, Lotharstr. 1, 47057 Duisburg.

Micromagnetic simulations of the relaxation of the magnetization and the stray field distribution of various ensembles of cube-shaped $Fe_3O_4$ nanoparticles (edge length of $\sim$ 70 nm) were performed to support the results obtained from magnetic imaging with a transmission electron microscope. The simulation matches the experimental data and allows to extract the magnetic parameters quantitatively (e. g. for a chain of 4 particles: magnetization M $\approx$ 11002.67 A/m, energy densities: $E_{Demag} \approx 477.93$ J/m$^3$, $E_{Exch} \approx 47.51$ J/m$^3$, $E_{MAE} \approx -15.98$ J/m$^3$). The dependence of the effective magnetic anisotropy energy density (MAE) and dipolar interaction on the orientation of the magnetization will be discussed.

In support of ferromagnetic resonance (FMR) measurements on single magnetic bacteria, which contain chains of various numbers of $Fe_3O_4$ nano particles, FMR-simulations of corresponding simplified particle chains were done. Non-uniform collective FMR excitations and the influence of dipolar coupling on the FMR in the particle chains can be clearly identified and quantified.

MA 48.8 Thu 15:00 Poster B1

**Enhancement of the spin-wave propagation distance in microstructures by localized parallel parametric amplification** — •Frank Heussner[1], Thomas Brächer[2], Philipp Pirro[3], Thomas Meyer[1], Tobias Fischer[1], Moritz Geilen[1], Björn Heinz[1], Bert Lägel[1], Alexander A. Serga[1], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, D-67663 Kaisersalutern, Germany — [2]Univ. Grenoble Alpes, CNRS, CEA, INAC-SPINTEC, 38054 Grenoble, France — [3]Institut Jean Lamour, Université Lorraine, CNRS, 54506 Vandoeuvre-lès-Nancy, France

We report on the localized parallel parametric amplification of a coherent spin wave in the non-adiabatic regime. We demonstrate that due to the co-propagating parametrically created magnons a strong enhancement of the propagation distance of the input spin wave can be realized. A microwave current flowing inside a transmission line with modulated width placed underneath the transversely magnetized $Ni_{81}Fe_{19}$ waveguide creates an alternating magnetic field, which is locally enhanced at the position of the narrowing. Only in the area of this locally enhanced field effective parametric pumping takes place. In addition to the strong amplification in the non-adiabatic regime, we show that the localization of the pumping field leads to a high signal-to-noise ratio of the amplification process behind the amplification area. Our results show that localized parallel parametric amplification recommends itself for applications in future spintronic devices to overcome the limitations due to a limited spin-wave propagation distance.

MA 48.9 Thu 15:00 Poster B1

**Magnon supercurrent in a magnon Bose-Einstein condensate subject to a thermal gradient** — •Dmytro A. Bozhko[1,2], Peter Clausen[1], Vitaliy I. Vasyuchka[1], Gennadii A. Melkov[3], Burkard Hillebrands[1], Victor S. L'vov[4], and Alexander A. Serga[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, Germany — [2]Graduate School Materials Science in Mainz, Germany — [3]Taras Shevchenko National University of Kyiv, Ukraine — [4]Weizmann Institute of Science, Israel

Bose-Einstein magnon condensation (BEC), the spontaneous appearance of a coherent state at the global energy minima of the spin-wave spectrum possesses zero group velocity. The presented here dynamics of a magnon BEC in a thermal gradient provides the first evidence of the formation of a magnon supercurrent at room temperature. The magnon dynamics was revealed by time- and wavevector-resolved Brillouin light scattering spectroscopy. It has been found that the freely evolving magnon BEC in a parametrically pumped spin system of a single-crystal film of yttrium iron garnet decays faster with the increase of a probing laser beam power. The behavior of the rest of the magnon gas remains undisturbed. A uniform sample heating does not affect the BEC behavior. Thus, the observed effect can be treated as the outflow of condensed magnons from the laser focal point due to the phase difference induced in the BEC wave function by a temperature gradient. The developed theoretical model perfectly describes the experimental data. The work is supported by the DFG within the SFB/TR 49.

MA 48.10 Thu 15:00 Poster B1

**Ultrafast magnetization dynamics in thin Co films studied by spin-resolved photoelectron spectroscopy with XUV pulses from HHG** — •Sebastian Emmerich[1], Moritz Plötzing[2], Steffen Eich[1], Markus Rollinger[1], Roman Adam[2], Cong Chen[3], Henry Kapteyn[3], Margret Murnane[3], Benjamin Stadtmüller[1], Mirko Cinchetti[1], Martin Aeschlimann[1], Stefan Mathias[1,4], and Claus Schneider[2] — [1]University of Kaiserslautern and Research Center OPTIMAS, Kaiserslautern, Germany — [2]Forschungszentrum Jülich GmbH, Peter Grünberg Institut, Jülich, Germany — [3]JILA and NIST, University of Colorado, Boulder, USA — [4]Georg-August-Universität Göttingen, I. Physikalisches Institut, Göttingen, Germany

We combine a bright 10 kHz high-order harmonic generation light source with an exchange scattering-based spin detector to investigate ultrafast magnetization dynamics in thin Co films. We map the spin-resolved band structure dynamics over the full valence band energy during the ultrafast demagnetization process following photoexcitation with a 1.57 eV pump pulse. We observe a >50% quenching of the spin polarization within the first 50 fs after the optical excitation, which is simultaneously occurring over the whole energy range. This finding gives strong evidence that the initial ultrafast demagnetization dynamics of the valence band in thin Co films is dominated by spin-mixing processes. A reduction of the exchange splitting, as expected in the Stoner model, is not observed.

MA 48.11 Thu 15:00 Poster B1

**Spin pumping at structurally engineered interfaces** — •Sascha Keller[1], Laura Mihalceanu[1], Andres Conca[1], Matthias R. Schweizer[1], Jörg Lösch[2], Burkard Hillebrands[1], and Evangelos Th. Papaioannou[1] — [1]Fachbereich Physik, Technische Universität Kaiserslautern, Erwin-Schrödinger-Str. 56, 67663 Kaiserslautern, Germany — [2]Institut für Oberflächen- und Schichtanalytik (IFOS), Trippstadter Str. 120, 67663 Kaiserslautern, Germany

The spin pumping effect allows for the injection of a spin current from a ferromagnetic (FM) layer at ferromagnetic resonance (FMR) into an attached non-magnetic metal (NM) layer. The spin current is then subsequently transformed into a charge current by the inverse spin Hall effect (ISHE) inside the NM layer. Epitaxially grown FM/NM interfaces can strongly affect the spin pumping effect due to the structural quality of the interface and the intrinsic magnetic anisotropy of the FM. In this work we address the manipulation of these effects by structurally engineering the interfaces in a Fe/Pt model system. We show how spin pumping is affected with respect to crystal symmetry of the interface, grain size, Pt layer thickness and different capping layers (MgO, Pd and Au). Furthermore we analyze the shielding effect of Pt in the sub-skin-depth regime as well as rectification effects that are occurring with microwave excitation which are superimposed to the ISHE signal. Financial support by the Carl Zeiss Stiftung is gratefully acknowledged.

MA 48.12 Thu 15:00 Poster B1

**Time-resolved spontaneous Raman scattering in complex materials** — •Christoph Boguschewski, Rolf B. Versteeg, Prashant Padmanabhan, Thomas Koethe, Jingyi Zhu, and Paul H.M. van Loosdrecht — II. Physikalisches Institut - Universität zu Köln, Zülpicher Straße 77, 50937 Cologne, Germany

Complex materials show a strong interplay between different degrees of freedom giving rise to a variety of intriguing ground states, and novel excitations. Raman spectroscopy allows to measure these excitations and to determine the symmetry of the probed ground state. Expanding the Raman spectroscopy technique into the time domain opens up new opportunities to study symmetry changes following optically induced phase transitions, to probe quasiparticle population statistics of unconventional ground states on ultrafast timescales, and to address fundamental questions regarding angular momentum transfer in complex materials.

Here, we present our newly constructed time-resolved, high spectral resolution Raman spectroscopy system, fully dedicated to the study of complex matter within the picosecond temporal regime. An overview of our first results on quasiparticle scattering in antiferromagnetic materials is presented.

MA 48.13 Thu 15:00 Poster B1

**Realization of a Spin-Wave Majority Gate** — •Tobias Fischer[1], Martin Kewenig[1], Dmytro A. Bozhko[1], Andrii V. Chumak[1], Alexander A. Serga[1], Ihor I. Syvorotka[2], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Department of Crystal Physics and Technology, Scientific Research Company *Carat*, Lviv, Ukraine

By promising a significant reduction of Joule heating due to Ohmic losses, spin-wave logic devices offer large advantages compared to modern CMOS-based elements. Also, a majority-based logic allows for a reduction of the number of gates for implementing a given operation [1]. The magnetic insulator material yttrium iron garnet (YIG) is of particular interest for applications in this field due to its intrinsically low Gilbert damping parameter and large spin-wave propagation lengths.
In this work, we present the investigation of a macroscopic spin-wave majority gate device made from YIG films. We examine the spin-wave-propagation by means of microwave techniques.
In order to analyze the operational properties of our device, we determine the coupling among the input channels and study the dependence of the output signal amplitude and phase on the parameters of the input signals.
Financial support by EU-FET (Grant InSpin 612759) is acknowledged.

[1] A. Khitun *et al.*, J. Phys. D: Appl. Phys. **43** (2010) 264005

MA 48.14 Thu 15:00 Poster B1

**Magnetoresistive detection of single magnetic vortices** — •Lakshmi Ramasubramanian[1,2], Ciarán Fowley[1], Jürgen Lindner[1], Jürgen Fassbender[1,3], Attila Kákay[1], Stefan Schulz[2], Sibylle Gemming[2], and Alina Maria Deac[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Bautzner Landstraße 400, 01328 Dresden, Germany — [2]Technische Universität Chemnitz, Elektrotechnik und Informationstechnik, 09126 Chemnitz, Germany. — [3]Institute for Physics of Solids, TU Dresden, 01069 Dresden, Germany

The fundamental oscillation mode of magnetic vortices in thin-film elements has recently been exploited in spin-torque-driven nano-oscillators [A. Wachowiak et al., Science (2002)]. The fundamental frequency is determined by the saturation magnetisation, as well as the geometrical confinement of the magnetisation e.g. the diameter and height of a magnetic disk. The objective of this study is to design magnetic discs, contact them with electrical leads and probe the dynamics of the vortex structures using magnetoresistive detection. By varying the thickness and dimensions of the disk, requirements for the magnetic vortex as a ground state will be determined. The electrical resistance of a single disc is expected to change based on the relative angle between the magnetisation direction and the applied current (the anisotropic magnetoresistance (AMR) effect) [S. Kasai et al, PRL 97, 107204 (2006)]. Using the AMR as a detection technique we will determine if electrical detection of dynamics is feasible in this geometry and its associated limits.

MA 48.15 Thu 15:00 Poster B1

**d.c. voltages in Fe/(Ga,Mn)As induced by ferromagnetic resonance** — •lin chen, martin decker, robert islinger, markus härtinger, matthias kronseder, dieter schuh, dominique bougeard, christian back, and dieter weiss — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg, Germany

The electrical detection of magnetization dynamics is by now a common method in spintronic devices operation. In this work, we investigate the dc voltages occurring in a Fe/(Ga,Mn)As structure under ferromagnetic resonance.

The sample consists of Fe (5 nm) and (Ga,Mn)As (50 nm) grown on GaAs (001) semi-insulating substrate by molecular-beam epitaxy. The Fe/(Ga,Mn)As stripe is integrated between the signal and ground line of the coplanar waveguide, where the ferromagnetic stripe is excited by an out-of-plane magnetic field. The dc voltage is measured as a function of the external magnetic field.

The characteristic dc voltage spectrum can be observed at each magnetic field angle, which can be decomposed into a symmetric Vsym and an anti-symmetric Va-sym component. The two components show distinct difference in their angular dependence. A detailed analysis shows that Va-sym is induced by the anisotropic magnetoresistance (AMR) of Fe; while Vsym is related to spin pumping from Fe into (Ga,Mn)As.

This work is supported by the German Science Foundation (DFG) via SFB 689. L. Chen is also grateful for support from Alexander von Humboldt Foundation.

MA 48.16 Thu 15:00 Poster B1

**Versatile approach to the spin dynamics of correlated electrons** — Malte Behrmann[1], Alexander I. Lichtenstein[1], Mikhail I. Katsnelson[2], and •Frank Lechermann[3] — [1]I. Institut für Theoretische Physik, Universität Hamburg, 20355 Hamburg — [2]Radboud University Nijmegen, Institute for Molecules and Materials, NL-6525 AJ Nijmegen, The Netherlands — [3]Institut für Keramische Hochleistungswerkstoffe, Technische Universität Hamburg-Harburg, 21073 Hamburg

Most theoretical approaches to time-dependent magnetism in condensed matter either focus on the spin-only limit or rely on a weak-correlation treatment based on band theory. However many experimental studies deal with itinerant local-moment systems, where the intricate coupling between spin and charge excitations within a moderate-to-strong correlation regime plays an important role. We thus here present a novel real-space treatment of the non-equilibrium Hubbard model, suitable to address correlated spin dynamics ranging from the Stoner to the Heisenberg limit. It is based on the time-dependent rotational-invariant slave-boson scheme [1], allowing to keep track of both, local-moment as well as itinerant degrees of freedom. The antiferromagnetic spin-wave spectrum at half filling is obtained in the linear-response limit of the generic non-adiabatic framework. Various examples with and without doping demonstrate the capabilities and potential of the methodology.

[1] M. Behrmann, M. Fabrizio and F. Lechermann, PRB **88**, 035116 (2013)

MA 48.17 Thu 15:00 Poster B1

**Ultrafast magnetization dynamics of Gd studied by XMCD in reflection** — •Kamil Bobowski[1], Björn Frietsch[1], Markus Gleich[1], Niko Pontius[2], Christian Schüssler-Langeheine[2], Christoph Trabant[1], Marko Wietstruk[1], and Martin Weinelt[1] — [1]Fachbereich Physik der Freien Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Albert-Einstein-Straße 15, 12489 Berlin, Germany

We studied the ultrafast magnetization dynamics of a 10-nm thick single-crystalline Gd(0001) film at the $M_4$ and $M_5$ absorption edges using X-ray magnetic circular dichroism (XMCD) in reflection geometry. In a laser-pump X-ray-probe experiment we find a two-step demagnetization behavior which shows similar results to earlier XMCD measurements on polycrystalline Gd [1]. On the fast time scale below 4 ps, we observe an exponential decrease of the sample magnetization with increasing pump laser fluence, while on the slow time scale of 100 ps, the demagnetization is linearly dependent on the pump laser fluence. Here, a critical slowing down of the magnetization dynamics is observed for pump pulse fluences above 8 mJ/cm$^2$. A simulation based on the microscopic three temperature model (M3TM) of Koopmans et al. [2] does not allow to quantitatively reproduce the first step of the magnetization dynamics.

[1] M. Wietstruk *et. al.*, *Phys. Rev. Lett.* **106**, 127401 (2011).
[2] B. Koopmans *et. al.*, *Nat Mater* **9**, 259-265 (2010).

MA 48.18 Thu 15:00 Poster B1

**Towards Ultrafast Magnetic Imaging Using Circularly Polarized High Harmonics** — •Christina Nolte[1], Sergey Zayko[2], Sascha Schäfer[2], Daniel Steil[1], Manfred Albrecht[3], Stefan Mathias[1], and Claus Ropers[2] — [1]I. Physikalisches Institut, Universität Göttingen — [2]IV. Physikalisches Institut, Universität Göttingen — [3]Institut für Physik, Universität Augsburg

The recently demonstrated generation of circularly polarized extreme ultraviolet (XUV) radiation from high-harmonic light sources [1,2] in combination with lensless imaging techniques opens a new and powerful route for the spatially resolved study of ultrafast magnetization dynamics [3]. Extending a recent implementation of high-harmonic-based coherent diffractive imaging [4], we will present first results employing circularly polarized harmonics in the 40-70 eV photon energy range.

[1] O. Kfir et al., Nature Photonics 9, 99-105 (2015)
[2] D. Hickstein et al., Nature Photonics 9, 743-750 (2015)
[3] S. Mathias et al., JESRP 189, 164-170 (2013)
[4] S. Zayko et al., Optics Express 23, 19911-19921 (2015)

MA 48.19 Thu 15:00 Poster B1

**Spin-current manipulation of photo-induced magnetization dynamics** — •Steffen Wittrock[1], Dennis Meyer[1], Markus Müller[1], Henning Ulrichs[1], Jakob Walowski[2], Ulrike Martens[2], and Markus Münzenberg[2] — [1]Georg-August-Universität Göttingen — [2]Ernst-Moritz-Arndt-Universität Greifswald

Spin currents offer a way to control static and dynamic magnetic properties, and therefore they are crucial for next-generation MRAM devices or spin- torque oscillators. Manipulating the dynamics is especially interesting within the context of photo-magnonics. In typical 3d transition metal ferromagnets like CoFeB, the lifetime of light-induced magnetization dynamics is restricted to about 1 ns, which e.g. strongly limits the opportunities to exploit the wave nature in a magnonic crystal filtering device. Here, we investigate the potential of spin-currents to increase the lifetime in a simple trilayer system, consisting of 8 nm $\beta$-Tantalum, 5 nm CoFeB, capped by 3 nm Ruthenium. The samples were grown in UHV by magnetron sputtering (Ta, CoFeB) and E-beam evaporation (Ru), and subsequently patterned into micron-sized conduction strips using E-beam-lithography. Due to the spin Hall effect, the Ta layer generates a transverse spin current when a lateral charge current passes through the strip. Using time-resolved all-optical pump-probe spectroscopy, we investigate how this spin current affects the magnetization dynamics in the adjacent CoFeB layer.

MA 48.20 Thu 15:00 Poster B1

**Laser-driven ferromagnetic ordering in FeRh** — •Robert Carley[1], Sebastian Carron[6], Manuel Izquierdo[1], Tyler Chase[4], Bruce Clemens[4], Georgi Dakovski[6], Eric Fullerton[5], Patrick Granitzka[4], Alexander Gray[3], Stefan Günther[2], Daniel Higley[4], Emmanuelle Jal[3], Loïc Le Guyader[7], Joel Li[4], Serguei Molodtsov[1], Mike Minitti[6], Ankush Mitra[6], Alexander Reid[3], William Schlotter[6], Vojtech Uhlir[5], Joachim Stöhr[3], Hermann Dürr[3], Christian Back[2], and Andreas Scherz[1] — [1]European XFEL — [2]Universität Regensburg, Germany — [3]Stanford Institute for Materials and Energy Science, USA — [4]Stanford University, USA — [5]University of California San Diego, USA — [6]Linac Coherent Light Source, Stanford, USA — [7]Helmholtz Zentrum Berlin für Materialien und Energie, Germany

FeRh undergoes a first order phase transition from antiferromagnetic (AFM) to ferromagnetic (FM) where the magnetization is the order parameter. The transition is accompanied by an isotropic lattice expansion in the bulk. The transition has been extensively studied theoretically and experimentally, in thermal equilibrium and in the time domain, but a precise understanding remains elusive. We have studied the laser-driven phase transition with time-resolved x-ray diffraction (tr-RXD) at the Linac Coherent Light Source. The experiment has revealed a number of phenomena from sub-ps magnetic transients, FM nucleation, and domain growth processes with nanometer spatial resolution and femtosecond time resolution from the electronic point-of-view of the Fe L3 edge.

MA 48.21 Thu 15:00 Poster B1

**Tunable magnon-photon coupling in a compensated rare earth garnet – 3D cavity system** — •Hannes Maier-Flaig[1,2], Michael Harder[3], Stefan Klingler[1,2], Zhiyong Qiu[4], Eiji Saitoh[4], Rudolf Gross[1,2], Hans Huebl[1,2], and Sebastian T.B. Goennenwein[1,2] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany — [2]Physik - Department, Technische Universität München, Garching, Germany — [3]Department of Physics and Astronomy, University of Manitoba, Canada — [4]Institute for Materials Research, Tohoku University, Sendai, Japan

Strong spin-photon coupling is a major goal in quantum information memory applications, as it allows to coherently exchange information between the photons of a microwave cavity and a paramagnetic spin ensemble. This concept was recently transferred to magnetically ordered systems showing coupling rates of hundreds of megahertz even at room temperatures. Here, we demonstrate strong coupling of a micrometer thick $Gd_3Fe_5O_{12}$ (GIG) film and a 3D microwave cavity at distinct cryogenic temperatures. By employing a first-principles model of the coupled magnon-photon system, we reliably extract the relevant coupling parameters. The strongly temperature dependent magnetization of GIG (a compensated ferrimagnetic oxide) allows to tune the effective coupling rate of the system over a wide range, solely by changing the temperature. We are therefore able to observe the transition from a strongly coupled system to the weakly coupled regime in which ferromagnetic resonance experiments are usually performed.

MA 48.22 Thu 15:00 Poster B1

**Electron dynamics driving ultrafast magnetization dynamics in itinerant ferromagnets and alloys** — •Sebastian Weber and Baerbel Rethfeld — Fachbereich Physik und Forschungszentrum OPTIMAS, TU Kaiserslautern, Germany

Irradiating ferromagnetic films with an ultrashort laser pulse leads to a quenching of the magnetization on a subpicosecond timescale [Beaurepaire et al., PRL 76, 4250 (1996)]. With help of a spin-resolved Boltzmann description, which allows to describe microscopic collision processes including spin-flips, we have identified the equilibration of chemical potentials of majority and minority electrons as a driving force for ultrafast magnetization dynamics [Mueller et al., NJP 13, 123010 (2011) and PRL 111, 167204 (2013)].

Recent experiments have revealed element-specific dynamics in exchange coupled ferromagnetic alloys [Mathias et al., PNAS 109, 4792 (2012)]. We set up a microscopic model to trace the electron dynamics with spin-resolution and in dependence on the material in the alloy.

MA 48.23 Thu 15:00 Poster B1

**Resonant optical excitation of ultrafast magnetization dynamics in Iron Garnets by a sequence of optical pulses** — •Manuel Jäckl[1], Dmitri Morosov[1], Igor V. Savochkin[2], Dmitri V. Dodonov[3], Ilya A. Akimov[1,4], Vladimir I. Belotelov[4,5], Anatoly K. Zvezdin[3,5], and Manfred Bayer[1,4] — [1]Experimentelle Physik 2, TU Dortmund, D-44221 Dortmund, Germany — [2]Lomonosov Moscow State University, 119991 Moscow, Russia — [3]Moscow Institute of Physics and Technology, Moscow Region, 141700 Russia — [4]A.F. Ioffe Physical-Technical Institute, Russian Academy of Sciences, 194021 St. Petersburg, Russia — [5]Russian Quantum Center, Skolkovo, Moscow Region, 143025 Russia

We use the inverse Faraday effect in order to influence the magnetization of a ferromagnetic bismuth iron garnet (BIG) films by means of circularly polarized femtosecond laser pulses, leading to a precession of the magnetization with a lifetime of several nanoseconds and a frequency between 2 – 7 GHz in transverse magnetic fields of 70 – 250 mT, respectively. Using a sequence of optical pulses with a repetition rate of $F_{\mathrm{Rep}} = 1$ GHz which is larger than the decay rate of the oscillation, allows us to achieve synchronization of spin wave modes with frequencies F which satisfy the resonance condition of $F = nF_{\mathrm{Rep}}$ ($n$ is an integer). Consequently the amplitude of the magnetization precession increases when the modes are synchronized. Fourier sum analysis of the data and its magnetic field dependence allow to evaluate the comprehensive spectrum of spin waves in studied samples.

MA 48.24 Thu 15:00 Poster B1

**Element-selective investigation of the spin dynamics in NixPd1-x magnetic alloys in the extreme ultraviolet spectral range** — •Seung-gi Gang[1], Roman Adam[1], Christian Weier[1], Moritz von Witzleben[1], Moritz Plötzing[1], Oliver Schmitt[4], Henry C. Kapteyn[2], Margaret M. Murnane[2], Pablo Maldonado[3], Stefan Mathias[5], Martin Aeschlimann[4], Peter M. Oppeneer[3], and Claus M. Schneider[1] — [1]Peter Grünberg Institut PGI-6, Research Centre Jülich, 52425 Jülich, Germany — [2]Department of Physics and JILA, University of Colorado, Boulder, CO 80309-0440, USA — [3]Department of Physics and Astronomy, Uppsala University, SE-75120 Uppsala, Sweden — [4]University of Kaiserslautern and OPTIMAS, 67663 Kaiserslautern, Germany — [5]University of Göttingen, 37077 Göttingen, Germany

Optical pump-probe experiments allow the investigation of spin dynamics in magnetic materials on femtosecond time scales. Alloying 4d non-magnetic and 3d magnetic transition metals is expected to improve our understanding of the exchange interaction. We studied the ultrafast demagnetization of NixPd1-x alloys with varying x element selectively using a laser-based extreme ultraviolet light source. The spin-orbit coupling was further tuned with mixing ratio to study its influence. Transversal MOKE results measured for the Ni subsystem display an opposite quenching dependence on the stoichiometry compared to longitudinal MOKE probing the integrated response of both materials. Further experiments addressing the Pd subsystem are expected to clarify the role of the Pd, as a possible spin reservoir.

MA 48.25 Thu 15:00 Poster B1

**Ultrafast Magnetostriction of Antiferromagnetic Holmium studied by Femtosecond X-ray Diffraction** — •Jan-Etienne Pudell[1], Alexander von Reppert[1], Flavio Zamponi[1], Matthias Rössle[1], Daniel Schick[2], and Matias Bargheer[1,2] — [1]Institut für Physik und Astronomie, Universität Potsdam, Karl-Liebknecht-Str. 24-25, 14476 Potsdam, Germany — [2]Helmholtz-Zentrum Berlin, Wilhelm-Conrad-Röntgen Campus, BESSY II, Albert-Einstein-Str. 15, 12489 Berlin, Germany

We present time-resolved X-ray diffraction on a Holmium thin film after femtosecond laser excitation. The lattice shows rich spatio-temporal dynamics, where the contraction and expansion are driven by the laser excitation. The indirect exchange interaction (RKKY) in the 80 nm Holmium film leads to an incommensurate helical antiferromagnetic (AFM) spin structure below the Néel temperature. The strong magnetostriction in Holmium results in a decrease of the lattice constant with temperature. The sub-pico to nanosecond lattice dynamics after photoexcitation are studied by ultrafast X-ray diffraction (UXRD) using a laser-driven Plasma X-ray Source (PXS). The sample is excited with an 800 nm femtosecond laser pulse at various temperatures. The phonon driven lattice expansion takes place within 15 ps and is sound velocity limited. Below the Néel temperature, the heating of the magnetic system induces an ultrafast magnetostriction, which leads to a maximal contraction within 25 ps. With a linear chain simulation the spacial and time resolved strain profile induced by the strong magnetostriction is analyzed.

MA 48.26 Thu 15:00 Poster B1

**Delay- and depth-dependent simulations of the fluence-dependent magnetization dynamics in Gd** — •Markus Gleich[1], Kamil Bobowski[1], Björn Frietsch[1], Niko Pontius[2], Christian Schüssler-Langeheine[2], Christoph Trabant[1], Marko Wietstruk[1], and Martin Weinelt[1] — [1]Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Albert-Einstein-Straße 15, 12489 Berlin, Germany

We performed delay- and depth-dependent simulations of the fluence-dependent magnetization dynamics in Gd based on the microscopic three temperature model (M3TM) by Koopmans *et al.* [1]. For the calculations the M3TM was modified and extended to model the laser excitation process [2]. Our results were compared with the fluence-dependent magnetization dynamics ($1.9 - 11.2\,\mathrm{mJ/cm^2}$) of a single-crystalline Gd(0001) sample measured with X-ray magnetic circular dichroism in reflection at the FEMTOSPEX facility at BESSY II. For the simulations several parameters, e.g., the thermal conductivity and the heat capacity, were varied to reproduce the measured fluence-dependent magnetization dynamics. Our simulations reproduce the two-step demagnetization qualitatively but we could not achieve the quantitative agreement previously demonstrated for nickel [3].

[1] B. Koopmans *et al.*, Nat. Mater. **9**, 259–265 (2010).
[2] Y. P. Meshcheryakov *et al.*, Appl. Phys. A **82**, 363–368 (2005).
[3] T. Roth *et al.*, Phys. Rev. X **2**, 021006 (2012).

MA 48.27 Thu 15:00 Poster B1

**Ultrafast Lorentz microscopy: towards femtosecond imaging of magnetization dynamics** — •Nara Rubiano da Silva[1], Marcel Möller[1], Jan Gregor Gatzmann[1], Armin Feist[1], Tim Eggebrecht[2], Ulrike Martens[3], Henning Ulrichs[2], Vladyslav Zbarsky[2], Markus Münzenberg[3], Claus Ropers[1], and Sascha Schäfer[1] — [1]4th Physical Institute, University of Göttingen, Germany — [2]1st Physical Institute, University of Göttingen, Germany — [3]Interface and Surface Physics, University of Greifswald, Germany

Lorentz microscopy (LM) enables magnetization imaging with a spatial resolution reaching 2-20 nm [1]. Based on this technique, we have developed two approaches to address rapid magnetization processes triggered by femtosecond laser excitation. In a first approach, irreversible changes of the magnetic structure after single excitation pulses are sampled via static LM. In continuous Fe thin films on a SiN substrate, we observe the laser-induced formation of a dense vortex/antivortex network that is metastable at room temperature [2]. Furthermore, we will present first results from the implementation of a laser-pump/electron-probe scheme in a transmission electron microscope. This instrument will be capable of elucidating ultrafast spin dynamics in magnetic nanostructures using highly coherent femtosecond electron pulses.

[1] J. N. Chapman et al., J. Magn. Magn. Mater. (1999).
[2] T. Eggebrecht et al., submitted.

MA 48.28 Thu 15:00 Poster B1

**Magnetization dynamics in ferromagnetic layers induced by spin-polarized current** — •Muhammad Imtiaz Khan[1], Johanna Hackl[1], Slavomír Nemšák[1], Umut Parlak[1], Hatice Doğanay[1], Daniel Gottlob[3], Stefan Cramm[1], Daniel Bürgler[1], and Claus Michael Schneider[1,2] — [1]Peter Grünberg Institut 6, Forschungszentrum Jülich, 52425 Jülich, Germany — [2]Fakultät für Physik and Center for Nanointegration Duisburg-Essen (CeNIDE), Universität Duisburg-Essen, 47048 Duisburg, Germany — [3]CEA Saclay, 91191 Gif-sur-Yvette Cedex, France

The spin-polarized current induced magnetization dynamics is investigated by time resolved aberration-corrected photoelectron emission microscope. We explicitly measure the domain wall motion after applying each subsequent pulse in a permalloy structure. The pump-probe technique is then carried out to image the time evolution of the domain wall's magnetization by synchronizing the current pulse with the synchrotron radiation pulse train.

MA 48.29 Thu 15:00 Poster B1

**Sub-monolayer film growth of volatile $\beta$-dikenonate lanthanide complexes on metallic surfaces** — •Jinjie Chen[1], Hironari Issihiki[1], Kevin Edelmann[1,2], and Wulf Wulfhekel[1,2] — [1]Physikalisches Institut, Karlsruhe Institute of Technology (KIT) — [2]Institut for Nanotechnology, Karlsruhe Institute of Technology (KIT)

We demonstrate that volatile $\beta$-dikenonate lanthanide complexes can be deposited on various metallic surfaces in ultra-high vacuum without molecule decomposition and surface contamination. The morphology of the well assembled sub-monolayer molecular films was studied by scanning tunneling microscopy at 5 K. The molecules order in commensurate structure on Cu(111), Ag(111). On Au(111), they nucleate at the elbows of the reconstruction. Delocalized molecular orbitals were found in scanning tunneling spectroscopy and spatially imaged by dI/dV maps. Our work expended the catalogue for rare earth magnetic molecules which can be studied by scanning tunneling microscopy.

MA 48.30 Thu 15:00 Poster B1

**Comparing XMCD and DFT with STM spin excitation spectroscopy for Fe and Co adatoms on $Cu_2N$/Cu(100)** — •Markus Etzkorn[1,2], Cyrus F. Hirjibehedin[3], Anne Lehnert[1], Safia Ouazi[1], Stefano. Rusponi[1], Sebastian Stepanow[4], Pietro Gambardella[4], Carsten Tieg[5], Pardeep Thakur[5], Alexander I. Lichtenstein[6], Alexander B. Shick[7], Sebastian Loth[8], Andreas Heinrich[9], and Harald Brune[1] — [1]EPFL, Lausanne, Switzerland — [2]MPI for Solid State Research, Stuttgart, Germany — [3]London Centre for Nanotechnology, UCL, United Kingdom — [4]ETH Zürich, Zürich, Switzerland — [5]ESRF, Grenoble, France — [6]University of Hamburg, Hamburg, Germany — [7]Institute of Physics, Prague, Czech Rep. — [8]CFEL, Hamburg, Germany — [9]IBM Almaden Research Center, San Jose, USA

We compare the magnetic properties of ensembles of single Fe and Co atoms on a $Cu_2N$ monolayer on Cu(100) deduced from x-ray circular magnetic dichroism (XMCD) and density functional (DFT) calculations with spin excitation spectroscopy (SES) measurements on single atoms [1]. We focus in particular on the values of the local magnetic moments determined by XMCD compared to the expectation values derived from the spin Hamiltonian used to describe the SES data. Within this model we are able to understand the angular dependence of the projected magnetic moments along the magnetic field, as measured by XMCD. In agreement with DFT, the XMCD measurements show large orbital contributions to the total magnetic moment for both magnetic adatoms. [1] M.Etzkorn *et al.*, PRB 92 (2015) 184406.

MA 48.31 Thu 15:00 Poster B1

**First-principles study of magnetism in FeIr bilayers on Rh(001)** — •Sebastian Meyer, Bertrand Dupé, Paolo Ferriani, and Stefan Heinze — Institut für Theoretische Physik und Astrophysik, Christian-Albrechts-Universität zu Kiel, Leibnizstr. 15, 24098 Kiel

Recently, complex non-collinear spin structures such as spin spirals, spin lattices or skyrmions have been discovered at transition-metal surfaces [1-3]. In particular, the magnetic ground state of Fe monolayers can be tuned at interfaces with other 4*d* and 5*d* transition-metals [4]. Here, we use density functional theory as implemented in the full-potential linearized augmented plane wave method to investigate the magnetic properties of bilayers from Fe and Ir on the Rh(001) surface. We consider both ways of growing the bilayer on the substrate, i.e. Fe/Ir/Rh(001) and Ir/Fe/Rh(001). Both systems are structurally relaxed and the magnetic ground state is determined by total energy calculations. We compare the ferro- and antiferromagnetic state of the Fe monolayer and find a significant influence of the stacking sequence of the bilayer. The calculated energy dispersion of spin spirals provides evidence for a non-collinear ground state.

[1] S. Heinze *et al.*, Nature Phys. **7**, 713 (2011).
[2] M. Hoffmann *et al.*, Phys. Rev. B **92**, 020401(R) (2015).
[3] N. Romming *et al.*, Science **341**, 636 (2013).
[4] B. Hardrat *et al.*, Phys. Rev. B **79**, 094411 (2009).

MA 48.32 Thu 15:00 Poster B1

**Magnetic linear dichroism of 3d metal thin films** — •Torsten Veltum[1], Tobias Löffler[1], Mathias Gehlmann[2], Sven Döring[2], Lukasz Plucinski[2], and Mathias Getzlaff[1] — [1]Institut für Angewandte Physik, Heinrich-Heine-Universität Düsseldorf, 40225 Düsseldorf — [2]Peter Grünberg Institut PGI-6, Forschungszentrum Jülich, 52428 Jülich

Magnetic linear dichroism in the angular distribution of photoelectrons (MLDAD) is a technique that allows the study of both the electronic band structure and the magnetic properties of thin films and single crystals. Because we are interested in a deeper understanding of the magnetic linear dichroism of 3d metals, we study epitaxially grown Co(0001) and Fe(110) thin films on a W(110) surface.

In this study linearly polarized synchrotron radiation (Beamline 5, DELTA Dortmund) in the VUV regime is used to gain the experimental data. At the beamline we have access to angle-resolved photoemission spectroscopy and low energy electron diffraction.

The electronic structure of the valence band is measured by variation of the photon energy. At excitation energies above 20 eV, dichroism measurements are reconfirmed and extended to angle-resolved spectra in off-normal geometry. The resonance between the 3d core-levels and the valence band of these materials shows an influence on the dichroism.

MA 48.33 Thu 15:00 Poster B1

**towards ferromagnetic resonance in scanning tunneling microscopy using homodyne detection** — •marie hervé, moritz peter, and wulf wulfhekel — Physikalisches Institut, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

In this communication we report on the experimental development of a new technique to measure locally ferromagnetic resonance signals with a SP-STM. The concept of this experiment, inspired by the spin torque diode effect [1], is based on the homodyne detection of the resonance signal in the sample. A continuous radio-frequency (rf) voltage (up to 3 GHz) is mixed to the bias voltage of the STM. If there is a magnetisation precession under the STM tip, the tunneling conductance will be modulated at the resonance frequency. When the high frequency signal mixed to the tunneling junction reach the resonance frequency of the precession, the tunneling current is rectified. This rectified current, measurable by conventional STM transimpedance amplifier correspond to a ferromagnetic resonance signal in the sample.

[1] A. A. Tulapurkar, Y. Suzuki, A. Fukushima, H. Kubota, H. Maehara, K. Tsunekawa, D. D. Djayaprawira, N. Watanabe and S. Yuasa, Nature 438, 339 (2005)

MA 48.34 Thu 15:00 Poster B1

**Spin wave propagation in anisotropic monocrystalline iron stripes** — •Helmut Körner, Johannes Stigloher, Matthias Kronseder, and Christian Back — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Germany

Pure iron might be a suitable candidate for spin wave based applications due to its promising properties such as low damping factor, high saturation magnetization and well-defined magneto-crystalline anisotropy, calling for profound investigations of spin wave propagation in this material. Our sample is a Fe(10 nm)/AlOx(5 nm) full film grown on top of a GaAs substrate by means of molecular beam epitaxy showing a pre-dominant cubic magneto-crystalline anisotropy which is then patterned into micrometer-sized stripes with different orientations with respect to the crystallographic axes of the iron. In these stripes, we study the propagation of electrically excited magnetostatic Damon-Eshbach spin waves employing time-resolved scanning Kerr microscopy in combination with micromagnetic simulations using the GPU-accelerated simulation program mumax[3].

MA 48.35 Thu 15:00 Poster B1

**Electrically detected FMR in the field-polarized phase of $Cu_2OSeO_3$** — •Stefan Weichselbaumer[1,2], Ioannis Stasinopoulos[1], Andreas Bauer[3], Helmuth Berger[4], Johannes Waizner[5], Markus Garst[5], Christian Pfleiderer[3], and Dirk Grundler[1,6] — [1]Physik-Department E10, TU München, Garching, Germany — [2]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [3]Physik-Department, FG Magnetische Materialien, TU München, Garching, Germany — [4]EPFL, Institut de physique de la matiere complexe, Lausanne, Switzerland — [5]Institute for Theoretical Physics, Univ. Köln, Köln, Germany — [6]LMGN, IMX, EPFL, Lausanne, Switzerland

The insulating chiral magnet $Cu_2OSeO_3$ recently gained a lot of interest as it exhibits a Skyrmion lattice and spin helix phase. The insulating nature of this material as well as the magnetoelectric coupling could lead to efficient spin-based devices. We investigate collective excitations in the field-polarized ferrimagnetic phase of $Cu_2OSeO_3$ using a broadband spectroscopy setup based on a vector network analyzer. By evaporating a thin Pt layer on our sample and measuring the voltage across the Pt stripe, we are able to electrically detect the ferromagnetic resonance (FMR) signal. We observe a significant influence of heating effects due to microwave irradiation. Our analysis shows that several effects contribute to the signal, including the spin rectification effect (SR) and spin pumping (SP). Financial support by the DFG via TRR80 is acknowledged.

MA 48.36 Thu 15:00 Poster B1

**Broadband spin-wave spectroscopy on a nanostructured ferrimagnetic thin film** — •Stefan Mändl[1], Florian Heimbach[1], Stefan Weichselbaumer[2], and Dirk Grundler[3] — [1]Physik Department E10, TU München, Garching, Germany — [2]Walther Meißner Institut, TU München, Garching, Germany — [3]Institut des Matériaux, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

Magnonics is a growing research field where one aims at controlling spin waves on the nanoscale. Microwave-to-magnon transducers are in particular important for coupling magnonic devices to conventional microwave circuits. It was found that the reciprocal-lattice vector provided by a periodic magnetic modulation in a metallic thin film adds to the wave vector of a Damon-Eshbach mode [1]. In our work, we explore 200 nm thick yttrium iron garnet (YIG) produced by liquid phase epitaxy by broadband spin-wave spectroscopy and excite spin waves using coplanar waveguides. We investigate spin waves induced in the unpatterned and periodically modulated YIG film containing a two-dimensional lattice of nanotroughs etched by argon ion milling. We compare our results with spin waves reported for a 20 nm thick ferrimagnetic YIG film produced by pulsed laser deposition [2]. The work is supported by the DFG via GR1640/5 in SPP 1538 and NIM.

[1] H. Yu et al., Nat. Commun. 4, 2702 (2013)
[2] H. Yu et al., Scientific Reports 4, 6848 (2014)

MA 48.37 Thu 15:00 Poster B1

**Coplanar waveguide based ferromagnetic resonance in thin magnetic films: influence of a superconducting layer** — •Philip D. Louis[1,2], Matthias Althammer[2], Hannes Maier-Flaig[1,2], Mathias Weiler[1,2], Hans Huebl[1,2,3], Rudolf Gross[1,2,3], and Sebastian T. B. Goennenwein[1,2,3] — [1]Physik-Department, Technische Universität München, Garching, Germany — [2]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [3]Nanosystems Initiative Munich (NIM), München, Germany

The high-frequency properties of magnetic materials are of general interest from both an application and a fundamental research point of view. Coplanar waveguide (CPW) based ferromagnetic resonance (FMR) allows for a broadband spectroscopy of magnetization dynamics. In order to maximise the FMR signal and enhance sensitivity, it is important to efficiently drive magnetisation dynamics via a CPW. In our experiment, we study the FMR response of cobalt/niobium thin film heterostructures at temperatures above and below the Nb superconducting phase transition temperature. The sample is mounted Co-side down on a CPW and the complex transmission $S_{21}$ is measured using vector network analysis. We observe an amplitude increase of the Co FMR signal by up to an order of magnitude when the Nb is in its superconducting state. This result can be explained by an efficient confinement of the FMR driving field between the superconducting Nb and the CPW. This effect can be used to increase the FMR signal of ultra thin/weakly magnetic films and has to be accounted for when including superconducting films into functional multi-layers.

MA 48.38 Thu 15:00 Poster B1

**Effect of Novel Exchange-Coupling Torque and Spin-Orbit Interaction on Current Induced Domain Wall Motion in Magnetic Nanowires** — •Robin Bläsing[1,2], See-Hun Yang[2], Gernot Güntherodt[1,3], and Stuart S. P. Parkin[1,2] — [1]Max Planck Institute for Microstructure Physics, Halle (Saale), D-006120, Germany — [2]IBM Almaden Research Center, San Jose, California 95120, USA — [3]2nd Institute of Physics, RWTH Aachen University, 52074 Aachen, Germany

Recent discoveries in the field of current induced domain wall motion open new possibilities for novel memory devices like the racetrack memory. Due to a large perpendicular magnetic anisotropy, the magnetization of an ultra-thin magnetic Co/Ni layer is pointing out-of-plane. In combination with the Dzyaloshinskii-Moriya interaction, Néel domain walls are formed which can be driven by a spin Hall current induced e.g. by an adjacent Pt underlayer, resulting in a domain wall velocity of about 400 m/s. In this work, a further improvement is achieved with synthetic antiferromagnetic structures, where two ultrathin ferromagnetic layers are coupled antiparallel via the Ruderman-Kittel-Kasuya-Yosida exchange interaction. This exchange coupling gives rise to a novel exchange-coupling torque which increases the domain wall velocity up to 750 m/s.

MA 48.39 Thu 15:00 Poster B1

**Spin-torque measurements in NiFe/Pt bilayers with different Pt thickness** — •Robert Islinger, Martin Decker, and Martin Obstbaum — Institute for Experimental and Applied Physics, University Regensburg, 93040 Regensburg, Germany

Spin-torque ferromagnetic resonance (ST-FMR) is a reliable method to determine the spin Hall angle in ferromagnetic/normal metal bilayers [1]. In this study we use NiFe/Pt bilayers with varying Pt thickness in order to extract the spin diffusion length and the spin Hall angle. We explain this method in detail and compare the values with modulation of damping and inverse spin Hall effect measurements.

[1] Liu et al. PRL 106, 036601 (2011)

MA 48.40 Thu 15:00 Poster B1

**Time Resolved Scanning Tunnelling Spectroscopy on Magnetic Vortex Cores** — Christian Saunus, •Marco Pratzer, Lukas Deutz, and Markus Morgenstern — II. Physikalisches Institut B, RWTH Aachen University and JARA-FIT, 52074 Aachen, Germany

A magnetic vortex is the simplest non-trivial magnetic order showing up in a magnetic disk with no magnetic anisotropy. The centre of this chiral magnetic structure features an out of plane magnetic moment called the vortex core. The vortex core can be driven to a resonant gyration by radio-frequency magnetic fields or spin polarized currents [1,2].

We performed spin polarized scanning tunnelling spectroscopy on Fe nano islands prepared on a W(110) crystal. The magnetic vortices are mapped using an anti-ferromagnetic tip made of bulk chromium. In order to excite the gyro mode we superimpose the bias voltage of the STM with a tunable high frequency voltage up to 3 GHz. We measure the resulting dc current as a function of frequency, which is interpreted in terms of the gyro mode.

[1] S.-B. Choe et al., Science 304, 420 (2004).
[2] S. Kasai et al., Phys. Rev. Lett. 97, 107204 (2006).

MA 48.41 Thu 15:00 Poster B1

**Twofold and fourfold symmetric anisotropic magnetoresistance effect in a model with crystal field** — •Satoshi Kokado[1] and Masakiyo Tsunoda[2] — [1]Shizuoka University, Hamamatsu, Japan — [2]Tohoku University, Sendai, Japan

We theoretically study the twofold and fourfold symmetric anisotropic magnetoresistance (AMR) effect [1]. We first extend our previous model [2, 3] to a model including the crystal field effect [1]. Using the model, we next obtain an analytical expression of the AMR ratio, i.e., AMR($\phi$)=$C_0 + C_2 \cos(2\phi) + C_4 \cos(4\phi)$, with $C_0$=$C_2 - C_4$ [1]. Here, $\phi$ is the relative angle between the magnetization direction and the electric current direction and $C_2$ ($C_4$) is a coefficient of the twofold (fourfold) symmetric term. The coefficients $C_2$ and $C_4$ are expressed by a spin-orbit coupling constant, an exchange field, a crystal field, and s-s and s-d scattering resistivities. Using this expression, we analyze the experimental results for $Fe_4N$ [4, 5], in which $|C_2|$ and $|C_4|$ increase with decreasing temperature. The experimental results can be reproduced by assuming that the tetragonal distortion increases with decreasing temperature.

[1] S. Kokado *et al.*, J. Phys. Soc. Jpn. **84**, 094710 (2015).
[2] S. Kokado *et al.*, J. Phys. Soc. Jpn. **81**, 024705 (2012).
[3] S. Kokado *et al.*, Adv. Mater. Res. **750-752**, 978 (2013).
[4] M. Tsunoda *et al.*, Appl. Phys. Express **3**, 113003 (2010).
[5] K. Kabara *et al.*, Appl. Phys. Express **7**, 063003 (2014).

MA 48.42 Thu 15:00 Poster B1

**Domain wall motion in a ferromagnet induced by pure diffusive spin currents in graphene** — •Fabienne Musseau[1], Michele Voto[2], Alexander Pfeiffer[1], Nils Richter[1], Luis Lopez Diaz[2], and Mathias Kläui[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — [2]Departamento de Física Aplicada, Universidad de Salamanca, 37008 Salamanca, Spain

Due to the miniaturization of systems to the nanoscale, the physics of surfaces and interfaces is a major area of research. The controlled motion of magnetic domain walls is a vital component of various spintronic devices and memory applications, such as the racetrack memory which uses spin currents [1]. Another possibility is to use pure diffusive spin currents to manipulate the magnetization in a ferromagnet at very low spin current densities [2,3]. In our measurements, the non-local spin valves consists of two permalloy half rings which are connected via a non-magnetic graphene spin conduit, a geometry which permits the precise positioning of domain walls. We choose graphene due to its low spin-orbit coupling and large spin diffusion length, allowing for the propagation of spin currents with little attenuation [4]. We investigated the displacement of domain walls via spin torques exerted by pure diffusive spin currents in the non-local spin valve geometry [2,3]. We compare our results to micromagnetic simulations to understand the acting torques. [1] S. S. P. Parkin et al., Science 320, 190 (2008), [2] N. Motzko et al., Phys. Rev. B, 88, 214405 (2013), [3] D. Ilgaz et al., Phys. Rev. Lett. 105, 076601 (2010), [4] N. Tombros et al., Nature 448, 571 (2007)

MA 48.43 Thu 15:00 Poster B1

**Mg diffusion in $Fe_3O_4$ based magnetic tunnel junctions with MgO barrier** — •Luca Marnitz[1], Tobias Peters[1], Denis Dyck[1], Jari Rodewald[2], Olga Kuschel[2], Joachim Wollschläger[2], Stephan Wallek[2], Karsten Rott[1], Jan-Michael Schmalhorst[1], Thorsten Glaser[2], Günter Reiss[1], and Timo Kuschel[1] — [1]Bielefeld University, Germany — [2]Universität Osnabrück, Germany

Due to its high spin polarization and Curie temperature, magnetite ($Fe_3O_4$) is a promising material for room temperature applications in spintronics and spincalorics. In a previous publication, a sign change in the tunneling magnetoresistance of CoFeB/MgO/$Fe_3O_4$/MgO(001) magnetic tunnel junctions was observed after annealing at temperatures above 240°C [1]. Mg diffusion from the MgO through the $Fe_3O_4$ is a possible explanation for this behaviour [2]. Further studies, including Sputter-Auger-Spectroscopy and X-ray Reflectivity have been undertaken to investigate this effect. Additionally, low temperature SQUID and Raman Spectroscopy measurements have been performed to characterise the magnetite samples.

[1] L. Marnitz et al., AIP Adv. 5, 047103 (2015)
[2] K. A. Shaw et al., J. Appl. Phys. 81, 5176 (1997)

MA 48.44 Thu 15:00 Poster B1

**Side-jump contribution to the spin Hall effect within a phase shift model** — •Christian Herschbach[1], Dmitry Fedorov[2,1], Martin Gradhand[3], Kristina Chadova[4], Diemo Ködderitzsch[4], Hubert Ebert[4], and Ingrid Mertig[1,2] — [1]Martin Luther University Halle-Wittenberg, Halle, Germany — [2]Max Planck Institute of Microstructure Physics, Halle, Germany — [3]University of Bristol, Bristol, United Kingdom — [4]Ludwig-Maximilians University, Munich, Germany

A precise theoretical description of the spin Hall effect (SHE) requires exhaustive and demanding *ab initio* calculations by means of relativistic codes. For a simplified description of the skew-scattering contribution to the SHE, several model approaches employing the scattering phase shifts were developed [1-5]. A corresponding resonant scattering model for the side-jump mechanism was proposed [3] as well.

Here, we present a generalized phase shift model for the description of side-jump. Its validity is studied in comparison to *ab initio* calculations performed within the Kubo-Středa approach [6]. Furthermore, we discuss the results in the light of the simplified approximation of Ref. [3]. It is shown that the model's restriction to impurity properties cannot reproduce the results of first-principles calculations, which, therefore, seem to be inevitable for reliable predictions.

[1] Fert *et al.*, JMMM **24**, 231 (1981); [2] Guo *et al.*, PRL **102**, 036401 (2009); [3] Fert and Levy, PRL **106**, 157208 (2011); [4] Fedorov *et al.*, PRB **88**, 085116 (2013); [5] Herschbach *et al.*, PRB **88**, 205102 (2013); [6] Chadova *et al.*, PRB **92**, 045120 (2015).

MA 48.45 Thu 15:00 Poster B1

**Spin-Transfer-Torque in Magnetic Tunnel Junctions** — •Christian Denker[1], Jakob Walowski[1], Ulrike Martens[1], Vladislav Zbarksi[2], Günter Reiss[3], and Markus Münzenberg[1] — [1]Institut für Physik, Ernst-Moritz-Arndt Universität, Greifswald, Germany — [2]Fakultät für Physik, Georg-August Universität, Göttingen, Germany — [3]CSMD, Physics Department, Universität Bielefeld, Germany

Magnetic tunnel junctions based on MgO symmetry filtering allow specific control of the electronic structure and are appealing for THz spintronics.

Our optimized MgO/CoFeB based layer stack with perpendicular tunnel junction shows a minimal critical switching of only 9.3 kA/cm$^2$. This is partly associated with a thermally activated switching probability and specific switching distribution [1]. We found the enhanced demagnetization observed by He et al. [2] and a distinct selection of electrons tunneling through the MgO barrier by switching parallel and antiparallel magnetization for varied anisotropy values along a wedge sample in pump-probe spectroscopy with fs excitation. We show that different effects on time scales related to energy-momentum distribution of hot electrons, which relax within 70 fs, determine the THz currents in samples with barrier thickness of only 2 monolayers MgO. This will eventually allow a spin transfer of the hot electrons into the second CoFeB layer even on a ps time scale.

[1] Leutenantsmeyer et al., Mater. Trans., 9, 56 (2015)
[2] He et al. Sci. Rep. 3, 2883 (2013)

MA 48.46 Thu 15:00 Poster B1

**Preparation and characterization of beta-W thin films for spin Hall effect experiments** — •Timo Oberbiermann[1], Christoph Klewe[1], Jari Rodewald[2], Olga Kuschel[2], Joachim Wollschläger[2], Günter Reiss[1], and Timo Kuschel[1] — [1]CSMD, Physics Department, Bielefeld University, Germany — [2]Fachbereich Physik, Universität Osnabrück, Germany

Recently, the spin Hall effect in metals, more precisely in Pt and $\beta$ W, was detected optically by magnetooptical Kerr effect (MOKE) measurements [1]. However, the physical properties of tungsten thin films are strongly affected by the film microstructure. While the thermodynamically stable $\alpha$ phase exhibits no detectable spin Hall effect, the metastable $\beta$ phase shows a large spin Hall angle $\alpha_{SH}$ of 0.33 [2]. Hence, it is important to find appropriate conditions to prepare W films for spincaloric applications.

In this work, different W thin films were fabricated using magnetron sputtering. Process preassure, deposition time and sputtering power were varied to evaluate the ideal deposition parameters. The samples were characterized by x-ray diffraction and x-ray reflectometry to determine their structures and interface properties.

Additionally, the temporal stability of the W $\beta$ phase was investigated and optical spin Hall measurements were performed, both via MOKE and x-ray resonant magnetic reflectivity (XRMR).

[1] O.M.J. Van t'Erve et al., Appl. Phys. Lett. 104, 172402 (2014)
[2] C.-F. Pai et al., Appl. Phys. Lett. 101, 122404 (2012)

MA 48.47 Thu 15:00 Poster B1

**Non-local magnetoresistance in YIG/Pt nanostructures** — •Tobias Wimmer[1,2], Sebastian Goennenwein[1,2,3], Kathrin Ganzhorn[1,2], Richard Schlitz[1,2], Matthias Pernpeintner[1,2,3], Matthias Althammer[1], Rudolf Gross[1,2,3], and Hans Huebl[1,2,3] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany — [2]Physik-Department, Technische Universität München, 85748 Garching, Germany — [3]Nanosystems Initiative Munich (NIM), Schellingstraße 4, 80799 München Germany

The spin Hall magnetoresistance (SMR) in ferrimagnetic insulator/normal metal heterostructures has been extensively studied in Yttrium Iron Garnet /Platinum (YIG/Pt) bilayer structures. Recently, a non-local analogue of the SMR has been discovered in YIG/Pt nanostructures with two parallel Pt strips separated by a few 100 nm. Owing to the spin Hall effect, a charge current flowing along one Pt strip will generate a transverse spin current. The latter can create or annihilate magnons in the ferrimagnet, depending on magnetization orientation. As a result, an electrically generated non-equilibrium magnon population diffuses within the ferrimagnet, generating a non-local voltage drop across the second Pt strip. We investigate the evolution of this non-local magnon mediated magnetoresistance with temperature, magnetic field strength and field orientation. Our results show that the mechanisms behind the spin Hall and the non-local magnetoresistance are qualitatively different.

MA 48.48 Thu 15:00 Poster B1

**Spin Hall magnetoresistance in erbium iron garnet** — •Hiroto Sakimura[1], Michaela Lammel[1], Matthias Althammer[1], Stephan Geprägs[1], Rudolf Gross[1,2], and Sebastian T. B. Goennenwein[1,2] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Fakultät für Physik, Technische Universität München, Garching, Germany

The interconversion of spin and charge currents via the (inverse) spin Hall effect in normal metal (NM)/ferromagnetic insulator (FMI) bilayers leads to the spin Hall magnetoresistance (SMR). The SMR manifests itself in the dependence of the electrical resistivity of the NM layer on the magnetization orientation of the FMI. By using erbium iron garnet ($Er_3Fe_5O_{12}$, ErIG) as the ferrimagnetic insulator with a magnetic compensation point at 78 K, further insight on the dependence of the SMR on the sub-lattice magnetizations can be obtained. Here we report on the fabrication of ErIG/Pt bilayers on (100)-oriented $Gd_3Fe_5O_{12}$ and $Y_3Al_5O_{12}$ substrates by pulsed laser deposition and subsequent electron beam evaporation. High crystalline quallity of our thin films is confirmed by X-ray diffraction measurement. The compensation temperatures of the thin films observed by SQUID magnetometry were close to the bulk value. The temperature dependence of the SMR in these ErIG/Pt bilayers shows a decrease of the SMR amplitude at the compensation point, suggesting a complex interplay of the different magnetic sub-lattices for the SMR. - This work is supported by the DFG via SPP 1538.

MA 48.49 Thu 15:00 Poster B1

**Spin Hall effect in the non-collinear antiferromagnets $IrMn_3$ and $PtMn_3$** — •James Taylor[1], Yong Pu[1], Jue Huang[1], Weifeng Zhang[2], Wei Han[2], See-Hun Yang[2], Claudia Felser[3], and Stuart S.P. Parkin[1,2] — [1]Max Planck Institute for Microstructure Physics, D-06120 Halle, Germany — [2]IBM Almaden Research Center, San Jose, California 95120, USA — [3]Max Planck Institute for Chemical Physics of Solids, 01187 Dresden, Germany

Recent work has demonstrated a large spin Hall effect (SHE) in antiferromagnets (AFM); including the ability to tune SHE by changing the crystal structure, and hence internal AFM ordering, of the materials. The triangular arrangement of magnetic moments in a non-collinear AFM is associated with a chirality, which is predicted to give rise to a significant anomalous Hall effect. With both effects sharing a common origin in spin-orbit coupling, such chiral spin textures may also give rise to large SHE. In this work, we report progress towards measurement of the spin Hall angle (SHA) in the non-collinear AFMs $IrMn_3$ and $PtMn_3$. SHA was measured using the spin-torque ferromagnetic resonance technique, in AFM/Py (= $Ni_{81}Fe_{19}$) bilayers. Initial results show a facet dependence of the SHA ($\theta_{SH}$) measured in $IrMn_3$. In (100) oriented $IrMn_3$, $\theta_{SH}$ = 0.2, but in the (111) orientation $\theta_{SH}$ = 0.12. Further measurements will extend to $PtMn_3$, which has been grown using DC magnetron sputtering, with composition confirmed by Rutherford back scattering and crystal structure investigated using X-ray diffraction. In future work we aim to elucidate the effect of chiral magnetic ordering on measured SHA.

MA 48.50 Thu 15:00 Poster B1

**Dependence of the temporal dynamics of the longitudinal spin Seebeck effect on the magnetic layer thickness in YIG/Pt bilayers** — •Timo Noack, Thomas Langner, Frank Heussner, Viktor Lauer, Alexander Serga, Burkard Hillebrands, and Vitaliy Vasyuchka — FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, Kaiserslautern, Germany

The longitudinal spin Seebeck effect (LSSE) attracts a rising interest for both fundamental studies and application developments. The spectral properties of the LSSE are not completely understood so far. Our main focus was to investigate the temporal dynamics of the LSSE with focus on the dependence of the transition processes on the thickness of a magnetic film (in our case yttrium-iron-garnet, YIG) (0.27$\mu$m-50$\mu$m) in YIG/Pt bilayers. To obtain spectral properties of the LSSE a time resolved measurement technique with single pulsed microwave-induced heating, as well as a frequency resolved measurement technique with amplitude modulated heating were utilized. Both experiments show that the temporal dynamics of the LSSE becomes slower with increase of the YIG thickness. Specifically, with decrease of the YIG film thickness single-pulse measurements result in an decrease in the LSSE risetime, while the frequency modulation method results in an increase of the cut-off frequencies (-3dB of initial LSSE voltage at 1kHz). This behavior evidences the significant contribution of bulk magnon modes to the LSSE. Financial support by the Deutsche Forschungsgemeinschaft within Priority Program 1538 "Spin Caloric Transport" is gratefully acknowledged.

MA 48.51 Thu 15:00 Poster B1

**Dependence of transverse magneto-thermoelectric effects on inhomogeneous magnetic fields** — •Anatoly Shestakov[1], Maximilian Schmid[1], Daniel Meier[2], Timo Kuschel[2], and Christian Back[1] — [1]Institute of Experimental and Applied Physics, University of Regensburg, 93040 Regensburg, Germany — [2]Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, 33615 Bielefeld, Germany

Transverse magneto-thermoelectric effects, namely Anomalous Nernst Effect (ANE), Anisotropic magneto-thermopower (AMTEP, also known as Planar Nernst effect) and transverse spin Seebeck effect (TSSE), are studied in Permalloy thin films grown on MgO substrates. For the detection of spin-currents Pt strips on top of the Permalloy films are used. We find that small static parasitic magnetic fields below 1 Oe can produce TSSE-like signals of the order of 1% of the amplitude of the AMTEP. The measured artifacts reveal a new source of uncertainties for the detection of the TSSE in conductive ferromagnets. Taking these results into account we conclude that the contribution of the TSSE to the detected voltages is below the noise level of 20 nV.

MA 48.52 Thu 15:00 Poster B1

**Investigation of thermal spin transfer torque in MgO-based magnetic tunnel junctions using FMR microresonators** — •Hamza Cansever[1,2], Ewa Kowalska[1,2], Ciaran Fowley[1], Yuriy Aleksandrov[1,2], Oguz Yildirim[1], Rysard Narkowicz[1], Kilian Lenz[1], Jürgen Lindner[1], Jürgen Fassbender[1], and Alina M. Deac[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Bautzner Landstraße 400, 01328 Dresden, Germany — [2]Technische Universität Dresden, Institute of Solid State Physics, 01069 Dresden, Germany

MgO-based magnetic tunnel junctions are commonly used in spintronic device applications, such as recent spin transfer torque random access memory (STT-RAM) because of their non-volatility, fast switching and high storage capacity. Spin transfer torque is defined as a spin polarized current flowing through a ferromagnet exerting a torque on the local magnetization. With thermal spin transfer torque (T-STT), thermally excited electron transport is used instead of spin polarized charge current and provides an interesting way of using thermoelectric effects in magnetic storage applications. Our study focuses on fundamental experimental research aimed at demonstrating that thermal gradients can generate spin-transfer torques in MgO-based magnetic tunnel junctions (MTJs). We use microresonators in order to analyze how the ferromagnetic resonance signal corresponding to the free layer of an in-plane MgO-based tunnel junction device is modified in the presence of a temperature gradient across the barrier. This work is supported by DFG-SPP 1538.

MA 48.53 Thu 15:00 Poster B1

**Field induced suppression of the spin Seebeck effect** — •Christoph Schneider[1], Joel Cramer[1], Andreas Kehlberger[1], Er-Jia Guo[1,2], Gerhard Jakob[1], and Mathias Kläui[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — [2]Quantum Condensed Materials Division, Oak Ridge National Laboratory, TN 37830, Oak Ridge, USA

By means of the spin Seebeck effect (SSE) pure spin currents can be generated in magnetic insulators when applying temperature gradients. Recent results have shown that this spin current can be identified as thermally generated magnons from the bulk of the ferromagnetic material [1]. We present magnetic field dependent measurements of the spin Seebeck effect at room and cryogenic temperatures [2]. At increased magnetic fields a suppression of the SSE signal is observed. On account of an opening frequency gap low energy magnons, which exhibit the longest propagation lengths, are cut off and thus the overall magnon propagation length is reduced [3]. This phenomenon is predicted not only to be observed in high magnetic fields but also in materials with high anisotropy. For this we use cobalt ferrite (CFO), which as a spinel ferrite allows to modify the anisotropy by tensile strain [4] and we study the spin Seebeck effect in this material. [1] A. Kehlberger et al. Phys. Rev. Lett. 115, 096602 (2015) [2] Er-Jia Guo et al. arXiv: 1506.06037 (2015) [3] U. Ritzmann et al. Phys. Rev. B 92, 174411 (2015) [4] Er-Jia Guo et al. arXiv: 1509.03601 (2015)

MA 48.54 Thu 15:00 Poster B1

**Detection of DC currents and resistance measurements in longitudinal spin Seebeck effect experiments on Pt/YIG and Pt/NFO** — •Daniel Meier[1], Timo Kuschel[1], Sibylle Meyer[2], Sebastian T. B. Goennenwein[2], Liming Shen[3], Arunava Gupta[3], Jan-Michael Schmalhorst[1], and Günter Reiss[1] — [1]CSMD, Physics Department, Bielefeld University, Germany — [2]Walther-Meißner-Institut, BAdW, Germany — [3]MINT Center, University of Alabama, USA

In this work we investigated thin films of the ferrimagnetic insulators $Y_3Fe_5O_{12}$ and $NiFe_2O_4$ capped with thin Pt layers in terms of the longitudinal spin Seebeck effect (LSSE). The electric response detected in the Pt layer under an out-of-plane temperature gradient can be interpreted as a pure spin current converted into a charge current via the inverse spin Hall effect. Typically, the transverse voltage is the quantity investigated in LSSE measurements (in the range of $\mu$V). Here, we present the directly detected DC current (in the range of nA) as an alternative quantity. Furthermore, we investigate the resistance of the Pt layer in the LSSE configuration. We observe an influence of the test current on the resistance by the spin Hall magnetoresistance effect. The typical shape of the LSSE curve varies for increasing test currents.

MA 48.55 Thu 15:00 Poster B1

**Critical Point in Antiferromagnetic Chromium Under Uniaxial Pressure** — •Alexander Schade, Robert Georgii, Tim Adams, Alfonso Chacon, and Peter Böni — Technische Universität München

The weakly first order character of the Néel transition in chromium has not yet been conclusively explained. Chromium exhibits an incommensurable spin density wave, which is stabilized by the nesting of its Fermi surface. Zvi Barak et al. [1] interpret the Néel transition of chromium as fluctuation induced first order transition, and predict the existence of a critical point in a temperature over uniaxial pressure phase diagram for pressure along the 110-direction. We report elastic neutron scattering experiments with uniaxial pressure along the 110-axis, performed at MIRA, MLZ [2]. The Néel transition remains first order for pressures up to 600 bar. For higher pressures, an irreversible broadening of the Néel transition was observed, which we show is compatible with a model of plastic deformation, leaving behind residual stresses. The existence of a critical point can be ruled out in the pressure range 0-600 bar.

[1] Effect of uniaxial stress on the first-order Neel transition in chromium, Zvi Barak and M. B. Walker, J. Phys. F: Met. Phys., 12(1982)483-95.

[2] MIRA: Dual wavelength band instrument, Robert Georgii, Klaus Seemann, Journal of large-scale research facilities JLSRF, Vol 1 (2015)

MA 48.56 Thu 15:00 Poster B1

**X-Ray Magnetic Circular Dichroism Measurements in doped Gadolinium Iron Garnet** — •Kathrin Ganzhorn[1,2], Stephan Gepraegs[1], Matthias Opel[1], Andre Rogalev[3], Fabrice Wilhelm[3], Katharina Ollefs[3,4], Francois Guillou[3], Rudolf Gross[1,2,5], and Sebastian T. B. Goennenwein[1,2,5] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany — [2]Physik-Department, Technische Universität München, 85748 Garching, Germany — [3]European Synchrotron Radiation Facility (ESRF), 38043 Grenoble Cedex 9, France — [4]Fakultät für Physik, Universität Duisburg-Essen, 47057 Duisburg, Germany — [5]Nanosystems Initiative Munich (NIM), 80799 München Germany

Magnetically compensated rare earth garnets, such as Gadolinium Iron Garnet ($Gd_3Fe_5O_{12}$, GdIG), exhibit a pronounced temperature and magnetic field dependence of the sublattice magnetizations. In particular, the Fe and Gd sublattices can switch from a collinear to a canted configuration, resulting in a complex magnetic phase diagram. In order to determine the sublattice magnetization orientations in GdIG thin films, we performed x-ray magnetic circular dichroism (XMCD) on the Gd-L3 and Fe-K edge as a function of temperature and magnetic field. We compare the magnetic phase diagram obtained from these measurements with calculations based on a mean field model and find good agreement.

Financial support by DFG via SPP 1538 is gratefully acknowledged.

MA 48.57 Thu 15:00 Poster B1

**Thermal expansion and magnetostriction studies on $R_2PdSi_3$(R = Ho, Dy) single crystals** — •Binh Tran[1], Wolfgang Löser[2], Chongde Cao[3], and Rüdiger Klingeler[1] — [1]Kirchhoff Institute of Physics, Heidelberg University, INF 227, 69120 Heidelberg, Germany — [2]Leibniz Institute for Solid State and Materials Research IFW Dresden, Helmholtzstr.20, 01069 Dresden, Germany — [3]Department of Applied Physics, Northwestern Polytechnical University, Xian 710072, P.R. China

The magnetic behavior of hexagonal $R_2PdSi_3$ (R = Ho, Dy) single crystals has been studied by means of capacitance dilatometry. The materials show antiferromagnetic order below $T_N$ = 7.9 K (R = Ho) resp. $T_N$ = 7.5 K (R = Dy) as indicated by pronounced anomalies in the uniaxial thermal expansion coefficients $\alpha_a$ and $\alpha_c$. In addition, the data imply significant length changes well above $T_N$ which are interpreted in terms of evolution of short range magnetic order. The application of an external magnetic field along the easy-axis leads to a transition from the antiferromagnetic order into a ferrimagnetic order. Magnetostriction measurements below $T_N$ reveal further metamagnetic transitions which will be used to determine and to discuss the magnetic phase diagram.

MA 48.58 Thu 15:00 Poster B1

**Polaronic Microstructure in Manganites** — •Sangeeta Rajpurohit[1] and Peter Blöchl[1,2] — [1]Institute of Theoretical Physics, Clausthal Institute of Technology — [2]Institute of Material Physics, University of Göttingen

Mixed-valence manganites exhibit interesting transport properties because of their complex interplay between charge, orbital, lattice and spin degrees of freedom. Strong electron-phonon coupling due to Jahn-Teller distortion localizes the electrons in the $e_g$ states as polarons. These polarons dictate the charge transport, structural and magnetic ordering properties of manganites. We investigate the dynamics on long length and time scales with Car-Parrinello molecular dynamics for a model Hamiltonian. The model Hamiltonian takes into account the electrons in the $e_g$orbitals of Mn, the classical spin of the $t_{2g}$ electrons on Mn and the cooperative Jahn-Teller distortions of the oxygen octahedra. The electrons are treated as two-component spinors, allowing for non-collinear spin arrangements. So far, we have explored the complex phase diagram of one-dimensional model and three-dimensional manganites as function of the model parameters and doping. We observe dimer and trimer phases for different doping. We investigate the charge transport across the hetero interface of different polaronic behaviour. The parameters used in the model are extracted from Density Functional Theory using hybrid functionals.Financial support by the DFG Collaborative Research Center 1073 "Atomic scale control of energy conversion", project B03 is gratefully acknowledged.

MA 48.59 Thu 15:00 Poster B1

**Hidden Symmetries in the Spin Molecules $MgCr_2O_4$, $ZnCr_2O_4$, and $CdCr_2O_4$** — •Mamoun Hemmida[1], Hans-Albrecht Krug von Nidda[1], Vladimir Tsurkan[1,2], and Alois Loidl[1] — [1]Experimental Physics V, Center for Electronic Correlations and Magnetism, Institute for Physics, University of Augsburg, Germany — [2]Institute of Applied Physics, Academy of Sciences of Moldova, Republic of Moldova

The spin dynamics of frustrated antiferromagnetic (AFM) chromium spinel oxides $XCr_2O_4$ (X: Mg, Zn, Cd) is investigated by means of Electron Spin Resonance (ESR) spectroscopy. From the temperature dependent ESR linewidth, an unconventional spin-relaxation behaviour is observed. Similar to the two-dimensional triangular lattice AFMs $ACrO_2$ (A: H, Li, Na, Cu, Ag, Pd), direct spin-spin interactions are dominant. A Berezinskii-Kosterlitz-Thouless-like (BKT) scenario successfully describes the linewidth in the whole paramagnetic Regime.[1,2] In order to describe the spin-relaxation via vortex-like excitations in $XCr_2O_4$ compounds, generalized BKT model with internal continuous Abelian symmetries is applied.[3]

1- M. Hemmida *et al.*, Phys. Rev. B 80, 054406 (2009).
2- M. Hemmida *et al.*, J. Phys. Soc. Jpn. 80, 053707 (2011).
3- S. A. Bulgadaev, J. Exp. and Theo. Phys. 89, 1107 (1999).

MA 48.60 Thu 15:00 Poster B1

**Slow holes in triangular-lattice antiferromagnets: Spin textures and quasiparticle destruction** — •Eugen Wolf[1], Eric C. Andrade[2], and Matthias Vojta[1] — [1]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany — [2]Instituto de Física Teórica, Universidade Estadual Paulista, São Paulo, SP, Brazil

We revisit the problem of a single hole doped into a triangular-lattice antiferromagnet with 120° spin order using the *t-J* model.
Recent work has shown that a static hole induces a non-trivial spin texture due to the release of frustration [1], and we study the fate of this texture upon introducing a finite hopping amplitude.
Our variational results show that the spin texture around a mobile hole is generically given by a superposition of octupolar and dipolar contributions, the latter being responsible for vanishing quasiparticle weight. We determine the single-hole dispersion and connect our results to those from self-consistent Born approximation. Within this approximation, we discuss various hole-spin correlation functions.

[1] Alexander Wollny, Lars Fritz, and Matthias Vojta, Phys. Rev. Lett. 107, 137204

MA 48.61 Thu 15:00 Poster B1

**Current-Driven Dynamics of Magnetic Skyrmions in Low Pinning Multilayer Structures at Room Temperature** — •Kai Litzius[1,2,3], Ivan Lemesh[4], Lucas Caretta[4], Kornel Richter[1], Benjamin Krüger[1], Markus Weigand[3], Hermann Stoll[3], Gisela Schütz[3], Geoffrey S. D. Beach[4], and Mathias Kläui[1,2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — [2]Graduate School of Excellence Materials Science in Mainz, Staudinger Weg 9, 55128 Mainz, Germany — [3]Max Planck Institute for Intelligent Systems, 70569 Stuttgart, Germany — [4]Department of Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

Magnetic skyrmions are topologically stabilized nanoscale magnetic configurations that are promising for future spintronic devices. Their topology stabilizes them against a continuous deformation into the uniform state and leads to novel physical effects.

Skyrmions have been first predicted in certain magnetic materials due to the Dzyaloshinskii-Moriya interaction (DMI) that favors a chiral spin canting. The interplay between the DMI and the exchange interaction finally gives rise to the creation of skyrmions.

Within the last years, skyrmions have been studied extensively, however no direct observation of real time skyrmion dynamics has been performed so far in for applications relevant geometries. In this work, we report the time-resolved pump-probe observation of stable magnetic skyrmions at room temperature in thin film devices by scanning transmission X-ray microscopy.

MA 48.62 Thu 15:00 Poster B1

**Magnon Spectroscopy** — •Isabella Boventer[1], Martin Weides[1,2], and Mathias Kläui[1] — [1]Institute of Physics, Johannes Gutenberg-Universität Mainz, 55128 Mainz — [2]Physikalisches Institut, Karlsruher Institut für Technologie, 76131 Karlsruhe

Within the research in information technology the spin based approach is promising for applications such as data storage, leading to the field of Spintronics. Instead of electrical charge the spin, i.e the magnetic moment of electrons, is utilized. The collective excitation of a spin ensemble results in a spin wave which exhibits a quasiparticle behaviour, termed magnon. We experimentally interface magnons with microwave cavities to investigate dynamics within the magnet. To this end, magnonic elements will be strongly coupled to a resonator, resulting in hybridized magnon - resonator states. Thus, we set up an experiment for the resonant coupling of spin waves in a magnetic bulk or thin film to either a microwave cavity or a coplanar waveguide (CPW) in the strong coupling regime. This will enable both readout at fixed frequency and broadband measurements using network analysis and ferromagnetic resonance (FMR) at various temperatures and magnetic fields. As a first step we characterized the microwave cavity with and without a YIG sphere ($\varnothing$ 0.5 mm ) in order to reproduce previous results [1,2]. At T = 300 K, we observe a total coupling strength of 50 MHz at $B_{dc}$ = 502 mT. This is almost five times higher than the magnitude reported in [2].

[1] Tabuchi, et al., Phys. Rev. Lett. 113, 083603 (2014)
[2] Zhang, et al., Phys. Rev. Lett 113, 156401 (2014)

MA 48.63 Thu 15:00 Poster B1

**Strong coupling of spin-waves and microwave photons in a 3D cavity** — •Julius Krause[1], Marco Pfirrmann[1], Oliver Hahn[1], Andre Schneider[1], Sebastian T. Skacel[1], Yannick Schön[1], Isabella Boventer[2], Hannes Rotzinger[1], Alexey V. Ustinov[1], and Martin Weides[1,2] — [1]Physikalisches Institut, Karlsruhe Institute of Technology — [2]Institute of Physics, Johannes Gutenberg University Mainz

The model of magnons describes quantized collective excitations of electron spins in a ferromagnet. The spin precession frequency (Larmor frequency) can be adjusted by tuning an external static magnetic field. An alternating magnetic field perpendicular to the static field drives the spin precession. This field component is generated in a cavity in which the electromagnetic field forms a standing wave at resonance conditions. At matching frequencies, cavity photons are able to excite or de-excite magnons.

We experimentally investigate the dynamics of a hybrid quantum system consisting of microwave photons coupled to a ferromagnet. Our goal is to study single magnon excitations at milliKelvin temperatures.

Our experimental setup employs a sub-millimeter YIG sphere within a 3D microwave cavity in an external magnetic field. The cavity provides a sharp resonance of 3 MHz FWHM at 5.3 GHz. In a static magnetic field of 180 mT, the fundamental uniform magnon mode (Kittel mode) matches the cavity resonance frequency. Initial measurements at room temperature show a strong coupling between the Kittel mode and the cavity mode photons with about 30 MHz coupling strength.

MA 48.64 Thu 15:00 Poster B1

**Interfacing ferromagnetic magnons with a superconducting qubit** — •Marco Pfirrmann[1], Julius Krause[1], Sebastian T. Skacel[1], Andre Schneider[1], Isabella Boventer[2], Hannes Rotzinger[1], Alexey V. Ustinov[1], and Martin Weides[1,2] — [1]Physikalisches Institut, Karlsruhe Institute of Technology — [2]Institut of Physics, Johannes Guttenberg University Mainz

Due to their quantum limited energy resolution and back-action on the measured object, superconducting quantum bits (qubits) are ideal detectors providing information of spectroscopy and coherence. The precessional frequency (Lamor frequency) of collective electron spin excitations (magnons) in a static magnetic field is found in the microwave frequency regime, thereby matching the frequencies of typical level splittings found in superconducting qubits. Such qubits enable the measurement, excitation and manipulation of magnons by choosing a qubit-magnon hybrid with strong coupling. Such a circuit extends the emerging field of classical data processing with magnons (magnonics) into the quantum regime, and aims to achieve quantum information processing with magnons at gigahertz frequencies.

We investigate experimentally a strongly coupled hybrid system consisting of a YIG sphere and a transmon qubit coupled by a 3D microwave cavity at milliKelvin temperatures. We focus on coherent excitation exchange between qubit and magnons to determine the coupling strength and the magnon coherence, i.e. its lifetime and dephasing rates. In this poster we will explain the experimental setup and present initial results.

MA 48.65 Thu 15:00 Poster B1

**Dynamics of magnetic skyrmions due to phase-space Berry phases** — •Robert Bamler and Achim Rosch — University of Cologne, Germany

We derive a theory for the motion of smooth magnetic whirls (skyrmions) the presence of spin-orbit coupling. Our theory predicts previously disregarded forces due to Berry phases in momentum and in mixed position/momentum space.

In magnetic materials without inversion symmetry (chiral magnets), the magnetization can build up smooth whirls (skyrmions). Lately, the manipulation of skyrmions has been of great interest due to potential applications in future magnetic storage devices. A popular model for skyrmion dynamics is the Thiele equation, which describes a gyrocoupling between external forces and the skyrmion velocity. This can be explained by Berry phases in position space. The Thiele equation neglects, however, Berry phases in momentum space, whose importance is demonstrated by the large anomalous Hall signal in, e.g., MnSi.

In our work, we derive an equation of motion for skyrmions that includes all effects due to phase-space Berry phases. Starting from a microscopic model we derive the classical equation of motion for the skyrmion position using a non-equilibrium field theory approach and a gradient expansion. The resulting equation of motion correctly reproduces the known gyro-coupling and predicts additional forces due to electron drag and due to Berry phases in momentum-space and in mixed position/momentum space. We also discuss the coupling of an external electric field to the electric charge of skyrmions.

MA 48.66 Thu 15:00 Poster B1

**Spin-orbit coupling and perpendicular magnetic anisotropy in structural inversion asymmetric stacks** — •Samridh Jaiswal[1,2], Berthold Ocker[2], Gerhard Jakob[1], and Mathias Kläui[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — [2]SINGULUS TECHNOLOGIES AG, Hanauer Landstrasse 103, 63796 Kahl am Main, Germany

The need for low-power data storage in magnetic memory devices for next generation MRAM such as the SOT-MRAM devices requires understanding the magnetisation dynamics in materials envisioned for use in such devices. Ferromagnets (FM) sandwiched between heavy metal (HM) and oxide thin films exhibit novel chiral structures[1,2] arising from an interfacial Dzyaloshinskii-Moriya Interaction. For applications it is most interesting to achieve low threshold currents for switching the magnetic state and to utilise spin orbit torques[3] for manipulation of the magnetisation in systems with a strong perpendicular anisotropy. In this study, the domain structures formed in sputtered thin films of W/CoFeB/MgO and Ta/CoFeB/MgO lacking structural inversion symmetry are studied and their perpendicular magnetic anisotropy is investigated along with the effects of different underlayers. Financial support by the EU Marie Curie ITN project WALL is gratefully acknowledged. [1] A. Fert et al Nat. Nanotechnol. 8(3), 152-156 (2013) [2] N. S. Kiselev et al J. Phys. D. Appl. Phys. 44(39), 392001 (2011) [3] Lo Conte, R. et al Appl. Phys. Lett., 105, 122404 (2014)

MA 48.67 Thu 15:00 Poster B1

**Ab initio analysis of the topological phase diagram of the Haldane model** — •Julen Ibañez-Azpiroz[1], Asier Eiguren[2], Aitor Bergara[2], Giulio Pettini[3], and Michele Modugno[2] — [1]Peter Grunberg Institute and Institute for Advanced Simulation, Forschungszentrum Julich — [2]University of the Basque Country UPV/EHU — [3]Dipartimento di Fisica e Astronomia, Universita di Firenze

We present an ab initio analysis of a continuous Hamiltonian that maps into the celebrated Haldane model. The tunnelling coefficients of the tight-binding model are computed by means of two independent methods - one based on the maximally localized Wannier functions, the other through analytic expressions in terms of gauge-invariant properties of the spectrum - that provide a remarkable agreement and allow to accurately reproduce the exact spectrum of the continuous Hamiltonian. Our calculations show that the commonly employed Peierls substitution for the complex tunneling coefficient does not provide a reasonable estimate, and we discuss the origin of this feature. Additionally, by combining these results with the numerical calculation of the Chern number, we are able to draw the phase diagram in terms of the physical parameters of the microscopic model. Remarkably, we find that only a small fraction of the original phase diagram of the Haldane model can be accessed, and that the topological insulator phase is suppressed in the deep tight-binding regime.

MA 48.68 Thu 15:00 Poster B1

**Investigation of spin-orbit torque effects in topological insulating half-Heusler / ferromagnetic hybrid structures** — •Jan Haskenhoff[1,2], Benedikt Ernst[3], Robin Klett[1,2], Karsten Rott[1,2], Claudia Felser[3], and Günter Reiss[1,2] — [1]Physics Department Bielefeld university, 33615 Bielefeld, Germany — [2]Center for Spinelectronic Materials and Devices, Universitätsstraße 25, 33604 Bielefeld, Germany — [3]Max-Planck-Institut für Chemische Physik fester Stoffe, Nöthnitzer Straße 40, 01187 Dresden, Germany

Topological insulators (TI) represent a new quantum state of matter, which host spin-polarized conducting surface channels paired with an insulating bulk. Due to the strong intrinsic spin-orbit coupling, TIs are promising candidates for spin-orbit torque measurements. Furthermore many ternary Heusler compounds are predicted to have topological nontrivial properties. Therefore we investigate spin-orbit torque effects of different TI Heusler / ferromagnetic hybrid structures like e.g. YPdBi/Fe by performing harmonic resistance measurements in a rotating magnetic field up to 1T at a temperature range from 2K to 300K.

MA 48.69 Thu 15:00 Poster B1

**Electronic structure of topological insulators** — •Michael Czerner, Jonas Friedrich Schäfer, Christian Franz, and Christian Heiliger — Justus Liebig University, Giessen, Germany

We present electronic structure calculations of the topological insulators $Bi_2Te_3$, $Bi_2Se_3$, $Sb_2Te_3$ by means of the Korringa-Kohn-Rostoker Green function method (KKR) based on density functional theory. Since spin-orbit coupling is important for the topological protected surface states, a fully-relativistic treatment is necessary. We show that the electronic structure is very sensitive to the chosen representation of the underlying potentials. We discuss the differences in the results of the atomic sphere approximation in comparison to a full-potential description and show the need of a full-potential calculation to catch the details of the electronic structure.

MA 48.70 Thu 15:00 Poster B1

**Spin textures in 3D topological insulator thin films probed with iron-oxide based spin detector** — •Lukasz Plucinski[1], Markus Eschbach[1], Ewa Mlynczak[1], Pika Gospodaric[1], Mathias Gehlmann[1], Sven Döring[1], Gustav Bihlmayer[2], Gregor Mussler[3], Detlev Grützmacher[3], Stefan Blügel[2], and Claus M. Schneider[1] — [1]PGI-6, FZ Jülich — [2]PGI-1 and IAS-1, FZ Jülich — [3]PGI-9, FZ Jülich

We will present high resolution spin- and angle-resolved photoemission data of the spin-texture of 3D topological insulator thin films (Bi2Te3, Sb2Te3, Bi2Se3). Spectra were measured using the combination of a hemispherical electron energy analyzer (MBS A1) with an iron-oxide based spin detector (Focus Gmbh Ferrum) which allows measuring one of the in-plane and the out-of-plane spin component of the sample.

We will present new data obtained using He discharge lamp (21.22 eV), Xe microwave source (8.4 eV), and 6 eV laser-based source. We will compare new spectra, taken at an energy resolution down to approx. 30 meV, with our previously published data [1, 2] measured using SPLEED spin detector, where the resolution was 150 meV.

[1] L. Plucinski et al., J. Appl. Phys. 113, 053706 (2013) [2] A. Herdt et al., Phys. Rev. B 87, 035127 (2013).

MA 48.71 Thu 15:00 Poster B1

**Stability of Weyl semimetals under the formation of charge density waves** — •Christoph Berke, Paolo Michetti, and Carsten Timm — Institute of Theoretical Physics, Technische Universität Dresden, 01062 Dresden, Germany

In Weyl semimetals, the valence and the conduction bands touch at point, called Weyl points, with a linear dispersion relation. Weyl points are topologically protected and thus stable against small perturbations, but may disappear if they annihilate with other Weyl points. We study an effective $J = \frac{1}{2}$-model for the pyrochlor lattice. Previous studies have predicted the appearance of a Weyl-semimetal phase together with antiferromagnetic all-in-all-out ordering. We are interested in the stability of the Weyl points under the formation of charge density waves that enlarge the unit cell. In the backfolded Brillouin zone, Weyl nodes that were far apart in the antiferromagnetic phase end up close together and could possibly annihilate and get gapped out if this reduces the free energy.

MA 48.72 Thu 15:00 Poster B1

**Experimental realization of a topological p-n junction by intrinsic defect-grading** — •Thomas Bathon[1], Simona Achilli[2], Paolo Sessi[1], Konstantin Kokh[3], Oleg Tereshchenko[3], and Matthias Bode[1] — [1]Physikalisches Institut, Experimentelle Physik II, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany — [2]Fisica, Universita Cattolica di Brescia, via dei Musei 41, 25121 Brescia, Italy — [3]Novosibirsk State University, 630090 Novosibirsk, Russia

The extraordinary properties of topological insulators (TIs) are related to linearly dispersing surface states which exhibit chiral spin-momentum-locking. Thereby, backscattering is forbidden and spin currents are intrinsically tied to charge currents. This unconventional spin-texture makes TIs not only fundamentally interesting, but also of great practical importance for applications. Within this framework, the fabrication of topological p-n junctions would represent a pivotal step towards the design of devices with new functionalities.

Here we demonstrate by transport measurements that the different defects inevitably incorporated during the growth process of the prototypical material $Bi_2Te_3$ result in topological p-n junctions. Atomic-scale STM data combined with *ab-initio* calculations show that this is the result of the different doping character of the various intrinsic defects. The transition region is found to be as narrow as few tens of nm with a built-in potential of approximately 110 meV.