# TT 73: Spincaloric Transport II (jointly with MA)

Time: Wednesday 15:00–17:00 Location: H 0110

TT 73.1 Wed 15:00 H 0110

**Interface spin polarization in FM/Pt bilayers investigated by XRMR** — •Christoph Klewe[1], Timo Kuschel[1], Jan-Michael Schmalhorst[1], Markus Meinert[1], Florian Bertram[2], Olga Schuckmann[3], Joachim Wollschläger[3], Matthias Opel[4], Francesco Della Coletta[4], Stephan Geprägs[4], and Günter Reiss[1] — [1]CSMD, Physics Department, Bielefeld University, Germany — [2]Division of Synchrotron Radiation Research, Lund University, Sweden — [3]Physics Department, Osnabrück University, Germany — [4]Walther-Meißner-Institut, BAdW, Garching, Germany

We demonstrate the suitability of x-ray resonant magnetic reflectivity (XRMR) for investigations of proximity induced interface spin polarizations. This technique was currently used to exclude magnetic proximity effects in $NiFe_2O_4$/Pt bilayers [1] in order to confirm the longitudinal spin Seebeck effect in this system, free from Nernst effects.

Here, we present photon energy dependent XRMR measurements (P09, PETRA III, DESY; ID12, ESRF) at the Pt $L_3$-absorption edge on Fe/Pt, and further investigations on the systems $Ni_{0.33}Fe_{0.66}$/Pt, $Ni_{80}Fe_{20}$/Pt, Ni/Pt, $Fe_3O_4$/Pt, and $Y_3Fe_5O_{12}$/Pt. A detailed analysis of the observed reflectivity curves based on varying magnetic profiles at the Pt interface and a comparison with ab initio calculations provides an accurate spatial distribution and quantitative values of the induced magnetic moments per Pt atom. We find a correlation of the Pt spin polarization and the Fe content of the adjacent ferromagnet, while we see no evidence for proximity effects in $Y_3Fe_5O_{12}$/Pt.

[1] T. Kuschel et al., submitted 2014, arxiv: 1411.0113

TT 73.2 Wed 15:15 H 0110

**Bias-enhanced tunnel magneto-Seebeck effect in Co-Fe-B/MgO-based magnetic tunnel junctions** — •Marvin von der Ehe[1], Alexander Boehnke[2], Marius Milnikel[1], Ulrike Martens[1], Vladyslav Zbarsky[1], Karsten Rott[2], Andy Thomas[2], Michael Czerner[3], Günter Reiss[2], Christian Heiliger[3], and Markus Münzenberg[1] — [1]Inst. f. Phys., Universität Greifswald, Germany — [2]CSMD, Physics Dep., Bielefeld University, Germany — [3]I. Phys. Inst., Universität Giessen, Germany

In recent spincaloritronic research, several groups have observed the tunnel magneto-Seebeck effect (TMS) in magnetic tunnel junctions (MTJs) incorporating CoFe electrodes and MgO tunnel barriers [1,2].

Here, we present an approach of tuning the TMS effect by applying a DC bias voltage to the MTJ while a temperature gradient is generated by laser heating. We prepared Co-Fe-B/MgO/Co-Fe-B magnetic tunnel junctions that show high TMR ratios and observed Seebeck voltages of several microvolt, generated locally in the MTJ layers. Our experiments show that the resulting thermocurrent can be tuned to exhibit an on/off- switching when the magnetization configuration of the electrodes is changed from parallel to antiparallel and vice versa. Consequently, very high bias-enhanced TMS ratios are obtained. This behavior can be understood by the interplay of the TMS effect and the ohmic properties of the MTJs for small voltages. Funding by DFG SPP 1538 is acknowledged.

[1] Walter, M., et al. Nature Mater. 10, 742 (2011)
[2] Liebing, N., et al. Phys. Rev. Lett. 107, 177201 (2011)

TT 73.3 Wed 15:30 H 0110

**Magnonic spin currents in ferro- and antiferromagnetic materials** — •Denise Hinzke, Severin Selzer, Ulrike Ritzmann, Frank Schlieckeiser, and Ulrich Nowak — Fachbereich Physik, Universität Konstanz, 78457 Konstanz

Recent experiments show that applied temperature gradients can excite magnonic spin currents in ferromagnetic (FM) materials [1]. These experiments have raised the question of the role of the relevant length scales for these spin currents. We perform atomistic spin model simulations using the Landau-Lifshitz-Gilbert equation to calculate these characteristic length scales of magnon propagation in the vicinity of temperatures gradients. Our numerical findings are supported by analytical descriptions [2]. Extending our investigations to antiferromagnetic (AFM) materials we determined the frequency dependent magnon propagation length and also simulate magnon propagation due to thermal excitation. One of our findings is that an applied temperature gradient can excite magnons still transporting heat even if the expected spin current is zero. Furthermore, it was shown that the maximisation of entropy drives FM domain walls (DW) in temperature gradients [3]. We extend our former numerical and analytical investigations of DW motion caused by magnon excitation to AFM materials and compare with FM materials [3]. We acknowledge financial support by the DFG through SFB 767 and through SPP "Spin Caloric Transport". [1] K. Uchida et al, Appl. Phys. Lett. 97, 122505 (2010) [2] U. Ritzmann et al. Phys. Rev. B 89, 024409 (2014) [3] D. Hinzke and U. Nowak, Phys. Rev. Lett. 107, 027205 (2011)

TT 73.4 Wed 15:45 H 0110

**Spin-wave propagation through a magnonic crystal in a thermal gradient** — •Thomas Langner, Andrii V. Chumak, Alexander A. Serga, Burkard Hillebrands, and Vitaliy I. Vasyuchka — Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, Erwin-Schrödinger-Str. 56, 67663 Kaiserslautern

Spin waves show a high potential to transport information in form of spin angular momentum. Magnonic crystals (MC), spin-wave waveguides with a periodic modulation of the magnetic properties, provide possibilities to code and process data in manifold ways. For the application of MC-based spin-wave devices it is of crucial importance to understand their behavior in thermally inhomogeneous surroundings since local heating might appear in real devices. We present studies on the dynamics of coherently excited spin waves in thermal gradients applied to a MC in form of an yttrium iron garnet (YIG) waveguide of varied thickness. We observe a broadening of the frequency bandgaps, the regions where spin-wave propagation is forbidden, as well as a decrease in the transmitted signal compared to the equilibrium temperature case. The mechanisms leading to these effects are discussed. The experimental results are accompanied by numerical calculations. A T-matrix formalism that includes the changes of the magnetic parameters induced by thermal gradients is used. We acknowledge financial support by the Deutsche Forschungsgemeinschaft (DFG) within priority program 1538 "Spin Caloric Transport".

TT 73.5 Wed 16:00 H 0110

**Magnetic field dependence of magnon accumulation in ferromagnets** — •Ulrike Ritzmann, Denise Hinzke, and Ulrich Nowak — Universität Konstanz, Konstanz, Germany

In the last years it was shown that in a magnetic material spin currents are created by applying temperature gradients. This spin currents are due to a net magnon current that propagates from the hotter towards to cooler region of the magnetic material [1].

We perform atomistic spin model simulation with the stochastic Landau-Lifshitz-Gilbert equation for different temperature profiles to study magnon accumulation and magnonic spin currents and its characteristic lengthscales in ferromagnetic insulators [2]. Furthermore, we present simulations regarding the magnetic field dependence of the magnon propagation in linear temperature gradients, which allow to control the excited spin current and tune the frequency spectra of the involved magnons. The results show an increasing signal with increasing length of the system with a saturating behavior in agreement with experimental measurements [3]. On the other hand, we study the magnetic field dependence of the magnon accumulation and find a decreasing accumulation for increasing magnetic field. Both effects can be explained with the frequency distribution of the propagating magnons that are excited in the temperature gradient and its dependence on the system parameters. We acknowledge financial support by the DFG through SFB 767 and through SPP "Spin Caloric Transport".

[1] K. Uchida et al., APL 97, 172505(2010); [2] Ritzmann et al., PRB 89, 024409 (2014); [3] Kehlberger et al., arXiv:1306.0784

TT 73.6 Wed 16:15 H 0110

**Longitudinal spin Seebeck effect contribution in transverse spin Seebeck effect experiments in Pt/YIG and Pt/NFO** — •Daniel Meier[1], Daniel Reinhardt[1], Michael van Straaten[1], Christoph Klewe[1], Matthias Althammer[2], Michael Schreier[2], Sebastian T. B. Goennenwein[2], Arunava Gupta[3], Maximilian Schmid[4], Christian H. Back[4], Jan-Michael Schmalhorst[1], Timo Kuschel[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 — [4]Department of Physics, University of Regensburg, Germany

We investigated the inverse spin Hall voltage generated in a 10 nm thin Pt strip deposited on the magnetic insulators $Y_3Fe_5O_{12}$ (YIG) and $NiFe_2O_4$ (NFO) with a temperature gradient in the film plane. We observed characteristics typical of the spin Seebeck effect (SSE), although we did not observe a change of sign of the voltage at the Pt strip when the direction of the heat flow was reversed, which is believed to be the most striking feature of the *transverse* SSE. Therefore, we relate the observed signals to the *longitudinal* SSE generated by a parasitic out-of-plane temperature gradient, which can be simulated by contact tips of different material and heat conductivities and by tip heating [1]. This work [2] gives new insights into the interpretation of transverse spin Seebeck effect experiments, which are still under discussion.

[1] D. Meier et al., Phys. Rev. B 88, 184425 (2013)
[2] D. Meier et al., arXiv:1411.6790 (2014)

TT 73.7 Wed 16:30 H 0110

**Thickness and temperature dependent thin film thermal conductance of YIG** — •Christoph Euler[1], Paulina Holuj[1,2], Andreas Kehlberger[1,2], Mathias Kläui[1,2], and Gerhard Jakob[1,2] — [1]Institut für Physik, Johannes Gutenberg-Universität mainz, Staudinger Weg 7, 55128 Mainz — [2]Graduate School of Excellence 'Materials Science in Mainz', Staudinger Weg 8, 55128 Mainz

Thin film YIG ($Y_3Fe_5O_{12}$) is commonly used in spin-caloritronics, as it is a prototype material for experiments on thermally generated pure spin currents and the spin Seebeck effect. However, bulk values of the thermal conductance are often used to determine temperature gradients even if the actual experimental geometry employs thin films. The $3\omega$ method is an established technique to measure the cross-plane thermal conductance of thin films, but it is inapplicable in YIG/GGG ($Ga_3Gd_5O_{12}$) systems in its standard form. We use two-dimensional modeling of heat transport and introduce a technique based on Bayesian statistics to evaluate measurement data obtained from the $3\omega$ method. This allows us to extract the temperature dependent thermal conductance of thin film YIG between room temperature and 10 K even for films in the hundreds of nanometer thickness range, which are of major importance for experiments in the field of spin-caloritronics. Moreover, our developed generic data evaluation scheme is suitable to analyze all thin film $3\omega$ measurements, which have so far not been accessible for analysis using the $3\omega$ method. We gratefully acknowledge financial support by DFG (Ja821/7-1) and (GSC 266).

TT 73.8 Wed 16:45 H 0110

**Optically-Reconfigurable Dynamic Magnetic Materials for the Control of Spin Waves** — •Marc Vogel[1], Andrii V. Chumak[1], Erik H. Waller[1], Thomas Langner[1], Vitaliy I. Vasyuchka[1], Burkard Hillebrands[1], and Georg von Freymann[1,2] — [1]Department of Physics and State Research Center OPTIMAS, University of Kaiserslautern, Erwin-Schroedinger-Str. 56, 67663 Kaiserslautern, Germany — [2]Fraunhofer-Institute for Physical Measurement Techniques IPM, Erwin-Schroedinger-Str. 56, 67663 Kaiserslautern, Germany

Spin waves - eigen excitations of the electrons' spin system - are of special importance nowadays due to the large potential for applications (e.g. processing, filtering or short-time storage of data). While all these applications rely on pre-defined constant structures, a dynamic variation of the structures opens access to novel physical phenomena and to novel applications. Here, we present the realization of such dynamic two-dimensional magnetic materials. By using laser light and a spatial light modulator, we reconstruct computer generated holograms on a ferrimagnetic yttrium iron garnet spin-wave waveguide. A black absorber (including carbon black nanoparticles) absorbs the light and creates thermal landscapes in the magnetic medium. The local change in temperature results in landscapes of the saturation magnetization. An acousto-optical modulator controls the temporal heating. Thus, the spin-wave characteristics can be controlled both in space and in time. The proposed fully-reconfigurable magnetic material is demonstrated using examples of one- and two-dimensional magnonic crystals.