MA 42: Joint Session "Novel Spincaloritronic Devices: Control of Heat, Charge and Momentum Flow" (jointly with TT), Organization: Markus Münzenberg (Univ. Göttingen), Mathias Weiler (WMI Garching)

Time: Thursday 15:00–17:30 Location: EB 301

Invited Talk MA 42.1 Thu 15:00 EB 301
Spin Seebeck and spin Peltier effects in ferromagnetic-nonmagnetic devices — •Bart van Wees — Zernike Institute of Advanced Materials, Groningen, The Netherlands

I will give an overview of two spincaloritronic effects in ferromagnet-nonmagnetic devices. First, the spin (dependent) Seebeck effect is demonstrated by the injection of a spin current into a non-magnetic metal, using a temperature gradient and an associated heatcurrent [1]. The second example is the recent observation of the spin Peltier effect [2]. In a specially designed device it is shown that a cooling or heating is associated with a spin current which flows in a specially designed permalloy/copper/permalloy structure. The cooling/heating due to the spin Peltier effect is detected as a change in temperature by an on-chip nanoscale thermocouple. Implications for further research will be discussed.

[1]A. Slachter, F. L. Bakker, J.-P. Adam, and B. J. van Wees, "Thermally driven spin injection from a ferromagnet into a non-magnetic metal", Nature Physics 6, 879-882(2010) [2]J. Flipse, F.L. bakker, A. Slachter, F.K. Dejene and B.J. van Wees, "Cooling and heating with electron spins: Observation of the spin Peltier effect", arXiv:1109.6898, subm. to Nature Nanotechnology

Topical Talk MA 42.2 Thu 15:30 EB 301
Magneto Seebeck effect in tunnel junctions — •Christian Heiliger — I. Physikalisches Institut, Justus Liebig University Giessen

The magneto Seebeck effect in magnetic tunnel junctions is the change of the Seebeck coefficient or thermopower caused by switching the relative magnetic orientation of the two ferromagnetic leads. For MgO based tunnel junctions we predict by ab initio calculations that the magneto Seebeck ratio can exceed several 1000% and depends strongly on temperature [1]. I will discuss the role of different magnetic materials and show the importance of the termination of the magnetic layer next to the MgO barrier for ordered FeCo alloys. In particular, the size of the magneto Seebeck ratio can change by two orders of magnitude and even the sign can be changed by changing the termination of the magnetic layer [2]. Further, I analyze the influence of the barrier thickness on the magneto Seebeck ratio. The theoretical results will be compared to recent experimental results [2].

[1] M. Czerner, M. Bachmann, C. Heiliger, Phys. Rev. B 83, 132405 (2011) [2] M. Walter, J. Walowski, V. Zbarsky, M. Münzenberg, M. Schäfers, D. Ebke, G. Reiss, A. Thomas, P. Peretzki, M. Seibt, J. S. Moodera, M. Czerner, M. Bachmann, C. Heiliger, Nature Materials 10, 742 (2011)

Invited Talk MA 42.3 Thu 16:00 EB 301
Seebeck spin tunneling into silicon — •Ron Jansen — National Institute of Advanced Industrial Science and Technology (AIST), Spintronics Research Center, Tsukuba, Ibaraki, 305-8568, Japan.

The combination of thermoelectrics and spintronics offers unique possibilities. On the one hand, it provides a new, spin-based approach to thermoelectric power generation and cooling. On the other hand, it provides a thermal route to create and control the flow of spin in spintronic devices that make functional use of heat and temperature gradients. Here we describe and report the demonstration of Seebeck spin tunneling - a thermally driven spin flow, of purely interfacial nature - generated in a tunnel contact between electrodes of different temperatures. It is shown to be due to the spin dependence of the Seebeck coefficient of a tunnel junction. Thus, Seebeck spin tunneling is the thermoelectric analog of spin-polarized tunneling.

By exploiting this in ferromagnet/oxide/silicon tunnel junctions, we observe a thermal flow of spin angular momentum from the ferromagnet to the silicon without a charge tunnel current. The spin accumulation induced in the silicon scales linearly with heating power and changes sign when the temperature differential is reversed. This thermal spin current can be used by itself, or in combination with electrical spin injection. The results highlight the engineering of heat transport in spintronic devices and enable the (re-)use of heat to increase device efficiency and reduce energy consumption.

J.C. Le Breton, S. Sharma, H. Saito, S. Yuasa and R. Jansen, Nature **475**, 82 (2011).

Topical Talk MA 42.4 Thu 16:30 EB 301
Spin currents in ferromagnetic insulator/normal metal hybrid structures — •Sebastian T.B. Goennenwein[1], Franz D. Czeschka[1], Johannes Lotze[1], Georg Woltersdorf[2], Mathias Weiler[1], Michael Schreier[1], Matthias Althammer[1], Matthias Opel[1], Hans Huebl[1], and Rudolf Gross[1] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Department of Physics, Universität Regensburg, Germany

In analogy to the well-established charge currents, one can define a *pure spin current* as the directed flow of spin angular momentum. However, in spite of the conceptual analogy, the properties of charge and spin currents are very different: In contrast to electrical currents, spin currents can flow in electrical insulators, since no charge motion is required for the propagation of angular momentum.

We experimentally study pure spin currents in magnetic insulators, using two complementary approaches. The samples comprise an epitaxial yttrium iron garnet (YIG) thin film – a ferrimagnetic insulator – covered in situ with a thin platinum layer. On the one hand, we use spin pumping in combination with the inverse spin Hall effect to generate and detect pure spin currents across the YIG/Pt interface. The spin mixing conductance derived from these experiments is quantitatively comparable to that of conductive ferromagnet/Pt hybrids. On the other hand, we investigate the local magneto-thermo-galvanic voltages induced in YIG/Pt by a focused, scanning laser beam, and discuss the contribution of spin currents generated by the spin Seebeck effect.

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Topical Talk MA 42.5 Thu 17:00 EB 301
Spin waves and spin currents in hybrid magnetic nanostructures — •Sergej O. Demokritov — Institute for Applied Physics, University of Muenster, Muenster, Germany

Unlike the charge current, the spin current, i.e., the flow of angular momentum without the simultaneous transfer of electrical charge, is not a conservative quantity within the conduction carrier system. This is due to the spin orbit interaction that couples the spin of the carriers to angular momentum in the lattice. This coupling usually acts as the source of damping for spin currents; the excess angular momentum in the magnetic subsystem flows into the lattice.

In this talk I will discuss our recent experiments [1] on the YIG/Pt hybrid system, where we show that this flow can be reversed by the three-magnon splitting process and experimentally achieve amplification of spin current due to interaction of spin waves with the lattice.

Finally I will address the interaction of spin current with thermal magnetic fluctuations in a Permalloy microdisk located on top of a Pt microstrip [2]. The spin current in the microdisk is generated by an electric current flowing through the microstrip. We show that the fluctuations in the microdisk can be efficiently suppressed or enhanced by spin currents with different polarizations. The observed phenomenon can be used for controllable reduction of thermal noise in spintronic nanodevices.

[1] H. Kurebayashi et al., Nature Materials, 10 (2011) 660.
[2] V. E. Demidov et al., Phys. Rev. Lett. 107 (2011) 107204