MA 54: Spin Excitations I

Time: Thursday 15:00–17:00 Location: HSZ 04

MA 54.1 Thu 15:00 HSZ 04

An X-ray View on Ultrafast Magnetization Switching of GdFeCo — •Ilie Radu[1,2], Kadir Vahaplar[1], Christian Stamm[2], Torsten Kachel[2], Niko Pontius[2], Hermann Dürr[2,5], Thomas Ostler[3], Joe Barker[3], Richard Evans[3], Roy Chantrell[3], Arata Tsukamoto[4], Akiyoshi Itoh[4], Andrei Kirilyuk[1], Theo Rasing[1], and Alexey Kimel[1] — [1]IMM/SSI Radboud University Nijemegen, The Netherlands — [2]Helmholtz-Zentrum Berlin, BESSY II, Germany — [3]Department of Physics, University of York, United Kingdom — [4]College of Science and Technology, Nihon University, Japan — [5]SLAC National Accelerator Laboratory, USA

Exchange interaction is the strongest force in magnetism, being ultimately responsible for ferromagnetic or antiferromagnetic spin order. How do spins react after being optically perturbed on a timescale faster than the exchange interaction? Here, we demonstrate that femtosecond measurements of ferrimagnetic GdFeCo alloy using X-ray magnetic circular dichroism provide revolutionary new insights into the problem of magnetism on timescales pertinent to the exchange interaction. In particular, we show that upon fs optical excitation the ultrafast spin reversal of GdFeCo - a material with antiferromagnetic coupling of spins - occurs via a transient ferromagnetic state. The latter one emerges due to different dynamics of Gd and Fe magnetic moments: Gd switches within 1.5 ps while it takes 300 fs for Fe. These observations, supported by atomistic simulations, present a novel concept of manipulating magnetic order on timescales of the exchange interaction. Funding from EU through UltraMagnetron programme is acknowledged.

MA 54.2 Thu 15:15 HSZ 04

Magnetization reversal process in Permalloy nanostructures — Markus König, Saleh Getlawi, •Haibin Gao, and Uwe Hartmann — Institute of Experimental Physics, Saarland University, P.O.Box 151150, D-66041 Saarbrücken, Germany

The understanding and control of the displacement and motion of magnetic domain walls (DW) induced by a magnetic field or a spin-polarized current is of great interest due to potential applications such as magnetic memory devices. Permalloy (Ni81Fe19) nanowires with various pad geometries for DW propagation and optimized geometries for DW nucleation and annihilation were fabricated by electron beam lithography (EBL) and focused-ion-beam (FIB) methods. The actual dimensions of the structures were determined by SEM and AFM. The DW was imaged using MFM before, during and after applying an in-plane one- or two-dimensional magnetic field. Results show that switching fields strongly depend on the nanowire widths and the pad geometries. Micromagnetic simulations by OOMMF were performed for comparison to determine the primary domain structure as well as the DW displacement and the switching field. Theoretical and experimental results are in fairly good agreement.

MA 54.3 Thu 15:30 HSZ 04

Magnetic excitations of atomic systems by femtosecond laser pulses — •Daria Popova, Andreas Bringer, and Stefan Blügel — Peter Grünberg Institut & Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany

Ultrafast optical control of the magnetic state of a medium attracts much scientific interest. It opens vistas for the development of novel concepts for high-speed magnetic recording and information processing. Furthermore, it uncovers magnetization dynamics in a strongly out-of-equilibrium regime. A set of experiments has revealed the direct optical control on magnetization via the inverse Faraday effect [1]. In these experiments circularly polarized high-intensity laser pulses at femtosecond time scale are used to excite the magnetic system of the sample. The fundamental mechanisms of the generation of magnetic field by light are still not understood.

In order to get insight into the magnetization dynamics at femtosecond time scales we study theoretically the influence of a subpicosecond laser pulse on the magnetic states of atomic systems. We consider isolated atoms, which are constituents of materials used in experiments, and the ones in a crystal field. We discuss the stimulated Raman-like scattering process, which was suggested to be responsible for the magnetization reversal by light [2].

We are thankful for the support by the FANTOMAS project.

[1] A. Kimel *et al.*, Nature **435**, 655 (2005).
[2] F. Hansteen *et al.*, Phys. Rev. B **73**, 014421 (2006).

MA 54.4 Thu 15:45 HSZ 04

Structural Effects on Magnon Excitations in Ultrathin Fe Films — •Tzu-Hung Chuang, Yu Zhang, Khalil Zakeri, and Jürgen Kirschner — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

We report the experimental results of high wave-vector magnon excitations in a 2 monolayer (ML) Fe film grown on 2ML Au/W(110) obtained by spin-polarized electron energy loss spectroscopy. It is found that the magnon energies in 2ML Fe on 2ML Au/W(110) are lower than the ones in 2ML Fe directly grown on W(110) [1]. This observation is correlated to the structure of the films, studied by means of low-energy electron diffraction (LEED) experiments. The LEED intensity-voltage analyses combined with the diffraction patterns revealed that the first two atomic-layers of Fe films grow on 2ML Au/W(110) are most likely the starting slabs of fcc Fe(111) surface.

The strength of the exchange coupling, estimated by using a classical Heisenberg model, is found to be weaker than the one of the bcc Fe(110) films directly grown on W(110). The experimental results are consistent with the earlier theoretical calculation of bulk fcc Fe [2].

[1] W.X. Tang,*et al.*, Phys. Rev. Lett., **99**, 087202 (2007).
[2] R.F. Sabiryanov and S.S. Jaswal, Phys. Rev. Lett. **83**, 2062 (1999).

MA 54.5 Thu 16:00 HSZ 04

Interface electron complexes and Landau spin-wave damping in ultrathin magnets — Pawel Buczek, Arthur Ernst, and •Leonid Sandratskii — Max Plank Institute of Microstructure Physics, Halle, Germany

The Landau damping of spin-waves in ultrathin magnets caused by the presence of non-magnetic metallic substrate is studied by means of *ab initio* linear response time dependent density functional theory. By contrasting two systems: 1ML Fe/Cu(100) and 1ML Fe/W(110), we show how the strength and the details of the hybridization of electronic states of the magnetic monolayer and the substrate influence the Landau damping, allowing to tune the latter from moderate to strong. We introduce the concept of *Landau map* to distinguish the contributions of different groups of electronic states to the spin-wave attenuation. We demonstrate that the contribution coming from the continuum of substrate states is rather weak and uniformly distributed on the Landau map. We explore a novel mechanism leading to a strongly enhanced Landau attenuation in thin magnets. This mechanism is related to the formation of electronic complexes localized at the film-substrate interface and leads to *Landau hot spots* in the Landau maps. It is demonstrated that the life-time of the magnons in ultrathin films can be longer than in the bulk phases. This paves the way to the design of metallic nanostructures with desired strength of the damping of high frequency magnetization dynamics by means of the engineering of substrate properties.

MA 54.6 Thu 16:15 HSZ 04

Scaling behavior of the spin pumping effect in conductive ferromagnet/platinum bilayers — Franz D. Czeschka[1], Lukas Dreher[2], Martin S. Brandt[2], Matthias Althammer[1], Inga-Mareen Imort[3], Günter Reiss[3], Andy Thomas[3], Wladimir Schoch[4], Wolfgang Limmer[4], Hans Huebl[1], Rudolf Gross[1], and •Sebastian T.B. Goennenwein[1] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Walter Schottky Institut, Technische Universität München, Garching, Germany — [3]Fakultät für Physik, Universität Bielefeld, Germany — [4]Abteilung Halbleiterphysik, Universität Ulm, Germany

Spin pumping experiments allow to measure spin currents or the spin Hall angle. We have systematically studied the spin pumping DC voltage occurring in conjunction with ferromagnetic resonance in a series of conductive ferromagnet/platinum bilayers, made from elemental 3d transition metals, Heusler compounds, ferrite spinel oxides, and magnetic semiconductors. In all bilayers, we invariably observe the same DC voltage polarity. Moreover, we find that the voltage magnitude scales with the magnetization precession cone angle with a universal prefactor, irrespective of the magnetic properties, the charge carrier transport mechanism, and the charge carrier type in a given ferromag-

net. These findings quantitatively corroborate the present theoretical understanding of spin pumping in combination with the inverse spin Hall effect, and establish spin pumping as a generic phenomenon.

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MA 54.7 Thu 16:30 HSZ 04

Theory of ac driven resonant spin amplification and depletion in FNF spin valves: prediction of negative GMR — •Denis Kochan, Martin Gmitra, and Jaroslav Fabian — University of Regensburg

Parallel (P) and antiparallel (AP) configurations of FNF junctions have, in a dc regime, different resistivities (AP>P), giving rise to the giant magnetoresistance (GMR) effect. This can be explained within the spin diffusion model.

We extend the model to include ac phenomena and predict resonant amplification and depletion of spin accumulation in the P and AP configurations, respectively. As a result, the spin valve impedance shows oscillations as a function of the driving ac frequency, with periods of negative GMR.

From the spin-valve oscillation periods, which are experimentally accessible, the time-dependent spin diffusion model allows to extract, all electronically, the spin relaxation times without additional input.

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MA 54.8 Thu 16:45 HSZ 04

Non-Collinear Ferromagnetic Luttinger Liquids — •Nicholas Sedlmayr, Sebastian Eggert, and Jesko Sirker — Technische Universität Kaiserslautern, Germany

In the now classic Tomonaga-Luttinger model the presence of the electron-electron interaction in one dimension is shown to profoundly change the properties of the system. We consider here the magnetic and electronic properties of a *ferromagnetic* Luttinger liquid when it has a region of non-collinearity present, i.e. a domain wall. Spin-charge separation does not survive in this system, and the absence of both spin-charge separation and coherent spin-charge excitations has consequences for the spin-transfer-torque effects which cause domain wall motion. Furthermore the presence of the domain wall introduces a spin dependent scatterer into the problem, which will alter both the transport, and the static electronic, properties of the system. Finally we show how the magnetization dynamics of the domain wall will be modified for a Luttinger liquid.