MA 27 Spin-Dynamics, Magnetization Reversal II

Time: Thursday 10:15–13:00 Room: HSZ 403

MA 27.1 Thu 10:15 HSZ 403

Time-resolved photoelectron emission microscopy after optical ps-excitation — •Klaus Schmalbuch[1], Reza Ghadimi[1], Bernd Beschoten[1], Gernot Güntherodt[1], Jörg Raabe[2], and Christoph Quitmann[2] — [1]II. Physikalisches Institut, RWTH Aachen and Virtual Institute of Spin Electronics VISel, Templergraben 55, 52056 Aachen, Germany — [2]Swiss Light Source, Paul-Scherrer-Institut, 5232 Villigen, Switzerland

In the last years photoelectron emission microscopy (PEEM) has been established as a powerful technique to image magnetic domains in magnetic nano-structures with high spatial resolution (<100 nm).

For studies of ultrafast magnetization dynamics such as precessional switching we have realized a novel time-resolved PEEM setup. A ps-laser pulse either causes an ultrafast excitation of a non-equilibrium carrier population or can act as a heating pulse. The resulting precessional dynamics can be probed by time-resolved PEEM using magnetic circular dichroism. The main experimental achievements are: (1) temporal overlap between the laser pump pulse and the synchrotron probe pulse and (2) spatial overlap of both, controlled by laser-induced 2-photon-photoemission. First time-resolved experiments have been performed on GaAs at room temperature. This method promises to monitor magnetization dynamics in exchange coupled magnetic multilayer systems.

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MA 27.2 Thu 10:30 HSZ 403

Ultraslow femtosecond relaxation observed for high excitation power — •Markus Münzenberg, Marija Djordjevic, and Gerrit Eilers — IV. Phys. Inst., University of Göttingen

All-optical pump probe experiments give a unique insight into high nonequilibrium femtosecond timescale. A micromagnetic model using the OOMMF simulation code (NIST) is developed, to explain the significant increase of the relaxation times observed for high pump fluences larger 30 mJ/cm^2. After the restoration of the local spin magnetization, small random few nanometer sized domains are formed with an average net magnetization of zero. If the magnetization below the disturbed region remains unaffected by the pump pulse, the energy is dissipated by the emission of spin waves an decreases the restoration time of the magnetization. The effect is analogous to the increased non local Gilbert damping by the emission of spin waves that was found in earlier investigation of our group in the spot geometry. The investigation and understanding of these effects is of strong importance for the application of thermally-assisted writing in the new generation of hard disc heads.

MA 27.3 Thu 10:45 HSZ 403

Spin-Wave Eigenmodes of Landau-Domain Patterns — •Markus Bolte[1], Guido Meier[1], and Christian Bayer[2] — [1]University of Hamburg, Institute of Applied Physics, Jungiusstr. 11, 20355 Hamburg, Germany — [2]Fachbereich Physik und Schwerpunktprogramm MINAS,Technische Universität Kaiserslautern, Erwin-Schrödinger-Straße 56, 67663 Kaiserslautern, Germany

We present micromagnetic simulations of the spin-wave spectra in Landau-domain patterns. Ultra-short field pulses of various spatial symmetries are used to excite distinct spin-wave eigenmodes. The frequencies as well as the symmetry of the mode patterns depend on the symmetry of the exciting torque. The latter is determined by the symmetries of the field pulse and the magnetic ground state. Landau-domain patterns have collective excitations, i.e., the spin-wave modes cannot be considered for each domain individually. We find transversal modes as well as longitudinal modes as observed experimentally.[1,2] From the mode profiles an effective dispersion relation is deduced which resembles the dispersion relation for infinitely extended thin films.[3]

[1] K. Perzlmaier, et al., Phys. Rev. Lett. 94, 057202 (2005). [2] M. Bolte, G. Meier, and C. Bayer, submitted (2005). [3] B. A. Kalinikos, A. N. Slavin, J. Phys. C 19, 7013 (1986).

MA 27.4 Thu 11:00 HSZ 403

Magnon decay in gapped quantum spin systems — •Oleksiy Kolezhuk and Subir Sachdev — Physics Dept., Harvard University, Cambridge MA 02138, USA

In the O(3) σ-model description of gapped spin systems, $S = 1$ magnons can only decay into *three* lower energy magnons. We show that the symmetry of the quantum spin Hamiltonian often allows decay into *two* magnons, and compute this decay rate in model systems. It is argued that two-magnon decay is present in Haldane gap $S = 1$ spin chains, even though it cannot be induced by any allowed term written in powers and gradients of the σ-model field. We compare our results with recent measurements of Stone *et al.* on a two-dimensional spin system $(C_4H_{12}N_2)Cu_2Cl_6$ (known as PHCC).

MA 27.5 Thu 11:15 HSZ 403

SPIN STATE BLOCKADE AT METAL-INSULATOR PHASE TRANSITION IN LAYERED COBALTITES $RBaCo_2O_{5.5}$ RAMAN STUDIES — •Yurii Pashkevich[1], Vladimir Gnezdilov[2], Peter Lemmens[3], Claudia Ambrosch-Draxl[4], Karina Lamonova[1], Alexander Gusev[1], Kwang-Yong Choi[5], Sergei Barilo[6], Sergei Shiryaev[6], and Georgii Bychkov[6] — [1]A. A. Galkin Donetsk Phystech NASU, 83114 Donetsk, Ukraine — [2]B. I. Verkin Institut for Low Temperature Physics NASU, 61164 Kharkov, Ukraine — [3]Institut für Physik d. Kondensierten Materie, D-38106 Braunschweig, Germany — [4]Institut für Theoretische Physik, Universität Graz, A-8010 Graz, Austria — [5]Institute for Material Research, Tohoku University, Katahira 2-1-1 Sendai 980-8577, Japan — [6]Institute of Physics of Solids & Semiconductors, ASB, 220072 Minsk, Belarus

Using Raman spectroscopy and ab-initio lattice dynamic calculations we uncover the structure of spin states below T_{MI}=350 K in single crystalline $RBaCo_2O_{5.5}$ (R=Gd, Eu). In $GdBaCo_2O_{5.5}$ we observe the G-type of high spin (HS) and intermediate spin (IS) state order of Co-octahedral sites which placed in ac-plane, while pyramidal sites remains in IS states all the way up to 400 K. We show that this type of spin state order strongly suppresses carrier's motion and lead to the anisotropy of resistivity. Below 200 K we observe the gap opening between HS and IS states in XZ-spectra (this gap equals to 55 cm^{-1} at 5 K).

MA 27.6 Thu 11:30 HSZ 403

Spin-wave eigenmodes of an infinite thin film withperiodically modulated exchange bias field — •B. Hillebrands[1], C. Bayer[1], M.P. Kostylev[1], and S.O. Demokritov[2] — [1]Fachbereich Physik and Forschungsschwerpunkt MINAS, TUKaiserslautern, Germany — [2]Institut für AngewandtePhysik, Westfälische Wilhelms-Universität Münster,Germany

We propose a method to modify the spin-wave spectrum of a technologically relevant exchange bias bilayer system. It is based on a periodical suppression of the exchange bias field on the micrometer scale which induces a superlattice in the internal field. This periodic modification can experimentally be realized by focussed ion beam [1]. We will calculate semi-analytically the spin-wave eigenmodes and -frequencies of such a superlattice. The calculation method is based on the Green's function approach and on Bloch's theorem. We identify two different kinds of eigenmodes of this system. The first kind are propagating spin waves which have a band gap at the edge of the Brillouin zone. The second one are localized within the wells of the internal field and are nearly dispersion free. We further show that, by choosing an appropriate periodicity of the superlattice, the band gaps can be introduced at desired frequencies and so this system corresponds to a one-dimensional magnonic crystal. The proposed method might be of real practical interest for applications as it tailors the spin wave frequencies in thin films without a change in the topography. This work was supported by the EC projects ULTRA-SWITCH and NEXBIAS and by the DFG.

[1] K. Potzger, et al., IEEE Trans. Magn. **41**, 10 (2005).

MA 27.7 Thu 11:45 HSZ 403

Magnetization Dynamics of the Ferrimagnet CoGd near the compensation point — •Michael Binder[1], Alexander Weber[1], Ingo Neudecker[1], Georg Woltersdorf[1], Oleksandr Mosendz[2], Jan-U. Thiele[3], Michael R. Scheinfein[2], and Christian H. Back[1] — [1]Universität Regensburg, Universitätsstr. 31, 93040 Regensburg — [2]Simon Fraser University, 8888 University Drive, V5A 1S6 Burnaby BC, Canada — [3]San Jose Research Center, Hitachi Global Storage Technologies, 650 Harry Road, San Jose, CA 95120

Transition metal (TM)- Rare Earth (RE) - ferrimagnets are interesting systems to study magnetization dynamics. When the antiferromagnetic coupling between the two sublattices is strong, as it is the case for CoGd, there exist two transition temperature points, the compensation temperature T_{comp}, where $M_{Gd} = -M_{Co}$, and the angular momentum compensation temperature T_L, where $(M/\gamma)_{Gd} = (M/\gamma)_{Co}$. These temperatures are sensitive to the concentration. For CoGd the room temperature concentration is about 78% Co. According to a simple mean field model for the coupled sub-lattices, the effective damping parameter α_{eff} and the effective frequency ω increase quickly at T_L. This total response can be measured using ferromagnetic resonance methods (FMR). However, one can also use laser pump/probe experiments which couple predominantly to the TM lattice. We present measurements on various samples. TR-MOKE and FMR were used to address the Co-subsystem and the whole ferromagnetic system. In FMR we find the expected increase of α_{eff} and ω at the compensation point, while TR-MOKE measurements seem to indicate that the rate of energy loss remains nearly constant.

MA 27.8 Thu 12:00 HSZ 403

Phase control of spin wave parametric interaction — •A. Serga[1], M. Kostylev[1], T. Schneider[1], B. Hillebrands[1], and A. Slavin[2] — [1]Fachbereich Physik, TU Kaiserslautern, 67663 Kaiserslautern — [2]Department of Physics, Oakland University, Rochester, MI, USA

Phase sensitive clipping of microwave pulses passed through a parametric non-adiabatic spin wave amplifier driven by pumping pulses of double frequency is discovered. It was known that intensive amplification of the input signal by any spin wave parametric amplifier takes place only for a short time interval immediately after the pumping pulse is switched on. After that, the signal is partially or fully suppressed due to the interaction with thermal spin waves excited by long-acting pumping. It was found that in non-adiabatic amplifier, where the pumping localization length is comparable to the signal carrier wavelength, the level of this suppression can be controlled in a wide range by changing the phase of pumping relative to the phase of the input signal. The phase control is possible because the influence of the parasitic thermal spin waves reveals itself mainly in misphasing between the signal spin wave and the pumping due to local decrease of magnitude of the static magnetization. Brillouin light scattering observation demonstrates that the parasitic waves are generated near the bottom of the spin wave spectrum apparently due to a kinetic instability of parametrically excited spin waves at half the pump frequency.

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MA 27.9 Thu 12:15 HSZ 403

Phase-sensitive Brillouin light scattering spectroscopy — •T. Schneider[1], A. Serga[1], B. Hillebrands[1], and S. Demokritov[2] — [1]Fachbereich Physik, TU Kaiserslautern, 67663 Kaiserslautern — [2]Institut für Angewandte Physik, Westfälische Wilhems-Universität, Münster

We report on the first implementation of phase sensitivity into Brillouin light scattering (BLS) spectroscopy. Combined with a time- and space-resolved BLS setup this allows for access to quantities such as the phase profile and the wave front of spin wave packets and beams. In order to access phase information, interference between the light inelastically scattered by the spin wave under investigation and a frequency shifted coherent reference beam was used. Designing an optical interferometer setup, mechanical and thermal stability is of paramount importance to yield reliable phase information. We have solved the problem of stability by spatially combining the optical reference and the signal beam along one single axis. To achieve the necessary frequency shift of the reference light, a microwave electro-optical resonance modulator based on a Lithium Niobate single crystal was constructed. As this modulator is driven by the same microwave source that is used for the excitation of the spin waves, coherency between the frequency shifted and the inelastically scattered light guaranteed. The measurements of dipolar dominated spin waves in ferrite films clear demonstrate a phase structure of the spin wave packets. Phase fronts are clearly visible. The measured values of the wavelength corresponds well with the calculated one.

Financial support by the DFG is acknowledged.

MA 27.10 Thu 12:30 HSZ 403

Thermal Switching Behaviour of Superparamagnetic Nanoislands: SP-STM on Fe/W(110) — •Stefan Krause, Luis Berbil-Bautista, Matthias Bode, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg, Jungiusstraße 11, 20335 Hamburg

Spin-polarized scanning tunneling microscopy (SP-STM) is a well-established tool to reveal the static magnetic structure of surfaces at spatial resolution down to the atomic scale. Recently it has been shown that SP-STM can also be applied to investigate the dynamic switching processes in real time and real space, e.g. the thermal switching behaviour of individual superparamagnetic nanoislands [1]. While the experiments of Ref. [1] were performed only for a very limited temperature range, we have now used a home-built variable-temperature STM for detailed temperature-dependent investigations. This allows a critical examination of the predictions on the temperature-dependence of the switching rate made by the so-called Néel-Brown law. This theory predicts an Arrhenius-like behaviour for nanoparticles which are coherently magnetized even during the switching process.

Our sample consists of in-plane magnetized uniaxial Fe monolayer islands on W(110). For islands with an area of about 20 nm^2 we find a blocking temperature of about 45 K. The high stability of our experimental setup allows the observation of the same islands over a wide temperature range. The experimental data will be discussed in terms of the particle's anisotropy barrier and the attempt frequency.

[1] M. Bode *et al.*, Phys. Rev. Lett. **92**, 067201 (2004).

MA 27.11 Thu 12:45 HSZ 403

Dynamic magnetization behavior of nanocrystalline tape wound cores — •Sybille Flohrer[1], Rudolf Schäfer[1], Jeffrey McCord[1], Stefan Roth[1], Giselher Herzer[2], and Ludwig Schultz[1] — [1]IFW Dresden, Institut für Metallische Werkstoffe, 01069 Dresden — [2]Vacuumschmelze GmbH & Co. KG, 63450 Hanau

The so-called excess loss is an important component of dynamic magnetization losses. It originates from localized eddy currents around moving domain walls. Therefore, observation of the dynamic magnetization process together with simultaneous loss measurement provides a useful tool to investigate excess loss. Stroboscopic Kerr-microscopy observations and loss measurements on nanocrystalline $Fe_{73}Cu_1Nb_3Si_{16}B_7$ tape wound cores with different strength and direction of induced anisotropy are presented. In cores with an induced anisotropy along the field direction, the correlation between excess loss, strength of the anisotropy, and measured domain wall velocity on the surface is studied. The relevance of the observed surface magnetization process for the core volume is discussed. Cores with an induced anisotropy transverse to the field direction should ideally show homogeneous magnetization rotation, preventing excess loss. However, besides homogeneous rotation, inhomogeneous rotations, wall displacement processes and domain nucleation are observed in the nanocrystalline cores, being responsible for a significant excess loss.