MA 10: Magnetization Dynamics I

Time: Monday 14:45–17:00 Location: HSZ 403

MA 10.1 Mon 14:45 HSZ 403

Direct observation of four-magnon scattering in spin-wave micro-conduits — Helmut Schultheiss[1,2], •Katrin Vogt[1], Philipp Pirro[1], Thomas Brächer[1], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Materials Science Division, Argonne National Laboratory, Argonne, IL 60439

We report on experiments which demonstrate the intrinsic nonlinear damping of spin waves due to four-magnon scattering processes in a micrometer sized permalloy stripe. The magnetization is excited by a microwave current transmitted through the shorted end of a coplanar waveguide. The excitation spectrum of the spin wave is locally probed by Brillouin light scattering microscopy for different excitation frequencies covering a range of excitation powers over three orders of magnitude. We find a transition from a pure and clean monochromatic excitation of spin waves at low microwave powers to a large broadening above a certain threshold power. The spectral distribution of the measured spin-wave intensities shows a unique profile which is in good agreement with theoretical expectations for four-magnon scattering processes.

Financial support by the Carl-Zeiss-Stiftung and the Graduate School of Excellence “Materials Science in Mainz” is gratefully acknowledged. The authors thank the Nano+Bio Center of the Technische Universität Kaiserslautern and A. Beck for sample preparation.

MA 10.2 Mon 15:00 HSZ 403

Interference of two magnon-Bose-Einstein-condensates in real space — •Patryk Nowik- Boltyk, Oleksandr Dzyapko, Vladislav Demidov, and Sergej O. Demokritov — Institute of Applied Physics, University of Münster, 48149 Münster, Germany

Since the discovery of Bose-Einstein condensation (BEC) of microwave-driven magnons in ferrite films [1] at room temperature several indirect demonstrations of the time and spatial coherence of the magnon-condensate have been published [2,3,4]. However, the most direct confirmation of the coherence is the interference of two condensates. The main distinction of magnon BEC from other BEC-systems is that it takes place at a quantum state with a non-zero wavevector, k. Due to the obvious symmetry of the system two condensates at +k and -k are simultaneously created in the same region of the real space.

Here we present the observation of the spatial inference of two condensates corresponding to +k and -k. To keep the coherence during the time of the measurement, the magnon gas was driven by microwaves continuously and two dimensional spatial interference patterns of the total condensate density in real space were mapped using the Brillouin light scattering spectroscopy. The wavevector of the condensate obtained from the spatial period of the patterns matches very well with the data of previous measurements in the phase space [4].

[1]Demokritov *et al.*, Nature 443, 430 (2006)
[2]Demokritov *et al.*, New Journal of Physics 10, 045029 (2008)
[3]Dzyapko *et al.*, Appl. Phys. Lett. 92, 162510 (2008)
[4]Demidov *et al.*, Phys. Rev. Lett. 101, 257201 (2008)

MA 10.3 Mon 15:15 HSZ 403

Dynamics of field-driven vortex walls in GMR nanostripes under the influence of transverse fields — •Björn Burkhardt, Sascha Glathe, and Roland Mattheis — IPHT Jena e.V., Albert-Einstein-Str. 9, 07745 Jena

The character of DW movement in nanostripes (l»w»d)is mainly determined by the thickness and width of a nanostripe. Two different types of domain walls, vortex (VW) or transverse walls (TW), can occur in these nanostripes. We have charterized wide nanostripes (w = 500nm) with a thickness of 20nm. In these dimensions VW are energetically preferred. However, for fields above a critical field H_{cr} (well below the Walker field H_w) the VW is converted to a TW.

The dependence of DW velocity on the applied field was measured using the giant GMR effect between a sense layer (NiFe) and a reference layer (CoFe - part of an AAF/AF-combination). We applied field pulses to investigate the DW motion independently of the nucleation field. Short current pulses in a coplanar wave guide crossing the GMR nanostripe were used to generate the magnetic field. The parameters of field driven DW motion e.g. critical field, Walker field and mobilities in the different regions were determined. Especially the VW characteristics below H_w are rarely treated, yet. The precession period of the domain wall above H_w was estimated by means of measurements with different pulse length.

Furthermore we will show the influence of an in-plane transverse field on the DW dynamics in wide nanostripes by simulations and experimental results.

MA 10.4 Mon 15:30 HSZ 403

Generation of Domain Walls by Local Magnetic Fields — •Falk-Ulrich Stein, Lars Bocklage, Michael Martens, Toru Matsuyama, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Germany

In recent years attention focussed on investigations of domain walls in nanowires for application in a racetrack memory [1]. While the field- and current-driven propagation of domain-walls along nanowires was the core theme in most cases [2,3], the study of domain-wall creation by local Oersted-fields has not been in focus. Mostly global fields are used to create domain walls. For devices such fields are improper because of their low efficiency, long time constants and overall impact on the magnetic structure. Our work investigates the creation of domain walls by local fields of a strip line. We present measurements of stochastic field-pulse induced domain-wall formation. From those results the strength and duration of the local fields are gained, which are required for the creation. The creation itself is investigated by micromagnetic simulations and by time-resolved measurements of the anisotropic magnetoresistance.

[1] S.S.P. Parkin, et al., Science 320, 190 (2008)
[2] G. Meier, et al., Phys. Rev. Lett. 98, 187202 (2007)
[3] L. Bocklage, et al., Phys. Rev. Lett. 103, 197204 (2009)

MA 10.5 Mon 15:45 HSZ 403

Indirect control of antiferromagnetic domain walls with spin current — •Robert Wieser, Elena Y. Vedmedenko, and Roland Wiesendanger — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstrasse 11, D-20355 Hamburg, Germany

Current induced domain wall motion is an important aspect in magnetism due to its potential applications in magnetic memory and logic devices. The motion of domain walls directly influenced by spin currents associated with a spin transfer torque has been studied experimentally and theoretically. However, the investigations of current driven antiferromagnetic domain walls is very limited. In this talk we propose two promising directions for experiments on the indirect control of an antiferromagnetic (AFM) domain wall. The antiferromagnetic domain wall can be shifted both by a spin-polarized tunnel current of a scanning tunneling microscope or by a current driven ferromagnetic domain wall in an exchange coupled antiferromagnetic/ferromagnetic layer system. While the manipulation using an SP-STM tip is restricted to the atomic length scale, the controlled interaction between domain walls is important for the development of new solid state devices. Furthermore, the results contribute to an improved understanding of the exchange bias effect and provide new insight into the domain wall dynamics of filled nanotubes.

MA 10.6 Mon 16:00 HSZ 403

Insights on all-optical magnetization switching by tailoring optical excitation parameters — •Sabine Alebrand, Daniel Steil, Alexander Hassdenteufel, Mirko Cinchetti, and Martin Aeschlimann — Department of Physics and Research Center OPTIMAS, University of Kaiserslautern, 67653 Kaiserslautern, Germany

In 2007 Stanciu et al. [1] discovered that it is possible to switch the magnetization in GdFeCo by using circularly polarized laser pulses. A phenomenological description of this effect based on the inverse Faraday Effect (IFE) was presented by Vahaplar et al. in 2009 [2]. Nevertheless until now the microscopic processes leading to all-optical switching are still unclear.

In this talk we focus on the investigation of the all-optical switching behaviour by changing the properties of the exciting laser pulse. We present wavelength- and pulse duration-dependent studies and demonstrate that all-optical switching is possible for all wavelengths in the visible range as well as for pulse durations up to almost 4 ps. In addition we show that the threshold fluence needed for all-optical switching is nearly independent on the pulse duration. We discuss our results in the context of the existing model based on the IFE and draw some conclusions with respect to possible microscopic mechanisms behind all-optical switching. This work was supportet by the EU project UltraMagnetron (NMP3-SL-2008-214469).

[1] Stanciu et al. PRL 99, 047601 (2007)
[2] Vahaplar et al. PRL 103, 117201 (2009)

MA 10.7 Mon 16:15 HSZ 403

Cherenkov-like spin wave emission by supermagnonic domain walls in ferromagnetic nanotubes — •Christian Andreas[1], Ming Yan[1], Attila Kákay[1], Felipe Garcia-Sanchez[1], and Riccardo Hertel[1,2] — [1]Institut für Festkörperforschung, Elektronische Eigenschaften, Forschungszentrum Jülich GmbH — [2]Institut de Physique et Chimie des Matériaux de Strasbourg, Université de Strasbourg, CNRS UMR 7504

The micromagnetic structure of vortex walls in nanotubes is comparable to that of transverse walls in thin strips, since the orientation of transverse walls corresponds to the vorticity of vortex walls in nanotubes [1]. In spite of this similarity of their static structures, we found that the dynamic properties of these domain walls (DWs) differ significantly. Unlike DWs in thin strips, the left-right symmetry of DW mobility is broken. While head-to-head DWs with left-handed chirality lead to a Walker breakdown [2] above a limiting velocity, those with right-handed chirality can reach propagation velocities beyond the phase velocity of spin waves (about 1000 m/s). As soon as the minimum spin-wave phase velocity is reached, tails of spin waves are formed in front of and behind the DW. Such a spontaneous emission of spin waves is analogous to Cherenkov radiation emitted by charged particles moving in a dielectric medium at velocities above the speed of light. The moving DW with attached spin-wave tails reaches a dynamic equilibrium and propagates as a topological soliton afterwards.

[1] R. Hertel et al., J. Magn. Magn. Mater. 278 291 (2004)
[2] N. L. Schryer and L. R. Walker, J. Appl. Phys. 45, 5406 (1974)

MA 10.8 Mon 16:30 HSZ 403

Imaging of the spin-wave eigenmodes of a garnet-film disc — Matthias Buchmeier, •Eric R.J. Edwards, Vladislav E. Demidov, and Sergej O. Demokritov — Institute for Applied Physics, University of Münster, Corrensstraße 2-4, 48149 Münster, Germany

Macroscopic structures based on low-loss garnet films are an ideal model system for the space-resolved investigation of spin-wave dynamics. Here we investigate the dipolar eigenmodes of a garnet-film disc by means of time- and space-resolved Faraday-effect microscopy. Thanks to the macroscopic dimensions of the studied samples, we were able to reliably image spatial profiles of the modes up to very high order. Our results show that the usual classification of eigenmodes based on their consideration as a product of standing waves in two orthogonal directions is not fully applicable in the case of in-plane magnetized disc samples. We find that the spatial distributions of the dynamic magnetization for the eigenmodes are strongly influenced by the intrinsic anisotropy of the dipolar spin-wave spectrum. Moreover, this anisotropy also leads to an appearance of a fine spatial structure, whose symmetry differs from the geometrical symmetry of the samples. These experimental results are corroborated by micromagentic simulations.

15 min. break