MA 2: Spin-Dynamics / Spin-Torque I

Time: Monday 11:00–13:15 Location: HSZ 04

MA 2.1 Mon 11:00 HSZ 04

Magnon dispersion and life times of thin Ni films studied with inelastic scanning tunneling spectroscopy — •Toyo Kazu Yamada[1], Nicolai Urban[1], Timofey Balashov[1], Albert Takács[1], Pawel Buczek[2], Leonid Sandratskii[2], Arthur Ernst[2], and Wulf Wulfhekel[1] — [1]Physikalisches Institut, Universität Karlsruhe, Wolfgang-Gaede-Straße 1, 76131 Karlsruhe, Germany — [2]Max-Plank-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany

Ni films of thickness between 4 and 12 monolayers were grown epitaxially on a Cu(100) substrate. Using inelastic scanning tunneling spectroscopy at 4 K magnons in the Ni film were studied. In the thin films, the magnons are confined and thus quantized along the surface normal. For a film of n momolayres, n magnon modes normal to the surface are expected. In the experiments these modes appear as peaks in the inelastic tunnelling spectra. By measuring the peak position and widths the magnon energies and lifetimes can be obtained. The observed lifetimes strongly depend on the momentum of the magnons in agreement with non-adiabatic dynamic susceptibility calculations.

MA 2.2 Mon 11:15 HSZ 04

One-dimensional YIG film based magnonic crystals — •Andrii V. Chumak, Alexander A. Serga, and Burkard Hillebrands — FB Physik and Forschungszentrum OPTIMAS, TU Kaiserslautern, Germany

Scattering of backward volume magnetostatic spin waves (BVMSW) from a one-dimensional magnonic crystal was experimentally studied. The crystal was produced by etching of a periodic groove array on a surface of a single crystal yttrium-iron-garnet ferrite film. We demonstrate that in the BVMSW configuration the one-dimensional magnonic crystal shows excellent spin-wave signal rejection of more than 30 dB. It was found that the optimal groove depth (ensuring that the loss in the transmission band inserted by the array is smaller than 5 dB) is approximately 10% of the film thickness. The rejection efficiency and the frequency width of the rejection bands increase with increasing groove depth.

A theoretical model based on the analogy of a spin-wave film waveguide with a microwave transmission line was used to interpret the obtained experimental results.

Financial support by the DFG within SE 1771/1-1 is acknowledged.

MA 2.3 Mon 11:30 HSZ 04

Ways to magnonic crystals: Studies with femtosecond pump-probe technique — •Benjamin Lenk, Jakob Walowski, Andreas Mann, Henning Ulrichs, Gerrit Eilers, and Markus Münzenberg — I. Physikalisches Institut, Universität Göttingen

The propagation of surface modes on thin Nickel films is investigated with all optical pump-probe experiments. Laser pulses with a duration of 60 fs from a Ti:Sa mode-coupled laser system are used for optical excitation (pump pulse) as well as observation of the subsequent magnetic relaxation taking place in the pico- and nanosecond regime (probe pulse). The time dependent magnetization curves $M(t)$, are recorded using the time-resolved magneto-optical Kerr effect (TRMOKE) in different external fields $0\,\mathrm{mT} \leq \mu_0 H \leq 150\,\mathrm{mT}$.

The behaviour of the different precessional modes observed (exchange-dominated perpendicular standing spin waves, dipole-dominated surface modes, and uniform precession) changes when going from a continuous to a periodically structured surface. The different mode wave vectors can be numerically determined from $\nu(H)$. Structuring the thin films with matching periodicity induces drastic changes in the mode frequency observed, indicating the interaction of the periodic modification with the propagating modes excited with the laser pulse.

Research is supported by *DFG Schwerpunkt SPP 1133: "Ultrafast magnetization processes"*.

MA 2.4 Mon 11:45 HSZ 04

Pumping free Bose-Einstein condensate of magnons — •Alexander A. Serga[1], Vitaliy I. Vasyuchka[1,2], Christian Sandweg[1], Andrii V. Chumak[1], Timo Neumann[1], Gennadiy A. Melkov[2], and Burkard Hillebrands[1] — [1]FB Physik and Forschungszentrum OPTIMAS, TU Kaiserslautern, Germany — [2]National Taras Shevchenko University of Kiev, Ukraine

A free evolution of a Bose-Einstein condensate (BEC) of parametrically injected magnons after shutdown of a pumping microwave field was studied by means of time-resolved Brillouin light scattering spectroscopy in a tangentially magnetized yttrium-iron-garnet film at room temperature. The light scattered by the primary magnon group, which was parametrically excited near the frequency of ferromagnetic resonance, and by the BEC of magnons at the bottom of spin-wave spectrum was detected and analyzed in the time domain.

A pronounced and sharp (by a factor of 10 during 30 ns) intensity jump of the BEC of magnons above its equilibrium value has been detected just after the external pumping source was switched off. This jump was accompanied by the fast nonlinear decay of the primary magnon group with the relaxation time of 60 ns. The subsequent decay of the BEC of magnons is much slower and is characterized by the relaxation time of 800 ns. The discovered surge is interpreted as an increase in scattering efficiency of the parametrically injected magnons to the Bose-Einstein condensate in absence of pumping.

Financial support by the DFG (SFB/TRR 49) and by the Ukrainian Fund for Fundamental Research (No. 25.2/009) is acknowledged.

MA 2.5 Mon 12:00 HSZ 04

Spatial handling of Bose-Einstein condensate of magnons — •Oleksandr Dzyapko, Vladislav E. Demidov, and Sergej O. Demokritov — Institut für Angewandte Physik, Westfälische Wilhelms-Universität Münster, Münster, Deutschland

After the experimental observation of Bose-Einstein condensation (BEC) of atoms and quasi-particles manipulating the condensate as a single whole and the study of interaction between two or more condensates are of particular interest. However, experimental results only for atomic condensate were reported. Recently discovered room temperature BEC of magnons driven by a microwave pumping [1] opens a new way for manipulation of condensates of quasi-particles. Here we demonstrate a way to create simultaneously two condensates of magnons separated in space and report the study of their spatial evolution using the space- and time-resolved Brillouin light scattering spectroscopy. Two separate condensates were created along the opposite edges of a microstrip resonator, which has a width of 500 mkm. The presented results show that, whereas the spatial separation between the condensates is determined by the width of the resonator, the width of each condensate depends on the applied microwave pumping power. Thus, varying the power and the width of the resonator one can handle the dimensions and the separation of the condensates which gives a convenient tool for realization of a magnon Josephson junction.

1. S.O. Demokritov, V.E. Demidov, O. Dzyapko, G.A. Melkov, A.A. Serga, B. Hillebrands, and A.N. Slavin, Nature 443, 430 (2006).

MA 2.6 Mon 12:15 HSZ 04

Spin-wave signal recovering under influence of multipulse parametric pumping — •Sebastian Schäfer, Volker Kegel, Alexander A. Serga, and Burkard Hillebrands — FB Physik und Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

We have studied the storage and parametrically stimulated recovery of microwave signals in a tangentially magnetized yttrium-iron-garnet (YIG) ferrite film. The microwave signal carried by a packet of magnetostatic surface spin waves (MSSW) is stored due to the excitation of dipolar-exchange standing spin-wave modes across the film thickness. A recovered MSSW packet appears in the film as a result of parametric amplification of one of these standing modes [1]. The recovery delay time as well as the duration and amplitude of the recovered signal are mostly controlled by the power of the pumping signal. Here we report on the behaviour of the spin-wave system under influence of multiple pumping pulses applied per one MSSW signal pulse. We demonstrate the ability of a multiple recovery process and discuss the dependence of its characteristics on the time interval between pumping pulses. Financial support by the DFG (SFB/TRR 49) is acknowledged.

[1] A.A. Serga, A.V. Chumak, A. Andre, G.A. Melkov, A.N. Slavin, S.O. Demokritov, and B. Hillebrands, PRL 99, 227202 (2007).

MA 2.7 Mon 12:30 HSZ 04

Oersted field influence on three-magnon-scattering pro-

cesses in nanopoint contact spin-valves — •F. Ciubotaru[1], H. Schultheiss[1], A.A. Serga[1], X. Janssens[2], M. van Kampen[2], L. Lagae[2], B. Leven[1], A.N. Slavin[3], and B. Hillebrands[1] — [1]FB Physik and Forschungszentrum OPTIMAS, TU Kaiserslautern, Germany — [2]IMEC, Leuven, Belgium — [3]Oakland University, Rochester, MI, USA

Using Brillouin light scattering microscopy we have investigated the spin-wave emission from a point contact spin-valve structure driven by a combined microwave and dc current. The spin waves irradiated into a free Py layer by an 80 nm point contact were studied for several applied microwave frequencies and powers with and without influence of dc current We report on observation of several nonlinear effects, namely the generation of higher harmonics (2f, 3f) as well as spin-wave modes with a half-integer factor (0.5f, 1.5 f) relative to the driving microwave frequency f. These modes are associated with three-magnon-scattering processes. The appearance of the 0.5f mode presents a clear threshold behavior as a function of the applied microwave power. Moreover, the threshold shows a strong nonlinear dependence on the dc current. The threshold power was calculated within three-magnon-scattering theory taking into account the influence of the Oersted field created by the dc current. The theoretical and experimental results agree and show that the threshold properties of 0.5 mode are controlled by the Oersted field. Support from EC-MRTN SPINSWITCH (MRTN-CT-2006-035327) is gratefully acknowledged.

MA 2.8 Mon 12:45 HSZ 04

Interaction of spin-wave envelope solitons with potential barriers and wells — •Ulf-Hendrik Hansen, Vladislav E. Demidov, and Sergej O. Demokritov — Institute for Applied Physics, University of Muenster, Corrensstr. 2-4, 48149 Muenster, Germany

The interaction of nonlinear waves with potential barriers and wells has recently attracted a strong interest, since it is believed that the tunneling-associated dynamics of nonlinear wave-packets in complex potentials can bring a new important knowledge to the physics of universal nonlinear phenomena [1]. Spin waves in thin ferromagnetic films are uniquely positioned as a flexible and convenient model nonlinear system. Recently it was demonstrated that linear spin waves can tunnel through a potential barrier, formed by an inhomogeneity of the static magnetic field [2]. Here we report an experimental study of interaction of nonlinear spin-wave packets, propagating in yittrium iron garnet films, with magnetic potential barriers and wells. We have found that the nonlinearity in the system causes a noticeable modification of this interaction in comparison to the linear case. The strongest modification is observed under conditions, where spin-wave envelope solitons are formed. Our findings show that for the case of potential barriers the solitons demonstrate an enhanced tunneling. Moreover, the nonlinear enhancement of the interaction was found to be stronger for potential wells, which was associated with its resonant character.

[1] O. Morsch and M. Oberthaler, Rev. Mod. Phys. 78, 179 (2006).
[2] S.O. Demokritov et al., Phys. Rev. Lett. 93, 047201 (2004).

MA 2.9 Mon 13:00 HSZ 04

New 2D approach to the k-vector sensitivity in the Brillouin light scattering spectroscopy — •Christian W. Sandweg, Vitaliy I. Vasyuchka, Alexander A. Serga, and Burkard Hillebrands — FB Physik und Forschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

An important step towards the understanding of the behavior of magnon gases and condensates in thin magnetic films will potentially allow one to determine the exact spectral positions of spin-wave excitations through experimental recognition of their frequencies and wave vectors. For the investigation and characterization of energy transfer processes initiated in a magnon gas by parametric excitation, an instrument capable of detecting and resolving the whole range of magnon wave vectors occurring during these processes is required. Here we report on our progress towards achieving this goal by varying the angle of incident light with respect to the orientation of magnetization. The distinct improvement of our approach is expanding this k-vector sensitivity to two dimensions so that spin-wave wavevectors oriented both parallel and perpendicular to the external field can be resolved and measured. The functionality of this setup is demonstrated by showing the results for (a) directly excited spin waves near the ferromagnetic resonance and (b) for magnons at the lowest energy state of a parametrically driven magnon gas in yttrium-iron-garnet ferrimagnetic film.