MA 33: Spindynamics / Switching III

Time: Friday 11:00–13:00 Location: H23

MA 33.1 Fri 11:00 H23

Time-resolved magneto-optics in the sub-ps regime with a modified Sagnac interferometer — •Andreas Goris, Andreas Bauer, and Günter Kaindl — Freie Universität Berlin, Institut für Experimentalphysik

In near-field imaging of magnetic nanostructures, the Sagnac interferometer has been shown to be a powerful tool for increasing image quality and magnetic contrast [1,2]. We have carried on this successful concept to the study of magneto-optical effects on the sub-ps timescale. The system studied was a 35-ML film of Ni/Cu(100) that was heated by the light pulse from a Ti:sapphire laser. The drop in magnetization of the film in less than 1 ps and the subsequent relaxation process was followed in real time, using a pump-probe setup with a modified Sagnac interferometer and - for comparison - a conventional crossed-polarizer setup.

[1] B.L. Petersen et al., Appl. Phys. Lett. **73**, 538 (1998).
[2] G. Meyer et al., Phys. Rev. B **68**, 212404 (2003).

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MA 33.2 Fri 11:15 H23

Spin Dynamics Probed by Femtosecond X-ray Pulses — •Christian Stamm, Niko Pontius, Torsten Kachel, Marko Wietstruk, Hermann A. Dürr, and Wolfgang Eberhardt — BESSY, Albert-Einstein-Str. 15, 12489 Berlin

When a ferromagnetic sample is highly excited by an intense fs laser pulse, the energy is first absorbed by the electronic system. Subsequently, energy is transferred to the lattice and spin subsystems on the fs time scale. This leads to a disordered spin system: ferromagnetic order is lost within several 100 fs. As the total angular momentum is conserved, the moment previously carried by the spins has to be transferred to other reservoirs on the same time scale.

Utilizing x-ray magnetic circular dichroism (XMCD), we observe the evolution of the magnetic moments as a function of time delay between laser pump and x-ray probe pulses. XMCD sum rules allow determining the contribution of spin and orbital moments separately. Our goal is to get new insight into the transfer mechanisms of energy and angular momentum during ultrafast demagnetization of thin ferromagnetic films.

The experiments were performed at the BESSY slicing source having a time resolution better than 150 fs. The available x-ray energies give access to x-ray absorption edges of the 3d transition elements and rare-earth elements (L and M edges, respectively), covering the important ferromagnetic elements Fe, Co, Ni, and Gd.

MA 33.3 Fri 11:30 H23

Ultrafast demagnetization dynamics in Fe, Co, and Ni films observed by THz emission spectroscopy — •Jan Nötzold, Tobias Kampfrath, Christian Frischkorn, and Martin Wolf — Freie Universität Berlin, Arnimalle 14, 14195 Berlin

The excitation of ferromagnetic thin films with ultrashort laser pulses results in an ultrafast drop of the magnetization, which is accompanied by the emission of electromagnetic radiation in the THz frequency range [1]. In our work, we excite 10nm thick ferromagnetic films of Fe, Co, and Ni with intense laser pulses ($\sim 1\,\mathrm{mJ\,cm^{-2}}$ fluence, 20fs duration, 800nm center wavelength) and measure the subsequently emitted radiation in the frequency window from 0.5 to 40 THz. The electric *field* is directly detected in the time domain via free-space electro-optic sampling. We discuss the origin of the emitted THz pulse and its relationship to the magnetization dynamics of the sample. No frequency components are found above 10 THz, which indicates that the laser induced demagnetization takes place on time scales larger than $\sim$ 100 fs.

[1] E. Beaurepaire, G. M. Turner, S. M. Harrel, C. Beard, J.-Y. Bigot, and C. A. Schmuttenmaer, Appl. Phys. Lett. **84**, 3465 (2004)

MA 33.4 Fri 11:45 H23

Microwave assisted switching of micron-sized magnetic elements — •Georg Woltersdorf, Christian Back, and Dieter Weiss — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, D-93040 Regensburg, Germany

We use time resolved magneto optic Kerr effect microscopy to study the magnetic resonance and the switching of micron and sub-micron sized magnetic elements. The Permalloy microstructures have a uniaxial shape anisotropy and are prepared on a coplanar waveguide using e-beam lithography and dry etching. The thickness of the magnetic elements is kept below 2.5 nm to ensure that the single domain state is the ground state. In addition to the dynamic response the time resolved Kerr microscopy combined with synchronized microwaves allows one to measure static hysteresis loops on individual magnetic elements: in the experiment the synchronized microwaves are chopped and lock-in detection is used. The phase of the magnetic response to the microwaves changes by 180 degrees and hence the signal changes sign when the magnetization switches. Monitoring the signal as function of the applied magnetic field therefore allows one to measure the magnetic hysteresis for individual elements as small as 100 nm.

Hysteresis loops are measured as a function of microwave frequency and power. At large microwave powers these measurements show a strong reduction of the coercive fields. The effect is strongest at the resonance frequency of the magnetic element. At sufficiently large microwave powers the hysteresis loop collapses entirely.

MA 33.5 Fri 12:00 H23

Propagation of Spin-Waves in Ferromagnetic Thin Films — •Korbinian Perzlmaier, Georg Woltersdorf, and Christian Back — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Universitätsstr. 31, 93040 Regensburg

In our aim to investigate the behaviour of spin-waves in interaction with different magnetic or topological potentials, we have observed the propagation of spin-waves and packets of spin-waves in a continuous 20nm thick $Ni_{80}Fe_{20}$ film upon microwave excitation. A magnetic in-plane bias field is applied to the sample in the Damon-Eschbach (DE) or Magneto Static Backward Volume Modes (MSBVM) geometry. Time Resolved Scanning Kerr Microscopy (TRSKEM) is used to detect the out-of plane component of the magnetization. The propagation of DE- and MSBVM- modes was optically detected over a range of some 50μm. In doing so, we are able to directly determine the phase- and group velocity of spin-waves and spin-wave packets propagating in a ferromagnetic thin film.

MA 33.6 Fri 12:15 H23

Magnetization dynamics in rare earth doped NiFe films — •Matthias Kiessling[1], Georg Woltersdorf[1], Jan-Ulrich Thiele[2], Manfred Schabes[2], and Christian Back[1] — [1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, D-93040 Regensburg, Germany — [2]Hitachi Global Storage Technologies, 3403 Yerba Buena Road, San Jose, CA 95135, U.S.A.

The influence of rare earth dopants on the damping parameter and the resulting possibility to control this parameter were investigated. In our experiments NiFe films were doped with Dysprosium, Holmium, Terbium, and Gadolinium. The magnetization dynamics of these rare earth doped films was mainly studied by means of ferromagnetic resonance (FMR) and network-analyzer ferromagnetic resonance.

It is demonstrated that the doping of a NiFe film by a small amount of rare earth elements (Holmium, Terbium and Dysprosium) greatly effects its magnetic relaxation rate. This additional damping is proportional to the doping level. Compared to the pure NiFe film it is possible to increase the damping parameter of the magnetic film by two orders of magnitude. On the other hand Gadolinium as a dopant has no influence on the damping parameter. For small dopant concentrations the in and out-of-plane FMR measurements at various frequencies can be well described by the same damping parameter. This is expected for the Gilbert damping term in the equation of motion. Therefore the increased damping can be attributed to an increased rate of transfer of angular momentum from the spin system to the lattice.

MA 33.7 Fri 12:30 H23

Linear and nonlinear phase accumulation of dipolar spin waves propagating in yttrium-iron-garnet films — •Thomas Schneider[1], Alexander A. Serga[1], Burkard Hillebrands[1], and Mikhail P. Kostylev[2] — [1]Fachbereich Physik, TU Kaiserslautern, Erwin-Schrödinger-Str. 56, 67663 Kaiserslautern, Germany — [2]School of Physics, M013, University of Western Australia, 35 Stirling Highway, Crawle, WA 6009, Australia

We report on phase resolved investigations of dipolar spin waves propagating in Yttrium-Iron-Garnet spin-wave waveguides. Microwave excited spin-wave packets with different intensities have been observed using space, time and phase resolved Brillouin light scattering spectroscopy. The phase sensitivity of our system allows the measurement of the phase profiles (i.e., the time dependent phase difference between the exciting microwave signal and the spin wave at any given point) and thus the phase accumulation over the complete propagation range. Changing the power of the input microwave signal gives the possibility to excite either linear or nonlinear spin-wave pulses. In the latter case we were able to investigate the influence of the spin-wave amplitude on the spin-wave phase. Nonlinear phase splitting between the peak and the tail of nonlinear spin-wave pulses was observed. An interpretation of this effect is presented.

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MA 33.8 Fri 12:45 H23

Ultrafast Spin Dynamics in GaMnN — •Nils Janssen[1], Tim Thomay[1], Markus Beyer[1], Ulrich Rüdiger[1], Mario Gjukic[2], Tobias Graf[2], Martin Brandt[2], and Rudolf Bratschitsch[1] — [1]Fachbereich Physik und Centrum für Angewandte Photonik, Universität Konstanz, D-78457 Konstanz, Germany — [2]Walter Schottky Institut, Technische Universität München, D-85784 Garching, Germany

We perform time-resolved Faraday rotation measurements on epitaxial GaN layers doped with Manganese in concentrations of the order of 10^{20} cm^{-3}. Optical absorption and electron spin resonance studies indicate that the majority of Manganese is built into the GaN host crystal either as Mn^{3+} ions or as "Mn^{2+} + hole"complexes.

With circularly polarized ultraviolet pump pulses resonant to the fundamental bandgap, we excite spin-polarized electrons and holes. The spin of these carriers precesses in an externally applied transverse magnetic field. The time-dependent magnetization is detected via polarization rotation of a delayed probe pulse transmitted through the sample. By slightly tuning the excitation energy above the absorption edge, we are able to selectively address Mn states, most likely resulting in the formation of "Mn^{2+} + hole"complexes. These data show a strongly temperature dependent g-factor.