MA 22: Magnetic Measurement Methods

Time: Tuesday 11:00–13:00 Location: HSZ 403

MA 22.1 Tue 11:00 HSZ 403

Cracking bits with serpent's bit - fast and easy experimental data evaluation using python — •Artur Glavic[1], Jörg Voigt[2], and Thomas Brückel[1,2] — [1]Institut für Festkörperforschung, FZ Jülich, D-52425 Jülich — [2]Jülich Centre for Neutron Science, IFF, FZ Jülich, Outstation at FRM II, Lichtenbergstrasse 1, D-85747 Garching

For many physical experiments with non commercial instruments it is necessary to program new software to evaluate the collected data. According to experience this is mostly done by small scripts developed in the experimental group using low-level languages as C or Fortran. The downside of this approach is, that these programs can't be changed very easily to adapt them to new problems and that they can't be used on different platforms.

For most of the cases the main advantage of e.g. C, namely the short execution time, is not important as the data size is small. In this contribution I will introduce the interpreter language python with some useful extension modules, which make it easy to write data evaluating script or even evaluate on-line. The resulting software doesn't have to be compiled and is platform independent. With the object oriented architecture the programs can be written very general making changes easier. I will demonstrate this on a complete evaluation of different measurement types on Multiferroic $TbMnO_3$ thin-films reaching from SQUID magnetometry, x-ray diffraction and reflectometry to magnetic neutron and x-ray scattering. All these evaluations were done with a general architecture using plug-in like parts for the different methods.

MA 22.2 Tue 11:15 HSZ 403

Noise characteristics of magnetoresistive fluxgates for weak magnetic field sensing — •Leoni Breth[1,3], Theodoros Dimopoulos[1], Rudolf Heer[1], Jörg Schotter[1], Karsten Rott[2], Dieter Süss[3], and Hubert Brückl[1] — [1]AIT Austrian Institute of Technology GmbH, Nano Systems, 1220 Vienna, Austria — [2]University of Bielefeld, Physics Department, Germany — [3]Vienna University of Technology, Solid State Physics Department, Austria

Magnetic tunnel junctions (MTJs) with MgO barriers are known for their high magnetoresistance (MR) ratio, which makes them possible candidates for measuring weak biomagnetic fields stemming from the human heart or brain activity. Today's established sensors for magneto-cardio and encephalogram employ costly SQUID systems. To make MTJ sensors competitive to SQUIDs, their detectivity, which is limited by their intrinsic noise level - especially in the low frequency range- has to reach the sub-nT regime. To this end, several designs have been proposed (e.g. integration of flux concentrators). Here, we introduce an alternative technique, inspired from fluxgate magnetometers, employing lock-in amplification. An alternating magnetic field that is produced by a current line is used to switch the free layer of the MTJ. The presence of a weak DC or low frequency magnetic field generates a second harmonic component in the MR signal of the MTJ, which is a linear measure for the magnetic field strength. We present the low frequency noise characteristics of MgO-based MTJs and discuss their influence on the magnetic field detectivity of the proposed MR fluxgate design.

MA 22.3 Tue 11:30 HSZ 403

Element-selective measurement of magnetic multilayers using a tabletop high-harmonic soft X-ray source. — •Roman Adam[1], Patrik Grychtol[1], Dennis Lvovsky[1], Chan La-O-Vorakiat[3], Stefan Mathias[2,3], Moritz Plötzing[1], Justin Shaw[4], Hans Nembach[4], Tom Silva[4], Timm Rohwer[5], Martin Aeschlimann[2], Henry Kapteyn[3], Margaret Murnane[3], and Claus Schneider[1] — [1]Institute of Solid State Research, Research Centre Jülich, Jülich, Germany — [2]TU Kaiserslautern und Forschungszentrum OPTIMAS, Kaiserslautern, Germany — [3]Department of Physics and JILA,University of Colorado, Boulder, CO, USA — [4]Electromagnetics Division, National Institute of Standards and Technology, Boulder, CO, USA — [5]Institute of Experimental and Applied Physics, University Kiel, Kiel, Germany

We performed static and time-resolved magneto-optic measurements on Ni/Ru/Fe and Ni/Cr/Fe multilayers using resonant scattering of laser-generated extreme ultraviolet (XUV) radiation tuned to the M absorption edges of Fe (53eV) and Ni (67eV). By exploiting the linear magneto dichroic effect a clear element selective magnetic contrast upon magnetization reversal can be obtained[1]. Our experiments show that the laser-generated higher harmonics can be employed for element-selective probing of magnetic multilayers with femtosecond time resolution, thus demonstrating a new experimental approach to measure ultrafast spin dynamics in heterogeneous magnetic systems. [1] C. La-O-Vorakiat et al., PRL 103, 257402 (2009.

MA 22.4 Tue 11:45 HSZ 403

Taking Ferromagnetic Resonance to Millikelvin Temperatures — •Hans Huebl, Christoph Zollitsch, Martin Radlmeier, Fredrik Hocke, Mathias Weiler, Karl Neumaier, Rudolf Gross, and Sebastian T. B. Goennenwein — Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany

Ferromagnetic Resonance (FMR) is a sensitive tool for the investigation of magnetic anisotropy and magnetization damping in thin magnetic films. Broadband FMR based on coplanar waveguide technology hereby is particularly attractive as it allows for the investigation of plain films as well as of single magnetic nanostructures. We here present broadband FMR data of 50 nm thick nickel and cobalt thin films, recorded at temperatures range from 4.2 K down to 50 mK. The excellent sensitivity of our setup allows for the detection of FMR with an incident microwave power of 100 fW at the base temperature of the dilution refrigerator. Our FMR measurements in Co and Ni reveal no distinct temperature dependence of the anisotropy and damping parameters in the temperature regime below 4.2 K, in agreement with the trend observed in measurements from room temperature down to 4.2 K. Our proof-of-principle experiments open the path for broadband FMR studies of magnetic anisotropy and magnetization damping at millikelvin temperatures, i.e., in a regime so far very scarcely explored.

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MA 22.5 Tue 12:00 HSZ 403

The new high-intensity polarized neutron reflectometer of the Jülich Centre of Neutron Science — •Stefan Mattauch[1], Denis Korolkov[1], Ulrich Rücker[2], Earl Babcock[1], Alexander Ioffe[1], and Thomas Brückel[2] — [1]JCNS,Institut für Streumethoden, Forschungszentrum Jülich GmbH — [2]Institut für Streumethoden, Forschungszentrum Jülich GmbH

The Jülich Centre of Neutron Science (JCNS) is building the new, high-intensity reflectometer MARIA in the neutron guide hall of the FRM II reactor in Garching. Unique features of MARIA include (i) vertical focussing with an elliptic guide from 170 mm down to 10 mm at the sample position, (ii) reflectometer and GISANS mode, (iii) polarization analysis over a large 2d position sensitive detector as standard, (iv) adjustable wavelength spread from 10 to 1 % by a combination of velocity selector and chopper, (v) flexible sample table using a Hexapod for magnetic field and low temperature sample environment and (vi) in-situ sample preparation facilities. Together with a 400 x 400 mm^2 position sensitive detector and a time-stable ^3He polarization analyzer based on Spin-Exchange Optical Pumping (SEOP), the instrument is dedicated to investigate specular reflectivity and off-specular scattering from magnetic layered structures down to the monolayer regime. In addition the GISANS option can be used to investigate lateral correlations in the nm range. This option is integrated into the reflectometer*s collimation, so it can be chosen during the measurement without any realignment.
The results of the first experiments will be presented at the conference.

MA 22.6 Tue 12:15 HSZ 403

magneto-optical dielectric tensor of Co, Fe, Ni, and of NiFe alloys under saturated magnetization conditions — •kahming mok, nan du, and heidemarie schmidt — Institute of Ion-Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Bautzner Landstrasse 400, 01328 Dresden, Germany

Magneto-optical generalized ellipsometry (MOGE) has become extensively important for characterization the magneto-optical response of single and multilayer materials. We setup a Vector-Magneto-Optical

Generalized Ellipsometer (VMOGE) in the spectral range from 250 nm to 1100 nm using an octupole magnet, to perform VMOGE measurements of the Mueller matrix in a magnetic field of arbitrary orientation and magnitude up to 0.4 T at room temperature. The VMOGE features a new "field orbit" measurement that can be performed without physically moving the sample, which is useful to study magnetic multilayer or nanostructure samples. An optical model based on the 4 x 4 matrix formalism is required to evaluate and fit the experimental Mueller matrix data. Searching the best match model between experimental and calculated VMOGE data, the magneto-optical dielectric tensor ϵ^{MO} of each layer in a multilayer sample system can be determined. In this work, we investigate the magneto-optical properties of the elemental ferromagnets Co, Fe, and Ni, as well as of $Ni_{1-x}Fe_x$ alloys (x=0.20, 0.65, and 0.80). We extracted the wavelength dependence of the magneto-optical dielectric tensor under saturated magnetization conditions.

MA 22.7 Tue 12:30 HSZ 403

Vectorial magnetometry and anisotropy studies on thin $Co_{50}Fe_{50}$ films using MOKE — •Timo Kuschel[1], Jaroslav Hamrle[2], Jaromir Pistora[2], Subrojati Bosu[3], Yuya Sakuraba[3], Koki Takanashi[3] und Joachim Wollschläger[1] — [1]Fachbereich Physik, Universität Osnabrück, Barbarastr. 7, 49069 Osnabrück, Germany — [2]Department of Physics, VSB - Technical University of Ostrava, 17. listopadu 15, 70833 Ostrava-Poruba, Czech Republic — [3]Institute for Materials Research (IMR), Tohoku University, Katahira 2-1-1, Aoba-ku, Sendai 980-8577, Japan

Magnetooptical Kerr effect (MOKE) is a powerful tool to determine magnetic properties of thin magnetic films. In some cases this technique is only applied to detect magnetization curves qualitatively. In order to perform a quantitative analysis we present MOKE measurements with s- and p-polarized incident light, using an external magnetic field either parallel or perpendicular to the plane of incidence of light and different orientations of the crystalline substrate. The processing of the data includes vectorial magnetometry as well as studies of the anisotropy constants and magnetic axes.

The investigated $Co_{50}Fe_{50}$ films of 50 nm thickness on MgO(001) are prepared with different annealing temperatures (RT up to 400°C). On the one hand the films with lower annealing temperatures show typical magnetic reversal processes of samples with four-fold symmetry as expected for cubic crystal structures. On the other hand the film annealed at 400°C presents an additional strong in-plane anisotropy, which is discussed in context of a classical free energy approach.

MA 22.8 Tue 12:45 HSZ 403

Theory of Resonant Inelastic X-Ray Scattering by Collective Magnetic Excitations — •Maurits Haverkort — Max Planck Institute for Solid State Research, Heisenbergstrasse 1, 70569 Stuttgart Germany

Magnetic excitations in solids are traditionally investigated with inelastic neutron scattering. This technique has led to a better understanding of magnetism in general and shaped the thinking of physicists in terms of magnons as the magnetic quasiparticles present within a solid. It is important that the interaction of neutrons with the magnetic moment is well understood and can be approximated by a function linear in spin operators.

Resonant inelastic x-ray scattering (RIXS) is a novel tool to measure magnetic quasiparticles (magnons) and the incoherent spectral weight, as well as multiple magnons up to very high energy losses, in small samples, thin films, and multilayers, complementary to neutron scattering. I present a tractable theory for the resonant inelastic x-ray scattering of magnons. The low-energy transition operator is written as a product of local spin operators and fundamental x-ray absorption spectral functions. This leads to simple selection rules. The scattering cross section linear (quadratic) in spin operators is proportional to the fundamental magnetic circular (linear) dichroic spectral function.