MA 29: Magnetic Measuring Methods / Sensors / Actuators

Time: Thursday 15:15–16:30 Location: H5

MA 29.1 Thu 15:15 H5

Interpreting magnetization from Faraday rotation in birefringent, magnetic media — •Simon Woodford, Andreas Bringer, and Stefan Blügel — Forschungszentrum Juelich, Juelich, Deutschland

The Faraday effect is an extremely useful probe of magnetization dynamics on an ultrafast scale. However, the measured Faraday rotation is difficult to interpret in birefringent media. We investigate the link between magnetization and Faraday rotation by solving Maxwell's equations in a magnetically-ordered, birefringent material. We find that the Faraday rotation can depend nonlinearly on the magnetization, meaning that symmetric magnetic oscillations may lead to asymmetric Faraday measurements. Furthermore, sample alignment becomes important — if the incident light is not polarized along a birefringence axis of the sample, the Faraday rotation may be strongly enhanced or weakened, and the interpretation of the magnetization amplitude may be wrong by an order of magnitude.

MA 29.2 Thu 15:30 H5

Three-dimensional Reconstruction of Magnetic Fields by Electron-Holographic Tomography — •Daniel Wolf[1], Petr Formanek[1], Hannes Lichte[1], and Ann Marie Hirt[2] — [1]Triebenberg Laboratory, Institute of Structure Physics, Technische Universität Dresden, D-01062 Dresden — [2]Institute of Geophysics, ETH-Hönggerberg, CH 8093 Zurich, Switzerland

The phase of an electron wave propagated through a magnetic material represents both the enclosed flux of the magnetic field and the electric potential. Off-axis electron holography combined with tomography allows reconstructing the electron wave in 3 D. At a lateral resolution of about 10nm, we measured the magnetic field in- and outside of magnetite crystals embedded in a magnetotactic bacterium Magnetospirillium gryphiswaldense. Holographic tomography is performed in the following steps: First, we record a tilt series of electron holograms between -60 and +60 degrees in 2 degrees steps. Second, we reconstruct the respective 2D-object exit waves from every electron hologram by usual Fourier analysis. Third, the 3D structure of the phase is built up by weighted back-projection. For separation of the magnetic part from the electric part, we record a second tilt series of the same bacterium magnetized in opposite direction and reconstruct the 3D-wave accordingly. The difference of both 3D-phases contains only the magnetic phase shift produced by the object and, hence, we can determine the three components of the magnetic field. The DFG is kindly acknowledged for funding our Holographic-Tomography project.

MA 29.3 Thu 15:45 H5

A novel method for a measurement of magneto-optical effects in thin self-supporting foils — •T. Weber, H. Backe, W. Lauth, P. Kunz, and A. Sharafutdinov — Institut für Kernphysik, Universität Mainz, Germany

A novel interferometric method for the measurement of the magneto optical rotation (MOR) of rare earth elements and 3d transition metals as Fe, Co, Ni was developed at Mainzer Mikrotron MAMI. The strong absorption lines resulting from allowed dipole transitions between the $2p_{3/2}$ $(2p_{1/2})$ core states and empty 3d valence states are accompanied by a strong X-ray magnetic circular dichroism (XMCD) effect wich can be used to probe the magnetic properties of materials. The experiment arrangement consists of two collinear undulators and a grating spectrometer. The second undulator can be both, moved along and also be rotated around the electron beam axis. A magnetized foil placed between the undulators causes a phase shift and an attenuation of the oscillation amplitude. Due to the XMCD and MOR effect the coherent linear polarized light from the first undulator suffers a helicity dependent rotation and absorption resulting in elliptical polarized light. The second undulator acts as an analyzer, and no additional polarization state analyzer is required. The method has been validated by a measurement of $\Delta\delta(\omega)$ and $\Delta\beta(\omega)$ of the complex index of refraction $n\pm = (\delta_0 \pm \Delta\delta) + i\ (\beta_0 \pm \Delta\beta)$ at the $L_{2,3}$-absorption edges of nickel. This work has been supported by DFG under contract BA 1336/1-3.

MA 29.4 Thu 16:00 H5

Noise in anisotropic magnetoresistive sensor elements — •Thomas Heuer, Jörg Wolff, Haibin Gao, and Uwe Hartmann — Fachrichtung Experimentalpysik, Universität des Saarlandes, Postfach 151150, 66041 Saarbrücken

The field resolution of magnetometers based on anisotropic magnetoresistive (AMR) sensors is mainly limited by noise. Besides environmental factors, the main source of noise is the sensor element itself. Thus, knowledge of the mechanisms producing noise and the factors influencing it is essential.

The detector noise has been found to be strongly influenced by the peak magnitude of periodic magnetic field pulses perpendicular to the sensor's sensing direction ("flipping"). Other factors, as temperature and pulse width, also affect the sensor noise, albeit to a much lower degree. It is well established that domain wall-related processes, e.g. Barkhausen noise, are the primary source of noise in magnetoresistive sensors. Thus removing the domain walls by applying field pulses strong enough to fully saturate the sensor will result in a significant noise reduction.

Sensors of same type but from different batches have been found to exhibit considerable differences in their characteristics, with sensor noise varying by several orders of magnitude for identical conditions. It is believed that variations of the magnetic and electric properties of the magnetoresistive films play a key role. Thus detector noise is being examined with respect to its dependence on pulse parameters and sensor temperature in order to deduce differences in material properties.

MA 29.5 Thu 16:15 H5

High field cryogen free vibrating sample magnetometer — •Jeremy Good — 30 Acton Park Industrial Estate, London W3 7QE

Cryogenic Ltd. have extended their expertise in Cryogen Free Technology to the development of a High Field Vibrating Sample Magnetometer (VSM). The VSM allows measurements of the DC magnetic moment or AC magnetic susceptibility of a sample. Sensitivity is to 10-6 emu with a suitable averaging time. The standard temperature range is 1.6K to 325K with fields up to 18 Tesla. The VSM measures the magnetic moment by moving the sample between two pick-up coils at a frequency of 1 to 100Hz. As the sample moves into one of the coils, the flux through this coil increases and an e.m.f is generated.

It is now possible to operate the VSM without requiring expensive liquid helium to cool down the magnet and the insert. We offer a choice of cryocoolers with cooling powers to suit the application. The Gifford McMahon (GM) cycle cryocooler has the advantage of a greater thermodynamic efficiency and reliable operation in any orientation. The pulse-tube (PM) cryocooler is quieter, has a longer service interval and low servicing costs, but must operate in the vertical mode only.