MA 31: Magnetic Imaging

Time: Wednesday 15:00–16:00 Location: BH 243

MA 31.1 Wed 15:00 BH 243

Fast magnetic imaging using nitrogen-vacancy centers — •Florestan Ziem[1], Steffen Steinert[1], Andrea Zappe[1], Liam Hall[2], Lloyd Hollenberg[2], Nicolas Götze[1], and Jörg Wrachtrup[1] — [1]3rd Physics Institute, University of Stuttgart, 70569 Stuttgart, Germany — [2]School of Physics, University of Melbourne, Victoria 3010, Australia

With the aim to image weak electromagnetic signals at high spatial resolution, e.g. signals of a neuron cell, we investigated the potential of an ensemble of negatively charged nitrogen-vacancy centers (NVs) as a sensor. The NV is a color center in diamond consisting of a substitutional nitrogen and an adjacent vacant lattice site. One of the remarkable features of the NV is, that its magnetic spin state can be optically polarized and read out via its fluorescence at ambient conditions. From Zeeman shifts and coherence lifetimes, the presence of static and fluctuating magnetic fields can be deduced. To detect the fluorescence signal, we employ a wide-field approach, where a CCD camera allows us to capture the fluorescence of a 60 μm x 60 μm area of densely implanted NVs within milliseconds. For samples placed on the diamond surface, this setup thus allows for fast, diffraction limited sensing, while being potentially non-invasive. On the other hand, integrating over the full sensor area allows for the detection of low concentrations of magnetic species in homogenous samples. The capabilities of the NV sensor in the spatially resolving and the integrating measurement mode will be evaluated.

MA 31.2 Wed 15:15 BH 243

Pushing the spatial resolution of X-ray holographic microscopy below 20nm — •Judith Bach[1], Robert Frömter[1], Daniel Stickler[1], Matthias Hille[1], Hans Peter Oepen[1], Leonard Müller[2], Christian Gutt[2], Gerhard Grübel[2], Carsten Tieg[3], and Flora Yakhou-Harris[3] — [1]Universität Hamburg, Germany — [2]DESY, Hamburg, Germany — [3]ESRF, Grenoble, France

Imaging techniques are one of the most direct and intuitive accesses to investigate the magnetic behavior of ferromagnets. On the nanoscale, soft X-ray Fourier-Transform Holography(FTH) [1] is a powerful lensless method that provides element specificity and fast image reconstruction. As one of many improvements over the last years, a new microscope setup was developed extending the method's applicabilty to a broader variety of samples [2]. We present experimental results on resolution achieved at the ID 08 soft X-ray beamline of the ESRF. The results demonstrate a significant improvement of the spatial resolution down to 18 nm. To a large part this was achieved by a smaller sample-camera distance, thus increasing the acceptance in q-space. An additional contribution comes from using so-called HERALDO [3] masks. In contrast to standard FTH masks with circular reference holes, they contain reference slits. We report on the first application of HERALDO to magnetic imaging and compare it to standard FTH.

[1] S. Eisebitt, *et al.*, Nature **432**, 885 (2004).

[2] D. Stickler, *et al.*, Appl. Phys. Lett. **96**, 042501 (2010).

[3] D. Zhu, *et al.*, Phys. Rev. Lett. **105**, 043901 (2010).

MA 31.3 Wed 15:30 BH 243

New approach for the magnetic characterization of isolated nanoparticles with nanometer lateral resolution — •Stephan Block[1] and Christiane A. Helm[2] — [1]ZIK HIKE - Zentrum für Innovationskompetenz Humorale Immunreaktionen bei kardiovaskulären Erkrankungen, Fleischmannstr. 42 - 44, D-17487 Greifswald, Germany — [2]Institut für Physik, Ernst-Moritz-Arndt Universität, Felix-Hausdorff-Str. 6, D-17487 Greifswald, Germany

We present a new atomic force microscopy (AFM) method, which allows the simultaneous measurement of magnetic and geometric properties of nm-sized objects (nanoparticles, e.g. colloids or clusters). Basically, an oscillating magnetic field is applied to the sample and the surface magnetization is probed using a magnetic AFM-tip. Spatial changes of the magnetic flux density affect the vibration amplitude and thus, (dynamic) magnetic properties of the surface can be determined with lateral resolution of few nanometers. We will give a brief introduction of the measurement principles and evaluate the feasibility by characterizing isolated diamagnetic and superparamagnetic nanoparticles on the nm-scale. Hence, it becomes possible to distinguish different materials during AFM measurements by their magnetism (e.g. superparamagnetism or diamagnetism).

MA 31.4 Wed 15:45 BH 243

Monopole-like probes for Magnetic Force Microscopy — •Thomas Mühl, Julia Körner, Albrecht Leonhardt, and Bernd Büchner — Leibniz-Institut für Festkörper- und Werkstoffforschung IFW Dresden

Magnetic force microscopy (MFM) is a powerful method dedicated to map stray-field distributions, or more precisely, derivatives in space of magnetic field components. Recently we developed a sensor for quantitative MFM based on an iron-filled carbon nanotube (FeCNT). The long Fe nanowire contained in the carbon nanotube can be regarded as an arrangement of two well-separated magnetic monopoles of which only the monopole nearest to the sample surface is involved in the imaging process. The monopole-like character of FeCNT MFM probes allows easy calibration [1]. Moreover, as compared to conventional coated MFM probes, FeCNT sensors show remarkable magnetic stability in external in-plane fields [2].

In this work, we present an improved MFM sensor design again employing FeCNTs. By using higher order flexural vibration modes of the cantilever the new sensor provides both in-plane and perpendicular sensitivity for quantitative MFM measurements. We discuss sensitivity issues related to the dynamic spring constants of the sensor.

[1] F. Wolny, T. Mühl, U. Weissker, K. Lipert, J. Schumann, A. Leonhardt, and B. Büchner, Nanotechnology 21, 435501 (2010).

[2] F. Wolny, T. Mühl, U. Weissker, A. Leonhardt, U. Wolff, D. Givord, and B. Büchner, J. Appl. Phys. 108, 01398 (2010).