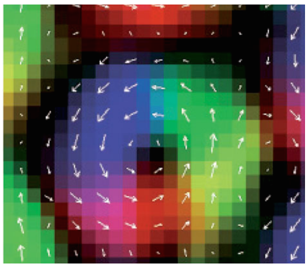


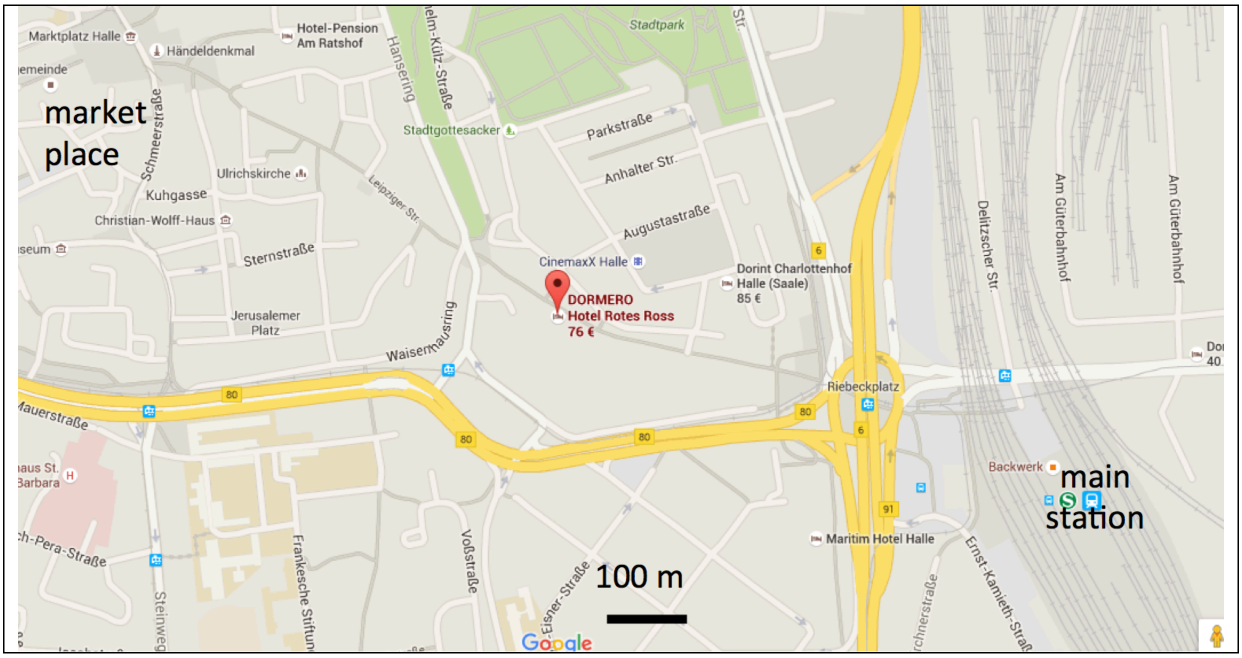
Symposium

“Electron Microscopy of Magnetic Structures”

Halle, 1. October 2015

Location:

DORMERO Hotel “Rotes Roß”
Leipziger Str. 76
D-06108 Halle
Tel. +49 - 345 - 233430



10 min walk from main station

You can reach the hotel from the airport “Leipzig-Halle” by local train or taxi.

Program

30. September

19:00 reception, get-together first, discussions,

1st October

Opening
8:45 introduction , P. Werner
8:55 welcome address, S. Parkin

Talks

9:00 - 9:50	S. Parkin:
9:50 - 10:40	M. De Graef
10:40 - 11:00	*coffee break*
11:00 - 11:50	M. McCartney
11:50 - 12:40	J. Zweck
12:40 - 13:30	*lunch*
13:30 - 14:20	R. Dunin-Borkowski
14:20 - 15:10	B. Freitag
15:10 - 15:30	*coffee break*
15:30 - 16:20	H. Sawada
16:20 - 17:30	discussion of perspectives (round table talk)
17:30 - 18:00	individual discussions

Evening discussion

19:00 -21:00	individual discussions, dinner

2nd October

Visit of the MPI (optional)

Speakers

M. De Graef
Carnegie Mellon University, Pittsburgh

"An Overview of Lorentz Transmission Electron Microscopy Modalities"

Abstract:
In this presentation we will begin by introducing the traditional Lorentz TEM (LTEM) imaging modalities: Fresnel (out-of-focus) contrast and Foucault contrast. Then we describe the quantum mechanical formalism for the electron wave phase shift, as well as the Lorentz point spread function and the resulting image simulation techniques.
The Transport-of-Intensity Equation (TIE) formalism is then introduced as a phase reconstruction technique, and we provide several examples in conventional and aberration-corrected modes. We conclude the presentation with an overview of recent progress in the area of 3D vector field electron tomography.

M. McCartney
Arizona State University, Tempe

„Electron holography of magnetic fields at the nanoscale“

Abstract:
Off-axis electron holography in the transmission electron microscope provides a unique and powerful approach to visualizing electric and magnetic fields within materials with resolutions approaching the nanometer scale. The ability to image phase shifts at medium resolution opens up a wide field of interesting and important materials problems. The technique has been successfully used to quantify magnetic fields in and around layered PMA thin films, fine grain ferrites and patterned nanomagnets. An important extension of this work has involved *in situ* application of magnetic fields to image local magnetic response during hysteresis loops. Applications include asymmetric pinning of domain walls at notches in nanowires.

J. Zweck
University of Regensburg

„Imaging of magnetic structures by Fresnel imaging and differential phase contrast“

Abstract:
Fresnel imaging ("Lorentz microscopy") is in general quite simple to achieve and has the advantage that the sensitivity can be adjusted by the amount of defocus used. This positive aspect, however, leads to a blurred image, the worse the weaker the magnetic structures under investigation are. Additionally, the contrast depends on the variation of the magnetic induction's strength and becomes nonlinear for higher

defocus values. Nevertheless, Fresnel imaging is commonly used for fast specimen inspection and may even be used quantitatively, if all relevant microscope parameters are sufficiently well known. Another way to observe micromagnetic structures is differential phase contrast, which is a STEM technique. It employs a four quadrant annular detector instead of the usually found annular dark field detector. While scanning across the specimen, it is possible to detect the minute deflections of the beam caused by the local induction acting on the electrons. The imaging is highly linear and quantitative, if properly calibrated. Both techniques will be presented and examples will be given.

R. Dunin-Borkowski
Ernst Ruska Center, Research Center Jülich

„Quantitative electron holography of magnetic fields in nanoscale materials and devices“

Abstract:
Off-axis electron holography is a powerful technique for recording the phase shift of a high-energy electron wave that has passed through an electron-transparent specimen in the transmission electron microscope. The phase shift is, in turn, sensitive to the electrostatic potential and magnetic induction in the specimen, projected in the electron beam direction. Recent developments in the technique have included the use of advanced specimen holders with multiple electrical contacts to study nanoscale working devices, the use of ultra-stable transmission electron microscopes to achieve sub-2π/1000-radian phase sensitivity and the application of electron holographic tomography to record three-dimensional potentials. In this talk, I will highlight a selection of recent examples of our use of off-axis electron holography to the study of dipolar interactions in arrays of nanoparticle magnets, lithographically patterned spin ice lattices, current-induced domain wall motion in ferromagnetic nanowires, phase transitions in naturally occurring minerals examined at elevated temperature and magnetic fields surrounding nanoscale current-carrying wires. In such applications of off-axis electron holography, which require the recording of weak phase shifts, it is important to remember that the sample must remain clean and undamaged for the time required to acquire images with a sufficient signal to noise ratio, electron-beam-induced charging can affect the measured phase shift and that for crystalline specimens careful comparisons with dynamical simulations may be required even for a thickness of only a few atoms.

H. Sawada
Jeol Germany

“Development of Segmented Detector for DPC in STEM”

Abstract:
We have been developing a segmented annular detector to characterize electric fields, magnetic fields, and atomic resolution structural properties in STEM. The circular detector is divided into 8 segments which are individually optically-coupled with photo-multiplier tubes. 8 atomic-resolution STEM images from each segmented

angle on the detector plane can be obtained simultaneously. These images are sensitive to the angler distribution of scattered electrons on the detector. Using differential phase contrast (DPC) with the developed detector, characterization of electric fields and magnetic fields inside materials have been demonstrated.

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