MA 2: Magnetic Imaging Techniques

Time: Monday 9:30–10:30 Location: H37

MA 2.1 Mon 9:30 H37

High resolution magnetic imaging with holography-aided phase retrieval — •Riccardo Battistelli[1], Sergey Zayko[2], Michael Schneider[3], Christian M. Günther[4], Kathinka Gerlinger[3], Daniel Metternich[1], Lisa-Marie Kern[3], Kai Litzius[5], Stefan Eisebitt[3,4], Bastian Pfau[3], and Felix Büttner[1] — [1]Helmholtz-Zentrum Berlin, Berlin, Germany — [2]University of Göttingen, Göttingen, Germany — [3]Max Born Institute, Berlin, Germany — [4]Technische Universität Berlin, Berlin, Germany — [5]Max-Planck-Institut für Intelligente Systeme, Stuttgart, Germany

In the fields of magnetism and spintronics, magnetic multilayers continue to thrive as pivotal structures to functionalize magnetic interactions and to engineer complex non-trivial spin textures. Despite the intense research on this topic, relatively little is known about 3D magnetic textures in multilayers and their interaction with local defects, despite the expected richer physics and potential in information technologies. The experimental challenges of studying such systems can be met by merging Fourier Transform Holography with phase retrieval algorithms for coherent diffractive imaging, obtaining high throughput, high resolution and high contrast images of magnetic materials. Here we present 5 nm resolution X-ray images of magnetic multilayers in which the presence of 3D magnetic defects can be inferred thanks to the high sensitivity of the technique. The interaction of magnetic domains with these defects favors the presence of domain walls, reducing the average domain size with respect to the pristine material.

MA 2.2 Mon 9:45 H37

Using electron microscopic methods to evaluate the magnetic proximity effect — •Daniela Ramermann[1,3], Inga Ennen[1], Dominik Graulich[1], Trevor Almeida[2], Stephen McVitie[2], Björn Büker[1], Timo Kuschel[1], and Andreas Hütten[1] — [1]Universität Bielefeld, Dünne Schichten und Physik der Nanostrukturen, Universitätsstr. 25, 33615 Bielefeld, Germany — [2]University of Glasgow, School of Physics and Astronomy, Glasgow G12 8QQ, UK — [3]Max Planck Institute for Chemical Energy Conversion, Stiftstraße 34-36, 45470 Mülheim an der Ruhr

Magnetic proximity effects are part of spintronic, superconducting, excitonic and topological phenomena which can induce desired or parasitic effects in measurements and devices. They are induced by a ferromagnet in a layer of a material close to the Stoner criterion in proximity to the ferromagnet. Usually magnetic proximity effects are studied by X-ray techniques. Modern analytical electron microscopy can be used to analyse the same underlying effects as well as electronic structure properties of materials. Therefore, it can be used to investigate the proximity effect in thin film systems.

As a model system a V/Fe thin film sample has been chosen. The techniques of electron energy loss magnetic chiral dichroism (EMCD) and differential phase contrast (DPC) have been used in combination. EMCD is used to show the presence of a magnetic moment on the material and DPC to locate the magnetic induction with high accuracy. Thus, we were able to observe a magnetic proximity effect of about 1.5 nm in V, which is in agreement with X-Ray measurements.

MA 2.3 Mon 10:00 H37

Coherent Correlation Imaging: Resolving fluctuating states of matter — •Christopher Klose[1], Felix Büttner[2,3,4], Wen Hu[3], Claudio Mazzoli[3], Kai Litzius[2], Riccardo Battistelli[4], Ivan Lemesh[2], Jason M. Bartell[2], Mantao Huang[2], Christian M. Günther[5], Michael Schneider[1], Andi Barbour[3], Stuart B. Wilkins[3], Geoffrey S.D. Beach[2], Stefan Eisebitt[1,5], and Bastian Pfau[1] — [1]Max Born Institute, Berlin — [2]Massachusetts Institute of Technology, Cambridge, MA, USA — [3]National Synchrotron Light Source II, Upton, NY, USA — [4]Helmholtz-Zentrum Berlin — [5]Technische Universität Berlin

Fluctuations and stochastic transitions are ubiquitous in nanometer-scale systems, especially in the presence of disorder. However, their direct observation has so far been impeded by a seemingly fundamental, signal-limited compromise between spatial and temporal resolution.

Here, we develop coherent correlation imaging (CCI) — a high-resolution, full-field imaging technique that realizes multi-shot, time-resolved imaging of stochastic processes. The key of CCI is the classification of camera frames that correspond to the same physical state by combining a correlation-based similarity metric with powerful classification algorithm developed for genome research.

We apply CCI to study previously inaccessible magnetic fluctuations in a highly degenerate magnetic stripe domain state with nanometer-scale resolution. The spatiotemporal imaging reveals the transition network between the states and details of the magnetic pinning landscape which have been inaccessible so far.

MA 2.4 Mon 10:15 H37

Charge State Instabilities of shallow Nitrogen-Vacancy Centers in Diamond at Cryogenic Ultra-High-Vacuum Conditions — Domenico Paone[1,2,5], •Toni Hache[1,5], Jeffrey N. Neethirajan[1,2,5], Dinesh Pinto[1,3], Andrej Denisenko[2], Rainer Stöhr[2], Péter Udvarhelyi[4], Ádám Gali[4], Aparajita Singha[1], Jörg Wrachtrup[1,2], and Klaus Kern[1,3] — [1]Max Planck Institute for Solid State Research — [2]3rd Institute of Physics and Research Center SCoPE, University of Stuttgart — [3]Institute de Physique, École Polytechnique Fédérale de Lausanne — [4]Wigner Research Centre for Physics, Institute for Solid State Physics and Optics, Hungarian Academy of Sciences — [5]Equal contribution.

Nitrogen-vacancy (NV) centers in diamond have attracted an immense interest for non-invasive magnetic imaging and quantum sensing. All NV based magnetic sensing protocols rely on the negative charge state of this quantum sensor (NV^-). In this work we demonstrate dramatic charge state conversions within individual NV centers at cryogenic (4.7 K) and $2 \cdot 10^{-10}$ mbar ultra-high-vacuum (UHV) conditions. The NV centers are characterized based on autocorrelation measurements, ODMR contrast and emission spectra. Under these extreme conditions, each of these measurements indicate a significant decrease of the relative occupancy of the NV^- charge state. Furthermore, we note a slight recovery of the NV^- charge state by dosing water (H_2O) on top of the diamond surface under UHV conditions. These results indicate that controlled surface treatments are essential for implementing NV center based quantum sensing protocols at cryogenic-UHV conditions.