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Hysteresis Design of Magnetic Materials for Efficient Energy Conversion

Tuesday, 19 November 2024, 9:00 s.t., UDE Campus Duisburg MG 272+ Zoom

Prof. Dr. Felix Büttner

Experimental Physics V,
Center for Electronic Correlations and Magnetism,
University of Augsburg + Helmholtz-Zentrum Berlin

Zoom information:
Meeting-ID: 225 349 6215
Kenncode: 0000

Coherent imaging with soft x-rays: An opportunity to see the interplay of fluctuations and disorder in magnetism

Abstract:

Functional materials and devices often exhibit enormous complexity in real space. Electron microscopy is routinely used in their development and testing, but the approach is usually limited to static and destructive imaging due thickness constraints and cross-talk of the electron probe. X-rays, by contrast, promise non-destructive, in-operando, 3D microscopy on materials and devices with a rich variety of contrast mechanisms. However, the challenge of such imaging experiments is that they require exceptional spatial and temporal resolution, often beyond the reach of established imaging techniques. In this context, coherent x-ray imaging offers unique opportunities to overcome technological and even apparently fundamental limits.

In this talk, I will introduce the method of coherent x-ray imaging, including the concept of phase retrieval, which allows to reconstruct a real-space image from a x-ray scattering data. We will understand why the technique yields superior spatial resolution compared to conventional x-ray microscopy [1], and by which means it can even capture stochastic dynamics [2]. Using this technique, we are able to observe the interaction of magnetic domain walls with magnetic pinning sites in space and time, and even quantify the micromagnetic energy behind such pinning. I will conclude with a perspective on the future of coherent imaging at upcoming light sources [3].

References:

[1] Battistelli, R., Metternich, D., Schneider, M., Kern, L.-M., Litzius, K., Fuchs, J., Klose, C., Gerlinger, K., Bagschik, K., Günther, C. M., Engel, D., Ropers, C., Eisebitt, S., Pfau, B., Büttner, F. and Zayko, S. Coherent x-ray magnetic imaging with 5 nm resolution. *Optica* **11**, 234–237 (2024).

[2] Klose, C., Büttner, F., Hu, W., Mazzoli, C., Litzius, K., Battistelli, R., Zayko, S., Lemesh, I., Bartell, J. M., Huang, M., Günther, C. M., Schneider, M., Barbour, A., Wilkins, S. B., Beach, G. S. D., Eisebitt, S. and Pfau, B. Coherent correlation imaging for resolving fluctuating states of matter. Nature 614, 256–261 (2023).

[3] Christensen, D. V., Staub, U., Devidas, T. R., Kalisky, B., Nowack, K. C., Webb, J. L., Andersen, U. L., Poggio, M., et al. 2024 roadmap on magnetic microscopy techniques and their applications in materials science. J. Phys. Mater. 7, 032501 (2024).

About the speaker:

Felix Büttner is the head of the Joint Research Group “MaXRay – Magnetism and Coherent X-ray Imaging” at University of Augsburg and Helmholtz-Zentrum in Berlin. The main focus of his work is the study of nanometer-scale emergent textures, such as magnetic domain walls and skyrmions, by time-resolved x-ray imaging. He obtained his PhD 2013 from the University of Mainz for a research project conducted jointly with TU Berlin. After his PhD, he worked for 18 months in industry and subsequently for almost five years as a postdoc at MIT. In 2020, he secured a Helmholtz Young Investigator Grant to start his independent research group at Helmholtz-Zentrum Berlin. Since 2022 he has been professor at University of Augsburg.