SFB1242

SFB 1242 Nichtgleichgewichtsdynamik kondensierter Materie in der Zeitdomäne

UNIVERSITÄT DUISBURG ESSEN

Open-Minded

11.11.2025 / 10 Uhr c.t., Raum MG 272
Campus Duisburg

Following complex spin structures in time & space using laser-driven soft-X-ray sources

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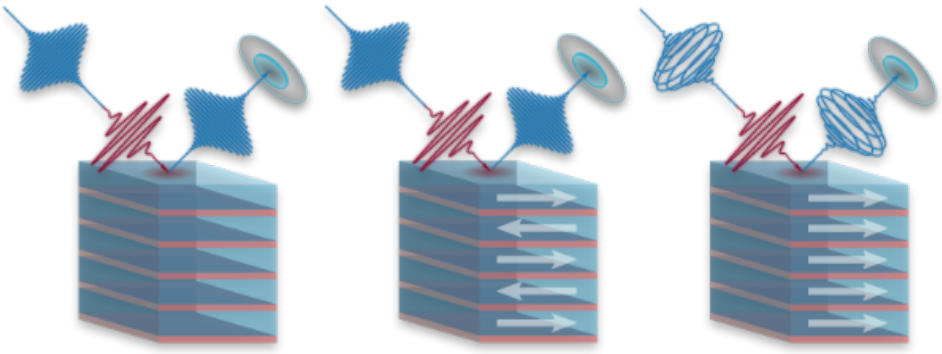
Controlling ultrafast spin dynamics directly on the quantum level with femtosecond light pulses promises a dramatic increase in speed, energy efficiency, and the density at which we transport, process, and store information. Recent advances in the field have enabled an understanding of laser-driven spin dynamics from microscopic processes toward macroscopic functionality in magnetic nanostructures, including charge and spin transport as well as interactions with spatially extended quasiparticles such as phonons and magnons. These processes generally lead to a nanoscale spatial rearrangement of magnetization, calling for experimental techniques that can directly access the ultrafast evolution of spatially inhomogeneous spin profiles and detect the transfer or accumulation of spins at interfaces. Such observables, providing nanometer spatial and femto- to picosecond temporal resolution, are particularly required for investigations of complex heterostructures and non-collinear antiferromagnets, where competing interactions give rise to a variety of complex spin structures already in equilibrium. In this talk, I will focus on time-resolved resonant soft-X-ray scattering (RSXS) as a unique technique for probing magnetic order in time and space with element selectivity as well as in buried layers. RSXS combines large spectroscopic and magnetic contrast in the soft-X-ray range with access to reciprocal space in addition to nanometer depth and lateral resolution. Based on the in-house development of two laser-driven soft-X-ray sources at the Max Born Institute, we have recently demonstrated the feasibility of time-resolved RSXS in laboratory experiments as a genuine alternative to large-scale facilities. I will discuss our recent RSXS results on the dynamics of artificial antiferromagnets [1], XMCD in ferrimagnet alloys [2], ferromagnetic domains [3], and magnons [4], as well as all-optical switching in ferrimagnetic alloys [5].

[1] Schick, D. *et al.* Laser-driven resonant magnetic soft-x-ray scattering for probing ultrafast antiferromagnetic and structural dynamics. Optica **8**, 1237 (2021).
[2] Borchert, M. *et al.* X-ray magnetic circular dichroism spectroscopy at the Fe L edges with a picosecond laser-driven plasma source. Optica **10**, 450 (2023).
[3] Lunin, L. *et al.* Laser-driven resonant soft-X-ray scattering for probing picosecond dynamics of nanometre-scale order. Light Sci. Appl. in press, (2025).
[4] Wittrock, S. *et al.* Soft-X-ray momentum microscopy of nonlinear magnon interactions below 100-nm wavelength. Nat. Phys., in review, arXiv: 2504.20958 (2025).
[5] Hennecke, M. *et al.* Transient domain boundary drives ultrafast magnetisation reversal. Nat. Commun. **16**, 8233 (2025).



Für diese Zeit steht eine Kinderbetreuung nach vorheriger Anmeldung zur Verfügung.

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