Catching Magnets in Motion:
Magnetodynamics Studied by Pulsed Synchrotron Radiation

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Magnetization reversal and its intrinisic time evolution determine the functionality in magnetic data storage and spintronic devices. Exploring the microscopic mechanisms and the ultimate time scales in magnetodynamics is thus of both fundamental interest and technological relevance.
A convenient approach to study the dynamic behavior in the nano- and picosecond regime is provided by pump-probe techniques. In our experiments an ultrashort magnetic field pulse (pump) excites the magnetic system of interest, and the time-evolution of the magnetization is probed by polarized soft x-ray pulses from a synchrotron radiation source, via magnetic x-ray circular dichroism. In this manner we combine magnetic sensitivity and element selectivity with a time-resolution in the picosecond range. Using a photoemission microscope (PEEM) we can follow the details of the magnetodynamics with high lateral resolution. In micron-sized permalloy elements, which are dominated by the shape anisotropy, we can discern a wide variety of microscopic processes, such as incoherent magnetization rotation, domain wall propagation, coherent rotation, or precessional modes. Additional magnetic interactions result in a more complex behavior. For example, magnetocrystalline anisotropies such as in single-crystal iron films suppress rotational processes and alter the magnetodynamics in a characteristic manner. In the case of trilayer systems which form the basis of the technologically relevant spin valve systems, both strength and character of the interlayer coupling are found to have a significant influence on the dynamic response.