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**X-ray Imaging of Spin Wave Dynamics at the Nanoscale**

HENDRIK OHLDAG, SLAC, Stanford University

Imaging current induced magnetization dynamics has so far remained an elusive task, due to the lack of microscopy techniques with combined high spatial and temporal resolution, and elemental magnetic sensitivity. Using synchrotron radiation, we have been able to create the first x-ray images of spin waves generated in nano-contact spin torque oscillators realized on different ferromagnetic thin films, using the x-ray magnetic circular dichroism (XMCD) effect as a probe. In nanocontacts with perpendicular magnetic anisotropy, we directly observed the appearance of a highly localized mode beneath the nanocontact with large precession angle. In samples with an easy-plane magnetic anisotropy, we have been able to implement time-resolution in the measurements and record the first spin wave "movie" of the spin torque induced dynamics with 35 nm spatial resolution and 50 ps temporal resolution. We observe that the spin wave dynamics is excited on the side of the nanocontact where the internal field in the thin film is at a minimum. Around this field minimum, the spin wave extends with a radius of approximately 250 nm, demonstrating the localized nature of the mode. Finally, our measurements show that the spin wave has a node in amplitude, around which the magnetization points in two opposite out-of-plane directions.

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