Time-resolved imaging of magnetic excitations in micro-particles using X-Ray microscopy

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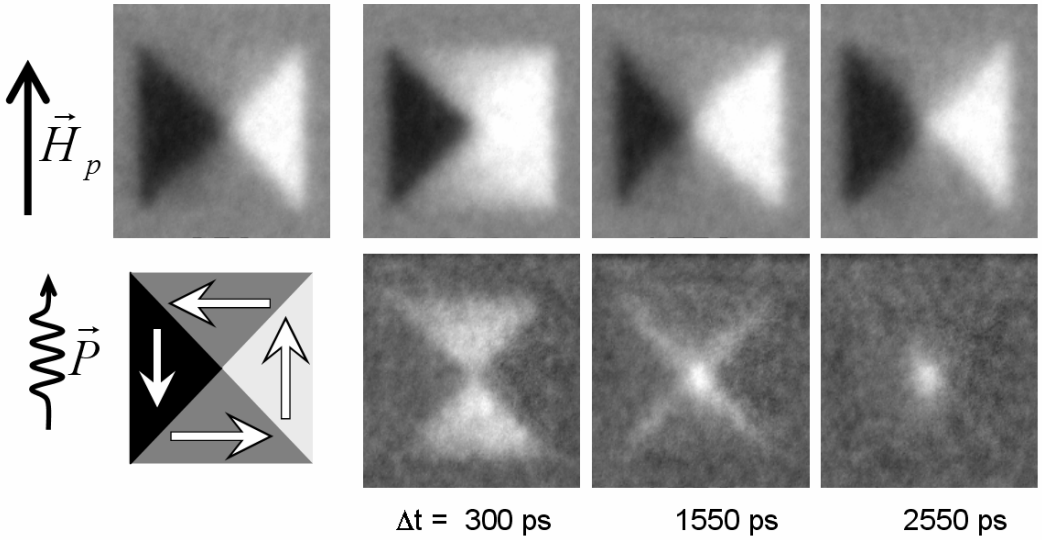
Synchrotrons are pulsed x-ray sources allowing experiments with time resolutions of <100ps. We combine this pulsed source with a Photoemission Electronmicroscope (PEEM) to image the magnetic state of micron sized permalloy objects following the excitation by a pulsed magnetic field.

The equilibrium state of permalloy squares is a Landau flux-closure pattern consisting of three substructures: the domains, the domain walls and the vortex core. The PEEM allows imaging all of them and following their evolution after excitation by a magnetic field pulse (H_p ~ 50Oe, 200ps rise time). After the excitation we first observe coherent precession of the magnetization (~300ps) in two of the domains (M perp. H_p). This precession is quickly (~1ns) damped transferring the energy into oscillations of the domain walls (1550ps). The domain walls oscillate analogous to an excited chord. The slowest process observed is the motion of the vortex core. This motion is perpendicular to the applied field pulse and strongly damped (2550ps). We observe no gyrotropic oscillation of the vortex.



Dichroic images (upper half) of a permalloy square (6x6 mum^2) following the excitation by a field pulse H_p. Sketch and difference images (lower half) highlighting the changes.

We compare excitations in permalloy squares to those in disks which do not contain domain walls. We also discuss how this technique can be extended to more complex materials like ferri-magnets and dilute magnetic semiconductors.