The Dance of the Domains

Very small magnetic particles have regions called domains, where the magnetic compass needles of all atoms point in the same direction. Synchrotron light makes these domains visible and because it comes in short flashes, it allows investigating how such domains react to very short applied magnetic field pulses.
Magnetism has puzzled scientists since its discovery about 3000 BC. In todays world it has found endless applications from electromotors over compasses to data storage on hard disks. Synchrotron light can visualize the orientation of a magnetic field and can do so with very high spatial (100nm) and temporal resolution (100ps). This has been used to study how squares of the magnetic material permalloy ($Fe_{19}Ni_{81}$) react when subjected to a very short magnetic field pulse H_P (~200ps).

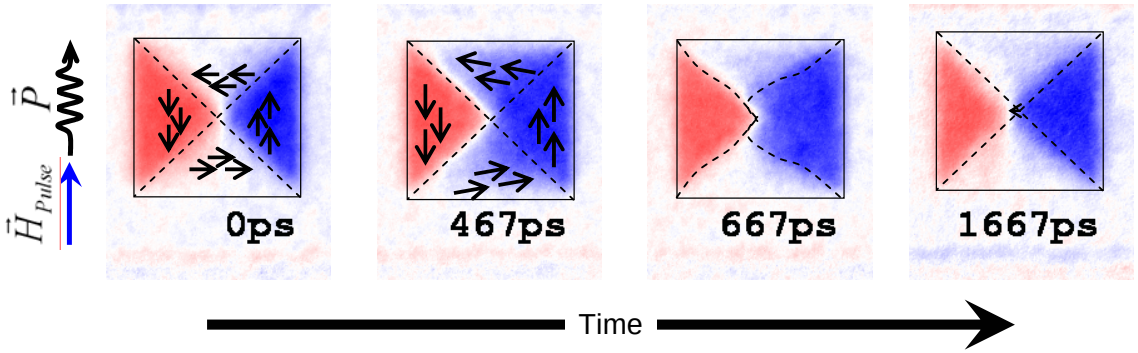

Figure 1: *Snap shots of a magnetic square (L = 6μm) following the application of a short magnetic field pulse H_P. The arrows indicate the direction of the atomic compass needles and dashed lines indicate the walls separating the domains.*

Before the application of an external field pulse H_P the square consists of four equal regions with homogenous magnetization, called domains. The direction of the magnetic field is indicated by arrows. After the field pulse (467ps) the magnetic field in the domains oriented perpendicular to H_P has rotated. The domains are oscillating with a frequency of about 2GHz. This oscillation of the domains drives a vibration of the domain walls, which is seen as a bulging (667ps). After even longer times (1667ps) the vortex which is formed at the intersection of two walls is seen to move.

This experiment not only allows visualizing such fast processes on a microscopic scale, but it allows quantitative analysis leading to an understanding of the underlying physics.

Publications

- **Quantitative Analysis of Magnetic Excitations in Landau Flux-Closure Structures Using Synchrotron-Radiation Microscopy**
  J. Raabe, C. Quitmann, C. H. Back, F. Nolting, S. Johnson, and C. Buehler*
  Phys. Rev. Lett. 94, 217204 (2005)
  doi: http://dx.doi.org/10.1103/PhysRevLett.94.217204

* To whom correspondence should be addressed. E-mail: christoph.quitmann@psi.ch