Magnetic Vortex Core Switching Studied by Scanning Transmission X-Ray Microscopy

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The magnetic vortex is a well known configuration of a ground state in geometrically confined ferromagnetic elements. It consists of an in-plane curling magnetization which in the centre, in order to avoid a singularity, turns out-of-plane and forms the vortex core. As the out-of-plane magnetisation of the vortex core polarization (p) can point in two directions, either 'up' or 'down' (p = +1 or -1), it could be regarded as memory element. It was reported that switching of the vortex core can be achieved by applying a magnetic field perpendicular to the sample plane. However, field strengths of about 0.5 T are necessary [1,2] for this kind of vortex core reversal.

Recently we discovered a new way to switch the vortex core polarization [3]. It was shown experimentally by scanning transmission X-ray microscopy (STXM) that short, low-amplitude bursts of an alternating in-plane magnetic field reverse the vortex core. Burst with lengths down to a single period (4 ns) and amplitudes down to 1.5 mT [3] could toggle the polarization state of the vortex core (Fig. 1). Based on micromagnetic simulations we also suggested that this dynamic vortex core reversal is mediated by the creation and annihilation of vortex-antivortex (VA) pairs [3]. This VA mediated switching scheme is now generally accepted for low-field vortex core switching, e.g., by excitation with linear magnetic field pulses, circular rotating fields or spin torque.

[1] T. Okuno et al., J. Magn. Magn. Mater. **240**, 1-6 (2002)
[2] A. Thiaville et al., Phys. Rev. B **67**, 094410 (2003)
[3] B. Van Waeyenberge et al. Nature **444**, 461-464 (2006)

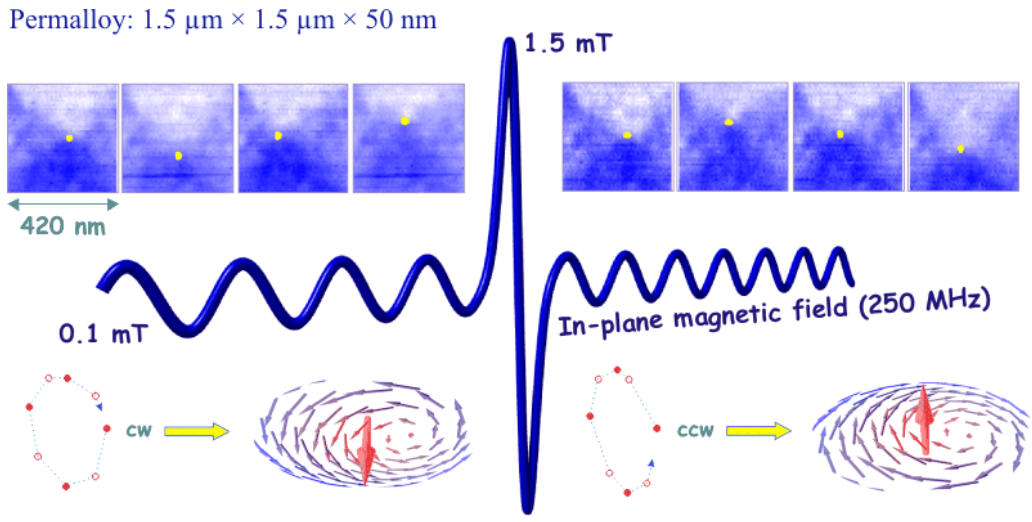

Fig. 1: Experimental results of switching the vortex core polarization see [3].