CB01

Experimental Investigation of Vortex Core Switching by Time Resolved X-ray Microscopy

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Microscopic thin film elements of soft ferromagnets can have an in-plane magnetic vortex configuration in the ground state. The nanometer sized, out-of-plane magnetized vortex core plays a key role in the dynamics of these structures. We report on the experimental study of vortex dynamics in micron and submicron Permalloy thin film elements. The dynamic response was recorded by means of time resolved magnetic X-ray microscopy after the application of different excitations: magnetic field pulses, alternating magnetic fields and rotating magnetic fields.

These studies have already revealed a new reversal mechanism for the out-of-plane vortex core. By excitation with short bursts of an in-plane alternating field as low as 1.5 mT, the vortex core could be toggled from its up to down state an vice versa [1].

Here we will report on vortex core switching observed with different types of excitation. Experimental data will be presented on vortex core switching resulting from linear, RF magnetic fields, rotating magnetic fields and short magnetic field pulses. The switching behaviour was studied for different field amplitude and field durations.

Additionally, the direct dynamic imaging of the out-of-plane magnetization of the vortex core [2] under different excitations, enabled us to evaluate directly the vortex velocity. In this way, the vortex threshold velocity for core switching could be estimated and was compared with analytic and micromagnetic models [3,4,5].

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CB02

Micromagnetism of Core Reversal Dynamics in Magnetic Vortices and Antivortices

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Over the last two years, the discovery of a new fundamental micromagnetic switching process has attracted much attention in the field of nanomagnetism: The dynamic magnetization reversal of a magnetic vortex core. This switching process can be triggered by weak in-plane field perturbations, which was a surprising finding because vortex cores were previously known to be very stable, even if strong perpendicular fields are applied. In an attempt to find a micromagnetic explanation for the experimental observation of a dynamic vortex core reversal [1], I proposed schematically a chain of pair-creation and annihilation events [1] as the fundamental micromagnetic process. This was then confirmed and analyzed in detail by various simulation studies [2,3,4]. It was also shown that the field emanating from the vortex core plays an important role [5]. The possibility of switching magnetic vortices by means of electric currents instead of magnetic fields was predicted [6] and demonstrated experimentally [7]. A particularity of the core reversal process is that it appears to be an intrinsically dynamic phenomenon. Nevertheless, we recently found that well-defined energy thresholds are required to obtain the switching – similar to usual magnetic hysteresis processes. We have further shown that the core of a magnetic antivortex can switch via a mechanism analogous to the vortex core reversal [8]. In this talk, I will summarize these exciting recent developments in the field of micromagnetism and outline possible applications.

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