Manipulation of magnetic skyrmions in ultrathin Pt/Co/MgO nanostructures

R. Juge[a], S-G Je[a], D. de Souza Chaves[b], S. Pizzini[b], L. D. Buda-Prejbeanu[a], L. Aballe[c], M. Foerster[c], A. Locatelli[d], T. O. Mentes[d], F. Maccherozzi[e], S. S.Dhesi[e], S. Auffret[a], G. Gaudin[a], J. Vogel[b] and O. Boulle[a,*].

[a] SPINTEC, CEA-INAC, CNRS, Université Grenoble Alpes, Grenoble INP, Grenoble, France.
[b] Institut Néel, CNRS, Université Grenoble Alpes, Grenoble, France.
[c] ALBA Synchrotron Light Facility, Cerdanyola Del Vallès, Barcelona, Spain.
[d] Elettra Sincrotrone, Trieste, Italy.
[e] Diamond Light Source, Chilton, Didcot, UK.
*Corresponding author: olivier.boulle@cea.fr

Magnetic skyrmions are nanoscale whirling spin configurations. Their small size, topological protection and the fact than they can be manipulated by small in-plane current densities have opened a new paradigm to manipulate the magnetisation at the nanoscale. This has led to proposal for novel memory and logic devices in which the magnetic skyrmions are the information carriers [1]. The recent observation of room-temperature magnetic skyrmions [2,3] and their current-induced manipulation [4,5] in ultrathin sputtered magnetic nanotracks have lifted an important bottleneck toward the practical realisation of such devices.

Here we report on the manipulation of isolated room-temperature magnetic skyrmions in sputtered single-layered Pt/Co/MgO nanostructures using external magnetic field [6] and in-plane current pulses. Using X-ray Magnetic Circular Dichroism - Photo-Emission Electron Microscopy (XMCD-PEEM), we observed a fast current-induced motion of small skyrmions (~150nm) in µm-wide tracks. In Fig.1.(a-c), we present a series of images showing a magnetic skyrmion after two consecutive 11 ns current pulses with opposite polarities and with an amplitude of 6×10^{11} A/m². The skyrmion is dragged back and forth with a motion characteristic of a left-handed Néel skyrmion: it moves against the electron flow with a component of the velocity transverse to it, an effect referred to as the Skyrmion Hall Effect. Mean velocities up to 100 m/s were observed for a current density of about 6.75×10^{11} A/m^2 (Fig 1.(d)).

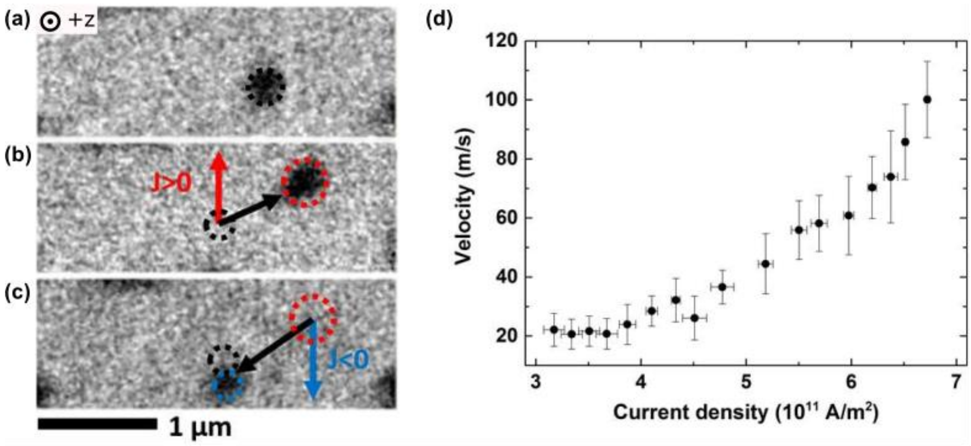

Figure 1 : (a-c) XMCD-PEEM images of a magnetic skyrmion **(a)** before, **(b)** after a positive 11 ns in-plane current pulse and **(c)** after a negative one with $|J|=6 \times 10^{11}$ A/m². The applied field is $\mu_0 H_z$=-4mT. **(d)** Average skyrmions velocity measured in 3 µm-wide tracks as a function of the current density.

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[2] Moreau-Luchaire *et al.*, Nat Nano, 11 (5), 444 (2016)
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