MAR15-2014-020755
Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Dynamics of Skyrmionic Spin Structures

CHRISTOFOROS MOUTAFIS, Paul Scherrer Institute

Magnetic skyrmions are topologically protected particle-like spin structures, with a topology characterised by their Skyrmion number. They can arise due to various interactions, including exchange, dipolar and anisotropy energy in the case of bubbles (skyrmion bubbles) and an additional Dzyaloshinskii-Moriya interaction (DMi) in the case of chiral skyrmions. Numerical predictions suggest that they exhibit rich dynamical behaviour governed by their topology, such as the basic gyrotropic and breathing eigenmodes [1,2]. The dynamical experiments are performed on skyrmion bubbles in nanostructures from symmetric CoB/Pt multilayers, tailored for high-frequency dynamics. Asymmetric layers were also fabricated (Co layers in-between 5d-metals) in order to tune the DMi, as expected from recent experiments [4]. Stabilizing chiral skyrmions confined in such nanostructures is highly desirable due to their enhanced stability and smaller size that makes them ideal candidates for integration in recently proposed novel spintronics devices [3]. By investigating the size of magnetic domains in magnetic field cycles, and comparing to micromagnetic simulations, asymmetric multilayers were explored. By performing pump-probe dynamical X-ray imaging on confined skyrmion bubbles the first observation of their basic eigenmode dynamics was demonstrated [5]. In particular, we present picosecond nanoscale imaging data i) of the gyrotropic mode of a single skyrmion bubble in the GHz regime and ii) the breathing-like behaviour of a pair of skyrmionic configurations. The observed dynamics is used to confirm the skyrmion topology and show the existence of an unexpectedly large inertia that is key for describing skyrmion dynamics [1,5]. These results demonstrate new ways for observing skyrmion dynamics and provide a framework for describing their behaviour. The next step is to achieve chiral skyrmion dynamics on a DMi system.

[1] C. Moutafis, S. Komineas, J. A. C. Bland, Phys. Rev. B 79, 224429 (2009).
[2] N. Nagaosa, Y. Tokura, Nat. Nanotech. 8, 899–911 (2013).
[3] A. Fert, V. Cros, J. Sampaio, Nat. Nanotech. 8, 152–156 (2013).
[4] G. Chen, et al. Nat. Comms. **4**, (2013).
[5] F. Buettner, C. Moutafis, et al., submitted, Nat. Physics (2014).