CRETE CENTER FOR QUANTUM COMPLEXITY AND NANOTECHNOLOGY

ΣΕΜΙΝΑΡΙΟ ΚΕΝΤΡΟΥ ΚΒΑΝΤΙΚΗΣ ΠΟΛΥΠΛΟΚΟΤΗΤΑΣ & ΝΑΝΟΤΕΧΝΟΛΟΓΙΑΣ/ CCQCN SEMINAR

Wednesday, 27 July 2016

11:00-12:00

3rd Floor Seminar Room

Room temperature chiral skyrmions and skyrmion dynamics and inertia

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Abstract

Magnetic skyrmions are topologically protected particle-like magnetic spin structures, with a topology characterised by their Skyrmion number. They can arise due to the anisotropy, exchange and dipolar energy in the case of skyrmion bubbles and an additional Dzyaloshinskii-Moriya interaction (DMi) in the case of chiral skyrmions [1]. Numerical predictions show that skyrmionic structures can exhibit rich dynamical behaviour governed by their topology [1-3]. At the same time the ultra small size of the chiral skyrmions, their robustness and the possibility of moving them with ultra low power makes them ideal candidates for a new generation of magnetoelectronic devices [2]. We demonstrate with nanoscale sub-nanosecond X-ray pump-probe imaging, for the first time, the gyrotropic mode of a single skyrmion bubble in the gigahertz regime and ii) the breathing-like behaviour of a pair of skyrmionic configurations. Specifically the observed dynamics confirm the skyrmion topology and show the existence of an unexpectedly large inertia that is key for describing skyrmion dynamics [4]. Furthermore, we demonstrate by X-ray imaging the discovery of room temperature nanoscale individual chiral skyrmions in a technologically relevant material. We tailor-design cobalt-based multilayer thin films where the cobalt layer is sandwiched between two heavy metals in order to engineer additive interfacial Dzyaloshinskii–Moriya interactions (DMIs) and thereby achieve a high value of ~2 mJ m– 2. Our observation of room temperature sub-100 nm skyrmions can serve as a basis for the development of skyrmion-based memory devices and logic applications and enable further fundamental studies on the very rich physics of skyrmions.

Relevant references:
[1] N. Nagaosa, & Y. Tokura, Nature Nanotech.8, 899–911 (2013).
[2] A. Fert, V. Cros, J. Sampaio, Nature Nanotech. 8, 152–156 (2013); J. Sampaio et al. Nature Nanotech. 8, 839 (2013).
[3] C. Moutafis, et al., Physical Review B 76 (10), 104426 (2007); C. Moutafis, S. Komineas, J. A. C. Bland, Phys. Rev. B 79, 224429 (2009).
[4] F. Büttner, C. Moutafis et al., Nature Physics 11, 225 (2015).
[5] C. Moreau-Luchaire, C. Moutafis, et al., Nature Nanotechnology 11, 444–448 (2016).

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