MAR15-2014-020029

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

Manipulation of magnetic skyrmions with spin-polarized STM

KIRSTEN VON BERGMANN, Department of Physics, University of Hamburg, Germany

Spin textures of ultra-thin magnetic layers exhibit a surprising variety. The loss of inversion symmetry at the interface of magnetic layer and substrate gives rise to the so-called Dzyaloshinskii-Moriya interaction (DMI) which favors non-collinear spin arrangements with unique rotational sense [1]. An ideal tool to investigate such systems down to the atomic scale is spin-polarized scanning tunneling microscopy (SP-STM), which has enabled the discovery spin spirals with unique rotational sense at surfaces [2-4]. Recently, different interface-driven skyrmion lattices have been found, that either exist without external magnetic field [5,6] or are induced by it [7]. A tuning of the magnetic properties can be realized by tiny variations of the electronic structure due to stacking and hybridization of the magnetic layer. Isolated skyrmions can be stabilized in a wide magnetic field range [7] and the high lateral resolution of SP-STM together with its magnetic sensitivity enables a precise characterization of the evolution of size and shape of single skyrmions with field. A comparison to micromagnetic theory yields the material parameters including the DMI which is responsible for skyrmion formation. The writing as well as the deletion of individual skyrmions based on local spin-polarized current injection has been demonstrated [7]. A new mechanism to detect skyrmions using non-spin-polarized currents has been discovered and can be understood based on the mixing of spin-up and spin-down bands. These interface-induced non-collinear magnetic states offer new exciting possibilities to study fundamental physical properties on the atomic-scale and to tailor material properties for spintronic applications.

[1] K. von Bergmann et al., J. Phys.: Condens. Matter 26, 394002 (2014).
[2] M. Bode et al., Nature 447, 190 (2007).
[3] P. Ferriani et al., Phys. Rev. Lett. 101, 27201 (2008).
[4] M. Menzel et al., Phys. Rev. Lett. 108, 197204 (2012).
[5] K. von Bergmann et al., Phys. Rev. Lett. 96, 167203 (2006).
[6] S. Heinze et al., Nature Phys. 7, 713 (2011).
[7] N. Romming et al., Science 341, 636 (2013).