Contribution ID: **19** Type: **Oral talk**

Circular stripe domains in a vertically stacked magnetic heterostructures

Wednesday, 23 December 2020 10:40 (20 minutes)

Magnetic vortex is known to form a ground state of magnetic nanodisk with easy-plane anisotropy [1]. A perpendicularly magnetized disk in a nanostack can also support the vortex state due to the interlayer exchange coupling with the vortex state thick layer [2].
<img src=”https://indico.bitp.kiev.ua/event/7/contributions/196/attachments/79/153/fig$_1.jpg$” $>$
$Fig.1 : Phasediagramofdifferentstatesonc Codisk.ThefollowingparametersoftheCodiskwereusedinOOMMFsimulation$
$diskradius$R = 500$nm, exchangeconstant$A = 2×10^{-11} J/m, saturation magnetization $Ms = 5 \times 10^5$ A/m, easy-normal anisotropy $K = 2 \times 10^5$ J/m^3.

Here we predict formation of circular stripe domains in the cylinder nanopillar of vertically stacked magnetic heterostructure. Using OOMMF micromagnetic simulations [3] we model the three-layer heterostructure where the topological magnetization texture is imprinted into an out-of-plane magnetized material through stacking three layers with in-plane magnetization (Py master layer), nonmagnetic material (Pd spacer layer) and out-of-plane magnetization (Co slave layer, the sample). The phase diagram of equilibrium magnetisation states in the sample disk is computed in a wide range of the coupling parameter for different thicknesses of the sample layer (see Fig.1): (i) The cone phase is realized for a weak coupling; within this phase the cone-state light vortex has a structure, similar to ones in easy-plane magnets under the action of perpendicular magnetic field [4]. (ii) The opposite limit case of strong coupling results to the vortex phase, which structure mimics the master layer vortex texture. (iii) The appearance of the new phase with the circular stripe domains is a key finding of the current study. This circular stripe phase is realized for the intermediate coupling parameters. The modulation instability of the cone state is triggered by the nonlocal magnetostatic interaction, which results in the generation of the stable equilibrium magnetization texture in the form of circular stripes domains. The number of stripes is controlled by both coupling parameters and the sample thickness. The phase transition between different states is described analytically using a simple Ansatz model and corresponds to the full scale micromagnetic simulations. The variety of magnetization textures with well-defined phases corresponds to the experimentally observed vortex and donut states in [2].
The possibility to switch between different topologically nontrivial states allows for engineering magnetic textures with possible applications in spintronic devices.

References

[1] A. Hubert and R. Schäfer, Magnetic domains: the analysis of magnetic microstructures, Springer (2009)
[2] R. Streubel et al, Scientific Reports 5, 8227 (2015)
[3] Object Oriented MicroMagnetic computing Framework (OOMMF)
[4] B. A. Ivanov and D. D. Sheka, Low Temperature Physics 21, 881 (1995)

Primary authors: ZAIETS, Oleksandr (Taras Shevchenko National University of Kyiv); Prof. SHEKA, Denis (Taras Shevchenko National University of Kyiv); Dr KRAVCHUK, Volodymyr (Karlsruher Institut für Technologie); Dr MAKAROV, Denis (Helmholtz-Zentrum Dresden-Rossendorf e.V.)

Presenter: ZAIETS, Oleksandr (Taras Shevchenko National University of Kyiv)

Session Classification: Condensed Matter Physics

Track Classification: Condensed Matter Physics