Curvature-induced effects in magnetic nanostructures

3Dmag

Dr. Denys Makarov, Helmholtz-Zentrum Dresden - Rossendorf e.V.

Dr. Attila Kákay, Helmholtz-Zentrum Dresden - Rossendorf e.V.

Prof. Dr. Michael Huth, Goethe University Frankfurt am Main, Frankfurt am Main

PD Dr. habil. Oleksandr Dobrovolskiy, University of Vienna, Vienna, Austria

Curvilinear magnetism; Nanomagnetism; Curvature effects in condensed matter

Materials with chiral interactions possessing chiral magnetic textures are at the forefront of current condensed matter research. Curvature effects in geometrically curved magnetic thin films emerged as a viable alternative to conventional approaches towards the realization of chiral magnetic textures, which are based on tuning of intrinsic properties of materials. Although there are numerous appealing theoretical predictions of curvature-induced effects in 3D shells, the novel physics of exchange- and magnetostatic-driven phenomena in nanomagnetism are not yet explored experimentally. This is mainly due to the lack of characterization tools and fabrication methods which can provide access to complex geometries at the low micrometer and sub-µm scale, e.g. tori, Möbius strips, spherical shells.
In this project we address these fundamentally relevant aspects. The main objective of this project is to join efforts of three experimental groups and one theory group to develop and exploit novel routes in fabrication of 3D curved magnetic shells at the low micrometer and sub-µm scale. In addition, we will fully characterize them and study their complex magnetic states and their dynamics both, experimentally and theoretically. In the focus will be mainly objects which were not realized before, including but not limited to torus, Möbius strip, and spherical shell. These new magnetic architectures will be characterized using a broad range of experimental techniques with respect to their static and dynamic properties. For the latter, new methods will be established and applied to study magnetization dynamics, e.g. in fundamentally appealing radially magnetized Swiss rolls. To understand complex magnetic structures in these architectures, advanced micromagnetic simulations will be carried out using finite element based micromagnetic solvers which are accelerated by the high parallel computing power of graphics cards.
This project will not only deepen our understanding on curvature-induced effects in condensed matter but also will put novel theoretical concepts and proposals to the test by experiment. This will provide deepened insight into how curvature effects can be used for future realization of novel 3D devices.