Three-dimensional magnetization textures

Daria Gusakova
Spintec/CEA/CNRS
daria.gusakova@cea.fr

Magnetization textures in three-dimensional objects promise to exhibit new properties, related to curvature, topology and an increased number of degrees of freedom. The continuous development of simulation codes, synthesis and imaging techniques, are currently allowing to push the frontiers forward in this field.
In our group, we are exploring the specific case of magnetic nanowires and nanotubes, as one-dimensional conduits providing an ideal playground to investigate the fundamentals of domain-wall motion and spin-wave propagation. While simulations have been dominating for two decades, the first experiments are only emerging. Here we highlight phenomena specific to the cylindrical shape of these nanostructures, related the OErsted field arising from a charge current, and its interplay with azimuthal magnetization textures. We have shown experimentally that the OErsted field is crucial for stabilizing the current-induced motion of Bloch-point walls, also selecting a circulation opposite to the one believed to result from the chirality of the LLG equation, while the OErsted field had been largely disregarded so far[1]. Using simulations we confirm this picture quantitatively, and draw a comprehensive panorama of the phenomenon[2]. We have also drawn the panorama of the impact of the OErsted field on wall motion in tubes with azimuthal domains, pointing at curiosities such as opposite directions of motion below and above the Walker current, and dramatic contrast between Néel and Bloch walls[3]. We finally report experiments in core-shell wires with azimuthal peripheral magnetization, revealing distinct regimes of motion of the peripheral versus core domain walls, the latter occuring at only a few 10^11 A/m2 current density[4].
Current frontiers include exploring the curiosities of Bloch points and their interplay with real materials, pushing theory and magnetic imaging at its limits, and the development of spintronics building blocks in tubes, based on core-shell type stacks..

REFERENCES

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