Magnetic imaging of three-dimensional magnetic textures using off-axis electron holography

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Nanoscale particle-like magnetization textures, such as Bloch-type and Néel-type skyrmions and chiral bobbers [1], are generating considerable interest for their fundamental physical properties and possible applications as information carriers. However, measurements of their magnetic structures and properties are challenging as a result of their small dimensions and three-dimensional magnetic field distributions.

Here, we highlight recent advances in the quantitative magnetic characterization of Bloch-type and Néel-type skyrmions and related spin textures. We also discuss prospects for studying more complex magnetic textures, such as magnetic globules and hopfions, based on micromagnetic simulations and phase image calculations.

We use off-axis electron holography in an aberration-corrected transmission electron microscope to record electron optical phase images [2] of both B20-type FeGe and sputtered polycrystalline magnetic heterostructures. The results are obtained as a function of temperature and applied magnetic field. The phase images are analysed using model-based iterative reconstruction to infer the projected or three-dimensional magnetisation distributions in the samples with nm spatial resolution.

[1] F. Zheng et al., Nat. Nanotechn. 13, 451 (2018).
[2] A. Kovács and R. E. Dunin-Borkowski, Handbook of Magnetic Materials, vol 27. P.59-153 (Elsevier) 2018.
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