Magnetic X-ray Tomography for the exploration of Magnetic Singularities and Topological Charge

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Spintronics and 3D Nanomagnetism future is related with the exploration and comprehension of topologically protected magnetization configurations being key for applications as well as for the study of fundamental phenomena [1,2]. However, topologically non-trivial textures are fully three-dimensional, requiring experimental techniques capable of unraveling their nature. In this framework, X-ray tomography approaches (high lateral resolution / large penetration depth) are excellent for the task [3,4].
In this work we experimentally demonstrate the capabilities of magnetic soft X-ray transmission tomography by recovering the complex magnetization of a $Ni_{80}Fe_{20}/NdCo_5/Ni_{80}Fe_{20}$ heterostructure [5]. Weak perpendicular magnetic anisotropy in the system leads to the formation of stripe domains and supports magnetic non-trivial topological configurations [6,7]. The reconstruction has revealed a Bloch point and a Meron-like texture. It has allowed us to calculate the experimental volume-resolved topological charge map bringing further insight on the character of observed singularities.
The results show the potential of the technique as a unique tool for experimental magnetic 3D characterization of arbitrary systems and heterostructures which could be of great interest for Spintronics, 3D Nanomagnetism and the broader magnetism community.

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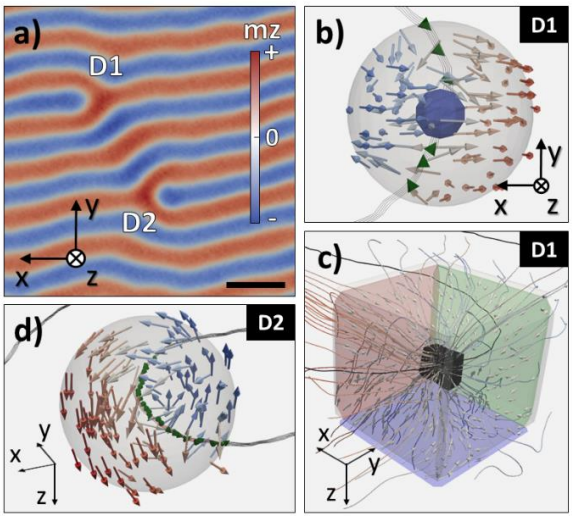

Fig. 1 a) Reconstructed mz magnetization slice showing stripe dislocations D1 and D2 (scale bar 520 nm). b) Magnetization configuration of the Bloch point at dislocation D1. c) Streamlines of the "emergent" field generated by the Bloch point singularity. d) Magnetization of the Meron-like texture at dislocation D2.