

ADVANCED MATERIALS

Supporting Information

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Anatomy of Skyrmionic Textures in Magnetic Multilayers

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S1. Domain wall width measured by ptychography and STXM

High-resolution ptychographic images make it possible to estimate the width of domain walls (DW) by analyzing the profile across the wall. Figures S1(a) and (b) are domain wall profiles measured by ptychography and STXM in the remanent state. The DW width can be calculated as $\Delta = \pi \sqrt{A/K_{\text{eff}}}$, where A is the exchange stiffness and K_{eff} the effective anisotropy. The exchange stiffness and anisotropy are obtained based on experimental measurements, where $A \approx 4.65 \times 10^{-12}$ J/m and $K_{\text{eff}} \approx 2.8 \times 10^4$ J/m³. The DW width determined this way is ~ 40.5 nm. The DW width determined by ptychography is (40.6 ± 4.8) nm, compared to (63.3 ± 6.6) nm as determined by STXM. The width of the edge is defined as the distance between the 10% and 90% intensity points.

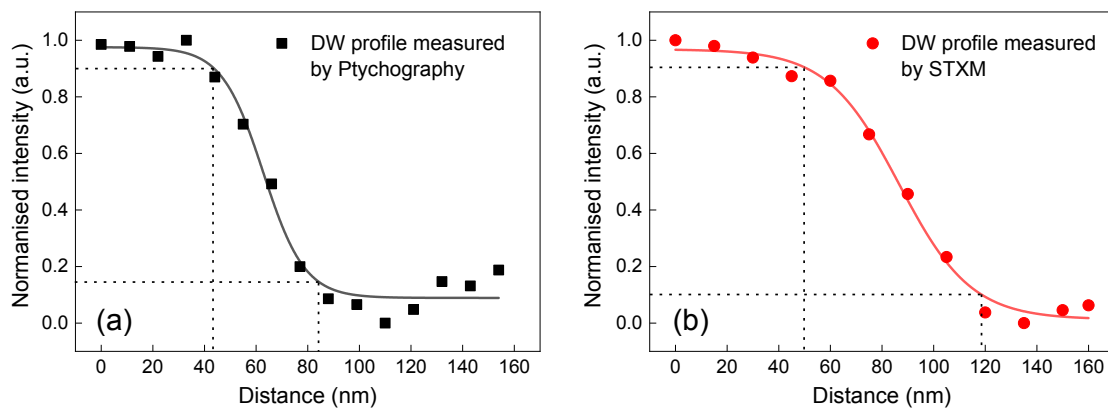


Fig. S1: Domain wall profile for the sample with $t_{\text{CoFeB}} = 1.45$ nm in the multi-domain state as imaged by ptychography, which shows a DW width of (40.6 ± 4.8) nm. The profiles were fitted with a

Boltzmann fit. The width of the edge is defined as the distance between the 10% and 90% intensity points.

S2. Skyrmions in Ta/CoFeB/MgO multilayers

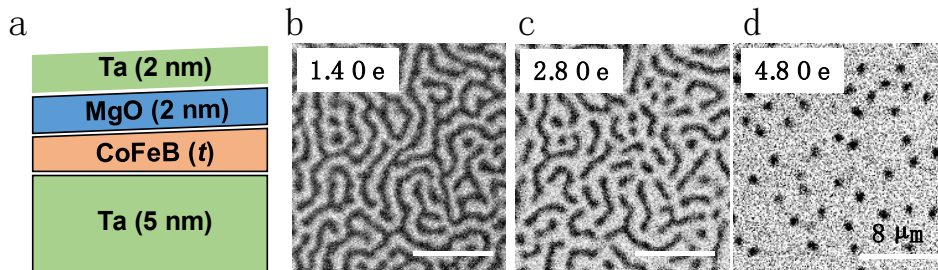


Fig. S2: (a) Schematic of the heterostructure which hosts skyrmions at room temperature. Note that the CoFeB layer is wedge-shaped to tune the perpendicular anisotropy across the sample. (b)-(d) Corresponding ptychography images in the different out-of-plane external magnetic fields, captured by magnetic optical Kerr effect (MOKE).

S3. Skyrmion size vs periodic number of the multilayer

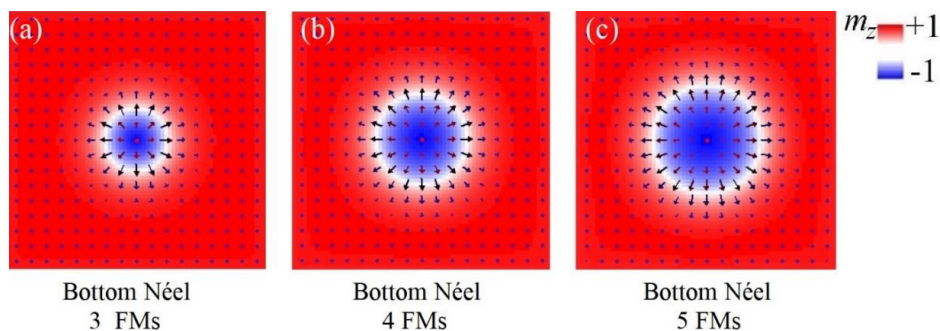


Fig. S3: Spatial distribution of the magnetization of the bottom Néel skyrmion in structures with a different number of ferromagnetic (FM) repeat layers (the color scale represents the z-component of the magnetization m_z , while the arrows represent the in-plane components). (a) A skyrmion diameter of 64 nm is found for three FM layer repeats, (b) 96 nm for four repeats, and (c) 112 nm for five repeats. In all the micromagnetic simulations, a saturation magnetization of 903 kA/m and a perpendicular anisotropy constant of 0.505 MJ/m³ were assumed. The out-of-plane external field was 40 mT.