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Magnetic order in skyrmion-hosting magnetic multilayers probed by small-angle neutron scattering and polarized neutron reflectometry

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Magnetic multilayers (MMLs) composed of alternating ferromagnetic / heavy-metal layers are one of the most technologically promising classes of skyrmion-hosting systems due to number of their advantages, such as skyrmion stability at room temperature and their tunability via layer engineering [1]. Through the combination of broken inversion symmetry and spin-orbit-coupling at the asymmetric interfaces, Dzyaloshinskii-Moriya interaction (DMI) is induced that leads to stabilization of Néel-type skyrmions in finite magnetic fields [1]. In this study we utilized small-angle neutron scattering (SANS) and polarized neutron reflectometry (PNR) methods to probe the magnetic order in $[Pt/CoFeB/Ru]_N$ (N=10 and 40 repetitions) MMLs with bulk and layer-resolved sensitivities, respectively. Neutron scattering experiments with polarisation analysis are needed to clarify the relation between Néel (DMI-induced) and Bloch (dipolar-induced) domain walls, that seem to be inaccessible in relatively thick samples (hundreds of nm) by any other experimental technique [2]. Here, long-periodic magnetic stripe domains and orientationally disordered skyrmion phases were unambiguously observed by SANS and off-specular reflectivity. Furthermore, by using the parameters deduced from quantitative modelling of the PNR, we were be able to refine the Hamiltonian parameters used for micromagnetic models.
[1] A. Fert, N. Reyren and V. Cros, Nat. Rev. Mater. 2, 17031 (2017)
[2] W. Legrand, et al. Science Advances 4.7, eaat0415 (2018)

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