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Neutron scattering study of skyrmions in MnSi thin films

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Chiral interactions in magnetic materials are unique in their ability to stabilize static magnetic solitons, known as skyrmions. At surfaces and interfaces, the chiral interaction results in novel magnetic surface states [1]. These surface twists help to further stabilize skyrmions in thin films [2], together with the influence of epitaxy induced magnetocrystalline anisotropy. These interactions play a crucial role in determining the observed magnetic textures, and lead to dramatically different behaviour in films as compared to bulk crystals.

The magnetic structure of MnSi thin films has been highly controversial. Our group was the first to report in-plane skyrmions [4], and the suppression of skyrmions out of plane [5], in contrast to reports from other groups. To resolve the controversy, we measured the magnetic structure of the in-plane skyrmions in epitaxial MnSi/Si(111) thin films, probed in three dimensions by the combination of polarized neutron reflectometry (PNR) and small angle neutron scattering (SANS) [6]. We demonstrate that skyrmions exist in a region of the phase diagram above a temperature of 10 K. PNR shows the skyrmions are confined to the middle of the film due to the potential well formed by the surface twists.

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