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Skyrmion crystal and topological Hall effect in B20-type transition-metal compounds

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Topological objects in solids such as domain walls and vortices have been attracting much attention for long. Among them the spin texture called skyrmion is an unusual topological object, in which the spins point in all the directions wrapping a sphere. The skyrmion hosts finite spin chirality, and therefore is anticipated to induce novel electromagnetic phenomena such as topological Hall effect. In B20-type transition metal compounds MnSi and $Fe_{1-x}Co_xSi$, the crystallization of skyrmions was observed by the neutron diffraction studies.[1,2] Recently, we have observed the real-space images of skyrmion crystal in thin films of related compounds ($Fe_{0.5}Co_{0.5}Si$ and FeGe) using Lorentz transmission electron spectroscopy.[3,4] We have observed the hexagonal arrangement of skyrmions including the topological defects (chiral domains and dislocations) under the magnetic field normal to the films, and found that the two dimensional skyrmion crystal phase is fairly stabilized by the thin film form of the samples. We have also studied the topological Hall effect caused by the spin chirality of the skyrmion crystal in a related material MnGe. In terms of the Hall measurement, they have shown the real space nature of the fictitious magnetic field caused by the magnetic configuration of the skyrmion crystal, in contrast with the momentum-space fictitious field in another spin chirality system, $Nd_2Mo_2O_7$.[5] This work was done in collaboration with X. Z. Yu, N. Kanazawa, J. H. Park, J. H. Han, K. Kimoto, W. Z. Zhang, S. Ishiwata, Y. Matsui, N. Nagaosa, and Y. Tokura.

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