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Formation and dynamics of Skyrmions in B20-type chiral magnets

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The topological stable spin texture called a Skyrmion, in which the directions of the spins wrap a sphere, has been attracting much attention as an arena for unconventional magneto-transport effects. Small angle neutron scattering (SANS) studies identify the formation of two-dimensional triangular Skyrmion lattice in B20-type transition-metal monosilicides, such as MnSi[1] and $Fe_{1-x}Co_xSi$.[2] In addition, novel transport properties due to its topological spin arrangement, namely the topological Hall effect[3] and the current-induced rotation of the Skyrmion lattice[4] are observed in MnSi. We have provided crucial evidence of the existence of Skyrmions in B20-type compounds by direct real-space observation using Lorentz transmission electron microscopy (TEM)[5,6] and also found a large topological Hall effect in much wider temperature region in MnGe than other B20-type magnets.[7] TEM observation reveals the detailed information on nucleation and fusion processes and topological defects besides the perfect hexagonal arrangement of Skyrmions. Furthermore, we have found that the Skyrmion lattice state is quite stabilized in a thin-plate formed sample with its thickness smaller than the skyrmion lattice constant. The orders of magnitude larger topological Hall effect in MnGe indicates the high-density Skyrmion crystal formation and distinguishable large responses in some novel electromagnetic phenomena. In addition, we have fabricated B20-type thin films where Skyrmions are more stabilized and applied electric current is more easily controlled than in bulk samples. This work was done in collaboration with X. Z. Yu, Y. Onose, J. H. Park, J. H. Han, N. Nagaosa, K. Kimoto, W. Z. Zhang, S. Ishiwata, Y. Matsui, T. Arima, D. Okuyama, K. Ohoyama, S. Wakimoto, K. Kakurai, A. Tsukazaki, M. Ichikawa, Y. Li, Y. Shiomi, K. Shibata, D. Inosov, J. H. Kim, J. White, N. Egetenmeyer, J. Gavilano, B. Keimer, and Y. Tokura.

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