Topological Spintronics using Weyl Antiferromagnets

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Among magnets, only ferromagnets have been used for applications, for example, as the main active materials for memory devices. On the other hand, antiferromagnets have attracted recent interest for designing next generation high-density and ultrafast devices because they produce no stray fields and have much faster dynamics. Here we introduce a new type of functional antiferromagnets with vanishingly small magnetization, namely, topological Weyl magnets that can be easily controlled by magnetic field, produce large responses, and thus could be useful for future applications including spintronics. After brief discussion on emergent electronic phases based on a Luttinger semimetal found in pyrochlore iridates, we will introduce the frustrated antiferromagnets, Mn_3X (X =Sn and Ge) as the examples of a topological Weyl magnet [1,2,3]. We show that the cluster multipole order on the kagome lattice of Mn moments can be controlled and lead to a variety of new functions at room temperature that have never been seen in antiferromagnetic metals. These include the large anomalous Hall and Nernst effects in bulk and thin films[1,2,4,5], large magnetic optical Kerr effect [5] and a novel type of spin Hall effect (magnetic spin Hall effect) [7]. Finally, we show that they should be significantly useful for designing antiferromagnetic spintronics, and energy harvesting technology [8]. This presentation is based on the collaboration with Takahiro Tomita, Tomoya Higo, Muhammad Ikhlas, Ryotaro Arita, Michito Suzuki, Takashi Koretsune, YoshiChika Otani, Motoi Kimata, Kouta Kondou, Kenta Kuroda, Takeshi Kondo, Shik Shin, Pallab Goswami, Hua Chen, Allan MacDonald, L. Wu, J. Orenstein, R.D. Shull, O. van't Erve.

Reference

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