Weyl Magnets: Novel Functional Magnets based on Topology of Electronic Structure

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Among magnets, only ferromagnets have been used for application, for example, the main active materials for memory devices. Despite a number of basic research made to date, antiferromagnets have been considered much less useful for applications, because their spin states are much harder to control as they possess no overall magnetization.

Meanwhile, recent rapid growth in the information technology has demanded the spintronic devices to acquire a higher integration density and higher speed data processing, for instance, in non-volatile magnetic memory devices. For this, actually antiferromagnets, which generate no perturbing stray field and have much faster spin dynamics than ferromagnets, have attracted much attention recently as an active material for next generation memory devices. Still, in order to employ antiferromagnetism, a number of obstacles exist.

Here, we report our recent discovery of a new type of functional antiferromagnets, the first example of topological “Weyl” magnets, that exhibit a variety of new functions that have never been seen in antiferromagnets. These include (1) anomalous Hall effect [1], (2) anomalous Nernst effect [2], and (3) magnetic optical Kerr effect. Moreover, they are controllable by a weak field at room temperature and thus significantly useful for designing antiferromagnetic spintronics and energy harvesting technology. We also show that the antiferromagnet exhibiting these effects hosts the new state of matter called magnetic Weyl metal, characterized by magnetic Weyl fermions [3]. Our discovery of the novel effects in an antiferromagnet represents the opening of a new chapter of applied research using the new type of functional magnets, Weyl magnets.

This presentation is based on the collaboration with Takahiro Tomita, Tomoya Higo, Muhammad, Ikhlas, YoshiChika Otani, Motoi Kimata, Kouta Kondo, Kenta Kuroda, Takeshi Kondo, Shik Shin, Pallab Goswami, Ryotaro Arita, Michito Suzuki, Takashi Koretsune.

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[2] M. Ikhlas, T. Tomita et al., Nature Physics 13, 1085 (2017).
[3] K. Kuroda, T. Tomita et al., Nature Materials 16, 1090 (2017).

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