Novel Type of Hall Transport in a Magnetically Frustrated Oxide

Yo Machida[1], Satoru Nakatsuji[1], Shigeki Onoda[2], Takashi Tayama[1] and Toshiro Sakakibara[1]

[1]*Institute for Solid State Physics, University of Tokyo, Kashiwa 277-8581, Japan* [2]*Condensed Matter Theory Laboratory,*

[2] *RIKEN, Wako 351-0198, Japan*

Abstract: An electric current flowing through a conductor in a magnetic field produces a transverse voltage drop known as the Hall effect. In the absence of the field, this effect also appears in ferromagnets in a plane normal to its spontaneous magnetization vector owing to the spin-orbit coupling. This anomalous Hall effect has been used to directly probe the uniform magnetization in ferromagnets, providing a variety of application uses including Hall effect sensors and MRAM. Generally, it may also detect a nontrivial order parameter breaking the time-reversal symmetry on a macroscopic scale, for example, scalar spin chirality. However, such a spontaneous Hall effect has never been observed in the absence of magnetic long-range order.

In this talk, we present our recent results on the Hall effect measurements on the geometrically frustrated magnet $Pr_2Ir_2O_7$ [1]. Strikingly, a spontaneous Hall effect is observed in the absence of both an external magnetic field and conventional magnetic long-range order. This strongly suggests the existence of a spin-liquid phase breaking the time-reversal symmetry. Both our measurements and calculations suggest that spin-ice correlations in the liquid phase lead to a non-coplanar spin texture forming a uniform but hidden order parameter: the spin chirality.

[1] Yo Machida, Satoru Nakatsuji, Shigeki Onoda, Takashi Tayama, Toshiro Sakakibara, Nature, **463** 210-213 (2010).