Frustrated Spins and Anomalous Hall Effect in the Pyrochlore Magnet $Pr_2Ir_2O_7$

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Metallic magnets on geometrical frustrated lattices have attracted interest because of their novel low temperature phenomena such as the heavy fermion behavior of LiV_2O_4 [1], YMn_2 [2], and the anomalous Hall effect of $Nd_2Mo_2O_7$ [3]. The pyrochlore magnet $Pr_2Ir_2O_7$ is quite unique for its metallic spin liquid behavior at low temperatures [4], and thus may lead to novel transport phenomena due to the strong geometrical frustration. While the <111> Ising-like Pr 4*f*-moments have an antiferromagnetic RKKY interaction of T^* = 20 K mediated by Ir 5*d*-conduction electrons, no magnetic long-range order is found down to 80 mK. Instead, the Kondo effect, including ln*T* dependence in the resistivity, emerges and leads to partial screening of the localized 4*f*-moments below T^*. Our single crystal study has further revealed that the underscreened 4*f*-moments show spin-liquid behavior below a renormalized energy scale of $\theta_W \sim 1.7$ K and $B_c \sim 1.0$ T [4].

Here, we report novel Hall transport phenomena observed in $Pr_2Ir_2O_7$ in its spin liquid regime below $_W$. Interestingly, the anomalous Hall coefficient R_s at the low field limit is found to increase logarithmically on cooling. In the same temperature regime, the normal resistivity ρ_{xx} has nearly no *T* dependence, and thus, the diverging behavior in R_s cannot be ascribed to the conventional mechanisms such as skew scattering and side jump processes. The short-range spin texture of the Pr-moments including spin-chirality might play an important role for the low temperature divergence of the Hall resistivity.

References

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