Giant Positive Magnetoresistivity in Spin-Orbit-Driven $BaIrO_3$

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Introduction

The most profound result of the ***spin-orbit interaction*** (SOI) on iridates is the ***J_{eff}=1/2 insulating state***, a new quantum state that represents the novel physics in the 5d-based systems. The SOI vigorously competes with Coulomb interactions, non-cubic crystal electric field and Hund's rule coupling, and critically biases their mutual competition to stabilize ground states with exotic behavior, which sharply contrasts with traditional models. Indeed, two conspicuous phenomena are commonly observed among layered iridates: **(1)** the J_{eff} = 1/2 insulating state, and **(2)** relatively high magnetic ordering temperatures and complex magnetic states that are not predicted by existing models. $BaIrO_3$ is among these iridates **[1]**. It weak-ferromagnetically orders at T_C=182 K with an extremely small saturation moment that is no more than 0.03 μ_B/Ir **[2,3]**. Application of high magnetic field up to 35 T results in exotic behavior characterized by the following two features: **(1)** a drastic rise in electrical resistivity by 250%; and **(2)** the magnetoresistivity is highly anisotropic with strong hysteresis. The behavior constitutes the novel physics associated with the strong SOI.

Experimental

Single crystals studied were grown using flux techniques. The measurements of transport properties were performed in the 35 T resistive magnet equipped with a He3 refrigerator.

Results and Discussion

We have observed a colossal magnetoresistivity in $BaIrO_3$ when B is perpendicular to ab plane as shown in **Figure 1**. The resistivity ρ_{ab} is increased by three orders of magnitude, and exhibits a large hysteresis. Such a colossal magnetoresistivity is striking in that the magnetic moment of this system is tiny, 0.03 μ_B/Ir. Our band structure calculations suggest a band structure near Fermi surface extraordinarily sensitive to any slight changes in lattice parameters, which captures underlying physical properties observed experimentally. This behavior signals an unusual, delicate interplay between structural and electronic degrees of freedom in $BaIrO_3$. We were unable to complete our planned experiments due to the technical issues.

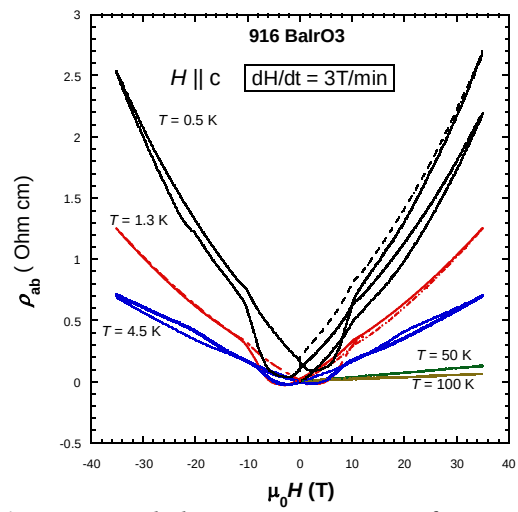

Figure 1. *Basal plane resistivity ρ_{ab} as a function of applied external field for T=0.5K, 1.3K, 4.5K, 50K and 100K.*

Conclusion

This novel phenomenon is driven by the strong SOI; its full understanding requires more magnet time.

Acknowledgements:

The work was supported by NSF Grants No. DMR-0856234.

References:

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