Anomalous Hall Effect on AuFe Compounds

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Introduction

We have made systematic measurements of the Anomalous Hall Effect in a series of AuFe alloys. The Hall coefficient $R_H$ has been measured and studied as a function of applied magnetic field and temperature. A further AHE term has recently been predicted [1] for conductors containing spins whose local magnetic axes are tilted away from the global magnetization direction in addition to the canonical Lorentz term and Karplus-Luttinger term.

Experimental

We have used the 14T PPMS available at the NHMFL-LANL. We performed DC magnetization, electrical resistivity and Hall effect measurements under applied magnetic fields between zero and 14 T. We used a temperature range between 4 K and room temperature.

Results and Discussion

The results are expressed in terms of the Hall coefficient $R_H$. A “conventional” $R_H^* (T) = R_0(T) + \lambda(c)M_H(T)\rho_{xx}(T)$ has been calculated (red line) and compared to the obtained results (figure 1). It is necessary to include a negative contribution in addition to $R_H^* (T)$ and the strength of this contribution is closely correlated to the degree of canting. Figure 2 shows the behavior of this additional contribution as a function of the applied field. The strength of the chiral term decreases with increasing of the field, as predicted by Kawamura [1].

Conclusions

The experimental results demonstrate that is necessary to consider a negative contribution to the Anomalous Hall Effect in addition to the conventional terms for low applied fields. This additional term is linked to the tilting of the local spins and can be identified with the chiral or real space Berry phase term [2,3]. It can be understood in terms of the Aharonov-Bohm-like intrinsic microscopic current loops arising from successive scatterings by canted local spins. This additional term is suppressed at higher magnetic fields, once the local spins became co-linear. These results confirm theoretical predictions of a novel topological Hall term induced when chirality is present.

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References