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Theory of the Anomalous Hall Effect in the Insulating Regime

XIONG-JUN LIU, XIN LIU, JAIRO SINOVA, Department of Physics, Texas A&M University, College Station, Texas 77843-4242, USA — The anomalous Hall effect (AHE) has been an enigmatic problem that has resisted theoretical and experimental assault for almost one century. The AHE in the metallic regime has been separated into different contributions, i.e. skew scattering side jump and intrinsic contribution. However, the recent experiments on AHE in the insulating regime discover a qualitatively different behavior described by a scaling relation which is different from that in the metallic regime. The new finding cannot be explained by available microscopic theories of metals based on impurity scattering. Here we present a theory to study the anomalous Hall conductivity (AHC) in this regime. With this theory we calculate the lower and upper limits for the AHC by taking simple assumptions of the impurity distributions. Our results are quantitatively in agreement with the experimental discoveries, and thus provides the understanding of the AHE in the insulating regime.

Xiong-Jun Liu
Department of Physics, Texas A&M University,
College Station, Texas 77843-4242, USA

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