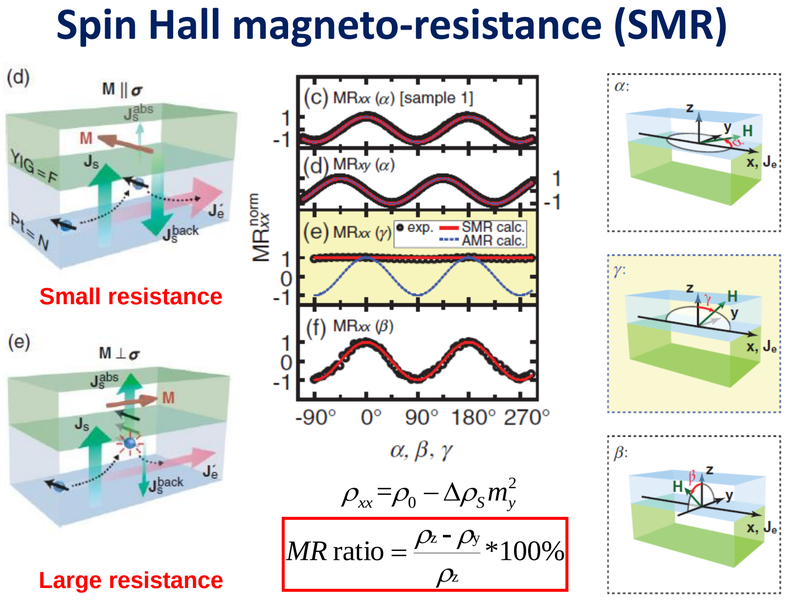
Abnormal Spin Hall Magnetoresistance in CoO/Pt bilayers

M. W. Jia, J. Xu and Y. Z. Wu

Department of Physics, State Key Laboratory of Surface Physics, and Advanced Materials Laboratory, Fudan University, Shanghai, China

Introduction

Spin Hall magneto-resistance (SMR)

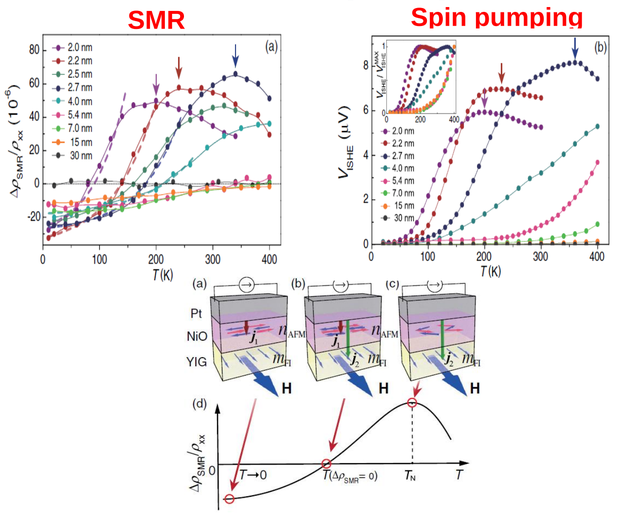


$$\rho_{xx} = \rho_0 - \Delta\rho_S m_y^2$$

$$MR\ \text{ratio} = \frac{\rho_z - \rho_y}{\rho_z} * 100\%$$

Nakayama et. al, *PRL* **110**, 206601 (2013).

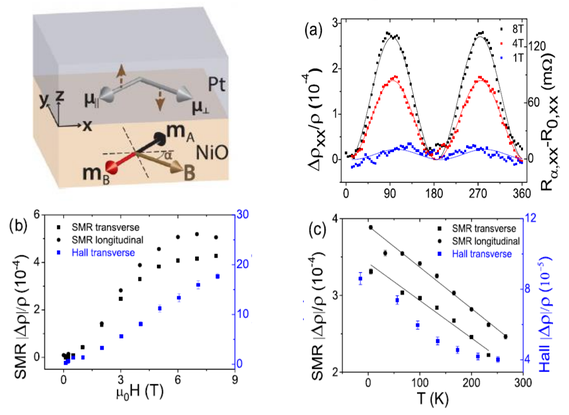
SMR in YIG/NiO/Pt



SMR ratios have sign reversion in different temperature.

Dazhi Hou et. al, PRL 118, 147202 (2017).

SMR in antiferromagnetic NiO/Pt



SMR ratios in NiO have opposite sign comparing with that in ferromagnetic materials..

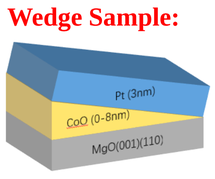
G. R. Hoogeboom et. al, *APL* **111**, 052409 (2017).

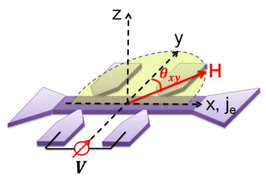
The SMR ratios have the same sign in all antiferromagnetic materials?

Experiment

Transport measurement geometry

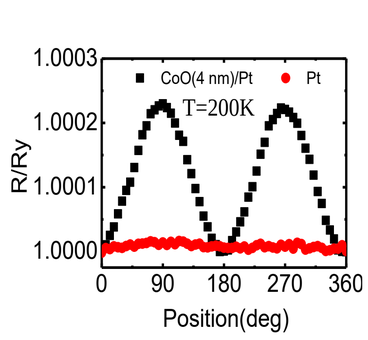
Wedge Sample:





$$MRxy = \frac{Rx - Ry}{Rx} * 100\%$$

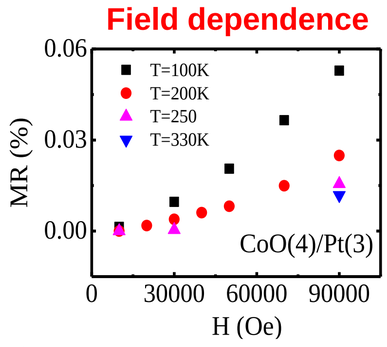
PPMS
T=10-300K H=9T



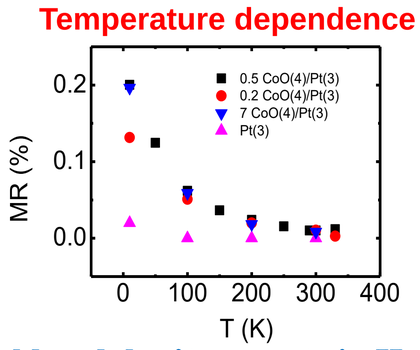
Results and discussion

Temperature and field dependence measuring in H=9T

Field dependence

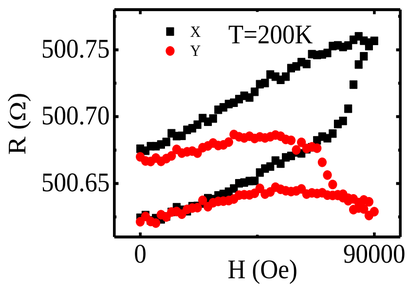


Temperature dependence

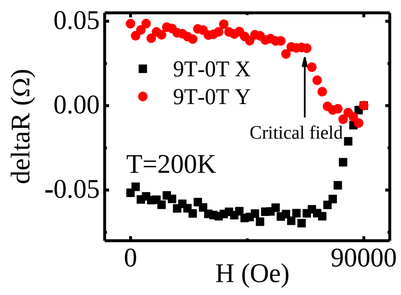


- **MR ratios increase with field and don't saturate in H=9T**
- **MR ratios increase when the temperature decreases and MR ratio can be 0.2% at T=10K, which has the same order of magnitude comparing with Anisotropic magnetoresistance.**

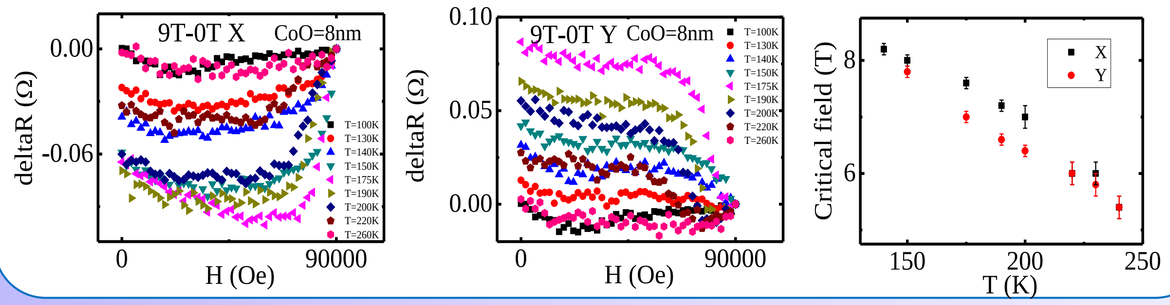
Field scan results



Field scan along X and Y directions

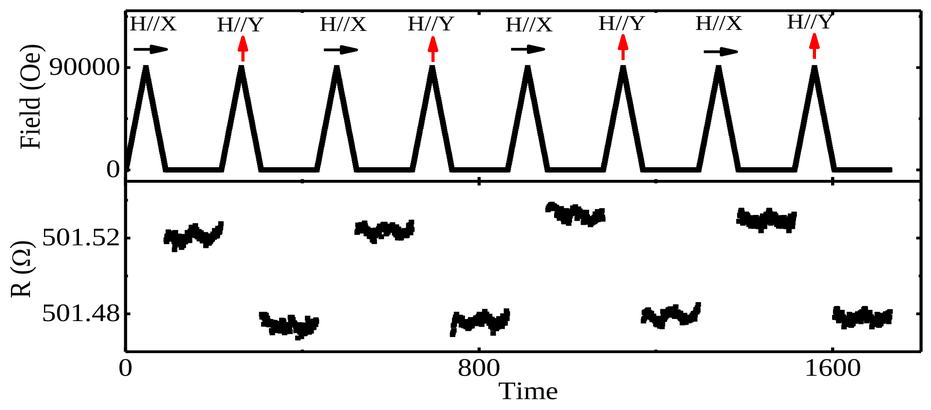


The difference between 0T to 9T scan and 9T to 0T scan

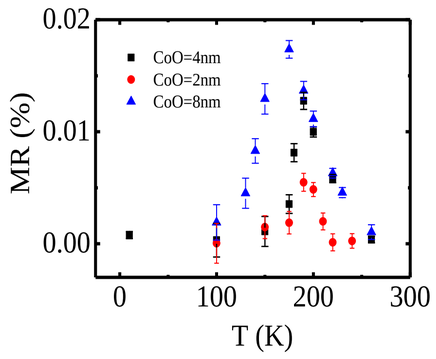


Results and discussion

SMR measured in H=0T at T=200K

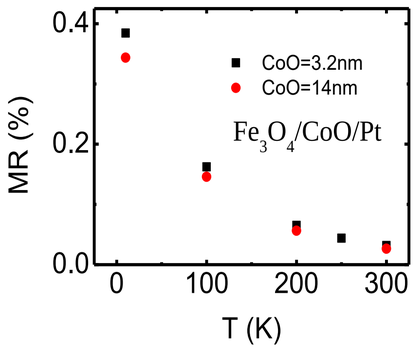


SMR ratios measured in H=0T

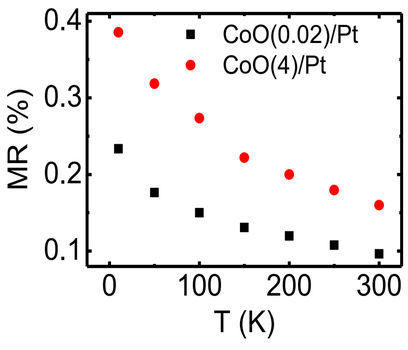


- **MR ratios are zero at low temperature and high temperature**
- **MR ratios are non-monotonic and have peaks at nearly 190K.**

More confirmatory experiment



The Neel vector of CoO is sure to be driven by the applied magnetic field



The abnormal temperature-dependent SMR comes from interface effect

Summary

- The SMR ratios in antiferromagnetic CoO have the opposite sign comparing with that in NiO.
- Temperature-dependence of the SMR measured in H=9T is different from that measured in H=0T.
- This abnormal SMR in CoO may arise from the Co doping in CoO/Pt interface.