

Spin-related Transport Study of Transition Metals

Bingfeng Miao

Recently, intense attention has been focused on the generation, detection, and exploitation of pure spin current. Once generated, a pure spin current cannot be detected electrically but by the inverse spin Hall effect (ISHE) that converts it back into a charge current. To date, ISHE has been observed only in non-magnetic metals, such as Pt and Au, with a strong spin-orbit coupling. We report the observation of ISHE in a ferromagnetic metal permalloy (Py) on ferromagnetic insulator yttrium iron garnet (YIG). Through controlling the spin current injection by altering the Py/YIG interface, we have isolated the spin current contribution and demonstrated the ISHE in a ferromagnetic metal, the reciprocal phenomenon of anomalous Hall effect. A large spin Hall angle in Py indicates many other ferromagnetic metals may be exploited as superior pure spin current detectors and for applications in spin current.

In this talk, I will also discuss a new type of magnetoresistance (MR) observed in Pt/YIG when nominally nonmagnetic Pt comes in contact with a ferrimagnetic insulator yttrium iron garnet (YIG), which has drawn intense experimental and theoretical interest. We experimentally demonstrate two physical origins of the new MR: a spin current across the Pt/YIG interface and the magnetic proximity effect. The new MR can also be reproduced when Pt is in contact with a nonmagnetic insulator doped with a few percent of Fe impurities.

Reference:

1. B. F. Miao, S. Y. Huang, D. Qu, and C. L. Chien, Inverse spin Hall effect in a ferromagnetic metal. *Phys. Rev. Lett.*, **111**, 066602 (2013).
2. B. F. Miao, S. Y. Huang, D. Qu, and C. L. Chien, “Physical Origins of the New Magnetoresistance in Pt/YIG”, *Phys. Rev. Lett.* **112**, 236601 (2014).