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Spin information propagation through metal/magnetic insulator interface[1]

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In metal-based spintronics, electron spin current plays pivotal roles in propagating spin information. Here we investigate the propagation of magnon current carried by non-equilibrium magnons, which can also serve as spin carriers in ferromagnet. By exploiting of the semiclassical Boltzmann approach, we explicitly derive the non-equilibrium magnon distribution and magnon current in ferromagnetic insulators [1]. In some limiting cases, we find that magnon density satisfies a diffusion equation, similar to the electron spin diffusion equation. At the interface between a metal layer (ML) and a magnetic insulator layer (MIL), we show that the spin current of the ML and the magnon current of the MIL are mutually transferable. We introduce a concept of spin convertance [1] that quantitatively measures magnon current induced by electron spin accumulation and spin current generated by magnon accumulation at the interface. With the above formalism, we predict some interesting spin transport phenomena for several layered structures with a MIL. In particular, we anticipate a novel electric drag mediated by magnons: an applied electric current in one ML induces an electric field in the other ML separated by a thick MIL. Our theory also provides a new perspective on the longitudinal spin Seebect effect [2] from the point of view of magnon current driven by the thermal gradient across a MIL. We discuss the dependence of these phenomena on temperature, materials properties, and geometric parameters.

[1] S. S.-L. Zhang and S. Zhang, Phys. Rev. Lett. 109, 096603 (2012); S. S.-L. Zhang and S. Zhang, arXiv:1210.2735v2.
[2] K. Uchida et al., Appl. Phys. Lett. 97, 172505 (2010); H. Adachi and S. Maekawa, arXiv:1209.0228v1.

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