Controllable Spin Current in van der Waals Ferromagnet Fe_3GeTe_2

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Abstract

The control of spin current is pivotal for spintronic applications, especially for spin-orbit torque devices [1]. Spin Hall effect (SHE) is a prevalent method to generate spin current. However, it is difficult to manipulate its spin polarization in nonmagnet. Recently, the discovery of spin current in ferromagnet offers opportunity to realize the manipulation [2,3]. In the present work, the spin current in van der Waals ferromagnet Fe_3GeTe_2 (FGT) with varying magnetization is investigated by *ab initio* calculations. It has been observed that the spin current in FGT presents the nonlinear behavior with respect to magnetization. The in-plane and out-of-plane spin polarizations emerge simultaneously, and the bilayer FGT can even exhibit arbitrary polarization thanks to the reduced symmetry. More intriguingly, the correlation between anomalous Hall effect (AHE) and spin anomalous Hall effect (SAHE) has been interpreted from the aspect of Berry curvature. This work illustrates that the interplay of magnetism and symmetry can effectively control the magnitude and polarization of the spin current, providing a practical method to realize exotic spin-orbit torques.

References

[1] B. Dieny *et al.*, *Nat. Electron.*, **3** (2020) 446–459
[2] C. Iihama *et al.*, *Nat. Electron.*, **1** (2018) 120–123
[3] S. Varotto *et al.*, *Phys. Rev. Lett.* **125** (2020) 267204

Figures

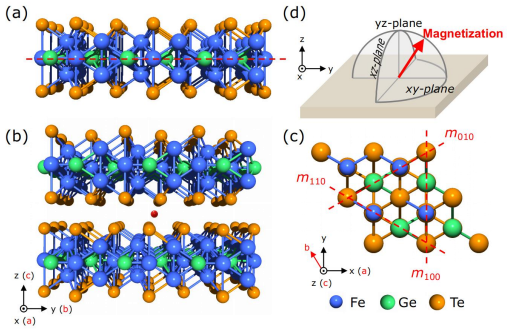

Figure 1: Atomic model of (a) monolayer FGT with a mirror symmetry, and (b) bilayer FGT with an inversion center. (c) Top view of bilayer FGT including mirror symmetries. (d) Illustration of the magnetization evolution in different planes.

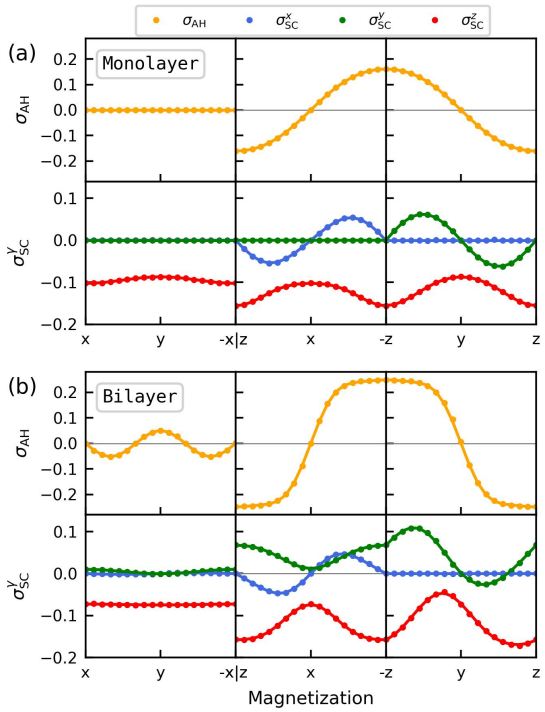

Figure 2: Anomalous Hall conductivity and spin current conductivity of (a) monolayer and (b) bilayer FGT with magnetization rotating inside xy-, xz-, and yz-planes.