Spin-orbit Caloritronics

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Topics such as spin Hall effect, topological insulators or skyrmions, all taking advantage of relativistic effects in solid state, have profoundly challenged our understanding of spin transport lately and presents tremendously rich opportunities for innovative expansion of the research in condensed matter systems. Utilizing spin-orbit coupling to enable the electrical manipulation of ferromagnets and magnetic textures has attracted a considerable amount of interest in the past few years. The key mechanism, tagged spin-orbit torque [1], appears in ultrathin magnetic systems displaying inversion symmetry breaking such as bilayers composed of noble metals and ferromagnets. In conjunction with spin-orbit torques, another adjacent emerging topic aims at exploiting magnonic spin currents driven by temperature gradients or propagating spin waves in magnetic materials. This field, called spin caloritronics [2], demonstrated the capacities of thermal spin waves to carry spin currents and even control the motion of magnetic domain walls. In this work, we demonstrate that even in the absence of magnetic texture, a magnon flow generates torques if magnons are subject to Dzyaloshinskii-Moriya interaction [3] just as an electron flow generates torques when submitted to Rashba interaction [4]. A direct consequence is the capability to control the magnetization direction of a homogeneous ferromagnet by applying a temperature gradient or local radio-frequency spin wave excitations. We show that merging the spin-orbit torques with spin caloritronics is rendered possible by the emergence of DMI in magnetic materials and opens promising avenues in the development of chargeless information technology.

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