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Connecting Spinwaves to Charge Currents in Ferromagnetic/Non-magnetic Heterostructures

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Spin waves are becoming attractive for information encoding and processing due to their long coherence lengths and times in ferromagnetic insulators with low magnetization damping. Nevertheless, in order to integrate devices based on spin waves with existing electronics it is necessary to manipulate spin waves with charge currents and voltages. One possible pathway for electric spin wave manipulation is via spin Hall effects, which intermix spin and charge currents. In particular, the transverse geometry of spin Hall effects is ideally suited for the integration with magnetic insulators, where the spin current can be coupled to magnetization dynamics via spin transfer torque and spin pumping. This is demonstrated in Pt/yttrium iron garnet (YIG) bilayers, where a charge current passed through the Pt layer can either reduce or increase the linewidth of ferromagnetic resonance in the YIG layer [1]. Aside from spin accumulations from spin Hall effects, another pathway for manipulating spin waves is via the Oersted magnetic fields that accompany charge currents. This can be used for guiding spin waves through curved waveguides, where otherwise the spin wave propagation is suppressed by the inherently anisotropic spin wave dispersion in thin films [2]. Beyond manipulating spin waves with electric currents, it is also desirable to detect spin waves with electric voltages. It turns out that in metallic ferromagnets, anomalous Nernst effects enable the thermoelectric detection of spin waves [3]. One interesting aspect of this detection scheme is that it is insensitive to the wavelength of the spin wave, and, therefore, overcomes limitations given by optical or inductive detection approaches.

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