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Manipulation of Spin Waves in Yttrium Iron Garnet Thin Films through Interfacial Spin Scattering

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Spin waves in magnetic films have many properties that can be utilized for microwave signal processing and logic operations. These applications, however, are bottlenecked by the damping of spin waves. This presentation reports on a new method for the amplification of spin waves. Specifically, the presentation reports the electric manipulation of spin waves in yttrium iron garnet (YIG) thin films via interfacial spin scattering (ISS). Experiments used a 4.6 μm-thick YIG film strip with a 20 nm-thick Pt capping layer. A dc pulse was applied to the Pt film that produced a spin current along the Pt thickness direction via the spin-Hall effect. As the spin current scatters off the surface of the YIG film, it exerts a torque on the YIG surface spins. Due to the dipolar and exchange interactions, the effect of this torque is extended to other spins across the YIG thickness and thereby to spin-wave pulses traveling in the YIG film. The net effect of the ISS process depends critically on the relative orientation of (1) the magnetic moments of the electrons in the Pt layer that scatter off the YIG surface and (2) the precession axis of the magnetic moments on the YIG surface. When they are anti-parallel, the spin-wave damping is reduced and the amplitude of a traveling spin-wave pulse is increased. In a parallel configuration, the pulse experiences an enhanced attenuation.