Nonreciprocal magnetoacoustic surface waves in a dipolar coupled ferromagnetic bilayer

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Surface acoustic waves (SAWs) have made their way into many everyday devices, thanks to the greatly reduced wavelength of SAWs compared to free-space microwaves of the same frequency. These "nano earthquakes" can be efficiently launched and detected on piezoelectric substrates with periodic metallic gratings in the MHz- to GHz-range. However, SAWs are in general propagating reciprocally, which means that SAW propagation does not change under inversion of the propagation direction and limits the usage of SAWs as reciprocal devices.

Since spin waves (SWs) are known to show a pronounced nonreciprocal behavior, magnetoelastic coupling of SAWs with SWs is a straightforward approach to obtain nonreciprocal magnetoacoustic surface waves (MASWs). Besides the nonreciprocity of the SAW-SW coupling mechanism itself [1,2], the SW dispersion relation can be nonreciprocal. For example, the Dzyaloshinskii–Moriya interaction (DMI) in an ultrathin ferromagnetic/heavy metal bilayer causes SW nonreciprocity and thus induces nonreciprocal SAW propagation [3].

In our recent study, we experimentally demonstrate the large coupling between SAWs and SWs to obtain highly nonreciprocal MASWs in a dipolar coupled ferromagnetic bilayer [4]. We show that nonreciprocal symmetric and antisymmetric SW modes form in a NiFe/Au/CoFeB magnetic bilayer. Furthermore, we model our results in a phenomenological approach and discuss the high tuneability of the nonreciprocity in such a bilayer.

References:

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