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Nonreciprocal spin-wave propagation induced by interfacial Dzyaloshinskii-Moriya interaction

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The magnetization can retain its spatially uniform alignment owing to the symmetric exchange interaction. On the other hand, there is anti-symmetric component of exchange interaction which can cause chiral magnetic order. The anti-symmetric interaction was proposed by Dzyaloshinskii to explain the weak ferromagnetism, and a related theory was developed by Moriya with a correction of spin-orbit coupling in Hamiltonian. Recently, the Dzyaloshinskii-Moriya interaction (DMI) has attracted an intense interest in the field of spintronics due to its great effect in magnetic dynamics such as, for instance, in magnetic domain wall motion in ferromagnetic thin films, where the interfacial DMI arises from spin-orbit coupling and broken inversion symmetry at the interfaces.

In this work, we show the nonreciprocal spin-wave propagation in ferromagnetic thin film induced by interfacial DMI. The spin-wave propagation is measured by a vector network analyzer. The presence of interfacial DMI leads to a nonreciprocity in the spin-wave propagation, and spin-wave frequency depends on the propagation direction. The frequency shift of spin wave provides an access to a quantitative measurement of interfacial DMI energy [1]. This approach using nonreciprocal spin-wave propagationcan be extended to quantify the interfacial DMI energy in various ferromagnetic systems.

Reference

[1] J.-H. Moon, S.-M. Seo, K.-J. Lee, K.-W. Kim, J. Ryu, H.-W. Lee, R. D. McMichael, and M. D. Stiles, Phys. Rev. B 88, 184404 (2013).