Refractive Index for Dipole-Exchange Spin Waves

Dae-Eun Jeong*, Dong-Soo Han and Sang-Koog Kim
Research Center for Spin Dynamics & Spin-Wave Devices, Nanospinics Laboratory, Research Institute of Advanced Materials, Department of Materials Science and Engineering, Seoul National University, Seoul 151-744, South Korea

1. Introduction

Dipole-exchange spin waves in magnetically ordered materials of restricted geometries including one-dimensional (1D) multilayer, 2D patterned rectangular-, circular-, and stripe-shaped magnetic elements have attracted increasing interest in the areas of nanomagnetism and spin dynamics[1]. Owing to the development in the fundamental understanding of excited spin-wave modes in micron or nano-sized magnetic thin films[2], new classes of logic devices along with other integrated electronic circuits based on spin waves are now emerging[3,4]. To make spin-wave-based functionalities be applicable to practical logic devices, guiding and controlling the propagations of spin waves in magnetic media are crucially important. Correspondingly, the understanding of reflection and refraction of spin waves in magnetic waveguides of lateral confinements is thus necessary.

2. Results and Conclusion

In this presentation, we report on macroscopic waves properties of spin waves in restricted geometry, particularly, reflection, refraction, and Snell's law. Furthermore, an explicit form of the refractive index is analytically derived from a microscopic approach using both an inverse of dispersion relations of two constituent magnetic media and a general boundary condition of magnetizations at their interface. Micromagnetic simulation results of the macroscopic propagation, reflection and refraction at a specific interface between Permalloy (Py: $Ni_{80}Fe_{20}$) and Yttrium iron garnet (YIG :$Y_3Fe_5O_{12}$) are compared with the analytical calculation results. Moreover, we show an example of total reflection of spin waves. Snell's law and an analytical form of the refractive index may provide not only analytic constraints of spin wave modes at various interfaces between different combinations of two magnetic media, but also much quantitative information on macroscopic reflection and refraction behaviors of spin waves[5].

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3. References

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†Author to whom correspondence should be addressed; electronic mail: sangkoog@snu.ac.kr