Origin of robust interaction of spin waves with a single skyrmion in perpendicularly magnetized nanostripes

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1. 서 론

The topological stability of skyrmions is highly advantageous to their memory-device applications, owing to both their nano-scale dimensions and ultra-low critical current density [1]. Therefore, reliable manipulation of magnetic skyrmions by spin-polarized currents or magnetic fields has attracted great interest[1-5]. Very recently, skyrmion motions also have been found to be driven by means of propagating spin waves (SWs) in nanostripes [6,7]. This alternative approach is of particular interest in terms of the promise of all-magnetic control of skyrmions in geometrically constricted elements. Despite their fundamental and technological importance, however, the underlying physics of spin-wave-skyrmion interactions remain obscure.

2. 실험방법과 결과

In the present study, weemployed micromagnetic numerical simulations to study interactions between propagating spin waves (SWs) and a single skyrmion in a perpendicularly magnetized CoFeB nanostripe where the magnetic layer is interfaced with W and MgO. Micromagnetic numerical calculations revealed that robust interactions between the incident SWs and the skyrmion give rise to considerable forward skyrmion motions for specific SW frequencies (e.g., here: f_{sw} = 12 − 19 GHz). Additionally, it was found that there exists a sufficiently low threshold field amplitude, e.g., 0.1 kOe for the f_{sw} = 15 GHz SWs.

3. 고 찰

Considerable SW reflection from the skyrmion will occurin the specific 12 − 19 GHz range, which corresponds to the skyrmion internal modes. The frequency-dependent interaction originated from the robust coupling of the SWs with the internal modes of the skyrmion, through the SWs' linear momentum transfer torque acting on the skyrmion.

4. 결 론

In summary, we observed considerable forward skyrmion motions driven by SWs of specific frequencies. The motion velocity varies with the incident SWs' frequency andamplitude. This work provides for all-magnetic control of skyrmion motions with outelectronic currents, and facilitates further understanding of the interactions between magnonsand topological solitons in constricted geometries.

5. 참고문헌

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