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Spin wave induced domain wall motion in perpendicularly magnetized system

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Domain wall (DW) motion in patterned ferromagnetic wires has been intensively studied due to its importance not only for underlying physics but also for its potential device application such as magnetic memories and logic devices. Recently, the novel way to drive the DW by the spin wave (SW) has been explored [1-4]. These reports focus on in-plane magnetized nanowire in presence of transverse DW [1-3] and vortex DW [4]. On the other hand, SW induced DW motion in perpendicularly magnetized nanowire is yet to be explored. In this study, we perform micromagnetic simulations of the DW motion in presence of SWs in perpendicularly magnetized nanowires.

The setup of the simulation is shown in Fig. 1. The wire dimension is 3072 × w × 1.4 nm^3. The wire width w varies from 18 nm to 72 nm. We assume typical material parameters of a perpendicularly magnetized Co/Ni multilayer film. Magnetic easy axis is set to z direction. In order to excite the SWs, we applied an alternating magnetic field $\boldsymbol{B} = B_0 \sin(2\pi f_{\mathrm{sw}} t)\hat{\boldsymbol{x}}$ along x direction at a localized area (3 × w × 1.4 nm^3) centered at x = −300 nm. The frequency f_{sw} is varied from 1 GHz to 100 GHz with 1 GHz step and the amplitude of magnetic field is fixed at B_0 = 1 T. No static magnetic field is applied.

Figure 2 shows the DW displacement at t = 20 ns as a function of frequency in the 21, 27, 36, and 72 nm-wide wire. Negative DW displacement is broadly observed above f_{sw} ~30 GHz for all the wires and positive DW displacement is resonantly observed at certain frequencies except 27 nm-wide wire. In 72 nm-wide wire two positive peaks are obtained. We will discuss the mechanism of the positive and negative DW displacement in the presentation.

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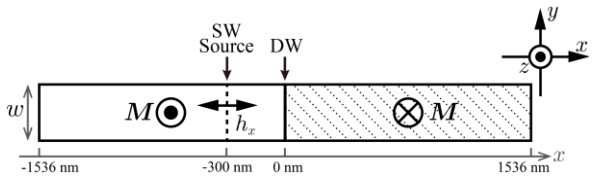

Fig. 1. Schematic of the simulation setup.

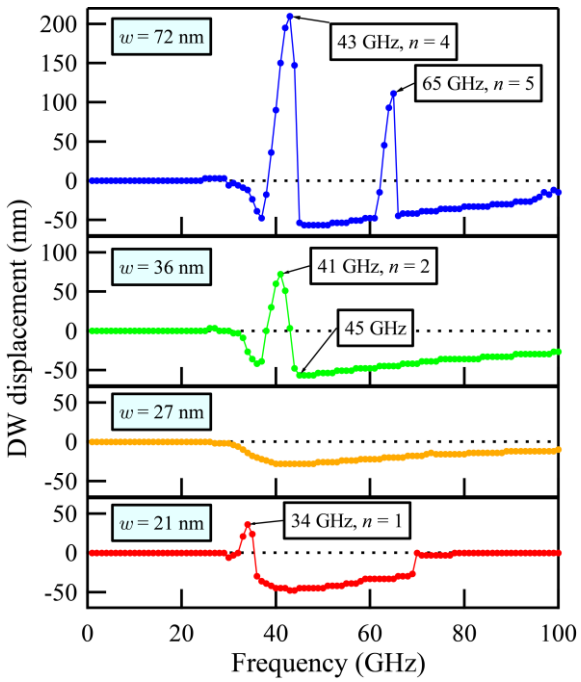

Fig. 2. DW displacement as a function of frequency in the 21, 27, 36, and 72 nm-wide wire.