Brillouin light scattering study of hybrid magnon–phonon modes in CoFeB films

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Hybrid wave phenomena combining magnetic and elastic excitations are attracting growing interest for their potential to enable low-power signal processing, directional transport, and multifunctional information carriers. In thin-film systems, the interplay between magnons and phonons offers a versatile platform to tailor dispersion relations and control energy transfer between coexisting degrees of freedom. Yet, even in structurally symmetric materials, the detailed conditions under which these hybrid excitations acquire directional or angular sensitivity remain largely unexplored.
In this work, we investigate the interaction between magnetic and elastic modes in nanometric CoFeB films using thermally activated Brillouin light scattering. Systematic measurements over a wide range of in-plane propagation angles reveal a clear directional dependence of the coupled magnon–phonon response. While the uncoupled magnetic and acoustic branches remain fully reciprocal, their mutual interaction exhibits angle-dependent frequency shifts, demonstrating that the hybridized dynamics are highly sensitive to propagation geometry.
To interpret these trends, we combine the experimental results with numerical simulations that treat magnetization and elastic motion on equal footing. The calculations reproduce the observed spectral evolution and show that subtle geometry-dependent features of the individual modes modulate the interaction strength, even in a laterally continuous and elastically symmetric film.
These findings establish that magnon–phonon interactions can acquire controlled directional characteristics without relying on structural asymmetry, opening new possibilities for angularly tunable hybrid waves in thin-film magnetic systems.