Excitation and Propagation Dynamics of Spin Waves Observed by Spin-wave Tomography

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In magnetic media, waves of precessional motion of magnetization serve as an elementary excitation, called spin wave. To know its properties, one should measure how its frequency with its wavenumber vector. This relation is called dispersion relation. Spin waves, mediated by dipole-diploe interaction, are called pure-magnetostatic waves. The dispersion relation of pure-magnetostatic spin waves is characterized by complicated and anisotropic dispersion relations; their slope may even become negative for the so-called backward volume magnetostatic waves. The magnetostatic waves have been employed in spintronic and magnonic devices, while the observation of dispersion relations of pure-magnetostatic waves was one of the challenges.

Recently, we developed a new method for the direct observation of the dispersion relation of pure-magnetostatic waves by developing a table-top all-optical spectroscopy; we named spin-wave tomography (SWaT) [1]. Spin waves are excited by the illumination of an ultrashort light pulse focused on a very small surface area of a magnet medium. When the pulse duration and the excitation area of the light pulse are infinitesimally small, the pulse includes all temporal and spatial wave components according to the Fourier theorem. Then, spin waves of all frequency and wavenumber vector are created simultaneously and propagate from the excitation point. The created spin waves are observed by using a time-resolved magneto-optical imaging technique [2]. The Fourier transformation of the observed waveform along the time and spatial coordinates gives the power spectra of spin waves as a function of the frequency and the wavenumber vector. The spectra represent the dispersion relation of spin waves. This is the basic concept of SWaT [1].

In this talk, I will introduce our recent studies about the excitation and the propagation dynamics of spin waves using time-resolved SWaT [1,3] and phase-resolved SWaT [4,5], of which typical data are shown in Figs. 1(a) and 1(b), respectively.

References
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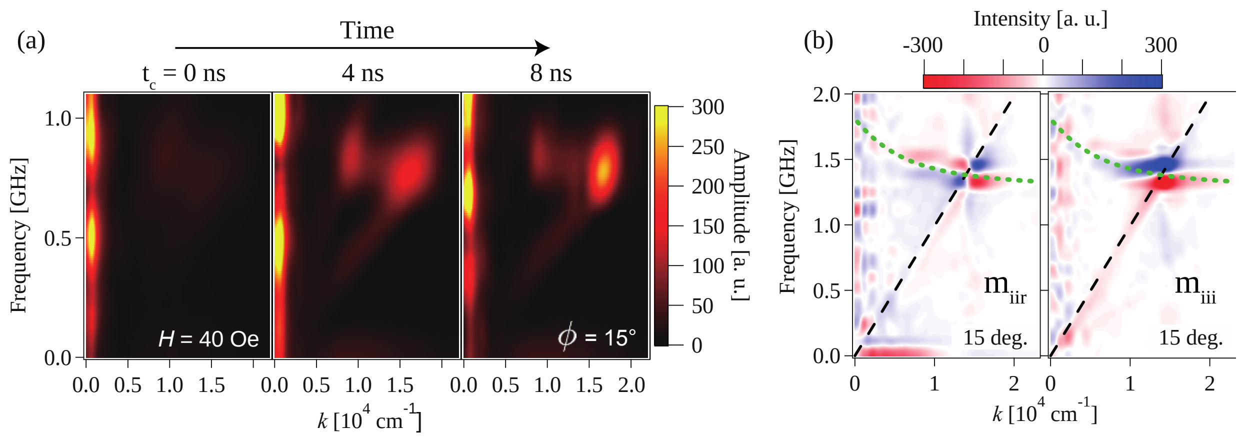

Fig. 1 Typical data of (a) time-resolved SWaT [1,3] and (b) phase-resolved SWaT [4,5].