Vorticity-inversion Brillouin light scattering by magnons in yttrium iron garnet crystal

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Angular momentum is a good quantum number for all physical processes under continuous rotational symmetry. Under such circumstances, the angular momentum can be transferred from one agent to the other so that the total amount of angular momentum is conserved. We previously demonstrated the existence of two-magnon Brillouin light scattering with helicity inversion in Faraday geometry (namely, light propagates parallel to the external magnetic field) using a spherical yttrium iron garnet (YIG) crystal, a kind of rare-earth garnet [1]. This result suggests the conservation of spin angular momentum in the light-magnon interaction process.

To gain further insight into the magnon-induced Brillouin scattering, we aim to observe optical-vortex-inversion Brillouin light scattering, which implies the conservation of orbital angular momentum. Magnetostatic modes in spherical ferromagnets were analyzed by L. Walker [2,3], suggesting the existence of modes with orbital angular momentum. Using the vortex-sensitive optical heterodyne measurement, we will demonstrate novel selection rules between a specific magnetostatic mode and optical vortices in a spherical YIG crystal.

[1] R. Hisatomi *et al.*, "Helicity-changing Brillouin light scattering by magnons in a ferromagnetic crystal", Physical Review Letters **123**, 207401 (2019).

[2] L. R. Walker, "Magnetostatic modes in ferromagnetic resonance", Physical Review **105**, 390 (1957).

[3] L. R. Walker, "Ferromagnetic resonance: line structure", Journal of applied physics **29**, 318 (1958).