Temperature dependent magnetic excitations in $Tb_3Fe_5O_{12}$ through inelastic neutron scattering

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In spintronics research, control of spin currents has been a key issue. Spin Seebeck effect (SSE) is known to create the spin currents in ferromagnetic or ferrimagnetic insulators under a temperature gradient.

In this research, we focus on peculiar sign-changes in the temperature dependence of the SSE signal from $Gd_3Fe_5O_{12}$ (GdIG) [1]. The compound shows twice changes: one is at 270 K corresponding to the magnetic compensation point. The other is at around 70 K, and it cannot stem from the magnetic structure change. The origin of the sign change at lower temperature has not been clarified yet. One possibile mechanism is a competition between the acoustic and gapped optical magnon modes that carry spin currents in the opposite direction due to their directions of the precessional motion of magnetizations (magnon polarization) [2].

Inelastic neutron scattering is a powerful method to study magnetic excitations including observation of the magnon polarization. Given that gadolinium has a very large neutron absorption cross section, it is supposed to be difficult to observe neutron scattering signal. We hence searched alternative iron garnets with distinct rare-earth elements, and have confirmed that $Tb_3Fe_5O_{12}$ (TbIG) shows similar behavior through SSE measurements. For the first step of our research, we performed an unpolarized inelastic neutron scattering experiment on BL01 4SEASONS at J-PARC to measure magnon dispersion relations in a wide ($\boldsymbol{Q}$, E) regime. In the poster presentation, we show observed three major magnon branches in TbIG and discuss on the mechanism of the sign-change based on their temperature dependences.

[1] S. Geprägs *et al.*, Nat. Commun **7**, 10452 (2016).

[2] Y. Nambu *et al.*, arXiv:1911.11968.