Spin Wave Excitation of $Y_3Fe_5O_{12}$ (YIG) in Thermal Gradient

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Spin Seebeck effect (SSE) refers to generation of a spin current normal to thermal gradient applied in magnetic materials [1], has great application prospects in spintronics devices. In ferrimagnetic insulator, the spin current is carried by spin wave [2], which means the direct observation of the spin wave spin current is feasible by inelastic neutron scattering (INS). Longitudinal SSE with magnetic field perpendicular to the thermal gradient has been reported in YIG [3], which means the typical magnetic insulator provides an excellent environment to further investigate the mechanism of SSE. Due to the gapless magnetic dispersion in YIG, external magnetic field is required for departing the low energy magnon excitation from the incoherent elastic scattering. The difference caused by SSE is expected to be observed in the region close to the bottom of the excitation which possess large spin wave populations. The INS experiments were performed on HER, C1-1 at JRR-3. Final energy E_f=5 meV was adopted to observe the spin wave excitation. The scattering plane is the (H,H,H)-(K,-K,0) plane. The total sample mass is 4.4 g. The sample mosaic is estimated to be within 1 degree. The thermal gradient was applied along the (-H,-H,-H) direction. The magnetic field was applied along the (L,L,-2L) direction.

Figure 1 shows constant-E scans at energy transfer E_t=1.75 meV along both (H,H,H) and (K,-K,0). The asymmetric feature already in no thermal gradient configuration is because of the instrument resolution. The higher intensity of the thermal gradient configurations is because of the scaled-up Bose factor. Summation and integration of the excitation of the left and right side to the Brillouin zone center was performed to identify whether the thermal gradient enhances the asymmetry. The obvious difference was not observed within our experimental resolution. In this experiment, stable thermal gradient was successfully applied to the crystal. The intensity quantity of several temperature conditions was obtained. For next experiment, we will try different setups such as focusing on energy gain side in HER mode or efficient measurement on energy loss side in HODACA mode.

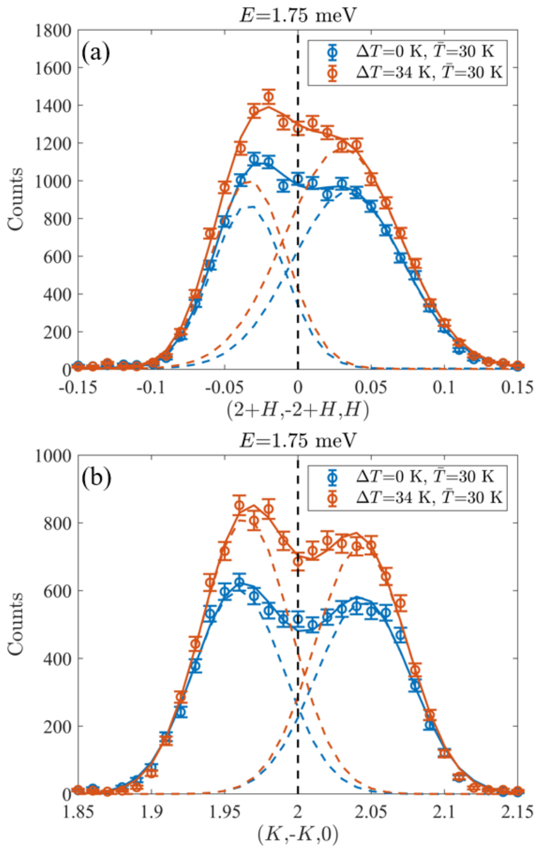

Fig. 1. Constant energy scans at different temperature conditions, H=5 T. The black dash line indicates the zone center. The dash curves are the Gaussian fitting. The solid curves are the summation of each two Gaussian peaks.

[1] K. Uchida *et al.*, Nature. **455**, 778–781 (2008).
[2] K. Uchida *et al.*, Nat. Mater. **9**, 894–897 (2010).
[3] T. Kikkawa *et al.*, Phys Rev. Lett. **110**, 067207 (2013).