Effect of in-plane magnetic field for the nonreciprocal magnon in α-$Cu_2V_2O_7$

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The recent inelastic neutron scattering study on the noncentrosymmetric antiferromagnet α-$Cu_2V_2O_7$ revealed unusual magnon band splitting resulting from symmetry breaking [1]. The magnon band splitting is due to the Dzyaloshinskii-Moriya (DM) interaction, and introduces the difference in the phase velocity of the counter rotating modes. For linearly polarized magnons, the difference of the phase velocity results in the rotation of the polarization direction. This effect is analogous to the optical rotation in noncentrosymmetric media and may be used in future spintronics devices.

Recently, a theoretical proposal was made, in which nonreciporocal magnetic quasiparticles may be realized in honeycomb and/or zigzag magnet due to the diagonal part of the anisotropic exchange interactions [2]. It is noted that the nonreciprocal magnon in honeycomb/zigzag compound may be enhanced under the in-plane magnetic field in a very intriguing manner; the dispersion is not only shifted, but also distorted so that it would have different group velocity for different directions. Hence, it may be possible that such diagonal anisotropy can bring about new type of nonreciprocity for the magnon and other magnetic quasiparticle propagation.

We performed an inelastic neutron scattering under the magnetic field on the single crystal of α-$Cu_2V_2O_7$ to investigate the effect of in-plane magnetic field to the magnetic excitation of α-$Cu_2V_2O_7$. The thermal-neutron triple-axis spectrometers 4G-GPTAS and C1-1 installed at the JRR-3 were used for this purpose. In the experiments, we applied the magnetic field along the *c*-axis of α-$Cu_2V_2O_7$. The measurement at 4G-GPTAS was performed using neutron with fixed final energy 14.7 meV and horizontal collimations of 40'-RC-RC-30mm slit. A PG filter was placed after the sample. The magnetic field up to 1 T was applied using the Saikoro magnet. We could not observe the change in the magnon dispersion under this experimental condition.

The measurement at C1-1 was performed using neutron with fixed final energy 3.635 meV and horizontal collimations of guide-open-80'-open. Cooled Be/oriented-PG crystals and room-temperature Be filters were placed in the incident and scattered beams. The magnetic field up to 4 T was applied using a superconducting magnet. Figure 1 shows the constant-Q scan at **Q** = (0, 2, 0) and T = 2.4 K. The energy shifts due to the applied magnetic field is observed. Nevertheless, the gap opening of the magnon dispersion at the band-crossing point predicted by the spin-wave theory could not be observed.

[1] G. Gitgeatpong et al., Phys. Rev. Lett. 119, 047201 (2017).
[2] T. Matsumoto and S. Hayami, Phys. Rev. B 101, 224419 (2020).

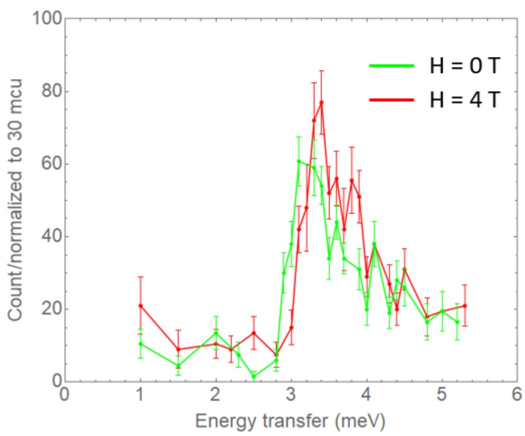

Fig. 1. The constant-Q scan at **Q** = (0, 2, 0) and T = 2.4 K. Red and green curves represent the data collected under the applied magnetic field H = 4 T and H = 0 T, respectively along the *c*-axis.