MLF Experimental Report	提出日 Date of Report 2013/06/05
課題番号 Project No. 2013A0087 実験課題名 Title of experiment Study of quasielastic diffuse scattering in the triangular-lattice Heisenberg antiferromagnet $CuCrO_2$ 実験責任者名 Name of principal investigator Ryoichi Kajimoto 所属 Affiliation J-PARC Center, Japan Atomic Energy Agency	装置責任者 Name of responsible person Kenji Nakajima 装置名 Name of Instrument/（BL No.） AMATERAS/(BL14) 実施日 Date of Experiment 13:00 on April 5 – 10:00 on April 8, 2013

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

A single crystal of $CuCrO_2$

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

$CuCrO_2$ has triangular-lattice layers of magnetic Cr ions, and S = 3/2 Heisenberg spins on the Cr sites form a nearly 120° magnetic structure below the magnetic transition temperature T_N = 24 K [1]. On the other hand, the Curie-Weiss temperature (T_{CW}) is estimated to be ~170 K [2], suggesting that strong two-dimensional (2D) spin correlations survive even above T_N. In our previous experiment (2012A0113), we observed that this compound shows characteristic diffuse scattering at $T > \sim T_N$. The diffuse scattering appears at slightly below T_N and still exists even at 60 K. As the origin of the diffuse scattering, there are several candidates: one of the most interesting scenarios is the Z_2-vortex, where the chirality defined by the local 120° correlations of spins forms a vortex structure [3]. Another possibility is spin molecules formed by correlations of three spins on a triangular lattice unit [4]. Since the spin molecule is more an elementary unit in the spin correlations and is involved in the Z_2-vortex, it is natural that both types of spin correlations can show similar scattering patterns. In order to distinguish these or investigate the transformation from one to the other, careful investigation of the temperature dependence of the diffuse scattering are required. Accordingly, we performed similar measurements at temperatures different from the previous experiment, to extend the temperature region studied.

2. 実験方法及び結果（つづき） Experimental method and results (continued)

The inelastic neutron scattering measurements were performed with the cold-neutron chopper spectrometer AMATERAS. We aligned a 140-mg crystal of $CuCrO_2$ so that the *c* axis is parallel to the incident neutron beam, and the [110] axis lies on the horizontal plane. Then, we rotated the crystal around the vertical axis by 40°. By projecting the observed data onto the *a***b** plane, we could map the 2D magnetic excitations in the *ab* plane. We utilized a set of incident energies (E_i's), 15, 7.7, 4.7, and 3.1 meV, which were produced by the monochromating disk chopper rotating at 150 Hz. The measured temperatures were 26, 30, 35, 120, and 250 K.

Figure 1 shows the scattering pattern on the (*H*,*H*)-(−*K*,*K*) plane at $\hbar\omega$ = 2±0.5 meV observed at several temperatures. At 35 K > T_N, well-defined spots are observed at K points: (1/3,1/3), (2/3,2/3), and (2/3,-1/3), which are attributed to the damped spin wave excitations. In addition, diffuse scattering connecting the K points are clearly observed. At 120 K, which is far above T_N but below T_{CW}, both the spin wave excitations and the diffuse scattering are largely suppressed, though they still retain finite intensities. Further increasing temperature to 250 K > T_{CW}, both the signals finally disappeared. This result suggests that the diffuse scattering as well as the dumped spin wave are related to the 2D spin correlations which exist at $T < T_{CW}$. By combining the present data and the previous data, investigating the temperature dependences of intensity and width of the diffuse scattering, and comparing them with a theoretical prediction, we expect to clarify the origin of the diffuse scattering. The detailed analysis is now in progress.

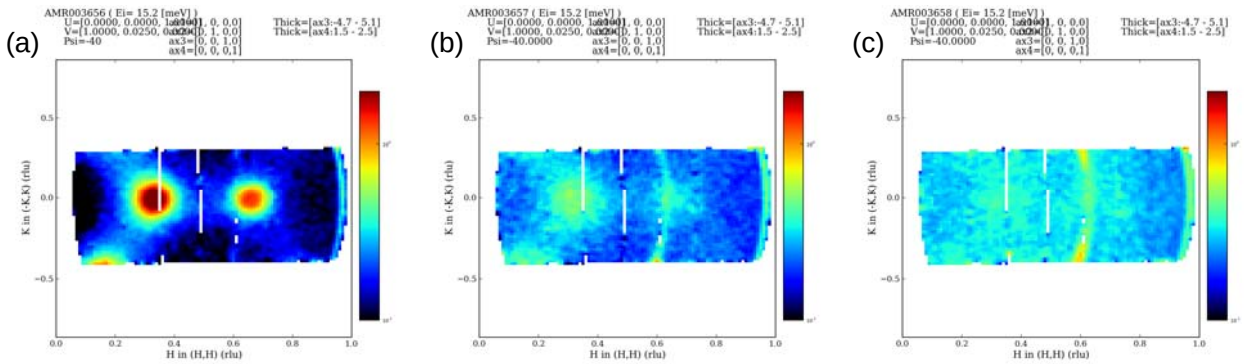

Fig. 1. Scattering pattern on the (*H*,*H*)-(−*K*,*K*) plane at $\hbar\omega$ = 2±0.5 meV observed at (a) 35 K, (b) 120 K, and (c) 250 K. The intensities are normalized versus the proton beam currents. The utilized E_i is 15 meV. Ring-shaped scatterings at *H* ~ 0.6 and ~1.0 are caused by aluminum of the sample holder.

[1] H. Kadowaki *et al.*, J. Phys.: Condens. Matter **2**, 4485 (1990); M. Poienar *et al.*, Phys. Rev. B **79**, 014412 (2009); M. Soda *et al.*, J. Phys. Soc. Jpn. **78**, 124703 (2009).

[2] T. Okuda *et al.*, Phys. Rev. B **72**, 144403 (2005).

[3] H. Kawamura and S. Miyashita, J. Phys. Soc. Jpn. **53**, 4138 (1984); T. Okubo and H. Kawamura, J. Phys. Soc. Jpn. **79**, 084706 (2010); H. Kawamura, J. Phys.: Conf. Ser. **320**, 012002 (2011).

[4] S.-H. Lee *et al.*, Nature **418**, 856 (2002); K. Tomiyasu *et al.*, Phys. Rev. Lett. **101**, 177401 (2008).