Incommensurate magnetic order in the spin-1/2 anisotropic triangular lattice antiferromagnet $Ca_3ReO_5Cl_2$

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Noncollinear magnetic structures induced by spin-orbit interactions have focused attention, such as a chiral magnetic soliton lattice [1] and a skyrmion lattice [2,3] induced by uniform Dzyaloshinskii-Moriya (DM) interactions in a noncentrosymmetric system. Uniform DM interactions act as a twist force between neighboring spins, while Zeeman energy forces all the spins to align along a magnetic field. Noncollinear spin structures with a large period can be induced by their competition. On the other hand, a variety of magnetic structures are also present in the centrosymmetric system because of competition among DM interactions, isotropic exchange, and Zeeman energy. From this viewpoint, compounds consisting of 4*d* or 5*d* elements, where spin-orbit interactions are strong, should be a good platform to search for interesting magnetic structures.

In this study we investigated the magnetic structure of the spin-1/2 anisotropic triangular lattice antiferromagnet $Ca_3ReO_5Cl_2$ [4,5], where Re^{6+} ions carry spin-1/2. Spinon-like continuous excitations observed in the inelastic neutrons scattering experiments indicate a quasi-one-dimensional characters in magnetism [6]. On the other hand, the presence of the incommensurate magnetic order below T_N of 1.13 K also suggests that DM interactions are also active [6]. To verify this expectation, we performed unpolarized and polarized single crystalline neutron diffraction experiments using the polarized neutron triple axis spectrometer PONTA in JRR-3. The spectrometer was operated in the two longitudinal polarization analysis mode with a wavelength of 2.36 Å by using Heusler 111 reflections for monochromating and analyzing neutrons. Intensities of the spin-flip (SF) and non-spin flip (NSF) channels were measured by controlling spin states by a spin flipper, guide fields and a Helmhelz coil. A single crystalline sample of 0.30 g was mounted in the aluminum cell with a He exchange gas so that the scattering plane becomes the *HK*0 plane. A closed-cycle ^{3}He refrigerator was used to cool down the sample to 0.3 K.

Polarized neutron diffraction experiments have revealed that magnetic reflections only appear in one channel, either a SF or NSF channel. Figure 1 shows the 2θ-θ scans around the 0 0.465 0 and 1 0.535 0 reflections. The 0 0.465 0 (1 0.535 0) reflections were observed in the SF (NSF) channel, whereas no intensities were present in the NSF (SF) channel. According to the magnetic representation analysis, only a single irreducible representation can satisfy this rule. Large intensities of the 0 0.465 0 and 2 0.465 0 reflections compared with that of the 1 0.535 0 reflection indicate that the *ab*-component of the magnetic moments are dominant. Combined with unpolarized single crystalline neutron diffraction experiments, the magnetic structure was found to be a counter-rotating spiral structure with a spiral plane mainly within the *ab*-plane. This structure suggests that the uniform DM vector along the *c*-axis is relevant for the magnetic properties, which is consistent with the spin excitation spectrum [5] and the recent ESR study [6].

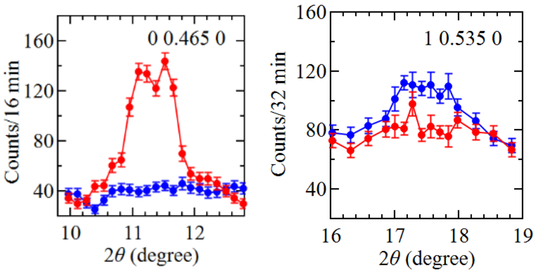

Figure 1. 2θ-θ scans around the 0 0.465 0 (left) and 1 0.535 0 (right) reflections. Red: spin-flip, Blue: non-spin-flip.

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