Homo-chiral crystal growth and mono-chiral helimagnetism in inorganic chiral magnetic compounds

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The concept of chirality, meaning left- or right-handedness, plays an essential role in symmetry properties of nature at all length scales from elementary particles to cosmic science. In material sciences, it is very important to understand the chirality in molecules, crystals and magnetic structures both from theoretical and experimental viewpoints. Chiral helimagnetic structure, forming only one-handed helimagnetic structure, has attracted attention due to emergence of unique magnetic textures such as skyrmion lattice and chiral magnetic soliton lattice. Therefore, it is very important to investigate interplay between crystallographic and helimagnetic chirality because the helicity of a screw magnetic structure strongly depends on the chiral crystal structure which allows an anti-symmetric Dzyaloshinskii-Moriya (DM) interaction. However, there have been few experimental results on the interplay between crystallographic chirality and that of magnetic structure because of difficulty in controlling the crystallographic chirality

Firstly, we will present our crystallization technique to make a single crystallographic chirality in inorganic compounds. For an example, by adapting spontaneous crystallization with stirring, we succeeded in obtaining the cm-sized homo-chiral single crystals of $CsCuCl_3$. Secondly, we will present polarized neutron diffraction works of $CsCuCl_3$ and $YbNi_3Al_9$, performed at BL15 (TAIKAN) in the Materials and Life Science Experimental Facility (MLF) of J-PARC and instrument POLI at Maier-Leibnitz Zentrum (MLZ) in Germany. We observed a strong relationship between crystal and magnetic chiralities, which governs the nature of anti-symmetric Dzyaloshinskii-Moriya interaction. Figure 1 shows omega-scan profiles of the (1/3, 1/3, 6-q) in homo-chiral crystals of $CsCuCl_3$. The difference in intensity between up- and down-spin neutron indicates that mono-chiral helimagnetic structure.

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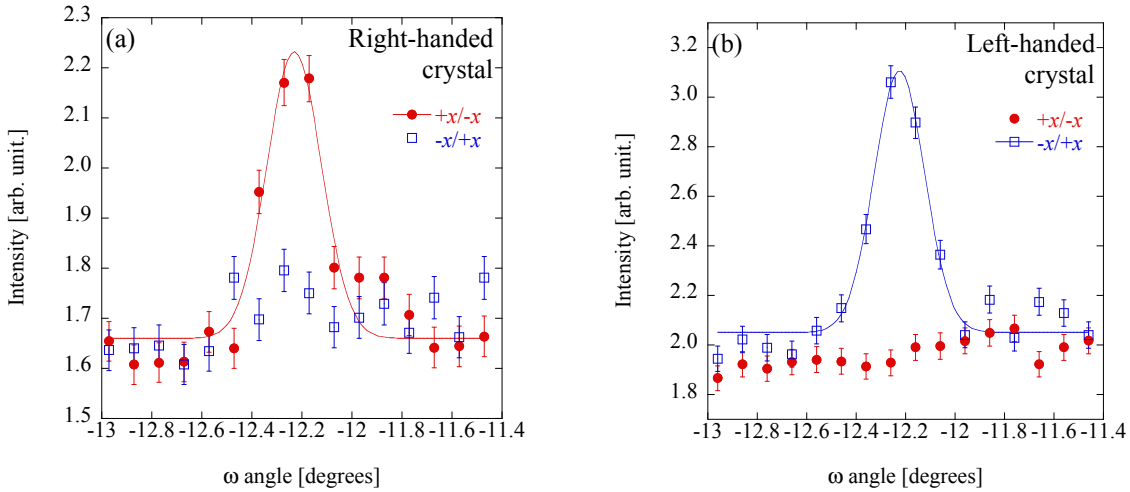

Fig. 1 Omega-scan profiles of the (1/3, 1/3, 6-q) magnetic Bragg reflections for (a) right-handed and (b) left-handed homo-chiral crystals of $CsCuCl_3$