Investigation of magnetic experiment influenced by high pressure in triangular lattice antiferromagnet $CuFeO_2$

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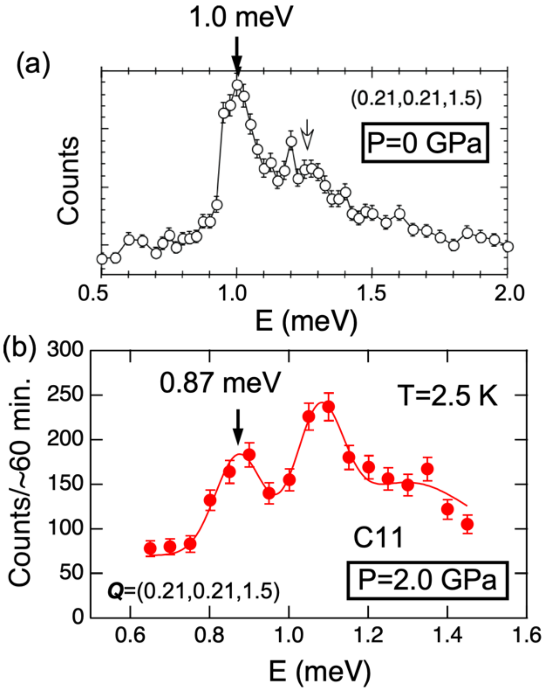
Frustrated magnetism is one of the main research areas in condensed matter physics. As a consequence of competing exchange interactions, caused by geometrical lattice patterns (triangular, Kagomé, pyrochlore lattices) and additional special interactions (Dzyaloshinskii-Moriya (DM), spin-orbit interactions etc), exotic magnetic ground states often emerge, such as spiral-order, spin ice, skyrmions and spin liquids. Furthermore, when frustrated spins are strongly coupled to crystal lattice through the inverse effects, such as exchange-striction and inverse DM effect, novel physical phenomena can happen; for example, magnetoelectric multiferroic property and magnetization plateau. Since a magnetic ground state in frustrated magnetic system is nearly degenerated with others, it can be renewed by a small change in the spin Hamiltonian parameters, Application of high pressure (hydrostatic and uniaxial) and chemical substitution are candidates to modify the parameters, leading to drastic change in the magnetic ground state through disturbing the delicate balance of the competing interactions.

Recently, pressure induced magnetic phase transitions have been reported in the triangular lattice antiferromagnet $CuFeO_2$ (CFO).[1] In the present experiment, we have investigated how magnetic excitation changes by application of pressure for CFO, which reflects the changes in the exchange interactions, by means of the inelastic neutron scattering (INS) experiment at HRC and PONTA in JRR-3. In these experiments, we used the clamp-cell manufactured by ElectroLab company and used the 38 mm^3 volume CFO single crystal. Note that elastic intensity from the sample was reduced to approximately 10 times lower than that measured without the clam cell due to absorption of neutrons for the cell, when we used 5 meV cold neutrons.

The comparison in the INS spectra at between ambient pressure and P =2.1 GPa at T =2.5 K is shown in Fig. 1. The energy gap for the energy minimum at the ICM position Q = (0, 0.4, 0.5) is lowered from 1.0 meV at ambient pressure to 0.87 meV at P =2.1 GPa. On the other hand, the spin- wave energy at the CM position Q = (0, 0.5, 0.5) remains unchanged within the experimental accuracy. (not shown) Furthermore, the energy around the zone boundary at Q = (0, 0, 0.5) also does not change within the experimental accuracy. (not shown) We are analyzing the spin-wave dispersion relations to explain the change in the energy gap by application of pressure.



[1] N. Terada *et al.*, Nat. Commnun. **9** 4368 (2018).

Fig. 1. Comparison in the constant-Q spectrum in $CuFeO_2$ between ambient pressure and P=2.0 GPa.