Spin dymamics of multiferroic compound of $HoMn_2O_5$

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$R Mn_2O_5$ shows a colossal magneto-electirc effect in which magnetization is induced by electric field or inversely electric polarization is induced by magnetic field. The key ingredient in the CME effect is *multiferroics* in which (anti)ferromagnetic and ferroelectric orders coexist and connect with each other. It has been experimentally shown that this system shows successive magnetic transitions of incommensurate–commensurate–incommensurate phases with decreasing temperature, where the bulk electric polarization is induced only in the commensurate phase. The microscopic magnetism in the view point of magnetic structure has been studied intensively to clarify the relation between the microscopic magnetism and bulk dielectrics in this system. However, there is only a few studies about the spin and lattice dynamics, which might be correlated with each other in this multiferroic system. In the present study, we have tried to detect "*electromagnons*", of which excitations can combine with the dielectric order parameter, to clarify the microscopic origin of the colossal magnetoelectric effect.

The experiments were performed using a single crystal of $HoMn_2O_5$ at TOPAN, AKANE and HER spectrometers installed at 6G, T1-3, and C1-1 beam ports in JRR-3M, respectively. In this paper, we introduce the summary of results taken at TOPAN. The constant-Q scans were carried out around magnetic zone center $Q \sim (0.5\ 0\ 1.75)$ at $T = 3$ K (incommensurate phase), 25 K (commensurate phase), and 50 K (paramagnetic phase). Figure 1(a) shows the energy spectra at $Q = (0.7\ 0\ 1.75)$ taken at three temperatures. It is seen that there are temperature dependent signals in the spectra around $\omega = 3 \sim 5$ meV. In order to know the details about these spectra, we took the temperature variation of the signals at $\omega = 3, 4, 5$ meV. As seen in Fig. 1(b), the signals gradually change with changing temperature. However, in the data of $\omega = 3$ and 4 meV, the intensities starts to deviate from each other below $\sim$ 18 K, where the magnetic order changes from commensurate to incommensurate. These signals are almost Q-independent, indicating that the excitation is a crystal field excitation associated with $4f$-moment of Ho^{3+} ion. These results suggest that the correlation between neighbored Ho^{3+} moments changes at the transition from the commensurate phase to the incommensurate phase.

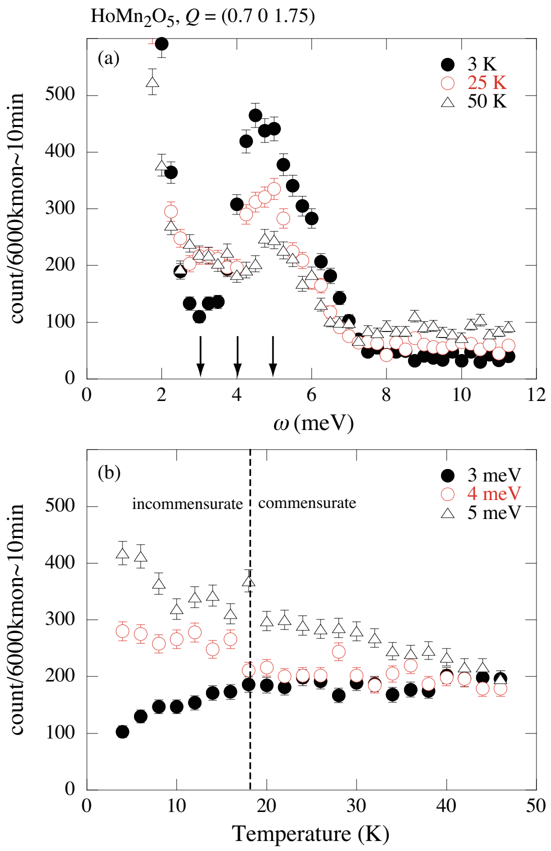

Fig. 1. (a); Energy spectrum at $Q = (0.7\ 0\ 1.75)$ taken at $T = 3$ K, 25 K, and 50 K. (b); Temperature dependences of excitation signals at $\omega = 3, 4, 5$ meV taken at $Q = (0.7\ 0\ 1.75)$.