Magnetic order and magnetic excitations in the Kondo-semiconductor $CeOs_4Sb_{12}$

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$CeOs_4Sb_{12}$ is a candidate of a Kondo-semiconductor realized in the group of the skutterudite compounds which show various strongly correlated electron phenomena in the same crystal structure. In our previous experiments we found that the compound shows an antiferomagnetic ordering with a tiny magnetic moment of about 0.05 μ_B/Ce at the temperatures below about 1 K. We also observed some indication of magnetic excitations with an energy scale of 10 K around the magnetic zone center in our inelastic neutron scattering measurement down to 0.7 K. The purpose of the present work is to get more detailed information on the nature of the unusual magnetic order and magnetic excitations in the compound. We carried out an experiment at the cold neutron triple axis spectrometer C1-1:HER equipped with a large horizontally focused analyzer. The single crystal sample of 13 g was cooled down to 80 mK using the dilution refrigerator. Final neutron energy of 5 meV (k_f=1.553 Å^{-1}) was employed.

In the inelastic scattering measurements, we observed similar inelastic response with the energy transfer below about 1 meV around Q=(1,0,0) reciprocal lattice point at 80 mK as those observed in the previous experiment. However, the signal intensities were very weak and it was difficult to well characterize them except the features described above from the data obtained within the allocated beam time.

We also measured temperature and magnetic field dependencies of the intensity of the (1,0,0) magnetic Bragg peak in order to get useful information about the ordered state below 1 K. Fig. 1 depicts the observed temperature dependences of the peak intensities at magnetic fields of zero and 0.5 T. Note that the horizontal axis is scaled by the 3/2 power of the temperature. The experimental result shows that the temperature dependence of the magnetic moment associated with the antiferromagnetic order obeys well the 3/4 power law. It was also observed that the intensity of the (1,0,0) magnetic peak decreases linearly with increasing magnetic field and disappears at about 1 T.

These results suggest that the low temperature ordered phase of $CeOs_4Sb_{12}$ observed below about 1 K is categorized as that of the weak antiferromagnetism in the itinerant electron system that is described by the spin-fluctuation theory by T. Moriya group. However, the fact of the disappearance of the antiferromagnetic Bragg peak at about 1T is puzzling since the reported upper critical magnetic field of the ordered phase determined by the specific heat and resistivity measurements is more than 10 T at low temperatures. Further experiment is necessary to establish overall features of the unusual electronic state of the compound.

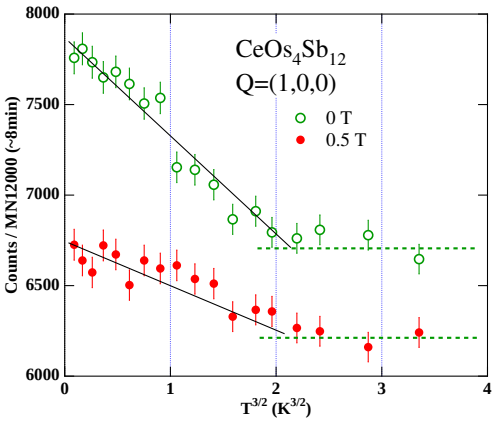

Fig. 1. Temperature dependence of the (1,0,0) peak of $CeOs_4Sb_{12}$