Study of spin gap in two-dimensional frustrated triangular lattice: YbAl3C3

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YbAl3C3 shows the highly frustrated phenomena with a spin gap. The inelastic neutron spectra of low-lying magnetic excitations at low temperatures are quite similar to those of SrCu2(BO3)2 and (CuCl)LaNb2O7 that exhibit a dimer ground state in a two-dimensional quantum spin system. In order to investigate low-lying magnetic excitations at low temperature, we performed inelastic neutron scattering (INS) measurements on the triple-axis spectrometer C1-1 (HER) installed at the JRR-3M reactor. The collimations after the monochromator were open-(Sample)-radial collimator-open.

Figure 1 shows the spectra measured using Ef=2.4 meV with a high resolution of 0.06 meV at T=0.7 K. As a result, it became clear that the first excited state consists of three excitations and the second excited state is composed of many excitations. The solid line shows the least-squares fit to the experimental data where the peaks are approximated by three Gaussian curves. The excitation energies are estimated to be 1.22, 1.42, and 1.62 meV using the same full widths at the half maximum of 0.18 meV. In single crystalline SrCu2(BO3)2, the three resolved branches of the triplet excitation, which are attributed to the Dzyaloshinski-Moriya interaction, were observed by high-resolution INS experiments. The crystal symmetry of YbAl3C3 lowers below the phase transition at 80 K; this will satisfy the condition of the Dzyaloshinski-Moriya interaction. When we consider the analogy between the results of the INS measurements for these two compounds, the first and the second excitations are expected to be the single-triplet excitations and two-triplet excitations, respectively. Moreover, the energy gaps, $\Delta_1 \simeq 1.5$ and $\Delta_2 \simeq 2.9$ meV, satisfy the relation $\Delta_2 \approx 2\Delta_1$.

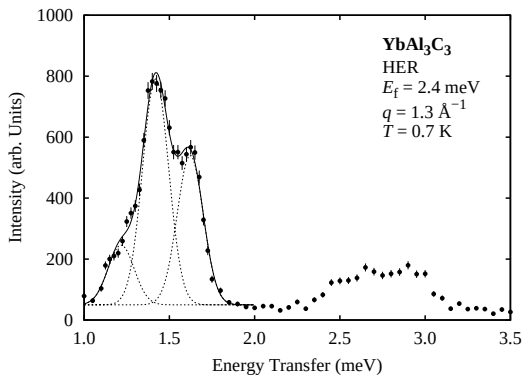

Fig. 1. Detailed inelastic neutron spectra of YbAl3C3 at 0.7 K with Ef=2.4 meV. The full curve represents the least-squares fit where the peaks are approximated by three Gaussian curves.