Magnetic excitations of NaxCoO2.yD2O

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Na0.3CoO2.1.3H2O with the 2-dimensional triangular lattice of Co atoms exhibits the superconducting transition at Tc of 4.5 K [1]. Because it attracted much attention as the first oxide superconductor with 3d-electrons found after the high-Tc Cu-oxides, various experimental and theoretical studies have been carried out to identify the superconducting mechanism.

Here, we have carried out the neutron magnetic inelastic scattering to investigate the relationship between the magnetism and the superconductivity. We used aligned crystals of NaxCoO2.yD2O, in which the volume fraction of the superconducting phase (bilayer phase, y~1.3) was about 75% and the remaining non-superconducting phase was found to be the non-deuterated phase y~0. Because parts of crystals exhibit the superconducting transition at Tc~ 4.5 K and other parts exhibits the anomalies at 6 K by in the T dependences of the magnetic susceptibility and specific heat, we estimate the nuQ value of crystals to be at around 12.5 MHz from the T-nuQ phase diagram reported in reference 2 (nuQ : 59Co-nuclear quadrupole frequency).

The neutron measurements were carried out using the spectrometer 5G installed at JRR-3 with the triple-axis condition. The aligned crystals were used with the [100] and [001] axes in the scattering plane.

Constant-E scans along (h, 0, 2.8) have been carried out at the energy transfer of 3 meV at several temperatures between 5 K and 100 K. In the measurement, the l value of 2.8 was chosen, because where the neutron background count becomes almost minimum in the scan along (0, 0, l). Two magnetic scattering peaks have been observed at h = 0 and h = 1/2. The peak at h = 0 is the two-dimensional ferromagnetic fluctuation and expected to appear when the eg ’band pockets exist at the Fermi surface.

The spectral weight chi ”(Q, omega=3meV) at h = 0 decreases with decreasing temperature and disappears below 25 K. This result indicates that the two-dimensional ferromagnetic fluctuation decreases with decreasing temperature and that the top of the eg ’band is below the Fermi energy. In contrast, the intensity at h = 1/2 seems to increase slightly with decreasing temperature from 100 K to 5 K. Because the intensities of the magnetic excitations observed at h = 0 at relatively high temperatures and h = 1/2 down to 5 K are almost constant with varying l, the magnetic correlations are two-dimensional character.

The present results exclude the possibility of the triplet-pairing of the superconductivity, and are consistent with the results of the NMR Knight shift reported by the present authors ’group [3, 4].

Reference

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