Magnetic excitations in halogen-bridged nickel complex

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Halogen-bridged metal complexes with a one-dimensional (1D) mixed-valence -X-M(II)-X-M(IV)-X- structure have been studied as a Peierls distorted chain system with a strong electron-lattice interaction resulting from the off-centered position of halogen between neighboring metal atoms. Among these compounds, [NiBr(chxn)2]Br2 (chxn:1R, 2R-cyclohexanediamine) have a non-distorted 1D structure expressed as -Br-Ni(III)-Br-Ni(III)-Br-[1,2]. This spin structure implies antiferromagnetic Heisenberg chains with S = 1/2. Magnetic susceptibility measurements up to the room temperature suggested a large exchange constant of J ˜ 0.3 eV [2]. Optical studies have been revealed that this system exhibits a 1D charge transfer insulator [3]. The observed optical properties can be explained by a 1D extended Hubbard model [4], and it suggested J ˜ 0.4 eV, which is consistent with the result on the susceptibility.

In order to detect magnetic excitations, we previously performed an inelastic neutron scattering experiment on HER (C1-1) at JRR3M in JAERI (Tokai) in 2002, by using 20 g of a single-crystal sample. However, we could not detect meaningful magnetic signals at the magnetic zone center at energy transfers up to 1.5 meV at 1.4 K.

Recently, this system has been suggested to be a spin-Peierls system with Tsp˜40K from magnetic susceptibility study as well as 81Br NQR study [5]. By applying the BCS theory to the spin-Peierls system, the gap energy can be estimated to be approximately 6 meV from Tsp. At present, in order to investigate the spin-Peierls nature in this system, an experiment was performed on PONTA (5G) at JRR3M in JAEA (Tokai), by using the same sample. Since, from the previous experiment in 2005, we thought that we could detect tiny magnetic signals at low energy region at the magnetic zone, we again tried to measure inelastic signals to improve statistics at present. The experiment was performed at 8 K and 100 K (below and above TSP), however, we could not detect meaningful magnetic signals because of huge incoherent inelastic signals from hydrogen atoms. In order to detect magnetic signals, deuteration of the sample is essential. For the next time, we try to observe magnetic signals using a deuterated sample.

References

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