Crystal field excitation in $YbNi_3Al_9$

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$YbNi_3Al_9$ is a chiral magnetic material, lacking both the space inversion and mirror reflection symmetries. The space group is *R32*. $YbNi_3Al_9$ exhibits a helical magnetic order propagating along the c-axis below T_N = 3.4 K. In $Yb(Ni,Cu)_3Al_9$, when a magnetic field is applied perpendicular to the c-axis, a chiral magnetic soliton lattice state is formed before the transition to the ferromagnetic state [1]. For H || c-axis, a conical order is induced, resulting in the monotonic increase in the magnetization [2]. To understand these phenomena, it is necessary to know the crystalline electric field (CEF) energy scheme. We performed inelastic neutron scattering experiment using a triple-axis spectrometer TOPAN to observe the CEF excitation and determine the CEF parameters. The measurement was performed using a collection of small pieces of single crystalline samples with a total mass of ~ 5 g, which was set in a He gas closed cycle refrigerator. The final neutron energy was fixed at E_f =13.5 meV. Sapphire filter was placed before the 30' second collimator to reduce the background.

Fig. 1. shows inelastic scattering spectra at 10 K, 20 K, and 50 K. The data has been converted to the scattering function S(E) after correction for the second harmonic incident neutrons. The solid lines are the calculated spectra based on the CEF parameters listed in Table I.

These parameters in Table I give doublet excited states at $E_{|\pm1/2>}$=3.02 meV, $E_{|+-7/2,-+5/2>}$=3.78 meV, and $E_{|\pm3/2>}$=5.95 meV. However, the location of $E_{|\pm1/2>}$ remains a question since the |±1/2> – |±3/2> excitation occurs at high temperatures, which can be less than 1 meV and could have been hidden in the elastic background in this experiment.

[1] T. Matsumura *et al.*, J. Phys. Soc. Jpn., **86**, 124702 (2017). [2] T. Yamashita *et al.*, J. Phys. Soc. Jpn., **81**, 034705 (2012).

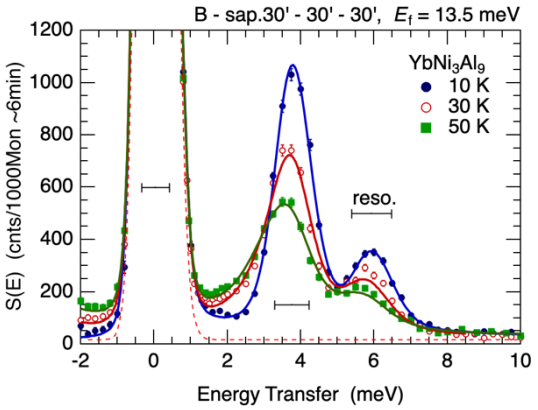

Fig. 1. Inelastic neutron scattering spectra S(E) at 10 K, 30 K, and 50 K. Solid lines are the calculated scattering functions. The horizontal bars represent the FWHM of the instrumental resolution.

Table 1. CEF parameters of $YbNi_3Al_9$.

B20	B40	B60	B66
-0.8	0.0001	0.0022	0.0233