Magnetic excitation spectrum in the frustrated magnet CuFe1-xAlx02

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CuFeO2 with delafossite crystal structure has been extensively studied as one of model materials of geometrically frustrated triangular lattice antiferromagnets (TLA). The magnetic properties in CuFe1-xAlxO2 are highly sensitive to nonmagnetic Al3+ impurity; quite small amount of nonmagnetic Al3+ impurity successively induces ferroelectric incommensurate (FEIC) state ($0.014<x<0.030$) and the oblique partially disordered (OPD) state ($x>0.030$) from the 4-sublattice (4sub) ground state of CuFeO2 [1]. Such dramatic changes due to nonmagnetic Al3+ impurity can be found also in the significant difference between the magnetic excitation spectrums of 4sub and FEIC magnetic orderings; while higher energy (HE) branch is insensitive, lower energy (LE) branch is quite sensitive.[2,3]

The magnetic orderings in OPD phase is also very curious in the viewpoint of thermodynamics, because, even in the lowest temperature, the length of the magnetic moment is modulated owing to the thermal fluctuation. In present study, in order to investigate the magnetic excitation spectrum for OPD state, we have performed inelastic neutron scattering on the sample with x=0.05(344mg) using GPTAS (Kf=2.67[A-1], 40-80-PG-40-40) for high-energy region and HER (Ki=1.25[A-1], Open-Open-Be-80-80) for low-energy region at JRR-3M. Note that we have also measured TA phonons for both x=0.015 and x=0.05 samples so as to quantitatively compare the magnetic excitation spectrums for OPD with these obtained previously for FEIC states.

As shown in the inset of Fig.1, in the typical constant-Q scan for HE branch, spin wave spectrum of the x=0.05 sample can be seen as is for the x=0.015 sample, suggesting that the HE branch still remains for OPD state. On the other hand, as is clearly seen in the typical constant-delta E scan for the x=0.05 sample shown in Fig.1(b), well-defined four spin wave peaks seen in the x=0.015 sample disappears and only diffusive magnetic response can be seen in the low energy region where LE branch for the x=0.015 sample exists.

References

[1] N. Terada et al, JPSJ 74, (2005) 2604
[2] N. Terada et al, JPCM(in press)[a proceeding paper of Highly Frustrated Magnetism 2006]
[3] N. Terada et al, J.Magn. and Magn. Mater. 272-276 Supplement 1 E997-E998 (2004)

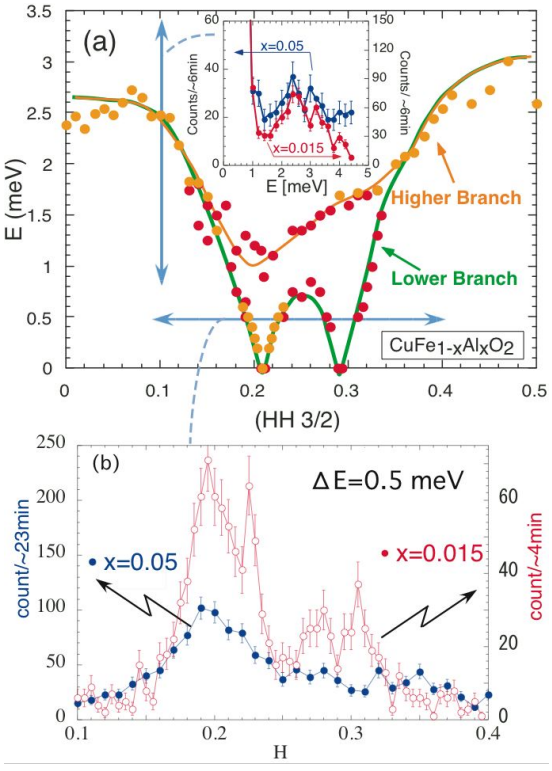

Fig. 1. (a)Spin wave dispersion relation for FEIC state, inset :Typical constant-Q scan profiles for higher branch, (b) Typical constant-dE scan profiles for lower branch