MLF Experimental Report	提出日 Date of Report 27th May 2016
課題番号 Project No. 2015A0225 実験課題名 Title of experiment Unconventional magnetic behavior in new diamond chain system $K_3Cu_3AlO_2(SO_4)_4$ 実験責任者名 Name of principal investigator Setsuo Mitsuda 所属 Affiliation Tokyo University of Science	装置責任者 Name of responsible person 装置名 Name of Instrument/(BL No.) BL 12 (HRC) 実施日 Date of Experiment 11/6-9 2015

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

$K_3Cu_3AlO_2(SO_4)_4$

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

Recently we have newly synthesized one-dimensional S=1/2 scalene diamond chain, Alumoklyuchevskite K3Cu3AlO2(SO4)4 and succeeded in preparing pure-phase [1][M. Fujihala et al. J. Phys. Soc. Jpn. 84 073702(2015)]. As two broad characteristic peaks is seen at T_{HM} ~ 200K and T_{LM} ~50K in the magnetic susceptibility (see Fig.1), the magnetic short-range order develops in a two-stage process, suggesting alternating dimers-monomer state (S=1/2 monomers are separated by S=0 dimers on the diamond chain backbone) which has been inferred in the first realization of the distorted diamond chain system, Azurite, Cu3(CO3)2(OH)2 [2][H. Kikuchi et al., Phys. Rev. Lett. 94, 227201 (2005)]. While Azurite shows a three dimensional long-range magnetic ordering at 1.8 K, Alumoklyuchevskite dose not down to 0.5 K, indicating its very good one-dimensionality. Therefore, to investigate if alternating dimers-monomer state is also realized and what is the ground state of distorted diamond chain system, we performed inelastic neutron scattering experiments on powder sample of Alumoklyuchevskite at 4 K and 100 K, where the energies of the incident neutron were Ei = 205.8 meV and 45.95 meV (second frame) yielding an energy resolutions of ΔE = 5 and 1 meV at the elastic position.

2. 実験方法及び結果（つづき） Experimental method and results (continued)

According to tentative analysis of magnetic susceptibility based on DMRG method, system can be composed of antiferromagnetic S=1/2 chain with coupling constant of 75K and isolated dimers with coupling constant of 450K, approximately. Therefore, inelastic neutron spectrum should be composed of spinon excitation due to 1D AF S=1/2 Heisenberg chain and dispersionless excitation due to isolated dimers.

In Fig.2 (a), the data of Ei = 45 meV, definite excitation starting from the zone center of Q = 0.68 (Å-1) can be seen. Because of powder averaging of the dispersion relation, however, it is hard to identify the spectrum as spinon excitation, as is seen in the inelastic neutron scattering data of a powder CuGeO3 in Fig.2 (c) [3][K.Tomiyasu et al., Appl. Phys. Lett.94, 092502 (2009)]. Definitely, conversion method[3] of powder inelastic scattering data for one-dimensional systems is necessary and data analysis using this method is now in progress. In Fig.2 (b), a data of Ei = 200 meV, weakly dispersive excitation can be seen around 40 meV corresponding to coupling constant 450K of isolated dimer. These results were consistent with an alternating dimer monomer spin liquid model of the distorted diamond chain system.

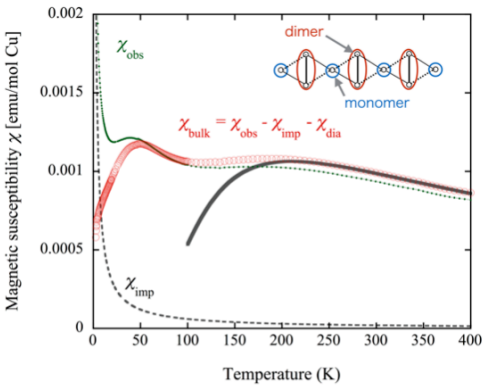

Fig.1 Temperature dependence of the intrinsic magnetic susceptibility χ_{bulk} (red circles) of K3Cu3AlO2(SO4)4 measured at 1T.

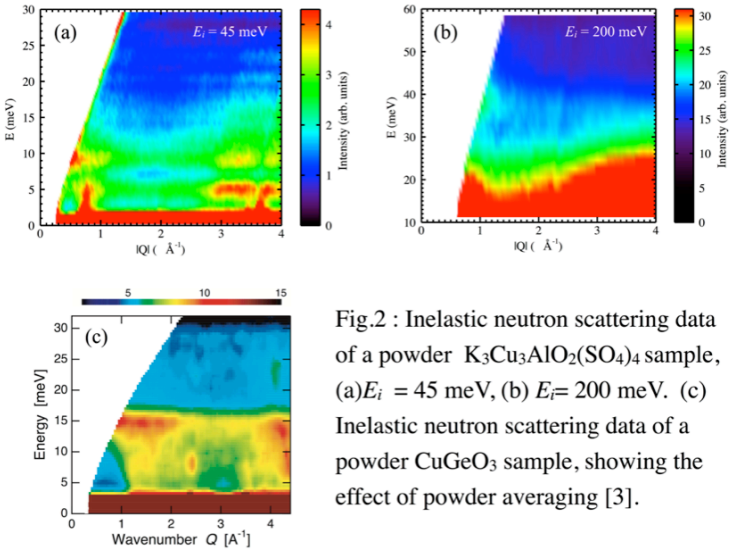

Fig.2 : Inelastic neutron scattering data of a powder $K_3Cu_3AlO_2(SO_4)_4$ sample, (a)E_i = 45 meV, (b) E_i= 200 meV. (c) Inelastic neutron scattering data of a powder $CuGeO_3$ sample, showing the effect of powder averaging [3].