CROSS TOKAI **Experimental Report** J-PARC	承認日 Date of Approval 2014/05/27 承認者 Approver Ryoichi Kajimoto 提出日 Date of Report 2014/05/27
実験課題番号 Project No.2013P0201 実験課題名 Title of experiment Study of structure and electronic properties of functional materials at BL01 実験責任者名 Name of principal investigator Shuichi Wakimoto 所属 Affiliation Japan Atomic Energy Agency	装置責任者 Name of Instrument scientist Ryoichi Kajimoto 装置名 Name of Instrument/（BL No.） 4SEASONS (BL01) 利用期間 Dates of experiments 2013/4/1 – 2014/3/31

1．研究成果概要（試料の名称、組成、物理的・化学的性状を明記するとともに、実験方法、利用の結果得られた主なデータ、考察、結論、図表等を記述してください。

Outline of experimental results (experimental method and results should be reported including sample information such as composition, physical and/or chemical characteristics.

Study of high-Tc cuprates

High-T_c cuprates show characteristic hour-glass shaped magnetic excitation, which has been expected to be closely related to the superconductivity. Previous neutron results of $La_{2-x}Sr_xCuO_4$ (LSCO) by TOF measurements revealed that magnetic dynamical structure factor S(w) has two maxima at ~18 meV and ~50 meV [1]. There are phonon branches near 18 meV and, therefore, it is possible that the crossing with phonons results in enhancement of magnetic excitation at this energy if there is a coupling between magnons and phonons at the first maximum in S(w). However previous TOF experiments measures projected magnetic signals on to the a*b*-plane by aligning the incident neutron parallel to the c-axis. This method misses detailed information of coupling between phonons and magnons. To test if there is such a coupling, we have carried out 4 dimensional mapping of S(Q,w) to see details of both magnons and phonons at different zones.

For these measurements, we used a chopper spectrometer 4SEASONS at MLF, J-PARC, and measured S(Q,w) by rotating crystals. Two compositions

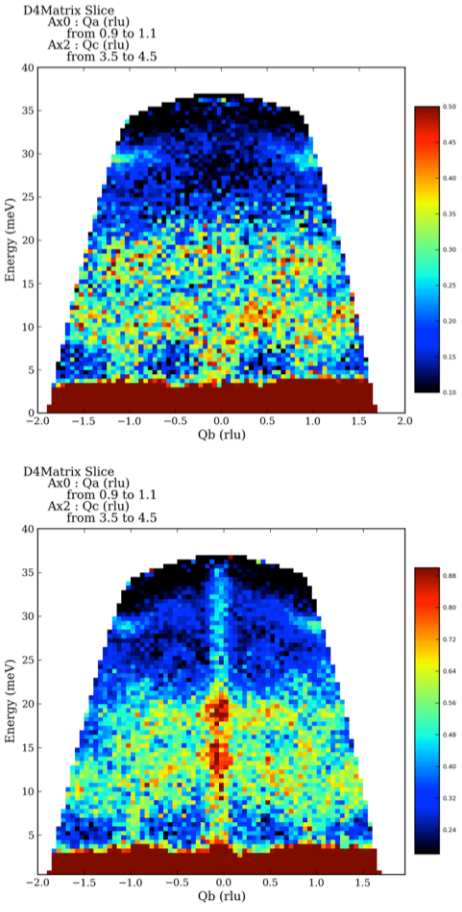

Fig. 1 : K-Energy slice for x=0.30 (upper) and x=0.08 (lower).

of LSCO, x=0.08 and 0.30, were measured. Here, x=0.08 shows magnetic excitation, while x=0.30 shows no magnetic excitation, so the x-0.30 sample is used to evaluate phonons (Fig. 1). Note that in Fig. 1, the hour-glass shape does not appear due to the resolution. We analyzed the magnetic excitation in x=0.008 by subtracting the phonon background estimated from the x=0.30 data. We find that S(Q,w) of x=0.08 indeed shows maximum at ~18 meV equally in different zones with different L values (Fig. 2). This result implies the existence of magnon-phonon coupling. We will study temperature dependence and also non-doped La2CuO4 to collect more experimental evidence of this coupling.

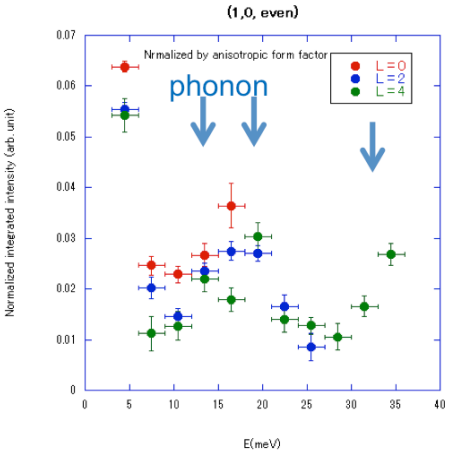

Fig. 2：S(Q,w) at different zones. Vertical arrows indicate energies where phonon branches locate.

Study of S=1 triangular lattice system

What kind of the ground state is observed in the S = 1 triangular lattice is still an interesting issue. For instance, $NiGa_2S_4$ undergoes a 60° short-range magnetic ordered ground state, while $LiVO_2$ shows a so-called valence bond solid (VBS) ground state. Recently, our colleague reported that $LiVS_2$, which is located at the border between a metal and a correlated insulator, shows a first order transition from a paramagnetic metal to a VBS insulator at T_c = 305 K upon cooling. The presence of a VBS state in the close vicinity of insulator-metal transition may suggest the importance of itinerancy in the formation of a VBS state. In addition, a pseudogap was also observed in the high temperature metallic phase of $LiVS_2$, which likely originates from the VBS fluctuation. On the other hand, however, it is not observed the spin gap in the VBS state nor the pseudogap. Therefore, we have performed that the time-of-flight neutron scattering measurements on powder $LiVS_2$ to investigate the origin of the VBS state in $LiVS_2$ by measuring the entire magnetic excitations.

Inelastic neutron scattering measurements were performed using powder $LiVS_2$, which was packed into the aluminum sample can with an indium seal. Measurements were done at T = 7, 150, and 300 K. Incident energy of neutrons was E_i = 308 meV with the Fermi chopper frequency f_{Fermi} = 300 Hz.

An inelastic peak was observed at $\hbar\omega$ = 220 meV, which is very closed to the value expected from the NMR measurement. On the other hand, the peak intensity is enhanced at high temperature. In addition, observed Bragg peaks of the sample were very weak. Since the $LiVS_2$ is air sensitive, we conclude that the quality of the present sample used for our measurement was not good. We are now asking our colleague to make a new sample.