（ ※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。 ）

MLF Experimental Report	提出日 Date of Report 17 October, 2012
課題番号 Project No. 2012A0146 実験課題名 Title of experiment Study of spin excitations in a spin-frustrated conductor LiV_2O_4 with extremely heavy fermion behavior 実験責任者名 Name of principal investigator Keisuke Tomiyasu 所属 Affiliation Tohoku University	装置責任者 Name of responsible person Kenji Nakajima 装置名 Name of Instrument/(BL No.) AMATERAS (BL14) 実施日 Date of Experiment from 15 June 2012 to 20 June 2012

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.

Spinel LiV_2O_4, powder

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.

I. Introduction

Geometrically spin-frustrated conductors are expected to present an intriguing playground for charge coupled with frustrated spin, probably with orbital and lattice also. The representative example is the extremely heavy fermion state in a spinel conductor LiV_2O_4 (averagely $V^{+3.5}$: 1.5 *d* electrons) among *d* electron systems. In the past, other groups found and studied the spin fluctuations/excitations tightly connected to the heavy fermion behavior in LiV_2O_4 by powder inelastic neutron scattering [1-2]. Quasi-elastic diffuse scattering was discovered to grow with half-width $\Gamma \sim 1$ meV around magnitude of momentum $Q \sim 0.6$ A^{-1}, and at least another one relaxation component coexists with different Γ value(s). However, the origin of the multiplicity and, in particular, the spatial correlations have been unknown thus far. Thus, in order to clarify them, we study the spin fluctuation in LiV_2O_4 with a new class of neutron spectrometer.

II. Experimental method

Standard inelastic neutron scattering experiments for powder specimen were performed using the CCR.

III. Results

Figure 1 shows the measured inelastic neutron scattering data obtained at the present lowest temperature 7 K. In the left panel, the fountain-like dispersive spin excitations are observed around momentum $|Q| \sim 0.6$ A^{-1}. This dispersive nature was revealed for the first time, and can explain why the spin excitations are seen to consist of multiple components, since dispersion normally means many excited states characterized many Q and E. Further, although there are many suggestions for spatial spin correlations; it could be low dimensional or three-dimensional, our data exhibits no Warren-function-like tail in the high-$|Q|$ side that evidences low-dimensional spin correlations. LiV_2O_4 therefore exhibits three-dimensional spin correlations.

The right panel shows the constant energy slice integrated from 2 to 3 meV. The second peak is newly found around 2.5 A^{-1}, which are identified to be partially phononic but mainly magnetic judged from high-$|Q|$ with high E_i data (not shown). The intensity is much weaker than that of the first peak around 0.6 A^{-1}, which probably explains why the second peak has not reported thus far. Interestingly, the set of the first and second peaks, including its intensity ratio, is quite similar to the magnetic scattering observed in another spinel $GeCo_2O_4$ [3]. Now we are trying the analysis of the spatial correlations along this line.

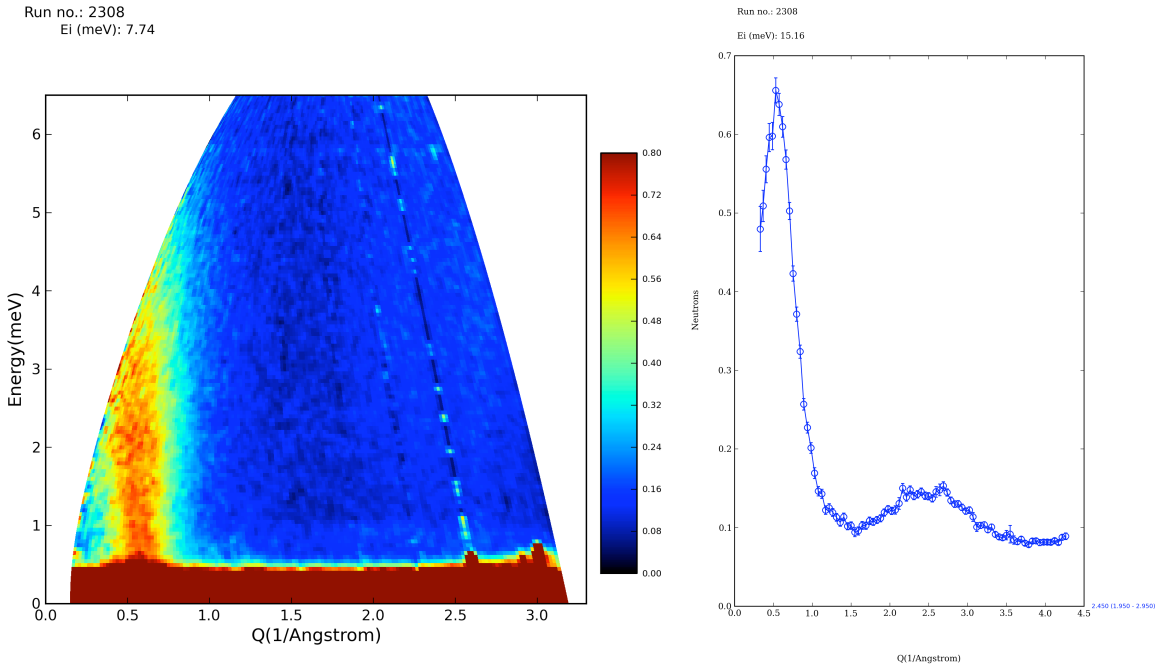

Figure 1. Measured inelastic neutron scattering data obtained at 7 K. The left panel shows the scattering intensity distribution in momentum (Q) and energy (E) space. The right panel shows $|Q|$ dependence of intensity integrated from 2 to 3 meV.

References

[1] S.-H. Lee *et al.*, Phys. Rev. Lett. **86**, 5554 (2001).
[2] A. P. Murani *et al.*, J. Phys.: Condens. Matter **16**, S607 (2004).
[3] K. Tomiyasu et al., Phys. Rev. B **84**, 054405 (2011),