CROSS TOKAI Experimental Report J-PARC	承認日 Date of Approval 2016/10/11 承認者 Approver Ryoichi Kajimoto 提出日 Date of Report 2016/10/5
課題番号 Project No.: 2014B0151 実験課題名 Title of experiment: Genuine ground state in the T'-structured cuprate oxide studied through the thermalevolution of spin excitation 実験責任者名 Name of principal investigator:Fujita Masaki 所属 Affiliation: Institute for Materials Research, Tohoku University	装置責任者 Name of Instrument scientist R. Kajimoto 装置名 Name of Instrument/（BL No.） 4 SEASONS BL. 01 実施日 Date of Experiment 2015/3/24 – 2016/4/1

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.

Annealed $Pr_{1.4}La_{0.6}CuO_4$

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.

Experimental method : Inelastic neutron scattering
Measured temperature : 6, 300 and 470 K
Fermi Chopper Frequency : 250 Hz, Incident neutron energies : 360, 254, 88 and 39 meV

The parent compound of T'-structured electron doped cuprate has been believed to be Mott insulator. However, the emergence of superconductivity in the thin film of R_2CuO_4 after an adequate annealing procedure was recently reported. Therefore, the genuine ground state of T'-structured cuprate oxide has attracted much attention from a viewpoint of new mechanism of superconductivity. In order to shed light on this issue, we studied the thermal evolution of spin excitation spectrum in the annealed $Pr_{1.4}La_{0.6}CuO_4$.

Figure 1 shows the excitation spectrum measured at 6 K, 300 K and 470 K. With using a large number of crystals, we succeeded in observing the excitation spectrum in a wide energy and momentum space above and below Néel temperature T_N (~180 K). At base temperature, the spin-wave excitation was observed. Even at the high temperature at 470 K, which is much large than $2T_N$, the magnetic signal was found to remain around the zone center. Then, we fitted the energy-sliced spectrum by single Gaussian function to evaluate the temperature dependence of

spectral shape and dynamical spin susceptibility. Figure 2 shows the spectral shape at three temperatures obtained by the analysis. The peak-width along the momentum direction (full-width at half-maximum) enlarges with increasing the energy transfer, reflecting the outward dispersion of spin wave excitation as seen in La_2CuO_4. The shape at 300 K and 470 K is almost same with the that at 6K. Therefore, the spectral shape is robust against the temperature even above T_N. Similarly, as seen in Fig. 3, the dynamical spin susceptibility shows negligible temperature dependence in a wide energy range below 180 meV. From these results, we conclude that the magnetic ground state is same as La_2CuO_4, which is known to be Mott insulator, in origin. The spin dynamics in the present system is originated from the corrective motion of localized spins with a strong super-exchange coupling. Due to the large coupling constant (~1500K), the excitation is robust against the temperature in the measured temperature range below 470 K.

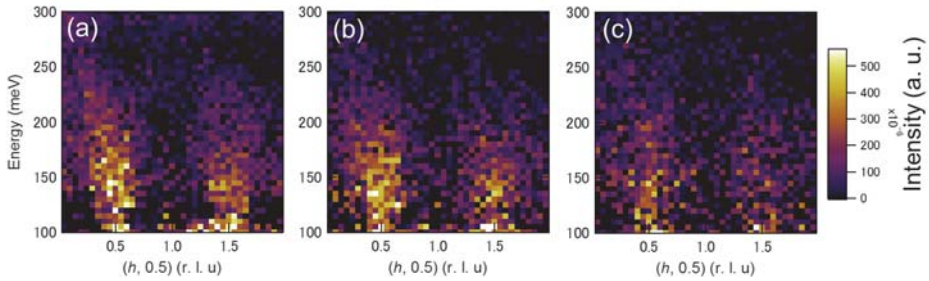

Fig 1 Magnetic excitation spectra measured at (a) 6K, (b) 300 K and (c) 470 K.

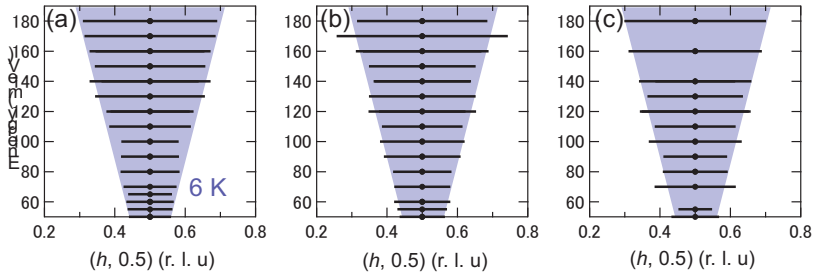

Fig 2 The spectral shape evaluated by the analysis for (a) 6K, (b) 300K and (c) 470 K. Horizontal bars indicate the peak-width in HWHM.

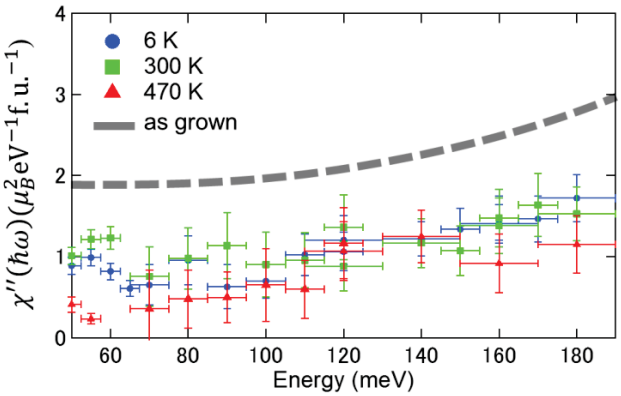

Fig 3 Energy dependence of dynamical spin susceptibility.