| MLF Experimental Report | 提出日 Date of Report |
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| 課題番号 Project No.<br>2012A0071<br>実験課題名 Title of experiment<br>muSR study on frustrated spin system (CuCl)La(Nb(1-x)Tax)2O7<br>実験責任者名 Name of principal investigator<br>Seiko Kawamura<br>所属 Affiliation<br>J-PARC Center, JAEA | 装置責任者 Name of responsible person<br>Prof. Yasuhiro Miyake<br>装置名 Name of Instrument/（BL No.）<br>D1<br>実施日 Date of Experiment<br>31 May 2012 - 03 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.

(CuCl)$LaTa_2O_7$ powder 3g

(CuCl)$LaNb_2O_7$ powder 3g

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.

(CuCl)La$B_2O_7$ ($B$ = Nb or Ta) is quantum spin systems on a two-dimensional square lattice. In these systems, spin frustration is expected to operate due to competition between the nearest and next-nearest exchange interactions, $J_1$ and $J_2$, of the magnetic Cu ions on the square lattice. The magnetic ground state of (CuCl)$LaNb_2O_7$ has been suggested to be spin-singlet with an excitation gap of $\Delta E$ ~ 2.3 meV [1], while (CuCl)$LaTa_2O_7$ exhibits an antiferromagnetic (AFM) order with collinear spin structure below $T_N$ = 7 K [2]. The phase diagram for their mixed compound is reported as shown in Fig. 1 [2]. We proposed μSR experiments on (CuCl)La$(Nb_{1-x}Ta_x)_2O_7$ for several Ta concentration $x$ in order

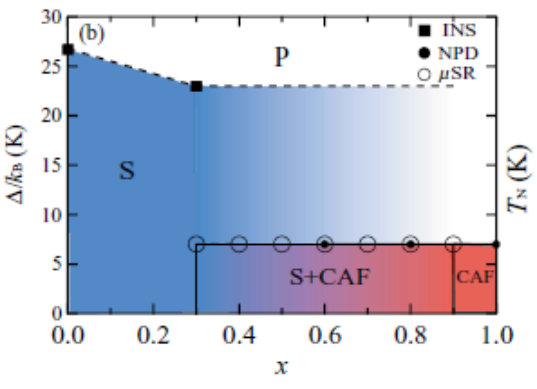


Fig. 1 : Magnetic phase diagram of (CuCl)La$(Nb_{1-x}Ta_x)_2O_7$. P stands for the paramagnetic state, S the spin-singlet state and CAF collinear AFM ordered state.

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

to understand their spin dynamics which reflects different ground states and commonly operating spin frustration. However, in the present experiment, we concentrated on the two pure systems, $(CuCl)LaNb_2O_7$ and $(CuCl)LaTa_2O_7$ because of limited beamtime.

The ZF- and LF-μSR measurements on powder samples of the above-mentioned systems were carried out at D1. Powder sample (~3 g for each) shaped into a disk was fixed onto a sample holder of a vertical flow-type $^4$He cryostat and cooled down to ~2 K. Longitudinal field up to 1500 G was applied.

ZF-μSR time spectra for $(CuCl)LaTa_2O_7$ are shown in Fig. 2. The static internal field due to nuclear dipoles is observed above 15 K, and the muon spin relaxation is gradually enhanced as temperature approaches $T_N$ = 7 K by a critical slow-down effect. Below $T_N$, rapid damping of the asymmetry is observed due to the long-range AFM order. In a previous μSR study on this material using a DC muon beam by Uemura et al., clear muon spin precession is observed [3] with high precession frequencies which are unobservable in the pulsed μSR setup. Our ZF-μSR result is consistent with the previous one though the fast oscillation is averaged. In the LF-μSR time spectra just above $T_N$, the muon spin depolarization due to strong spin fluctuation was expected. However, the obtained time spectra indicate rather static internal field as shown in Fig. 3. It is necessary to do quantitative discussion based on the results of the LF decoupling measurements. On the other hand, the μSR time spectra for $(CuCl)LaNb_2O_7$ show no remarkable enhancement of the muon spin relaxation down to ~2 K in contrast to $(CuCl)LaNb_2O_7$, reflecting different magnetic ground state. Detailed analysis will be proceeded.

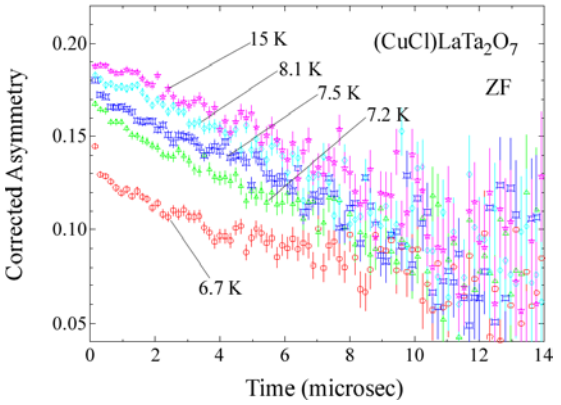


Fig. 2 : ZF-μSR time spectra for $(CuCl)LaTa_2O_7$.

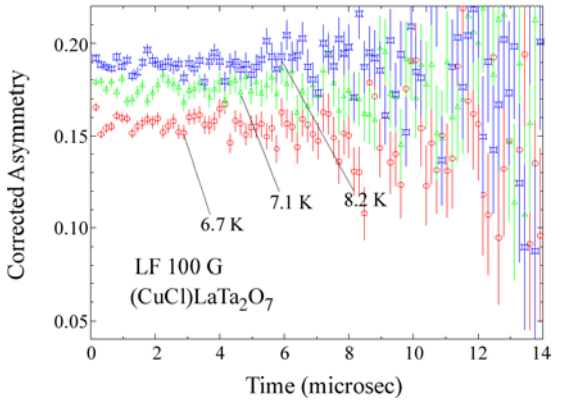


Fig. 3 : LF-μSR time spectra under LF of 100 G for $(CuCl)LaTa_2O_7$

References

[1] H. Kageyama et al., J. Phys. Soc. Jpn. **74** (2005) 1702.

[2] A. Kitada et al., Phys. Rev. B **80** (2009) 174409.

[3] Y. J. Uemura et al., Phys. Rev. B **80** (2009) 174408.