

## Precise $\mu$ SR Measurements in Zero- and Longitudinal-Fields on $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ and $\text{YBa}_2\text{Cu}_3\text{O}_{6+\delta}$

I. Watanabe<sup>1</sup>, T. Adachi<sup>2</sup>, S. Yairi<sup>2</sup>, M. Akoshima<sup>2\*</sup>, Y. Koike<sup>2</sup> and K. Nagamine<sup>3,4,5</sup>

<sup>1</sup>*Advanced Meson Science Laboratory, RIKEN Nishina Center, 2-1 Hirosawa, Wako, Saitama, 351-0198, Japan.*

<sup>2</sup>*Department of Applied Physics, Graduate School of Engineering, Tohoku University, 6-6-05 Aoba, Aramaki, Aoba-ku, Sendai, 980-8579, Japan.*

<sup>3</sup>*Atomic Physics Laboratory, RIKEN (The Institute of Physical and Chemical Research), 2-1 Hirosawa, Wako, Saitama 351-0198, Japan.*

<sup>4</sup>*Muon Science Laboratory, Institute of Materials Structure Science and J-PARC Planning Office, KEK, 1-1 Oho, Tsukuba, Ibaraki 305-0801, Japan.*

<sup>5</sup>*Physics Department, University of California, Riverside (UCR), Riverside, CA92521, USA.*

Precise zero-field and longitudinal-field muon-spin-relaxation ( $\mu$ SR) measurements have been carried out in order to investigate the electronic and magnetic states in  $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$  (LSCO) and  $\text{YBa}_2\text{Cu}_3\text{O}_{6+\delta}$  (YBCO) over a wide range of hole concentration. The measurements have been carried out at the RIKEN-RAL Muon Facility using an intense double-pulsed muon beam and higher statistics of muon events rather than usual have been gathered to measure tiny changes of time spectra. Samples are polycrystalline ones and checked to be of a single phase by X-ray measurements before  $\mu$ SR measurements.

In the case of LSCO, it has been found that the dynamic depolarization rate of muon spins in zero field starts to increase monotonically with decreasing temperature at a high temperature around 100 K. This effect is enhanced around the hole concentration of 1/8 per Cu and seems to be correlated with the localization of holes [1-3]. From the longitudinal-field  $\mu$ SR measurements, it has been found the existence of the muon-spin depolarization behavior by dynamically fluctuating internal fields at the muon site. Thus, it is suggested from the present study on LSCO that the change of the dynamic muon-spin depolarization rate is caused by a change of the dynamics of a small and quasi-static internal field. In the case of YBCO, similar enhancement of dynamic muon-spin depolarization has also been found over a wide range of the hole concentration. The hole-concentration dependence of the change of the muon-spin depolarization behavior shows the similar tendency to that observed in the case of LSCO. From the longitudinal-field  $\mu$ SR measurements, it has also been found the existence of a small and quasi-static internal field at the muon site. The origin of the small and quasi static internal field at the muon site is discussed in terms of stripes of spins and holes or a spin gap in the normal state.

[\*] Present Address: Thermophysical properties Section, Material Properties and Metrological Statistics Division, National Metrology Institute of Japan.

[1] I. Watanabe *et al.*, J. Low Temp. Phys. **131**, 331 (2003).

[2] I. Watanabe *et al.*, J. Magn. Magn. Mater. **272-276**, e1061 (2004).

[3] I. Watanabe *et al.*, to be published.