1. Title of research.

Study of Iron-based high temperature superconductors by means of μSR

2. List of collaborators with full name, position, affiliation, e-mail.

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3. Period of research

July 2019 - July 2019

4. Main location of the research and experiments.

TRIUMF in Canada

5. Publication list including any kinds of papers, talks and so on.

In preparation.

6. Description of the results and outputs

Please see attached paper.

Study of μSR in Iron-Based Superconductor $LaFeAs_{1-x}P_xO_{0.9}F_{0.1}$

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In the iron-based superconductors $LaFeAs_{1-x}P_xO_{1-y}F_y$, the electron doping level and the local crystal structure can be controlled by the F substitution for O and P substitution for As. With these chemical substitutions, Fermi surface (FS) topology changes giving three different superconducting (SC) phases [1]. For example, at y =0.1, the As-rich compounds are in the first superconducting phase (SC1), while the P-rich compounds are in the second superconducting phase (SC2) [2]. The theoretical study by Kuroki and coworkers has indicated that the different nesting in LaFeAsO-type and LaFePO-type FSs induces the different SC gap symmetries, i.e., full and nodal gaps [3].

In the present work, we have investigated the difference between SC gap symmetry in SC1 and SC2 using μSR measurement in $LaFeAs_{1-x}P_xO_{0.9}F_{0.1}$ (x =0∼0.8). The μSR measurement were performed at TRIUMF in Canada and Research Center for Nuclear Physics (RCNP), Osaka University in Japan in 2019 using a He gas-flow cryostat in a magnetic field of 250 Oe. Figure 1 shows temperature (T) dependence of the muon spin relaxation rate σ for plycrystalline samples of $LaFeAs_{1-x}P_xO_{0.9}F_{0.1}$ with various xs. At x =0, the T dependence of the σ shows a rapid increase with decreasing T below T_c and a saturation at low temperatures, indicating the s-wave behavior. In contrast, $LaFeAs_{1-x}P_xO_{0.9}F_{0.1}$ (y =0.2∼0.8) show the slightly different T dependence of the relaxation rate σ. In these P doping compounds, the T dependence of the relaxation rate σ does not show a clear saturation at low temperatures and cannot be fitted by the simple s-wave model. These results suggest that the P-doped compounds have several SC gaps with different gap sizes or a nodal SC gap, and the SC gap symmetries in the SC1 and SC2 phases may be different.

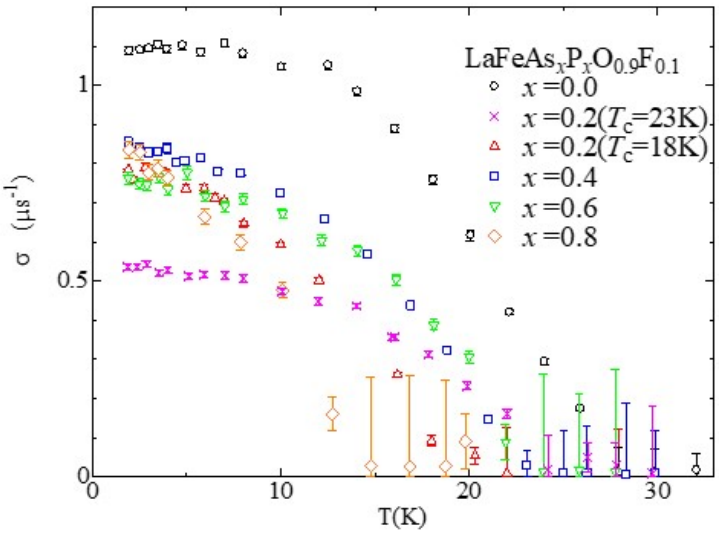

Figure 1: Temperature (T) dependence of the muon spin relaxation rate σ for $LaFeAs_{1-x}P_xO_{0.9}F_{0.1}$ with x =0, 0.2 (two samples with the different T_c =23 K and 18 K), 0.4, 0.6, and 0.8.

References

[1] S. Miyasaka *et al.*, Phys. Rev. B **95**, 214515 (2017).
[2] K. T. Lai *et al.*, Phys. Rev. B **90**, 064504 (2014).
[3] K. Kuroki *et al.*, Phys. Rev. B **79**, 224511 (2009).