Coexistence of superconductivity and magnetism in $LaFeAsO_{1-x}F_x$ proved by μSR

M. Hiraishi[A], R. Kadono[A,B], K. M. Kojima[A,B], M. Miyazaki[A], A. Koda[A,B], M. Ishikado[C], S. Syamoto[C] and S. Wakimoto[C]
[A]Sokendai, [B]KEK-IMSS, [C]JAEA

Fe-based superconductors are attracting much interest regarding the mechanism of superconductivity and their high-T_c. Their parent compounds have similar features to cuprates that they exhibit structural transition and magnetic order (although they remain metallic in contrast to cuprates). Carrier doping brings superconductivity with T_c showing a dome-shape dependence against carrier concentration x. We reported the coexistence and competition between superconductivity and magnetism in a peculiar form of phase separation ("Insular superconductivity") in $CaFe_{1-x}Co_xAsF$[1]. In this presentation, we report new result on the relation between superconductivity and magnetism near the phase boundary of spin density wave (SDW) and superconductivity in $LaFeAsO_{1-x}F_x$ (LFAO). Zero-field (ZF) and transverse-field (TF) μSR experiment were performed on a polycrystal sample of LFAO with $x = 0.057$ at J-PARC MUSE and TRIUMF, respectively.

It is observed in ZF-μSR spectra that the initial asymmetry decreases with reduced temperature, indicating the occurrence of rapid depolarization associated with the development of magnetic domain. The volume fraction of the magnetic domain at the lowest temperature (4.5 K) reaches ~ 15 %. TF-μSR spectra show two kinds of signals with different magnitude of frequency shift below T_c. Detailed analysis reveals that the frequency shift of superconducting (magnetic) domain corresponds to smaller (larger) shift (see Fig. 1), as estimated from the relative yield of volumetric fraction observed in ZF-μSR. The magnitude of shift in the magnetic domain (Δf_m) is as large as ~ 2 %. More interestingly, muon depolarization in superconducting and magnetic domains (δ_s, Δ_m) develops simultaneously below T_c. This behavior is qualitatively the same as that observed previously in a sample with $x = 0.06$ from independent source [2]. Thus, $LaFeAsO_{1-x}F_x$ are quite different from $CaFe_{1-x}Co_xAsF$ in terms of coexistence of superconductivity and magnetism.

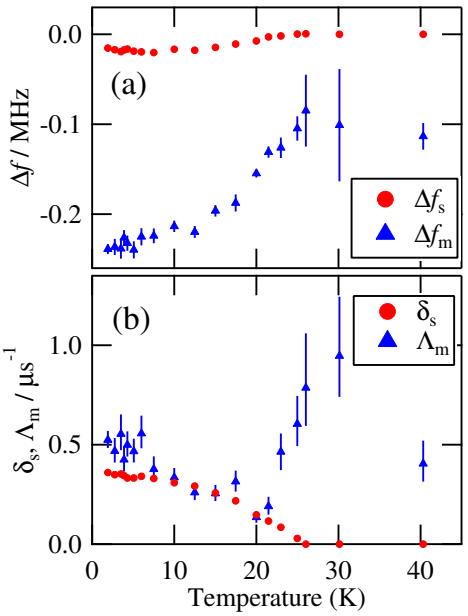

Fig. 1: Temperature dependence of (a) frequency shift from central frequency and (b) relaxation rate of superconducting and magnetic domain under TF 50 mT.

[1] S. Takeshita, *et. al.*, Phys. Rev. Lett., **103** (2009) 027002.
[2] S. Takeshita, *et. al.*, J. Phys. Soc. Jpn., **77** (2008) 103703.