Unconventional phase diagram of (Bi,Pb)2201 cuprates

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$Bi_2Sr_2CuO_{6+\delta}$ (Bi2201) is one of very few cuprates in which doping can be attained over a wide range from nearly insulating phase to non-superconducting overdoped phase. We performed zero- (ZF) and transverse-field (TF) muon spin rotation/relaxation (μSR) measurements on single crystals of $Bi_{1.74}Pb_{0.38}Sr_{1.88}CuO_{6+\delta}$ [(Bi,Pb)2201] with several different doping levels controlled by oxygen depletion to investigate the phase diagram.

It is inferred from ZF-μSR that (Bi,Pb)2201 exhibits no static magnetic order of any kind in the most underdoped sample (T_c <2K). This is in stark contrast to the case of $La_{2-x}Sr_xCuO_4$where a spin glass-like magnetism is clearly observed near the corresponding doping range.

The temperature (T) dependence of superfluid density, n_s, was also studied by TF-μSR. Figure 1 shows the Gaussian relaxation rate (σ_{sc}, proportional to n_s) normalized by the value extrapolated to T=0. While $\sigma_{sc}(T)$ in the samples at higher doping (OPT, OD) exhibits a T-dependence expected for d-wave pairing, it behaves more like that of conventional s-wave pairing in an underdoped sample (SUD). Considering these observations, we will discuss possible structures of the superconducting order parameter and nature of phase diagram in (Bi,Pb)2201.

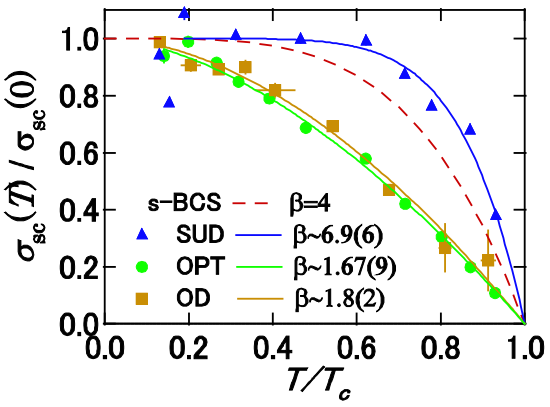

Fig.1 T/T_cdependence of normalized σ_{sc} obtained by TF-μSR with B_{ext}= 100G (H//c-axis) in single crystals of (Bi,Pb)2201 with slightly underdoped (SUD, T_c ~16K), optimally doped (OPT, T_c ~19K), and overdoped (OD, T_c ~15K) conditions. The solid curves represent fits using the form $\sigma_{sc}(T)/\sigma_{sc}(0) = 1-(T/T_c)^{\beta}$.

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[2] R. Nemetschek, *et al.*, Eur. Phys. J. B 5 (1998) 495.