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Non-magnetic Impurity Effect of Novel Heavy-Fermion Superconductor : An Sb-NQR Study of $Pr_xLa_{1-x}Os_4Sb_{12}$

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We report on nonmagnetic impurity effect of superconducting (SC) characteristics of $PrOs_4Sb_{12}$ via the measurements of Sb nuclear spin-lattice relaxation rate $1/T_1$ of $Pr_xLa_{1-x}Os_4Sb_{12}$. In the previous work [1], the $1/T_1$ in $PrOs_4Sb_{12}$ shows neither a coherence peak just beow T_c=1.85 K nor a T^3 like behavior observed for unconventional heavy-fermion (HF) superconductors with the line-node gap. It is well known that nonmagnetic impurity effect has shed further light on unique SC characteristics on HF superconductors with the line-node gap, yielding finite density of states at the Fermi level. If the symmetry of SC order parameter were an anisotropic s-wave type, the gap structure would reveal a rather uniform full-gap structure averaged over a whole Fermi surface by impurity scattering. Therefore, the nonmagnetic impurity effect on the SC gap structure in $PrOs_4Sb_{12}$ was addressed through the measurement of $1/T_1$ on $Pr_xLa_{1-x}Os_4Sb_{12}$.

Fig.1 indicates the ^{123}Sb-$2\nu_Q$ transition spectrum at 4.2K and the temperature dependence of $1/T_1$ for $Pr_xLa_{1-x}Os_4Sb_{12}$. As shown in Fig.1(a), two peaks were observed for site-1 and site-2 where the Sb_{12} cage surrounds a guest La and a host Pr ions, respectively. Note that the respective $1/T_1$'s at the site-1 and site-2 differ from those of parent compounds $LaOs_4Sb_{12}$ and $PrOs_4Sb_{12}$ (shown in fig.1(b)), confirming that La atoms are randomly distributed over the Pr sites in $PrOs_4Sb_{12}$ without any trance for phase separation. As shown in Fig.1(b), no coherence peak in $1/T_1$ was observed just below T_c at both sites. This result demonstrates that $PrOs_4Sb_{12}$ is not of anisotropic s-wave.

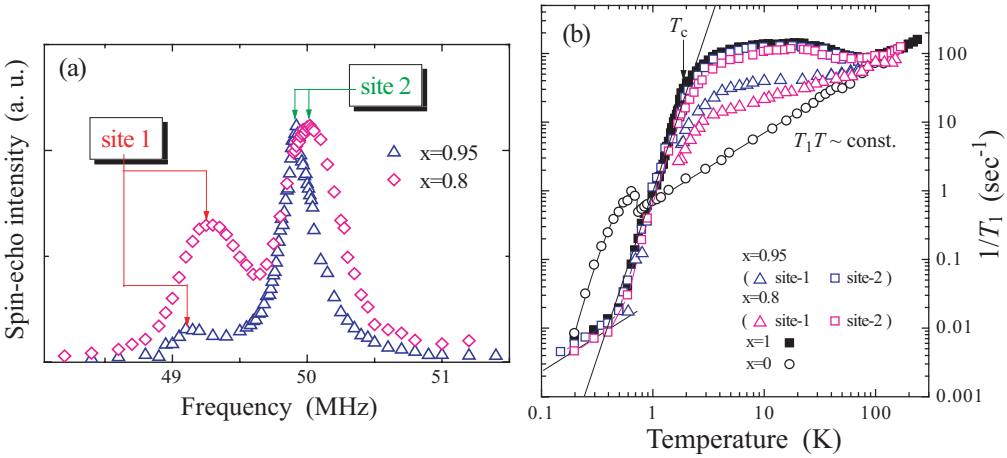

Figure 1: (a) The ^{123}Sb-$2\nu_Q$ transition spectrum for $Pr_xLa_{1-x}Os_4Sb_{12}$ (x=0.95, 0.8) at 4.2K. (b) Temperature dependence of $1/T_1$ for $Pr_xLa_{1-x}Os_4Sb_{12}$ (x=1, 0.95, 0.8, 0).

[1] H. Kotegawa, M. Yogi, Y. Imamura, Y. Kawasaki, G. -q. Zheng, Y.Kitaoka, S. Ohsaki, H. Sugawara, Y. Aoki and H. Sato, Phys. Rev. Lett. **90** (2003) 027001.