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Sb-NQR study of impurity effect on novel superconductivity for $PrOs_4Sb_{12}$-La substitution effect-

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We report superconducting characteristics for $PrOs_4Sb_{12}$ and La substituted $Pr_{1-x}La_xOs_4Sb_{12}$ ($x = 0.05$) via the measurements of Sb nuclear spin-lattice relaxation rate $1/T_1$. In the previous study [1], it was shown that the $1/T_1$ in $PrOs_4Sb_{12}$ shows neither a coherence peak just below $T_c = 1.85$ K nor a T^3 like power-law behavior observed for *anisotropic* HF superconductors with the line-node gap and hence $PrOs_4Sb_{12}$ looks like an *isotropic* HF superconductor. In order to gain further insight into whether the SC gap structure in $PrOs_4Sb_{12}$ belongs to a class of an anisotropic s-wave or an unconventional one without the line-node gap, we have measured $1/T_1$ for 5% La-substitution sample.

A satellite transition of the ^{123}Sb-$2\nu_Q$ for $Pr_{0.95}La_{0.05}Os_4Sb_{12}$ is observed at $f_s = 49.14$MHz in addition to the main one at $f_0 = 49.93$MHz (see the inset in Fig. 1). The satellite arises from the Sb nuclei with one La substitution for the nearest neighbor Pr sites. Note that the $1/T_1$ at the satellite differs from that of $LaOs_4Sb_{12}$, confirming that La atoms are adequately substituted for the Pr sites in $PrOs_4Sb_{12}$ without any trance for phase separation. Fig. 1 shows temperature dependencies of $1/T_1$ for the pure and 5%-La substituted samples. The result that no coherence peak in $1/T_1$ is observed just below T_c at either the satellite and the main sites demonstrates that $PrOs_4Sb_{12}$ is not an anisotropic s-wave superconductor. The $1/T_1$ at the main sites behaves as tracking the T dependence in $PrOs_4Sb_{12}$ besides the $1/T_1$=const. behavior at low temperatures below T=0.3 K. These results suggest that the SC gap structure is not significantly affected by the impurity substitution, and the $1/T_1$=const. behavior does not originate from spin fluctuations of inevitably presenting impurities.

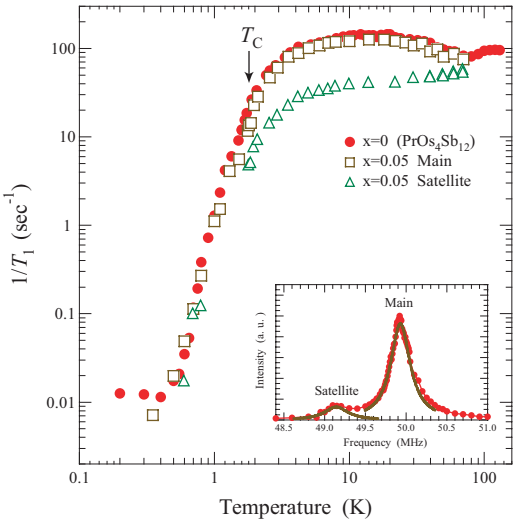

Figure 1: Temperature dependence of $1/T_1$ for $PrOs_4Sb_{12}$ and $Pr_{0.95}La_{0.05}Os_4Sb_{12}$. The inset shows the ^{123}Sb-$2\nu_Q$ transition spectra for $Pr_{0.95}La_{0.05}Os_4Sb_{12}$.

[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.