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Properties of the superconducting state in $Pr(Os,Ru)_4Sb_{12}$ studied by NQR and NMR

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We report the contrasting superconducting properties of $PrOs_4Sb_{12}$ and $PrRu_4Sb_{12}$ revealed by nuclear magnetic resonance (NMR) and nuclear quadrupole resonance (NQR) measurements. In $PrOs_4Sb_{12}$, the nuclear spin-lattice relaxation rate ($1/T_1$) decreases below T_c=1.8 K without a coherence peak, and follows an exponential function of T [1]. This behavior differs from those observed in known Ce- and U-based heavy fermion superconductors in which $1/T_1$ follows a T^3 law at low temperatures. Detailed analysis suggests that $PrOs_4Sb_{12}$ is a strong-coupling superconductor with an isotropic gap. We also found that these properties are insensitive to impurity, which supports an isotropic gap.

By contrast, $PrRu_4Sb_{12}$ shows a typical behavior seen in BCS superconductors [2]. Namely, a coherence peak is seen just below T_c followed by an exponential decrease of $1/T_1$ upon further lowing temperature.

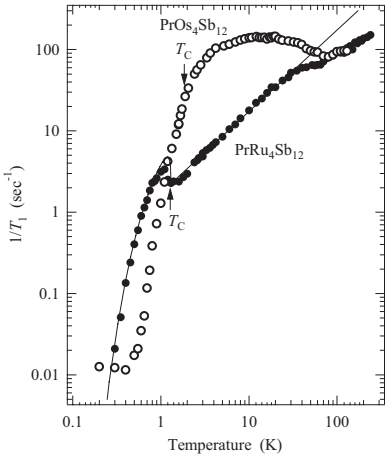

Figure 1: Temperature dependence of $1/T_1$ in $PrOs_4Sb_{12}$ and $PrRu_4Sb_{12}$.

The contrasting superconducting properties in these two compounds are discussed in conjunction with their strikingly different CEF(crystal electric field) enegy scheme which points to the possible role of quadrupole fluctuation in the occurance of the superconductivity in $PrOs_4Sb_{12}$. We will also discuss on the double superconducting transitions on the basis of NMR data under finite magnetic fields.

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[1] H. Kotegawa, M. Yogi, Y. Imamura, G.-q. Zheng, Y. Kitaoka, H. Sugawara, and H. Sato, Phys. Rev. Lett. **90** (2003) 027001.
[2] M. Yogi, H. Kotegawa, Y. Imamura, G.-q. Zheng, Y. Kitaoka, H. Sugawara, and H. Sato, Phys. Rev. B. **67** (2003) 180501(R).