

Spin dynamics of Pr-4*f* moments in PrFe₄P₁₂ and PrOs₄Sb₁₂ revealed by NMR Study

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NMR studies have been carried out to investigate magnetic properties, especially the mechanism of the heavy-fermion (HF) state in Pr-based filled-skutterudite. In this presentation, the magnetic fluctuations in the paramagnetic state of PrFe₄P₁₂ is discussed, in which the antiferro-quadrupole (AFQ) ordering occurs in low temperature region below 50 kOe, and the HF state is realized above 50 kOe. The nuclear spin-lattice relaxation rate ($1/T_1$) above the AFQ ordering temperature shows the typical behavior of Kondo systems in Ce and Yb compounds. Using experimental results of $1/T_1$ and susceptibility, the characteristic energy Γ of spin fluctuations by Pr-4*f* moments is estimated as shown in figure. $\Gamma(T)/k_B$ varies proportionally to T between 50 and 125 K, which is anticipated for the scattering of the independent local moments by conduction electrons via direct interaction $J_{cf}\sigma S$. The resistivity and $1/T_1$ results suggest the occurrence of local-moment screening below 50 K by the “*magnetic Kondo effect*”. If the impurity-Kondo model for Ce³⁺ and Yb³⁺ of HF compounds by Cox *et al.* is applied to the interpretation of temperature dependence of Γ , T_0 related to the Kondo temperature is estimated as $T_0 \sim 6.5$ K from the fitting the experimental data to a theoretical curve. The fitting result is shown by the dashed curve in the figure. We suggest that the HF state in PrFe₄P₁₂ is understood by the magnetic Kondo resonance picture which has been applied to ordinary Ce and Yb HF compounds.

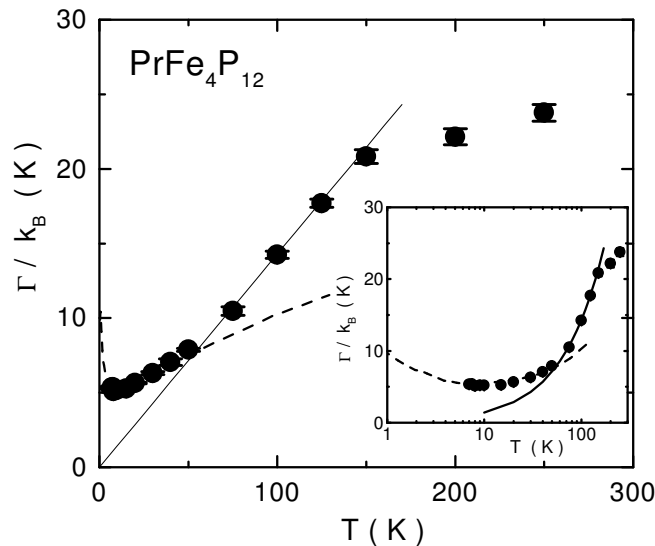


Figure 1: Temperature dependence of the characteristic energy of the spin fluctuations $\Gamma(T)$. The solid line shows the relation of $\Gamma \sim T$, and the dotted curve shows the calculated temperature dependence of Γ based on the impurity Kondo model by Cox *et al.* with the characteristic temperature $T_0 \sim 6.5$ K.