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NMR study in Sm-based sukutterudite compounds

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We present the results of NMR study on (Sm,La)Fe_4P_{12}. It was recently reported by Takeda *et al.* that $SmFe_4P_{12}$ shows heavy Fermion behavior with a large electronic specific heat coefficient of 370 mJ/mol K^2 and ferromagnetic ordering below a Curie temperature $T_C = 1.6$ K [1]. Substitution of La for Sm in this system has a tendency to suppress both the ferromagnetic state and the formation of the heavy electrons [2]. In order to elucidate the electronic properties of this system, we have performed ^{31}P-NMR measurements of powder and single crystal samples of stoichiometric $SmFe_4P_{12}$ and 20% La-substituted (La-20%) compounds.

With decreasing temperature (T), NMR spectrum of the stoichiometric sample starts to broaden below $\sim$ 10 K as seen in fig. 1(a), suggesting magnetic correlations develop from far above T_C. Such a significant broadening is not observed in the La-20% sample which does not show the magnetic ordering at low T. As shown in fig. 1(b), the T-dependence of the spin lattice relaxation rate $1/T_1$ changes from a moderate one for $T > 30$ K to $1/T_1T \sim const.$ behavior for 7 K $< T <$ 30 K. The $1/T_1T \sim const.$ behavior is typically observed when the system is in the Fermi liquid state, and the characteristic temperature of $\sim$ 30 K mentioned above is consistent with the temperature below which the electrical resistivity sharply decreases. Therefore this temperature probably corresponds to the Kondo temperature of heavy Fermion compounds. However it should be noted that $1/T_1$ again deviates from $1/T_1T \sim const.$ behavior and becomes nearly $1/T_1 \sim const.$ in the T range of $T_C(H) < T <$ 7 K. To clarify the origin of the anomalous behavior of $1/T_1$ and complicated shape of the NMR spectra in the low T region, NMR measurements using single crystal samples are now in progress.

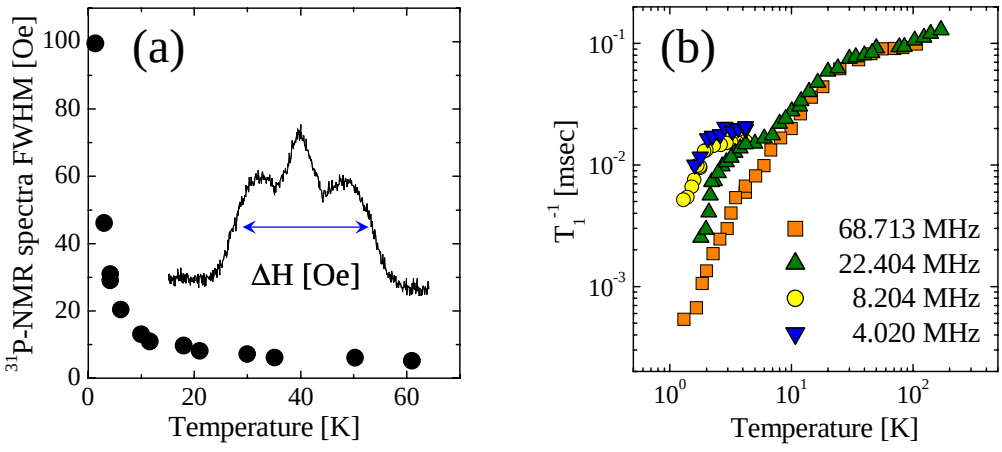

Figure 1: (a) Temperature dependence of ^{31}P-NMR line-width in SmF_4P_{12} and a typical NMR spectrum (inset). (b) Temperature dependence of $1/T_1$ measured at various NMR frequencies.

[1] M. Takeda, and M. Ishikawa, J. Phys.: Condens. Matter **15** (2003) L229.
[2] M. Takeda, and M. Ishikawa, in print.