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^{31}P-NMR and μSR Studies of Sm-based Phosphide SmT_4P$_{12}$ (T = Fe, Ru and Os)

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SmT_4P$_{12}$ (T = Fe, Ru and Os) have recently attracted much attention for the variety of the physical properties, such as the heavy fermion (HF) behavior, the metal-insulator (M-I) transition, the antiferro-quadrupolar (AFQ) order and the magnetic order (FM/AFM). The electronic states of these compounds have been studied by the ^{31}P-NMR and the μSR.

The HF behavior (T_K = 30 K) and FM (T_C = 1.6 K) in SmFe$_4$P$_{12}$ and AFM (T_N = 4.6 K) in SmOs$_4$P$_{12}$ have been confirmed from microscopic viewpoints by our ^{31}P-NMR and μSR (at RIKEN-RAL in UK and at PSI in Switzerland). However, SmRu$_4$P$_{12}$ system seems to be not so simple [1]. SmRu$_4$P$_{12}$ was reported to exhibit the M-I transition at T_{MI} = 16.5 K below which two successive transitions occur: AFQ order below 16.5 K and the AFM below 15K, respectively in ZF [2].

The line width of the ^{31}P-NMR spectrum rapidly increases below T_{AFQ} (not below T_N). The line shapes are different from those of the typical AFM in SmOs$_4$P$_{12}$, and indicate the complicated magnetic structure (Fig. 1). The temperature T dependence of the spin-lattice relaxation rate $1/T_1$ around T_{MI} depends on the applied magnetic field. We have observed the two anomalies in 70 kOe (Fig. 2). In fact, the magnetic field dependences of T_{AFQ} and T_N have been reported [2]. The complicated line-shape structure appears in high fields, which was not observed in low fields.

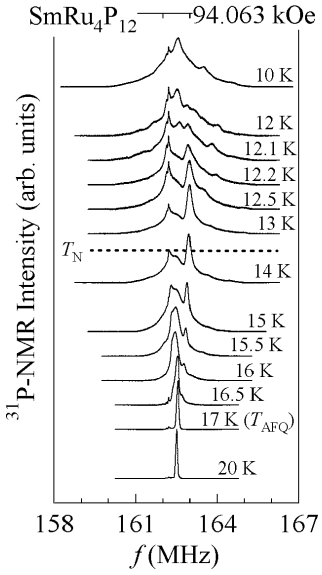

Fig. 1 Temperature dependence (below T_{MI}) of the ^{31}P-NMR spectrum of SmRu$_4$P$_{12}$.

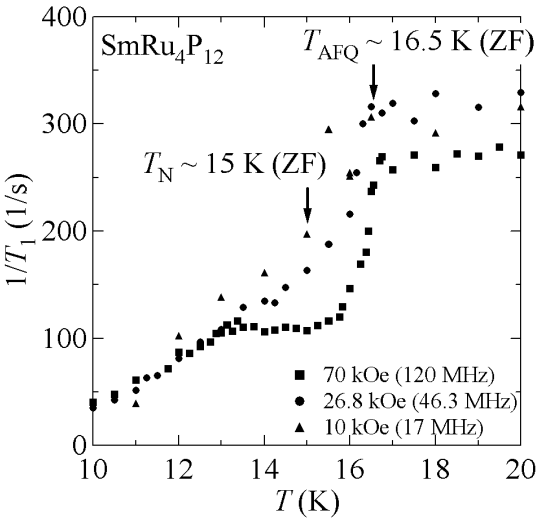

Fig. 2 Temperature T and the applied magnetic field dependences (around T_{MI}) of the spin-lattice relaxation rate $1/T_1$ of SmRu$_4$P$_{12}$.

[1] K. Hachitani *et. al*: Journal of the Institute of Pure and Applied Physics (In Press).
[2] C. Sekine *et. al*: Acta Physica Polonica B **34** (2003) 983.