(PS48)

Magnetic Properties of $PrAg_2In$ with the Cubic Γ_3 Ground State

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$PrAg_2In$ crystallizes in Heusler-type structure where Pr ions are at the cubic-symmetry site. Inelastic neutron scattering measurements[1,2] revealed the CEF level scheme as Γ_3(0 K)-Γ_4(69 K)-Γ_5(96 K)-Γ_1(164 K), where the Γ_3 is non-Kramers doublet, and has no magnetic dipole moment but has both quadrupole (O_{20}, O_{22}) and octupole ($T_{\rm xyz}$) moments. Since the CEF first excited state Γ_4 lies about 70 K above the Γ_3 $PrAg_2In$ is expected to be an ideal Γ_3 system, to show novel properties derived from the degrees of freedom of the multipole moments.

It has been considered that the T-dependence of $C_{\rm p}(T)$ and $\chi(T)$ above 15 K can be roughly explained in terms of the CEF level scheme. $\rho(T)$ decreases monotonously with decreasing T down to the lowest-T[3]. However, $C_{\rm p}(T)$ shows a huge broad peak around 0.4 K, or more specifically, a low-T extrapolated value is quite huge as $C_{\rm p}(T)/T \sim 6.5$ J/mol K^2. Therefore, it has been discussed sometimes a possibility of quadrupolar glass-like ordering or quadrupolar Kondo effects[4]. Recently, it was reported that an elastic constant $(c_{11} - c_{12})/2$ mode shows the frequency dependence for 10 K to 60 K[5], which suggests a possibility of the existence of quadrupolar fluctuation at least in this T-range.

We have been studying the microscopic magnetic/quadrupolar properties of $PrAg_2In$ by complementarily utilizing the NMR methods on ^{115}In and ^{109}Ag, where ^{109}Ag(I=1/2) can probe only magnetic effects, but ^{115}In(I=9/2) can probe both magnetic and quadrupolar effects. Single crystals of $PrAg_2In$ were prepared by the bridgeman method and crushed into fine powders. The ^{115}In NMR was observed around 4.4, 7.6 T and ^{109}Ag NMR around 10.0 T. Our results can be summarized as follows.

1. *Resonance Shift* $^{115}K(T)$, $^{109}K(T)$

Above 15K, both $^{115}K(T)$ and $^{109}K(T)$ increase monotonously with decreasing T. But below 15 K, both show slight upturn with lowering-T. This low-T behavior can hardly be understood in terms of the Van Vleck paramagnetism.

2. *Line Width* $^{115}\Delta H(T)$, $^{109}\Delta H(T)$

Above 60 K, both $^{115}\Delta H(T)$ and $^{109}\Delta H(T)$ vary in proportional to the magnetization. But below 30 K, an additional line broadening has been observed for $^{115}\Delta H(T)$. (i)For 10 K$< T <$30 K, this broadening is field independent with a local maximum around 20 K, while (ii)below $T <$5 K, it has field dependence and shows abrupt broadening around 7.6 T.

3. *Spin-Lattice Relaxation Rate* $1/^{115}T_1(T)$

Above 50 K, the T-dependence of $1/^{115}T_1(T)$ can be understood in terms of localized Pr4f magnetic fluctuation. Since the CEF ground state is non magnetic, it is expected that $1/^{115}T_1(T)$ shows remarkable decrease below 50 K with disappearing of the low energy magnetic fluctuation. But we found unexpectedly large relaxation rates. It suggests the existence of low energy fluctuations below 50 K.

More detailed results will be presented at the workshop.

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