

Ultrasonic study of quadrupolar effect and rattling motion in heavy fermion superconductor $\text{PrOs}_4\text{Sb}_{12}$

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The filled skutterudite compound $\text{PrOs}_4\text{Sb}_{12}$ exhibits superconductivity below a critical temperature $T_C = 1.85$ K that develops out of a heavy Fermi liquid with an effective mass $m^* = 50m_e$, where it is the free electron mass. The crystal electric field (CEF) is important for the origin of superconductivity. The behavior of elastic constant is reflected the CEF, especially the elastic constant $(C_{11} - C_{12})/2$ responsible for the quadrupole O_2^0 and O_2^2 is hopeful about pronounced softening proportional to reciprocal temperature $1/T$, when the CEF ground state is a non-Kramers doublet Γ_{23} .

The elastic constant of $\text{PrOs}_4\text{Sb}_{12}$ have been investigated so that we obtained knowledge for the CEF ground state. Figure 1 shows temperature dependence of $(C_{11} - C_{12})/2$ and C_{44} of $\text{PrOs}_4\text{Sb}_{12}$. A remarkable softening of $(C_{11} - C_{12})/2$ in Fig. 1 has been found with decreasing temperature below 20 K. And softening turns up around the superconducting transition T_C . The result indicates that a ground state of non-Kramers doublet affected superconducting transition. On the other hand, the elastic constant of C_{44} in Fig. 1 is governed by the Van-Vleck term of the quadrupole susceptibility due to off-diagonal transitions from the ground state Γ_{23} to excited state $\Gamma_4^{(2)}$.

The ultrasonic dispersion has been observed in the elastic constant of $(C_{11} - C_{12})/2$, C_{11} and C_L around 30 K. This probably leads to the rattling motion of off-center Pr ion in an oversized cage consisting Sb-polyhedron.

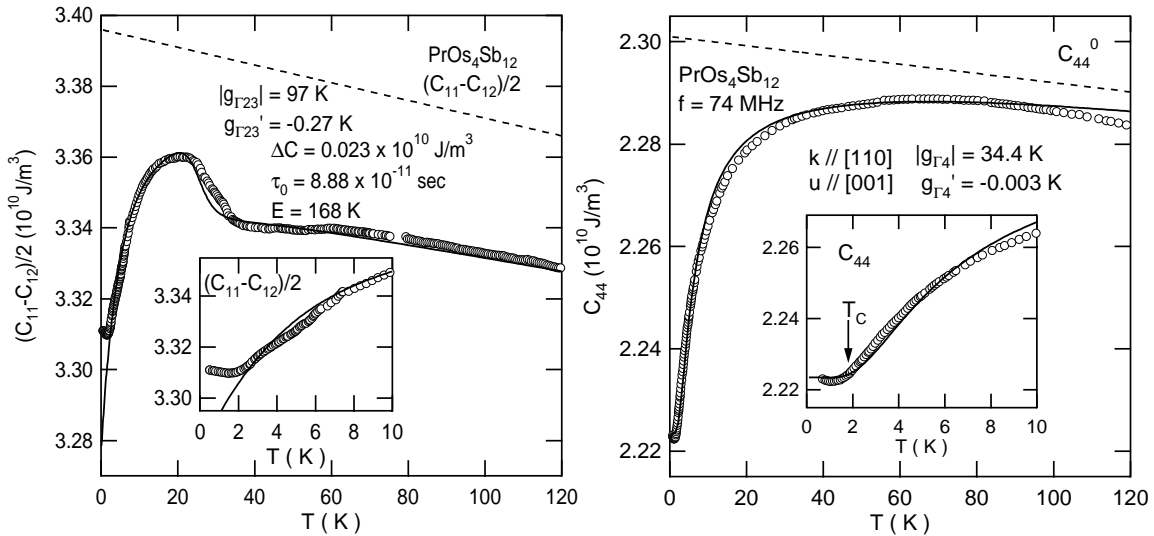


Figure 1: Temperature dependence of the elastic constants in $\text{PrOs}_4\text{Sb}_{12}$.

[1] E.D. Bauer *et al.*, Phys. Rev. B **65**, M.B. Maple *et al.*, J. Phys. Soc. Jpn. **71**

[2] Goto *et al.*, (Submitted to Phys. Rev. Lett)