(27b4)

Crystalline electric field and superconductivity of filled skutterudite $PrOs_4Sb_{12}$

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The ultrasonic measurements on a filled skutterudite $PrOs_4Sb_{12}$ revealed that $(C_{11}-C_{12})/2$ and C_{44} exhibit softening with decreasing temperature down to a superconducting transition point $T_C = 1.85$ K. The quadrupolar susceptibility of O_2^0 and O_2^2 for a CEF state with a Γ_{23} ground state doublet and a $\Gamma_4^{(2)}$ excited state triplet at 8.2 K reproduces well the elastic softening of $(C_{11}-C_{12})/2$ of Fig. 1 proportional to reciprocal temperature $1/T$ in particular. The turning up of the $(C_{11}-C_{12})/2$ softening in Fig. 1 means the suppression of the quadrupolar fluctuation in the superconducting phase. This is caused by the superconducting energy gap of the heavy Fermion quasiparticle band, being formed by the coupling of the quadroupolar fluctation to conduction electron. $PrOs_4Sb_{12}$ is probably the first compound of the unconventional superconductor, where the quadrupolpar fluctuation of the non-Kramers doublet participates in the Cooper pair potential.

We have also found a Debye-type dispersion in elastic constants around 30 K, which is responsible for a thermally activated Γ_{23} rattling motion of Pr^{3+} ion with fractional Pr-ion distribution in Sb-polyhedron. The charge fluctuation due to off-center motion may mix with the quadrupolar fluctuation due to the non-Karamers doublet because they possess the same Γ_{23} symmetry. This is a remarkable consequence for understanding the unconventional superconductivity of $PrOs_4Sb_{12}$.

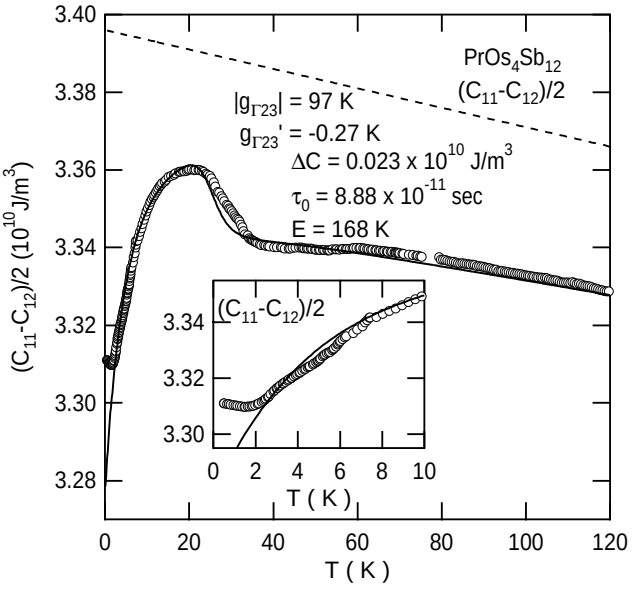

Figure 1: Temperature dependence of $(C_{11}-C_{12})/2$ in $PrOs_4Sb_{12}$

[1] T. Goto *et al.*, to be sublimed in Phys. Rev. Lett.