

Rattling of the filled skutterudite compounds $\text{Pr}(\text{Os}_{1-x}\text{Ru}_x)_4\text{Sb}_{12}$ using ultrasonic measurements

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The filled skutterudite compound $\text{PrOs}_4\text{Sb}_{12}$ exhibits unconventional superconductivity involving heavy fermion quasiparticles, below a critical temperature $T_C=1.85\text{K}$ [1]. $\text{Pr}(\text{Os}_{1-x}\text{Ru}_x)_4\text{Sb}_{12}$ exhibits the large specific-heat jump at T_C , $\Delta C/T_C=500 - 700\text{mJ/mol} \cdot \text{K}^2$ [2]. An ultrasonic dispersion in $(C_{11} - C_{12})/2$ around 30 K suggests a thermally activated off-center rattling of Pr ion in a cage of Sb. A Debye-type dispersion in the elastic constants around 30 K revealed a thermally activated Γ_{23} rattling due to the off-center Pr-atom motion obeying $\tau = \tau_0 \exp(E/k_B T)$.

We have measured elastic constant of $\text{Pr}(\text{Os}_{0.7}\text{Ru}_{0.3})_4\text{Sb}_{12}$, $\text{Pr}(\text{Os}_{0.5}\text{Ru}_{0.5})_4\text{Sb}_{12}$ where the ultra sonic dispersion in the elastic constant of C_{11} is observed. The result of experiment is shown in Fig 1. As Os is substituted for Ru, rattling fade out because this dispersion don't observe to $\text{PrRu}_4\text{Sb}_{12}$. BCS-type superconductivity is relevant for $\text{PrRu}_4\text{Sb}_{12}$ where off-center oscillation is absent. There is a possibility that off-center oscillation contributes to the unconventional superconductivity in $\text{PrOs}_4\text{Sb}_{12}$. We intend to lecture $\text{LaOs}_4\text{Sb}_{12}$ elastic constant C_{11} .

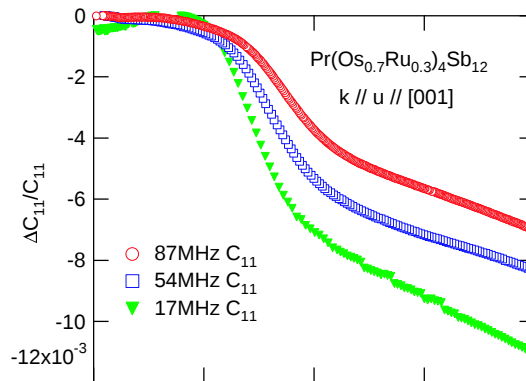


Figure 1: Temperature dependence of $\Delta C_{11}/C_{11}$ in $\text{Pr}(\text{Os}_{0.7}\text{Ru}_{0.3})_4\text{Sb}_{12}$

[1] H. Kotegawa et al., Phys. Rev. Lett. 90 (2003) 027001

[2] E.D. Bauer, et al., Phys. Rev. B 65 (2002) 100506

[3] N. Takeda, et al., J. Phys. Soc. Jpn. 69 (2000) 868.