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Elastic softening induced by high pressures in $SmRu_4P_{12}$

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Filled skutterudite compound $SmRu_4P_{12}$ shows two successive phase transitions [1]. The first is a metal-insulator transition at $T_{MI} = 16$ K and the second is a magnetic one at $T_N = 14$ K. Such successive transitions resemble those of CeB_6 so were attributed to an antiferro-quadrupolar ordering. This argument was questioned by elastic measurements. Elastic measurements suggest an octupole scenario for the transitions [2]. One of the evidences leading to the octupole scenario is the absence of elastic softening above T_{MI} at ambient pressure. We performed ultrasonic measurements under hydrostatic high pressures up to 1.15 GPa. Elastic softening, especially in the transverse mode C_T, was observed under pressures. This observation indicates the existence of quadrupolar moments in the ground state. Such elastic softening is not contradictory with the octupole scenario, instead, it is helpful to understand the peculiar magnetic phase diagram of $SmRu_4P_{12}$, where T_{MI} increases with growing magnetic field. However, the elastic softening does not show a simple relationship with pressure; we observed the strongest softening at around 0.5-0.6 GPa. On the other hand, T_{MI} is found to increase by applying pressure, with a considerable large Grüneisen parameter $\Omega = 12$. Such a large Ω has two possible origins, one is the interplay between the MI transition and the magnetic transition that has a very large Ω; the other is the Kondo effect in $SmRu_4P_{12}$.

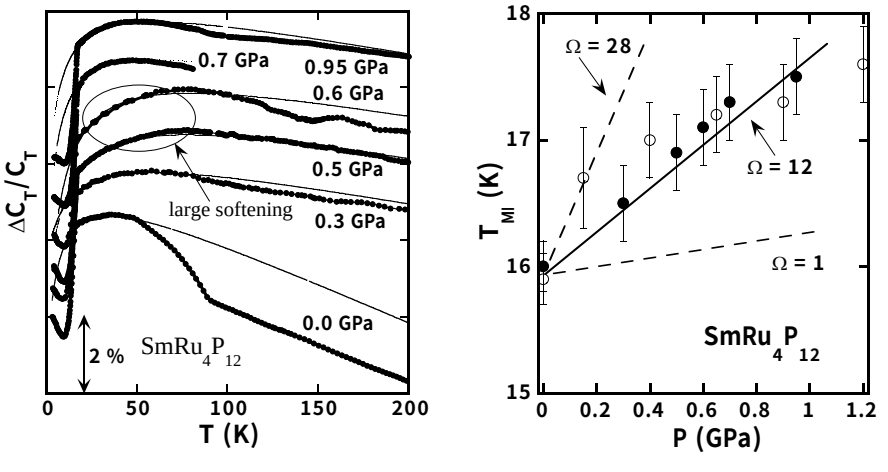

Figure 1: (left) Temperature dependence of the transverse elastic constant C_T under various pressures, together with the calculated curves. (right) Pressure dependence of the metal-insulator transition T_{MI}. The lines are based on different Grüneisen parameters Ω.

[1]C. Sekine, *et al.*, in *Science and Technology of High Pressure*, ed. M. H. Manghnani, W. J. Nellis and M. F. Nicol (Universities Press, Hyderabad, India, 2000) p. 826.

[2] M. Yoshizawa *et al.*, J. Phy. Soc. Jpn. **74** (2005) 2141.