(6a5)

On the singular behavior in the successive phase transitions of $SmRu_4P_{12}$

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$SmRu_4P_{12}$ undergoes successive phase transitions at $T_{MI} = 16$ K and $T^* = 14$ K [1, 2]. We have performed the ultrasonic measurements for $SmRu_4P_{12}$, so far [3, 4]. The elastic constants show a steep drop below T_{MI} in zero magnetic field. The elastic anomaly at T_{MI}, however, tends to disappear with the increase of magnetic field. It is very striking, because the specific heat anomaly at T_{MI} still survives in the same field region [2]. Such singular behavior has not been reported, so far, to the best of my knowledge. We focus our attention on this puzzling phenomenon to understand the origin of the successive phase transitions in $SmRu_4P_{12}$.

The elastic constant $C_E = \frac{1}{2}(C_{11} - C_{12})$ for $SmRu_4P_{12}$ is shown, together with the normal part C_0, in Fig. 1(a) as a function of temperature in the magnetic field. The inverse of the anomalous elastic constant $(C_0 - C_E)^{-1}$ in Fig. 1(b) shows a clear kink at T_{MI}. The straight line above T_{MI} comes from the ground state multiplet of Γ_{67}. Below T_{MI}, $(C_0 - C_E)^{-1}$ shows no linear temperature dependence in weak magnetic field. However, a linear temperature dependence is found in high magnetic field. It strongly suggests that the order parameter below T^* couples linearly with the elastic strain at the temperatures below T_{MI}, although it is excluded by the experimental results. NMR measurement shows the phase below T^* to be magnetically ordered [5], for example. Time reversal symmetry prohibits this type of coupling. Such paradox is closely related to the fact that the transition at T^* is indistinct in weak magnetic field. We will discuss the origin of such a strange magnetoelastic coupling.

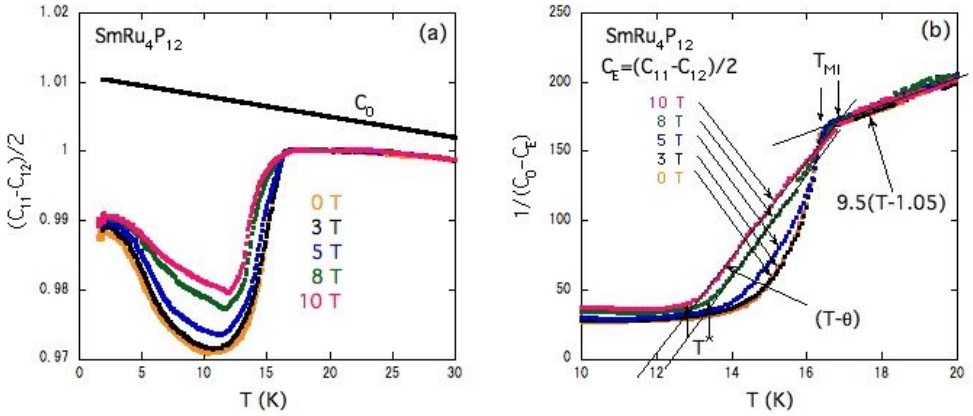

Figure 1: (a) Temperature dependence of C_E and (b) the inverse of its anomalous part.

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