(6a3)

Thermal expansion and phase diagram of $SmRu_4P_{12}$ exhibits metal-insulator transition

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The filled skutterudite compound $SmRu_4P_{12}$ exhibits a metal-insulator (M-I) transition near 16K (T_{MI}). The specific heat shows a λ-shaped peak anomaly at the M-I transition. The temperature dependence of the magnetization M(T) shows an upturn at T_{MI} and a round peak near 15K below T_{MI}. T_{MI}(H) slightly increases (H^2-dependence) with increasing magnetic field H. This behavior is consistent with the upturn in M(T) considering thermodynamic relations for second order transition. Such an upturn in M(T) is often observed in compounds which show antiferro-quadrupolar (AFQ) ordering. Recent work has revealed that this M-I transition occurs in fact in two successive steps. The specific heat exhibits a double peak in field. The thermal expansion coefficient (Fig. 1.), the temperature derivative of the electrical resistivity $d\rho(T)/dT$ and of the magnetization $dM(T)/dT$ also exhibit two anomalies at the same positions as the specific heat peaks. The magnetic entropy estimated at zero field reaches Rln4 at T_{MI}. This indicates that the crystalline electric field (CEF) ground state is Γ_{67} quartet in the cubic point group T_h. The ground state Γ_{67} has both magnetic and orbital degree of freedom. The existence of a double anomaly can be ascribed to two successive transitions on cooling: orbital ordering (AFQ is most likely), then magnetic ordering such as in CeB_6. The magnetic phase diagram of $SmRu_4P_{12}$ up to 30T also supports this scenario.

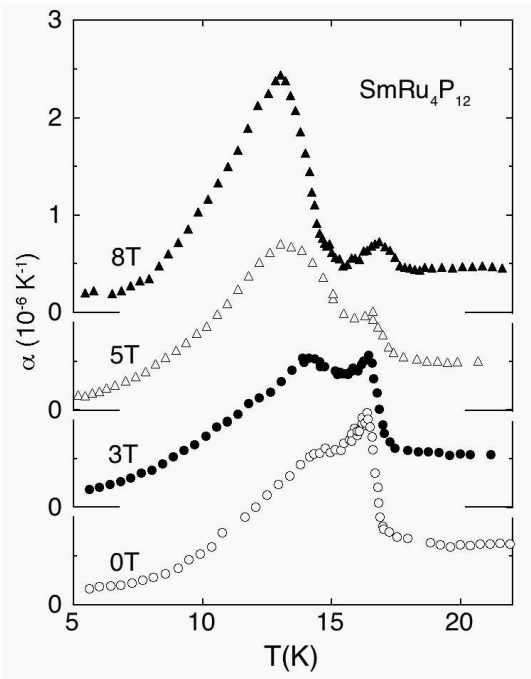

Figure 1: Temperature dependence of the linear thermal expansion coefficient of $SmRu_4P_{12}$.