ture $\Delta T_c(p)=T_{c0}(p)-T_c(p)$ is thus expected to have a maximum if the Kondo temperature is shifted monotonically to values $T_k \gg T_{c0}$ by application of pressure. The pressure p_m at the maximum should characterize the Kondo temperature $T_k(p_m)=\vartheta \cdot T_{c0}(p_m)$. Meanwhile Maple *et al.*[6,7] have found such a maximum of $\Delta T_c(p)$ in La-Ce. Their explanation, however, is based on the assumptions that, with gradual application of pressure, ΔT_c first increases as a consequence of an increase in $|J|$ and then decreases because the Ce ion undergoes a transition from a magnetic to nonmagnetic state. These authors already mention the possibility that such a transition may also be caused by the development of a quasi bound state as a consequence of an increase in the Kondo temperature; or that, alternatively, the decrease in ΔT_c may reflect the gradual onset of magnetic order at higher pressure. Although the present understanding of the Kondo effect is still semiquantitative at best, it offers a quite natural explanation of the observed $T_c(p)$ variation. We have thus compiled further experimental information on this problem by measuring the pressure dependence of both the superconducting transition temperature and the resistance anomaly. From the latter a considerable increase of the Kondo temperature with pressure can be deduced.

Experimental Results

First the depression $\Delta T_c(c)$ at zero pressure was measured for several alloys with different Ce concentrations c. The results for the dhcp and the fcc phase are 1.22 ± 0.05 (K/at %) and 1.45 ± 0.05 (K/at %), respectively. From these data the Kondo temperatures can be calculated from the relation

$$\frac{\Delta T_c}{\Delta c}=\frac{1}{8 k_B N(0)} \frac{\pi^2 (S+1/2)^2}{(\ln T_k/12\, T_{c0})^2+\pi^2 (S+1/2)^2} \cdot \left[1+\frac{B[(\ln T_k/12\, T_{c0})/(S+1/2)]}{(S+1/2)^2}\right] \tag{1}$$

which is the main result of the theory of Ref.[4] where also a plot for the correction function B is given. Assuming $N(0)=2.4\,\mathrm{eV}^{-1}$ (density of states)[8], $S=1/2$ (spin of the Ce ion), $T_{c0}=4.9$ K for dhcp La and $T_{c0}=6$ K for fcc La, we find $T_k=0.15$ and 0.20 K for the dhcp and the fcc phases, respectively.

It was also attempted to determine the Kondo temperature of a La 1% Ce alloy from resistance measurements down to 0.3 K. For the suppression of superconductivity a magnetic field of 8.5 kG is necessary for this alloy. We observed that the R vs. ln T curve already reached a plateau at 0.3 K and that upon further increase of the field to 12 and 15 kG, the plateau changes over into a maximum. The onset of the maximum was shifted to higher temperatures and the level was depressed. So we infer that the resistance curve at low temperatures is strongly influenced by a magnetic field. A determination of T_k by resistance measurements seems in principle, therefore, to be impossible for low concentration LaCe alloys.

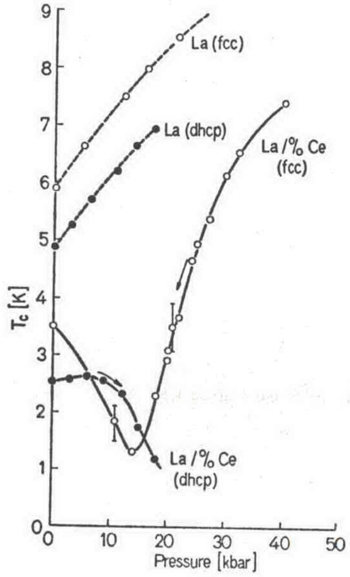

Fig. 1

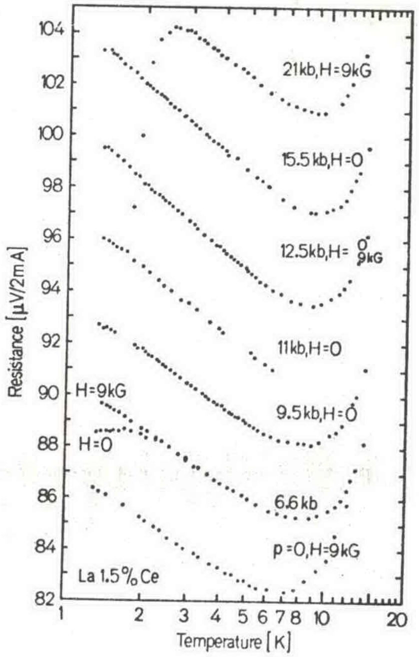

Fig. 2

Fig. 1. Pressure dependence of the superconducting transition temperature of pure La (Maple *et al.*[7]) and of La 1% Ce (present work)

Fig. 2. Variation of the Kondo resistance anomaly in La 1.5% Ce with pressure

The pressure experiments were performed in an apparatus described earlier[9]. Samples with dimensions of 0.02×0.2×2 mm required for these experiments were prepared by cold rolling. Due to this preparation

---

[6] Maple, M. B., Kim, K. S.: Phys. Rev. Letters 23, 118 (1969).

[7] Maple, M. B., Wittig, J., Kim, K. S.: Phys. Rev. Letters 23, 1355 (1969).

[8] Andres, K.: Phys. Rev. 168, 708 (1968).

[9] Buckel, W., Gey, W.: Z. Physik 176, 336 (1963).