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SPECIFIC HEAT OF (Ce, La) Ru₂Si₂ AT HIGH MAGNETIC FIELDS

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Abstract. – Specific heat (C) measurements on Ce_{1-x}La_xRu₂Si₂ were made in order to observe the change in C on going from a long range magnetically ordered system ($x \geq 0.08$) to a paramagnetic system. Magnetic field measurements of C show that a maximum of the effective mass occurs at the metamagnetic-like transition.

The compound CeRu₂Si₂ exhibits interesting magnetic features [1]. Its magnetization for H parallel to the tetragonal c -axis (M) displays a metamagnetic-like transition at $H_M \approx 8$ T, although no long range magnetic order could be detected. This field corresponds to the quenching of the antiferromagnetic (AF) correlations occurring below 60 K [2]. In reference [1] it was argued by comparing the temperature dependences of the resistivity at various fields that the electronic effective mass m^* would go through a maximum at H_M . In order to check this suggestion, we have performed specific heat measurements on single crystals of Ce_{1-x}La_xRu₂Si₂ ($x = 0, 0.05, 0.10$ and 0.13). Substituting La for Ce reduces H_M [3] and induces antiferromagnetic (AF) order for $x \geq 0.08$ [4]. The corresponding critical fields are respectively 7.9, 5.7, 3.8, 3.65 T at ≈ 1.4 K (i.e. below T_N for the two last systems) [3]. For $H = 0$, the measurements extended from ≈ 0.1 K to ≈ 30 K. Magnetic fields up to 7.5 T were applied along the c -direction for $T \geq 0.4$ K.

The $H = 0$ data are displayed as C vs. T (up to 16 K) in figure 1a; figure 1b shows C/T vs. T up to 9 K. These data are consistent with previous results for polycrystals [5]. The value of C/T extrapolated to $T = 0$ (γ_0) increases from 360 mJ mol⁻¹ K⁻² for $x = 0$ to 585 mJ mol⁻¹ K⁻² for $x = 0.1$ and then decreases again. γ_0 may reach a critical value $\gamma_{0c} \approx 600$ mJ mol⁻¹ K⁻² at the magnetic - non magnetic (M-NM) transition which occurs near $x = 0.08$ as shown by neutron diffraction experiments [4]. Indeed, for $x = 0.13$, AF ordering leads to a peak in C at $T_N = 3.8$ K. This anomaly is very similar to that reported [6] for CePb₃, a typical long range magnetically ordered heavy fermion compound. Although no peak in $C(T)$ is observed for $x = 0.1$, it is worth noticing the similarity between the $x = 0.1$ and $x = 0.13$ data in the C/T representation, i.e. a sharp increase on cooling followed by an almost flattening (see Fig. 1b). This suggests that our $x = 0.1$ crystal orders below

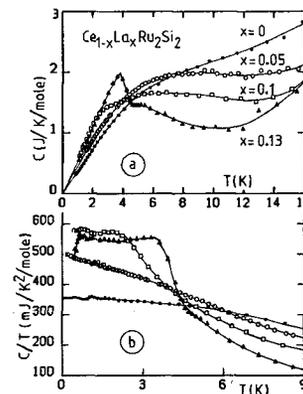


Fig. 1. – Specific heat of single crystals of Ce_{1-x}La_xRu₂Si₂. a) as C vs. T : (●) $x = 0$, (○) $x = 0.05$, (□) $x = 0.1$ and (▲) $x = 0.13$; b) as C/T vs. T below 9 K.

≈ 2.5 K which is consistent with $T_N = 2.7$ K determined by neutron experiments [4]. On the non magnetic side of the M-NM transition ($x = 0$ and 0.05), the smooth increase of C/T on cooling is very similar to that reported [7] for CeCu₆.

Figure 2 shows the field dependence of γ_0 . A clear increase of γ_0 towards H_M is observed for the two NM compounds. For $x = 0.05$ for which it was possible to perform experiments well above H_M , $\gamma_0(H)$ goes through a maximum at a field of ≈ 5.5 T, consistent with the value of H_M derived from magnetization data [3]. While $\gamma_0 = 500$ mJ mol⁻¹ K⁻² at $H = 0$, $\gamma_0(H_M) = 655$ mJ mol⁻¹ K⁻²: an increase of 30%. Magnetization experiments at 1.5 K lead to an increase of the differential susceptibility $\chi = \partial M / \partial H$ by a factor of 2.7 at H_M . Such a dependence of γ_0 with H stresses the importance of the magnetic correlations [1, 2]. $\gamma_0(H_M) = 655$ mJ mol⁻¹ K⁻² is roughly the same value as the critical value γ_{0c} defined above, which suggests that this critical magnitude of γ_0 drives the

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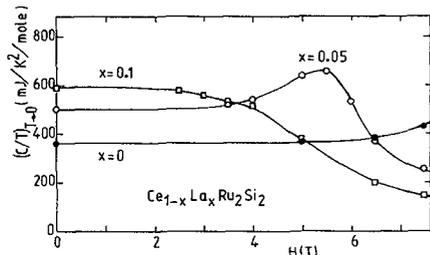


Fig. 2. - Field variation of C/T extrapolated at $T \rightarrow 0$ K. Same symbols as in figure 1.

magnetic instabilities induced either by H or by addition of La.

No maximum in $\gamma_0(H)$ can be seen for $x = 0.1$. This may be due to the fact that γ_0 is already very close to γ_{0c} . However, the occurrence of a new feature (the existence of maxima in the C/T vs. T curves in magnetic fields, connected to the crossing of lines of the (H, T) magnetic phase diagram [3]) prevents accurate extrapolations of C/T to $T = 0$, making measurements at lower temperatures desirable.

Finally, $\gamma_0(H)$ decreases rapidly with H above H_M where high magnetic polarization is achieved. Further studies of these polarized phases will lead to a better understanding of the heavy fermion compounds.

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