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### Authors

Brison, JP  
Briggs, A  
Flouquet, J  
[et al.](#)

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## MAGNETORESISTIVITY AND HALL EXPERIMENTS ON $\text{UBe}_{13}$

J.P. BRISON, A. BRIGGS, J. FLOUQUET, F. LAPIERRE, Z. FISK \* and J.L. SMITH \*

*CRTBT-CNRS, B.P. 166X, 38042 Grenoble Cédex, France*

\* *Los Alamos National Laboratories, Los Alamos NM 87545, USA*

Low temperature magnetoresistivity of  $\text{UBe}_{13}$  shows that the interactions between heavy fermions are field dependent. This suggests a field variation of the superconducting condensation energy. The Hall resistivity is strongly nonlinear in magnetic field.

The magnetoresistivity  $\rho(H)$  of  $\text{UBe}_{13}$  is large and negative in the whole range of fields and temperatures yet explored [1–3]. We report here measurements performed on a sample which has, at low temperature and high magnetic fields ( $H > 10$  T), the lowest published residual resistivity:  $\rho_0(H = 20 \text{ T}) \sim 10 \mu\Omega\text{cm}$ . We focus on the low temperature regime ( $T \leq 1$  K) where the resistivity can be decomposed like:  $\rho(H, T) = A(H)T^2 + \rho_0(H)$ .

Such an analysis is common in heavy fermion systems. However it presents striking features in  $\text{UBe}_{13}$ : – the upper limit of validity of a  $T^2$  law (roughly 900 mK) is field independent although  $A(H)$  has a strong field variation (fig. 1), – up to 20 T, both  $A(H)$  and  $\rho_0(H)$  decrease with  $H$ ,  $\rho_0(H)$  being quasiconstant above 10 T but never showing a positive magnetoresistivity. The new phenomena is that the usual relations between the field variation of  $A(H)$ , of the susceptibility  $\chi(H)$  and of the coefficient  $\gamma(H)$  of the linear  $T$  term of the specific heat also break down:  $\gamma(H)$  and  $\chi(H)$  are field independent (almost up to 8 T [4] and to 20 T [2] respectively).

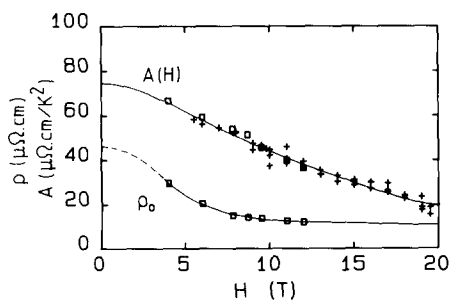


Fig. 1. Field dependence of  $\rho_0(H)$  and  $A(H)$ . The full lines are the interpolation of the experimental points for  $H \geq 4$  T. The dashed line is the extrapolation in low field ( $H < 4$  T) based on the  $H^2$  dependence of  $\rho(H)$  above  $T_c$ .

Nevertheless, these results can be simply understood in the framework of “classical Fermi liquid theories” where the  $T^2$  term in  $\rho$  originates from direct interactions between quasiparticles, assuming these interactions are field dependent (because related to magnetism) while band properties are not. The importance of such a  $T^2$  term [5] in  $\text{UBe}_{13}$  is due to: – the unusual large strength of direct interactions between quasiparticles, clearly revealed by the proximity of the superconducting transition (at 950 mK) to the coherence temperature (2.5 K) yielding so a short lifetime for the quasiparticles, – the equality of the transport relaxation time and of the lifetime of the quasiparticles since  $\text{UBe}_{13}$  is a compensated metal (there is an even number of electrons per unit cell: also confirmed by band calculations [6]). The interactions between electrons and holes then lead to a relaxation of their relative velocity, and so of the current. This hypothesis could be checked in a funny way with the attempt to relate  $A(H)$  with superconductivity [7]. This connection is suggested by the example of pure aluminium where the coefficient  $A$  is strongly enhanced due to the virtual phonon mediated interactions which govern here superconductivity [5]. If  $A(H)$  is proportionnal to the square of the attractive potential, the interaction is field dependent and thus the superconducting condensation energy. Using BCS relations, the unusual shape of the upper critical field can be reproduced. This agreement gives strong support to a non phonon mechanism for the superconductivity of  $\text{UBe}_{13}$ .

The low temperature Hall resistivity ( $r_H$ ) is shown in fig. 2. The main effect is the nonlinearity of  $r_H$  with  $H$ : a maximum of  $r_H$  seems to be observed for  $H = 2$  T and a minimum for  $H = 4.5$  T. Thus, we disagree with the assumption [9] that the low field Hall coefficient may become nega-

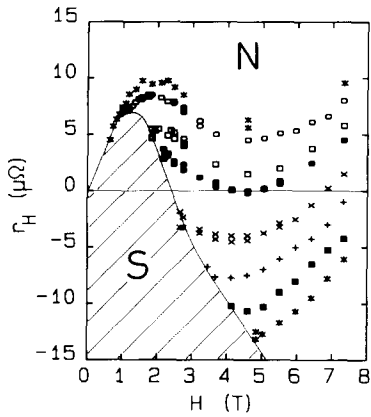


Fig. 2. Field dependence of the Hall resistivity at different temperatures: \* 915 mK,  $\circ$  900 mK,  $\square$  865 mK,  $\bullet$  850 mK,  $\times$  793 mK,  $+$  748 mK,  $\blacksquare$  695 mK and \* 647 mK.

tive. The Hall effect may be dominated by magnetic properties: this has been clearly observed in other heavy fermion compounds like CeRu<sub>2</sub>Si<sub>2</sub> [9] and CeCu<sub>6</sub> [10]. Specific heat measurements suggest that the normal phase of UBe<sub>13</sub> may become

long range magnetic ordered below 150 mK [7]. Magnetic correlations could be also important in this compound.

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