**Physics.** — *The specific heats of tantalum in the normal and in the superconducting state.* By W. H. KEESOM and M. DÉSIRANT. (Abstract of Communication No. 257*b* from the Kamerlingh Onnes Laboratory at Leiden).

(Communicated at the meeting of June 24, 1939.)

From measurements made by MENDELSSOHN and MOORE [1]) it seems to follow that tantalum, as to the phenomena of superconductivity in a magnetic field, more nearly corresponds to an alloy than to a pure metal. It was therefore interesting to compare the calorimetric behaviour of tantalum with that of superconductors such as tin and thallium, who have been investigated previously [2]) [3]).

In the absence of a magnetic field the sample of tantalum investigated by us appeared to show a discontinuity in the specific heat at 4.075° K. Why this transition temperature differs so essentially from that found by MEISSNER [4]), viz. 4.38° K, is a question for further investigation. The purity of our sample was stated to be 99.96 %. Spectroscopic analysis corroborated this statement.

At 4.075° K the difference of the specific heat at the superconducting from that at the normal condition $\triangle C_0 = 0.00881$ cal/degree. mol. This value is approximately equal to that which follows from RUTGERS' formula with as a basis the induction curve of DAUNT and MENDELSSOHN [5]). Measurements made in a magnetic field, however, gave values of $\triangle C$ which are much lower than the values calculated on that same basis.

In connection with this we observe that for tantalum the curve in the $H, T$-diagram which indicates the temperatures at which the magnetic induction penetrates into the metal is essentially different from the curve which shows the temperatures at which the electric resistance reappears, and it is not a priori evident that it is the first mentioned curve that characterises the difference between the superconducting and the normal conditions.

As a matter of fact measurements on tantalum in magnetic fields of 446.8 and 691.6 gauss have shown discontinuities in the specific heat for 3.705 and 3.49° K respectively. These transition temperatures are appreciably higher than those which should follow from the induction curve. They agree, however, with the temperatures which follow from MENDELSSOHN and MOORE's resistance curve, if this curve, corresponding to the difference between our and MEISSNER's values of the transition temperature in the absence of a magnetic field, is transferred over 0.3 degrees to lower temperatures.



From this it seems to follow that the superconductive condition still persists at fields for which $B \neq 0$, at least in a certain part of the metallic bloc.

To determine the specific heat in the normal condition in a large interval of temperature we made use of a magnetic field of 3000 gauss. Our results can be represented by the formula

$$C_n = 464.5 \left(\frac{T}{246.5}\right)^3 + 0\ 00141\ T,$$

in which the first term is due to the atomic lattice, the second term to the conduction electrons.

The DEBIJE characteristic temperature $\theta_D = 246.5$ is approximately equal to the value found by SIMON and RUHEMANN [6]) at about 70° K.

As the coefficient of the second term (0.00141) is seven times as large as the value calculated according to SOMMERFELD's formula for the two electrons of the 6s-band considered as free, one may conclude that the limiting density $N(\zeta_0)$ of the energy levels in the 5d-band for tantalum is larger than that for free electrons. From that value of the limiting density the magnetic susceptibility can be calculated. The result is appreciably smaller than the experimental value. This may indicate that between the electronic spins an exchange effect exists of the same character as that which is responsible for ferromagnetism.

REFERENCES.


1. K. MENDELSSOHN and J. R. MOORE, Phil. Mag. **21**, 532 (1936).
2. J. A. KOK, Thesis, Leiden (1935).
3. P. H. VAN LAER, Thesis, Leiden (1938).
4. W. MEISSNER, Phys. Zs. **29**, 897 (1928); Zs. f. Instrum.kunde, **49**, 166 (1929).
5. J. G. DAUNT and K. MENDELSSOHN, Proc. Roy. Soc., London (A) **160**, 127 (1937).
6. F. SIMON und M. RUHEMANN, Zs. f. phys. Chem. (A), **129**, 321 (1927).