sections.[12] It is perhaps worth mentioning at this point, therefore, that the absolute value of the *mesonic* contribution to the nucleon magnetic moments, given by the above values for f^2 and k_{max} is 1.8 nuclear magnetons.[13] An analysis of the photopion production problem, as well as the neutron-electron interaction, is proceeding on the same basis.

In conclusion, it should be emphasized that even if the success of the calculations reported here is not accidental, the particular form of the Yukawa theory (e.g., pseudoscalar or pseudovector coupling) has by no means been established. *Any theory with a coupling linear in the pion field, which has a nonrelativistic limit for the nucleon*, will lead to the results described here.

The author is indebted to R. Serber and T. D. Lee for the idea of using the Dancoff approximation. Discussion with J. S. Blair, K. Brueckner, and N. Kroll also contributed significantly to the progress of the problem. Complete details of the calculations reported here, together with applications of the same general approach to other problems, will be published at a later time.

[12] J. S. Blair and G. F. Chew, Ann. Rev. Nuc. Sci. 2 (1952).
[13] M. H. Friedman (to be published).

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Heat Conduction of the Boundary Layer in Liquid Helium II*

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In experiments on the thermal conductivity of liquid helium II, an anomalous heat conduction has been found in the vicinity of the heat source. The magnitude of this effect is given as a function of temperature and is shown to be independent of the heat flux. The effect has been ascribed to a thin layer of liquid helium in the vicinity of the energy source having a poor heat conduction. The existence of this layer is probably a consequence of the finite rate of conversion from superfluid to normal particles.

AN investigation carried out in this laboratory[1] on the thermal conductivity of liquid helium II and He^3-He^4 mixtures yielded, in the former case, anomalously low values of heat conduction without the characteristic maximum between 1.2°K and the λ-point. The apparatus used in this connection (solid lines in Fig. 1) consisted of a thin-walled Monel capillary, 0.01-cm inner diameter and 17.5 cm long, with the lower end embedded 0.635 cm in a copper block on which were wound a heater and phosphor bronze thermometer. After exit through the vacuum jacket, the capillary passed through another copper block in contact with a liquid helium bath. The observed temperature differences between these two blocks were used to calculate the values of thermal conductivity. In order to determine unambiguously that the low results arose from an end effect originating in the heat input wall, the measurements were repeated with the following changes:

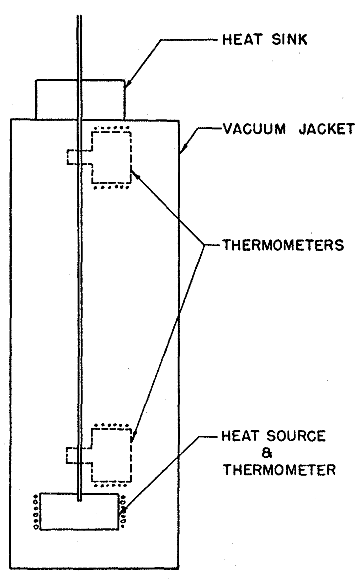

FIG. 1. Diagram of apparatus.

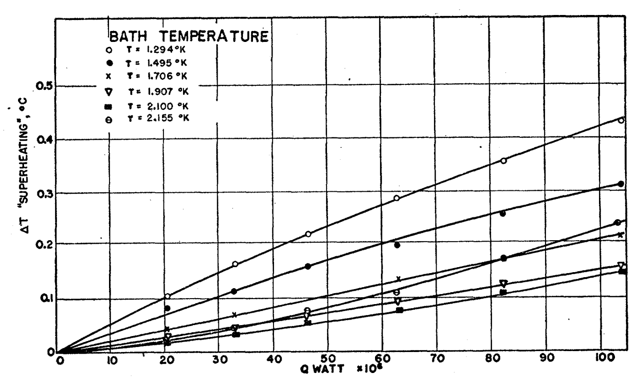

FIG. 2. "Superheating", ΔT, as a function of energy input Q and temperature T.

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[1] R. E. Probst, Massachusetts Institute of Technology Low Temperature Conference (1949), unpublished.

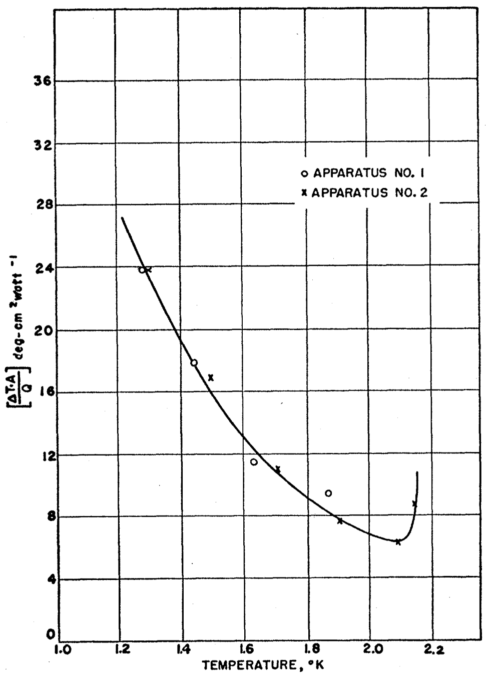

FIG. 3. $\Delta T \cdot A/Q$ as a function of temperature.

(a) adding two thermometer stations (dotted lines, Fig. 1) 1 cm from the heat source and the heat sink, and (b) changing the area of contact of the capillary with the heat source by embedding it, in a second series of experiments, only 0.079 cm in the lower copper block.

When ΔT's are measured by the two thermometer stations, shown by the dotted lines for various energy inputs at various temperatures, no anamolous thermal conductivity is found, and the data so obtained are very similar to those of Allen and Ganz.[2] However, a large temperature difference between the energy input block and the thermometer station 1 cm above it was still noticed. This "superheating" is shown in Fig. 2 as a function of energy input and temperature for the case where the capillary was embedded 0.079 cm. The plot of ΔT *versus* Q gives almost straight lines except at the highest temperatures. Assuming these are straight lines for every temperature, a plot of $\Delta T \cdot A/Q$ *versus* temperature is shown in Fig. 3 for the two series of experiments where the capillary was embedded (1) 0.635 cm and (2) 0.079 cm. A is the inner area of the capillary, and hence also of liquid helium, in contact with the energy input block. Since the data of both sets of experiments fall on the same curve, this indicates that the "superheating" must arise from this area of liquid helium in contact with the heat source. An examination of the magnitude of the effect verifies the above, since this excludes the possibility of the "superheating" arising across the boundary between the heater and the copper block, the copper block itself, or the wall of the Monel capillary. It must be then the result of a film of poorly conducting helium.

The dependence of $Q/\Delta T \cdot A$ on temperature is as $T^{2.6}$, if one excludes the point very near the λ-point. These results are very similar in magnitude and temperature dependence to those reported by Kapitza[3] for a similar series of experiments. He ascribed the effect to the low thermal conductivity of helium II which does not take part in mass transfer. Assuming a static layer of liquid helium II in our case, one can calculate the film thickness. Using the extrapolated thermal conductivity of normal helium for the thermal conductivity of the film, one gets a thickness of 2.5×10^{-4} cm at 2.0°K. This film is thicker by several orders of magnitudes than either the Rollin film or a static film produced by absorption on the wall.

The manner in which this film is formed and the question as to whether the thickness remains constant cannot be quantitatively deduced from these experiments. Since it is well known that some of the conversion of superfluid atoms to normal atoms takes place at the energy input wall, it is probable, as Gorter[4] has already pointed out, that the film results from a finite conversion rate. If this mechanism is correct, Gorter predicts that this effect will cause the attenuation of second sound, with a relaxation time of approximately 5×10^{-5} sec near the λ-point. This is not inconsistant with existing experimental results. It should also be interesting to repeat these experiments using different capillary sizes. One should expect the magnitude of this effect to vary, since the rate of heat transfer, and hence the amount of conversion at the wall, varies with capillary size.

[2] J. F. Allen and E. Ganz, Proc. Roy. Soc. (London) **A171**, 242 (1939).

[3] P. Kapitza, J. Phys. U.S.S.R. 4, 181 (1941).

[4] C. S. Gorter, Proceedings of the International Conference on Low Temperature Physics, Oxford, August, 1951.