ON THE PROBLEM OF THE λ-POINT SHIFT IN ROTATING LIQUID HELIUM

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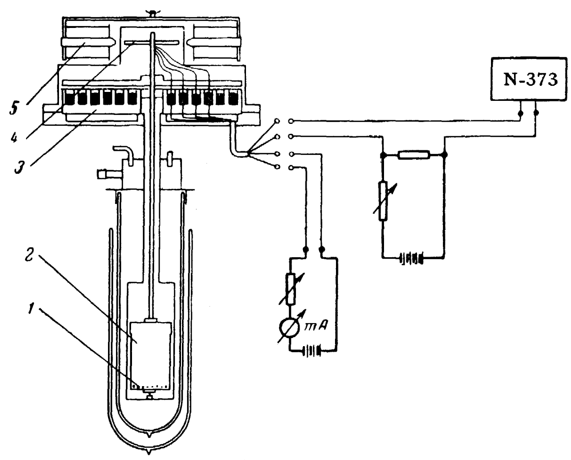
The position of the discontinuity in the heating or cooling curves, recorded by means of a resistance thermometer, shows that the rotation of helium does not displace the λ-point to that temperature region (2.17–2.23°K) where hydrodynamic experiments show the presence of vortex effects.

EARLIER experiments of the Tbilisi group on the elastoviscous properties of rotating liquid helium established[1)] that the Onsager–Feynman vortex structure, characteristic of the low-temperature modification of this liquid, is also retained at temperatures which are 0.02 deg K higher than the λ-point of helium at rest. Since the vortex structure should be a characteristic of helium II and not of helium I, the question arose of the possible displacement of the λ-point in rotating liquid helium II in the direction of higher temperatures.

Later hydrodynamic investigations[1] showed that the phenomena observed earlier are more likely to be of the relaxation kind rather than being related to the λ-point displacement. One of the experiments by means of which the displacement of the λ-point can be deduced is the observation of the discontinuity in the heating (or cooling) curve of rotating and stationary helium on passing through the λ-point.

A block diagram of the experimental apparatus is shown in the figure. A Perspex vessel filled with liquid helium, and with a lead brass resistance thermometer attached to its base, could be rotated uniformly by means of an electromagnet and an iron core. The electrical connection with the rotating parts of the apparatus was made by means of ring mercury contacts. The voltage across the potential terminals of the thermometer was first compensated at a selected temperature close to the λ-point. The unbalance voltage produced by further changes of temperature was recorded with an automatic recorder N-373 in the form of heating (or cooling) curves of liquid helium. A sudden change of the thermal characteristics of liquid helium at the λ-point produced a discontinuity in the heating and cooling curves. The λ-transition temperature was determined from the positions of these discontinuities. In the immediate vicinity of the λ-point, the width of a single division of the recorder chart represented not more than 10^{-3} deg K. This made it possible to determine the λ-transition temperature to within 5×10^{-4} deg K. In the experiments of Andronikashvili, Mesoed, and Tsakadze,[1] referred to above, the angular velocity of rotation was $\omega_0 = 0.055\ \text{sec}^{-1}$. In our experiments, the measurements were extended toward higher rotational velocities: $\omega_1 = 0.057\ \text{sec}^{-1}$, $\omega_2 = 0.21\ \text{sec}^{-1}$, $\omega_3 = 0.32\ \text{sec}^{-1}$, and $\omega_4 = 0.56\ \text{sec}^{-1}$.



Block diagram of the apparatus: 1) resistance thermometer, 2) Perspex vessel, 3) ring mercury contacts, 4) iron core, 5) rotating electromagnet.

A comparison of the results for stationary and rotating helium shows the absence of any displacement toward either higher or lower temperatures of the λ-point over the whole range of the angular ve-

1)E. L. Andronikashvili, Dzh. S. Tsakadze, Yu. H. Mamaladze, and S. G. Matinyan. Paper presented at V-th All-Union Conference on Low-Temperature Physics, Tbilisi, 1958.

locities employed, the result being accurate to within 5×10^{-4} deg K.

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[1] Andronikashvili, Mesoed, and Tsakadze, JETP **46**, 157 (1964), Soviet Phys. JETP **19**, 113 (1964).

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