

IV. LOW-TEMPERATURE PHYSICS

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A. DETERMINATION OF THE THERMODYNAMIC TEMPERATURE BY A MAGNETIC METHOD

The attempt to use a superconducting solenoid as a field producer was unsuccessful because of the excessive heating of the bath by the current leads. A conventional solenoid that will be cooled with liquid air has been built instead.

J. W. Wright

B. THERMAL CONDUCTIVITY OF MAGNESIUM

Data already taken indicate that the temperature range of interest for thermal conductivity measurements is lower than 1.5°K , and that the points of greatest interest would lie below 1°K . In order to make measurements in this region, additional pumping equipment has been obtained which will permit helium-bath temperatures down to approximately 0.9°K .

The carbon resistor thermometers have been lowered in resistance in order to permit more sensitivity of measurement at the lower temperatures. With the allied equipment in use at present, the lowered resistance values make the sensitivity slightly lower in the higher temperature range.

Professor Morris Cohen of the Metallurgy Department has initiated procurement of a series of samples containing five different percentages of manganese impurity in pure magnesium. These samples will be reproducible to a high degree so that results obtained from them should be significant.

It is expected that the measurement of the temperature dependence of the thermal conductivity of these samples, correlated with the electrical resistance data on the same samples, will give an indication of the nature of the phenomena causing the electrical resistance minimum.

E. G. Sharkoff

C. PRESSURE DEPENDENCE OF SECOND-SOUND VELOCITY IN THE DEMAGNETIZATION REGION

The results recently obtained in this experiment have been summarized in a letter to the editor of the Physical Review, and will be published soon. Work is being continued on the problem of the anomalous rise in velocity at very low temperatures as

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reported in the letter and also by De Klerk, Hudson, and Pellam at the Office of Naval Research-General Electric Cryogenics Conference, Schenectady, New York, October 6 and 7, 1952.

V. Mayper, Jr.

D. MEASUREMENTS OF SECOND-SOUND PULSE AMPLITUDES IN LIQUID HELIUM II

Improved electronic equipment for observing and measuring second-sound pulses has been set up, and measurements have been made in liquid helium at 1.31°K, 1.33°K, and 1.47°K. A scale drawing of the received pulse observed at 1.31°K is shown in Fig. IV-1. The time scale is indicated in microseconds. The input to the second-sound transmitter (carbon film on bakelite backing) was a square voltage pulse of 200- μ sec duration. The pulse shapes at the other temperatures were similar.

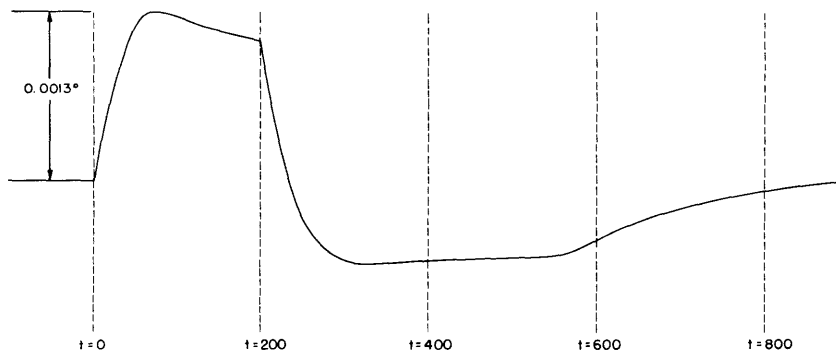


Fig. IV-1
Second-sound pulse at 1.31°K.

Measured pulse amplitudes at the peak in the waveform are approximately 1.5 times the theoretically expected amplitude for a nonreflected pulse. This factor should be either 2 in the case of complete reflection or 1 in the case of no reflection. This discrepancy and the unexpected form of the received pulse are believed to be results of the thermal boundary conditions imposed by the type of transmitter and receiver used (the receiver structure is identical with that of the transmitter). To produce boundary conditions more likely to facilitate the making of the desired measurements without complications, a different type of receiver has been designed and is being constructed.

B. Bernstein

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E. THE VISCOSITY OF LIQUID HELIUM

The Quarterly Progress Report, October 15, 1952, described preliminary experiments with an electromagnetically coupled, constant rotation viscosimeter having as its only moving part a metallic, cylindrical rotor which is free to rotate about its vertical axis inside a glass tube in the liquid helium bath. When this rotor is driven by a transverse three-phase field, the torque required to maintain constant rotation is proportional to the slip frequency, which is susceptible to accurate measurement. The major problem encountered in this technique is the construction of bearings which will satisfy two requirements: They must (a) provide frictional torque which is sufficiently constant compared to the extremely small viscous torque to be measured, and (b) maintain the position of the rotor with sufficient accuracy to permit so small a clearance between the cylindrical rotor and the fixed cylindrical boundary as to render the viscous torque measurable. The magnetic bearings used in the preliminary experiments described in the last Quarterly Progress Report satisfied the first but not the second of these requirements. The best jewel bearings available satisfy the second but not the first.

In re-examining the problem of a magnetic bearing, we found that J. W. Beams and others (1,2) have developed servomechanically controlled magnetic bearings which definitely satisfy both of our requirements: the bearing torque was not measurable even at speeds of the order of 50,000 rps, and the positional stability of the rotors was such that no motion was detectable by means of a 50-power microscope. Since a bearing of this type is literally frictionless, it may be used to measure the viscosity of liquid helium by simply recording the deceleration of the rotor when it is coasting freely. The viscosity can thus be obtained as a function of speed and entirely from measurements of geometry and time intervals.

We have completed the construction of a magnetic bearing controlled by a first-order servomechanism similar to that used by Beams which is capable of supporting an iron rotor 0.5 inch in diameter and 7 inches in length inside a liquid helium Dewar. The upper extremity of the rotor is positioned by the bearing with complete stability, but it is necessary to provide means for preventing slight pendulation of the lower extremity. Such equipment has been designed and is under construction along with the cryostat and associated parts and the apparatus for accelerating the rotor.

H. H. Kolm

References

1. J. W. Beams, J. D. Ross, J. F. Dillon: Rev. Sci. Instr. 22, 77, 1951
2. J. W. Beams, J. L. Young III, J. W. Moore: J. Appl. Phys. 17, 886, 1946

F. VELOCITY AND ATTENUATION OF FIRST SOUND IN LIQUID HELIUM
BELOW 1°K

Apparatus is being constructed for the measurement of the velocity and absorption of ordinary (first) sound in liquid helium in the temperature range from 0.1°K to 1°K, both under vapor pressure and at higher pressures. The helium is to be cooled by the adiabatic demagnetization of a paramagnetic salt, and the measurements are to be made by means of an ultrasonic pulse technique at a frequency of 2 Mc/sec. This work is a continuation of research performed by the author at the Royal Society Mond Laboratory, Cambridge, England (1, 2, 3).

C. E. Chase, Jr.

References

1. K. R. Atkins, C. E. Chase: Proc. Phys. Soc. Sec. A, 64, 826, 1951
2. K. R. Atkins, C. E. Chase: Report of the International Ultrasonics Conference, Brussels, June 1951, p. 270
3. C. E. Chase: Ultrasonic Measurements in Liquid Helium (to be published shortly)