

Physics 410/510
Experiment SS-11

Second Sound in Superfluid Helium (He II)

The experiment concerns the propagation of second sound waves (temperature waves) in superfluid helium (He II). The object of the experiment is not only to measure parameters of second sound propagation, but also to give the student experience in the handling of liquid helium and its hardware. This experiment is closely described in an article by Merrill (with Xerox notes SS-11), though important changes have been made as outlined in the "Notes" (SS-11). General information on superfluid helium and handling of liquid helium is described in the general references given below (and in the Xerox Notes SS-II). Familiarize yourself with procedures to transfer liquid helium (see instructions given below) before you start on the low temperature equipment. Be sure to observe the λ -point transition visually.

1. Measure with the "standing wave" method the velocity of second sound as a function of temperature with the simple cavity.
2. Use the pulse propagation method to find the velocity of second sound as a function of temperature. Discuss the pulse shape and resonant Q as functions of various parameters.
3. Measure 4th sound with the special cavity filled with fine powder. Plot velocity of fourth sound against temperature and explain in terms of superfluid component.

References:

- J.R. Merrill, Am. J. Physics, 137 (1968).
K.R. Atkins, "Liquid Helium" (Cambridge Univ. Press, Cambridge, 1959).
C.T. Lane, "Superfluid Physics" (McGraw Hill Book Co., New York, 1962).
K.N. Zinoveva, Soviet Physice--JETP , 4, 36 (1957).
J.R. Pellan, Phys. Rev. 75, 1183 (1949).
Brewer and Edwards, Proc. Roy. Soc. A251, 247 (1959).
Rose-Jnnes, "Low Temperature Techniques".
Jackson, "Low Temperature Physics".

July 20, 1994