GENERAL PHYSICS

I. MOLECULAR BEAMS*

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A. VAPOR PRESSURE OF He^4 BELOW 1.5°K

A new technique for an indirect, in situ, measurement of $helium^4$ vapor pressure below 1.5°K has been attempted. Experimental data on $helium^4$ extends down to 1°K. Below that temperature thermomolecular pressure gradients make oil manometer readings impossible. In this technique an ionization chamber for the measurement of number densities and a germanium resistance thermometer for the measurement of temperature are employed. This new technique gives promise of measuring number densities down to 0.33°K.

The present apparatus comprises a $helium^4$ refrigeration and dewar system to cool a brass vessel in which the experiment takes place. Inside the brass vessel there are the Am^{241} alpha source and an ionization chamber. The collected ions (or electrons) are detected by a Keithley 600A electrometer. The temperature of the helium in the vessel is measured by a germanium resistor, which is one arm of a 33-Hz Wheatstone bridge. The signal is amplified and sent through a PAR. The stability of temperature is maintained to better than one thousandth of a degree by a servo heater in the $helium^4$ bath.

Experimental data have been taken down to 1.16°K. The data are in agreement with the 1958 $helium^4$ vapor-pressure scale to better than 1%. Number densities equal to those found at 0.68°K have been measured using helium at 300°K. The detected current is in agreement with perfect-gas theory to better than 1%.

The use of a $helium^3$ refrigerator and a vibrating reed electrometer will make it possible to take data on $helium^4$ down to 0.33°K.

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*This work was supported by the Joint Services Electronics Programs (U.S. Army, U.S. Navy, and U.S. Air Force) under Contract DA 28-043-AMC-02536(E), and in part by the Sloan Fund for Basic Research (M.I.T. Grant 367).

B. ELECTRON MICROSCOPY

The procedure for computer simulation of the electrostatic lens containing a shaped thin-foil electrode now uses three principal programs:

PREP — a preprocessor to generate data cards describing the shape of the foil given its description in functional form.

VOLT — a program to calculate the potential in the space within the lens.

TRAJ — a program to calculate electron trajectories within the field calculated by VOLT.

It has been found that VOLT requires a finer mesh-width near the shaped foil in order to describe the shape with sufficient accuracy. This requires a smaller time-step of integration in TRAJ.

The object of this research has been to design a lens which will focus Auger electrons emitted from a point on the cathode of the lens with a wide range of emission angles. We are not dealing only with paraxial electron trajectories, so it is not possible to describe the action of the lens by the accustomed parameters. Instead, a useful figure of merit for a lens may be obtained by computing trajectories for several electrons, all of which are emitted from the center of the cathode (on the axis of symmetry of the lens) with identical energy but varying emission angles (up to 90° off the axis). Ideally, all these trajectories would cross the axis at the same place, producing a point image. The actual lens has these crossing points spread along the axis. It has been found that a graph of crossing-point co-ordinates vs emission angles not only gives a description of the lens but also indicates the modifications needed in the foil shape. The most recent calculations, using a lens containing a single foil electrode, give a range of emission angles $5° \leq \alpha_o \leq 70°$ for which all the crossing points are within 0.16 mm, and $20° \leq \alpha_o \leq 60°$ for which all the crossing points are within 0.04 mm. This latter value would resolve a point source to a spot of about 2×10^4 A. Further calculations are in progress aimed at adjusting the foil shape so as to achieve 1A resolution.

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