tained using the value $\alpha=2.0\times10^{-7}$ cc/ion-sec. for neon given in reference 2. The slope of the curve yields a value, $\tau=1.75$ milliseconds for the diffusion decay time. The diffusion of the electrons takes place in a quartz cylinder with an inside radius, $R=2.22$ cm and inside height, $H=3.82$ cm. For this geometry, the characteristic diffusion length, Λ, as determined by the equation in Fig. 6 of reference 1 is equal to 0.735 cm.

The ambipolar diffusion coefficient, D_a, is given by Eq. (9) of reference 1.

$$D_a=\Lambda^2/\tau=309 \text{ cm}^2/\text{sec.} \quad (p=0.356 \text{ mm Hg}).$$

Data of the type shown in Fig. 1 were taken over the pressure range 0.27 to 1.10 mm Hg. According to kinetic theory, the product D_ap, where p is the gas pressure, should be constant at constant temperature. The experimental results are shown in Fig. 2. The value $D_ap=115\pm10$ (cm²/sec.) – (mm Hg) is obtained at $T=300°$K, which agrees with unpublished estimates obtained with the previous apparatus. With the knowledge of D_ap, one may calculate the positive ion mobility from Eqs. (18) and (19) of reference 1. The extrapolated value for 760 mm Hg and 20°C is 2.9 cm/sec. per volt/cm as compared to Munson and Tyndall's value[3] of 6.23. As in the analogous case of helium,[4] a possible explanation of the discrepancy is that the ions observed by Munson and Tyndall were molecular; i.e., Ne_2^+. Rough estimates of the rate of conversion of atomic to molecular ions by three-body collisions with normal atoms indicate that, at the pressures used in our experiment, the ions are predominantly atomic. Unfortunately, the lack of pressure data in reference 4 prevents the drawing of conclusions as to the nature of the ions observed.

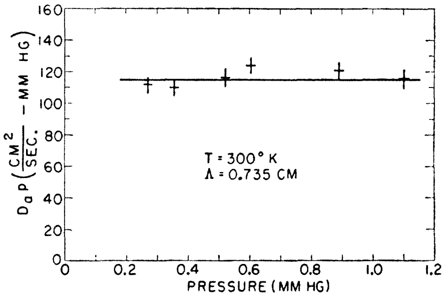

FIG. 2. Pressure dependence of the ambipolar diffusion coefficient for neon.

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A New Method for Measuring Film Transport in Liquid He II*

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FILM transport rates of liquid He II have heretofore been measured mainly by a visual method; i.e., by observation of the changes in height of liquid helium columns in glass vessels.[1,2] The optical technique requires the incidence of external radiation upon the helium film, and is limited to studies of transport rates over transparent dielectric surfaces.

In the present method the dielectric property of liquid helium is employed to indicate the total amount of liquid helium between the walls of a cylindrical capacitor. Variations in height of the liquid helium contained within the annular space are observed as changes in capacitance. The capacitor, serving in this way as a depth gauge, is placed within a container of the material over whose surface the transport rate is to be measured. The container and capacitor assembly is enclosed within a copper radiation shield provided with small holes to allow the passage of liquid and vapor. Electrical connections are brought down through the liquid helium bath to minimize thermal conduction to the container.

The capacitor is connected in parallel with the tuned circuit of a radiofrequency oscillator, and changes in capacitance are observed by means of frequency changes of the oscillator. The oscillator frequency has been measured by beating the signal against the output of a heterodyne frequency meter, and reading the frequency of the meter in the condition of zero beat note. An automatic frequency recording circuit has also been used. In this case, the frequency meter is not tuned during the course of a transport rate measurement. The audio beat signal is amplified and fed to a voltage divider consisting of a large resistance in series with an air core inductance. The voltage across the inductance, proportional to frequency, is rectified and fed to a recording potentiometer.

The depth gauge has been calibrated with a cathetometer in the He II region, and shows a satisfactorily linear frequency *vs.* height dependence.

As a check on the method, transport rates in glass containers have been measured in this way, and found to compare very closely with the results of Daunt and Mendelssohn.

Preliminary measurements of creep over copper indicate rates significantly higher than those over glass. Further studies over various materials are now in progress.

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A Precision Determination of the Half-Life of Radium C′

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THE widespread use of RaC′ to check the proper functioning of delayed coincidence and variable resolution coincidence equipment made a redetermination of the half-life with high accuracy desirable.

The apparatus used was a 20-channel time analyzer, originally intended for neutron time-of-flight measurements, and similar in principle to other time-of-flight spectrometers already described.[1,2] For the measurement, a gated amplifier was inserted between the time analyzer proper and the crystal oscillator which produced pulses to switch the analyzer. A β-ray pulse from a set of 6 G-M tubes in parallel will open the amplifier, which stays open for a sequence of 20 pulses. In this way each β-pulse renders all the channels in turn operative once. The six β-ray tubes surround a thin-walled proportional counter, in whose sensitive volume a small thin-walled glass capillary containing radon is mounted. A β-pulse from RaC will be registered by the G-M tubes and is followed by an α-particle from RaC′, which is registered by the proportional counter. The time-distribution of the α-pulses relative to the β-pulses is analyzed by the time analyzer. The α-pulses are first fed to a special prearranging circuit where they are replaced by standard pulses derived from the oscillator. The position of these pulses has been chosen such that they always fall definitely in one channel and not on the border between two channels. These standard pulses are then fed to the time analyzer proper. With this arrangement the channels will be entirely equivalent and will not depend on varying tube characteristics and stray capacities which would otherwise influence the wave forms of the respective grating pulses and the effective width of the channels.

The number of counts in the channels will fit an exponential curve with the half-life of RaC′, superimposed on a constant background. As all channels are in operation during the entire measurement, all varying factors such as sample decay, and changes in G-M tube characteristics, will influence them in the same way, and would not affect the half-life determination. A close analysis of possible sources of error failed to reveal any important source besides the statistical fluctuations of the number of counts. A treatment of the influence of the statistical fluctuations on the standard error in the half-life determination has been given by Peierls[3] and his procedure has been followed in the treatment of the data.

The measurements included a number of runs with a total measuring time of about 700 hours. For each run the half-life was calculated according to Peierls' procedure. The weighted average of these values was found, and the scattering of the individual values around this mean was checked, and found to agree with what could be expected if the only source of error were the statistical fluctuations of the number of counts. It was, considered reasonable, however, to assume the possible existence of unknown systematic errors of the same order of magnitude as those caused by the statistical fluctuations. The final value for the half-life with its standard error under this assumption is 163.7±0.2 μsec. This value is in fair agreement with previous values obtained by the method of delayed coincidences[4] (155±5 μsec.), but seems to be outside the expected accidental errors of the values obtained by the coincidence method of variable resolution, which has yielded values[5–7] of about 145±5 μsec. It is suggested that the possible presence of systematic errors in this method as previously applied should be investigated.

A multichannel system of the present sort seems to be capable of considerably higher precision than are previous methods. It is particularly suited for measurements on rapidly decaying substances where point by point measurements are difficult and inaccurate.

A detailed account of the experiment will be published in *Arkiv för fysik.*

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Decay Time and Efficiency of a Liquid Scintillator*

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THE fluorescence decay time and efficiency for fast counting of a liquid scintillator[1,2] has been investigated, using a pulsed counter technique previously described.[3] The liquid studied was a saturated solution of terphenyl (*p*-diphenylbenzene) in toluene. Toluene was chosen as the solvent in preference to xylene because of its simple structure. By contrast, commercial c.p. xylene, which was the only grade available, contains all of the three components, meta, para and ortho. The relative effects of these components on the fluorescence was not known. Thus, although similar results were found using xylene as a solvent, toluene was chosen for the investigation here reported.

To obtain the decay time several photographs of count pulses from a Ag^{110} source immersed in the liquid were analyzed. The pulses were smoothed by tracing and an average decay time was determined, neglecting corrections due to the pulse rise times. The value and r.m.s. deviation found for the decay time (for decay $1/e$) at room temperature was: $1/\lambda=2.2\pm0.3\times10^{-9}$ second. The observed rise times (10 to 90 percent) ranged between 6 and 10×10^{-10} second, so that the error made in neglecting the finite rise time in the measurements is probably small.

For fast counting applications the maximum absolute rate of emission of photons from the scintillator is more important than is the integrated photon output. If observed by a system with a time resolution small compared with the decay time, the scintillation pulse heights are proportional to the rate of emission of photons. Thus, under these circumstances relative pulse heights per unit energy of excitation can be used as a criterion of excellence in comparing scintillators to be used for fast counting. Using an oscilloscope method described below, a measurement was made of maximum pulse heights obtained from the liquid scintillator, and also those obtained from a stilbene crystal of comparable size and shape. In the setup employed it was found that the maximum pulse heights obtainable from the liquid were up to 30 percent greater than those from stilbene. These results are of course peculiar to the particular optical geometry employed. Since no attempt was made to optimize the optical coupling between liquid and photo-multiplier, this performance of the liquid scintillator indicated that it should be superior to stilbene for use in fast counting. Although it can be inferred from the relative decay times of stilbene[4] and the toluene-terphenyl solution that the total number of photons per unit energy of excitation may be smaller in the case of the liquid, the maximum absolute rate of photon emission appears to be higher for the liquid.

In the experiments a small sample of the saturated solution was used, contained in a piece of fused quart tubing, core diameter about 1 cm and length about 3 cm. This tube was held close to the 931A photo-multiplier, and the assembly was then wrapped with aluminum foil to improve the optical coupling. The Bakelite base was removed from the photo-multiplier to reduce lead inductance and capacitance effects. A short length of RG7U 100 ohm coaxial cable was connected to the anode and first dynode of the photo-multiplier. This transmission line was terminated by a 100 ohm resistor at the photo-multiplier. Its other end was connected directly to one deflection plate of a DuMont K1017 high speed cathode-ray tube. A horizontal sweep of about 0.07-μsec. duration was used in obtaining the photographs of the count pulses. To obtain pulse height distributions the sweep connections were removed and a mask was placed across part of the oscilloscope screen. A photo-multiplier viewing the screen and operating into a conventional scaler was used to count pulses which appeared above the mask. Pulse height discrimination was introduced by applying a variable d.c. bias to the lower oscilloscope deflection plate, thus moving the spot away from the edge of the mask.

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The Velocity of Second Sound in Mixtures of He^3 and He^4

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IT is now well established that small amounts of He^3 dissolved in liquid He II are associated with the normal component of the liquid. Since the normal component density is greatly decreased at low temperatures, many properties of the liquid are substantially affected by even a very small concentration of He^3. In particular, Pomeranchuk[1] has treated theoretically the effect of small amounts of He^3 on the velocity of second sound, and pre-