cated a sudden and rather surprising increase in yield around mass 60. Thus the $Ni^{58}(\gamma, n)$ yield is about 6 as compared with about 30 for Cu^{63}.

It may be pointed out that these figures are not necessarily inconsistent with the statistical theory of nuclear reactions (evaporation model). According to the statistical theory,[2] the yield will depend quite sensitively on the binding energy of a neutron to the nucleus in question. New thresholds of (γ, n) reactions have been measured by Baldwin and Koch,[3] who find a threshold of 10.9 ± 0.3 Mev for the Cu^{63} reaction. Although no data seem to be available on Ni^{58}, the same authors find 14.2 ± 0.4 Mev for the $Fe^{54}(\gamma, n)$ reaction. Since $_{28}Ni^{58}$ and $_{26}Fe^{54}$ both have a neutron excess of two, and in fact differ from each other by just an alpha-particle, whereas $_{29}Cu^{63}$ has a neutron excess of five, differing from $_{28}Ni^{58}$ by the addition of one proton and four neutrons, it is perhaps reasonable to suppose the binding energy of a neutron in the Ni^{58} nucleus to be about the same as that in Fe^{54}. With this assumption one can calculate the ratio of Cu^{63} to $Ni^{58}(\gamma, n)$ yield, using the level density formula $\exp(aE)^{\frac{1}{2}}$,[2] with $a=15$ Mev^{-1}, and taking the betatron spectrum to be inversely proportional to the energy.[1] One finds a ratio of about 4 using the neutron binding energies 10.9 Mev and 14.2 Mev, respectively, for Cu^{63} and Ni^{58}. By going to the extreme values consistent with the experiments quoted above, namely, 10.6 Mev and 14.6 Mev, respectively, one raises the ratio to slightly over 5, which is about the same as the experimental value.

Thus the experimental (γ, n) yields for the heavier nuclei can probably be understood within the framework of the statistical theory, considering all the uncertainties in the theoretical formulae (level densities, binding energies, etc.). For the lighter nuclei (mass <50), the statistical treatment is not expected to hold.

[1] M. L. Perlman and G. Friedlander, Phys. Rev. **74**, 442 (1948).
[2] V. F. Weisskopf and D. T. Ewing, Phys. Rev. **57**, 472 (1940).
[3] G. C. Baldwin and H. W. Koch, Phys. Rev. **67**, 1 (1945).

The Melting Pressure of Helium II

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TAMMANN[1] proposed the equation

$$T-1=\log(P_{\text{atmos}}-24.0),$$

for representing the melting pressure of helium up to 2.5°K. The equation, however, does not account for the singularity in the curve on meeting the λ-line.

The elliptic function,

$$p=a-[r-n(T-l)^2]^{\frac{1}{2}}, \quad (1)$$

$$dp/dT=[n(T-l)/a-p], \quad (2)$$

reproduces the values given by Keesom and Keesom[2] from 1.15 to 1.78°K with an average deviation of 0.1 percent and a maximum deviation of 0.3 percent.

TABLE I.

T, °K Scale 1937	p, atmos. K.K.	Eq. (1)	dp/dT Eq. (2)
1.15	25.27	25.29	0.13
1.20	25.32	25.32	0.89
1.30	25.50	25.49	2.46
1.40	25.81	25.82	4.20
1.50	26.32	26.34	6.36
1.60	27.13	27.12	9.43
1.70	28.39	28.31	15.2
1.75	29.30	29.21	21.1
1.78	29.96	29.99	31.8

With $a=32$, $r=45$, $n=100$, and $b=1.14$, the results of the calculations are shown in Table I.

[1] W. H. Keesom, *Helium* (Elsevier Publishing Company, Inc., Amsterdam, 1942), p. 202.
[2] Reference 1, p. 203.

Discrepancies Caused by Source Charging in Beta-Spectrometers

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A STUDY is being made of the radiations from Na^{22}, which emits positrons and gammas with a half-life of about three years. A small 180° spectrometer, a thin lens, and a large double-focusing spectrometer[1] have been used for this purpose. Each instrument employs G-M tubes whose thin Zapon windows have a low energy cut-off of less than five kilovolts.

The purpose of this letter is to report on a somewhat disturbing phenomenon which became apparent early in the investigation. A measurement of the positron spectrum with the lens spectrometer, which does not resolve positrons and negatrons, indicated the presence of a strong low energy peak at about 9 kev. Further work with the 180° instrument uncovered a strong negatron peak at 8 kev, whose intensity is roughly half that of the positron spectrum. This disagreement on the energy of the peak led us to seek a further check using the double-focusing spectrometer. The strong negatron peak was again found, but at about 25 kev. In all three instruments the same sodium chloride source was used. It was deposited in a thin layer upon a thin backing of Zapon.

It has been found that this enormous discrepancy stems from the fact that the sources are Zapon-mounted, and are therefore well insulated electrically from the body of the spectrometer. The sodium source and the spectrometer body form, in effect, a small capacitance, with a very high resistance leakage path between them. The magnitude of the capacitance will vary from instrument to instrument. The excess of positron emission dèvelops a negative charge on the source, thus gradually establishing a considerable potential difference between source and vacuum chamber. As a result, positrons are decelerated and negatrons are accelerated.

To substantiate the above explanation, further experiments were carried out. In one, the source was backed by a grounded aluminum foil and a search was made for the negatron line with the lens spectrometer. No peak was observed, indicating that the unaccelerated negatrons have an energy below the cut-off energy of the window. In a second experiment, this time with the double-focusing spectrometer, the negatron peak from a Zapon-mounted, ungrounded, originally uncharged source was followed over a period of about eleven days.

The results are shown in Fig. 1, where the energy of the

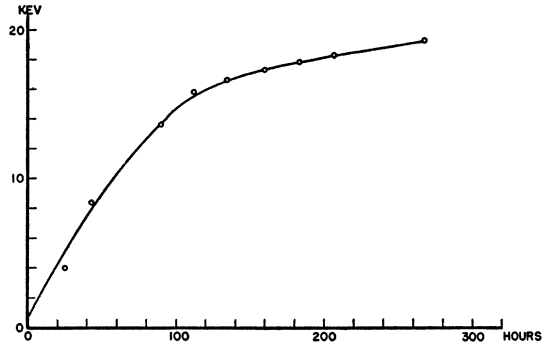

FIG. 1. Plot showing charging of an insulated beta-source. The circles indicate the measured energy of a monochromatic negatron line at different times following the insertion of an uncharged source.

negatron line is plotted as a function of time. The peak was unobservable during the first few hours, being completely stopped by the counter window. Thereafter, its energy was found to increase as a roughly exponential function of time, approaching an asymptotic value of about 21 kev. Extrapolation back to zero time indicates that the unaccelerated negatron energy is probably less than one kev, but the exact value is very uncertain. It is perhaps conceivable that these negatrons are Auger electrons which follow a K-capture process, but this is only a hypothesis at present. Further work is under way in search of a more positive identification.

The importance of these findings lies in the fact that a considerable number of recent studies of beta-spectra and internal conversion lines have been performed with sources which were supported on non-conducting backing-foils such as Zapon, Nylon, Cellophane, and the like. In such cases, the experimental data must be viewed with suspicion, since it seems altogether possible that source-charging effects similar to those described here may have been involved. Not only are energy measurements affected, but it seems quite likely that the effective solid angle of the spectrometer for beta-particles of low energy is altered, thus distorting the spectrum shape.

It is possible that the phenomenon discussed in this letter has contributed largely to the discrepancies noted in results reported by different workers in the field.

This work has been assisted by the joint program of the Office of Naval Research and Atomic Energy Commission.

[1] F. N. D. Kurie, J. S. Osoba, and L. Slack, Rev. Sci. Inst. **19**, 771 (1948).

Half-Life of UX_1 (Th_{234})*

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THE half-life of UX_1 has recently been redetermined in this laboratory. Several values are reported in the literature including 24.5 days by Curie *et al.*[1] in 1931 and more recently 24.1±0.2 days by Sargent[2] in 1939. The present work was undertaken to reduce the uncertainty in this constant and thereby allow a more accurate calculation of the quantities of U_{234} grown from samples of UX_1. As a preliminary step, the data of Sargent[2] were re-evaluated statistically. The estimate of the half-life arrived at by applying the method of least squares to the logarithm of Sargent's observed activities and associated decay times was 24.03±0.27 days. The error here forms the limits of the 95 percent confidence belt. The half-life was then redetermined independently.

Samples of uranium largely freed of the U_{235} and U_{234} isotopes and other radioactive contaminants were used as a source of UX_1 for half-life determinations. The UX_1 was isolated after a suitable growth period by precipitating zirconium iodate as a carrier in a uranyl nitrate solution. The first precipitate so formed was dissolved in concentrated hydrochloric acid, and a second precipitation then made to further reduce the traces of occluded uranium present.

The final precipitate was mounted for counting in a thin film on a one-inch filter paper disk. Two such samples were prepared and counted.

Two standard thin-walled (0.006-inch) Geiger counters (Technical Associated Model GS-4 mountings and circuits) were used, each sample being counted on both. The first sample had an initial counting rate of some eleven hundred counts per minute and was counted for seventy-one hour periods on each counter during the 1700 hours (3 half-lives) immediately following sample preparation. The second sample had an initial rate near three thousand and was counted for about one hundred one-hour periods on each counter during the 2200 hours (4 half-lives) immediately following its preparation.

A close check on counter sensitivity was maintained by overnight counts of high purity U_3O_8 samples which had had two years to approach equilibrium with UX_1 and UX_2.

All sample counts were corrected for counter shift, coincidence losses (never over 1.5 percent), and background (determined by counting zirconium iodate blanks).

The decay curve of each of the four samples was found by the usual method of fitting a least squares line to the collection of points formed by the logarithms of the corrected counting rates with the associated time of measurement of each rate, assuming the time as precisely known. Each point was weighted as the reciprocal of the total variance of its logarithm. From the slope of this least squares line, an estimate of the half-life may be readily computed.

The data for each sample on each counter were tested for curvature (the expected effect of a long-lived contami-