impurities, nitrogen and oxygen, are much above the energy available for the metastable state of argon (11.6 ev). However, by a well-chosen contaminant with an ionization potential below this value one can obtain a large increase in the ionization in argon. Thus, 0.2 percent of acetylene (ionization potential 11.2 ev) added to pure argon will produce an increase in ionization of 25 percent and a W of 21 ev/ion pair.

In view of the well-known difficulties of obtaining saturation for alpha-particle ionization measurements for air and probably oxygen, the corresponding values in the table may well be accepted with some degree of reserve. These difficulties have been emphasized by recent work,[4] where saturation was attained only at fields above 10 000 volts/cm. Alder, Huber, and Metzger,[5] also using fields of this order, employed a method of extrapolation to obtain a value of W for air at saturation of 34.7±0.5 ev/ion pair.

A ratio often calculated is that of W to the ionization potential of the gas in question. Such ratios, based on the W values for the five noble gases in column two of Table I, yield for the first four gases values which are almost constant at about 1.71. The ratio for xenon is only slightly higher. All semblance of constancy is lost if one uses in this way the older values of W found in the literature for helium and neon.

[1] Jesse, Forstat, and Sadauskis, Phys. Rev. **77**, 782 (1950).
[2] W. P. Jesse and J. Sadauskis, Phys. Rev. **88**, 417 (1952).
[3] In a very recent letter, T. E. Bortnis and G. S. Hurst [Phys. Rev. **90**, 160 (1953)] give a value of W for helium of 46.0±0.4 ev per ion pair. This is higher than our own value and much above the previously accepted value. Their values for argon, nitrogen, ethylene, and hydrogen agree well with those given above.
[4] Kimura, Ishiwari, Yuasa, Yamashita, Miyake, and Kimura, J. Phys. Soc. Japan **7**, 111 (1952).
[5] Alder, Huber, and Metzger, Helv. Phys. Acta **20**, 234 (1947).

The Neutron Activation of Ca^{46}

L. G. Cook and K. D. Shafer
Chemistry Branch, Atomic Energy of Canada, Limited, Chalk River, Ontario, Canada
(Received April 24, 1953)

THE natural abundance of Ca^{46} is low, and Ca^{47} has never been reported as observed in neutron-irradiated calcium. Sc^{47} has been observed as a product of $Ca(\alpha,p)$, (d,n), (p,γ),[1] $Ti(n,p)$,[2] $Ti(d,\alpha)$,[3] and Ca^{47} as a product of $Ca(d,p)$.[4] Ca^{47} has been observed directly in the calcium fraction from Cu spallation with 340-Mev protons, and the decay of Sc^{47} observed.[5] We have observed the decay of Ca^{47} in neutron-irradiated calcium indirectly, by observing the decrease in yield of Sc^{47} on successive milkings.

The irradiated calcium was spiked with Sc^{46} tracer, and the Sc fraction was removed, purified by T.T.A.-benzene extraction and ion exchange on Dowex-50, and estimated. This was repeated at weekly intervals for eight weeks.

The decrease in yield of Sc^{47} gave a half-life for Ca^{47} of 4.8±0.5 days, agreeing with the half-life quoted by Batzel, Miller, and Seaborg,[5] but not with the 5.8 days quoted by Matthews and Pool.[4] The thermal neutron activation cross section $Ca^{46}\rightarrow Ca^{47}$ was $0.25\pm0.1\times10^{-24}$ cm²/atom.

[1] C. T. Hebdon and M. L. Pool, Phys. Rev. **67**, 313 (1945).
[2] R. E. Hein and A. F. Voigt, Phys. Rev. **74**, 1265 (1948).
[3] N. L. Krisberg and M. L. Pool, Phys. Rev. **75**, 1693 (1949).
[4] D. E. Matthews and M. L. Pool, Phys. Rev. **72**, 163 (1947).
[5] Batzel, Miller, and Seaborg, Phys. Rev. **84**, 671 (1951).

Neutron Capture Cross Section of Em^{222}

A. P. Baerg
Chemistry Branch, Atomic Energy of Canada, Limited, Chalk River, Ontario, Canada
(Received April 24, 1953)

MEASUREMENTS have been made of the cross section of Em^{222}(Rn) for slow neutron capture in the NRX reactor, to form Em^{223} which has not been previously reported. This nuclide is expected to be a β-emitter with a calculated disintegration energy of 1.58 Mev,[1] and from this it may be estimated to have a half-life of about 5 minutes. Fr^{223}, the β-decay daughter of Em^{223}, is also short-lived but decays to Ra^{223}(AcX) which is an α-emitter with a half-life of 11.2 days. It seemed convenient to measure the production of Em^{223} by the growth of Ra^{223} during the neutron irradiation of the Em^{222}.

TABLE I. Data for cross-section calculation.

Expt.	$(Em^{222})_0$ mC	t hr	F n/cm²/sec	$(Ra^{223})_t$ dis/min	$\sigma(n,\gamma)Em^{222}$ barn
1	0.32_7	239	4.8×10^{13}	2460	0.7_6
2	0.27_2	264	4.7	1640	0.6_3
3	0.36_4	222	5.19	3035	0.7_8

The Em^{222} was extracted from an acid solution of $RaCl_2$, purified and sealed in a small quartz bulb for irradiation. A slow stream of helium gas was used to sweep the Em^{222} from the heated $RaCl_2$ solution. The gas was passed through two dry ice traps to remove water vapor and through an Ascarite absorber to remove hydrochloric acid gas. The Em^{222} was then adsorbed in a charcoal trap in a dry ice—acetone mixture. The charcoal trap was then heated and a small volume of helium gas used to sweep the Em^{222} into a small U-shaped quartz bulb immersed in liquid nitrogen to condense the Em^{222}. The bulb was finally evacuated and quickly sealed with a small flame just above the liquid nitrogen level. Some of the Em^{222} was lost in the evacuation, but sufficient was retained for the irradiation.

After about ten days irradiation in a high-flux position of the NRX reactor, the quartz bulb was crushed in a vacuum system and the residual Em^{222} removed. The Ra^{223} and the decay products of Em^{222} were taken up in nitric acid. The Po, Bi, and Pb decay products were separated from the Ra^{223} by two sulfide precipitations using 1 mg each of Bi and Pb carrier. About 25 μg of Ba was used as holdback carrier for the Ra^{223}. The solution was evaporated on a platinum disk for α-counting. The sulfide precipitates were dissolved in nitric acid, and an aliquot was evaporated on platinum for α-counting of the Po^{210} to determine the initial quantity of Em^{222} sealed in the quartz bulb.

The Ra^{223} was identified by α-pulse analysis which showed the three α-groups with energies of 5.72, 5.61, and 5.53 Mev characteristic of Ra^{223}. The α-activity decayed with a half-life of 11.1±0.2 days over a period of at least two half-lives.

The (n,γ) cross section of Em^{222} was calculated from the following equation:

$$\frac{(Ra^{223})_t}{(Em^{222})_0}=\frac{\sigma F\lambda_0}{(\lambda_0-\lambda_1)\lambda_1}(e^{-\lambda_1 t}-e^{-\lambda_0 t}),$$

where $(Em^{222})_0$ is the disintegration rate of the Em^{222} at the beginning of the irradiation, $(Ra^{223})_t$ that of Ra^{223} at the end, and λ_1 and λ_0 are the respective decay constants. F is the neutron flux during the time t of irradiation and was obtained from the calculated neutron distribution within the reactor and the reactor power log.

In three experiments an average value of 0.7_2 barn was found for the cross section σ of Em^{222}. The pertinent data are given in Table I.

The author is greatly indebted to B. G. Harvey for continued guidance and assistance throughout the course of this work.

[1] G. T. Seaborg, Lecture, Eta Chapter of Phi Lambda Upsilon, Ohio State University, March, 1952 (unpublished).

The β-Decay of Li^8

D. Stp. Bunbury
Department of Physics, Imperial College, London, England
(Received April 22, 1953)

THE β-decay of Li^8 is known to lead predominantly to the broad excited state of Be^8 at 3 Mev.[1] This provides an opportunity for studying the β-decay by observing the angular

correlation between the decay electrons and the α-particles from the subsequent break-up of Be^8.

This letter reports measurements which have been made on the angular correlation with a β-ray spectrometer,[2] to select electrons from the high energy part of the spectrum. The α-particles were detected with a thin-window proportional counter which could be rotated about the source.

Li^8 was produced by bombarding natural Li with 530-kev deuterons. The beam was interrupted periodically by deflecting it off the target by means of a 50-cps rectangular voltage wave applied to deflecting plates. The signals from the counters were passed through electronic gates which were opened only when the beam was off the target. The random coincidence rate was continuously monitored by counting delayed coincidences.

The spectrometer resolution was set at about 7 percent, and two sets of measurements were made, with the coil current set to select electrons of 9.8 Mev and 7.5 Mev, corresponding to 0.8 and 0.6 of the end-point energy of the β-spectrum, respectively. Measurements were made at five angles from 90° to 175°, and the results were fitted by least squares to the expression $(1+A\cos^2\theta)$. The values of A found in the two cases were, respectively (0.04 ± 0.2) and (0.12 ± 0.09).

These results are substantially in agreement with the recent measurements by Class and Hanna.[3]

An attempt was made to compute the theoretical angular correlation from the results of Falkoff and Uhlenbeck.[4] However, the results are uncertain, owing to the uncertainty as to the form of interaction involved in β-decay. This and the rather large experimental error make it impossible to arrive at any definite conclusion at present. The calculations of Gardner[5] for the angular correlation in this case appear to be in error. The above results can, however, be taken as confirming the nonzero spin of the 3-Mev level in Be^8, while they also rule out the possibility that the Li^8 β-decay is allowed.

A search was also made for γ-rays in coincidence with decay electrons of Li^8, since there is known to be a γ-ray emitting level at 4.9 Mev in Be^8.[6] In order to reduce as much as possible the effects of bremsstrahlung, the target was deposited at the end of a thin-walled aluminium tube, and the β-counter, which was also of very light construction, was placed as close to the target as possible. Two γ-counters were placed one on each side of the target, and glass walled β-counters, connected in anticoincidence with the other counters, were placed between the target and the γ-counters, to avoid spurious coincidences due to bremsstrahlung produced in the lead surrounding the latter. Bombardment and counting were carried out alternately, as described above, and the background coincidence rate was measured after each run of six minutes. The result obtained was that an upper limit of (0.8 ± 0.3) percent could be placed on the number of disintegrations leading to the 4.9-Mev level in Be^8. This is somewhat lower than the result of Vendryes[7] who obtained (2 ± 1) percent after making a correction for bremsstrahlung. If we take the spin of this level as one,[6] it is difficult to reconcile the above results with a spin of less than three for Li^8.

In the course of this work the half-life of Li^8 was also remeasured. The result obtained was (0.89 ± 0.01) sec, which is not in agreement with the recent measurement of Rall and McNeill[8] who obtained (0.825 ± 0.02) sec, but is in agreement with earlier measurements.[9–11]

The writer is indebted to Professor S. Devons for his interest and encouragement. He also wishes to thank the Senate of the University of London for a postgraduate studentship.

[1] W. F. Hornyak and T. Lauritsen, Phys. Rev. **77**, 160 (1950).
[2] R. L. Graham and O. Klemperer, Proc. Phys. Soc. (London) **B65**, 921 (1952).
[3] C. M. Class and S. S. Hanna, Phys. Rev. **89**, 877 (1953).
[4] D. L. Falkoff and G. E. Uhlenbeck, Phys. Rev. **79**, 323 and 334 (1950).
[5] J. W. Gardner, Phys. Rev. **82**, 283 (1951).
[6] F. Ajzenberg and T. Lauritsen, Revs. Modern Phys. **24**, 321 (1952).
[7] G. Vendryes, Compt. rend. **232**, 1549 (1951).
[8] W. Rall and K. G. McNeill, Phys. Rev. **83**, 1244 (1951).
[9] Lever, Burcham, and Chang, Nature **139**, 24 (1937).
[10] Hughes, Hall, Eggler, and Goldfarb, Phys. Rev. **72**, 646 (1947).
[11] G. C. Baldwin, Phys. Rev. **76**, 182 (1949).

An Unusual Example of V^0 Decay*

R. W. Thompson, A. V. Buskirk, L. R. Etter, C. J. Karzmark, and R. H. Rediker
Department of Physics, Indiana University, Bloomington, Indiana
(Received April 6, 1953)

THE object of this note is to report in detail a rather unusual V^0 decay recently observed in the new magnetic chamber.[1] Event R-118 is shown in Fig. 1. The V^0 particle, occurring with a penetrating shower, decays after traversing about one-eighth of the illuminated height of the chamber. The decay takes place very near the center of the illuminated depth; the positive fragment (track a) is projected almost vertically down, and the negative fragment (track b) almost horizontally to the right.

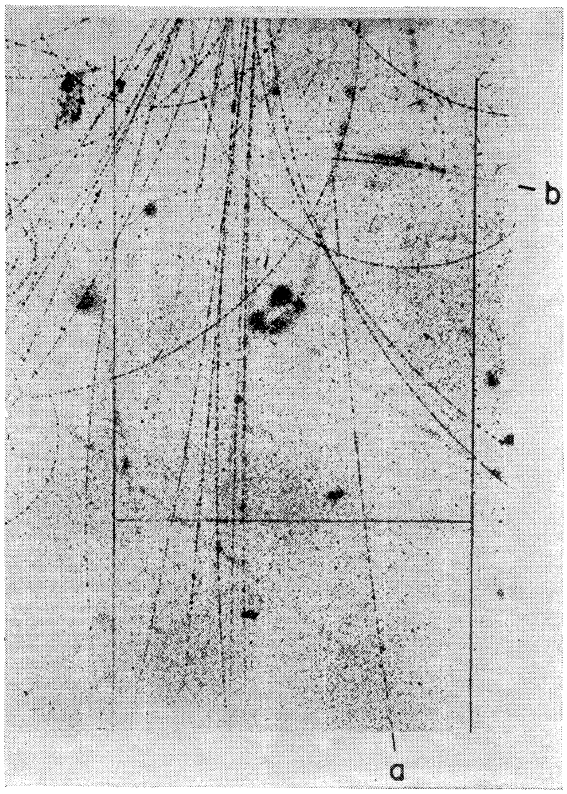

FIG. 1. Event R-118. The upper $\frac{3}{4}$ of the chamber is shown. The obscuration of track b, by an unrelated old track, is less in the other two stereoscopic views.

The track of the positive fragment is 43 cm long and is well illuminated throughout its entire length. The comparator plot for the left eye is shown in Fig. 2. The corrected momentum, derived from the three eyes, is 0.67 ± 0.02 Bev/c, and the ionization is indistinguishable from that of electronic tracks nearby. A proton of this momentum would be heavily ionizing by a factor 2.3, which it is believed would not easily escape detection under these conditions. Thus it is probable that the positive fragment is lighter than a proton, which means that the disintegration is not of the type $V_1^0\rightarrow p+\pi$.

The track of the negative fragment, although relatively short, is highly curved and distinctly heavily ionizing. The track makes an angle of 26° with the plane of the chamber and crosses the front boundary of the illuminated depth near the right side of the chamber, as evidenced by the fading of track b in Fig. 1. The comparator plot for the left eye is shown in Fig. 2. The momentum is 0.094 ± 0.008 Bev/c, and the track is heavily