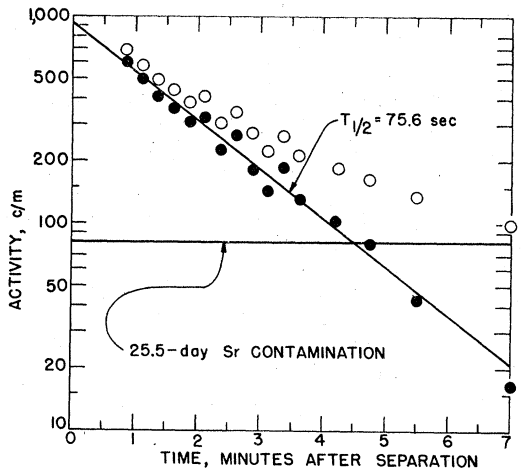

FIG. 1. Decay curve of rubidium separated from 25.5-day Sr. ○, original points; ●, activity of 25.5-day Sr contamination subtracted from original points.

tween the 6.3-hr Rb and the 25.5-day Sr, as well as between the 6.3-hr Rb and the 76-sec Rb. Although the possibility of isomerism seems quite likely because of spin considerations in the region of Rb^{82}, the recent spin assignment of 3+ and the proposed decay scheme[5] of 6.3-hr Rb^{82} make it difficult to explain the isomery of the 76-sec Rb with the 6.3-hr Rb^{82}.

* This research was supported in part by a grant from the U. S. Atomic Energy Commission.

[1] Way, Fano, Scott, and Thew, *Nuclear Data*, National Bureau of Standards Circular No. 499 (1950).
[2] G. T. Seaborg and I. Perlman, Revs. Modern Phys. **20**, 585 (1948).
[3] S. V. Castner, University of California Radiation Laboratory Unclassified Report No. 942 (1950); S. V. Castner and D. H. Templeton, Phys. Rev. **88**, 1126 (1952).
[4] D. G. Karraker and D. H. Templeton, Phys. Rev. **80**, 647 (1950).
[5] C. M. Huddleston and A. C. G. Mitchell, Phys. Rev. **88**, 1350 (1952).

The Angular Correlation of the Cascade Gamma-Rays from the Decay of Au^{198}

CARLTON D. SCHRADER, EDWARD B. NELSON, AND JAMES A. JACOBS
Department of Physics, State University of Iowa, Iowa City, Iowa
(Received February 16, 1953)

ALTHOUGH the beta-decay of Au^{198} occurs predominantly to the 0.411-Mev level in Hg^{198}, about 2 percent of the decay occurs to the 1.09-Mev level. The gamma-decay of the 1.09-Mev level occurs by cascade through the 0.411-Mev level as well as by a direct transition to the ground state.[1] Our observed angular correlation of the cascade gamma-rays determines the spin and parity of the 1.09-Mev level as 2+ in agreement with the internal conversion results of Elliott and Wolfson,[2] and the 0.68-Mev radiation has been found to be a 60 percent quadrupole, 40 percent dipole mixture.

The detectors consisted of two magnetically shielded scintillation counters using 2-in. by $1\frac{3}{4}$-in. cylindrical NaI(Tl) crystals and RCA 5819 photomultiplier tubes. Aluminum shielding was used to prevent the counting of beta-particles. Integral pulse height selection was used so that one detector counted only the 0.68-Mev gammas while the other counted both 0.411 and 0.68-Mev gammas. The bias settings were high enough so that no scattering between counters of gammas from the Au^{198} decay could be detected. The correction for accidentals was about 20 percent of the total coincidence counting rate, while the background coincidence correction was about 10 percent of the total. After these corrections the experimental curve was symmetric about 90°.

The data were fitted by the method of weighted least squares to a Legendre polynomial expansion of the form $1+A_2P_2(\cos\theta)+A_4P_4(\cos\theta)$, where $A_2=-0.261\pm0.023$ and $A_4=0.137\pm0.012$. Since the lifetime of the 0.411-Mev state is short (10^{-11} second)[3,4] compared to the time of Larmor precession, the observed correlation should be unperturbed by extra-nuclear magnetic fields.

The ground state of the even-even Hg^{198} nucleus is assumed to have zero spin and even parity. Several investigators[5,6] have found from internal conversion measurements that the 0.411-Mev radiation is pure electric quadrupole, from which it follows that the spin of the first excited state in Hg^{198} is 2. The existence of the 1.09-Mev cross-over gamma means that the spin of the second excited state cannot be zero. Also from relative intensity considerations a spin greater than three is very improbable since the cross-over gamma competes favorably with the cascade gammas.

On the assumption of a spin of 1, 2, or 3 for the second state, there is no theoretical function for pure dipole or quadrupole radiation which fits the data. Furthermore, any dipole-quadrupole mixture from a second excited state with odd integer spin would theoretically yield a coefficient $\leqslant 0$ for the $P_4(\cos\theta)$ term, while the observed coefficient is positive. Hence, the spin of the second excited state of Hg^{198} is 2. A theoretical function, corrected for finite resolution of the counters, assuming a spin of 2 and a 60 percent quadrupole, 40 percent dipole mixture for the 0.68-Mev radiation agrees best with the data, while any mixture between 65 percent Q—35 percent D and 55 percent Q—45 percent D would be statistically allowable. Full details will soon be published.

[1] P. E. Cavanagh, Phys. Rev. **82**, 791 (1951).
[2] L. G. Elliott and J. L. Wolfson, Phys. Rev. **82**, 333 (1951).
[3] P. B. Moon, Proc. Phys. Soc. (London) **A64**, 76 (1951).
[4] Bell, Graham, and Petch, Can. J. Phys. **30**, 35 (1952).
[5] M. Moon, Thesis, State University of Iowa, 1951 (unpublished).
[6] L. Simons, Phys. Rev. **86**, 570 (1952).

Spectrometer Measurement on the High Energy Positrons of Sodium 22*

BYRON T. WRIGHT
Department of Physics, University of California, Los Angeles, California
(Received December 18, 1952)

USING a small solenoidal spectrometer,[1] a measurement of the ratio R of the partial decay constant for the lower energy spectrum A to that of the higher energy spectrum B of positrons from Na^{22} was made.

The source,[2] whose strength was approximately 0.3 millicuries, was deposited on a Nylon foil whose thickness was 2.5 mg cm^{-2}. The source was 15 mm in diameter and its average thickness 2 mg cm^{-2}.

The detector was a miniature end-window Geiger counter of length 25 mm and cathode diameter 7 mm. The end of the counter formed the "energy-selecting hole" of the spectrometer. The

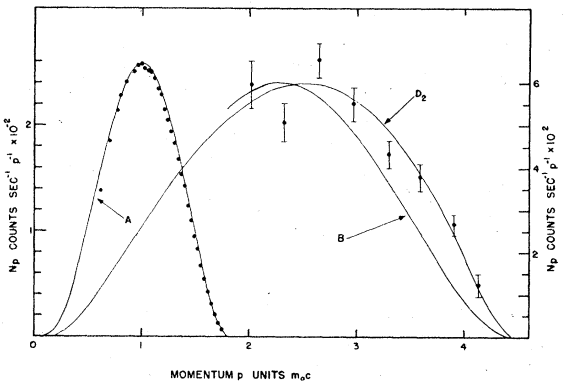

FIG. 1. Momentum plots for the two positron spectra of Na^{22}.

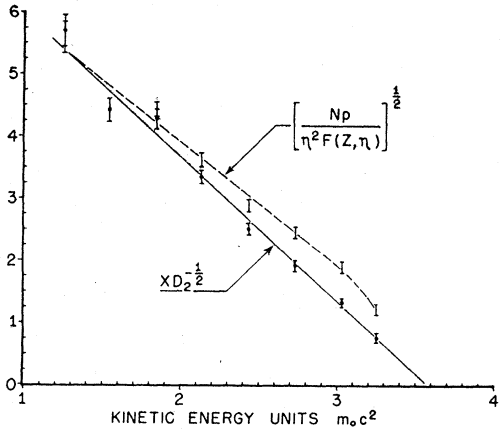

FIG. 2. Kurie plots of spectrum B.

background counting rate with no source in the spectrometer was 0.07 counts sec^{-1}. This increased to 0.09 counts sec^{-1} with the 0.3 millicurie source in position and with an aluminum plate blanking off the "angle selecting baffles" near the source. The background further increased to 0.10–0.12 counts sec^{-1} with the source in position and with a Lucite ring sufficiently thick to stop the most energetic positrons placed at the ring focus. The values quoted are for the range observed in spectrum B, points near the upper limit corresponding to the smaller background. It was by the use of such a ring absorber placed at the ring focus that a background counting rate for each of the points observed in spectrum B was determined. The most uncertain of these background rates had a standard deviation of 8 percent.

Momentum plots of the observed spectra are shown in Fig. 1. The scale of ordinates is in counts sec^{-1} per unit momentum (the momentum being measured in units m_0c). The lines A and B indicate theoretical shapes for allowed spectra. Spectrum A agrees with the theoretical shape down to 0.8 m_0c, a point well below the maximum. A Kurie plot yields an end point of 540±5 kev, in agreement with prior results.[3]

Because of the great similarity of the transitions between the ground states of $Be^{10}-B^{10}$ and $Na^{22}-Ne^{22}$, the so-called D_2 correction[4] was considered for spectrum B. The data fit the D_2 spectrum considerably better than the allowed shape B. This is indicated by Fig. 1 and shown more clearly by the Kurie plots of spectrum B in Fig. 2. The end point of spectrum B is at 1830±60 kev, a value in agreement with the sum of the energy of the gamma-ray (1277 kev)[5] of Na^{22} and the end point of spectrum A (542 kev).[3] The net counting rate for points near the peak of spectrum B was 1.5 times the background rate. The standard deviations in the net counting rates are indicated.

To obtain R we compared the areas under curves A and D_2. The result is $R=1600\pm400$. This leads, using a half-life of 2.60 years[6] for the decay via spectrum A, to a decay constant for the decay of Na^{22} to the ground state of Ne^{22} of $\geqslant 5.3\pm1.0\times10^{-12}$ sec^{-1}, the value being greater if a fraction of the decay of spectrum B is by orbital electron capture.

The ft value which results is $\sim10^{13}$. This is an order of magnitude less than the value based[7] on earlier experimental work[8] and about half an order less than the value based in part on a theoretical consideration.[9]

* Supported in part by the joint program of the U. S. Office of Naval Research and the U. S. Atomic Energy Commission.
[1] Byron T. Wright, Am. J. Phys. **20**, 230 (1952).
[2] Purchased from the Isotopes Division of the U. S. Atomic Energy Commission.
[3] Macklin, Lidofsky, and Wu, Phys. Rev. **78**, 318 (1950).
[4] R. E. Marshak, Phys. Rev. **75**, 513 (1949).
[5] D. E. Alburger, Phys. Rev. **76**, 435 (1949).
[6] L. J. Laslett, Phys. Rev. **76**, 858 (1949).
[7] Arnold M. Feingold, Revs. Modern Phys. **23**, 10 (1951).
[8] K. H. Morganstern and K. P. Wolf, Phys. Rev. **76**, 1261 (1949).
[9] E. Feenberg and K. C. Hammack, Phys. Rev. **75**, 1877 (1949).

Energy per Ion Pair for 5-Mev Alpha-Particles in Helium

T. E. BORTNER AND G. S. HURST
Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee
(Received February 6, 1953)

THE average number of ion pairs formed by Pu^{239} alpha-particles in helium has been measured. A parallel plate ionization chamber was filled to a pressure such that the alpha-particles (45 500 per minute) lost all of their energy in the sensitive volume. The rate of voltage change on an accurately calibrated condenser was measured by means of a potentiometer, using an ac operated electrometer[1] as a null indicator.

Our w values (electron volts per ion pair) agree well with the measurements of other investigators[2–5] for the following gases:

Gas	w (ev/ion pair) Present values	Other results	Reference
Nitrogen	36.3	36.3±0.4	2
Argon	26.4	26.4	3
Ethylene	28.0	28.2	4
Hydrogen	37.0	37.0	5

Because of the above agreement with other observers, it is believed that the self-absorption in the alpha-source is small.

With no purification grade A helium[6] taken from different tanks gave a spread for w between 31 and 43 electron volts. Two different methods of purification gave w for helium equal to 46.0±0.4 electron volts. One method of purification consisted of flowing helium over cocoanut charcoal held at liquid nitrogen temperature, the ionization being measured during flow. Stopping the flow resulted in a rapid decrease in w (increase in ionization) after a few minutes. The second method of purification involved continuous circulation of helium over metallic calcium kept at 400°C. Jesse[7] associates low values of w for helium with gas impurity. He obtained a value of 41.3 electron volts as compared with the present value of 46 electron volts.

It is interesting to note that Fano[8] based his argument that the value of w is independent of the ionization potential on a very much lower experimental value for helium, namely, 30 electron volts. His choice of comparing hydrogen and helium was unfortunate, for indeed the present results show an increase in w with the ionization potential for these gases.

[1] F. M. Glass, Nucleonics **10**, No. 2, 36 (1952).
[2] Alder, Huber, and Metzger, Helv. Phys. Acta **20**, 234 (1947).
[3] W. P. Jesse, Argonne National Laboratory Report ANL-4778 (unpublished).
[4] J. Dainty, National Research Council of Canada, Atomic Energy Project Report CRM-482, 1950 (unpublished).
[5] J. M. Valentine and S. C. Curran, Phil. Mag. **43**, 964 (1952).
[6] Grade A is the designation of helium bottled by the U. S. Bureau of Mines. This helium has a purity of 99.99 percent when bottled. This information was supplied by Dr. M. M. Deaton, Chief, Research Branch, Helium Division, Region IV (private communication).
[7] W. P. Jesse, Argonne National Laboratory Report ANL-4828 (unpublished).
[8] U. Fano, Phys. Rev. **70**, 44 (1946).

Elastic Pion-Deuteron Scattering*

E. ARASE, GERSON GOLDHABER, AND S. GOLDHABER
Columbia University, New York, New York
(Received February 13, 1953)

IT has been shown that elastic π+H scatterings can be identified uniquely in nuclear emulsions from energy-momentum conservation.[1] This method was applied to the identification of π^-+D elastic scattering in heavy water (D_2O) loaded Ilford G5 emulsions,[2] and an angular distribution at 140 Mev was obtained.

By soaking Ilford G5 600μ emulsions at 13°C for 2 hours in heavy water, $\sim$1 g D_2O/cm^3 of dry emulsion was introduced which is equivalent to 0.11 g of D/cm^3 of loaded emulsion. These emulsions as well as nonloaded emulsions were exposed to a total flux of $\sim3\times10^4$ mesons/cm^2 in the 140-Mev magnetically sepa-