ionizing by an estimated factor of 2 or 3. A pion of this momentum would be heavily ionizing by a factor 2.5; and a muon by a factor 1.8; thus it is likely that the negative fragment is a pion or nuon. A τ-meson of this momentum would be heavily ionizing by a factor in the neighborhood of 15 and would not easily escape detection. We thus consider it unlikely that this event represents a decay of the type suggested by the California Institute of Technology group,[2] namely $V_3^0 \rightarrow (\tau^- \text{ or } \kappa^-) + \pi^+ + 60$ Mev.

The corrected angle between the tracks is 79.2°±0.4°, the relatively large error arising primarily from the shortness of the negative track. Although the orientation of the event with respect to the associated shower suggests that it represents the decay of a neutral V particle (the angle of decay being so large), the possibility that the event is grossly misinterpreted must not be overlooked. The possibility that the event represents the decay of a charged particle (track b) which enters the chamber from the right can be excluded on energetic grounds since the total energy indicated by track b is considerably less than the kinetic energy of track a. The possibility that the event represents the decay of a charged particle (track a) which enters the chamber from below is a possible but relatively improbable interpretation.

The $Q(\pi, \pi)$ value is 215 ± 7. The next most accurate cases[1] R-32 and R-39 give 212 ± 10 and 216 ± 7, and a recent unpublished event (R-151) gives 219 ± 15. Confirmation of individual $Q(\pi, \pi)$ values in the neighborhood of 214 Mev has not been forthcoming from other groups, and there is certainly no indication therefrom for the existence of either a line or a pronounced maximum in that neighborhood. We are inclined to consider that the values in the neighborhood of 214 determined as described above are incompatible with a value of 170 Mev,[3] limits of 115–185 Mev,[4] or a range of 100–130 Mev,[2] so that the present observations appear to be distinct from those of other investigators.

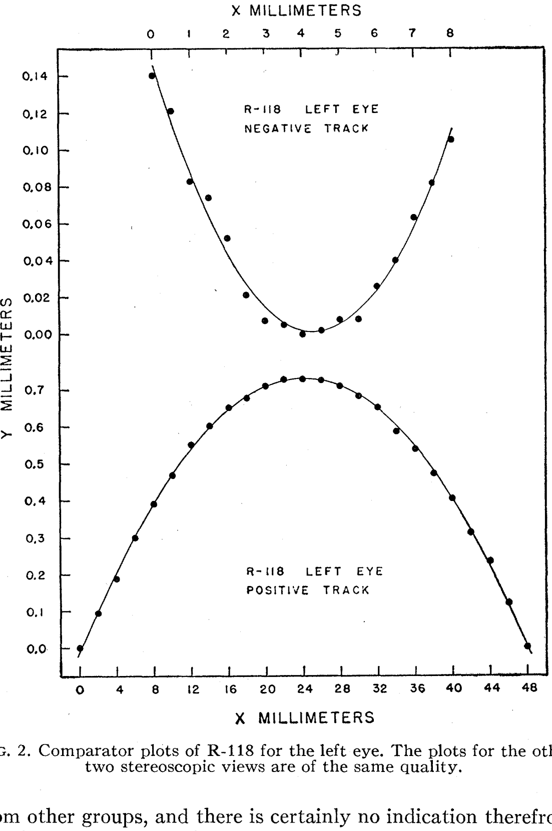

FIG. 2. Comparator plots of R-118 for the left eye. The plots for the other two stereoscopic views are of the same quality.

It may be that the experimental arrangement has biased[5] our observations in favor of a different type[6] of neutral V particle, $V_4^0 \rightarrow (\pi^+ \text{ or } \mu^+) + (\pi^- \text{ or } \mu^-) + Q$, where $Q(\pi, \pi) = 214 \pm 5$ Mev.[7,8] In view of the limited statistics (7 cases of V_4^0), we cannot, of course, exclude a splitting of the V_4^0 structure in the Q-curve plot,[1] or a three-body decay. The latter might account for part of the differences with the results of other investigators, and for events[1] 328 and R65B.

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[1] Proceedings of the Third Rochester Conference. See Thompson, Buskirk, Etter, Karzmark, and Rediker, Phys. Rev. **90**, 329 (1953).

[2] Leighton, Wanlass, and Anderson, Phys. Rev. **89**, 148 (1953).

[3] We are indebted to Dr. Butler for recently informing us that the Manchester data has been remeasured to give $Q(\pi, \pi)$ values in the neighborhood of 170 Mev instead of 122 Mev as previously reported.

[4] We are indebted to Dr. Bridge for sending us a preprint of a forthcoming paper of the Massachusetts Institute of Technology group.

[5] With the new magnetic chamber, we find roughly equal numbers of V_1^0 and V_4^0 (see below).

[6] The Manchester group and the Massachusetts Institute of Technology group use the symbol V_2^0 to indicate the class of all neutral V particles other than $V_1^0 \rightarrow p + \pi$. In that usage, the V_2^0 symbol seems inappropriate here, in view of the large variety of decay schemes in that class which have been reported (see reference 2), but which we have not as yet observed.

[7] In case one or both fragments are muons, slight modification of the Q value would be necessary.

[8] The kinetic energy per pion in the c.m. system would be 107 Mev, very near $E_\pi = 115 \pm 10$ Mev for the χ-decay. See the excellent review paper of D. H. Perkins in the *Proceedings of the Third Annual Rochester Conference on High Energy Physics* (Interscience Publishing Company, New York, 1953).

The O^{14} β-Decay and the Fermi Interaction

M. E. ROSE
Oak Ridge National Laboratory, Oak Ridge, Tennessee

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IN view of the results of the angular correlation measurements[1] in the He^6 decay it now appears that the Gamow-Teller (GT) part of the β-interaction is tensor or almost wholly so. It is clear that a measurement of the angular correlation or recoil momentum spectrum for an allowed transition with $\Delta J = 0$ could, in principle, provide corresponding information concerning the composition of the Fermi (F) interaction.[2,3] However, the analysis of transitions other than $J = 0 \rightarrow J = 0$ cases is complicated by the necessity of an accurate knowledge of the relative values of GT and F matrix elements and also by the fact that the He^6 angular correlation measurements, together with β-energy spectra of GT transitions, does not distinguish between pure tensor and an interaction containing an admixture of axial vector coupling. Specifically, if the GT interaction is $\mathcal{H}_{GT} = g(C_T \mathcal{H}_T + C_A \mathcal{H}_A)$ one can conclude only that $|C_A/C_T| \lesssim 0.1$.

In view of these remarks, the C^{10} and O^{14} decays become more interesting. Since the C^{10} decay is a 2 percent branch and is followed by two gamma-rays, the correlation or recoil experiment would be very difficult to carry out and interpret. In the O^{14} decay there is only the 2.31-Mev gamma-ray to consider. This does not interfere with the possibility of carrying out either of the experiments in question, since the recoil due to the gamma-ray is easily taken into account, as shown below.

It has been suggested[3] that the gamma-recoil can be taken into account by observing triple coincidences between the photon, positron, and recoil N^{14}. While this does serve the useful purpose of better definition of the effective source volume, it entails a severe reduction of intensity. It seems preferable to take the gamma-recoil into consideration by a direct and simple calculation. We have considered the recoil experiment since this involves the detection of only one particle. However, the difficulties of this experiment are recognized and similar considerations to those described below can be applied to the angular correlation experiment.

The nuclear recoil momentum is $\mathbf{P} = -(\mathbf{p} + \mathbf{q} + \mathbf{k}) = -(\mathbf{Q} + \mathbf{k})$, where $\mathbf{p}$, $\mathbf{q}$, and $\mathbf{k}$ are the momenta of positron, neutrino, and photon, respectively. Since the photon is isotropic with respect to $\mathbf{p}$ and $\mathbf{q}$, the distribution $N(P)dP$ of recoils with momentum between P and $P + dP$ is obtained essentially by integrating the spectrum of β-recoils (distribution in Q) over the appropriate Q limits. The analytic form of the result depends upon whether or not $k>Q_{\max}=(W_0^2-1)^{\frac{1}{2}}$. However, the shape of the spectrum changes continuously through this point. Present evidence gives $k=4.52$ and $Q_{\max}=4.41$ (corresponding to 1.8 Mev for the maximum β-energy). Figure 1 exhibits the recoil momentum spectrum for this case and for pure S, V, and T interactions. The latter is included because of the slight chance that the first excited state of N^{14} has $J=1$. The experiment is thus capable of settling the question of whether or not the O^{14} decay is a $0\rightarrow 0$ transition. We consider only pure interactions because, on the evidence of linear Kurie plots in general, an admixture, if present, would change the spectrum by an amount too small to detect.

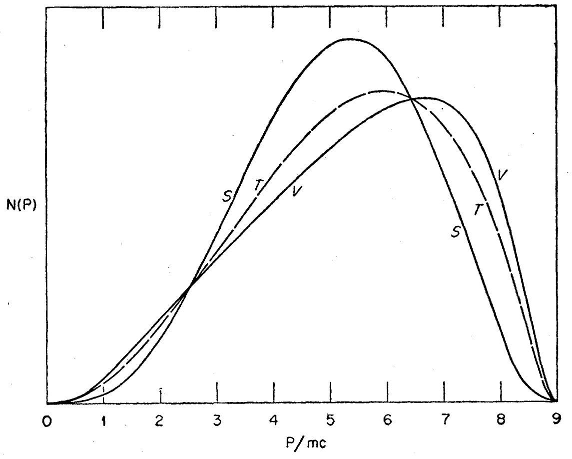

FIG. 1. The recoil momentum spectrum from the O^{14} β-decay, with the recoil due to the 2.31-Mev gamma-ray taken into account. The ordinate (arbitrary scale) is the number of recoils per dP and the abscissa is the recoil momentum in mc units ($P_{\max}$ corresponding to 791 ev). The curves labeled S, V, T refer to pure scalar, vector, and tensor interactions. The maximum kinetic energy of the β's is taken as 1.8 Mev, but for 1.7 Mev (curves not shown) the shapes of the spectra are changed rather little. The energy distributions are all symmetrical about $P=k$.

There is one possible difficulty which arises in connection with the O^{14} decay which has not yet been discussed. The decay results in the formation of an atomic ion N^{14-}, provided that the extra electron is not stripped off in the β-process itself. The electron affinity of N is not very well known, but a value of 0.04 ev has been obtained by uncertain extrapolation methods.[4] In any case, one would not expect a value of much more than a fraction per volt. With the value quoted, a rough calculation indicates a probability of only 3×10^{-4} that the sudden charge change will not strip off the extra electron. In this case, the feasibility of the experiment lies in the possibility that further electrons will be ejected resulting in a positive ion. While there will probably be many neutral atoms, these have the effect of reducing the intensity but do not distort the spectrum. In any case an e/M analysis of the residual N^{14} seems advisable.

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[1] B. M. Rustad and S. L. Ruby, Phys. Rev. **89**, 880 (1953).
[2] D. C. Peaslee, Phys. Rev. **89**, 1148 (1953).
[3] J. M. Blatt, Phys. Rev. **89**, 83 (1953).
[4] H. S. W. Massey, *Negative Ions* (Cambridge University Press Cambridge, 1938), p. 15. According to preliminary calculations of Ta-You Wu (private communication), N^- is not even stable.

The Decay of Cr^{49}

BERND CRASEMANN AND HARRY T. EASTERDAY
Radiation Laboratory, Department of Physics, University of California, Berkeley, California
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THE radioactive isotope Cr^{49} was first described by O'Connor, Pool, and Kurbatov,[1] who determined its half-life as 41.9 ± 0.3 minutes and measured positrons of 1.45 Mev and gamma-rays of 1.55 and 0.18 Mev by absorption techniques. Huber, Lienhard, and Wäffler[2] measured the half-life of Cr^{49} as 45 ± 5 minutes.

In the present work, titanium foils were bombarded for one hour with 40-Mev alpha-particles which produced Cr^{49} by the reactions $Ti^{48}(\alpha,3n)$ and $Ti^{47}(\alpha,2n)$.

The activated titanium foils were dissolved in hot concentrated nitric acid containing a few drops of hydrofluoric acid and 1-mg chromium carrier. Boric acid was added to complex the hydrofluoric acid. The solution was boiled with potassium bromate to oxidize the chromium to chromate. It was then neutralized with ammonium hydroxide and the precipitate redissolved by addition of a few drops of nitric acid. After chilling to −5°C, more potassium bromate was added to hold the chromium in the 6-state. Addition of a few drops of hydrogen peroxide formed peroxychromic acid, which was then extracted into prechilled di-isopropyl ketone. After washing with prechilled $\frac{1}{2}N$ nitric acid containing some potassium bromate, the peroxychromic acid was back-extracted into a dilute ammonium hydroxide solution. This was boiled down to near dryness and transferred to the thin Tygon film that served as source backing. The remaining moisture was then evaporated.

The half-life of Cr^{49}, followed on a trochoidal analyzer, was found to be 41.7 ± 0.5 minutes.

The positron spectrum was determined using a thick lens β-spectrograph of two percent transmission and four percent resolution. Fermi plots were constructed that could be resolved into three components, as shown in Table I.

TABLE I. Positron spectrum of Cr^{49}.

Energy Mev	Abundance percent	logft
1.54 ± 0.01	50	4.9
1.39 ± 0.02	35	4.9
0.73 ± 0.05	15	4.1

Photoelectrons ejected from a gold radiator were observed and yielded one set of energy values for the gamma-rays present. Conversion electrons belonging to the 153-kev line were also measured, whereas no conversion electrons could be detected for the 609-kev line. Table II shows measured gamma-energies and conversion coefficients.

TABLE II. Gamma-rays of Cr^{49}.

Energy from photoelectrons kev	Energy from conversion electrons kev	Conversion coefficient α_K	Type of transition
609		$<4\times 10^{-4}$	$M1$
153	153	$(2.2\pm 0.8)\times 10^{-2}$	$M1$

No evidence of the 762-kev crossover transition could be found.

Figure 1 shows a suggested decay scheme, based on the present data. Cr^{49} is expected to have a 5/2 −ground state. Since in the low Z region proton and neutron shells fill in the same order as given by the shell model,[3] Cr^{49} with 25 neutrons will have the same spin and parity as Mn^{55} with 25 protons. Mn^{55} has a measured spin of 5/2 resulting from the configuration $(f_{7/2})^5{}_{5/2}$.

V^{49} should have the same ground state spin and parity as V^{51}, which is $f_{7/2}$. Since all three beta-components are allowed, the first two excited states of V^{49} must have odd parity like its ground state. The conversion coefficient of the 153-kev gamma-ray identifies it as a magnetic dipole transition. The measured upper limit on the conversion coefficient of the 609-kev gamma-ray indicates that it is of multipole order one. Since its initial and its final state have the same parity, this transition must also be magnetic dipole. The first two excited states of V^{49} are assigned spins of 5/2 and 3/2, respectively, to account for the allowed nature of the three beta-components as well as for the two mag-