for B^8 than for Li^8. During bombardment, a shield around the target protected the α counter from any sputtered target material and from any recoiling B^8 or Li^8 ions which left the target. The spectra of α particles from the Be^{8*} coincident with β rays from the B^8 were much improved by these changes, as compared with the earlier experiment, and were in fact very similar to the Li^8 spectra. Figure 1 shows the B^8 α spectra for a typical case.

New α counters, thin to β rays, permitted measurements to be made when the angle between the α momentum and the β momentum was $\theta = 0°$ as well as 90° and 180°. However, at $\theta = 0°$, a small fraction of the β rays going through the α counter and into the β counter, produced small pulses in the α counter in coincidence with the β counter. For this reason the low-energy tail of the $\theta = 0°$ coincident α spectrum was extrapolated by subtracting these β-β coincidences, as determined by stopping all the α particles from the target. (See Fig. 1.) Errors produced by this extrapolation would be expected to be in the same direction for both $B(Li^8)$ and $B(B^8)$, and tend to cancel in the difference δ. To estimate the possible magnitude of this error, we have also determined δ by analyzing only the $\theta = 90°$ and 180° data and find δ decreased by $0.0002W_\beta$.

The lithium targets were evaporated in a narrow 2-mm wide vertical strip on the thin aluminum backing to minimize changes in geometry due to lateral motion of the incoming beam. A check for motion of the target spot relative to the α counter was also made with a monitor counter. From the ratio of monitor counts to noncoincident α counts, we conclude that the α-counter solid angle was constant to within 0.002, which when divided by the average β energy, $\overline{W}_\beta \cong 11$ Mev, represents an uncertainty of $0.0002W_\beta$ in δ. The determination of $\overline{W}_\beta$ could be in error by ~5%, which would produce an error in δ of $\sim 0.0004W_\beta$. We estimate the systematic error from all these sources to be less than $0.001W_\beta$ in δ.

Including the statistical and estimated systematic errors, our experimentally determined value for δ lies within the range predicted by the C.V.C. theory based upon intermediate-coupling calculations. An experimental determination of the relevant $M1$ and $E2$ matrix elements is desirable, as a check on the theoretical estimates.

The authors would like to thank Professor F. Boehm, Professor R. F. Christy, Professor W. A. Fowler, Professor T. Lauritsen, and Dr. H. A. Weidenmüller for valuable discussions.

†Supported in part by the joint program of the Office of Naval Research and the U. S. Atomic Energy Commission.

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ft VALUE OF O^{14} AND THE UNIVERSAL FERMI INTERACTION*

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The experimentally observed near equality of the coupling constants in the nuclear beta-decay and in muon decay has suggested the attractive idea that all of the "weak interactions" proceed by a universal Fermi interaction.[1] The fact that the coupling constant in nuclear beta-decay is not considerably decreased by virtue of the neutron or proton existing part of the time as a proton or neutron plus pion cloud finds an elegant explanation in the conserved vector current hypothesis of Feynman and Gell-Mann.[1,2] It is thus of considerable interest to establish the degree to which the coupling constants G_V for the vector nuclear beta decay and G_μ for the muon decay are equal.[3-5] Recently the precision with which G_μ is known has improved considerably due to

more accurate measurements of the muon mean lifetime (2.211 ± 0.003 μsec,[6] 2.208 ± 0.004 μsec[7]) and the muon mass (206.76 ± 0.03 m_e[8]). To determine G_V more accurately we have remeasured the ft value of the $0^+ \to 0^+$ beta transition in $O^{14}(\beta^+\nu)N^{14*}$.

Due to the difficulty of directly determining the energy end point of the positron spectrum,[9,10] which is the most critical quantity entering the ft value, one must resort to measurement of the mass difference of O^{14} and N^{14*}(2.311-Mev state), the parent and daughter states of the beta decay. Previous workers have determined this mass difference by measuring the neutron threshold for the reaction $C^{12}(He^3, n)O^{14}$ which yields $O^{14} - C^{12}$ and by determining $N^{14*} - C^{12}$ from various reaction cycles and mass doublets.

Bromley et al.[11] determined the neutron threshold as $E_{th} = 1449.6 \pm 2.8$ kev relative to the $Li^7(p, n)Be^7$ threshold assumed as 1881.6 ± 0.45 kev, which yields a Q value for the $C^{12}(He^3, n)O^{14}$ reaction of -1158.5 ± 3 kev. Using adjusted Q values and tabulated mass defects quoted by Mattauch et al.[12] and the work of Bockelman et al.,[13] they calculated $E_{max}(\beta^+) = 1809.7 \pm 7.8$ kev. Threshold values $E_{th} = 1435 \pm 5$ kev[14] and 1436.2 ± 0.9 kev[15] have been obtained at the Naval Research Laboratory. Bondelid et al.[15] combined their Q value for the $C^{12}(He^3, n)O^{14}$ reaction ($Q = -1147.7 \pm 0.7$ kev) with values from Mattauch et al.[12] and Ajzenberg-Selove and Lauritsen[16] to get $E_{max}(\beta^+) = 1800.0 \pm 6.5$ kev.

In view of these discrepancies, and in view of the sizable changes in the mass tables of Everling et al.,[17] we have measured the mass difference of O^{14} and N^{14*} directly from the reactions

$$C^{12} + He^3 \to O^{14} + n + Q_n, \tag{1}$$

$$C^{12} + He^3 \to N^{14*} + H^1 + Q_p. \tag{2}$$

In terms of the Q values of these reactions,

$$\begin{aligned} E_{max}(\beta^+) &= (O^{14} - N^{14*})c^2 - 2m_e c^2 \\ &= Q_p - Q_n + (H^1 - n)c^2 - 2m_e c^2 \\ &= Q_p - Q_n - 1804.6 \pm 0.5 \text{ kev}, \end{aligned} \tag{3}$$

where we have used only the well-known hydrogen atom-neutron mass difference from the mass tables[17] and the electron mass.[18] Here, and in our own work discussed below, the errors quoted are standard deviations.

To avoid neutron background, the threshold of reaction (1) was measured by studying the delayed yield of 2.3-Mev gamma rays following the O^{14} beta decay. The incident He^3 energy was determined in a 90° electrostatic analyzer which was calibrated by the $Li^7(p, n)Be^7$ threshold, assumed at 1880.7 ± 0.4 kev.[19] A plot of the 2/3 power of the O^{14} yield vs incident He^3 energy is shown in Fig. 1 together with a least-squares fitted intercept, for one of the runs of reaction

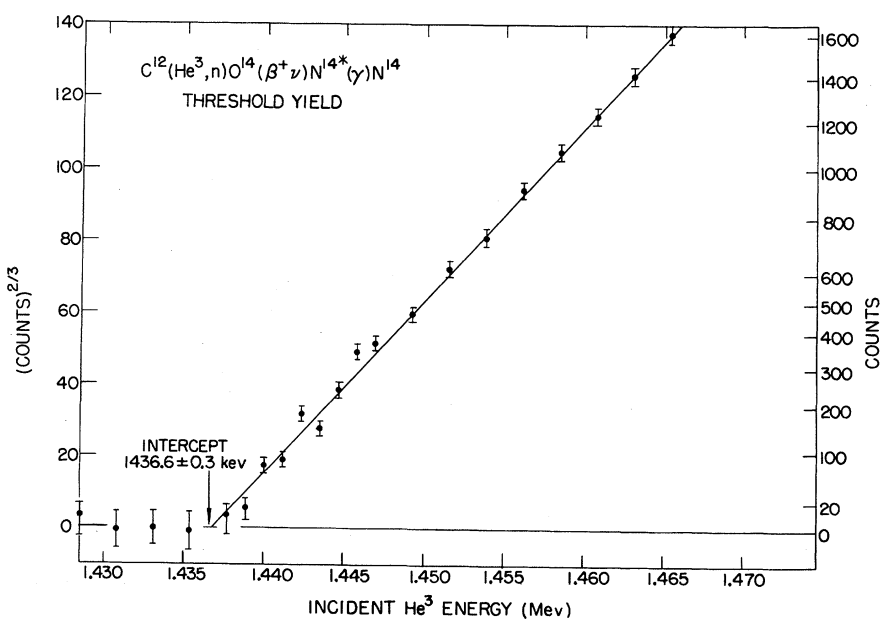

FIG. 1. The 2/3 power of the O^{14} yield vs incident He^3 energy near threshold.

(1). The average of two such runs gives $E_{th} = 1437.0 \pm 0.9$ kev, or $Q_n = -1148.3 \pm 0.7$ kev, in good agreement with Bondelid et al.[15]

For reaction (2), a 16-inch radius double-focusing magnetic spectrometer was used to determine the energy of the outgoing protons. The spectrometer was calibrated at the field employed in the energy determination using deuterons scattered into it at known energy. A yield curve near $E(He^3) = 2.69$ Mev and $\theta(\text{lab}) = 150°$ for reaction (2) using a thick natural carbon target, is shown in Fig. 2. The weighted mean of sixteen similar runs gives $Q_p = 2466.9 \pm 1.1$ kev, again based on the $Li^7(p,n)Be^7$ threshold at 1880.7 ± 0.4 kev.[19]

Using the results of Sanders[20] for $N^{14*} - N^{14} = 2311.4 \pm 1.2$ kev corrected to the new $Li^7(p,n)Be^7$ threshold yields a Q value for $C^{12}(He^3,p)N^{14}$ equal to 4778.3 ± 1.5 kev, in excellent agreement with the value 4778.6 kev computed from the mass tables of Everling et al.[17] Our results can be taken as direct experimental confirmation via nuclear reactions of the value for $N^{14} - C^{12}$ given in these new mass tables.

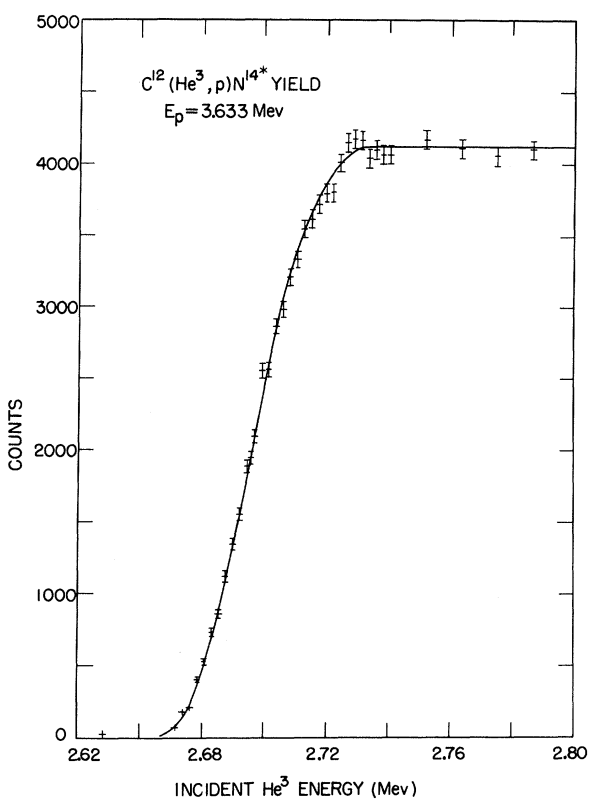

FIG. 2. Yield curve near $E(He^3) = 2.69$ Mev and $\theta(\text{lab}) = 150°$ for the reaction $C^{12}(He^3,p)N^{14*}$. The magnetic spectrometer was set to detect protons with $E_p = 3.633$ Mev.

Combining our experimentally determined values of Q_n and Q_p as in Eq. (3), we have

$$E_{max}(\beta^+) = 1810.6 \pm 1.5 \text{ kev},$$

where the error quoted is compounded from the standard deviations in Q_n, Q_p, the $(H^1 - n)$ mass difference, the electron mass, and the uncertainty in the $Li^7(p,n)Be^7$ threshold.

We have remeasured the half-life of O^{14} and find 71.1 ± 0.2 sec, in only fair agreement with the value 72.1 ± 0.4 sec.[9] In our measurements, using the 2.3-Mev radiation, special precautions were taken to avoid the effects of long-lived annihilation radiation from C^{11} and N^{13}. Our half-life for O^{14} corrected for the ground-state branch $(0.6 \pm 0.1\%)$[21] gives 71.5 ± 0.2 sec for the half-life of the transition to N^{14*}. The calculated ft value[22] is then 3060 ± 13 sec taking $f = 42.78 \pm 0.14$ for $W_{max}(\beta^+) = 2321.6 \pm 1.5$ kev.

After a total correction of +0.289% for nuclear electromagnetic form factors, competition from K capture, and electron screening,[5] the ft value becomes 3069 ± 13 sec. We do not make the radiative and other corrections listed by Durand et al.[5] at this point. The corrected ft value yields $G_V = (1.416 \pm 0.003) \times 10^{-49}$ erg cm^3. If this value is adopted for G_μ, then, without radiative corrections, the calculated mean lifetime of the muon becomes 2.250 ± 0.010 μsec which is 1.8 $\pm 0.5\%$ greater than the mean of the observed lifetimes, 2.210 ± 0.003 μsec. The relative corrections, radiative and otherwise, for O^{14} vs the muon calculated by Durand et al.[5] reduce the discrepancy to 1.7% while those of Kinoshita and Sirlin[3] increase it to 4.0%. Whether the discrepancy is the result of errors of omission or commission in the corrections, or is the result of a failure of the universality hypothesis, remains an open question. There is, in our minds, considerable question concerning the validity of current Coulomb corrections to the matrix element for $O^{14}(\beta^+\nu)N^{14*}$ $(0^+ \to 0^+)$.

We are grateful to Barbara Zimmerman for help with computations.

*Supported in part by the joint program of the Office of Naval Research and the U. S. Atomic Energy Commission.

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ISOTOPIC SPIN CONSERVATION AND BETA-GAMMA CIRCULAR POLARIZATION CORRELATION IN A^{41} AND Sc^{46}*

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Recently several experiments[1-4] have been performed which indicate that at least in the cases of the beta decay of Sc^{44}, Mn^{52}, and Sc^{46} the isotopic spin conservation law is poorly obeyed if obeyed at all. These experiments, which so far constitute the only evidence for this breakdown, measure the beta-gamma circular polarization correlation using the method introduced by Schopper[5] and Boehm and Wapstra[5] a few years ago. We have further investigated this situation in the case of A^{41}, whose decay is characterized by $\Delta J = 0$ and $\Delta T \neq 0$ (see Fig. 1). These conditions

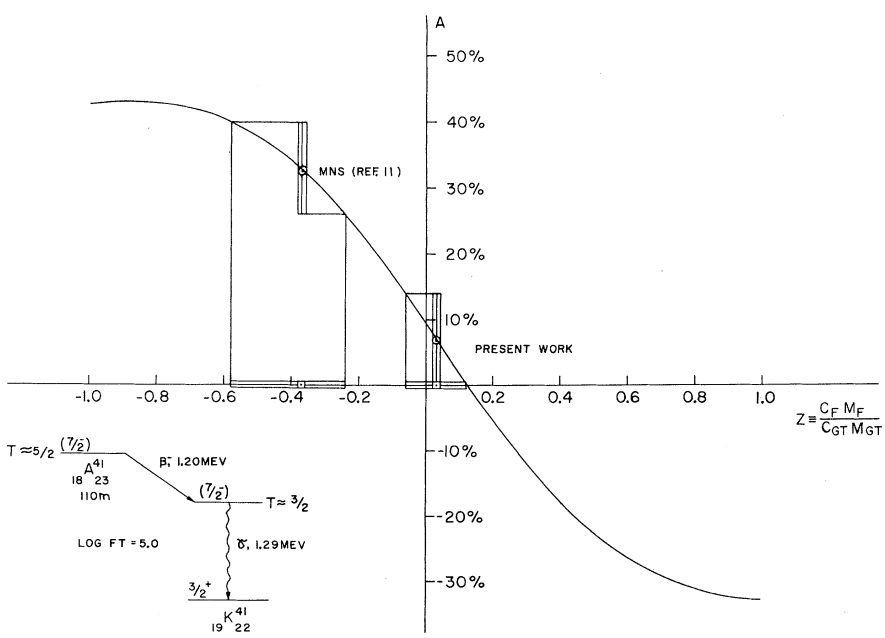

FIG. 1. A^{41} experimental asymmetry parameter as a function of Fermi to Gamow-Teller matrix element ratio. The solid curve is calculated using the $(V-A)$ theory (see reference 7). The isotopic spin assignments are approximate because of impurities introduced in the nuclear wave functions due to Coulomb effects (see references 5-7).