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Half-Life of K^{37} †

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A more accurate value of the half-life of K^{37} is 1.23 ± 0.02 seconds, in agreement with the value reported by Sun and Wright. The Gamow-Teller matrix element is recalculated using new values of the coupling constants, and is found to be in agreement with the theoretical value calculated by Winther and Kofoed-Hansen from the shell model. The experimental method is described in detail.

THE existence of the mirror nuclide K^{37} has been established by Sun and Wright.[1] They reported a positron activity with an end point of 5.10 ± 0.07 Mev and a half-life of 1.2 ± 0.12 seconds. They used these results to obtain an ft-value of 4150 ± 500 and a Gamow-Teller matrix element $|\int\sigma|^2=0.43\pm0.14$.

The purpose of the present paper is to report a more accurate value of the half-life of K^{37}, namely 1.23 ± 0.02 seconds, which is the mean of the half-lives obtained from twelve integral decay curves. This result is then used to establish more stringent limits of error on the ft-value. Also, the Gamow-Teller matrix element is recalculated using new values of the coupling constants, and is found to be 0.38 ± 0.08, which is in agreement with the theoretical value calculated by Winther and Kofoed-Hansen[2] from the shell model.

Natural calcium foil was bombarded with 12.8-Mev protons in the circulating beam of the UCLA synchrocyclotron. The target, mounted on a rider inside a pneumatic tube,[3] arrived at the counting position 0.5 second after the end of the bombardment. Its decay was then followed for 10 minutes by a scintillation counter which was equipped with a beta crystal consisting of a 1 in.$\times\frac{1}{16}$ in. disk of plastic phosphor. The pulses were fed into a Bell-Jordan amplifier, then into a discriminator, and finally into four separate scalers that were gated by an electronic timer. The scalers were turned on in succession at $t=0$, 1, 2, and 7 seconds in the first six runs and at $t=0$, 2, 4, and 7 seconds in the last six runs. ($t=0$ corresponds to 0.7 second after the end of the bombardment.) The first three scalers were turned off together at $t=7$ seconds. From this instant until $t=599$ seconds, every twentieth pulse was recorded on one channel of a Sanborn Twin-Viso recorder. The scaler gate voltage was recorded on the second channel in order to fix the time scale relative to $t=0$. In addition, the recorder supplied one-second marker pips on a third channel. About 40 seconds after the bombardment, the paper speed was changed from 25 mm/sec to 2.5 mm/sec by shifting the recorder into low gear. The arrangement permitted following a decay from an initial counting rate of about 5000 counts/sec to a background counting rate of about 0.25 count/sec—a factor of 20 000. It would have been impossible to follow this decay using the Sanborn recorder alone.

The number of counts $N(t)$ accumulated in the time from t to 599 seconds was plotted as a function of t on Cartesian paper. The background, which was a descending straight line, was subtracted. The resulting curve was plotted on semilogarithmic paper. After subtraction of an unidentified activity with a half-life of about 6 seconds, the remaining curve was a straight line on a semilogarithmic plot. Each of these final curves yielded a value for the half-life of K^{37}. On the average, the probable error due to the manner of drawing the final decay curve is 0.02 second, if the uncertainty in each value of $N(t)$ is $\surd N$ according to a Poisson distribution. The mean of the twelve values of the half-life of K^{37} is 1.230 seconds with a probable error of 0.006 second. The graphical error of 0.02 second is a conservative estimate of the probable error in the result. The dead-time correction was small compared to this error. The graphical accuracy might be improved by the use of least-square analysis for plotting the curves. The half-life of K^{37} is 1.23 ± 0.02 seconds, in agreement with the value reported by Sun and Wright.

The integral decay curve was plotted in order to avoid the error that would be introduced by the determination of the counting rate, which involves numerical differentiation of the data.

If f is found from Sun and Wright's end point and the curves of Moszkowski and Jantzen,[4] then the new half-life gives the following results:

$$ft=4290\pm280;\quad \log ft=3.63\pm0.03.$$

The Gamow-Teller matrix element $|\int\sigma|^2$ is found from the relation[5]

$$A=ft\left(\left|\int 1\right|^2+R\left|\int\sigma\right|^2\right),$$

where A and R are related to the coupling constants,

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and $|\int 1|^2$ is the Fermi matrix element. Recent *ft*-values[4,6,7] for the 0→0 transition in O^{14}, Al^{26}, and Cl^{34} give $A=6200\pm100$. This value of A and recent *ft*-values[4] for the mirror transition in O^{15} and F^{17}, which are closed shells±one nucleon, give $R=1.17\pm0.10$.

The resulting Gamow-Teller matrix element for K^{37} is 0.38 ± 0.08, which is in agreement with the theoretical value 0.32 that Winther and Kofoed-Hansen have calculated from the shell model. The error in the experimental value of the Gamow-Teller matrix element is now principally due to the error in the end point of the K^{37} positron spectrum.

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Photoprotons from N^{15}†

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The photoprotons ejected by bremsstrahlung photons from nitrogen gas enriched in N^{15} were detected in nuclear emulsions and the proton energy and angular distributions measured for 18.7- and 24.6-Mev betatron energies. The photoproton yield is 10^5 protons per atomic weight per roentgen unit at 24.6 Mev. The integrated cross section in the giant resonance is 10-Mev millibarns for ground-state transitions. Structure is observed in the giant resonance and the angular distributions in this region are predominantly $\sin^2\theta$.

INTRODUCTION

THE excitation of nuclei by high-energy photons is enhanced in the "giant resonance" region and can be detected by observing the ejected photoparticles. Such observations can give information concerning highly excited states of the absorbing nucleus. The high available intensity of bremsstrahlung radiation can be utilized in those cases where the resultant nucleus has wide spacing between levels, so that a measurement of photoproton energy identifies the absorbed photon energy. The reaction $N^{15}+\gamma\rightarrow C^{14}+H^1-10.207$ Mev is especially favorable since the first excited state of C^{14} is at 6.091 Mev. Furthermore, the N^{15} ground state is $\frac{1}{2}^-$, different from isotopes previously examined here.[1] The resolution attainable using nuclear emulsion recording of the photoprotons is about 0.2 Mev. We have therefore observed the photoprotons from N^{15}, using betatron bremsstrahlung and nuclear emulsion detectors.

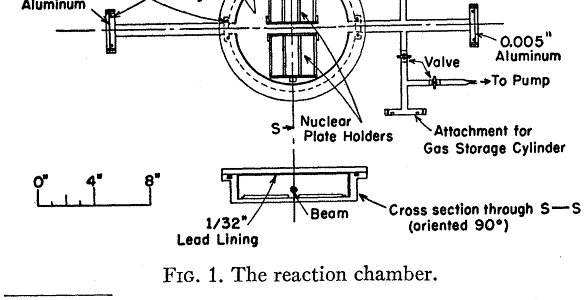

FIG. 1. The reaction chamber.

EXPERIMENT

A well-collimated bremsstrahlung x-ray beam from the betatron passes through the reaction chamber shown in Fig. 1. This aluminum chamber contains the gas to be irradiated and the nuclear emulsion plates to detect the photoprotons. It is lined with $\frac{1}{32}$-inch lead to reduce the proton background. Details of the several runs are given in Table I. 200-micron Ilford C-2 nuclear emulsion plates were used and scanned with a Leitz Ortholux microscope at a magnification of 848. The proton ranges were corrected for absorption in the gas and for photon momentum, and the proton energies determined from Rotblat's range-energy data. Background was deter-

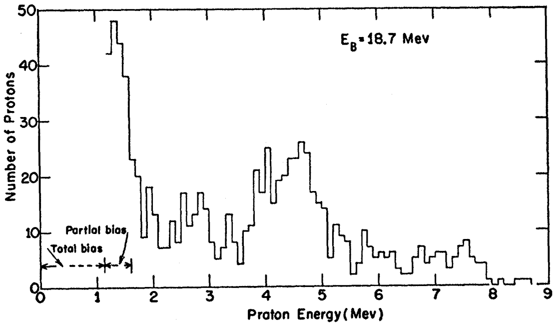

FIG. 2. Photoproton energy distribution for 18.7-Mev exposure.

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