The Reaction $N^{14}(\gamma, 2n)N^{12}$†

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YIELDS for $(\gamma, 2n)$ processes have been observed in medium weight elements only, where they have been observed to be of the order of ten lower than the corresponding (γ, n) reactions. In light elements, the lower yield of $(\gamma, 2n)$ processes has made positive identification difficult; search for the reaction $C^{12}(\gamma, 2n)C^{10}$ has only led to a limit on the cross sections and the end products of $F^{19}(\gamma, 2n)F^{17}$ and $P^{31}(\gamma, 2n)P^{29}$ have not been identified with certainty.[1]

The reason for the low $(\gamma, 2n)$ yields for light elements is presumably that the reaction does not proceed via compound nucleus formation. (γ, n) and (γ, p) processses in light elements can at least be qualitatively explained by a direct photoeffect.[2] None of the mechanisms discussed applies directly to a $(\gamma, 2n)$ process. A $(\gamma, 2n)$ process can proceed by direct electric photoeffect only as a secondary process, e.g., by a primary (γ, pn) process with a subsequent internal absorption of the proton. By a photomagnetic absorption the process could proceed directly; however, the contribution of photomagnetic processes is small. It is, therefore, of interest to obtain an actual measurement of such a process.

The reaction $N^{14}(\gamma, 2n)N^{12}$ was chosen because of the singular properties of N^{12}. The pulsed beam of the Stanford linear accelerator permits convenient detection of the 12.5-millisecond period between pulses.

Samples of melamine ($N_6C_3H_6$) enclosed in a carbon cartridge were bombarded in the direct beam of the accelerator. 0.040 in. of W were placed ahead of the sample to convert the electron beam. The repetition rate was adjusted to about 10 pulses per second and the machine operated near 120 Mev. The beam was monitored with an air ionization chamber; for the quantitative measurements the N^{12} yield was compared with the β^+ activity from a polystyrene foil; the cross section for the process $C^{12}(\gamma, n)C^{11}$ is well known from the measurements of Marshall.[3]

A small vertical focusing β-spectrometer was constructed consisting of an H-core magnet with trapezoidal pole pieces. Two Geiger counters in coincidence with suitable absorbers were used as detectors. The counts were separated in time by a 5-channel delayed gate arrangement. The first gate was started about 15 milliseconds after the pulse in order to avoid background from slow neutrons.

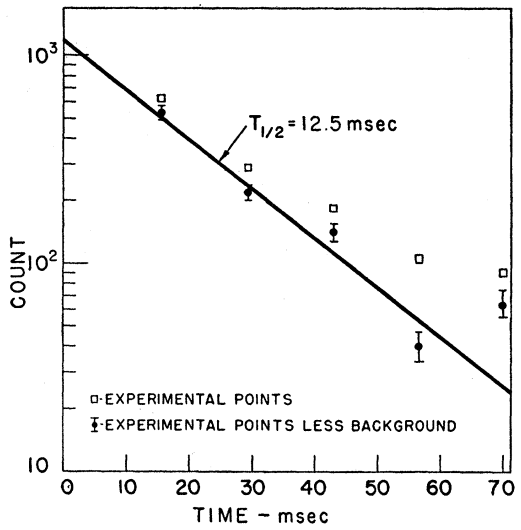

FIG. 1. Decay curve of double coincidences in β-spectrometer melamine target. The half-life as measured by Alvarez (see reference 4) is plotted. The uncorrected data are shown as well as those obtained by correcting for background. The background was measured by substituting an equivalent carbon target.

Figure 1 shows the resultant decay curve taken at a spectrometer setting of 8 Mev. Although the smallness of the yield prevented the taking of more extensive data, it is clear that the decay is real. It was also shown that no decay occurred if carbon was substituted for melamine and if absorbers beyond the β-spectrum end point were inserted.

The geometrical efficiency of the spectrometer was obtained by exploring the possible trajectories with a current carrying wire. The over-all efficiency was then obtained by a numerical integration over the orbits and the β-spectrum. A rather large correction for scattering out of the absorbers was necessary. The result is

$$\int \sigma dE = (5.5 \pm 2) \times 10^{-4} \text{ Mev barns.}$$

N^{12} has a limit of stability[4] of not more than 100 kev. This, however, cannot account for the smallness of this cross section since even with a somewhat wider limit of stability only one level in N^{12} would be available.

We are indebted to Phyllis Hanson and George Masek for efficient operation of the accelerator.

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[1] M. L. Perlman and G. Friedlander, Phys. Rev. **74**, 442 (1948).
[2] See, e.g., E. D. Courant, Phys. Rev. **82**, 703 (1951).
[3] L. Marshall, Phys. Rev. **83**, 345 (1951).
[4] L. W. Alvarez, Phys. Rev. **75**, 1815 (1949); **80**, 519 (1950).

Average Charge Produced by Electron Capture in A^{37}†

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THERE have been few, if any measurements of the charge on the primary product of a radioactive transition in which the result is unambiguous. The difficulties and limitations of various schemes have been discussed by Kofoed-Hansen.[1]

The method of charge measurement described in this letter is free of many of the ambiguities of other methods and is applicable to a variety of radioactive substances. It depends on a determination of the current produced by the collection of the primary recoil ions from a low-pressure gaseous source whose absolute disintegration rate is known.

$Argon^{37}$ produced by the irradiation of calcium metal in the Brookhaven reactor was released by melting the metal in vacuum and introduced into a previously outgassed tube shown in Fig. 1. The outer electrode A is maintained at any desired positive potential by a carefully designed power supply;[2] the positive ion current, at the central electrode C, is measured with a vibrating reed electrometer; application of a negative potential at the highly transparent grid serves to suppress secondary electron emission from the central electrode. The geometry and electric fields are designed to return wall secondaries to the wall, and to allow only a small fraction of the energetic primary electrons to intercept the central electrode. At the press of approximately 10^{-4} mm which existed in the tube the mean free path is large compared with the tube dimensions.

The current measured st the central electrode was of the order of 10^{-12} ampere. At a fixed grid voltage it was found that there is a range of wall voltage over which the ion current is substantially independent of wall voltage. The magnitude of the plateau current was independent of grid voltage except for a small known grid-to-cathode leakage. Current measurements made over a period of 45 days showed a decay with half-time 35.5 days, in good agreement with the 35.0±0.4 day half-life of A^{37} determined in a proportional counter. The measured value of the current was corrected for dead space in the chamber, interception of positive ions by the grid, and interception of fast (2.6 kev) electrons by the center electrode.