γ-Rays from the Decay of N^{16}

C. H. MILLAR, G. A. BARTHOLOMEW, AND B. B. KINSEY
Atomic Energy Project, National Research Council of Canada, Chalk River, Ontario, Canada
November 6, 1950

SOMMERS and Sherr[1] observed that γ-radiation of about 6 Mev is emitted in the β-decay of N^{16}; and more recently, Millar, Cameron, and Glicksman[2] have demonstrated that this radiation consists of at least two components. Since a direct and accurate measurement of these γ-rays is of interest in connection with the levels of O^{16}, we have studied them with the aid of a pair spectrometer.

The N^{16} is produced in the cooling water from the Chalk River pile by the fast neutron reaction $O^{16}(n, p)N^{16}$. Since the half-life of this isotope is only 7.35 sec, it was necessary to maintain a continuous flow of the active water through a reservoir in front of the spectrometer.

In a survey of the γ-ray spectrum between 5.8 and 9.8 Mev only two γ-rays were found. These have energies of 6.133 ± 0.011 and 7.10 ± 0.02 Mev, which are in good agreement with the values 6.136 ± 0.030 and 7.111 ± 0.030 Mev recently reported by Chao, Tollestrup, Fowler, and Lauritsen[3] for the energies of two of the excited states of O^{16}. The ratio of the intensity of the 7.10-Mev γ-ray to that of the 6.133-Mev γ-ray is 0.08 ± 0.02.

No definite evidence was obtained for a γ-ray with an energy corresponding to that of the 6.91 Mev excited state of O^{16}. Since we determine the energy of a γ-ray by measuring the end point of its coincidence spectrum, the most energetic component of a partially resolved doublet can always be observed and measured, while the existence of the lower energy component is difficult to establish. For this reason, a γ-ray of 6.91 Mev with an intensity not much less than that of the 7.10-Mev γ-ray might have escaped detection, especially since the coincidence counting rates obtained were extremely low.

Recent independent measurements by Barnes, French, and Devons,[4] and Arnold[5] have shown that the γ-ray emitting level of O^{16} excited by the bombardment of F^{19} with 340-kev protons has a spin of 3 units and is of opposite parity to that of the ground state of O^{16}. Under these conditions of bombardment, the 6.133-Mev level of O^{16} is the one most frequently produced,[6] and assuming that the ground state of O^{16} is of even parity, it follows that the excited level has a spin of 3 and odd parity. Bleuler, Scherrer, Walter, and Zünti[7] showed that β-decay of N^{16} to the ground state of O^{16} is a first-forbidden transition, while decay to the γ-ray emitting levels is allowed. From these results it may be deduced that the N^{16} ground state has a spin of 2 and odd parity, and from our measurements it follows that the 7.10-Mev level of O^{16} has odd parity.

[1] H. S. Sommers and R. Sherr, Phys. Rev. **69**, 21 (1946).
[2] Millar, Cameron, and Glicksman, Phys. Rev. **77**, 742 (1950), and Can. J. Research **A28**, 475 (1950).
[3] Chao, Tollestrup, Fowler, and Lauritsen, Phys. Rev. **79**, 108 (1950).
[4] Barnes, French, and Devons, Nature **166**, 145 (1950).
[5] W. R. Arnold, Phys. Rev. **80**, 34 (1950).
[6] W. E. Burcham and J. M. Freeman, Phys. Rev. **75**, 1756 (1949).
[7] Bleuler, Scherrer, Walter and Zünti, Helv. Phys. Acta. **20**, 96 (1947).

Precise Determination of the $Li^7(p, \alpha)He^4$ and $Be^9(d, \alpha)Li^7$ Q-Values*

WARD WHALING† AND C. W. LI
Kellogg Radiation Laboratory, California Institute of Technology, Pasadena, California
October 26, 1950

A MAGNETIC spectrograph of the double-focusing 180° sector type has recently been constructed in this laboratory and used to measure the energy released in the $Li^7(p, \alpha)He^4$ reaction. This 16-in. spectrograph follows closely the design of the 10.5-in. instrument used previously but has an extended energy range and a larger aperture (0.007 steradian). The angle θ between the direction of the proton beam incident on the target and the direction in which alpha particles leaving the target enter the spectrograph was measured by two independent methods: (1) by the ratio of the energies of monoenergetic protons elastically scattered from Be and Ta targets; (2) by means of a stop with a narrow slit in it which could be rotated about the target to intercept first the incident protons and then the particles entering the spectrograph. The angle through which the slit turned was read from a dividing head fixed to it. Both methods agree within 0.1° and show the angle of observation to be 89.3°; we assign a probable error of 0.2°.

Both thick and thin targets of lithium, evaporated in vacuum on copper backings, were used. Figure 1 shows typical thin and thick target spectra, together with the alpha-spectrum from ThC′ source located in the target position. The energy scale is fixed by the peak in the ThC′ curve. For the thick target curve the energy of the alphas coming from the surface of the target was taken to be that of a point at 54 percent of the maximum thick target yield, indicated by the arrow in the figure. This value was chosen by consideration of the shape of the curve obtained by folding the spectrograph window into the spectrum for infinite resolution. For the thin target the peak in the curve shows the energy of the alpha-particles, which must be corrected for the finite target thickness. This correction was made by adding to the peak energy one-half the thickness of the target measured in units of alpha-particle energy.

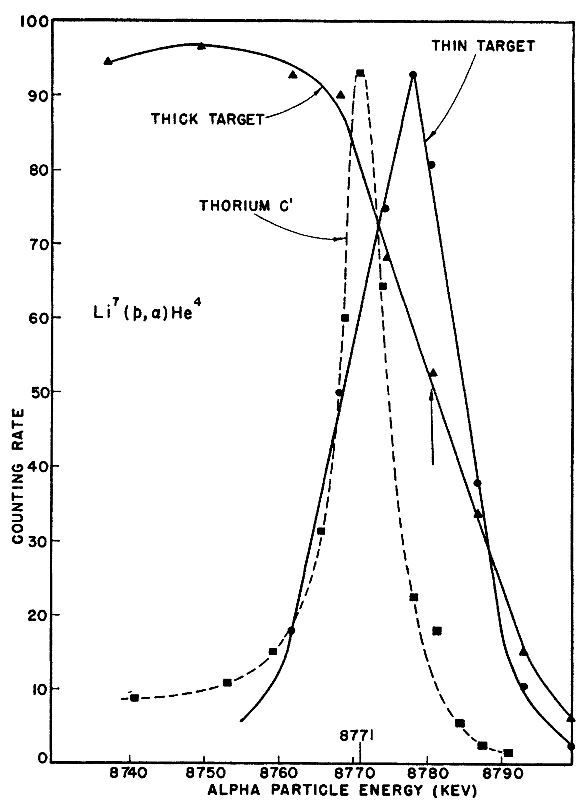

FIG. 1. Typical thin and thick target spectra of α-particles from $Li^7(p, \alpha)He^4$. Bombarding energy 336 kev. Angle of observation 89.3°. Energy scale fixed by peak in ThC′ spectrum.

The proton bombarding energy was held constant to within 0.1 percent with an electrostatic analyzer. Three determinations of Q were made at a bombarding energy of 1008 kev using H^+ ions and eight at 336 kev using HHH^+ ions. At the lower bombarding