where

$$K=(2/\pi)(1/137)(1-4m^2/M^2)^{-\frac{1}{2}}=0.0056.$$

The function $p(\Delta Q/M)$ is plotted in Fig. 1.

As an example, the total probability for finding an apparent Q value below 194 Mev ($\Delta Q=20$ Mev) turns out to be $\sim$0.7 percent.

* Supported by the U. S. Office of Naval Research and the U. S. Atomic Energy Commission.

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Photodisintegration of Deuterium by 165-Mev X-Rays*

E. A. Whalin, Jr.
Physics Research Laboratory, University of Illinois, Champaign, Illinois

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A LIQUID deuterium target[1] 1.25 in. in diameter with walls of 0.0005-in. brass was exposed to a collimated beam of 165-Mev x-rays from the University of Illinois 320-Mev betatron. The x-ray beam was monitored with an 8-in. diameter flat Cu ion chamber which had been calibrated calorimetrically by Kerst and Edwards.[2] The photoprotons were detected by 600-micron thick Ilford G-5 emulsions mounted on 1-in. by 3-in. glass plates. The plates, which were tipped at an angle of about 10° to the equatorial plane, were placed around the outside of the liquid deuterium target at angles of 30°, 45°, 75°, 120°, and 150° with respect to the direction of the x-ray beam. The number of protons per unit area of the plates and their energies were determined by scanning the plates using Leitz Ortholux binocular microscopes. The energies were obtained from measurements of the range of the protons which stopped and from measurements of the grain density of the tracks of the protons which passed through the emulsions.

Figure 1 shows the angular distributions determined for average center-of-mass energies of 62.9 Mev and 130.6 Mev. The curves shown have the form

$$(A+B\sin^2\theta)(1+2\beta\cos\theta).$$

The angular distributions were smoothed simultaneously with the energy dependence curves so that the two sets of curves coincided at the energy and angle of each data point. It can be seen that the $\sin^2\theta$ component which is appreciable at 62.9 Mev has practically disappeared at 130.6 Mev. Here the angular distribution is characterized primarily by the large fore and aft asymmetry presumably due to a retardation effect.

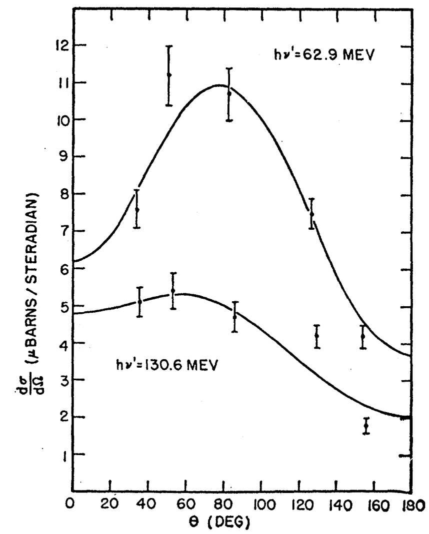

Fig. 1. Angular distributions of the photoprotons in the center-of-mass system for center-of-mass photon energies of 62.9 Mev and 130.6 Mev.

The experimental retardation factor β is shown in Fig. 2, where v_p/c, the ratio of emitted proton velocity to the velocity of light, is also shown for comparison.

Figure 2 also shows the total cross sections calculated from the angular distributions. In addition to the data from this experiment, data are plotted which were taken from the work of Allen,[3] Dwight-Schriever,[4] and Keck *et al.*[5]

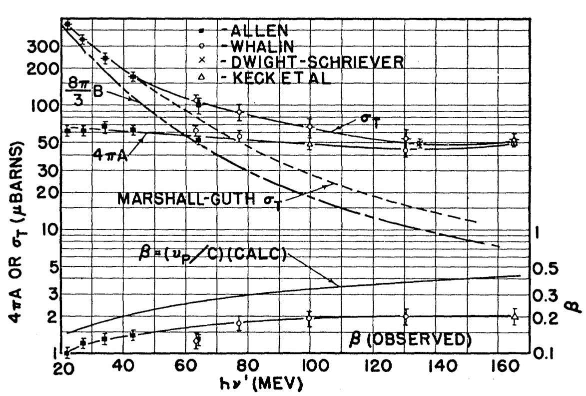

Fig. 2. The experimental total cross section, $\sigma_T=4\pi A+\frac{1}{3}8\pi B$, and $4\pi A$, the isotropic component, and $\frac{1}{3}8\pi B$, the $\sin^2\theta$ component, are shown together with the total cross section calculated by Marshall and Guth. Also shown are the experimental retardation factor β and the ratio of the center-of-mass proton velocity to the velocity of light v_p/c.

The similarity between the total cross section of Marshall and Guth[6] and the experimentally determined $\sin^2\theta$ component, $8\pi B/3$, suggests that this component is largely accounted for by their calculations, while the isotropic component $4\pi A$ is mainly due to a specific mesonic effect. Figure 3 shows the difference between

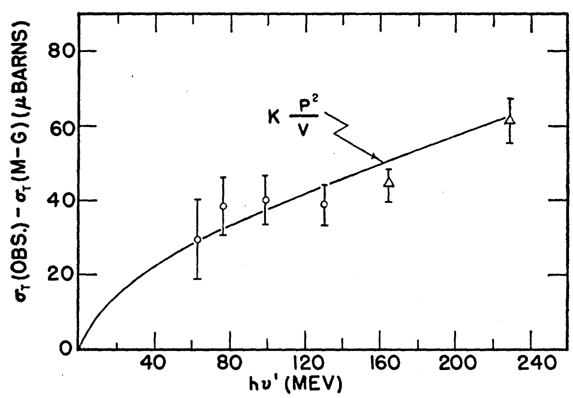

FIG. 3. Difference between the experimental total cross section and the total cross section calculated by Marshall and Guth. P is the momentum and V is the velocity of the photoproton in the center-of-mass system.

the observed total cross section and the total cross section of Marshall and Guth. The difference is a slowly rising quantity which is approximately proportional to the momentum of the emitted proton. This suggests that the matrix element for this part of the cross section is approximately constant. The lack of a distinct difference in the behavior of this component above and below the meson threshold indicates it does not compete with the low-energy photomeson production. This can be understood in terms of an argument of Wilson[7] concerning the absorption of a photon by the meson field in a small volume with a radius less than the pion Compton wavelength. If this volume is occupied by more than one nucleon, nucleons are emitted practically every time because of their much greater statistical weight.

Two more specific mesonic models also seem to show promise of explaining the observed cross sections. The first interaction is suggested by the well known electric dipole transition which is involved in low-energy photopion production. In this transition the photon is absorbed by one of the nucleons flipping its spin and producing an S wave meson. The meson is subsequently absorbed by the other nucleon accompanied by another spin flip producing a final odd-parity state. Such a state could be described as approximately a $^3P_0$ state and would account for the observed isotropic angular distribution.[8] The second interaction involves the interaction magnetic moment and has been considered by Nagahara and Fujimura[9] and also by Bruno and Depken.[10] In this case a P wave meson is emitted by one nucleon, which absorbs the photon. The meson is then absorbed by the other nucleon. These authors show that the magnitude of the observed cross section as well as the angular distribution can be accounted for by this process. A more definite interpretation of the experimental results seems to require more complete theoretical calculations.

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

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Energy Levels in Be^8 from $Li^7(d,n)Be^8$

CARROLL C. TRAIL* AND C. H. JOHNSON
Oak Ridge National Laboratory, Oak Ridge, Tennessee
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SEVERAL low-lying states in Be^8 have been reported in addition to a well-established broad level at 3 Mev.[1] In particular, Titterton[2] has discussed the evidence for levels in Be^8 at 4, 5.3 and 7.5 Mev. Existence of the 4-, 5.3-, and 7.5-Mev levels is suggested[3–9] from $B^{11}(\gamma,t)Be^8$, $B^{10}(\gamma,d)Be^8$, $Li^7(d,n)Be^8$, and $Li^7(p,\gamma\alpha)He^4$. Additional evidence for the 7.5-Mev level is given by the $\alpha-\alpha$ scattering experiment of Steigert and Sampson.[10] The neutron spectrum from $Li^7(d,n)Be^8$ has been obtained previously with photographic plates,[5–8] and the purpose of this investigation was to measure this neutron spectrum with good statistics with a spectrometer described elsewhere.[11]

In a recent article Kunz, Moak, and Good[12] reported the proton spectrum from $Li^6(He^3,p)Be^8$. The spectrum indicates only the 3.0-Mev excited state in Be^8 up to an excitation of 10 Mev. Malm and Inglis[13] observed the α-particle spectrum from $B^{11}(p,\alpha)Be^8$ and found only the 3-Mev excited state up to an excitation of 7 Mev. The $B^{10}(d,\alpha)Be^8$ reaction[14] was found to leave Be^8 in only the ground and 3.0-Mev states.

The spectrometer for this study contains a polyethylene radiator, two proportional counters, and a NaI scintillation counter. Protons which recoil in the forward direction from the radiator pass through the two proportional counters and terminate in the NaI crystal. Triple coincidences produced in this manner gate a twenty-channel pulse sorter which analyzes the pulses in the scintillation counter. The crystal was found to give three percent resolution from 15-Mev protons