is a line displaced upward by 4 Mev from a continuum, this curve is essentially a plot of the estimated resolution. Curve II, for the case in which the product nucleons are in the singlet S state, also exhibits a peak because of the resonance resulting from the low energy virtual state. It is clear that the experimental points, also plotted, are not in agreement with either the half-width or the asymmetric character of curve II. On the other hand, the close fit of curve I with the experimental results is strong evidence that the peak corresponds to deuteron formation. Therefore, it is the deuteron mass which should be used in the calculation of the π^+ meson mass from the meson energy at the peak.

The proton beam energy was measured from its Čerenkov radiation by R. Mather to an accuracy of about ±1 Mev. The energy of each meson was found from its range, as calculated from the most recent range-energy curves.[6-8]

The π^+ meson mass, as determined by this experiment, is 275.1±2.5 electron masses. The estimated systematic errors account for most of the quoted probable error.

The details of the entire experiment will be published later.

It is a pleasure to acknowledge the help and encouragement of Professors C. Richman and H. A. Wilcox, and Dr. K. M. Watson.

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Photonuclear Effects in Carbon from 100-Mev Betatron X-Rays

E. R. GAERTTNER AND M. L. YEATER
General Electric Research Laboratory, Schenectady, New York
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A METHANE-FILLED cloud chamber[1] has been used to observe the photodisintegration of carbon nuclei by x-rays from a 100-Mev betatron. The disintegrations are produced in the gas at one-half atmosphere pressure by a collimated beam of x-rays which passes diametrically through the cloud chamber. The present results are based on the examination of 1800 disintegrations involving the emission of charged particles.

The observed disintegrations form "stars," consisting of three or more tracks with a common origin, and "flags," consisting of a short heavy track from the residual nucleus and a longer, lighter track from a single emitted charged particle. The ratios of flags to 3-prong stars to 4-prong stars are found to be 31:5.5:1 at a peak x-ray energy of 100 Mev and 60:5.5:1 at a peak x-ray energy of 50 Mev. Two 5-prong stars were observed.

About ninety percent of the flags from carbon represent the emission of a charged particle alone, without an accompanying neutron. The identification procedure is the same as previously described.[2] Not more than ten percent of the flags can be ascribed to $C^{12}(\gamma, np)B^{10}$. It is believed that the $C^{12}(\gamma, p)B^{11}$ reaction is principally involved, although a contribution from the (γ, d) or (γ, He^3) reactions is not ruled out by the present evidence. The reaction $C^{12}(\gamma, He^4)Be^8$ is, of course, excluded as an origin of flags by the instability of the Be^8, but it is undoubtedly responsible for some of the observed 3-prong stars.

The yield of flags in methane has been referred to the yield of flags in nitrogen,[3] for which the approximate integrated cross section has been previously determined, by comparing x-ray intensities with an ionization chamber. In this way, we obtain an integrated cross section for the carbon flags, which is 0.22±0.09 Mev-barn, for a peak x-ray energy of 100 Mev.

The angular distribution of the flags from carbon for a peak x-ray energy of 100 Mev is shown in Fig. 1. The angle measured is

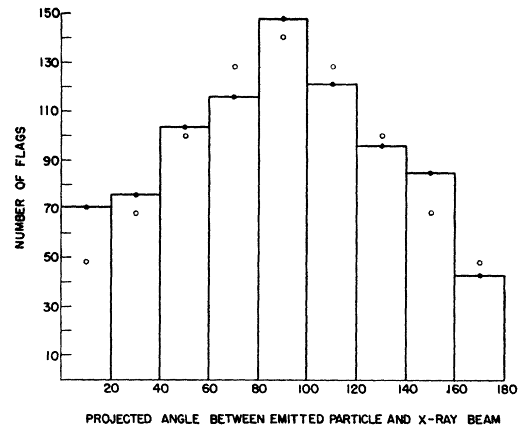

FIG. 1. The angular distribution of the carbon flags in methane. The angles are measured between the x-ray beam and the projection in the plane of the cloud chamber of the track of the emitted particle. The points indicated by open circles are calculated from the space distribution $f(\theta)d\Omega \sim (1+3\sin^2\theta)d\Omega$ by a transformation appropriate to the cloud chamber geometry.

that between the x-ray beam and the projection in the plane of the cloud chamber of the track of the emitted particle. Flags which obviously involve neutron emission are not included. This angular distribution, when transformed into a space distribution, can be represented approximately by the function

$$f(\theta)d\Omega \sim (1+a\sin^2\theta)d\Omega,$$

where θ is the space angle between the x-ray beam and the path of the emitted particle, and $a \cong 3$. This differs from the helium photo-proton distribution,[4] which is compatible with a pure $\sin^2\theta$ function.

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Coincidence Studies on the Radiations from Ba^{131}

W. H. CUFFEY
*Physics Department, Indiana University, Bloomington, Indiana**
(Received February 26, 1951)

THE half-life of Ba^{131} is 12 days, and it can be formed by neutron capture in barium. It is the parent in the chain $Ba^{131} \rightarrow Cs^{131} \rightarrow Xe^{131}$. The properties of the radiations from Ba^{131} were first investigated by Yu, Gideon, and Kurbatov[1] using absorption and cloud-chamber techniques. These investigations showed that no positrons were emitted and established the fact that Ba^{131} decays by orbital electron capture. Internal conversion electrons were found. Absorption experiments in lead of the gamma-rays showed three gamma-rays of energies 0.220, 0.500, and 1.7 Mev. Katcoff[2] performed similar absorption experiments and found gamma-rays of energy 0.26, 0.5, and 1.2 Mev. In addition, he measured the absorption of the electrons in aluminum and found two groups at energies of 0.42 and 0.24 Mev. Finally, Dale, Richert, Redfield, and Kurbatov[3] and Zimmerman. Dale, Thomas, and Kurbatov[4] have measured the spectrum of the gamma-rays in a magnetic lens spectrograph and found two lines—one at 0.496 and the other at 0.213 Mev.

Since the investigation of the $Ba^{131} \rightarrow Cs^{131}$ chain is under investigation in this laboratory, the present experiments were undertaken to obtain more information, especially on the high energy gamma-ray.

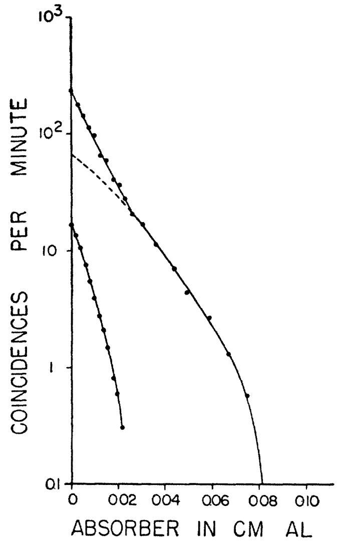

FIG. 1. Coincidence absorption curve.

Barium was irradiated by neutrons in the Oak Ridge pile, and after a chemical separation the barium fraction was investigated using coincidence counting techniques. Since Cs^{131} emits only x-rays and Auger electrons,[5] the growth of the daughter poses no problems. An absorption curve in lead was taken on the gamma-rays of Ba^{131}, with a lead lined counter whose gamma-ray efficiency is known as a function of energy. These experiments showed three gamma-ray groups at energies 0.16, 0.42, and 1.2 Mev, of relative intensities 1:1:0.25.

A coincidence absorption curve of Compton electrons ejected from a brass radiator by the gamma-rays was taken and is shown in Fig. 1. An analysis of the data by the method of Bleuler and Zunti shows two gamma-rays of energies 0.83 and 0.46 Mev.

Absorption in aluminum of the electrons from Ba^{131} showed two groups of energies approximately 0.5 and 0.2 Mev. These are presumably conversion electrons.

A measurement of gamma-gamma coincidences was made using two lead-lined counters. Coincidences were found, and a value of $N_{\gamma\gamma}/N_{\gamma}=0.24\times10^{-3}$ obtained. The interposition of 0.37 cm of lead reduced the gamma-gamma coincidence rate by a factor of 17. From consideration of counter efficiencies it seems likely that the gamma-gamma coincidences are between the gamma-ray at 0.46 Mev (actually 0.497 Mev) and one of the lower energy gamma-rays, around 0.2 Mev. Efficiency considerations exclude the 0.46- and the 0.83-Mev lines being in coincidence.

Spectroscopic experiments in this laboratory[5] show that Ba^{131} has a number of gamma-rays. These come at 0.497, 0.371, 0.241, 0.213, 0.196, and 0.122 Mev with the 0.497 being the strongest. The present experiments are in agreement with these findings, confirm the results of earlier workers, and establish a lower value, 0.83 Mev, for the highest energy gamma-ray. In addition, the coincidence experiments show that the gamma-ray at 0.46 Mev is in cascade with lower energy gamma-rays.

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