decrease appreciably (by not less than a factor 2) with increasing n, at the minimum value $k^2_{min} < 1$ GeV^2/c^2.

4) There were 15 events with low values of k^2_n (all $k^2_n \leq 1$ GeV^2/c^2).

We regard events of type 1) as central interactions and accordingly estimate them to be (14 ± 7)% of the total. Events of type 3) correspond to peripheral interactions with essentially asymmetrical excitation of both nucleons, with the effective masses of the proton with small k^2_n and the proton closest to it (in terms of the emission angle) lying in three out of nine cases in the range 1.15 - 1.30 GeV/c^2. Events of type 4) correspond apparently to peripheral interactions with weak excitation of one or two nucleons; finally, an event of type 2) can be interpreted as a rare case (at the given energy) of formation of a fireball with effective mass ~3 GeV/c^2.

We considered also the distribution of the values of k^2_{min} over all the events. It has the form of a curve that decreases steeply at $k^2_{min} > 0.2$ GeV^2/c^2 and is almost horizontal in the interval 1 - 3 GeV^2/c^2. This indeed is one of the grounds for drawing a somewhat arbitrary boundary between peripheral and central interactions at 1 GeV^2/c^2.

A detailed theoretical justification of the method will be presented elsewhere.

[1] E. Braunersrenther, J. C. Combe, L. Hoffman, and M. Morpurgo, CERN Report 62-7.

ENERGY SPECTRA AND ANGULAR DISTRIBUTIONS OF NUCLEONS IN THREE-PARTICLE PHOTODISINTEGRATION OF THE He^3 NUCLEUS

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From the point of view of the dynamics of three-nucleon systems, great importance attaches to the investigation of the photodisintegration of three-particle nuclei. Fetisov et al. [1] have presented experimental energy spectra and angular distributions of the nucleons from the reaction

$$\gamma + He^3 \rightarrow p + p + n. \quad (1)$$

The same paper contains a brief theoretical analysis of the results, concerning the energy distribution of the neutrons. It is concluded at the same time that the theory which takes into account the singlet interactions between the protons in the final state (neglecting Coulomb effects) reconstructs well the principal maximum of the energy spectrum of the neutrons. However, the deduction that it is impossible to describe the foregoing maximum within the framework of the Born approximation is based on an error made by Fetisov et al. [1] Unfortunately, this erroneous conclusion was used subsequently as a basis for a theoretical analysis of the total cross section of the reaction (1), which is very sensitive to the details of the interaction in the final state.

In this note we discuss the spectrum of the neutrons in reaction (1) and point out the character of error in the work of Fetisov et al. [1] We consider also the spectrum of the protons and the angular distributions of the photonucleons.

Within the framework of the assumption of direct knockout of inidividual nucelons, the reaction (1) can proceed via two channels

$$\gamma + He^3 \rightarrow (p + p) + n, \qquad (I)$$

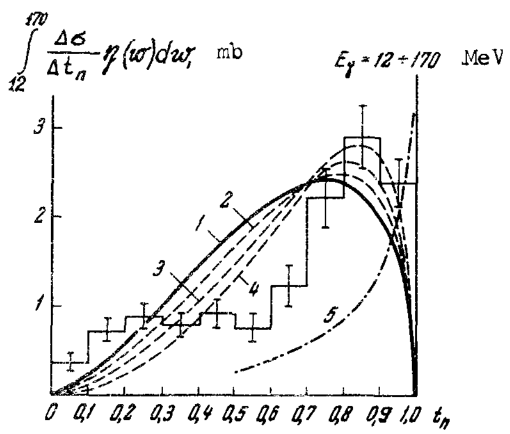
$$\gamma + He^3 \rightarrow (n + p) + p, \qquad (II)$$

where the parentheses denote that the corresponding pair is in the singlet S-state. The high-energy part of the neutron spectrum, where the principal maximum is situated, is determined by channel I. We therefore confine ourselves to an analysis of this channel only.

We introduce the quantity $t = E_n/E$, where E_n is the energy of the neutron in the c.m.s., $E = \frac{2}{3}(E_\gamma - Q)$, E_γ is the γ-quantum energy, and Q is the threshold of reaction (1). Then, describing the initial state of the He^3 nucleus by a Gaussian function, with allowance for the admixture of an S' state of mixed symmetry [3], and the final state by means of plane waves, we obtain in the electric-dipole approximation for the neutron spectrum in channel I:

$$\frac{d\sigma}{dt} \sim t^{3/2}(1 - t)^{1/2}\left[1 + \left(\frac{P}{6}\right)^{1/2} \frac{2M(E_\gamma - Q)}{2\hbar^2\alpha^2}(2t - 1)\right]^2, \qquad (2)$$

where $\alpha = 0.384\ F^{-1}$ is the Gauss parameter of the wave function, and P is the percentage of the S' state. The figure shows the energy distributions of the nucleons in the reaction $\gamma + He^3 \rightarrow p + p + n$. The theoretical curves 1, 2, 3, and 4 correspond to the Born approximation ($1 - P = 0$, $2\text{-}4 - P = 0.04$ [3]). Curves 2, 3, and 4 take into account the 4% admixture of the S' state and pertain to energies $(E_\gamma - Q) = 15$, 30, and 50 MeV, respectively. The theoretical curves are normalized. $\eta(w)$ is a function describing the bremsstrahlung spectrum. Comparing the theoretical curve with the experimental histogram and recognizing at the same time that the experimental neutron spectrum is averaged over the bremsstrahlung



spectrum in a large energy interval ($E_\gamma = 12 - 170$ MeV), we can conclude that the principal maximum of the spectrum is correctly reproduced even in the Born approximation. Allowance for the interaction between the protons in the same approximation as was used earlier [4,1] leads to results (curve 5 on the figure, $E_\gamma - Q = 10$ MeV) which differ from experiment both with respect to the shape of the spectral curve and with respect to the location of its maximum. In the cited paper [1], in the comparison of theory and experiment, the ordinates were erroneously chosen to be the quantity $\sigma(\beta) \equiv d\sigma/d\beta = 2t^{\frac{1}{2}}(1 - t)^{\frac{1}{2}} d\sigma/dt$, in place of $d\sigma/dt$ ($t = \sin^2\beta$), and this has led the authors of that paper to incorrect conclusions concerning the role of the nuclear interaction between the protons in the final state in reaction (1).

Let us point out that within the framework of the Born approximation it is also possible to reproduce satisfactorily the characteristic features of both the angular distributions of the photonucleons and the energy spectrum of the protons.

The foregoing analysis indicates that allowance for only attractive nuclear interaction between protons, within the framework of the approximation employed by us [4], is not valid, for this results in an underestimate of the role of Coulomb repulsion. The actual situation is apparently such that the effects of Coulomb nuclear forces almost cancel each other in the phenomenon under consideration, so that the true spectrum of the neutrons, and also other differential characteristics of the process (1), differ little from those calculated in the Born approximation. It is of interest in this connection to investigate experimentally the mirror reaction of (1):

$$\gamma + He^3 \rightarrow n + n + p, \qquad (3)$$

in which, owing to the absence of Coulomb forces, the attractive action of the nuclear forces appears in full force, thus causing the spectrum of the protons in reaction (3) to be richer in high-energy protons than the neutron spectrum in reaction (1) - rich in high-energy neutrons.

[1] V. N. Fetisov, A. N. Gorbunov, and A. T. Varfolomeev, Nucl. Phys. 71, 305 (1965).

[2] V. N. Fetisov, JETP Letters 3, 170 (1966), transl. p. 108.

[3] L. I. Schiff, Phys. Rev. 133B, 802 (1964).

[4] G. Gyorgyi and P. Hrasko, Acta Phys. Hung. 17, 253 (1964).