Distribution in the Treiman-Yang angle for the reaction $^4He(\gamma, pn)^2H$

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Experimental distributions in the Treiman-Yang angle were determined in the investigated process for the purpose of completing the program of identification of the pole mechanism in the $^4He(\gamma, pn)^2H$ reaction.

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In studying the problem of identification of the pole mechanism in three-particle reaction (Fig. 1), it is important to verify the Treiman-Yang criterion. By defining the Treiman-Yang angle as the angle between the (a, b) and (II, c) planes in the antilaboratory system (particle I is at rest),[1] we obtain an isotropic distribution in it, if the spin i of the particle is equal to zero. There are several papers on Treiman-Yang angle distributions known at this time (see, for example, Ref. 2). There are no papers avail-

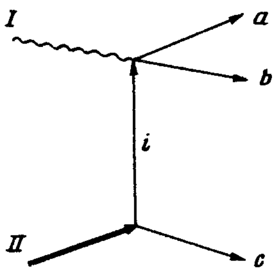

FIG. 1. Pole diagram for a three-particle reaction.

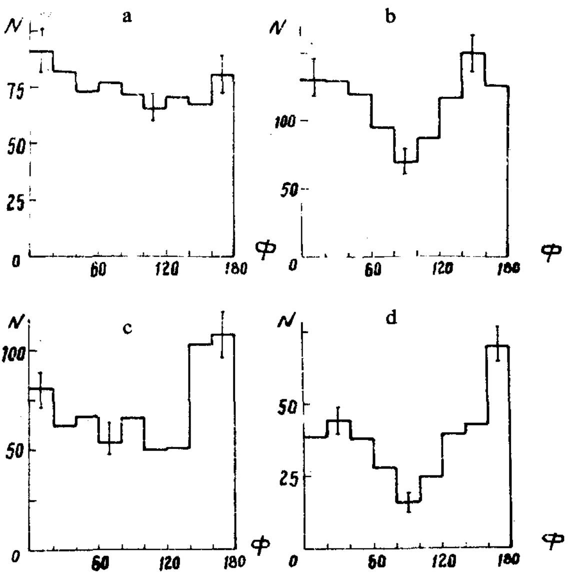

FIG. 2. Distribution in the Treiman-Yang angle as a function of the photon energy: a, 28–45 MeV; b, 45–70 MeV; c, 70–100 MeV; d, 100–150 MeV.

able at this time, however, in which the Treiman-Yang criterion is used for photonuclear reactions. This is apparently attributable to the specific properties of the reaction (the incident particle is a photon and there is no frame in which it is at rest) and to systematic difficulties associated with the need to completely reconstruct all the kinematic parameters of particles in the final state.

The difficulty in determining the Treiman-Yang angle for photonuclear reactions can be avoided if it is defined as the angle between the (γ, a) and (II, c) planes in the c.m.s. of the particles $(a + b)$:

$$\cos \phi = \frac{(\mathbf{p}_{II}\,\mathbf{p}_a)(\mathbf{p}_c\,\mathbf{p}_I) - (\mathbf{p}_{II}\,\mathbf{p}_I)(\mathbf{p}_c\,\mathbf{p}_a)}{\{[p_{II}^2\,p_c^2 - (\mathbf{p}_{II}\,\mathbf{p}_c)^2][p_a^2\,p_I^2 - (\mathbf{p}_a\,\mathbf{p}_I)^2]\}^{1/2}}, \qquad (1)$$

where $(\mathbf{p}_j\mathbf{p}_k)$ is the scalar product of the momenta of particles j and k in the c.m.s. of the particles $(a + b)$. In this case we obtain the same constraints on the angular distributions as those for the Treiman-Yang criterion.

The parameters of all the particles in the investigated process can be completely reconstructed by using the track method[3] (diffusion chamber in a magnetic field) in the investigation of the ^{4}He$(\gamma, pn)^2$H reaction. This made it possible for us to determine experimentally the distributions in the Treiman-Yang angle—the angle between the (^{4}He, ^{2}He) and (γ, p) planes in the rest frame of the (pn) pair. Figure 2 shows these distributions.

Taking into account our earlier conclusions[4] about two-nucleon absorption of photons in the ^{4}He$(\gamma, pn)^2$H reaction, we can conclude that the spin i of the intermediate particle is nonzero is those energy regions in which the distributions in the Treiman-Yang angle, shown in Fig. 2, are anisotropic (at E_γ greater than 45 MeV).

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