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Two-Body High-Energy Photodisintegration of ^{4}He.

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In a previous paper (1) we have reported some experimental results on the reaction

$$\gamma + {}^3\text{He} \to \text{p} + \text{d} \tag{1}$$

at a gamma-ray energy between 180 and 550 MeV. The present results concern the reaction

$$\gamma + {}^4\text{He} \to \text{p} + \text{t} \tag{2}$$

in the same energy region. This second experiment has been performed in order to gain directly comparable results on the photodisintegration of light nuclei in the energy region around the first pion-nucleon isobar ($J = \frac{3}{2}$, $I = \frac{3}{2}$). We have measured the differential cross-section for reaction (2) at 90° c.m.s. in the gamma-ray energy region between 200 and 460 MeV.

The experimental apparatus, consisting of a liquid ^{4}He target and two telescopes of spark chambers and scintillation counters, is very similar to the one described in ref. (1); minor modifica-

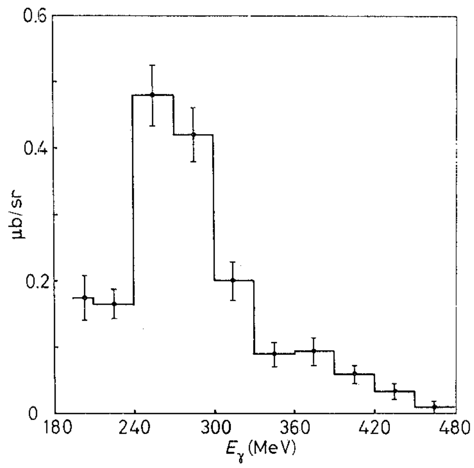

Fig. 1. – Experimental differential cross-section (c.m.s. angle = 90°) for the reaction $\gamma + {}^4\text{He} \to \text{p} + \text{t}$.

(1) P. PICOZZA, C. SCHAERF, R. SCRIMAGLIO, G. GOGGI, A. PIAZZOLI and D. SCANNICCHIO: *Nuovo Cimento*, 55 A, 206 (1968).

tions have been introduced to improve the signal-to-noise ratio. Photodisintegration of ^{4}He at these energies is possible in many final states. The quantities measured in this experiment, the angles and ranges of two charged particles, allowed the selection of events due to the reaction (2) by means of a kinematical reconstruction with two constraints.

Our preliminary results, about 30% of the events available up today, are shown in Fig. 1. Raw data are corrected for geometrical and single-gap efficiency, and for nuclear scattering of the detected particles in the spark chamber plates.

The empty-target background, less than 10% of the full-target counting rate, has been subtracted from the experimental data. The error bars indicated in the Figures represent statistical fluctuations only. No serious attempt has been made at this point to evaluate systematic errors.

In Fig. 2 we have collected all the experimental data available to us on this reaction ([2-4]). The results of the various experiments appear to be generally consistent with each other.

For comparison we have plotted in Fig. 3 the data from reactions (1), (2) and from the reaction ([5,6])

$$\gamma + d \rightarrow p + n \,. \tag{3}$$

The most relevant feature of these cross-sections is a pronounced resonant behaviour

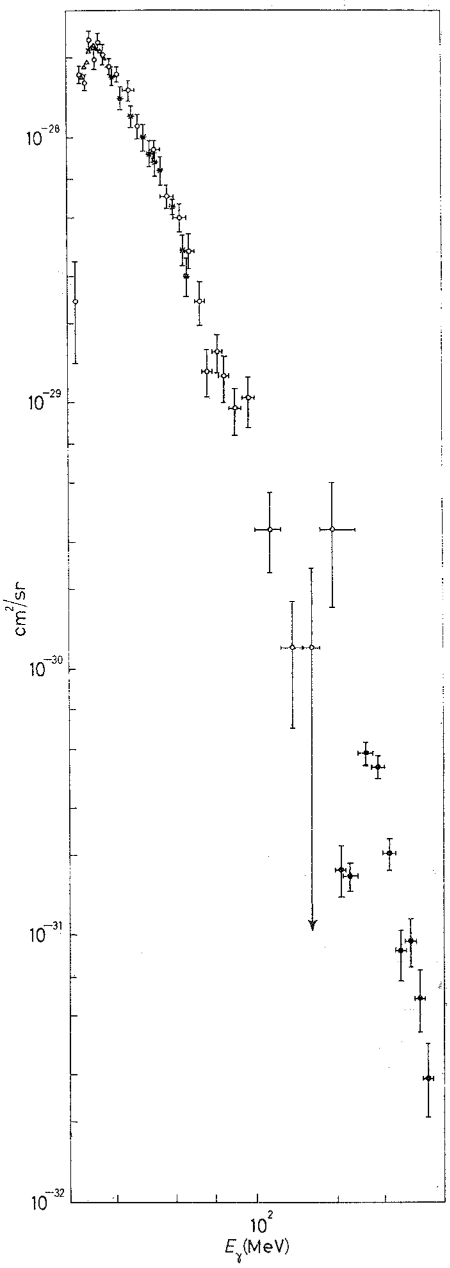

Fig. 2. – Comparison of the experimental 90° c.m.s. differential two-body ^{4}He photodisintegration cross-section. Assuming a $\sin^2\tilde{\vartheta}$ angular distribution in the whole energy range, the data by GORBUNOV (○, ref. ([2])), CLERC *et al.* (×, ref. ([3])), GEMMELL *et al.* (△, ref. ([4])) have been multiplied by $3/8\pi$ to compare them with our data (●).

([2]) A. N. GORBUNOV: *Phys. Lett.*, **27**, B 436 (1968).
([3]) H. G. CLERC, R. J. STEWART and R. C. MORRISON: *Phys. Lett.*, **18**, 316 (1965).
([4]) D. S. GEMMELL and G. A. JONES: *Nucl. Phys.*, **33**, 102 (1962).
([5]) J. C. KECK and A. V. TOLLESTRUP: *Phys. Rev.*, **101**, 360 (1956).
([6]) R. CHING and C. SCHAERF: *Phys. Rev.*, **141**, 1320 (1966).

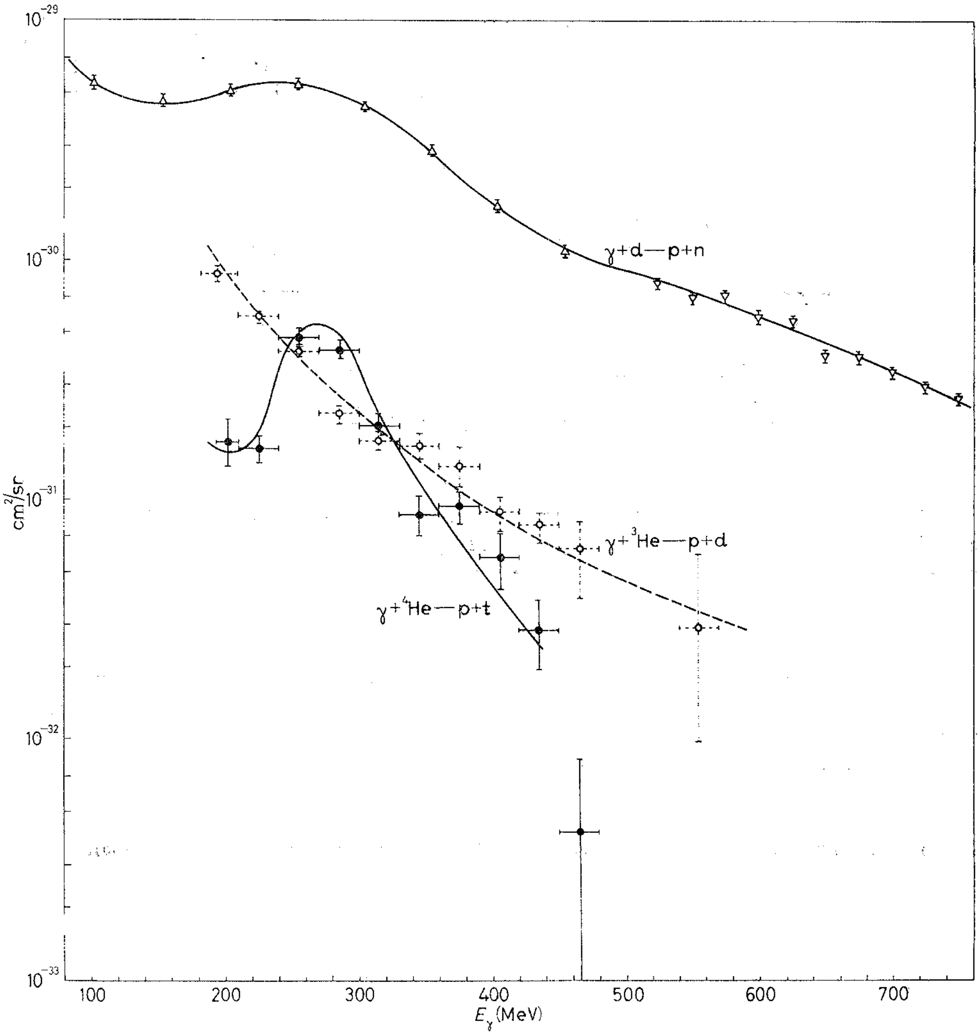

Fig. 3. – Comparison of the experimental 90° c.m.s. differential photodisintegration cross-section in two bodies for d, ^{3}He, ^{4}He. ○ PICOZZA *et al.* (ref. (1)); △ KECK *et al.* (ref. (8)); ▽ CHING *et al.* (ref. (9)); ● this experiment.

for reactions (2) and (3) in the energy region of the first pion-nucleon isobar. No such resonant behaviour is apparent in reaction (1).

To understand this phenomenon we can use the same argument first introduced by WILSON (7) to explain the deuteron data on the basis of pion production and reabsorption.

In Fig. 4 we have indicated the relevant diagrams for a possible resonant contribution to these reactions. Both diagrams *a*) and *b*) give a large contribution to the photodisintegration of the deuteron. Diagram *a*) gives a small contribution to the ^{3}He

(7) R. R. WILSON: *Phys. Rev.*, **104**, 218 (1956).

and ^4He photodisintegration because the coherent photoproduction of π-mesons in light nuclei at resonance (upper vertex) is known (8) to be depressed by multiple pion nuclear scattering. Diagram *b*) is forbidden in the case of photodisintegration of ^3He by isotopic-spin conservation at lower right vertex, but is allowed for ^4He photodisintegration.

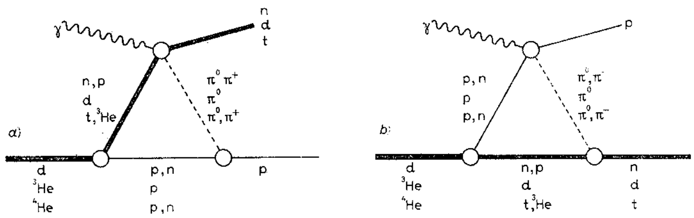

Fig. 4. – Diagram *a*) represents the processes $\gamma+d \to p+n$ (π^0 or π^+ exchange), $\gamma+{}^3He \to p+d$ (π^0 exchange), $\gamma+{}^4He \to p+t$ (π^0 or π^+ exchange). Diagram *b*) represents the processes $\gamma+d \to p+n$ (π^0 or π^- exchange), $\gamma+{}^3He \to p+d$ (π^0 exchange), $\gamma+{}^4He \to p+t$ (π^0 or π^- exchange).

With these arguments a relevant resonant behaviour is expected between 250 and 350 MeV in deuteron and ^4He but not in ^3He photodisintegration. Our experiments confirm this simple phenomenological prediction.

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(8) M. DAVIER, D. BENAKSAS, D. DRICKEY and P. LEHMAN: *Phys. Rev.*, **137**, B 119 (1965).

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