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High-Energy Photodisintegration of ^{3}He.

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A number of experiments on ^{3}He photodisintegration have been recently performed by many authors ([1-7]), but only for γ energies below the pion-photoproduction threshold. In this paper we report some preliminary results on the two-body photodisintegration of ^{3}He in the γ energy region around the first pion-nucleon resonance.

At present there is no available theory allowing an interpretation of the process in this energy region, but we feel that this experiment may be interesting in order to extend the actual data and to compare the experimental situation on ^{3}He and on deuteron in a wide energy range.

Photodisintegration of ^{3}He, without pion photoproduction, is possible in two different final states:

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

$$\gamma + {}^3\text{He} \rightarrow 2\text{p} + \text{n}\,. \tag{2}$$

We measured the differential cross-section for the reaction (1) for $E_\gamma = (180 \div 550)$ MeV at a center-of-mass angle of 90°.

The experimental layout is shown in Fig. 1. An 800 MeV bremsstrahlung beam of the Frascati electrosyncrotron was collimated, cleared by a magnetic field and then

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entered in the target vacuum chamber. The details of the liquid ^{3}He target are described in ref. ([8]). The actual cell has a lens-shaped form with a maximum thickness of 17.5 mm and consists of two nickel foils, 0.03 mm thick, welded to a nickel frame, and is oriented

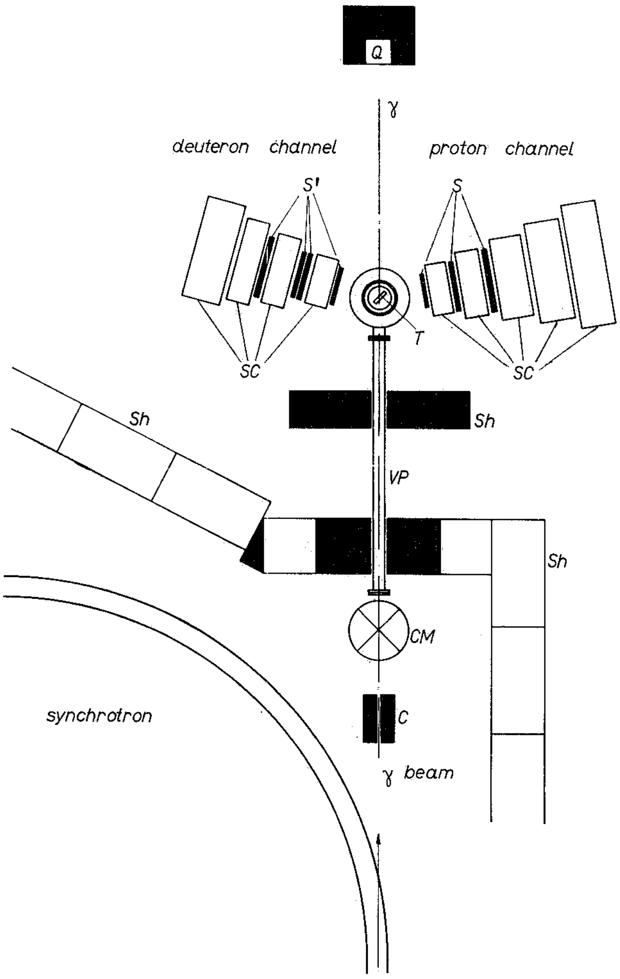


Fig. 1. – General view of the experimental arrangement: *CM*, Clearing magnet; *C*, collimator; *Sh*, concrete and lead shielding; *T*, liquid ^{3}He target; *Q*, quantameter; *VP*, vacuum pipe; *SS'*, scintillator counters; *SC*, spark chambers.

at 45° with respect to the beam axis. The temperature of the liquid ^{3}He is 2.5 °K, corresponding to a density of 74.5 mg/cm^3.

The detection apparatus consisted of 7 scintillation counters in coincidence and 9 spark chambers of conventional design. The covered solid angle was $5.5\cdot10^{-2}$ sr. Five spark chambers were used to detect the emitted proton and four to detect the

([8]) I. MODENA V. MONTELATICI and F. SCARAMUZZI: *Nucl. Instr. Meth.*, **44**, 175 (1966).

deuteron. The first chamber in each set was used to measure the angle of the emitted particles. The other chambers were used for range measurements.

In this configuration two angles and two momenta were measured and this implies for reaction (1) a kinematics with 2 constraints.

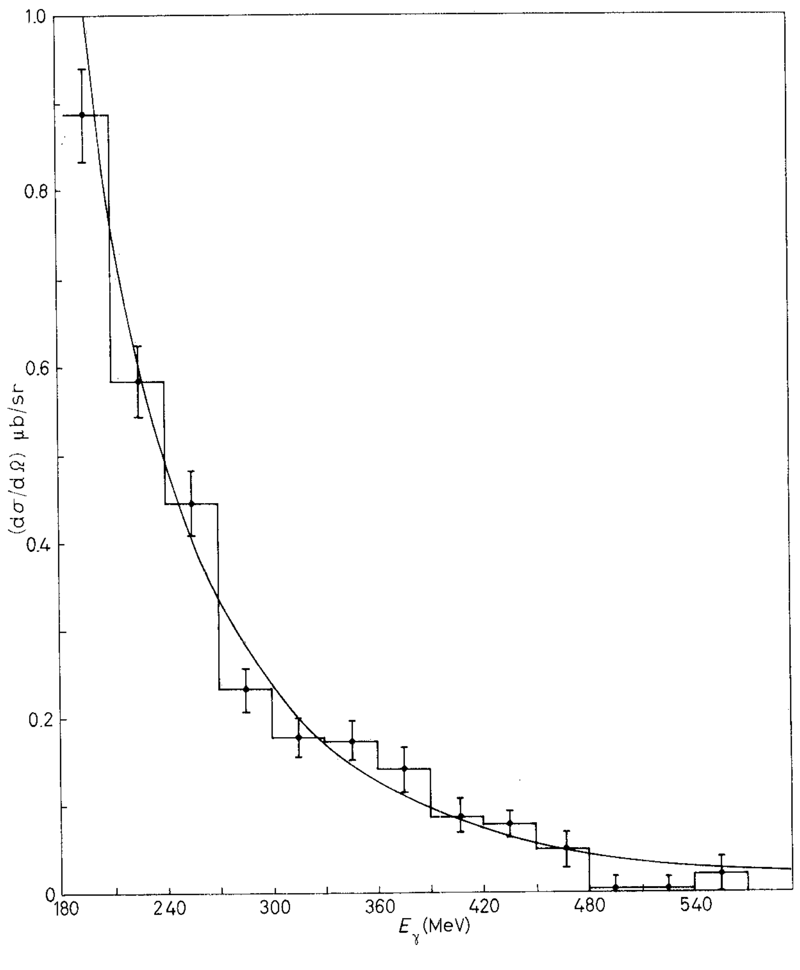


Fig. 2. – Experimental differential cross-section (c.m.s. angle = 90°) for the reaction $\gamma + {}^3He \rightarrow p + d$.

Our preliminary results, concerning a large part of the available data, are shown in Fig. 2, where only statistical errors are given. The results were corrected for empty-cell background and for nuclear scattering in the spark-chamber aluminium plates. The last correction was evaluated by a Monte Carlo calculation as well as the detection efficiency of the apparatus. In Fig. 3 our data are plotted together with the low-energy results of previous experiments. The normalization of our data seems to be consistent with an average of the other experiments.

The most relevant feature of our data is the absence of any relevant resonant behaviour in the region of the first pion-nucleon resonance, as one should expect from

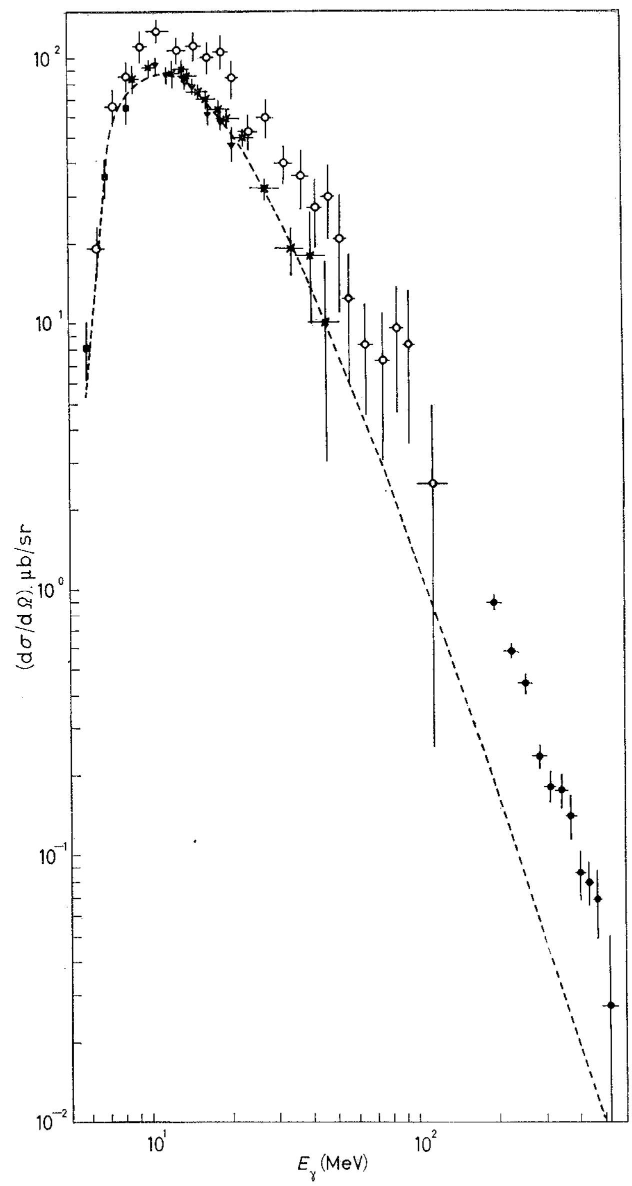
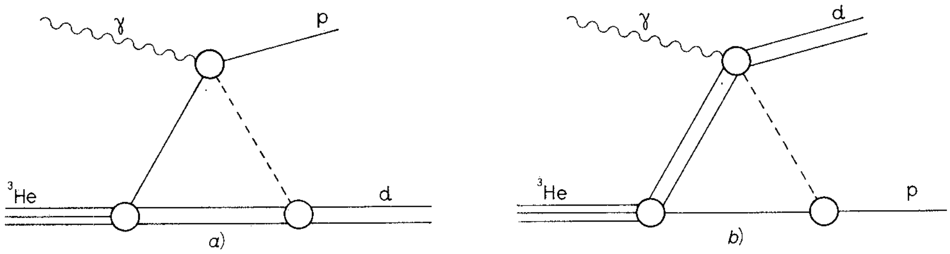


Fig. 3. – Comparison of the experimental 90° c.m.s. differential two-body photodisintegration cross-sections. Assuming a $\sin^2\tilde{\theta}$ angular distribution in the whole energy range, the data by FETISOV *et al.* and by BÖSCH *et al.* have been multiplied by $3/8\pi$ to compare them with the other data. The dashed curve is the Gunn and Irving theoretical calculation with $\mu^{-1} = 2.6$ fm. ○, FETISOV *et al.* $\times 3/8\pi$ (ref. (1)); ▼, BERMAN *et al.* (ref. (3)); ■, BÖSCH *et al.* $\times 3/8\pi$ (ref. (4)); ×, STEWART *et al.* (ref. (6)); ●, this experiment; — — —, GUNN and IRVING, $1/\mu = 2.6$ fm (ref. (10)).

the data on the deuteron photodisintegration, where there is a pronounced maximum at a γ-ray energy of 280 MeV (9).

Furthermore a theoretical calculation of the photodisintegration cross-section for electric-dipole transitions using a Gunn and Irving wave function (10) does not fit simultaneously the available data. Separated satisfactory fits of the low-energy and the high-energy data can be obtained for two different values of the free parameter μ.

To understand the lack of a pronounced resonant behaviour in our results we try the same phenomenological arguments used by WILSON (11) to explain the deuteron data. In the Wilson model the resonant peak has been interpreted as the contribution of a pion reabsorption process. Applying the same model to our reaction the following graphs can be considered:



Clearly the diagram *a*) does not contribute to our reaction because of isospin conservation in the π^0-d vertex. The resonant contribution of diagram *b*) is likely not relevant because some experiments on deuteron show a much lower π^0 elastic photoproduction cross-section than predicted by the impulse approximation (12).

We whish to remark that this argument is just a tentative and preliminary interpretation of our results. Further calculations and experimental work are now in progress.

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