COMITATO NAZIONALE PER L'ENERGIA NUCLEARE
Laboratori Nazionali di Frascati

LNF - 69/82
23 Dicembre 1969

F.L. Fabbri, P. Picozza and C. Schaerf: PHOTODISINTEGRATION OF ^3He BY POLARIZED GAMMA RAYS. -

Servizio Documentazione
dei Laboratori Nazionali di Frascati del CNEN
Casella Postale 70 - Frascati (Roma)

Laboratori Nazionali di Frascati del CNEN
Servizio Documentazione

LNF-69/82

Nota interna: n. 463
23 Dicembre 1969

F. L. Fabbri, P. Picozza and C. Schaerf: PHOTODISINTEGRATION OF ^{3}He BY POLARIZED GAMMA RAYS. -

In previous papers we have reported our results on the high energy two body photodisintegration of ^{3}He and ^{4}He nuclei(1, 2) with an unpolarized gamma ray beam. In this note we would like to present one preliminary result on the reaction

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

with linearly polarized bremsstrahlung. The interest of this measurement has been enhanced by the previous result that has shown no indication of a resonant behaviour of the cross section in the energy region of the first pion-nucleon isobar. This phenomenon seems to exclude the possibility of a resonant magnetic dipole absorption of the electromagnetic radiation. Therefore it is interesting to find out the amount of non resonant magnetic dipole transitions in this reaction.

Current models of the two body photodisintegration of ^{3}He tend to include only the transitions indicated in Fig. 1(3). The lower E1 transition is the dominant one, while the M1 and E2 transitions from a $S_{1/2}$ state are the other more relevant contributions. There is no interference between E1 and M1 because they lead to final states with different spin. At 90° in the CMS E2 does not contribute. The angular distribution from M1 is isotropic, while E1 produces a P wave of the type:

$$\sin^2\vartheta \cos 2\chi \ .$$

As a consequence of these considerations we have, for the asymmetry parameter defined in the usual way:

$$A = \frac{B}{\Sigma_1} = \frac{\sigma_{\parallel} - \sigma_{\perp}}{\sigma_{\parallel} + \sigma_{\perp}} = \frac{b_e}{a_m + b_e}$$

where :

ϑ is the C. M. angle;

χ is the angle between the reaction plane and the plane of polarization of the electric field;

$\sigma_{\parallel}$ is the differential cross section at 90° CMS measured in the plane of linear polarization of the gamma ray beam : $\chi = 0^{\circ}$;

$\sigma_{\perp}$ is the differential cross section at 90° CMS measured in the plane perpendicular to the plane of polarization of the gamma ray beam: $\chi = 90^{\circ}$;

Σ_1 is the amount of linear polarization of the gamma ray beam;

b_e is the contribution to the cross section from the E1 transition;

a_m is the contribution to the cross section from the M1 transition;

B is the experimentally measured asymmetry

A is the asymmetry parameter.

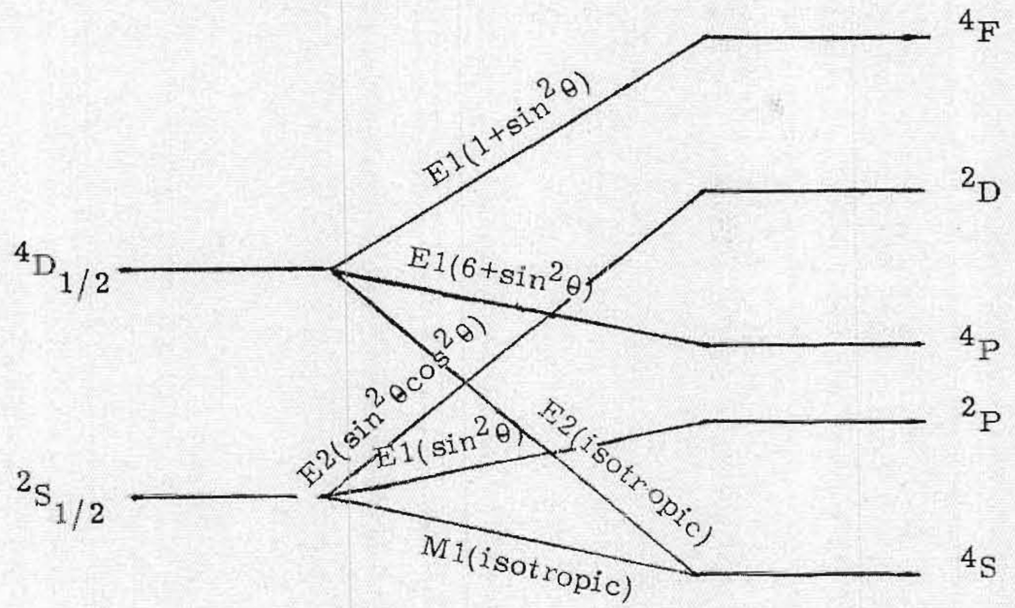

FIG. 1 - Electromagnetic transitions of the three-nucleons system from ground state to continuum of two particles with indication of angular distributions.

It is clear from this formula that the asymmetry parameter A gives directly, under our semplifications, the partial contribution of the electric dipole transition to the cross section.

To perform our measurement we have used the partially polarized gamma ray beam produced by the coherent bremsstrahlung of electrons in a diamond crystal(4). The liquid Helium target has been the same one used in the previous experiment and is described in ref. (5).

The detection apparatus consisted of a NaI(Tl) crystal and two thin plastic scintillators in the deuteron channel. The proton telescope had three plastic scintillators and aluminium absorbers. Bidimensional analysis of the pulses in the NaI crystal and the plastic scintillator in front of it permitted identification and counting of the deuterons emitted in coincidence with a proton on the other side of the target.

The result of this preliminary measurement is the following:

$$A = 0.36 \pm 0.08.$$

at a CMS angle of 90^{o} and a gamma ray energy around 260 MeV.

This result indicates, under our oversimplified assumptions, that the M1 contribution is comparable (and probably larger) to E1. This fact suggests that more emphasis should be placed in the future on theoretical calculations which take into account higher multipoles and do not limit themselves to E1 transitions only.

It is pleasure to thank Dr. A. Costanzi and Dr. A. Marino for their intelligent collaboration in the setting up of the apparatus and the first data taking period.

REFERENCES. -

(1) - P. Picozza, C. Schaerf, R. Scrimaglio, G. Goggi, A. Piazzoli and D. Scannicchio, Nuovo Cimento 55A, 206 (1968).
(2) - P. Picozza, C. Schaerf, R. Scrimaglio, G. Goggi, A. Piazzoli and D. Scannicchio, Lett. Nuovo Cimento 2, 445 (1969).
(3) - H. Bock, Thesis (1969), unpublished.
(4) - G. Barbiellini, G. Bologna, G. Diambrini and G. P. Murtas, Phys. Rev. Letters 9, 396 (1962).
(5) - I. Modena, V. Montelatici and F. Scaramuzzi, Nuclear Instr. and Meth. 44, 175 (1966).