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Photoproduction of Neutral Pions in the Energy Region 400–630 MeV

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1. Introduction

We present here some preliminary results on the differential cross section for the photoproduction of single neutral pions, i. e. for the reaction

$$\gamma + p \rightarrow \pi^\circ + p \qquad (1)$$

in the energy region between 400 and 630 MeV, at an angle of 135° of the π° in the c.m.s.

This is the first part of a research program devoted to a systematic measurement in an energy region which is still rather unknown and which recently arose new interest.

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In fact, the experimental data on π-N scattering [1] have provided evidence that the total elastic cross section in the T = 1/2 state shows a "shoulder" at around 430 MeV kinetic energy of the incident pions.

Furthermore the phase-shift analysis of the π-N scattering in this energy region indicates as a possible explanation of this fact the presence of a resonant state $P_{1/2\,1/2}$.

This makes this energy region of the π-N system very interesting, and suggests to study it in different reaction channels.

In this regard, the process (1) may play an important role in the study of the elastic channels, due to its semplicity from the point of view of the electric charge involved (absence of the photoelectric term).

2. Experimental equipment and results

The experimental set-up is shown in Fig. 1.

The γ-ray beam of the Frascati Electron-Synchrotron hits a cylindrical liquid hydrogen target 7,4 cm in diameter and is monitored in a Wilson quantameter [2].

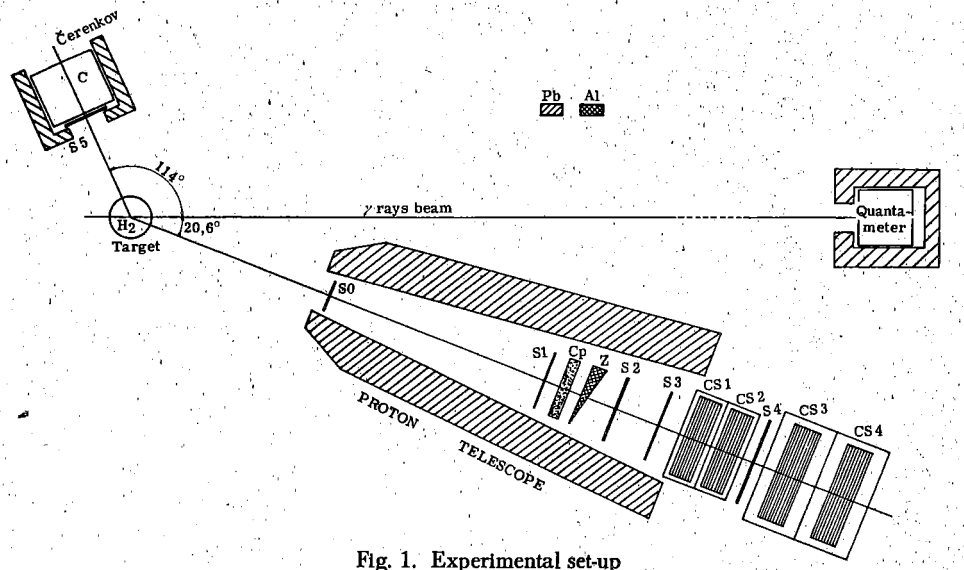

Fig. 1. Experimental set-up

The proton channel consists of scintillation counters and spark chambers; C is a total absorption lead glass Cerenkov counter and detects the π^0's.

The neutral pion photoproduction is detected by the coincidence between a proton in the proton channel and a γ-ray in the Cerenkov counter C.

The problem of the extraction of the cross section for the process (1) through the efficiency of detection of C and the usual corrections and normalizations is a rather standard well known procedure.

With the apparatus shown we have succeded in having a rather fast collection of data and a high resolution. These good conditions descend rather obviously from the large solid angle of the telescope and the high energy resolution of the spark chambers (52 Aluminum plates 3 mm thick to measure the range of the protons).

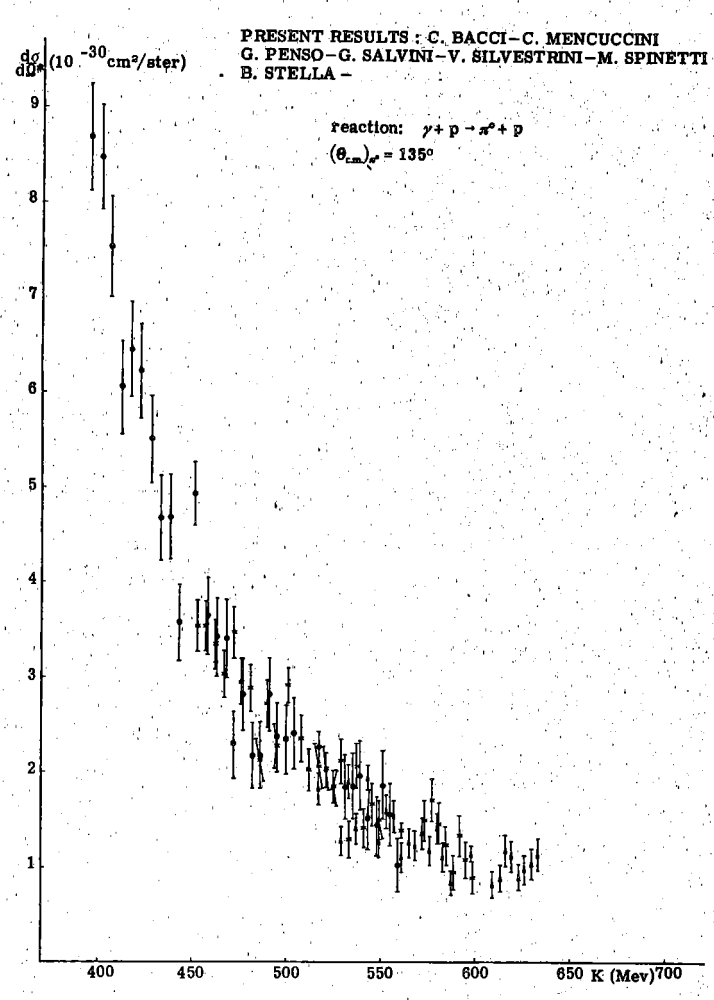

Fig. 2. Values of the differential cross section at 135° for the process $\gamma + p \rightarrow \pi^0 + p$ as obtained in three different series of measurements. In abscissae the energies of the incident photons are reported

As far as the experimental results are concerned in this first part of the experiment through the whole energy region explored the c.m. angle of emission of the pion is practically constant around a value of $134° \pm 2°$.

The γ-ray energy resolution of the experimental points is of the order of ± 4 MeV.

In Fig. 2 we report separately the values of differential cross section as obtained from three different series of measurements we have done; the difference among the three series consists essentially in the choice of the absorbers in the telescope and the maximum energy of the γ-ray beam.

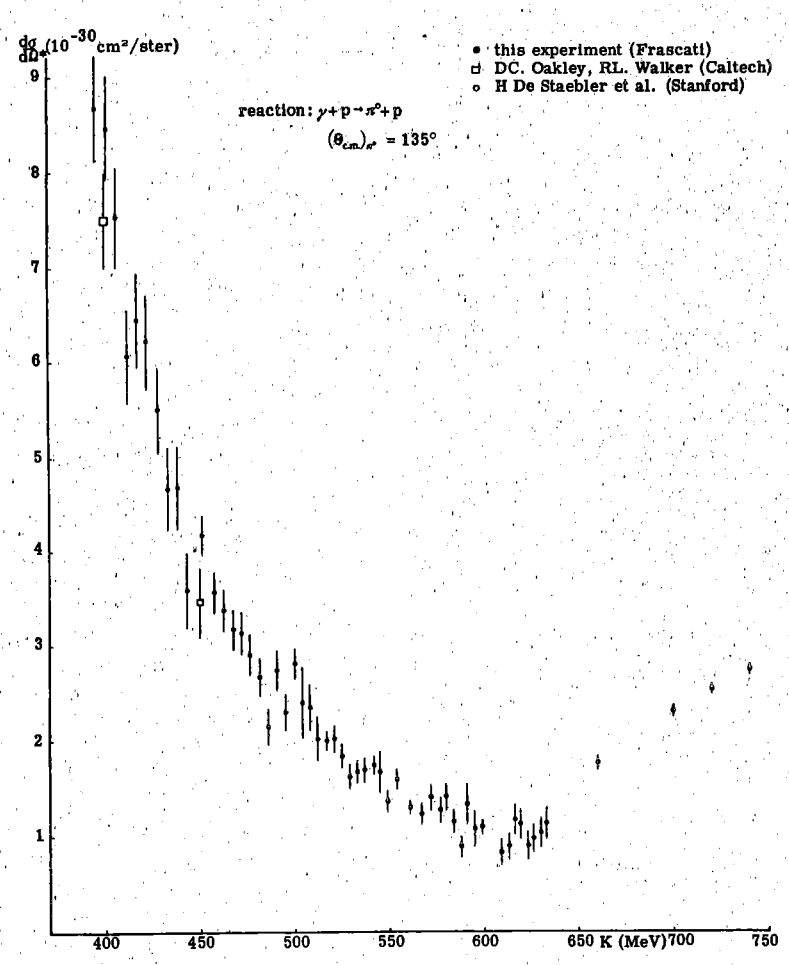

Fig. 3. Final results for the differential cross section at 135° c.m. for the process $\gamma + p \rightarrow \pi^\circ + p$

Combining the points at the same energy from the three different series the results shown in Fig. 3 are obtained. In the same figure we report also almost all the previous results available before our measurements.

3. Conclusions

Our results exhibit two characteristic features:
a) The energy distribution joins rather well the decrease of the first resonance and the rise of the second one. In the energy interval we explored with high resolution no evident shoulder or peak or bump appears dearly.
b) The $P_{1/2\,1/2}$ resonance, whose width is very large, of the order of ± 100 MeV, would not appear in our data as a sharp bump, but rather as a flat background rising the level of the cross section around 500–600 MeV where is the valley of the distribution.

Just in this last respect the low experimental value of the minimum ($\sim 1\,\mu$b/sr) leaves a quite little room for an high amplitude of $P_{1/2\,1/2}$, when any reasonable space is left to the tails of the neighbouring resonances.

In conclusion, apart from possible interferences, our preliminary results tend to show that the $P_{1/2\,1/2}$ should have a small contribute, if any, in single neutral pion photoproduction.

However, to get more definite conclusions, measurements at various angles are in progress in Frascati with our group.

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Elastic Photoproduction of π° Mesons from Deuterium in the Energy Range from 500 MeV to 700 MeV

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Elastic photoproduction of π° mesons from deuterium has been used to measure the isotopic vector part of the photopion production amplitude from nucleons around the $\left(\frac{1}{2}, \frac{3}{2}\right)$ second resonance. Since the deuteron remains intact after the reaction, the elastic π° production is a coherent superposition

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