Angular Distributions of Pions from
\( \gamma + p \rightarrow \pi^+ + n \)

at Photon Energies between 220 and 425 MeV

G. Fischer*, G. von Holtey*, G. Knop and J. Stümpfig

Physikalisches Institut der Universität Bonn

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Earlier measurements of the differential cross section for \( \pi^+ \) photoproduction on hydrogen at forward angles have been extended up to 180°. The pions were analysed in angle and momentum by a magnetic spectrometer. Angular distributions have been measured at 16 energies between 220 and 425 MeV. Most of them cover the region between 15° and 180° in steps of 5 degree with a statistical error of about 3%. Moravcsik equivalent fits give a very good representation of the data.

1. Introduction

Recent theoretical calculations of photoproduction of pions on nucleons\(^1\) show discrepancies between theory and experiment which are outside experimental uncertainties. In order to get a better understanding of these deviations a simultaneous multipole analysis of two or more reactions using the Watson theorem will facilitate the theoretical interpretation. Looking at the experimental data, \( \pi^0 \) production on protons has been investigated thoroughly in recent time\(^2\) whereas the \( \pi^+ \) production on protons showed various inconsistencies. The aim of the present experiment has been to improve this situation.

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\* Now at CERN, Geneva.


2. Experimental Method

This experiment has been performed with the same experimental method that has been developed for a previous experiment on $\pi^0$ photoproduction. As the latter has been described in detail elsewhere, we will repeat here only the main features of the experimental method.

The general arrangement of this experiment may be seen in Fig. 1. The $\pi^+$ mesons are produced in a liquid hydrogen target by a high energy bremsstrahlung beam from the Bonn 500 MeV electron synchrotron. The pions were analysed in angle and momentum by a magnetic spectrometer and detected by four scintillation counters. The total angular aperture of this system was 0.71 msr, the momentum acceptance $\pm 2.7\%$ and the relative error in momentum $\Delta p/p = \pm 5 \times 10^{-3}$.

The separation of pions from protons was achieved by time-of-flight measurements between the scintillation counters 1 and 3 and by pulse height analysis in counters 3 and 4. Positrons coming from pair production were detected by a threshold gas-Čerenkov counter ($\eta_{\text{max}} = 0.997$) in the region of small $\theta_L$ and were measured directly at larger $\theta_L$ by changing the polarity of the spectrometer magnet. The $\pi^+$-contamination as well as the loss of $\pi^+$ mesons resulting from the $\pi^+$-decay were computed by a Monte Carlo method.

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Fig. 1. Experimental lay out. S(1) to S(4) scintillation counters