ANGULAR DISTRIBUTIONS OF THE ASYMMETRY OF THE REACTION $\gamma n \to \pi^- p$ ON A LINEARLY POLARIZED BEAM OF PHOTONS WITH ENERGIES 300, 400, AND 500 MeV

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Submitted 22 September 1972
ZhETF Pis. Red. 16, No. 9, 535 - 537 (5 November 1972)

To study the isotopic structure of the multipole amplitudes of the single pion photoproduction it is necessary to have rather complete experimental data on the photoproduction of charged and neutral pions both on protons and on neutrons. The bulk of the presently available data pertain to reactions on protons.

The present paper is devoted to the reaction

$$\gamma + n \to \pi^- + p, \tag{1}$$

which has been little studied to date. A study of this reaction permits a more detailed investigation of the isotopic structure of the multipole amplitudes, and also casts light on the role of the P_{11} resonance in single photoproduction processes [1].

In our experiment, we measured the angular dependences of the asymmetry of the π^--meson production cross section in the reaction

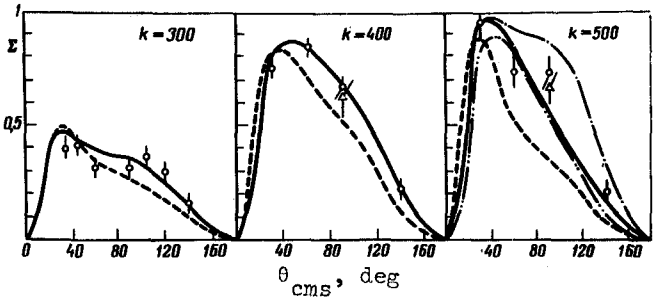
$$\gamma + d \to \pi^- + 2p. \tag{2}$$

There are no analogous data in the literature. The asymmetry $\Sigma = (\sigma_\perp - \sigma_\parallel)/(\sigma_\perp + \sigma_\parallel)$ (where $\sigma_\perp$ and $\sigma_\parallel$ are the pion production cross sections for perpendicular and parallel directions of the photon polarization vector relative to the reaction plane) is a very sensitive test for the selection of solutions of multipole analyses and for verification of various models [2].

The experiment was performed on a linearly-polarized photon beam from the diamond single crystal of the 2-GeV electron accelerator of our Institute. The photon beam was shaped by two lead collimators and a clearing magnet. The beam intensity was measured with a Wilson quantameter. A liquid-deuterium target was used. The π^- mesons were registered with a magnetic spectrometer and a scintillation-counter telescope. To take into account the background due to π^--meson photoproduction on protons, we measured the π^--meson yield from a liquid-hydrogen target. To determine the corrections that must be introduced into the asymmetry to allow for the use of deuterium as a neutron target, we measured the asymmetry in the reactions

$$\gamma + p \to \pi^+ + n \text{ and } \gamma + d \to \pi^+ + 2n \tag{3}$$

on liquid-hydrogen and deuterium targets, respectively. It turned out that the asymmetry in the π^+-meson yields from both targets is approximately the same. One can therefore hope that the asymmetry of the photoproduction of π^- mesons in the reaction (2) will not differ noticeably from the asymmetry in reaction (1). The table and the figure show the measured asymmetries



Asymmetry of π^-meson photoproduction in the reaction $\gamma + d \to \pi^- + 2p$; o - our data, Δ - data of Japanese group [3].

Asymmetry of π^--meson photoproduction cross section in the reaction $\gamma + d \to \pi^- + 2p$

k_{lab}, MeV \ θ_{cms}, deg	30	35	45	60	90	105	120	140
300	– –	0,40 ±0,04	0,41 ±0,06	0,31 ±0,04	0,31 ±0,02	0,37 ±0,03	0,30 ±0,03	0,26 ±0.03
400	0,75 ±0,05	– –	– –	0,85 ±0,05	0,66 ±0,04	– –	– –	0,22 ± 0,05
500	0,95 ±0,08	– –	– –	0,75 ±0,09	0,75 ±0,09	– –	– –	0,22 ±0,06

in reaction (2) at photon energies 300, 400, and 500 MeV. The energy and angular resolutions were of the order of 17% and 13°, respectively.

The data agrees well with the results of a Japanese group [3] and not as well with the measurements of [4].

The curves on the figure are the results of various multipole analyses. The dashed curve is the result of the B.D.W. analysis [1] based on the dispersion relations with the resonances P_{11} and D_{13} included. The dash-dot line represents the analysis of a Japanese group [5], in which the free fitting parameters were chosen to be the amplitudes $M_{1-}^{(0,1)}$, $E_{2-}^{(0,1)}$, and $M_{2-}^{(0,1)}$, while the remaining amplitudes were taken mainly from the B.D.W. analysis.

The dash and double dot curve represents Schmidt's analysis [6], which contains purely Born terms and the P_{33} resonance, the effect of which was taken into account only by the imaginary part of the amplitude M_{1+} in the dispersion integral. The continuous curve represents Schwela's analysis [7], which is based on dispersion relations with six fitting constants. This analysis is closer to our data than all the others.

[1] F.A. Berends, A. Donnachie, and D.L. Weaver, Nucl. Phys. B4, 54 (1968).
[2] D. Schwela, Z. Phys. 221, 158 (1969).
[3] K. Kondo, T. Nishikawa, T. Suzuki, et al., J. Phys. Soc. Japan 29, 13 (1970).
[4] F.F. Liu, D.J. Drickey, and R.F. Mozley, Phys. Rev. 136, 1183 (1964).
[5] K. Kondo, T. Nishikawa, T. Suzuki, et al., J. Phys. Soc. Japan 29, 30 (1970).
[6] W. Schmidt, Z. Phys. 182, 76 (1964); G. Hohler and W. Schmidt, Ann. Phys. (USA), 28 (1964).
[7] D. Schwela, Bonn Univ. P-12-86 (1970).