Photoproduction of π^+ Mesons from Hydrogen Near Threshold*

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An experiment has been undertaken with the purpose of investigating, in detail, the photoproduction of π^+ mesons from hydrogen near the meson threshold.

The procedure was to use Ilford G-5 nuclear emulsions as detectors of mesons produced in a liquid hydrogen target by the x-ray beam of the Illinois 300-Mev betatron. Figure 1 shows a schematic diagram of the experimental setup. The target proper was a vertical cylinder $1\frac{1}{4}$ in. in diameter. In the region of the x-ray beam, the cylinder walls were 0.0005-in. brass. These walls contributed to a total meson background which was less than 5 percent. Outside the vacuum shell, plate holders constructed of light materials were distributed. Plates were mounted so that mesons from the target came through 0.017-in. aluminum windows in the vacuum shell, and entered at a glancing angle of about 5°. The low-energy limit for meson detection in the plates was taken to be 5 Mev. This corresponds to a 9–10 Mev meson produced in the target. Particles whose tracks were observed in the emulsions were identified by measuring the relative grain density and angular deviations of the tracks. The energy of each meson identified by this procedure was taken to be the mean of the two energies thus obtained. Energies of stopping mesons were calculated from their ranges. Scattering and grain counting calibrations were established for each plate from measurements made on stopping mesons.

Plates were exposed at laboratory angles ranging from 30° to 150°. Three independent types of exposures were made during the course of the experiment. Most runs were made with no absorber in front of the plates; some were made with absorbers, and finally some pellicles were exposed. These were immersed in a sea of emulsion so arranged as to constitute detectors in an infinite homogeneous medium.

In the analysis of the plates, surface scanning was employed. For the pellicles, volume scanning for $\pi-\mu$ decays was used. The three different methods were used as a check on inefficiencies inherent in the various scannings. Consistent results have been obtained for all mesons having more than twice minimum grain density on fully developed plates.

Energy measurements made on individual tracks by scattering and grain count usually differed by less than 5 Mev. Each calculated meson energy is believed to have less than 10 percent probable error.

The differential cross sections per unit solid angle in the center-of-mass system, measured at 175, 185, and 195 Mev photon energy in the laboratory system are shown in Table I listed under the center-of-mass angles at which they were obtained. The indicated errors are statistical.

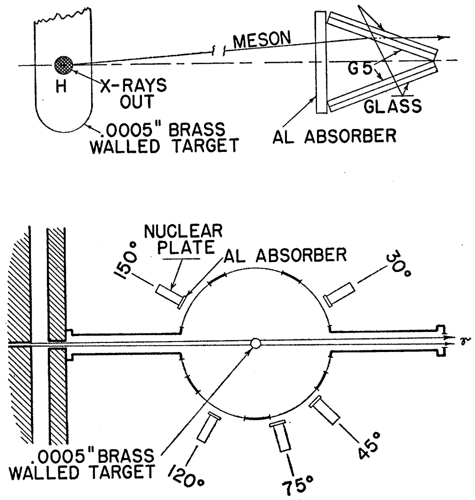

FIG. 1. Schematic diagram of liquid target and nuclear emulsion detectors.

Previous results[1–3] at higher energies, considered in the light of current theoretical proposals,[4,5] may be interpreted as a combination of S and P wave emission of the mesons. It is clear from the data in Table I that at these low energies an interpretation of the results can be given in terms of a predominant S wave. This aspect of the angular distribution is further borne out by a rough check of the momentum dependence of the cross sections at 90° as shown in Table II. It is apparent here that the momentum dependence is very closely linear and therefore is consistent with the S-wave interpretation.

A more detailed discussion of these results will soon be forthcoming.

TABLE I. Cross section as a function of lab energy and c.m. angle.

E_γ, Mev \ Θ	$(d\sigma/d\Omega^*)\times10^{29}$ 40°	59°	93°	123°	148°	159°
175		0.61±0.07	0.64±0.04	0.64±0.07		
185	0.60±0.14	0.63±0.15	0.69±0.08	0.74±0.06	0.85±0.13	0.82±0.08
195	0.79±0.17		0.90±0.07	1.09±0.1	0.99±0.14	0.90±0.12

TABLE II. Cross section *vs* lab energy and meson c.m. momentum.

E_γ	$\frac{d\sigma}{d\Omega^*}$	$\frac{d\sigma}{d\Omega^*}\left(\frac{m_0c^2}{pc}\right)$	$\frac{d\sigma}{d\Omega^*}\left(\frac{m_0c^2}{pc}\right)^3$
165	0.48×10^{-29}	1.35×10^{-29}	10.8×10^{-29}
175	0.64×10^{-29}	1.31×10^{-29}	5.45×10^{-29}
185	0.69×10^{-29}	1.16×10^{-29}	3.24×10^{-29}

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[1] J. Steinberger and A. S. Bishop, Phys. Rev. **86**, 171 (1952).
[2] Goldschmidt-Clermont, Osborne, and Winston, Phys. Rev. **91**, 468 (1953).
[3] Bacher, Kick, Peterson, Teasdale, Tollestrup, Walker and Worlock, Phys. Rev. **92**, 1090 (1953).
[4] K. A. Brueckner and K. M. Watson, Phys. Rev. **86**, 923 (1952).
[5] B. T. Feld, Phys. Rev. **89**, 330 (1952).

Nuclide V^{53}†

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A search for the nuclide V^{53} was made by bombarding separated Cr^{53} as Cr_2O_3 with neutrons in the pile at Oak Ridge for 16 hours. The isotopic composition of the separated Cr^{53} was as follows: Cr^{54}, 1.7 percent; Cr^{53}, 92.1 percent; Cr^{52}, 5.7 percent; Cr^{50}, 0.5 percent. The nuclear reaction expected was $Cr^{53}(n,p)V^{53}$.

The sample was dissolved in concentrated HCl and 4 mg of vanadium carrier added. The solution was evaporated nearly to dryness and 10 ml of 4 percent H_2SO_4 added. This solution was then cooled in an ice bath and 5 drops of 6 percent cupferron