$\pi^{\pm}$-p Elastic Scattering at 30 Mev*

G. GIACOMELLI†
Department of Physics, University of Rochester, Rochester, New York
(Received July 16, 1959)

Differential scattering cross sections in hydrogen for (30±1.5)-Mev positive and negative pions have been measured at the two center-of-mass angles of 82 and 99.9 degrees.

The cross sections for positive pions in mb/sterad in the center-of-mass system are 0.435±0.028 and 0.590±0.030; for negative ones, 0.268±0.028 and 0.239±0.021, respectively.

DIFFERENTIAL scattering cross sections in hydrogen for (30±1.5) Mev positive and negative mesons have been measured at the two laboratory angles of 72½ and 90 degrees. The 30-Mev external pion beam available at the Rochester 130-in. synchrocyclotron laboratory was focused both by the fringing field and a deflecting magnet. The beam was defined and counted by a double coincidence telescope consisting of the two plastic scintillation counters 1 and 2 of Fig. 1. The beam so defined was quite parallel and it had a maximum cross-fire angle of 4°. The positive pion beam had a 6% muon-positron contamination and an average double counting rate of 80 000 mesons a minute through a 1-in. diameter disk-shaped counter 2. By reversing the magnetic fields one obtained the negative beam which had a 12% muon-electron contamination and an average double rate of 25 000 mesons a minute.

The liquid hydrogen scattering chamber (Fig. 1) was specifically designed for 90° scattering. Its shape is cylindrical and the beam comes along its axis. The cylinders are made of stainless steel foils silver-soldered to shape. The inner cylinder is of 0.002-in. foil while that of the outer is of 0.005-in. foil. The separation between the two cylinders is $\frac{3}{16}$ in. 0.002-in. beryllium-copper foils form end windows.

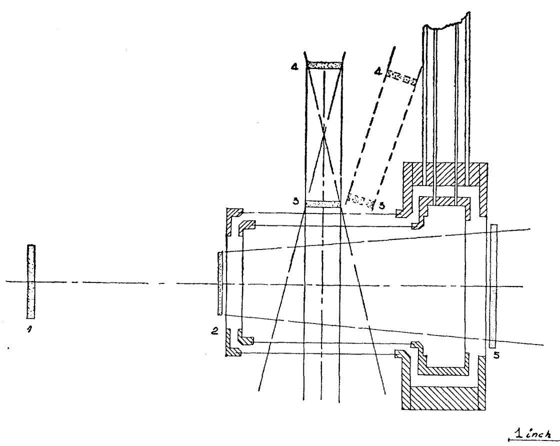

FIG. 1. Geometry used for 90° and 72½° scattering experiments.

The geometry is the semicylindrical-symmetry, no-wall-scattering geometry typical of other Rochester measurements[1] (Fig. 1). Counters 3 and 4 define the solid angle and the angular resolution function (which is of a triangular shape symmetric about the nominal scattering angle). Counter No. 3 has a $\Delta\varphi=290°$ while counter No. 4 has a $\Delta\varphi=240°$ and thus defines the solid angle in the φ direction. Counter No. 4 was not too uniform in pulse height over its whole extent but was used only as a coincidence crystal. Counter 5 is used as an anticoincidence to reduce the random background. A coincidence-anticoincidence $1234(\overline{125})$ opens a gate which allows the signal from counter 3 to pass to the 20-channel pulse-height analyzer.

Figure 2 shows the data obtained with the target full and the target empty as displayed by the 20-channel pulse-height analyzer. Signal to noise ratios up to 12 to 1 were achieved. The results, corrected for beam contaminations, absorptions, decays, efficiencies, energy dependence, and charge exchange scattering for negative mesons, are given in Table I, where θ_l is the laboratory scattering angle; $\theta_{l\,\min}$ and $\theta_{l\,\max}$ are, respectively, the minimum and maximum scattering angles accepted by the detecting telescope; $\theta_{\mathrm{c.m.}}$ is the center-of-mass scattering angle; Ω_{eff} is the effective solid angle integrated along the beam axis and taking into account the known distribution of incident beam intensity across the scattering region; S/N is the signal to noise ratio defined as $(F-E)/E$, where $F=$counts with target full and $E=$counts with target empty.

TABLE I. The results expressed in the laboratory and in the center-of-mass system. $\theta_{l\,\min}$ and $\theta_{l\,\max}$ give the total angular spread, Ω_{eff} is the effective solid angle $[\int\Omega(\rho,z)dz]$ averaged over the target in steradians-inches, and S/N is the signal to noise ratio.

	Scattering angles (degrees) laboratory			c.m.			Hydrogen cross section (10^{-27} cm²/sterad)	
π	θ_l	$\theta_{l\,\min}$	$\theta_{l\,\max}$	$\theta_{\mathrm{c.m.}}$	Ω_{eff}	S/N	$(d\sigma/d\Omega)$ lab	$(d\sigma/d\Omega)$ c.m.
+	72½	60	85	82	0.417	4.5	0.475±0.031	0.435±0.028
−	72½	60	85	82	0.417	3	0.292±0.031	0.268±0.028
+	90	76	104	99.9	0.566	11	0.579±0.029	0.590±0.030
−	90	76	104	99.9	0.566	6	0.235±0.020	0.239±0.021

* Based upon a thesis submitted to the Graduate School of the University of Rochester in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

† Now at Istituto di Fisica dell'Università di Bologna, Bologna, Italy.

[1] Barnes, Rose, Giacomelli, Ring, Miyake, and Kinsey, this issue [Phys. Rev. 117, 226 (1960)].

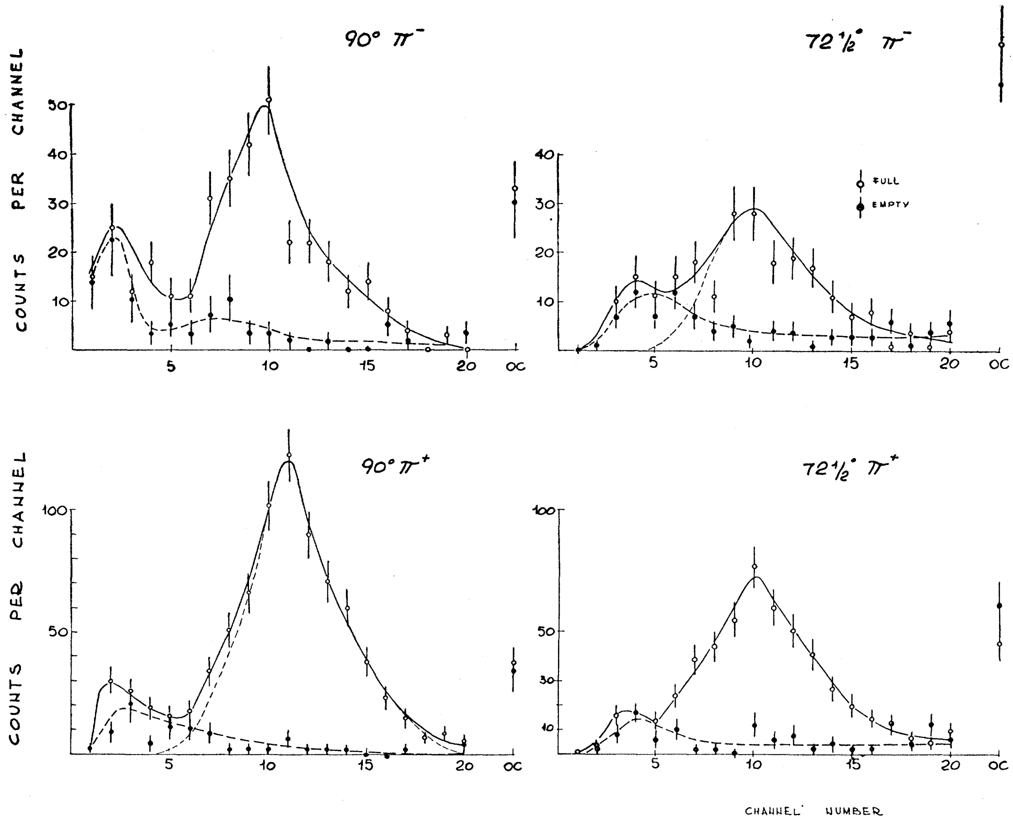

FIG. 2. Results with the target full and empty as displayed in the 20-channel pulse-height analyzer.

The errors are standard deviations and include uncertainties in the corrections as well as those due to counting statistics.

All our results seem to be consistently high compared to the other recent Rochester data,[1–3] though still in reasonable agreement with them.

This work is part of a more complete one at 30 Mev; a phase shift analysis of the data will be carried out in the near future as soon as the measurements are completed.

[2] D. Miller and J. Ring, Atomic Energy Commission Report NYO-2168; Phys. Rev. (to be published).

[3] B. Johnson and M. Camac, Atomic Energy Commission Report NYO-2169 (to be published).

ACKNOWLEDGMENTS

The author is indebted to Dr. S. W. Barnes for guidance, to Dr. H. Winick and B. Rose for advices and to Mr. A. Wieber, K. Miyake, and K. Kinsey for assistance in taking the data. A Fulbright travel grant is gratefully acknowledged.