MEASUREMENT OF THE RECOIL PROTON POLARIZATION IN ELASTIC $\pi^- p$ SCATTERING AT $T_\pi = 410$ AND 492 MeV

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We report here results for the recoil proton polarization in negative pion-proton elastic scattering as measured with a carbon plate spark chamber. The results for positive pion scattering have been already published.[1] The experimental setup was described in reference 1. In the second part of the present paper will also be given preliminary results of a calibration run, made to verify the values adopted for the analyzing power of the chamber.

$\pi^- p$ polarization results.—(a) 410 MeV. Table I gives the results based on 20 000 elastic scattering events. The polarization has been computed by the maximum-likelihood method. The given value is that which maximizes the product[2]

$$\prod_{i=1}^{N} [1 + P_1 P_2(\theta_{2i}, T_{2i}) \cos\varphi_i].$$

Figure 1 shows the horizontal and vertical asymmetries obtained for each angular position of the chamber, and the average polarization.

(b) 492 MeV. For this energy, about 25 000 elastic events were selected. The results are given in Table II and Fig. 2.

At both energies the vertical asymmetries are consistent with zero and the measurements made with the chamber at right and at left of the beam are in good agreement.

Check of the analyzing power of the chamber.—The polarization in the proton-carbon elastic scattering at 220 MeV is known with high accuracy from measurements at Rochester.[3] The test was made with incident protons of this energy using an experimental setup similar to that for the pion-proton measurement. The hydrogen target was replaced by a carbon plate 1.7 cm thick. The chamber was placed at 11.5° relative to the incident beam and triggered for each proton interacting in the target

Table I. Polarization for $T_\pi = 410$ MeV. We give, for each interval of 0.1 in the cosine of the pion scattering angle in the c.m. system, the polarization as measured with the chamber at the right and at the left of the incident beam, and the average polarization. The error is statistical only and corresponds to the root mean square of the likelihood curve.

	Polarization		
$\cos\theta_\pi^*$	Left position	Right position	Average
−0.8	+0.515 ± 0.17	+0.265 ± 0.16	+0.38 ± 0.12
−0.7	+0.605 ± 0.105	+0.695 ± 0.09	+0.655 ± 0.065
−0.6	+1.0 ± 0.09	+0.83 ± 0.075	+0.91 ± 0.055
−0.5	+0.83 ± 0.075	+0.97 ± 0.075	+0.90 ± 0.05
−0.4	+0.725 ± 0.085	+0.72 ± 0.08	+0.72 ± 0.06
−0.3	+0.36 ± 0.09	+0.45 ± 0.08	+0.41 ± 0.06
−0.2	+0.08 ± 0.09	−0.03 ± 0.085	+0.02 ± 0.065
−0.1	−0.18 ± 0.10	−0.295 ± 0.085	−0.25 ± 0.065
0.0	−0.45 ± 0.12	−0.35 ± 0.095	−0.39 ± 0.075
+0.1	−0.665 ± 0.175	−0.55 ± 0.16	−0.60 ± 0.125
+0.2	−0.775 ± 0.27	0.435 ± 0.24	−0.585 ± 0.18
+0.3	−0.71 ± 0.41	−0.30 ± 0.40	−0.50 ± 0.31

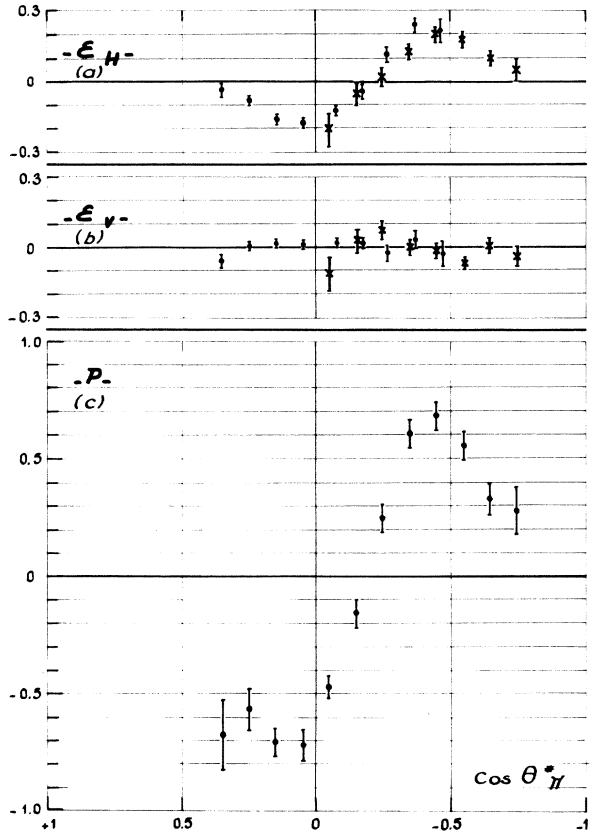

FIG. 1. Angular distributions of the asymmetries and of the polarization at 410 MeV. In (a) and (b), solid points represent the data obtained with the chamber at 43° and crossed points those with the chamber at 30°. The points in (c) represent the average polarization (column 4 in Table I).

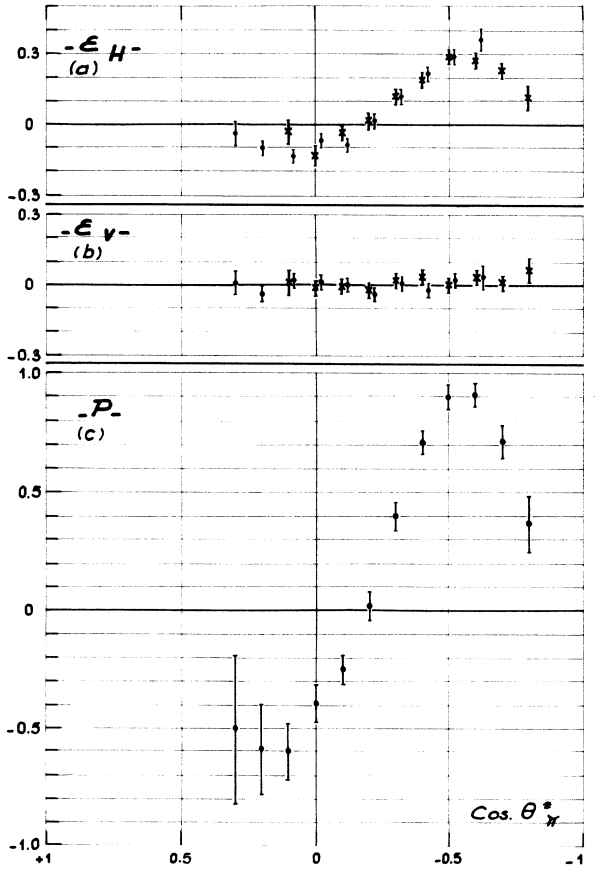

FIG. 2. Angular distributions of the asymmetries and of the polarization at 492 MeV. (Symbols are the same as in Fig. 1.)

Table II. Polarization for T_π = 492 MeV (as for Table I).

$\cos\theta_\pi^*$	Polarization Left position	Right position	Average
−0.75		+0.28 ±0.105	+0.28 ±0.105
−0.65	+0.425 ±0.15	+0.31 ±0.075	+0.335 ±0.065
−0.55	+0.60 ±0.12	+0.55 ±0.07	+0.565 ±0.06
−0.45	+0.625 ±0.12	+0.71 ±0.07	+0.685 ±0.06
−0.35	+0.625 ±0.12	+0.60 ±0.07	+0.61 ±0.06
−0.25	+0.165 ±0.10	+0.29 ±0.075	+0.245 ±0.06
−0.15	−0.04 ±0.10	−0.21 ±0.075	−0.15 ±0.06
−0.05	−0.675 ±0.08	−0.35 ±0.075	−0.47 ±0.05
+0.05	−0.76 ±0.095	−0.695 ±0.065	−0.715 ±0.06
+0.15	−0.86 ±0.105	−0.62 ±0.08	−0.70 ±0.06
+0.25	−0.44 ±0.18	−0.60 ±0.10	−0.56 ±0.095
+0.35	−0.06 ±0.40	−0.78 ±0.16	−0.67 ±0.15

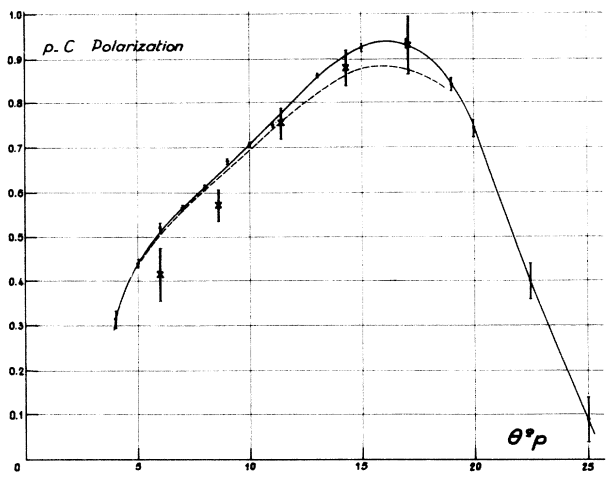

FIG. 3. Proton-carbon polarization at 220 MeV. Solid points: data of reference 3; crossed points: our results. The dashed line is the polarization calculated when taking into account some inelastic proton-carbon scattering.

and giving a charged particle in the spark chamber.

About a half-million events were scanned, and 60 000 measured and analyzed in the same manner as explained in reference 1. 18 000 events were retained in the angular range 5° to 18° for the first scattering. Here, the elastic selection criterion was $|T_C - T_\gamma| < 10$ MeV as the resolution was better in this experiment. (The notations are the same as in reference 1.) The computed polarization is shown in Fig. 3, and compared with the values given by Hafner.[3]

We have shown that our $\pi^{\pm}p$ polarization results are not affected by instrumental biases. However, some systematic error, due principally to the arbitrariness when interpolating in the table of the analyzing power of carbon, could still affect our results. Figure 3 shows that the corrected values of the polarization in the pion-proton experiments would not differ from the one given by more than 0.05.

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[1]P. Bareyre, C. Bricman, M. J. Longo, G. Valladas, G. Villet, G. Bizard, J. Duchon, J. M. Fontaine, J. P. Patry, J. Seguinot, and J. Yonnet, Phys. Rev. Letters 14, 198 (1965).

[2]In reference 1 some symbols were misinterpreted in this formula.

[3]E. M. Hafner, Phys. Rev. 111, 297 (1958).