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Polarization and C_{NN} Measurements between 0.5 and 1.2 GeV

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The polarization parameter P was measured at Saclay, at 7 energies, and the C_{NN} parameter at 3 energies. We used a polarized target and the extracted beam of the synchrotron "Saturne." The beam momentum was known at $\pm 1\%$. The beam intensity was limited at 10^7 protons in 400 sec.

DESCRIPTION OF APPARATUS

The polarized target was composed of 7 crystals of L.M.N. The polarization was on the average $|P| = 0.65$. An important point in this kind of experiment is to know the polarization as well as possible. In our case the nuclear magnetic resonance method gives us the value of polarization with a relative error of $\delta p/p \pm 6\%$. We assume that the polarization is uniform inside the target; the magnetic field of the coil being uniform inside the crystal. This hypothesis has been checked within 10% with nuclear diffusion method, which consists in analyzing 3 different points of the target and measuring the parameter $\mathcal{A}$ for these 3 regions. Furthermore at these energies we never saw any depolarization effect due to the proton beam.

RESULTS

We measured the polarization P at 7 energies and C_{NN} at 3 energies[1] (Tables I and II).

Polarization

Our results confirm the existence of a maximum of the polarization at $\simeq$730 MeV. At 609 MeV our angular distribution disagrees with the result of Betz *et al.*[2]: the maximum of the polarization decreases from 58% at 735 MeV to 40% at 1194 MeV.

Our results at 735 MeV agree with those of Dost[3] at 680 MeV. The value of C_{NN} at 90° in the center-of-mass system seems to decrease from about 0.80 at 735 MeV to about 0.50 at 1194 MeV. Our results favor solution 1 of the Hama–Hoshizaki analysis at 970 MeV.

The variation of the product $(d\delta/d\Omega)\times P$ can give some idea of the variation of the different triplet states in the pp interaction. We have expanded this product in terms of Legendre polynomials of the first kind: $(d\sigma/d\Omega)\times P = \sum C_n P_n{}^1$.

The presence of a $P_4{}^1$ term between 500 and 600 MeV (without $P_6{}^1$) is an indication of a strong interference effect between P waves and F waves. Above 600 MeV the F waves are important. The H waves themselves seem to be different from zero above 900 MeV due to the presence of a $P_8{}^1$ term.

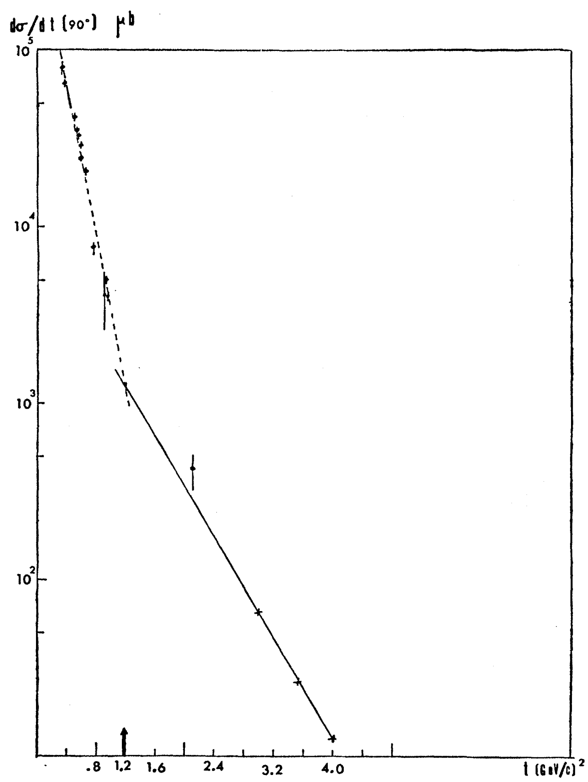

FIG. 1. Values of $d\sigma/dt$ (90°) versus t. The crosses and the continuous line correspond to the C. W. Akerlof *et al.* results.

At 1194 MeV the polarization is very low and compatible with zero between 75° and 90° scattering angles in the center-of-mass system. It is interesting to notice that at all energies above 1.2 GeV[4] the polarization is compatible with zero for values of t greater than $1.2(\mathrm{GeV})^2$.

[1] G. Cozzika, Y. Ducros, A. de Lesquen, J. M. Movchet, J. C. Raoul, L. Van Rossum, L. Deregel, and L. M. Fontaine, Phys. Rev. (to be published).
[2] F. W. Betz *et al.*, Report UCRL 11440.
[3] H. E. Dost, Report UCRL 11877.
[4] M. J. Longo, A. N. Homer, and O. E. Overseth, Phys. Rev. Letters **16**, 536 (1966).

TABLE I. Polarization.

$T_{p\ \mathrm{lab}}$ (MeV)	500			609			735			820			924			1029			1194		
	$\theta_{c.m.}$	$\alpha\%$	$\Delta\alpha$	$\theta_{c.m.}$	$\alpha\%$	$\Delta\alpha$	$\theta_{c.m.}$	$\alpha\%$	$\Delta\alpha$	$\theta_{c.m.}$	$\alpha\%$	$\Delta\alpha$	$\theta_{c.m.}$	$\alpha\%$	$\Delta\alpha$	$\theta_{c.m.}$	$\alpha\%$	$\Delta\alpha$	$\theta_{c.m.}$	$\alpha\%$	$\Delta\alpha$
	34.6	49.	3.5	30.3	44.0	8.0	6.7	11.8	16.0	23.2	43.5	3.5	23.4	34.0	1.8	25.9	34.5	4.0	13.8	12.4	3.3
	39.6	44.	5.4	30.8	36.0	9.1	±2.			28.0	46.5	3.5	28.0	40.0	1.7	30.9	35.5	2.0	±2.		
	43.2	43.	2.2	35.2	41.5	4.3	18.3	36.7	3.2	30.0	44.3	2.9	32.8	43.5	2.1	35.6	37.0	3.0	21.7	22.4	3.0
	43.8	49.	3.4	37.8	44.0	2.6	±2.			32.6	47.0	2.5	37.4	44.5	2.4	40.6	38.5	3.0	±2.		
	47.6	42.	3.2	39.8	41.5	2.9	25.4	49.0	3.0	34.6	44.3	1.6	42.4	38.5	2.4	42.0	40.5	2.7	23.9	35.0	9.0
	48.2	45.4	3.0	42.6	48.0	2.7	29.8	52.0	4.0	37.2	48.4	2.5	47.0	38.5	2.4	45.4	37.0	2.0	28.8	35.5	3.4
	51.7	37.5	2.2	44.1	45.0	2.6	34.2	53.0	4.0	39.4	45.5	1.2	51.4	37.0	1.8	46.6	36.0	2.5	29.0	39.0	2.5
	52.4	43.5	4.0	47.0	47.6	2.9	39.0	57.0	3.0	42.0	47.6	3.0				50.0	34.5	2.1	34.0	37.0	4.4
	56.0	34.5	2.2	48.7	45.0	1.9	43.6	55.0	3.0	43.8	47.5	1.6				51.2	33.0	2.0	34.2	40.5	1.6
	57.2	34.0	3.2	50.0	50.0	2.3	48.0	50.0	3.0	44.8	45.0	1.7				55.4	33.0	2.0	39.0	39.2	6.0
	60.0	33.0	2.	51.1	41.0	4.5	54.2	48.6	3.0	46.3	41.0	41.0				60.0	28.5	2.0	39.2	37.5	1.5
	61.0	30.0	2.	53.1	45.5	2.4	58.2	46.0	20.	48.2	43.5	2.2				64.6	26.5	3.0	43.9	38.5	3.7
	63.8	29.5	2.	54.2	50.0	2.4	62.4	40.4	3.0	49.3	45.5	1.5				67.2	28.7	5.0	44.2	38.5	1.7
	64.8	26.0	2.	57.3	41.0	2.5	66.2	36.4	3.0	52.8	46.5	1.6				68.7	21.0	6.0	45.7	31.0	3.6
	68.6	23.0	2.	58.4	46.5	2.5	70.4	29.5	5.0	53.6	44.5	1.6				71.6	21.0	2.0	49.0	33.7	4.0
	72.4	19.0	2.	62.2	40.0	3.6	74.4	26.8	1.5	58.4	41.0	1.7				75.6	8.0	3.5	49.0	33.0	1.9
	73.4	14.1	1.7	66.4	38.0	1.8				62.4	39.2	1.2				79.4	9.2	1.3	50.6	30.5	2.4
	76.0	12.5	1.3	67.4	34.5	2.0				63.6	33.0	1.7				83.2	9.0	2.0	53.8	32.0	2.5
	77.0	8.7	1.9	70.3	32.0	1.9				66.4	35.3	1.7				87.0	−1.7	4.6	54.0	24.5	2.0
	79.8	9.5	0.9	71.4	26.5	2.				67.4	33.5	2.5							55.2	27.5	2.4
	80.6	9.4	0.5	74.0	29.0	7.0				70.4	31.5	3.5							59.8	19.0	2.0
	83.4	6.0	1.8	75.1	21.0	2.				71.2	30.0	1.1							64.4	10.5	1.9
	87.2	1.5	1.6	78.9	16.0	1.5				75.4	22.5	1.7							65.3	8.5	2.4
	90.4	−3.1	1.3	82.6	12.2	1.5				79.2	15.5	1.6							68.5	8.5	3.0
	93.6	−7.0	0.5	86.1	2.9	1.5				82.9	10.0	3.6							69.6	8.0	2.8
				89.6	−0.6	2.0				86.6	5.6	8.5							73.7	2.0	3.5
																			77.8	3.5	1.7
																			81.6	−8.3	2.5
																			85.4	−1.6	7.0

TABLE II. C_{nn}.

$T_{p\ \text{lab.}}$ (MeV)	735			978			1190		
	$\theta_{\text{c.m.}}$	C_{nn}	$\delta_{c_{nn}}$	$\theta_{\text{c.m.}}$	C_{nn}	$\delta_{c_{nn}}$	$\theta_{\text{c.m.}}$	C_{nn}	$\delta_{c_{nn}}$
	92.1	0.88	0.21	77.4	0.79	0.17	92.2	0.44	0.32
	88.8	0.55	0.34	73.4	0.69	0.16	88.6	0.43	0.39
	85.5	0.88	0.29	70.0	0.39	0.27	85.0	0.50	0.27
	82.0	0.65	0.25	68.6	0.71	0.47	81.1	0.46	0.21
	78.5	0.83	0.23	64.3	0.44	0.27	77.1	0.37	0.22
	74.8	0.47	0.16	60.0	0.46	0.26	73.1	0.59	0.22
	71.0	0.66	0.19	55.6	0.62	0.20	69.0	0.38	0.15
	66.7	0.51	0.10	51.2	0.61	0.16	65.0	0.31	0.21
	62.3	0.45	0.09	46.7	0.72	0.15	60.2	0.47	0.14
	58.4	0.50	0.09	42.0	0.70	0.19	55.6	0.57	0.12
	53.9	0.43	0.09				50.8	0.43	0.11
	49.6	0.38	0.06				46.0	0.36	0.11
	45.3	0.53	0.06				41.2	0.48	0.10
	40.9	0.35	0.09				36.2	0.35	0.10
	35.5	0.46	0.11						

Akerlof *et al.*[5] measured the cross section at 90° at high energies (continuous line of Fig. 1). From the results at low energies (shown by the broken line in Fig. 1) one sees a discontinuity for a value of t around 1.2 (GeV)^2. On the other hand, the pp inelastic data at high energies[6] and the results of the magnetic form factor of the proton (DESY) seems to confirm that in the regions above 1.2 (GeV/c)^2, pp elastic scattering is due to a different phenomenon than at low momentum transfers.

With respect to this conclusion we can ask ourselves what is the meaning of a phase-shift above 1.2 GeV, and for this reason it seems more convenient to analyze pp elastic scattering data in terms of scattering amplitudes.

[5] C. W. Akerlof, R. H. Hieber, A. D. Krisch, K. W. Edwards, L. G. Ratner, and K. Ruddick, Phys. Rev. Letters **17**, 1105 (1966).

[6] E. W. Anderson *et al.*, this conference.