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PROPOSAL TO MEASURE POSSIBLE SPIN DEPENDENT EFFECT IN ($\pi^{\pm}$ - p) SCATTERING AT HIGH ENERGIES USING A POLARIZED TARGET

G. Coignet[*)], L. Dick, L. di Lella and P. Macq[**)]
CERN, Geneva

Recent experimental results[1)] have shown that it is difficult to interpret the high energy ($\gtrsim$ 7 GeV/c) $\pi^{\pm}$ p scattering at small momentum transfers ($0.05 \leqslant |t| \leqslant 0.5$ (GeV/c)^2) without the presence of a real part in the scattering amplitude.

In order to have a more complete description of the scattering amplitude, it is essential to know the behaviour of the spin dependent term as a function of both the energy and the momentum transfer.

If the incoming particles have spin 0, and the target has spin $\frac{1}{2}$, the scattering matrix has the form

$$M = a(s,t) + b(s,t)\,\vec{\sigma} \cdot \vec{n} \qquad (1)$$

where a and b are complex functions of the total energy s and the momentum transfer t; $\vec{n}$ is a unit vector perpendicular to the scattering plane.

In the case of ($\pi^{\pm}$ p) scattering from an unpolarized target, the presence of the spin dependent term b gives rise to a non vanishing polarization of the recoil proton, $\vec{P}_o$, through the relation

$$\vec{P}_o = \frac{2\,\mathrm{Re}\,(a^*b)}{|a|^2 + |b|^2}\;\vec{n} \qquad (2)$$

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*) on leave from Institut du Radium, Orsay (S. et O.) France.

**) University of Louvain, Belgium.

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If the target protons are polarized, the right-left asymmetry in the elastic scattering is related to $\vec{P}_o$ by the relation

$$\epsilon = \vec{P}_o \cdot \vec{P}_T \qquad (3)$$

where $\vec{P}_T$ is the target polarization.

We propose to measure $\vec{P}_o$ for both π^+ and π^-, from ~5 to ~15 Gev/c, in the momentum transfer interval from -0.090 to -0.500 $(\mathrm{GeV/c})^2$, using a polarized target. The apparatus will be substantially the same as recently proposed for a p-p scattering experiment[2]. The only modification will be an increase of the azimuthal acceptance by a factor of 10, using 10 horizontal scintillation counters, each subtending an azimuthal angle $\Delta\phi \sim 2^o$, to detect the recoil protons. Another similar set of counters will be also used in the scattered π detector, to define the scattering plane. The relevant experimental quantities which characterize this experiment are shown in Table I.

The apparatus will measure $\vec{P}_o$ simultaneously at 8 values of the momentum transfer t, for a given value of the incoming beam momentum. The absolute error obtained on will increase with increasing $|t|$, and will be in any case $< 3\%$.

The most important source of background is quasi-elastic scattering of the pions on the complex nuclei of the target crystal. Such background will be recorded and subtracted in the way described in ref.[2]. According to the results of other π-p[3] and p-p[4][5] scattering experiments, performed at values of t similar to the ones we propose, a factor ~ 4 should be expected for the ratio of hydrogen to non-hydrogen events.

MACHINE TIME REQUEST

Two weeks of parasitic time will be needed to set up the beam and test the detectors. If the beam intensity is $\gtrsim 10^5 \pi$/P.S. burst, two weeks will be necessary to perform the measurement of P_o at 4 different energies for a given sign of the pion charge. This includes running with a dummy target.

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TABLE I

Beam momentum (GeV/c)	$\Delta\theta_{\pi}^{lab}$ (mrad)	$\Delta\theta_{\pi}^{c.m.}$ (degrees)	$\Delta\theta_{p}^{lab}$ (degrees)	$\Delta\theta_{p}^{lab}$ (MeV)	Δt $(GeV/c)^2$	Number of events elastically scattered from H_2/day in the interval Δt*
5.0	61 - 146	12 - 28	65 - 79	50-265	0.09-0.5	67 500
8.0	39 - 89	9.5-21.5	66-79.5	50-265	0.09-0.5	58 500
10.0	31 - 71	8.5-19.0	67-79.5	50-265	0.09-0.5	56 000
12.0	25 - 60	7.5-17.5	67.5-80	50-265	0.09-0.5	54 000
15.0	19 - 47	6.3-15.5	68 - 80	50-265	0.09-0.5	52 000

* The following values are assumed :

Target length : 4.5 cm

Beam intensity : 10^5 π/machine burst

Azimuthal acceptance : 20^o

1 day = 3×10^4 machine bursts