EXPERIMENTS ON NUCLEON-NUCLEON SCATTERING WITH 280 MEV POLARIZED PROTONS

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In a previous paper[1] we reported our results on p-p scattering using polarized protons. In the framework of our general program of studying nucleon nucleon scattering, we would have liked to investigate n-p scattering with polarized neutrons; however, we are still unable to obtain highly polarized neutrons and the next best possibility is to bombard deuterons with highly polarized protons.[2]

Neglecting in first approximation the binding of the deuteron, the processes that occur in pd bombardment are p-p and p-n scattering in which a p-p pair or an n-p pair escapes at approximately 90° in the laboratory system. In addition to this there is elastic scattering of the protons. These processes are schematically represented in Fig. 1.

We have detected and measured processes (a) and (b) by coincidence techniques and we have also counted single neutrons and single protons.

In Figs. 2 and 2 we show the asymmetrical part of the cross section $P\sigma$.

$$P\sigma = \frac{1}{2}\left[\sigma\,(\theta, 0) - \sigma\,(\theta, \pi)\right] \qquad (1)$$

where $\sigma\,(\theta, \phi)$ is the differential cross section for a completely polarized beam scattering on an unpolarized target. The incident protons travel in the z direction and are polarized along the y axis. The quantity $P\sigma$ is computed from the relation

$$P\sigma = e\sigma_{\text{unpolarized}}/P' \qquad (2)$$

where P' is the polarization of the incident beam used. The deuterium scattering experiment yields e; P' = 0.73 is obtained from measurements of the asymmetry when the scattering is elastic and targets A and B are identical; $\sigma_{\text{unpolarized}}$ is assumed to be 3.75 mb/ster for p-p scattering,[3] and for n-p scattering it is taken from previous work.[4]

Figure 2 refers to the asymmetric part of the p-p scattering with some points taken from previously reported data[1] using a hydrogen target, and some points from p-p coincidence counting with a deuterium target(process (a)). Figure 3 refers to process (b), with data obtained partly by p-n coincidence counting and partly by counting neutrons alone, all from a deuterium target. Data on process (c), as well as the experimental description of the work and a detailed discussion, are to be given later.

The curves thus obtained give some information on nucleon-nucleon scattering. A first step in their analysis is to obtain from them whatever information is possible on phase shifts of the different partial waves.

By Fourier analysis of the asymmetric part of the cross section limited to the minimum number of harmonics necessary to fit the data we find:

$$(P\sigma)_{p-p} = 1.348 \sin 2\theta + 0.242 \sin 4\theta + 0.116 \sin 6\theta \qquad (3)$$

$$(P\sigma)_{n-p} = -0.016 \sin \theta + 0.958 \sin 2\theta + 0.324 \sin 3\theta + 0.366 \sin 4\theta \qquad (4)$$

The solid curves in Figs. 2 and 3 represent these equations. If the sixth harmonic term is omitted from Eq. (3) the fit is still fairly good; however, the fourth harmonic term is necessary in both Eqs. (3) and (4) to fit the data satisfactorily.

From the Fourier analysis it is possible to infer some conclusions on the phase shifts, as is to be shown in the following letter by Dr. B. D. Fried.

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REFERENCES

1. Chamberlain, Segrè, Tripp, Wiegand, Ypsilantis, Phys. Rev. 93, 1430 (1954). We use the same notation as in this paper.

2. Marshall, Marshall, Nagle and Skolnik have worked on the same subject. We thank them for communicating their results before publication.

3. Chamberlain, Segrè, Wiegand, Phys. Rev. 83, 923 (1951); Chamberlain, Pettengill, Segrè, Wiegand, Phys. Rev. 93, 1424 (1954).

4. Kelly, Leith, Segrè, Wiegand, Phys. Rev. 79, 96 (1950).

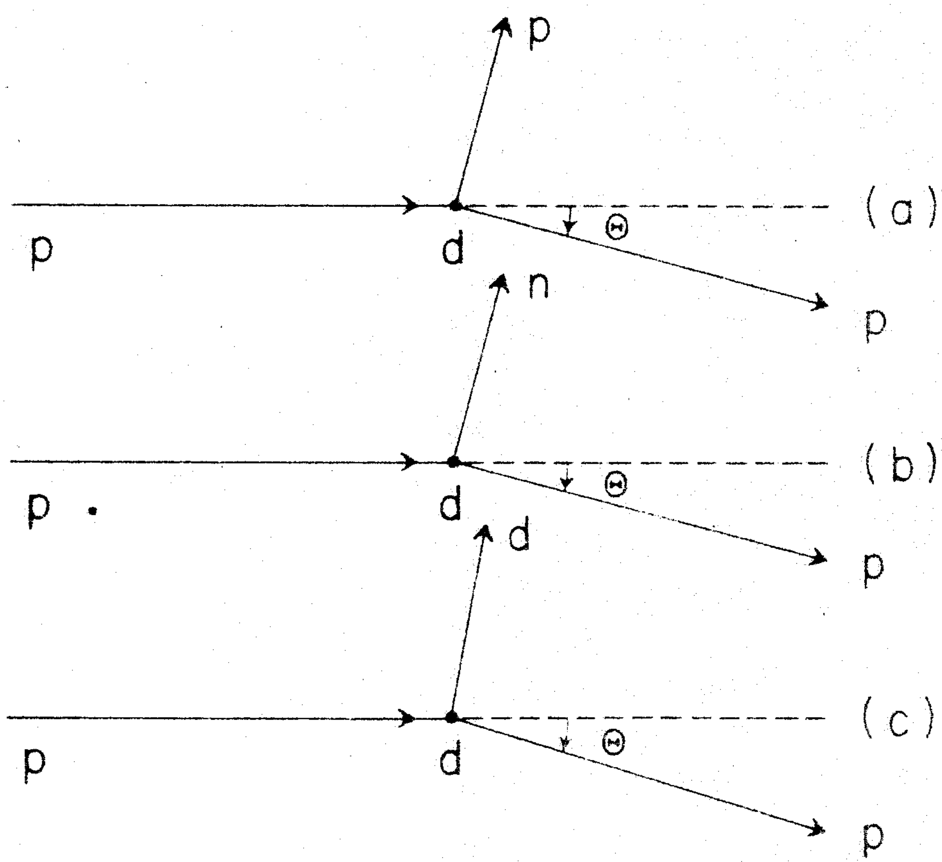
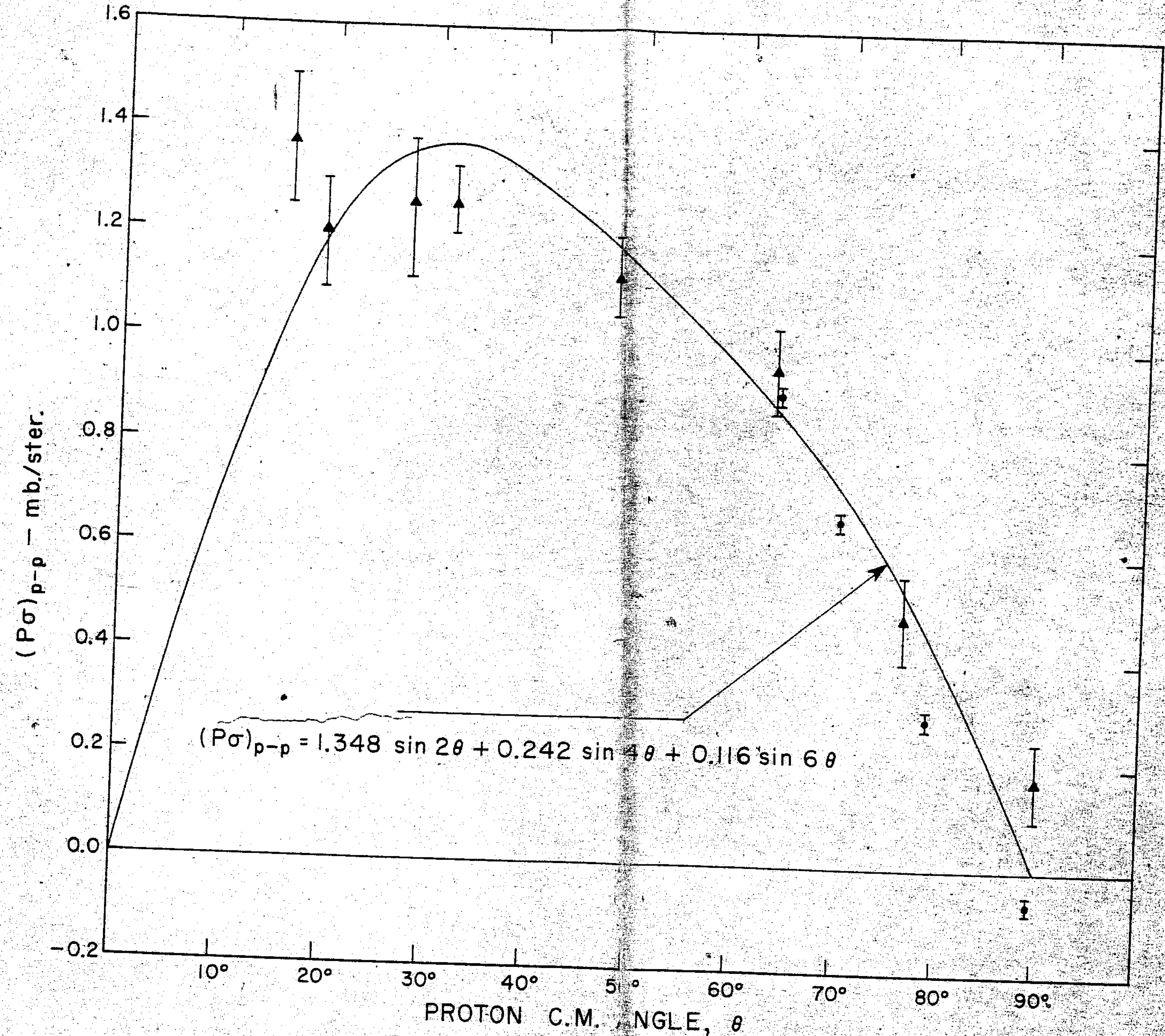
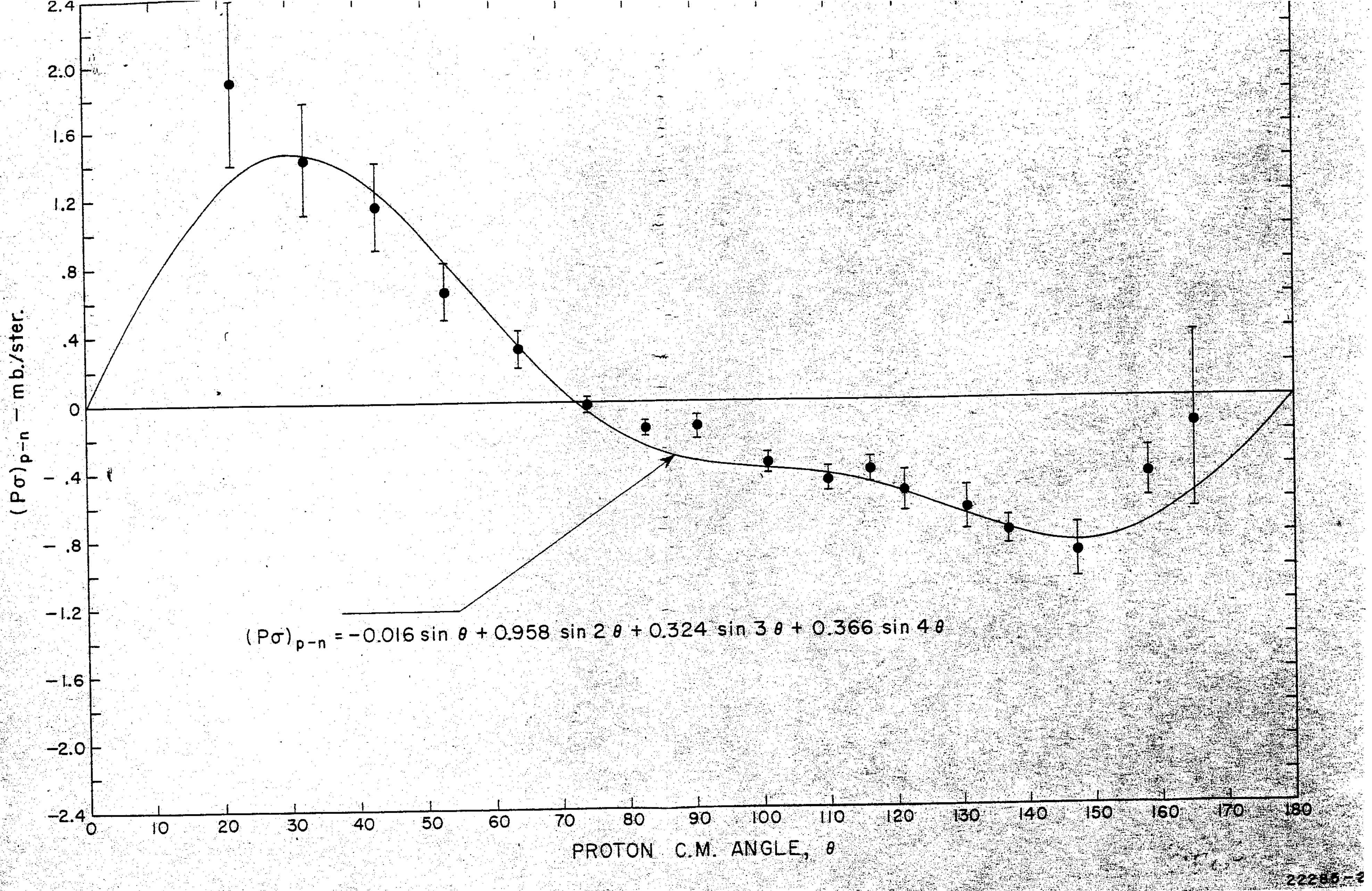


FIGURE 1



1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
$(P\sigma)_{p-p}$ — mb./ster.
$(P\sigma)_{p-p} = 1.348 \sin 2\theta + 0.242 \sin 4\theta + 0.116 \sin 6\theta$
10°
20°
30°
40°
60°
70°
80°
90°
PROTON C.M. NGLE, θ



(Pσ)p-n — mb./ster.
2.4
2.0
1.6
1.2
.8
.4
0
-.4
-.8
-1.2
-1.6
-2.0
-2.4
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
(Pσ)p-n = -0.016 sin θ + 0.958 sin 2θ + 0.324 sin 3θ + 0.366 sin 4θ
PROTON C.M. ANGLE, θ
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