I. Introduction

Over the last year or so, new and quite interesting polarization data have become available from various accelerators. I am going to review some of the results which look the most interesting to me, and discuss the interpretations one might give to them. I will try to point out areas where various people believe experimental results might be suggesting an important clue about the underlying theory. In these cases a definite prejudice must be taken in favor of some theory. One of the most popular prejudices among particle theorists these days is a belief in Quantum Chromo-Dynamics (QCD), a non-abelian gauge field theory of colored quarks interacting with massless vector gluons. It is hoped that the non-perturbative solutions to such a theory will provide an adequate description of both low and high energy strong interaction phenomena. Although this dream has not yet been realized, it is not so far fetched as to be ignored and holds the promise for a deeper understanding of the data we will be discussing. If the theory were correct, it could not help but provide an interpretation of the data we will be discussing which is quite different from the usual meson theory.

The papers I am to review fall into four categories, depending upon the incident beam energy: Very Low, less than about 10 MeV lab. kinetic energy; Low, between 10 MeV and 100 MeV; Intermediate, between 100 MeV and 2000 MeV; High, above 3 GeV/c lab. momentum (2000 MeV lab. kinetic energy). The physics issues in these regions differ, as do the experimental techniques. In all regions polarized beams and targets provide valuable tools for extracting the physics, and we can hope there will ultimately exist a unified understanding of all of these phenomena.

II. Very Low Energy

There were two contributions to this conference of very low energy data. One by K. Frank et al.¹ concerns the measurement of the component $A_{yy}$ of the spin correlation tensor for pp scattering at 10 MeV lab. kinetic energy, and $\theta_{\text{cm}} = 90^\circ$. The physics issue is the size of the tensor and spin orbit parts of the p-wave interaction; measurements...
of $A_{xx}$ and $A_{yy}$ allow the separation of these effects. The resultant values can then be compared against theoretical estimates based on one pion exchange (OPE).

The other contribution was by G. Bittner et al.\textsuperscript{2} on a polarization measurement in proton-proton scattering at 6.14 MeV. At the Delhi Conference, the p-wave phase shifts seemed to be fairly well sorted out\textsuperscript{3} at 10 MeV on the basis of the polarization data of Hutton et al.\textsuperscript{4} (see Table 1). They measured the analyzing power very accurately and were able to extract the three p-wave phase shift combinations. The two contributions from this conference on the subject don't contradict this previous analysis.

Table 1

<table>
<thead>
<tr>
<th>Ref.</th>
<th>$T_{\text{Lab}}$ (MeV)</th>
<th>$\delta(3P_0)$</th>
<th>$\delta(3P_{LS})$</th>
<th>$\delta(3P_T)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>J.D. Hutton et al.\textsuperscript{4}</td>
<td>10.0</td>
<td>$-0.003^\circ \pm 0.034^\circ$</td>
<td>$0.31^\circ \pm 0.11^\circ$</td>
<td>$-4.87^\circ \pm 0.33^\circ$</td>
</tr>
<tr>
<td>G. Bittner et al.\textsuperscript{2}</td>
<td>6.14</td>
<td>$-0.02^\circ \pm 0.008^\circ$</td>
<td>$0.11^\circ \pm 0.08^\circ$</td>
<td>$-2.58^\circ \pm 0.6^\circ$</td>
</tr>
<tr>
<td>P. Catillon et al.\textsuperscript{5}</td>
<td>11.4</td>
<td>--</td>
<td>$0.17^\circ$</td>
<td>$-8.6^\circ$</td>
</tr>
<tr>
<td>K. Frank et al.\textsuperscript{1}</td>
<td>10.0</td>
<td>--</td>
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</tbody>
</table>

The measurement of $A_{yy}$ uses a 10 MeV transversely polarized (normal to the reaction plane) proton beam from the Erlangen tandem accelerator, and scatters it off of a target polarized parallel or anti parallel to the beam polarization. By changing the sign of the beam and target polarization, one obtains the rates $\sigma(\uparrow\uparrow), \sigma(\uparrow\downarrow), \sigma(\downarrow\uparrow),$ and $\sigma(\downarrow\downarrow)$ from which

$$A_{yy} = \frac{\sigma(\uparrow\uparrow) + \sigma(\uparrow\downarrow) - \sigma(\downarrow\uparrow) - \sigma(\downarrow\downarrow)}{\sigma(\uparrow\uparrow) + \sigma(\downarrow\downarrow) + \sigma(\uparrow\downarrow) + \sigma(\downarrow\uparrow)}$$

can be constructed. Note at higher energies, this asymmetry is also called $A_{nn}$ and is equal to $C_{nn}$ by time reversal invariance or by parity conservation. At 90° c.m., since the polarization vanishes by particle symmetry, $A_{yy}$ can be (and is) determined without flipping the target spin.

In terms of the s and p wave S-matrix elements

$$R = e^{i\delta} \sin\delta,$$

a convenient expression at $\theta_{\text{cm}} = 90^\circ$ is (ignoring Coulomb corrections which are small at this energy and angle)

$$\frac{1+A_{yy}}{1-A_{yy}} = \frac{|R(3P_0) - R(3P_2)|^2 + \frac{9}{4}|R(3P_1) - R(3P_2)|^2}{|R(1S_0)|^2}.$$