A COMPARISON OF $\bar{p}p$ AND pp ELASTIC SCATTERING AT 90°

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Our study of low momentum antiproton-proton interactions in the momentum range 0.7 to 2.4 GeV/c has yielded differential cross sections for the elastic channel. This experiment was part of a programme performed at the CERN PS, in which full angular distributions ($-.95 < \cos\theta^* < .95$) were determined for the reactions

$$\bar{p}p \rightarrow \bar{p}p$$
$$\bar{p}p \rightarrow \pi^-\pi^+$$
$$\bar{p}p \rightarrow K^-K^+$$

using a magnetic spectrometer. Twenty momenta were measured with ~100 thousand elastic events per momentum. The data on $\pi^-\pi^+$ and K^-K has been published,[1] and the elastic cross sections are now in their final form[2]. We present here an observation of one property of the data when compared with pp elastic scattering within the framework of quark-parton models. The pp and $\bar{p}p$ systems, related by crossing symmetry, provided significant constraints on any particular model.

A study of the interactions of hadrons involving large P_T is most likely to reflect the properties of their constituents. We do not believe that we are working in an energy region where one expects constituent models to apply, since

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our maximum P_T is $\sim$900 MeV/c. However two kinds of models make distinctly different predictions for the relative magnitude of the $\bar{p}$-p and p-p elastic scattering at 90^o, and it is interesting to see how the predicted high energy asymtotic ratio is approached.

Quark-parton models have been reviewed many times (3) and there exist many variations. Here we consider two different types

I If at large angles the most important process responsible for an exclusive scattering is the direct interaction between two constituents via the exchange of a massive 'photon'-gluon[4], then p-p scattering may be represented diagramatically as shown in fig 1a. In this model one would not expect a difference in the interaction between qq or $\bar{q}q$, and consequently the wide angle pp and $\bar{p}p$ cross sections may be expected to be roughly equal, more precisely[5]

$$R = \frac{d\sigma/dt \mid 90^o(\bar{p}p \to \bar{p}p)}{d\sigma/dt \mid 90^o(pp \to pp)} = 5/18$$

II In another class of model it is assumed that the dominant interaction at large angles is the interchange of two constituents with large P_T[6]. Figure 1b shows diagrammatically large angle p-p scattering. In this case one would expect a very small cross section for $\bar{p}$-p scattering since the antiproton contains three valence antiquarks which cannot be interchanged with the quarks in the proton. The value of R predicted on this model is $\sim$ 1/50

The low momentum data from this experiment is shown in figure 2 along with data on p-p. It can be seen that for momenta greater than 1.3 GeV/c, the two sets of data are approximately parallel, R $\sim$1/5 and $d\sigma/dt \mid 90^o$ has a dependence $\sim s^{-7}$. We extend the comparison to higher energies in figure 3 where data up to $\sim$14 GeV/c is presented - a representative sample of p-p data is plotted with individual experiments not identified. There is very little high momentum $\bar{p}p$ data at 90^o but the cross sections appear to remain parallel as a

function of s, with $R \sim 1/5$, except for the point at 5.0 GeV/c of Chabaud et al[10] where $R \sim 1/375$.

The situation is intriguing. Between 3.66 GeV/c and 5.0 GeV/c there appears to be a change in the physics of $\bar{p}p$ at large angles, and we are left with the obvious questions.

(1) What is the asymptotic value of R and how is it approached?

(2) Is the data at 5.0 GeV/c anomalously low, perhaps because there is still diffraction structure in the angular distribution?

These questions can only be answered by good data in $\bar{p}p$ elastic scattering at high momenta. These experiments are difficult because of the low cross sections involved and may have to await antiproton beams derived from CERN SPS or NAL machines. Such measurements on exclusive channels related by crossing provide an excellent test of constituent models and may help to select the correct version.

REFERENCES

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FIGURE CAPTIONS

1. The constituent interactions in p-p elastic scattering, 1a by gluon exchange, 1b by constituent interchange.

2. A comparison of low momentum $\bar{p}$-p and p-p elastic scattering at 90^{o}.

3. A comparison of $\bar{p}$-p and p-p extended up to $\sim$14 GeV/c.

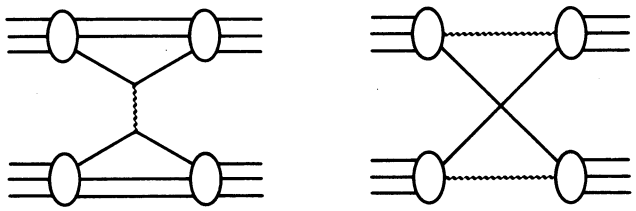
a)
b)

Fig. 1

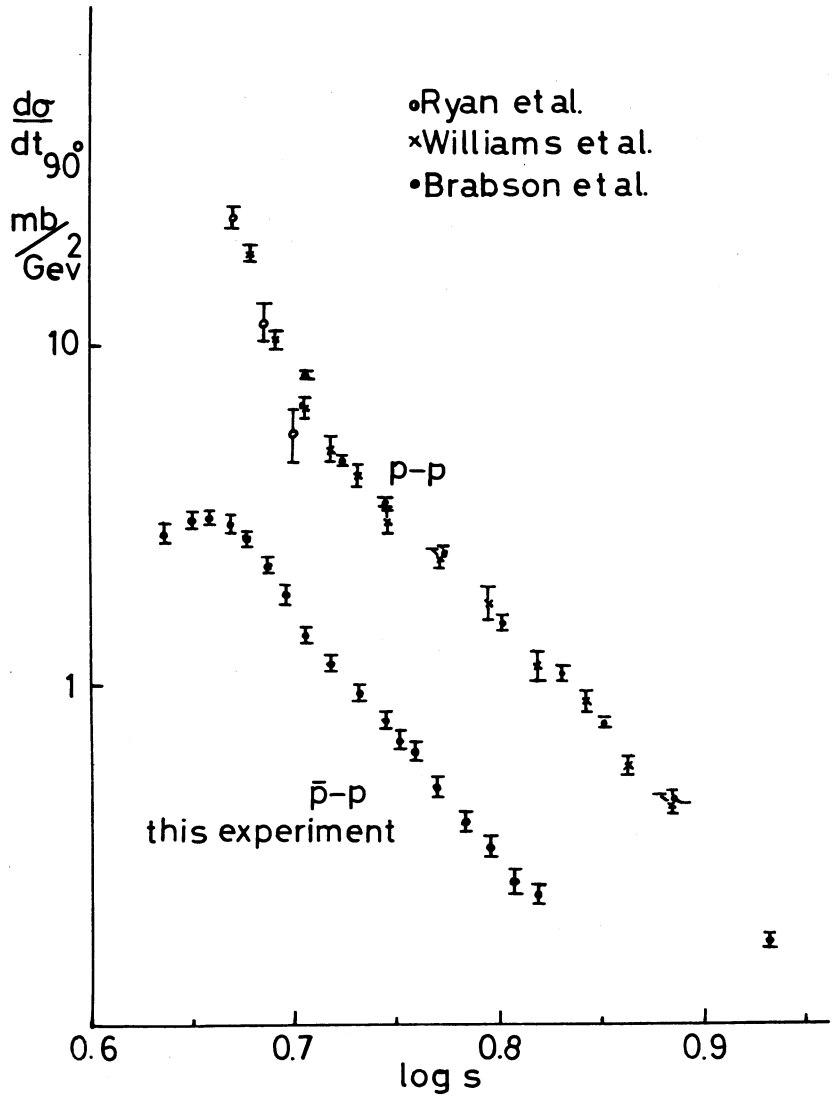
dσ/dt 90°
mb/Gev²
10
1
0.6
0.7
0.8
0.9
log s
•Ryan et al.
×Williams et al.
•Brabson et al.
p-p
p̄-p
this experiment

Fig. 2

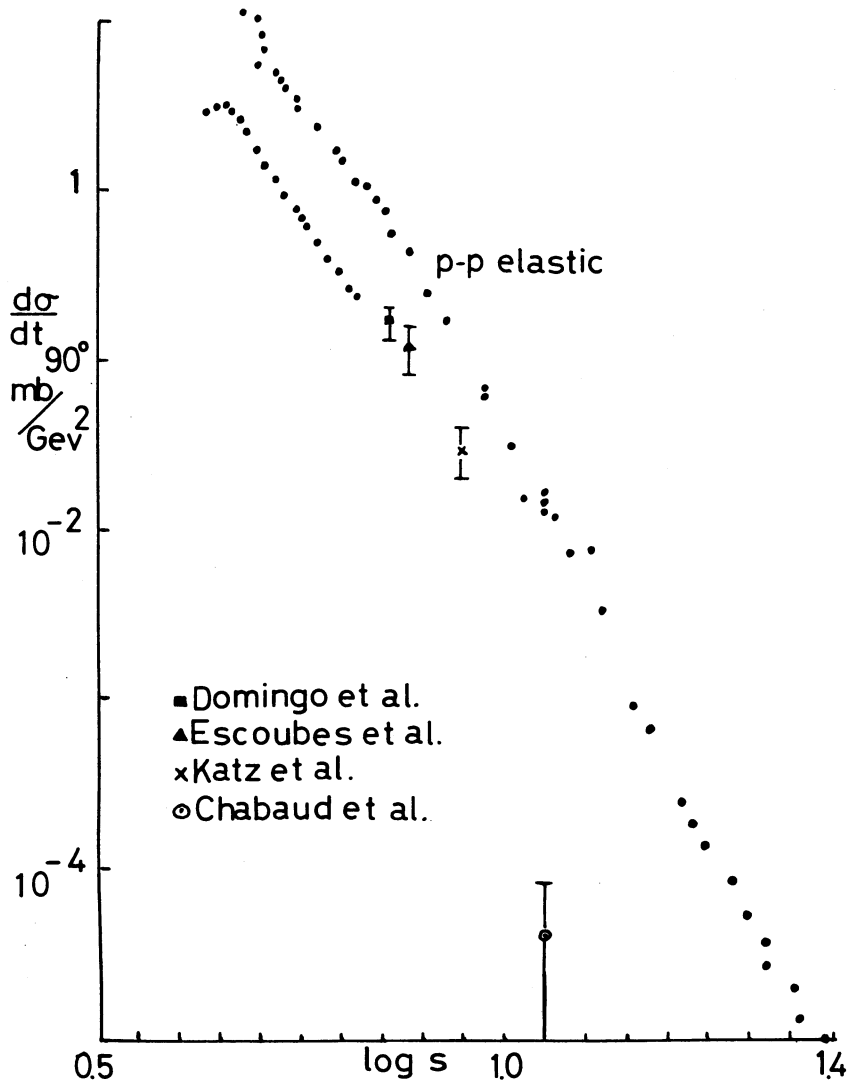
1
$\frac{d\sigma}{dt}_{90°}$
mb/Gev^2
10^{-2}
10^{-4}
p-p elastic
■Domingo et al.
▲Escoubes et al.
×Katz et al.
⊙Chabaud et al.
0.5
log s
1.0
1.4

Fig. 3

D I S C U S S I O N

- *Fields:*

What are the slopes of the 90° pp and $\bar{p}p$ data? Is it s^{-10} for pp?

- *Astbury:*

It might be also s^{-7}, but it seems to become steeper with energy. If you try to accommodate all the data, you would get something like 9.2.

- *Diaz:*

I was looking into your papers in Physics Letters to find the point at 700 MeV/c on $\bar{p}p \to K^+K^-$ to compare it with our results. I would like to see that point.

- *Astbury:*

The elastic data go from 0.7 to 2.4 GeV/c, but 2π and 2K data only go from 0.8 to 2.4 GeV/c.