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DOUBLE-POMERON PREDICTION FOR COLLIDING BEAM EXPERIMENTS*

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Abstract

It is shown that recent ISR measurements of double-pomeron cross sections contain a special kinematic constraint that forces the cross section to decrease with increasing energy,in contrast to the natural constraint which corresponds to an increasing cross section.The observed energy dependence is shown to be in agreement with theoretical expectation.

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In an earlier paper, predictions of double-pomeron inclusive cross sections have been made on the basis of inclusive single diffraction measurements[1], integrated cross sections being presented for the phase-space interval where both of the two Feynman x variables are greater than 0.9 in absolute value. It turns out, however, that in colliding-beam experiments[2] it is awkward to cover a uniform x range for different values of the total energy; in the actually used experimental arrangement, the minimum value of $|x|$ increases with increasing total energy. In this note, we show how the earlier predictions are to be modified in order to accommodate a typical colliding-beam configuration. Comparison is made with recently reported measurements[2a,2b].

In Ref. [1], the cross section for the two-particle inclusive reaction $A + B \to A + B + M_X$ was approximately related to the corresponding single-particle cross sections for $A + B \to A + M_{XA}$ and $A + B \to B + M_{XB}$ by the formula:

$$\frac{d\sigma^{AB}_{AB}}{dt_A dt_B dZ_A dZ_B} \sim \frac{1}{\sigma_{TOT}} \cdot \frac{d\sigma^{A}_{AB}}{dt_A dZ_A} \cdot \frac{d\sigma^{B}_{AB}}{dt_B dZ_B} \quad ; \qquad (1)$$

the notation is explained in fig. 1 (see also Ref[1]). The relation of the variables $Z_{A,B}$ to the Feynman x variables is :

$$Z_{A,B} \approx \ln \frac{1}{1 - |x_{A,B}|} \quad . \qquad (2)$$

In a typical colliding-beam experiment, although the total energy is known with reasonable accuracy, the direct measurement of $|x_{A,B}|$ of the forward-moving particles A and B is insufficiently precise. Instead, one depends on the measuring of particles in the central cluster, most naturally with a fixed array of detectors corresponding to a rapidity interval $-y_m < y < y_m$ (fig.2). Requiring that all central-cluster particles fall within this interval corresponds to requiring minimum rapidity gaps between the leading protons and the "nearest" particle in the central cluster. As shown in ref.[3], these gaps are approximately $Z_{A,B} - 1$. The requirement is thus :

$$Z_{A,B} - 1. \approx \ln \frac{1}{1 - |x_m|} - 1 \quad > |y_{A,B}| - y_m \quad , \qquad (3)$$

where $y_{A,B}$ are the (barycentric system) rapidities of the leading protons. Now in a typical event,

$$y_{A,B} \approx \ln (\sqrt{s} / m_{\perp A,B}) \qquad (4)$$

where $m_\perp$ is the transverse mass, so the minimum . of $Z_{A,B}$ (and thus of $|x_{A,B}|$) increases with increasing energy.

Having recognized this basic fact, it is easy to modify the prediction of Ref.[1] for the integrated two-particle inclusive cross section. For example, if we define:

$$q_m = \text{minimum value of } \frac{1}{1 - |x_{A,B}|} = \frac{1}{1 - |x_m|}$$

and use the 3-parameter representation of single diffraction introduced in Ref.[1], then for pp collisions the integral over the generalization to arbitrary q_m of Formula (10) from Ref.[1] is:

$$\sigma_{DPE}(q_m ,s) \approx \frac{C_{pp}^2}{\sigma_{TOT}^{pp}} \cdot \frac{1}{b_{pp}^2} \cdot \frac{1}{\varepsilon^2} \{ (\frac{1}{q_m})^{2\varepsilon} - (\frac{s_o}{s})^{\varepsilon} (1 + \varepsilon \ln \frac{s}{q_m^2 s_o}) \} \quad . (5)$$

Fig.3 shows the inclusive double-pomeron cross section as predicted from Ref.[1] (using values of the parameters given therein) for different values of $|x_m|$,such that all events are counted which have for both protons $| x_m | < |x| < 1$. (The plot given in Ref.[1] corresponds to $| x_m |=0.9$ or $q_m =10$).

From these curves,together with Formulae(3) and (4),one easily finds the cross section as a function of energy for fixed y_m ,predictions shown by the dotted curves on the same figure.Note that the predicted cross section increases with increasing energy at fixed $|x_m|$ but decreases at fixed y_m .

Two different ISR experiments have been reported,one corresponding to $y_m \simeq 1.5$ (Ref.[2a]) and the other to $y_m \simeq 1.0$ (Ref.[2b]).The experimental results multiplied by 3/2 to include clusters with only neutral particles,are shown in Fig.3 and are in accord with our predictions.

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Figure Captions

Fig.1.Diagram defining the variables for single diffraction and double - pomeron exchange as needed in formula (1) (see ref.[1]).

Fig.2.Rapidity range of a typical proton-proton colliding-beam experiment (see ref.[2]).

Fig.3.The predicted inclusive double-pomeron cross section as a function of s ,for different (fixed) values of $|x_m|$ in a pp experiment,(see ref.[1]).The dotted curves are the corresponding predictions for different (fixed) values of y_m.The experimental points are taken from ref.[2a] (♦) and ref.[2b] (▪) ,multiplied by 3/2,as explained in ref. [1].

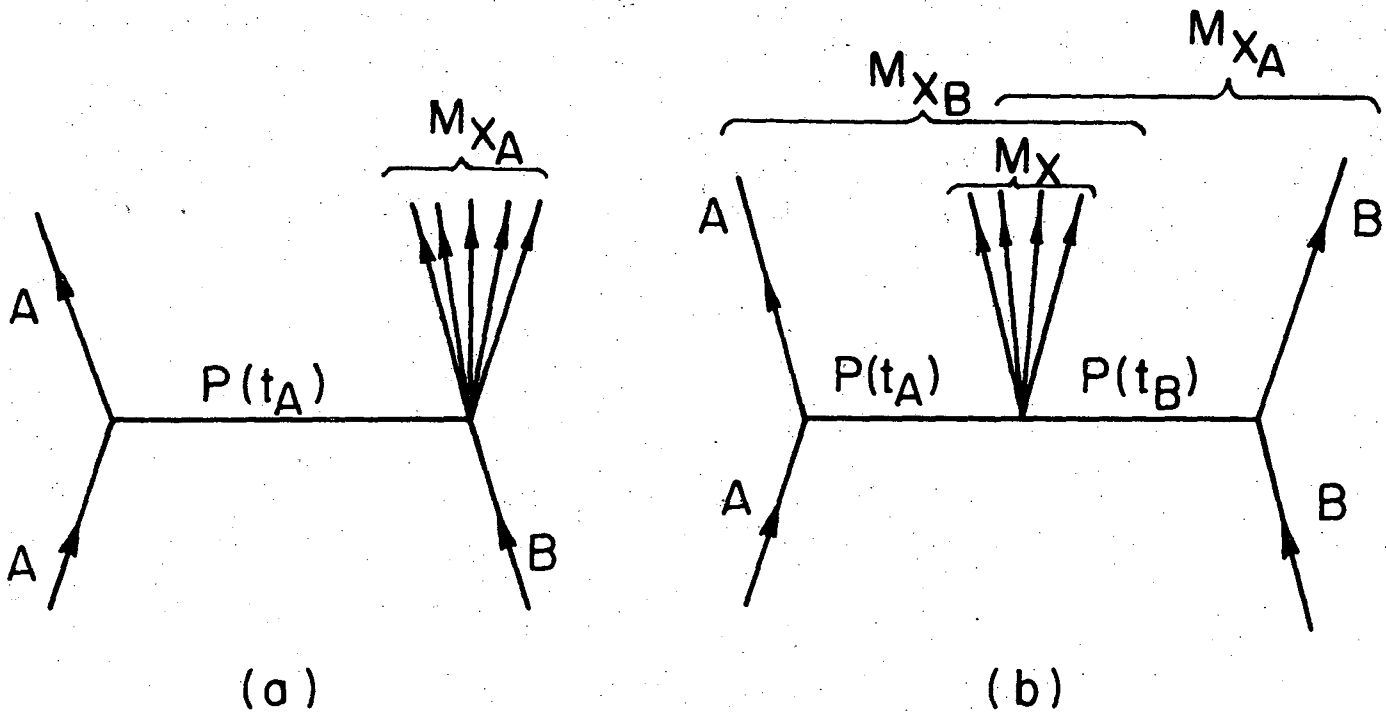

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Figure 1

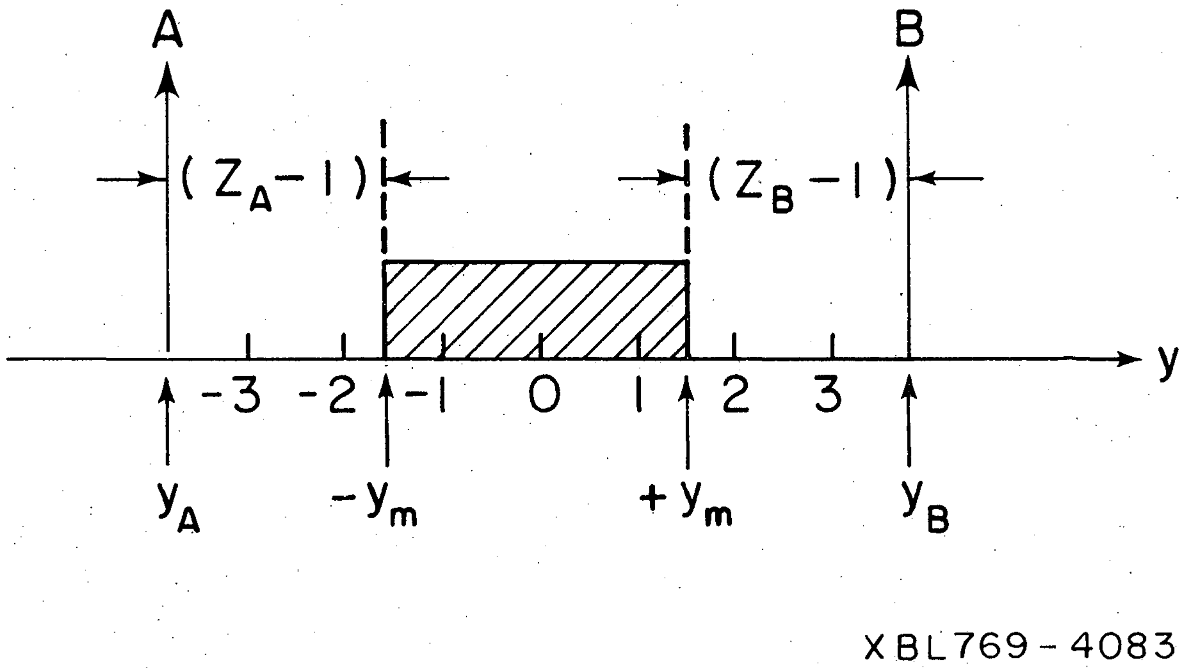

Figure 2

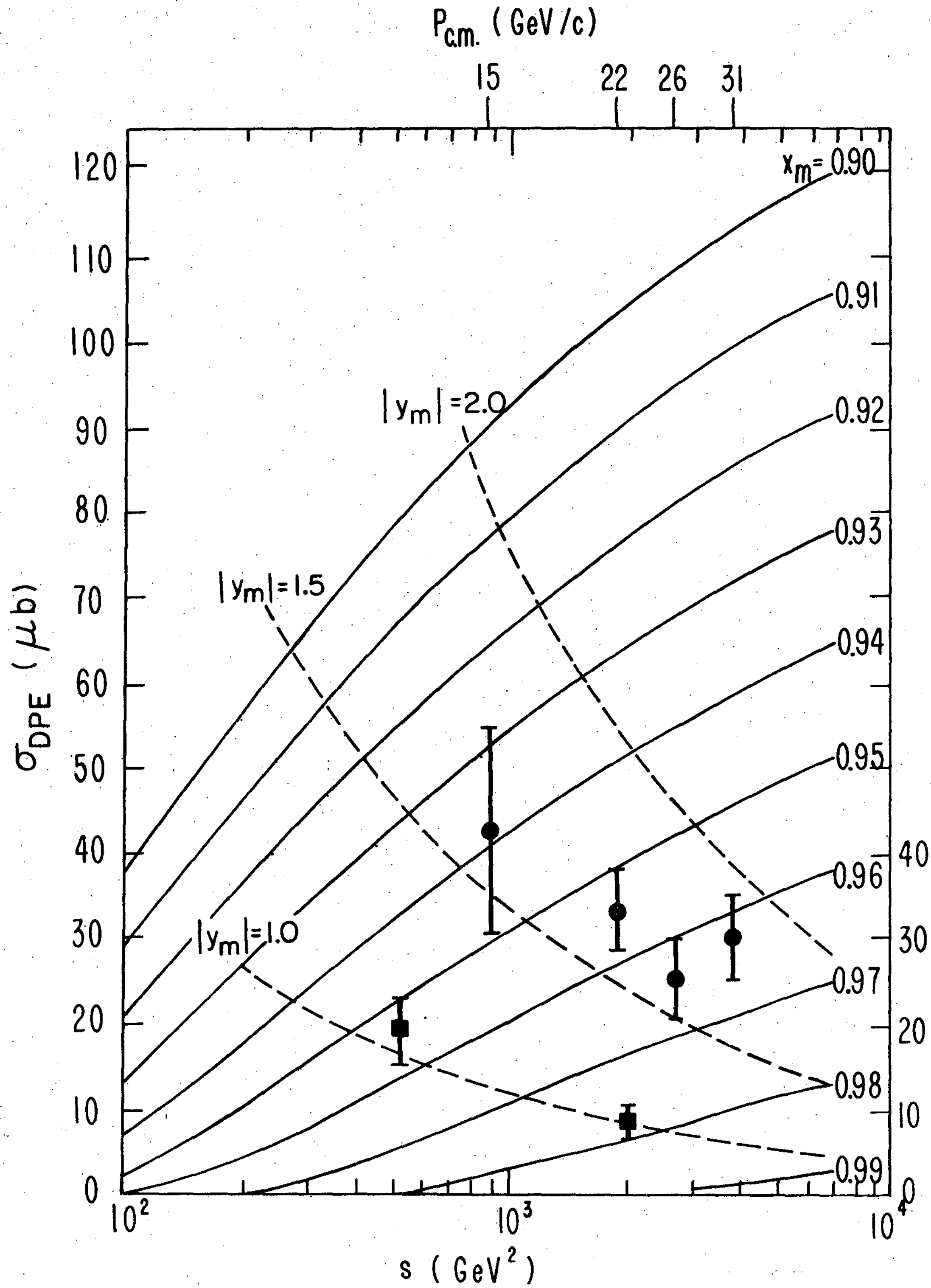

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Figure 3

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