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"Pomeron"- "Pomeron" Collisions at Collider Energies

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A B S T R A C T

Events in hadronic collisions, which contain a central cluster of mass M_x together with the two quasi-elastically scattered beam particles are usually described by Pomeron-Pomeron scattering. We investigate these processes at collider energies, assuming the Pomeron to be a gluonic object. It is shown, that the rates expected for such events with large M_x up to ~ 30 GeV is very comfortable, already for SPPS. A study of these events, especially of hard processes like heavy flavour production or jets, should lead to an understanding of diffraction in terms of QCD.

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1. INTRODUCTION

There exists a wide class of hadronic diffractive interactions, ranging from simple elastic scattering over diffractive excitation of one of the interacting particles to the case of double diffraction, where both target and projectile are dissociated. All characteristic features of these diffractive processes, for instance their approximate energy-independent cross-sections and the factorization relations by which various diffraction channels are linked to each other, are field-theoretically well understood by the exchange of a Pomeron. Ten years ago, on the basis of single diffractive measurements, Chew and Chew¹⁾ have made predictions for double-Pomeron inclusive cross-sections DPE (Fig.1), as a new kind of diffractive phenomena, which appeared as a natural consequence of the Pomeron exchange concept. In DPE, both incoming hadrons are quasielastically scattered and therefore emerge at very large Feynman x_F

$$|x_1|, |x_2| \geq c, \quad c \geq 0.9 \quad (1)$$

A central cluster of particles is produced in the Pomeron-Pomeron interaction and is well separated from the beam particles by large rapidity gaps.²⁾ The invariant mass of this central cluster X is given approximately by:

$$M_X^2 \approx s (1 - |x_1|) \cdot (1 - |x_2|) \quad (2)$$

In (2) we have neglected a possible small transverse momentum of the cluster. Experiments at ISR³⁾ have confirmed the expectations from DPE - like independence of the mass spectra on $\sqrt{s}$ and on the incident particle type⁴⁾. Also, the exponential t -slope is similar to the one of elastic scattering. An interesting experimental result is the apparent SU(3)-flavour independence of the Pomeron-Pomeron scattering. The main purpose of the ISR DPE experiments was to search for glueball states, triggered by the QCD hypothesis that the Pomeron is a gluonic system⁵⁾.

Ingelman and Schlein⁶⁾ recently suggested, that at the SP $\overline{\text{P}}$ S or the TEVATRON the internal structure of the Pomeron can be studied by searching for high- p_t jets in single diffractively produced high mass states from Pomeron-Nucleon interactions. In a previous letter together with H. Fritzsch⁷⁾, we showed that one also expects large rates for heavy flavour production in PP scattering. In DPE, according to condition (1), the maximal accessible mass M_X extends up to 30 GeV at the CERN SP $\overline{\text{P}}$ S and to 100 GeV at the TEVATRON (for $c \approx 0.95$). It is

therefore very suggestive to assume that DPE experiments at these colliders can investigate hard $\mathbb{P}$ - $\mathbb{P}$ scattering processes and give additional insight in the physical nature of the Pomeron, perhaps even revealing some new phenomena associated with QCD.

In Section 2 we derive our main formula, the differential cross-section for DPE with respect to the invariant mass of the central cluster. In Section 3 we discuss the various possible gluon densities for the Pomeron. As an application, we study in Section 4 the production of charm and bottom in DPE, and Section 5 contains our conclusions.

2. CROSS-SECTION FOR DOUBLE-POMERON-EXCHANGE PROCESSES

We derive in this section the cross-section formula for DPE, following very closely the analysis of Kaidalov and Ter-Martirosyan⁸⁾. The differential cross-section (for notations see Fig.1) is given by:

$$\frac{(s_1 s_2) d^4 \sigma}{ds_1 ds_2 dt_1 dt_2} = \frac{1}{4} \sigma_{\mathbb{P}\mathbb{P}}^{\text{tot}} \left(\ln \frac{M_X^2}{m^2}, t_1, t_2 \right) \cdot g_a^2(t_1) \cdot g_b^2(t_2) \cdot \left| H_{\mathbb{P}} \left(\ln \frac{s_1}{s_0}, t_1 \right) \cdot H_{\mathbb{P}} \left(\ln \frac{s_2}{s_0}, t_2 \right) \right| \quad (3)$$

The normalization is such that the P-pole contribution to σ_{ab}^{tot} has the form $\sigma_{ab}^{\text{tot}} = 8\pi g_a^2(0)$,

$$H_{\mathbb{P}} \left(\ln \frac{s}{s_0}, t \right) = \left(\frac{s}{s_0} \right)^{\alpha_{\mathbb{P}}(t)-1} \eta(\alpha_{\mathbb{P}})$$

is the Green function of the Pomeron and $g_N(t)$:

$$g_N^2(t) = g_N^2(0) \cdot e^{-R_N^2 \cdot t}$$

is the coupling at the $\mathbb{P}$ -p vertex. The $\mathbb{P}$ - $\mathbb{P}$ total cross-section at large M_X^2 :

$$\sigma_{\mathbb{P}\mathbb{P}}^{\text{tot}} \left(\ln \frac{M_X^2}{m^2}, t_1, t_2 \right)_{M_X \rightarrow \infty} \approx 8\pi r(t_1) r(t_2) \quad (4)$$

is expressible in terms of the triple-Pomeron vertex $r(t)$. Experiments on diffractive dissociation showed that $r(t)$ and therefore also $\sigma_{\mathbb{P}\mathbb{P}}^{\text{tot}}$ are independent of t ⁹⁾. We can therefore integrate Eq. (3) over dt_1 and dt_2 :

$$\frac{d^2 \sigma^{\text{DPE}}}{dM_x^2 \cdot ds_1} = \sigma_{\text{PP}}^{\text{tot}} \cdot \frac{g_N^4(0)}{4s_1 M_x^4} \cdot \frac{1}{(2\alpha'_P \ln(\frac{s}{s_1}) + R_N^2)} \cdot \frac{1}{(2\alpha'_P \ln(\frac{s}{s_2}) + R_N^2)} \quad (5)$$

The experiments we are suggesting in the following accept a DPE event if both scattered beam particles emerge with a Feynman-x larger than some experimental cut c. Inserting the kinematical boundaries:

$$M_0 \leq M_x \leq (1-c)\sqrt{s}, \quad \frac{M_x^2}{1-c} \leq s_1 \leq (1-c)s \quad (6)$$

results in:

$$\frac{d\sigma^{\text{DPE}}}{dM_x^2} = \frac{\sigma_{\text{PP}}^{\text{tot}}}{M_x^2} \cdot \frac{g_N^4(0)}{8\alpha'_P (\alpha'_P \ln(\frac{s}{M_x^2}) + R_N^2)} \ln \left(\frac{2\alpha'_P \ln \frac{(1-c)s}{M_x^2} + R_N^2}{2\alpha'_P \ln \frac{1}{1-c} + R_N^2} \right) \quad (7)$$

The corresponding production cross-sections for a specific final state in DPE reactions is given by (7) with the replacement of $\sigma_{\text{PP}}^{\text{tot}}$ by the corresponding exclusive (respectively semi-inclusive) P-P cross-section. We choose for our numerical studies the following values:

$$\begin{aligned} g_N(0) &= 1.8 \text{ GeV}^{-1} \\ R_N^2 &= 3.5 \text{ GeV}^{-2} \\ \alpha'_P &= 0.3 \text{ GeV}^{-2} \\ r(0) &= 0.12 \text{ GeV}^{-1} \end{aligned} \quad (8)$$

which allow us to reproduce analogously the fit to the single diffractive c.s. $d^2\sigma/dM_x^2 dt$ presented in Ref. 4) and are in reasonable agreement with the elastic scattering data^{*)}. The value for $r(0)$ is taken from Ref. 9). The total P-P cross-section is of the order

^{*)} It might be of interest to know how sensitive the log-factor in (7) is to a change in α'_P and R_N^2 . We have repeated our calculation for $\alpha'_P = 0.25$ and $R_N^2 = 4.7$. These values are taken from Ref. 14) and they would lower the predicted rates generally by about 20%.

$$\sigma_{PP}^{\text{tot}} = 8\pi r(0)^2 \approx 140 \mu\text{b} \quad (9)$$

which means, that if we assume the relation between σ_{PP}^{tot} and the interaction radius R_P provided by the optical analogy, the Pomeron has extremely small dimensions:

$$R_P^{-1} \sim 6 \text{ GeV} \quad (10)$$

The hypothesis, that the Pomeron is very narrow should be connected with the explanation of Landshoff and Polkinghorne¹⁰⁾ for the experimental fact that total hadronic cross-sections satisfy the additive quark rule: the Pomeron does not couple to hadrons as a whole, but to the individual valence quarks inside. This statement is in agreement with recent experimental data¹¹⁾.

In Fig. 2a we show the expected mass spectrum in DPE at the $\text{SP}\bar{\text{P}}\text{S}$ collider for three different x_F - cuts: for $x_F^{\text{min}} = 0.97, 0.95$ and 0.90 . For $x_F^{\text{min}} = 0.97(0.95)$ the rate drops from about $10\mu\text{b}/\text{GeV}$ ($13\mu\text{b}/\text{GeV}$) at $M_X = 5 \text{ GeV}$ exponentially down to $\sim \frac{1}{2} \mu\text{b}/\text{GeV}$ at $M_X = 16 \text{ GeV}$ (24 GeV), while a detector which can identify the protons down to $x_F^{\text{min}} = 0.90$ has such a cross-section still at 45 GeV . Fig. 2b shows the corresponding predictions for a $\sqrt{s} = 2 \text{ TeV}$ collider.

To give an idea about absolute rates we want to add that for $\sqrt{s} = 630 \text{ GeV}$ (2TeV) the predicted cross-section for DPE events with $M_X > 3\text{GeV}$ (charm threshold) is $\sim 60\mu\text{b}$ ($\sim 90\mu\text{b}$) for $x_F^{\text{min}} = 0.97$; $\sim 90\mu\text{b}$ ($\sim 150\mu\text{b}$) for $x_F^{\text{min}} = 0.95$ and $\sim 190\mu\text{b}$ ($\sim 230\mu\text{b}$) for $x_F^{\text{min}} = 0.90$. The corresponding values for $M_X > 9.4 \text{ GeV}$ (bottom threshold) are $\sim 10\mu\text{b}$ ($\sim 30\mu\text{b}$) for $x_F^{\text{min}} = 0.97$; $\sim 30\mu\text{b}$ ($\sim 60\mu\text{b}$) for $x_F^{\text{min}} = 0.95$ and $\sim 80\mu\text{b}$ ($120\mu\text{b}$) for $x_F^{\text{min}} = 0.9$.

3. GLUON DISTRIBUTION FOR THE POMERON

In order to derive from Eq. (7) QCD predictions, we assume a partonic structure of the Pomeron that can be described by some yet unknown distribution functions $D_i(x)$. We follow the hypothesis that the Pomeron is a gluonic system⁵⁾, with a possible $q\bar{q}$ -sea which we neglect in the following. Note however, that

this assumption can be tested in high mass single-diffractive scatterings, as well as DPE, by looking for Drell-Yan μ -pairs.

Contrary to the application of this concept to single-diffractive scatterings^{6),7)}, our DPE predictions will depend very sensitively on the gluon distribution $G_P(x)$. It is therefore necessary to discuss first the various possible forms of $G_P(x)$ in some detail. A very reasonable assumption is that the Pomeron contains valence gluons. The quite successive counting rules¹²⁾ determine the large x behaviour of an n -gluon state:

$$G_n(x) \sim (1-x)^{2(n-1)-1} \quad (11)$$

At low x there must be an additional enhancement due to an additional gluon sea respectively from QCD Q^2 -evolution. From the parametrizations of parton densities in the nucleon it is suggestive to include these low x gluons by replacing (11) by

$$G_n'(x) \sim \frac{1}{x} (1-x)^{2(n-1)-1} \quad (12)$$

However, due to the small size of the Pomeron as emphasized in (10), it is reasonable to expect, that $G_P(x)$ does not increase so fast at low x . For instance, screening effects¹³⁾ discussed for proton structure functions at very low x will here be present at larger x . Therefore, we will also discuss densities of the form:

$$G_n''(x) \sim \frac{1}{\sqrt{x}} (1-x)^{2(n-1)-1} \quad (13)$$

An important constraint on $G_P(x)$, we think, is the smallness of σ_{PP}^{tot} . Any form for $G_P(x)$ which, in a perturbative QCD calculation for some hard P - P process, leads to a cross-section of similar or even larger magnitude at moderate P - P invariant masses is quite certainly an unrealistic parametrization for a large x -range. For instance, a gluon density similar to the one in the nucleons ($G_P(x) \sim 6/x(1-x)^5$) would lead to 100 μ b charm production in P - P scattering already at $\sqrt{s} \sim 90$ GeV. In the next section we discuss the production of heavy flavour in DPE and present the predictions for the following five choices for $G_P(x)$:

$$G_0(x) = 6(1-x)$$

$$G_{1/2}(x) = \frac{15}{4\sqrt{x}}(1-x)$$

$$\begin{aligned}
 G_1(x) &= \frac{2}{x} (1-x) \\
 G_{3/2}(x) &= \frac{315}{32\sqrt{x}} (1-x)^3 \\
 G_3(x) &= \frac{4}{x} (1-x)^3.
 \end{aligned}
 \tag{14}$$

4. HEAVY FLAVOUR PRODUCTION IN DPE

One possible problem we want to mention first is that, if the Pomeron is such a narrow state as indicated in (10), the parton model assumption of an incoherent scattering of two gluons, one from each of the incoming Pomerons to produce a charm-anticharm pair is only well justified at very large $M_{(cc)}$. Therefore, our predictions might be much more naive than the ones of heavy flavour production in usual hadron scatterings.

In Fig. 3 we present total charm production rates for PP collisions at $10 \text{ GeV} < \sqrt{s} < 150 \text{ GeV}$, choosing $m_c = 1.5 \text{ GeV}$, $\alpha_s = \alpha_s(\frac{1}{2}\hat{s})$ with $\hat{s}$ being the invariant $c\bar{c}$ -mass and $\Lambda_{\text{QCD}} = 200 \text{ MeV}$. For the hard distribution $G_0(x)$ $\sigma(PP \rightarrow c\bar{c}+X)$ falls off rather rapidly with s for $\sqrt{s} > 20 \text{ GeV}$, while it rises with $\sqrt{s}$ strongly if the gluon density increases like $1/x$ at low x and is of the order of σ_{PP}^{tot} for $\sqrt{s}$ between 50 and 200 GeV, depending on the value of n in (12). However, if $G_P(x)$ behaves like $1/\sqrt{x}$ at low x , the $c\bar{c}$ -production cross-section is very flat for $\sqrt{s} > 30 \text{ GeV}$ and stays well below σ_{PP}^{tot} for $G_{\frac{1}{2}}(x)$. Our QCD predictions are therefore consistent with a small and rather constant σ_{PP}^{tot} , if we use $G_{\frac{1}{2}}(x)$ or $G_{3/2}(x)$. In any case, we conclude from Fig. 3 that for all the $G_P(x)$ parametrizations (14), for $\sqrt{s} > 20 \text{ GeV}$ in PP - collisions the production rate for charm is not very much suppressed compared to the production of light flavours. For low M_X we note, that for all choices (14) $\sigma(PP \rightarrow c\bar{c})$ is already of order $1 \mu\text{b}$ at $\sqrt{s} = 8 \text{ GeV}$. The charm contribution in the central cluster of DPE events is given by the branching ratio $\sigma(PP \rightarrow c\bar{c}+X)/\sigma_{PP}^{\text{tot}}$ and is therefore expected to be $\sim 1\%$ for $M_X = 9 \text{ GeV}$ and $\sim 5\%$ for $M_X = 20 \text{ GeV}$, quite independent of the form of $G_P(x)$.

The charm production rate in DPE does not in principle depend on the value of σ_{PP}^{tot} . In Table 1 are listed the total cross-sections:

$$\sigma(p + \bar{p} \rightarrow p + \bar{p} + c + \bar{c} + \dots) = \int_{4m_c^2}^{(1-x_F^{\min})^2 s} dM_x^2 \frac{d\sigma}{dM_x^2}(p\bar{p} \rightarrow p\bar{p} + c\bar{c} + \dots) \quad (15)$$

for $x_F^{\min} = 0.97, 0.95$ and 0.90 separately for a $\sqrt{s} = 630$ GeV, 2 TeV and a 10 TeV collider. We predict DPE collisions with $c\bar{c}$ -production of $\sim 1.5\mu\text{b}$ ($\sim 5\mu\text{b}$) for $x_F^{\min} = 0.95$ (0.90) at the SPPS, quite independent of $G_{\mathbb{P}}(x)$. An interesting quantity is the contamination of onium states to $\sigma(pp \rightarrow pp + c\bar{c} + \dots)$. We calculated the total rate into charmonium states following the well-known duality assumption. It is large, about 30% at $\sqrt{s} = 630$ GeV, as can be seen in Table 2. As in usual hadron-hadron collisions, we expect that about 10% of these charmonium states are J/ψ 's. We expect this prediction to be rather sensitive to possible coherence effects at low $M_{c\bar{c}}$.

Finally, we have also calculated bottom production in DPE collisions. Total cross-sections are presented in Table 3. At the SPPS we expect ~ 5 (40)nb for $x_F^{\min} = 0.95$ (0.90), while at the TEVATRON these cross-sections should be ~ 100 (300) nb, large enough to look for B signals in DPE collisions.

5. CONCLUSIONS

All known characteristic features of diffractive phenomena are very well described by the exchange of a Pomeron, nevertheless the physical nature of the Pomeron is very unclear. Hadron-hadron colliders have the opportunity to investigate the scattering of two Pomerons in exactly the same way photon-photon scattering is studied at e^+e^- machines, by detecting the two quasi-elastically scattered beam particles at very large x_F and a central cluster which represents the final state of the $\mathbb{P}\text{-}\mathbb{P}$ collision. At colliders with $\sqrt{s} \gg 500$ GeV one can investigate $\mathbb{P}\text{-}\mathbb{P}$ collisions above 30 GeV, an energy range where hard QCD processes can be studied, if the Pomeron (what should surely be the case) has a partonic, probably gluonic interpretation. The cross-sections for hard processes with $M_X \gg 10\text{GeV}$ is about $30\mu\text{b}$ ($x_F^{\min} = 0.95$). We have applied a QCD calculation to predict the heavy flavour content in these events. We predict that, contrary to usual hadron-hadron collisions, the percentage of charm in the central cluster is several percent and therefore easily detectable. The main reason for this fact is the smallness of $\sigma_{\mathbb{P}\mathbb{P}}^{\text{tot}}$, a fact which might suggest, that the application of QCD to Pomeron collisions must not follow completely our traditional experience.

Finally, it has been argued by M. Albrow¹⁵⁾, that the central cluster of DPE has a rather high probability to contain two heavy quark pairs from multigluon interactions. In fact, the probability for a second interaction process of two accompanying subconstituents from the Pomerons is proportional to their flux factor¹⁶⁾. This flux is proportional to the inverse of the extension of the Pomeron. From this we conclude, that multigluon interactions in DPE should occur at least hundred to thousand times more often than in usual hadron-hadron scatterings. Detailed predictions about multigluon interactions in DPE will be presented elsewhere¹⁷⁾.

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$\sqrt{s}$		630 GeV	2 TeV	10 TeV
$x_F^{\min} = 0.97$	G_0	0.6	2.3	5
	$G_{1/2}$	0.5	3	8.4
	G_1	0.4	3.6	18
	$G_{3/2}$	0.3	4.2	18
$x_F^{\min} = 0.95$	G_0	1.4	3.7	6.7
	$G_{1/2}$	1.5	5.4	14
	G_1	1.4	8.3	42
	$G_{3/2}$	1.5	9.3	33
$x_F^{\min} = 0.90$	G_0	3.1	5.4	10
	$G_{1/2}$	4	9.3	19
	G_1	5	19	66
	$G_{3/2}$	6	19	39

TABLE 1: $\sigma(p\bar{p} \rightarrow p\bar{p} \text{ cc} + \dots)$ in μb for a $p\text{--}(\bar{p})$ collider at $\sqrt{s} = 630 \text{ GeV}$, 2 TeV or 10 TeV. Predictions are shown for four different $G_p(x)$: $G_0(x) = 6(1-x)$, $G_{1/2}(x) = 15/(4\sqrt{x}) \cdot (1-x)$, $G_1(x) = (2/x) \cdot (1-x)$ and $G_{3/2}(x) = 315/(32\sqrt{x}) \cdot (1-x)^3$, and for three different $x_F^{\min}$ cuts.

$\sqrt{s}$		630 GeV	2 TeV	10 TeV
$x_F^{\min} = 0.97$	G_0	34%	23%	17%
	$G_{1/2}$	37%	26%	21%
	G_1	41%	31%	28%
	$G_{3/2}$	47%	31%	24%
$x_F^{\min} = 0.95$	G_0	27%	20%	17%
	$G_{1/2}$	30%	22%	17%
	G_1	34%	27%	20%
	$G_{3/2}$	37%	26%	18%
$x_F^{\min} = 0.90$	G_0	22%	19%	14%
	$G_{1/2}$	25%	21%	17%
	G_1	30%	25%	22%
	$G_{3/2}$	30%	23%	22%

TABLE 2: Charmonium contamination of $\sigma(\vec{p}\vec{p} \rightarrow \vec{p}\vec{p} + c\bar{c} + \dots)$

$\sqrt{s}$		630 GeV	2 TeV	10 TeV
$x_F^{\min} = 0.97$	G_0	0.4nb	34nb	0.2 μ b
	$G_{1/2}$	0.2nb	30nb	0.28 μ b
	G_1	0.09nb	22nb	0.4 μ b
	$G_{3/2}$	0.01nb	19nb	0.48 μ b
$x_F^{\min} = 0.95$	G_0	7.0nb	85nb	0.28 μ b
	$G_{1/2}$	5.0nb	91nb	0.47 μ b
	G_1	2.5nb	83nb	0.92 μ b
	$G_{3/2}$	1.0nb	91nb	0.95 μ b
$x_F^{\min} = 0.90$	G_0	49nb	0.19 μ b	0.42 μ b
	$G_{1/2}$	44nb	0.25 μ b	0.75 μ b
	G_1	32nb	0.32 μ b	1.9 μ b
	$G_{3/2}$	30nb	0.38 μ b	1.7 μ b

TABLE 3: $\sigma(p\bar{p} \rightarrow p\bar{p} + b\bar{b} + \dots)$ for a $p\text{--}(\bar{p})$ collider with $\sqrt{s} = 630$ GeV, 2 TeV or 10 TeV. Predictions are shown for 4 different gluon densities in the Pomeron: $G_0(x) = 6(1-x)$; $G_{1/2}(x) = 15/(4\sqrt{x}) \cdot (1-x)$; $G_1(x) = (2/x) \cdot (1-x)$; $G_{3/2}(x) = 315/(32\sqrt{x}) \cdot (1-x)^3$, and 3 different $x_F(p, \bar{p})$ - cuts.

REFERENCES

- 1) D.M. Chew and G.F. Chew - Phys. Lett. 53B (1974) 191.
- 2) B.R. Desai, B.C. Shen and M. Jacob - Nucl. Phys. B142 (1978) 258.
- 3) L. Baksay et al. - Phys. Lett. 61B (1976) 89;
H. DeKerret et al. - Phys. Lett. 68B (1977) 385;
D. Drijard et al. - Nucl. Phys. B143 (1978) 61;
R. Waldi et al. - Z. Phys. C18 (1983) 301.
- 4) T. Åkesson et al. - CERN-EP/85-115, July 1985.
- 5) F. Low - Phys. Rev. D12 (1975) 163;
S. Nussinov - Phys. Rev. D14 (1976) 246.
- 6) G. Ingelman and P. Schlein - Phys. Lett. 152B (1985) 256.
- 7) H. Fritzsch and K.H. Streng - MPI-PAE/PTh 53-85/(1985) to be published in Phys. Lett. B.
- 8) A.B. Kaidalov and K.A. Ter-Martirosyan - Nucl. Phys. B75 (1974) 471.
- 9) R.L. Cool et al. - Phys. Rev. Lett. 47 (1981) 701.
- 10) P.V. Landshoff and J.C. Polkinghorne - Nucl. Phys. B32 (1971) 541.
- 11) A.M. Smith et al. - CERN-EP/85-129, August 1985.
- 12) R. Blankenbecler and S. Brodsky, Phys. Rev. D10 (1974) 2973.
- 13) L.V. Gribov, E.M. Levin and M.G. Ryskin - Phys. Rep. 100 (1983) 1;
L. Durand and W. Putikka - Madison preprint MAD/TH/85-3 (1985).
- 14) A. Donnachie and P.V. Landshoff - Nucl. Phys. B244 (1984) 322.
- 15) M. Albrow - Talk presented at the Workshop on "Physics in the 90's at the SPS collider", Zinal, June 1985.
- 16) B. Humpert - Phys. Lett. 131B (1983) 461;
N. Paver and D. Treleani, Nuovo Cimento 70A (1982) 215.
- 17) K.H. Streng - in preparation.

FIGURE CAPTIONS

Figure 1 Diagram for the particle production in Double-Pomeron-Exchange reactions.

Figure 2 Double-Pomeron-Exchange cross section $d\sigma/dM_X(p(\bar{p}) \rightarrow p(\bar{p}) + X)$ as function of M_X for

a) $\sqrt{s} = 630$ GeV collider energy

b) $\sqrt{s} = 2$ TeV collider energy

Predictions are shown for experimental lower cuts on x_{Feynman} of p and $(\bar{p})$ of 0.97, 0.35 and 0.90.

Figure 3 Cross-section for charm production in Pomeron-Pomeron collisions as a function of the (PP) -invariant mass. Predictions are shown for five different choices for a gluonic density inside the Pomeron.

Fig. 1

Fig. 2a

Fig 2b

Fig.3