

Soft Scattering Re–Visited

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An updated formulation of soft diffraction, compatible with unitarity is presented. Its consequent soft scattering features are explored. The critical interplay between theory and data analysis will be discussed.

1 Introduction

The present vigorous studies of soft scattering and Pomeron (\mathbb{P}) physics are based on sophisticated utilisation of relatively old theoretical ideas and models, such as Gribov’s Reggeon field theory [1], Good and Walker (GW) decomposition of the proton wave function accounting for low mass diffraction [2] and the eikonal approximation [3] which secures the compatibility of the scattering amplitudes with s channel unitarity. Compliance with t channel unitarity is associated with multi Pomeron interactions (\mathbb{P} enhancement) which are a generalisation of Mueller’s triple Pomeron mechanism [4] provided $G_{3\mathbb{P}}$, the triple Pomeron coupling, is large enough. This mechanism supplements GW diffraction with an additional high mass diffraction.

In this talk I shall discuss the modelling and predictions derived from the above dynamical considerations, stressing the critical interplay between theory and data analysis. The implied gap survival probabilities will be discussed by Gotsman in the following talk. I shall assume a Regge like parametrisation in which the \mathbb{P} is super critical, i.e. $\alpha_{\mathbb{P}}(t) = 1 + \Delta_{\mathbb{P}} + \alpha'_{\mathbb{P}}t$, where $\Delta_{\mathbb{P}} > 1$. The above \mathbb{P} exchange violates s -unitarity at high energies. Recall that implementing s -unitarity is model dependent. I shall confine myself to eikonal models which have the virtue of simplicity.

In the ISR-Tevatron range σ_{tot} and σ_{el} are well reproduced by Donnachie-Landshoff (DL) non screened Regge parametrisation with $\Delta_{\mathbb{P}} = 0.08$ and $\alpha'_{\mathbb{P}} = 0.25 \text{ GeV}^{-2}$. The energy dependence of the soft diffractive cross sections (notably σ_{sd}) is much milder, implying that strong screenings initiated by s -unitarity must be taken into account. As we shall see, the interplay between theory and data analysis results in strong constraints on both $\Delta_{\mathbb{P}}$ and $\alpha'_{\mathbb{P}}$ inputs. This results has profound consequences for the nature of the Pomeron and its QCD foundations, suggesting a unifying interpretation of soft and hard Pomerons.

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2 Good-Walker Eikonal Models

Consider a system of two states, a hadron Ψ_h and a diffractive state Ψ_D which are orthonormal. The GW mechanism stems from the observation that these states do not diagonalise the 2x2 interaction matrix \mathbf{T} . Lets introduce two wave functions Ψ_1 and Ψ_2 which diagonalise \mathbf{T} ,

$$A_{i,k}^{i',k'} = \langle \Psi_i \Psi_k | \mathbf{T} | \Psi_{i'} \Psi_{k'} \rangle = A_{i,k} \delta_{i,i'} \delta_{k,k'}. \quad (1)$$

i.e. the $A_{i,k}$ amplitudes are constructed from the elastic scattering of Ψ_i and Ψ_k . In this representation the observed hadronic states are written

$$\Psi_h = \alpha \Psi_1 + \beta \Psi_2 \quad \Psi_D = -\beta \Psi_1 + \alpha \Psi_2, \quad (2)$$

where $\alpha^2 + \beta^2 = 1$. The corresponding unitarity equations are

$$\text{Im } A_{i,k}^S(s, b) = |A_{i,k}^S(s, b)|^2 + G_{i,k}^{in}(s, b), \quad (3)$$

where $G_{i,k}^{in}$ is the summed probability for all non GW inelastic processes induced by an initial (i, k) state. A general solution of Eq. (3) can be written as

$$A_{i,k}^S(s, b) = i \left(1 - \exp \left(-\frac{\Omega_{i,k}^S(s, b)}{2} \right) \right), \quad (4)$$

$$G_{i,k}^{in}(s, b) = 1 - \exp(-\Omega_{i,k}^S(s, b)), \quad (5)$$

where $\Omega_{i,k}^S$ are arbitrary. In the eikonal approximation $\Omega_{i,k}^S$ are assumed to be real and determined by the Born (non-screened) input. From Eq. (5) we deduce that the probability that the initial projectiles (i, k) reach the final LRG diffractive interaction unchanged, regardless of the initial state re-scatterings, is given by $P_{i,k}^S = \exp(-\Omega_{i,k}^S(s, b))$. In general, we have to consider four possible (i, k) elastic re-scattering options. For initial p - p (or \bar{p} - p) the two off diagonal amplitudes are equal, $A_{1,2}^S = A_{2,1}^S$. The corresponding elastic, SD and DD amplitudes are

$$a_{el}(s, b) = i \{ \alpha^4 A_{1,1}^S + 2\alpha^2 \beta^2 A_{1,2}^S + \beta^4 A_{2,2}^S \}, \quad (6)$$

$$a_{sd}(s, b) = i \alpha \beta \{ -\alpha^2 A_{1,1}^S + (\alpha^2 - \beta^2) A_{1,2}^S + \beta^2 A_{2,2}^S \}, \quad (7)$$

$$a_{dd} = i \alpha^2 \beta^2 \{ A_{1,1}^S - 2A_{1,2}^S + A_{2,2}^S \}. \quad (8)$$

The GW mechanism was originally conceived so as to describe a system of a nucleon plus its diffractive N^* isobars. Obviously, this simplistic approach is not suitable for high energy diffraction where M_{diff}^2 is bounded by $0.05s$ ¹, implying a continua of diffractive Fock states. Throughout this talk I shall relate to GLMM [5] and KMR [6] models which are conceptually very similar, but differ significantly in both their formalism and data analysis. In the present context, two procedures were devised to overcome the above difficulty: GLMM lump together all GW diffractive states to an effective $|D\rangle$ state, to which we add the non GW \mathcal{P} enhanced high mass diffraction. In this approach the GW contribution is very significant and the mass distribution is smooth. KMR and LKMR [7] chose to confine GW diffraction to low

¹this is an arbitrary bound commonly used.

$M_{diff}^2 < 10 \text{ GeV}^2$, to which they add the high mass \mathbb{P} enhanced contribution. In this approximation the bulk of the diffractive mass is non GW, and its smoothness at 10 GeV^2 is not secured.

GLMM, KMR and LKMR are multi channel eikonal models in which the initial re-scatterings of the incoming projectiles includes also GW diffractive states.

$$\Omega_{i,k}^S(s, b) = \nu_{i,k}^S(s) \Gamma_{i,k}^S(s, b, \dots), \quad (9)$$

where $\nu_{i,k}^S(s) = g_i g_k (\frac{s}{s_0})^{\Delta_{\mathbb{P}}}$ and $\Gamma_{i,k}^S$ are the b -space profiles. The profiles are external information in as much as, beside their normalization and asymptotic constraints on their behaviour, they are determined by the data analysis. In GLMM $\Gamma_{i,k}^S$ are given as the b -transform of a two t -poles expression ($t = -q^2$). Setting $\alpha'_{\mathbb{P}}=0$, the profiles are energy independent

$$\frac{1}{(1 + q^2/m_i^2)^2} \times \frac{1}{(1 + q^2/m_k^2)^2} \implies \Gamma^S(b; m_i, m_k; \alpha'_{\mathbb{P}} = 0). \quad (10)$$

GLMM introduce a small energy dependence

$$m_i^2 \implies m_i^2(s) \equiv \frac{m_i^2}{1 + 4m_i^2 \alpha'_{\mathbb{P}} \ln(s/s_0)}. \quad (11)$$

The above parametrisation is compatible with the requirements of analyticity/crossing symmetry at large b , pQCD at large q^2 and Regge at small q^2 . For details see Ref. [5]. KMR and LKMR use a different parametrisation for $\Gamma_{i,k}^S$ which is numerically compatible with GLMM. The 3 groups reproduce $d\sigma_{el}/dt$ well in the forward $t < 0.5 \text{ GeV}^2$ cone.

Consider a model in which diffraction is exclusively GW. This was recently considered by GLMM and LKMR. These, as well as earlier KMR GW models, fit the (different) elastic sectors of their data bases, obtaining output fitted $\Delta_{\mathbb{P}} = 0.10 - 0.12$ with $\chi^2/d.o.f. < 1.0$. The above GW models fail to reproduce the diffractive sectors of their data bases. This deficiency is traced to the need to add the enhanced \mathbb{P} high mass contributions. This has been done in GLMM and KMR. LKMR model is confined to Muller's $3\mathbb{P}$ approximation.

3 Multi Pomeron Interactions

Consider a single diffraction channel $p + p \rightarrow p + M_{sd}$. Mueller's triple Pomeron mechanism, derived from 3 body unitarity, leads to high SD mass which is non GW. In the leading order

$$M_{sd}^2 \frac{d\sigma^{3\mathbb{P}}}{dt dM_{sd}^2} = \frac{1}{16\pi^2} g_p^2(t) g_p(0) G_{3\mathbb{P}}(t) \left(\frac{s}{M_{sd}^2} \right)^{2\Delta_{\mathbb{P}} + 2\alpha'_{\mathbb{P}} t} \left(\frac{M_{sd}^2}{s_0} \right)^{\Delta_{\mathbb{P}}}. \quad (12)$$

The virtue of Eq. (12) is that $\Delta_{\mathbb{P}}$ can be determined from either the energy or mass dependences of the SD cross sections. This approximation is valid for $s \gg M_{sd}^2 \gg m_p^2$.

CDF analysis suggests [8] a relatively large value of $G_{3\mathbb{P}}$. Consequently, we need to consider a very large family of multi Pomeron interactions (enhanced \mathbb{P}) which are not included in the GW mechanism. As we shall see, this "new" dynamical feature initiates profound differences in the calculated values of soft cross sections and induces additional non GW diffractive gap

survival probabilities (soft and hard). Note that these features become significant above the Tevatron energy.

GLMM and KMR treatment of \mathbb{P} enhanced interactions stems from Gribov [1] and Kaidalov et al. [9] classical papers on Reggeon calculus. Recall that in this context the soft Pomeron is a simple pole in the J -plane, while the hard (BFKL) Pomeron is a branch cut. KMR model, which is a partonic model, derives directly from these sources. Its summation is confined to semi-enhanced \mathbb{P} diagrams (see Fig. 1b). KMR calculations are based on two ad hoc assumptions: 1) The coupling of a multi \mathbb{P} point vertex $n\mathbb{P} \rightarrow m\mathbb{P}$ ($n + m > 2$) is $g_m^n = \frac{1}{2}g_N n m \lambda^{n+m-2}$. In this notation $G_{3\mathbb{P}} = \lambda g_N$. Note that in Kaidalov et al. $g_m^n = \frac{1}{2}g_N \lambda^{n+m-2}$. 2) Most of LHC non GW diffractive reactions of interest are hard. Given a $3\mathbb{P}$ vertex, $G_{3\mathbb{P}}$ is unchanged by the interchange of soft and hard Pomerons. This is not self evident. A possible support for the above is obtained from GLMM interpretation of the Pomeron (see below).

As we shall see in the next chapter, the data analysis executed by GLMM and KMR converges to compatible exceedingly small $\alpha'_{\mathbb{P}}$ values and high, BFKL like, $\Delta_{\mathbb{P}} \simeq 0.30 - 0.35$. The adjustments of these parameters are correlated. In non screened Regge model $\Delta_{\mathbb{P}}$ controls the elastic cross section energy dependence, while $\alpha'_{\mathbb{P}}$ controls the energy dependence of the (shrinking) elastic slope. As $\alpha'_{\mathbb{P}}$ gets smaller $\Delta_{\mathbb{P}}$ becomes larger initiating stronger screening which compensates the reduction of $\alpha'_{\mathbb{P}}$, and vice versa. As we saw, the vanishing value of the fitted $\alpha'_{\mathbb{P}}$ was induced by the GLMM and KMR b-profiles chosen so as to reproduce the elastic differential cross section. These results have profound implications:

1) A key observation of GLMM is that the exceedingly small fitted value of $\alpha'_{\mathbb{P}}$ implies that the “soft” \mathbb{P} is hard enough to be treated perturbatively. Following Gribov we identify the correlation between $\alpha'_{\mathbb{P}}$ and $\langle p_t \rangle$, the mean transverse momentum of the partons (actually, colour dipoles) associated with the \mathbb{P} . $\langle p_t \rangle = 1/\sqrt{\alpha'_{\mathbb{P}}}$, from which we deduce that the QCD running coupling constant $\alpha_S \ll 1$. Accordingly, we proceed from Gribov’s parton model interpretation to pQCD. GLMM sum over the enhanced diagrams. Technically, we have adopted the MPSI procedure [10] in which g_m^n is reduced to a sequence of triple \mathbb{P} vertexes (Fan diagrams). For details see Ref. [5]. This may pose a problem for the calculation of SD cross section for which the lowest order diagram is semi enhanced. To avoid this problem we have added to this calculation a term by term summation of the relevant semi enhanced diagrams.

2) The fitted high value of $\Delta_{\mathbb{P}}$ initiates strong screening which results in a renormalisation of the Pomeron exchange amplitudes. As a result $\Delta_{\mathbb{P}}^{eff}$ is reduced monotonically with energy. In GLMM calculations $\Delta_{\mathbb{P}}^{eff}(2 \text{ TeV}) \simeq 0.070$, $\Delta_{\mathbb{P}}^{eff}(14 \text{ TeV}) \simeq 0.045$ and $\Delta_{\mathbb{P}}^{eff}(60 \text{ TeV}) \simeq 0.032$. KMR results are compatible with ours, see Table 2. The slow decrease of $\Delta_{\mathbb{P}}^{eff}$ raises the question if its value may become negative at high enough energies, larger than $W = 10^5 \text{ GeV}$ which is the bound of validity of both GLMM and KMR. In GLMM we have checked that $\Delta_{\mathbb{P}}^{eff}(100 \text{ TeV}) > 0$. I am less clear about KMR. The compatibility between GLMM and KMR is surprising. As noted, GLMM sum over the enhanced diagrams (Fig. 1a) while KMR sum over the semi enhanced diagrams (Fig. 1b). Very intuitively (at the risk of being wrong), it

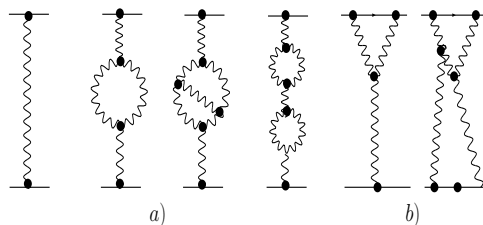


Figure 1: Low order terms of the Pomeron Green’s function. a) Enhanced. b) Semi-enhanced.

seems that GLMM renormalise the \mathbb{P} propagator while KMR renormalise the \mathbb{P} vertex. A complete calculation should, obviously, include both contributions.

4 The Interplay Between Theory and Data Analysis

The data analysis of interest aims to adjust the theoretical parameters. To this end we construct:

- 1) A suitable data base adjusted, so as to fix the parameters with a satisfactory resolution.
- 2) An adjustment procedure, be it a fit (GLMM, LKMR) or tuning by trial and error (KMR).
- 3) We distinguish between an adjustment of all free parameters which is executed through a reconstruction of the entire data base in one step (GLMM), and a two steps (KMR, LKMR) procedure, in which the first step determines the GW free parameters by adjusting the elastic sector of the data base. These parameters are fixed in the second step in which the rest of the free parameters are determined.

There is a significant difference between the data analysis carried out by GLMM and KMR. This reflects both in the choices of data bases made by the two groups and their adjustment procedures. The starting point of both investigations is the observation that a GW model reproduces the elastic data well, but its reproduction of the diffractive sector is deficient. Both groups claim to achieve an improved reproduction of their over all data base once the contributions of enhanced Pomeron diagrams are included.

GLMM have constructed a global data base so as to simultaneously fit all its free parameters. It includes σ_{tot} , σ_{el} , σ_{sd} , σ_{dd} and B_{el} in the ISR-Tevatron range, CDF differential elastic cross sections and SD mass distribution were checked for consistency. The conceptual approach of KMR and LKMR is completely different. Their data base contains only the measured values of $d\sigma_{el}/dt$, which enables to predict σ_{tot} , and $d\sigma_{sd}/dt d(M_{sd}^2/s)$. In my opinion KMR data base is too limited to enable a substantiation of their premises. Specifically:

- 1) As we saw, the b -profiles $\Gamma_{i,k}^S$ control the features of $d\sigma_{el}/dt$ which are only weakly coupled to the proposed dynamics. I have checked 6 models, published over the last 10 years (3KMR+LKMR+2GLMM) with different dynamics, i.e., exclusive GW (GLMM, LKMR), GW+zero order \mathbb{P} enhancement (LKMR) and GW+ \mathbb{P} enhancement (GLMM+2KMR). The output fitted parameters spread over $0.1 \leq \Delta_{\mathbb{P}} \leq 0.55$ and $0 \leq \alpha'_{\mathbb{P}} \leq 0.066$. All 6 models reproduce, almost identically, the CDF distributions of $d\sigma_{el}/dt$ with $|t| \leq 0.5 \text{ GeV}^2$. The unavoidable conclusion is that a reconstruction of $d\sigma_{el}/dt$ on its own has no resolution power. The only common ingredient to all 6 models is their compatible b -profiles. These profiles constrain $\alpha'_{\mathbb{P}}$ to very small values. This is the key observation leading to a pQCD (GLMM) or partonic (KMR) \mathbb{P} interpretation.
- 2) The reconstructions of CDF $d\sigma_{sd}/dt d(M_{sd}^2/s)$ by GLMM, LKMR and KMR, are remarkably similar. They support the introduction of high mass multi Pomeron interactions. In my opinion, though, this investigation, in its present state, is unable to provide a decisive verdict on this issue. GLMM and KMR sum different sectors of the enhanced diagrams. LKMR take into account only the lowest order Mueller's $3\mathbb{P}$ diagram. Regardless of these differences, the three groups produce compatible output results which indicate that CDF data, as is, is not sufficient to differentiate between different modes of \mathbb{P} enhanced diagram summations.
- 3) To further clarify the experimental limitations, let us recall that CDF non conventionally define their high mass diffraction bound at $1 - x_L = \frac{M_{sd}^2}{s} \leq 0.15$ (the common bound is 0.05).

KMR and LKMR define a lower bound $M_{sd}^2 > 10 \text{ GeV}^2$ which corresponds to $1 - x_L = 3 \cdot 10^{-6}$. Note that CDF SD mass distribution available for analysis corresponds to $1 - x_L > 3 \cdot 10^{-3}$. This mass distribution covers less than 35% of the expected high diffractive mass spectra. GLMM have a completely different classification in which the GW low mass diffraction reduces monotonically with no arbitrary upper bound and the high mass is defined above 10 GeV^2 , identical to KMR. Additional difficulty with the analysis of CDF data with $1 - x_L > 0.03$ is that a large arbitrary background contribution has to be added. It is induced by secondary Regge diagrams such as $\mathbb{P}\mathbb{P}R$. An added element of ambiguity is that LKMR with a zero order $3\mathbb{P}$ calculation is as successful as the high order summations of GLMM and KMR.

	$\Delta_{\mathbb{P}}$	β	$\alpha'_{\mathbb{P}}$ GeV ⁻²	g_1 GeV ⁻¹	g_2 GeV ⁻¹	m_1 GeV	m_2 GeV	$\chi^2/d.o.f.$
GW	0.120	0.46	0.012	1.27	3.33	0.913	0.98	0.87
GW+ \mathbb{P} - <i>enh.</i>	0.335	0.34	0.010	5.82	239.6	1.54	3.06	1.00

Table 1: Fitted parameters for GLMM GW and GW+ \mathbb{P} -enhanced models.

GLMM fitting procedure aims to reproduce our global data base. A fit with a GW model (no \mathbb{P} -enh) provides excellent reproduction of our elastic sector while the the reproduction of the diffractive sector is very poor! The repeated fit with a GW+ \mathbb{P} -enh model results with a very good χ^2 . The outputs of both models are presented in Table 1. Checking we note that the exceedingly small value of $\alpha'_{\mathbb{P}}$ is persistently obtained in both models. The outputs of $\Delta_{\mathbb{P}}$ and g_2 change drastically once \mathbb{P} -enh is included. As we shall see this has significant consequences for the approach of $a_{el}(s, b)$ toward the black disc bound. As we have noted, KMR and LKMR tune g_1 and g_2 through a reproduction of $d\sigma_{el}/dt$ which are frozen in the next phase reproduction of $d\sigma_{sd}/dt d(M_{sd}^2/s)$. The values they obtain for $\Delta_{\mathbb{P}}$ and $\alpha'_{\mathbb{P}}$ are compatible with GLMM.

	Tevatron			LHC			W=10 ⁵ GeV		
	GLMM	KMR(07)	KMR(08)	GLMM	KMR(07)	KMR(08)	GLMM	KMR(07)	KMR(08)
σ_{tot}	73.3	74.0	73.7	92.1	88.0	91.7	108.0	98.0	108.0
σ_{el}	16.3	16.3	16.4	20.9	20.1	21.5	24.0	22.9	26.2
σ_{sd}	9.8	10.9	13.8	11.8	13.3	19.0	14.4	15.7	24.2
σ_{dd}	5.4	7.2		6.1	13.4		6.3	17.3	

Table 2: Comparison of GLMM, KMR(07) and KMR(08) cross sections in mb.

GLMM and KMR high energy Tevatron, LHC and Cosmic Rays predicted cross sections are summarised in Table 2. The elastic and total cross section outputs of the two models are compatible and, above the Tevatron, significantly lower than those obtained in models with no multi-Pomeron contributions. This is a consequence of $\Delta_{\mathbb{P}}$ renormalization due to the enhanced \mathbb{P} contributions. GLMM and KMR(07) predicted σ_{sd} are compatible, where KMR(07) are systematically larger by approximately 10%. KMR(08) predicted σ_{sd} are considerably larger than GLMM as well as KMR(07) and are growing at a faster rate. The difference between KMR(07) and GLMM σ_{dd} predictions is even more dramatic, where $\sigma_{dd}(KMR(07))/\sigma_{dd}(GLMM) \simeq 3$ at $W = 10^5 \text{ GeV}$. This very large difference is due to KMR large diffractive high mass predictions. The recent KMR(08) neglects to mention the high diffractive mass sector of double diffraction while showing higher SD cross sections than in KMR(07).

In my opinion the GLMM and KMR compatible predictions of total and elastic cross sections at the LHC and AUGER are of fundamental importance because they are significantly lower than the predicted values based on unitarity models with no \mathcal{P} enhancement. These measurements may provide a decisive support for the importance of multi-Pomeron interactions at high enough energies and, consequently, imply that the growth of the total and elastic cross sections with energy is much more moderate than anticipated. This feature reflects in the slow decrease of $\Delta_{\mathcal{P}}^{eff}$ shown in Sec 3.

5 The Approach Toward the Black Disc Bound

The base amplitudes of GLMM are $A_{i,k}^S$, with b dependences specified in Eq. (10) – Eq. (11). These are the building blocks with which we construct a_{el} , a_{sd} and a_{dd} (Eq. (6) – Eq. (8)). The $A_{i,k}^S$ amplitudes are bounded by the black disc unitarity limit of unity. Checking GLMM fitted parameters, presented in Table 1, we observe that g_1 and g_2 , which are comparable in the GW model, significantly change in the GW+ \mathcal{P} enhanced model where we obtain $g_2 \gg g_1$. The implication of our fitted values of g_1 and g_2 , is that including the diffractive data in our global fit forces a large inequality between the three GW $A_{i,k}^S$ components. $A_{2,2}^S(s, b = 0)$ reaches unity at a very low energy, $A_{1,2}^S(s, b = 0)$ reaches unity at approximately $W = 100$ GeV and $A_{1,1}^S(s, b = 0)$ reaches unity at exceedingly high energies, well above LHC. The observation that one, or even two, of our $A_{i,k}^S(s, b) = 1$ does not imply that the elastic scattering amplitude has reached the unitarity bound at these (s, b) values. $a_{el}(s, b)$ reaches the black disc bound when, and only when, $A_{1,1}^S(s, b) = A_{1,2}^S(s, b) = A_{2,2}^S(s, b) = 1$, independent of β . The approach of $a_{el}(s, b = 0)$ toward the black bound depends on the rate at which $A_{1,1}^S(s, b)$ increases with energy. Recall that this increase above LHC becomes ever so moderate as a consequence of the renormalization reduction of $\Delta_{\mathcal{P}}$. This feature coupled to the smallness of g_1^2 implies that $a_{el}(s, b)$ will reach the black bound at energies well above the LHC. Our results are different from the predictions of most available models, notably KMR, in which $a_{el}(s, b = 0)$ reaches unity a few TeV above LHC. Note, though, that GLMM is the only model which includes the diffractive along side the elastic data in its data analysis. All models which predict saturation of $a_{el}(s, b = 0)$ just above LHC have confined their data analysis exclusively to the elastic sector.

A consequence of the input $\Omega_{i,k}^S$ being very large at small b , is that $P_{i,k}^S(s, b)$ is exceedingly small at these small b values. As a result, given a diffractive (non screened) input, its output (screened) amplitude is peripheral in b . This is a general feature, common to all eikonal models regardless of their b -profiles details. The general behaviour indicated above becomes more extreme at ultra high energies, where a_{el} continues to get darker and expand. Consequently, the inelastic diffractive channels (soft and hard) becomes more and more peripheral and relatively smaller when compared with the elastic channel. Given (s, b) at which $a_{el}(s, b) = 1$, the corresponding diffractive amplitudes, GW and non GW, vanish.

The behaviour of the ratio $R_D = (\sigma_{el} + \sigma_{sd} + \sigma_{dd})/\sigma_{tot}$ conveys information regarding the onset of s-unitarity at very high energies. Assuming diffraction to be exclusively GW, we obtain [11] $R_D \leq 0.5$. Multi \mathcal{P} induced diffraction is not included in R_D since it originates from $G_{i,k}^{in}$. Hence its non screened high mass cross section is suppressed by its survival probability which decreases with energy. In GLMM $R_D < 0.5$, decreasing slowly. In KMR(07) $R_D > 0.5$, increasing slowly with energy. The partial information available on KMR(08) suggests that its R_D grows even faster.

6 Conclusions

This presentation centred on the phenomenology implied by multi Pomeron dynamics incorporated in soft diffraction and its consequences for soft scattering.

The concept of \mathbb{P} enhancement was triggered, at the time, by the assessment that $G_{3\mathbb{P}}$ is not too small. Our view of the Pomeron got more focused with the updated data analysis of soft scattering in which we get $\Delta_{\mathbb{P}} \simeq 0.30 - 0.35$ and $\alpha'_{\mathbb{P}} \simeq 0.01$. The implied KMR Pomeron is hard enough to be treated partonically, in which the traditional classification of the soft \mathbb{P} as a simple J-pole and the hard \mathbb{P} as a branch cut in the J-plane is maintained. GLMM went further ahead identifying the soft \mathbb{P} with the hard \mathbb{P} . This is, clearly, a fundamental theoretical issue which should be further investigated.

As it stands this dynamics is compatible with the data, but we can not support it, as yet, with a decisive signature. A GLMM and KMR prediction is the expected significant reduction, compared with non screened predictions, of σ_{tot} and σ_{el} at the LHC. In my opinion this measurement is of a critical value.

Decisive experimental signatures of \mathbb{P} -enh are expected, essentially, above the Tevatron. Consequently, we should be prudent when evaluating phenomenological models which reproduce the Tevatron data well. This is, obviously, required of a successful model, but is definitely not sufficient.

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