EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN-SL-2000-077 AP

Single diffraction at high momentum transfers

I. Baishev*

Abstract

In this report an exponential trajectory for the Pomeron is introduced for better description of the inclusive differential cross-section of single diffraction at high 4-momentum transfers.

Geneva, Switzerland

November 2000

* Also IHEP, Protvino, Russia

The single diffractive collisions in the interaction points of the LHC can be important for beam loss studies [1], [2]. Each of the two high luminosity interaction points will produce up to $1.5 \cdot 10^8$ diffractive protons per second. The location of such proton losses in the machine depends on 4-momentum transfer t and on the fraction of the momentum loss $\xi = 1 - p/p_0$.

The majority of the measured differential cross-sections covers the range of $|t| \leq 1\mathrm{GeV}^2$ and the parameters of theoretical and phenomenological models were fitted in the same range of t. The most recent comprehensive analysis of single diffraction data is given in [3] for the widest possible range of the center of mass energy squared s. The formula for the differential cross-section proposed in [3] can be written as

$$\frac{d^2\,\sigma_{sd}}{d\xi\,dt} = 5.865\left(\frac{1}{s}\right)^{\epsilon} F^2(t)\,\xi^{1+\epsilon-2\alpha_P(t)}\ [\frac{\mathrm{mb}}{\mathrm{GeV}^2}]\ , \qquad (1)$$

where $\alpha_P(t)$ is the Pomeron Regge trajectory and

$$F(t) = \frac{4m^2 - 2.8t}{4m^2 - t}\left(1 - \frac{t}{0.71}\right)^{-2}$$

is the proton form factor, m is the mass of the proton.

All the experimental data at small t are described successfully by the expression (1) with the linear Pomeron trajectory

$$\alpha_P(t) = 1 + \epsilon + \alpha' t \qquad (2)$$

with $\epsilon = 0.104$, $\alpha' = 0.25\ \mathrm{GeV}^{-2}$. However the higher is $|t|$ the worse is the agreement with the measured data. This can be clearly seen in Figure 1 where the case of linear $\alpha_P(t)$ is shown by the dashed curves.

The analysis [6] of single diffraction at $\sqrt{s} = 630$ GeV measured by UA8 collaboration shows that $\alpha_P(t)$ is not linear for $|t| > 1\mathrm{GeV}^2$. A quadratic term in t is introduced in [6] for the best fit of their data measured in the range $2\mathrm{GeV}^2 > |t| > 0.8\mathrm{GeV}^2$. Such an approach means that if new data at higher t would appear then, more cubic, biquadratic etc. terms with corresponding free parameters should be added to the linear trajectory of Pomeron.

We therefore propose to replace the linear trajectory by the exponential one

$$\alpha_P(t) = \epsilon + e^{\alpha' t} \qquad (3)$$

without introducing any new parameters. This empirical trajectory improves the agreement of formula (1) with the experimental data at the highest measured t (see solid lines in Figure 1) while the good agreement at lower t remains unchanged.

We would like to thank J.B. Jeanneret for his helpful comments.

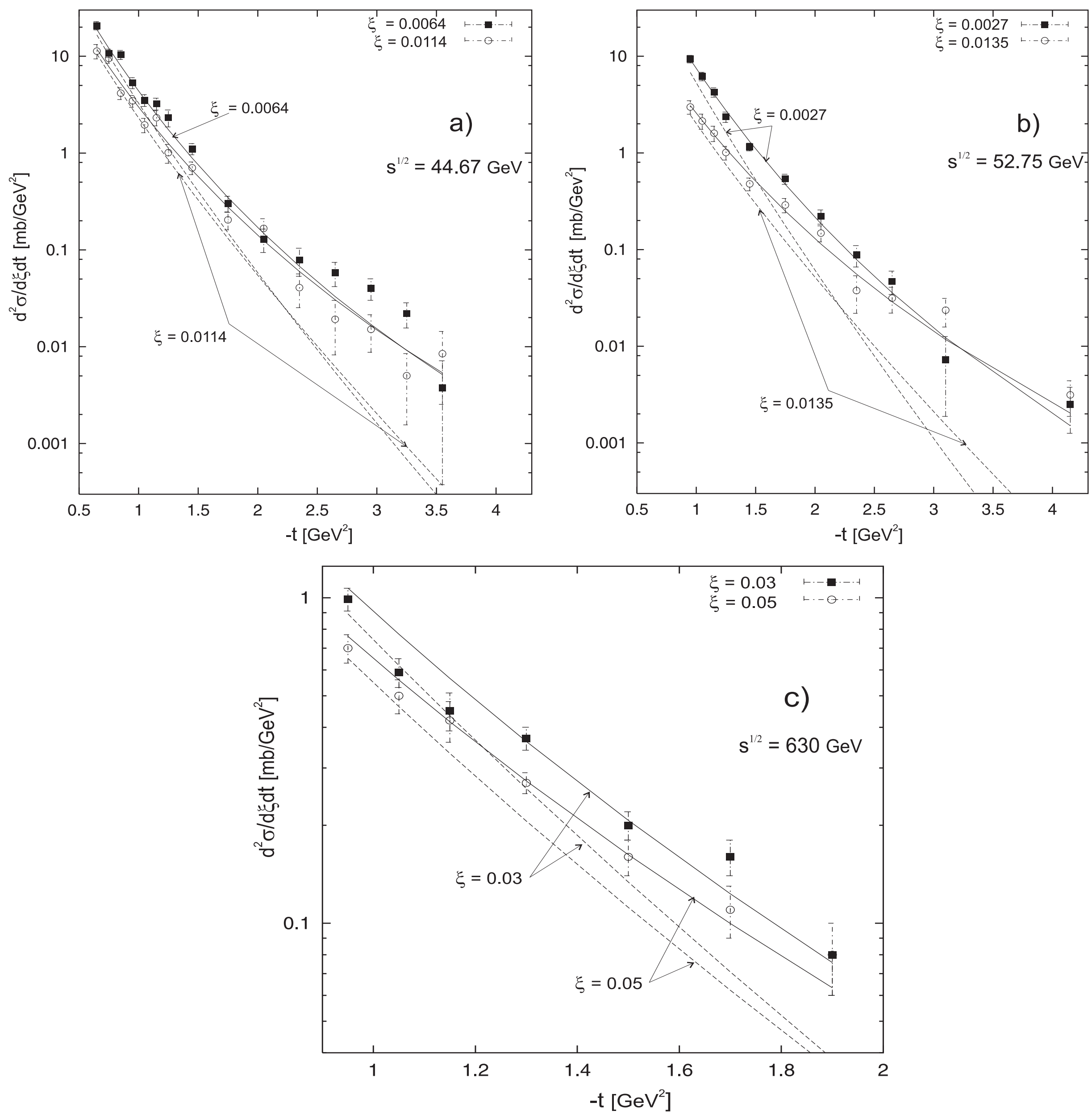

Figure 1: The inclusive differential cross-sections of the single diffraction. Points with errorbars show the experimental data: ISR [5] - a),b) and UA8 [6] - c). Dashed lines represent the formula (1) with linear $\alpha_P(t)$ as given by the expression (2). Solid lines represent the same formula (1) with the proposed nonlinear expression (3) for $\alpha_P(t)$.

References

[1] LHC Conceptual Design, CERN/AC/95-05, (1995), p.48.

[2] I. Ajguirei et al., LHC Project Report 398, 2000.

[3] K. Goulianos and J. Montanha, Phys.Rev. D59, 114017(1999)

[4] A. Donnachie and P.V. Landshoff, Nucl.Phys. B303, 634(1988)

[5] M.G. Albrow et al., Nucl.Phys. B108, 1(1976)

[6] A. Brandt et al., Nucl.Phys. B514, 3(1998)