

High energy proton-proton cross-section and Froissart bound

R C BADATYA[†] and P K PATNAIK,

[†]Present Address: Bhima Bhoi College, Rairakhol, Sambalour, India
Post Graduate Department of Physics, Sambalpur University, Jyoti Vihar, Burla,
Sambalpur 768 017, India

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Abstract. A model for high energy proton-proton system is developed which obeys several asymptotic bounds including Froissart bound. The amplitude taken has two parts, a Regge part and a pomeron part. The Regge part is described by the exchange degenerate pair w and P' . To calculate the pomeron part the Freund-Harari duality is invoked which states that the pomeron is dual to the s -channel background. The s -channel background is estimated by parametrising the branch cuts in S through a conformal mapping method. Expressions for total cross-section, ratio of real-to-imaginary parts of forward amplitude and the slope parameter are presented. The corresponding quantities for $p\bar{p}$ are also evaluated. Our analysis favours strong exchange degeneracy.

Keywords. Proton-proton cross-section; Froissart bound; duality; pomeron; asymptotic bounds; scattering amplitude.

1. Introduction

High energy proton-proton scattering is characterised by a rising cross-section, shrinking forward peak, almost imaginary nature of the amplitude and a smooth t -dependence of differential cross-section which develops a dip at relatively higher energies. The dominant high energy behaviour of the total cross-section is very close to $(\ln s/s_0)^2$. Doubt still persists whether the data actually saturate the Froissart bound or violates it. Analysis of CERN, ISR and NAL data by Leith (1975) gives a fit for σ_T (in mb);

$$\sigma_T = 38.34 + (0.376 \pm 0.015) (\ln s/93.7 \text{ GeV}^2)^{2.10 \pm 0.07}. \quad (1)$$

This fit does violate Froissart bound. However Leader and Maor (1973) suggested a similar fit which obeys Froissart bound and still agrees with the experiment. Amaldi *et al* (1977, 1978) also presented two sets of data analysis, one preserving the Froissart bound at lower limit and the other violating it explicitly. The expressions are:

$$\begin{aligned} \sigma_T^{A1} = & (41.9 \pm 1.1) E^{-0.37 \pm 0.37} - (24.2 \pm 1.1) E^{-0.55 \pm 0.02} \\ & + (27.0 \pm 1.0) + (0.17 \pm 0.08) (\ln s)^{2.10 \pm 0.10}, \end{aligned} \quad (2)$$

$$\begin{aligned} \sigma_T^{A2} = & 4.40 N_a^H P_{\text{lab}}^{0.13} + 4.00 N_a^H \cdot N_{\text{ns}}^H P_{\text{lab}}^{-0.20} \\ & - 7.8 (N_a^H + 2 N_{\bar{a}}^H) P_{\text{lab}}^{-0.50}. \end{aligned} \quad (3)$$