Addendum to "Geometric scaling and multiplicity distribution in high-energy pp collisions"*

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We have used the parametrization of the profile function proposed by us in an earlier paper to predict the large-t differential cross section for pp elastic scattering at CERN ISR center-of-mass energies $\sqrt{s} = 23.5$ GeV and above. For $\sqrt{s} = 53$ GeV this extends our $-t$ range from $0.0 \le -t \le 5.2$ GeV^2 to $0.0 \le -t \le 8$ GeV^2. We predict a second dip at $-t = 5.6 \pm 0.5$ GeV^2.

In an earlier paper[1] we had proposed a parametrization for the profile function $\Gamma(b,s)$ [or equivalently, the opacity $\Omega(b,s)$] to fit the CERN ISR pp elastic data at center-of-mass energies $\sqrt{s} = 23.5$, 30.7, 44.9, and 53 GeV. The parametrization of the profile function in terms of the impact parameter b is given by[1]

$$\Gamma(b,s) = 1 - e^{-\Omega(b,s)} = N_0\left[\frac{1}{1+e^{(b-B_0)A}} + \frac{C}{2} e^{-b^2/4D}\right]. \quad (1)$$

The five parameters A, B_0, C, D, and N_0 were determined by fitting the total cross section[2,3] and the differential cross sections[4] at $\sqrt{s} = 53$ GeV and $0 \le -t \le 5.2$ GeV^2. The values of the five parameters at other energies were then obtained by using the concept of geometric scaling.[5-7] The details are to be found in our earlier paper.[1] The fits to the differential cross sections then available were satisfactory. As experiments at larger-momentum transfers are now being done[8] at the CERN ISR, we have extended our analysis to momentum transfers $-t$ up to 8 GeV^2.

In Fig. 1 we show our results on a geometric scaling plot.[7] By plotting $(1/\sigma_T{}^2)d\sigma/dt$ vs $-t\sigma_T$ we present results that should be energy-independent and valid at least for $\sqrt{s} > 23.5$ GeV. Note the presence of a second dip at $-t\sigma_T = (240 \pm 20)$ mb GeV^2. The error given is obtained by varying C and D of Eq. (1) within tolerable limits. At $\sqrt{s} = 53$ GeV this corresponds to $-t = 5.6 \pm 0.5$ GeV^2 using $\sigma_T = 43.1$ mb. The total cross section rises[9] to 44 mb at $\sqrt{s} = 62.3$ GeV. Thus, at this energy the second dip would move in to $-t = 5.5 \pm 0.5$ GeV^2.

Our model gives zero amplitudes at $-t\sigma_T = 54$ mb GeV^2 and at 240 mb GeV^2, owing to our neglect of the real part. Using the method of Dias de Deus,[10] we computed the correction in $d\sigma/dt$ due to the real part. We find that although the second dip is filled in, its position is not changed (as in the case of the first dip).[7] In conclusion, our parametrization of the profile function implies a second dip at all the CERN ISR energies. In particular, we expect a second dip between 5 and 6 GeV^2 in $-t$ at CERN ISR energies $\sqrt{s} = 62.3$ and 53 GeV. It would be very desirable to have good data in the momentum-transfer range $5 \le -t \le 7$ GeV^2.

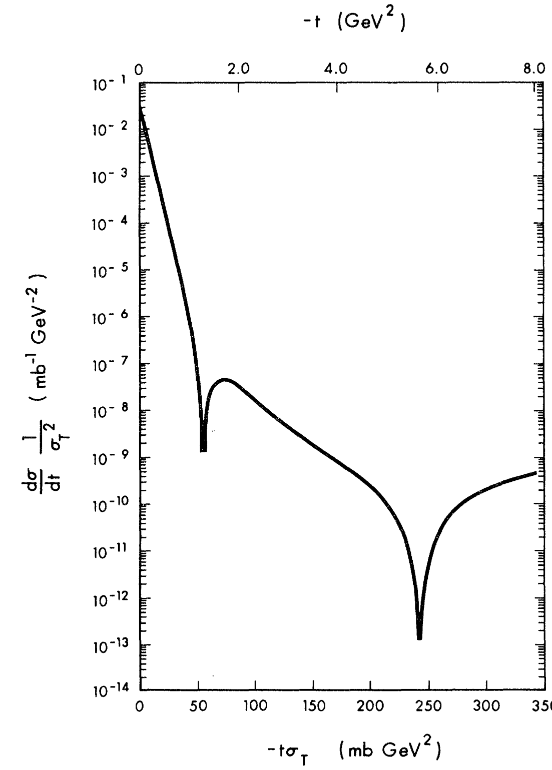

FIG. 1. Geometric scaling plot of the proton-proton elastic differential cross section predicted by Ref. 1. This should be valid for all ISR energies. In addition to the energy-independent $-t\sigma_T$ abscissa we have presented a scale for $-t$ valid for $\sqrt{s} = 53$ GeV.

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