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ЛАБОРАТОРИЯ ВЫСОКИХ ЭНЕРГИЙ

COMPARISON OF NEW DATA ON p-p ELASTIC SCATTERING AT 15 - 30 GEV/C WITH CALCULATIONS BASED ON THE MODEL OF THE DISCRETE VALUES $< P_{\perp}^{2} >^{1/2}$

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COMPARISON OF NEW DATA ON p-p ELASTIC SCATTERING AT 15 - 30 GEV/C WITH CALCULATIONS BASED ON THE MODEL OF THE DISCRETE VALUES $< p_{\perp}^{2} >^{1/2}$

The experimental data on $p-p$ elastic scattering at > 7 GeV in a wide range of angles - from small ones (when the Coulomb scattering contribution is unessential) to angles of ~ 70° (when differential cross sections at a given energy tend to saturation) have been described in refs.[1,2] by the formula:

$$\frac{d\sigma}{d|t|} = \{ C_1 \exp\left(\frac{t+\frac{t^2}{4p^2}}{<p_\perp^2>}\right) + C_2 \exp\left(\frac{t+\frac{t^2}{4p^2}}{4<p_\perp^2>}\right) + C_3 \exp\left(\frac{t+\frac{t^2}{4p^2}}{9<p_\perp^2>}\right) +$$

$$+ 2(C_1 C_2)^{1/2} \cos\phi_2 \exp\left(\frac{t+\frac{t^2}{4p^2}}{\frac{8}{5}<p_\perp^2>}\right) + 2(C_1 C_3)^{1/2} \cos\phi_3 \exp\left(\frac{t+\frac{t^2}{4p^2}}{\frac{9}{5}<p_\perp^2>}\right) +$$

$$+ 2(C_2 C_3)^{1/2} \cos(\phi_2 - \phi_3) \exp\left(\frac{t+\frac{t^2}{4p^2}}{\frac{72}{13}<p_\perp^2>}\right) \} \left[1 + \frac{t}{2p^2}\right],$$

where p is the momentum in the c.m.s. This formula has been obtained on the assumption of the interference of partial waves due to discrete effective scattering radii. This is equivalent to the condition:

$$< P_{\perp}^{2} >_{1}^{1/2} : < P_{\perp}^{2} >_{2}^{1/2} : < P_{\perp}^{2} >_{3} = 1 : 2 : 3 \; {}^{x/}, \qquad (2)$$

where $< P_{\perp}^{2} >^{1/2}$ is the root-mean-square transversal momenta. In ref.[3] $p - p$ elastic scattering has been studied at 15, 20 and 30 GeV/c. In this case the region $/t/ \approx 1 (GeV/c)^2$ has been inverstigated in detail. Figure 1 presents the curve obtained for the following parameters by formula (1): $< p_{\perp}^{2} >^{1/2} = 0.345$ GeV/c; C_1, C_2, C_3 are equal to $88 \cdot 10^{-27} cm^2/(GeV/c)^2$; $0.15 \cdot 10^{-27} cm^2/(GeV/c)^2$; $0.001 \cdot 10^{-27} cm^2/(GeV/c)^2$, respectively; $\phi_2 = 150^{\circ}$; $\phi_3 = 0^{\circ}$. The experimental data in Fig. 1 are taken at 20 GeV/c from[3] and at 19.2 GeV/c from[4]. Figure 2 shows the curves illustrating contributions of different exponents from formula (1) at 19.2 GeV/c. As is seen from Fig. 2, exponent 1, involving C_1, gives a main contribution to $\frac{d\sigma}{d|t|}$ for $P_{\perp} \approx 0.5$GeV/c; for $P_{\perp} \approx 1.5 \div 2$ GeV/c $\frac{d\sigma}{d|t|}$ is in the main determined by exponent 2 with C_2, and for $P_{\perp} > 2.5$ GeV/c - by exponent 3 with C_3.

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x/ The general view of formula (1) at $< P_{\perp}^{2} >^{1/2} : \ldots : < P_{\perp}^{2} > = 1 \ldots n$

$$\frac{d\sigma}{d|t|} = \{ \sum_{k=1}^{n} C_k \exp\left(\frac{t + \frac{t^2}{4p^2}}{< P_{\perp}^{2} >}\right) + 2 \sum_{k=2}^{n} (C_1 C_k)^{1/2} \cos\phi_k \exp\left[\frac{t + \frac{t^2}{4p^2}}{< P_{\perp}^{2} >} \left(1 + \frac{1}{k^2}\right)\right] +$$

$$+ \sum_{k=2,\, m=1}^{k+m<n} (C_k C_{k+m})^{1/2} \cos(\phi_k - \phi_{k+m}) \exp\left[\left(\frac{t + \frac{t^2}{4p^2}}{< P_{\perp}^{2} >}\right)\left(\frac{1}{k^2} + \frac{1}{(k+m)^2}\right)\right] \} \left[1 + \frac{t}{2p^2}\right].$$

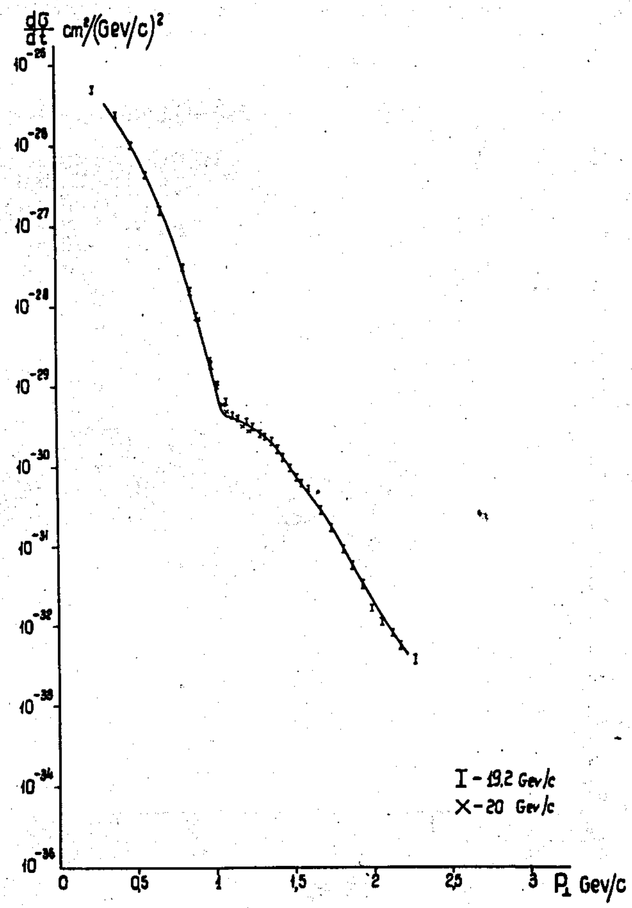
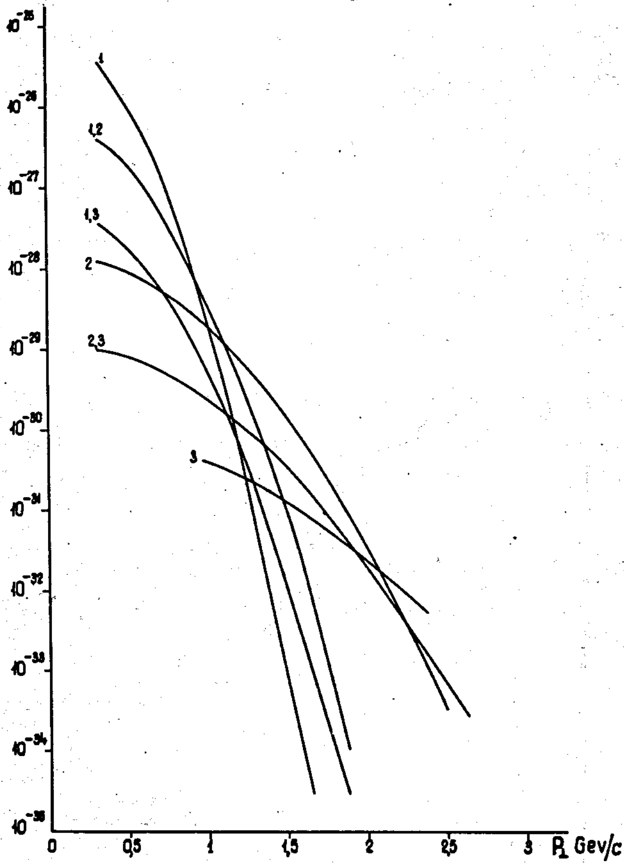

$\frac{d\sigma}{dt}$ cm²/(Gev/c)²
10⁻²⁵
10⁻²⁶
10⁻²⁷
10⁻²⁸
10⁻²⁹
10⁻³⁰
10⁻³¹
10⁻³²
10⁻³³
10⁻³⁴
10⁻³⁵
0
0,5
1
1,5
2
2,5
3
$P_\perp$ Gev/c
I - 19,2 Gev/c
X - 20 Gev/c

Fig. 1.



10^{-25}
10^{-26}
10^{-27}
10^{-28}
10^{-29}
10^{-30}
10^{-31}
10^{-32}
10^{-33}
10^{-34}
10^{-35}
1
1,2
1,3
2
2,3
3
0
0,5
1
1,5
2
2,5
3
$P_\perp$ Gev/c

Fig. 2.

Consequently, condition (2) is a decisive factor in determining $\frac{d\sigma}{d|t|}$ for the given values of $P_\perp$. In a region of $P_\perp \approx 1$ GeV/c according to Fig. 2 three exponents: 1,2 and (1,2), which involve the interference term $(C_1 \ C_2)^{1/2} \cos\phi_2$, come closer together. In ref.[3] at 29.7 GeV/c and /t/ ≈ 1.3 the minimum is pronounced for $\frac{d\sigma}{d|t|}$. However, as the authors note, it is not statistically presented.

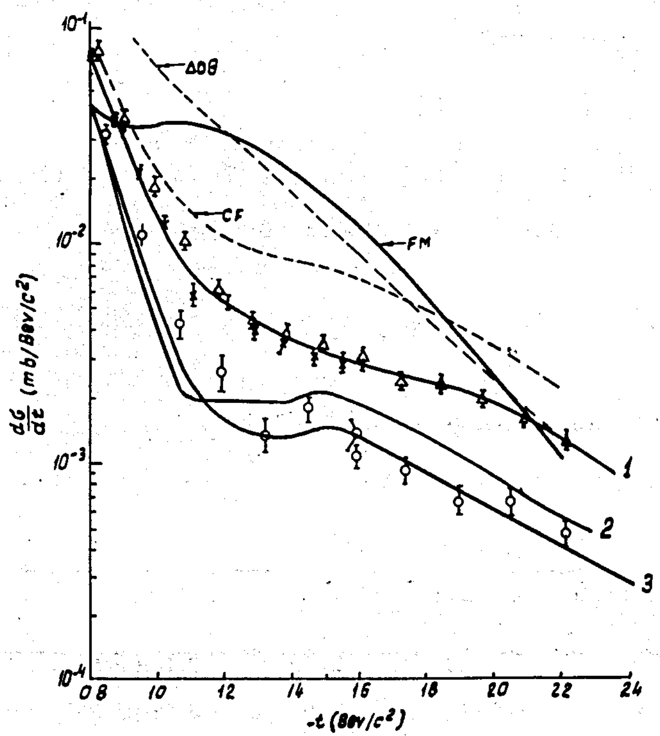


Fig. 3.

Figure 3 gives the experimental data and diagrams from ref.[3] with parameters C_1, C_2 and ϕ_3 having the above mentioned values; $\langle P_\perp^2 \rangle^{1/2} = 0.340$; $\phi_2 = 160^\circ$; $C_2 = 0.13$ for curve 2 and 0.10 for

for curve 3. Curve 1 presents (in a large scale) a part of the curve from Fig. 1 and calculations as well:

FM is the 30-BeV/c prediction of Frautschi and Margolis;

CF is the 25-BeV/c cross section of Chiu and Finkelstein;

ADG is the asymptotic cross section of Abarbanel, Drell and Gilman.

In a diffraction peak region $\frac{d\sigma}{d|t|}$ was described by the phenomenological formula:

$$\frac{d\sigma}{dt} = \exp(a + bt + ct^2) \tag{3}$$

At /t/ < 1 GeV/c the factor $1 + \frac{t}{2p^2}$ in (1) is close to 1 and comparing formula (1) with (3) we obtain the relation between "b" and "c":

$$C = \frac{b}{4p^2} . \tag{4}$$

Table presents the data given in /3/.

Table

Refs.	Momentum GeV/c	Range /t/ $(GeV/c)^2$	b	c
3	15.1	0.22 /t/ 0.78	7.89±0.59	-0.43±0.59
5	18.4	0.2 /t/ 0.5	8.58±0.24	-
6	19.84	0.2 /t/ 0.8	8.68±0.79	0.70±0.92
3	20.0	0.2 /t/ 0.8	9.15±0.45	0.72±0.45
6	24.63	0.25 /t/ 0.75	7.97±1.56	0.82±1.83
3	29.7	0.21 /t/ 0.73	8.02±0.60	-0.64±0.63

It follows from the table that in a range of 15÷30 GeV/c and $0.2 < /t/ < 0.8$ "b" is constant within the limits or errors, and its weight-average value is 8.5 ± 0.4. The weight-average value of "c" is ≈ 0.2 (this value agrees with the estimate from (4); however, the averaging is rough because of a large spread in values). The value of "b" being equal to 8.5 ± 0.4 is in agreement with the estimate of $b \approx \frac{1}{\langle P_\perp^2 \rangle}$ 8.3, with the help of which the experimental data in Figs. 1 and 3 are fairly well described. In ref./7/ when measuring the slope parameter "b" at 12÷70 GeV the following formula was defined:

$$b = [(6,8 + 0,3) + (0,94 + 0,18) \ln \frac{s}{s_0}] (GeV/c)^2 , \qquad (5)$$

where "S" is the square of the total energy in the c.m.s. $s_0 = 1$GeV/c. From (5) at 30 GeV/c we obtain $b = 10.6 \pm 0.8$ i.e. the difference of about two root-mean-square errors with the above-mentioned values of "b". This difference is possibly connected with increasing "b" at small values of /t/, since in/7/ the measurements have been made at 0.01 /t/ 0.12 $(GeV/c)^2$. This fact was also noted in/3/.

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