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THE TOTAL ELASTIC PROTON-PROTON CROSS SECTION FROM 9 TO 300 GEV/C

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THE TOTAL ELASTIC PROTON-PROTON CROSS SECTION FROM 9 TO 300 GEV/C

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E1 - 8456

Полное сечение упругого протон-протонного рассеяния от 9 до 300 ГэВ/с

Приводятся значения полного сечения упругого pp -рассеяния в интервале от 9 до 300 ГэВ/с.

Препринт Объединенного института ядерных исследований. Дубна, 1974

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E1 - 8456

The Total Elastic Proton-Proton Cross Section from 9 to 300 GeV/c

We report values of σ_{el} in pp collisions in the range $9 \le p \le 300$ GeV/c.

Preprint. Joint Institute for Nuclear Research. Dubna, 1974

In this letter we calculate $\sigma_{el}(pp)$ in the region from 9 to 300 GeV/c, using the form

$$\sigma_{el} = \int_0^{t_{max}} \left(\frac{d\sigma}{dt}\right)_{el} dt \simeq \frac{\sigma_t^2 (1+\rho)}{16\pi\hbar^2}\left(\frac{1-e^{b_1 t_1}}{b_1} + \frac{e^{b_2 t_1}}{b_2}\right). \qquad (1)$$

This form is based on the empirical observation /1,2/ that the differential cross section above 10 GeV/c is described well by an exponential with different slopes in the regions $|t| < 0.1\ (\mathrm{GeV/c})^2$ and $|t| > 0.1\ (\mathrm{GeV/c})^2$.

We use the following input in our calculation: σ_t is the total pp cross section. We use data from existing experiments /3-8/ including recent precise Fermilab-data /8/. Where more than one measurement exist at the same momentum an average is used. ρ is the ratio of the real to the imaginary pp scattering amplitude at $t=0$. Fermilabdata /9/ is used. b_1 is the slope parameter measured in our experiment /10/ for $|t| \le |t_1| = 0.1\ (\mathrm{GeV/c})^2$. b_2 is the slope parameter for $|t| > |t_1|$ calculated from the equation $b_2 = 5.8 + 0.75 \cdot \ln s$ /11/. The second term in (1) contributes $\approx 40\%$ of σ_{el}. The error in b_2 is taken as ± 0.2.

The calculated values of σ_{el} and the ratio σ_{el}/σ_t are given in the table and shown in figs.1 and 2, respectively.

The ratio σ_{el}/σ_t is approximately constant and equal to 0.18 above 100 GeV/c. However this constancy is not surprising since it is known that σ_t and $b_1 (b_2)$ are both

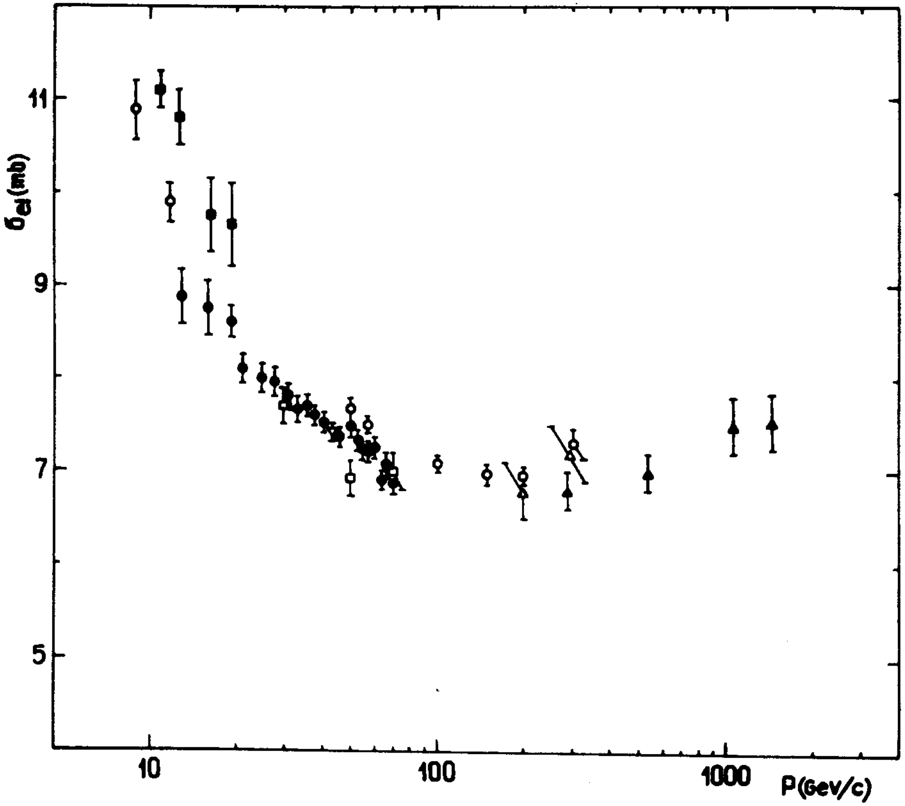

Fig. 1. Elastic pp cross section as a function of lab. momentum. o - our data; ■ –[13]; ●–[16]; □–[14]; △–[6,17]; ▲–[15]; ∇ –[18].

increasing slowly in this region. However the value of 0.18 is somewhat greater than a recent impact model calculation[19] shown in fig. 2 and much less than the value 0.5 predicted by[20] to occur at asymptotic energies ($S \gg 10^{10}$ GeV^2) and corresponding to the scattering on the black disc. The weak energy dependence of $\sigma_{el} / \sigma_{tot}$ from 100 GeV to 2000 GeV can be explained well in the frame of the complex angular momentum theory[21,22]: curves 2 and 3 (fig. 2) show the fastest fall

and the fastest rise of the ratio $\sigma_{el} / \sigma_{tot}$ predicted by the models[22] taking into account the cut contributions (2. quasieikonal model, 3. summing of half-enhanced diagrams).

Note, finally, that in the case of pp interactions the observed behaviour of $\sigma_{el} / \sigma_{tot}$ is in accord with the geometric scaling hypothesis[23] starting from 100 GeV.

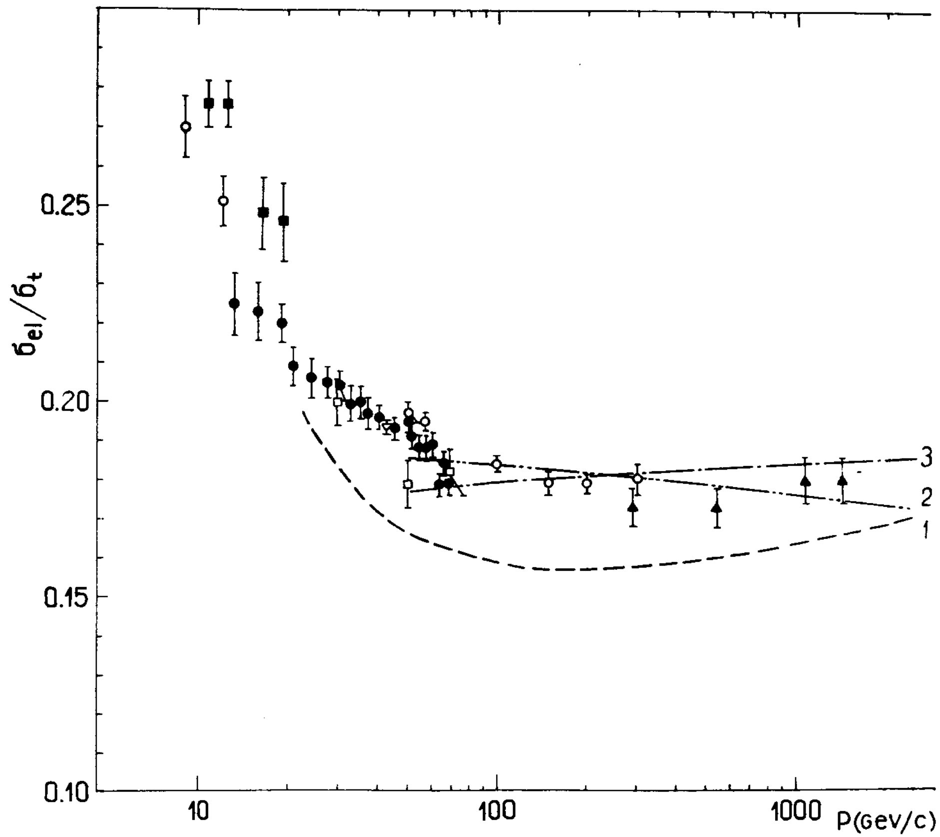

Fig. 2. Ratio of the elastic to the total cross section above 8 GeV/c. o - our data; ■ – [13]; ●–[16]; □–[14]; ▲ – [15]; ∇ –[18].
Curves 1,2,3. Predictions of the theoretical models [19,22].

TABLE

№	P_{lab} GeV/c	σ_t mb	σ_{el}^* mb	σ_{in} mb	σ_{el}/σ_t	σ_t Ref.
1	9	40.05±0.12	10.84±0.32	29.32±0.38	0.270±0.008	5
2	12	39.62±0.12	9.87±0.23	29.77±0.26	0.251±0.006	5
3	50	38.30±0.12	7.56±0.12	30.74±0.17	0.197±0.003	6,10
4	58	38.44±0.12	7.49±0.08	30.95±0.15	0.195±0.002	6
5	100	38.39±0.07	7.08±0.09	31.31±0.14	0.184±0.002	10
6	150	38.62±0.07	6.97±0.11	31.65±0.15	0.179±0.003	10
7	200	38.90±0.07	6.95±0.08	31.95±0.13	0.179±0.002	10
8	300	40.46±0.24	7.29±0.16	33.17±0.33	0.180±0.004	7,8,9

* A systematic error in σ_{el} due to corresponding error in slope parameter is ~ 3%.

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