COMPARISON OF IMPACT-PICTURE PREDICTIONS WITH DATA FROM THE CERN $p\bar{p}$ COLLIDER

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Recent data on the total cross section and the elastic slope parameters at small momentum transfers from the UA1 and UA4 Collaborations at the CERN $p\bar{p}$ collider are compared with the impact-picture predictions.

In 1970 Cheng and Wu predicted the rising total cross section [1] on the basis of a systematic study of the high-energy behavior of quantum field theory [2]. The first phenomenological analysis incorporating this prediction was carried out [3] using Serpukhov data and on the assumption of the absence of exotic exchange. This analysis was greatly improved [4] a year later when the ISR data [5] showed that the increase in total cross section was only about 50% higher than that from the first analysis [3]. Numerous predictions were presented at the 1973 Stony Brook Conference [6]. Other results were summarized at the 18th International Conference on High-energy physics [7].

Recently, data became available from the CERN $p\bar{p}$ collider at a high energy of $\sqrt{s} = 540$ GeV [8,9]. It is the purpose of this note to compare the 1973 predictions with the 1982 data.

In ref. [6] two sets of predictions were given, labelled as $c' = 0$ and $c' = 1$ respectively in the notation there. The case of $c' = 0$ is the same as that given in ref. [4]. In fig. 1 here we show the total pp and $p\bar{p}$ cross sections fo ref. [6] (fig. 8 there) together with the UA4 data [8]. In fig. 2, we show the slope parameters of ref. [6] (fig. 14 there) with the UA1 and UA4 data [8,9]. From these comparisons, which are also given in table 1, the case $c' = 1$ is favored.

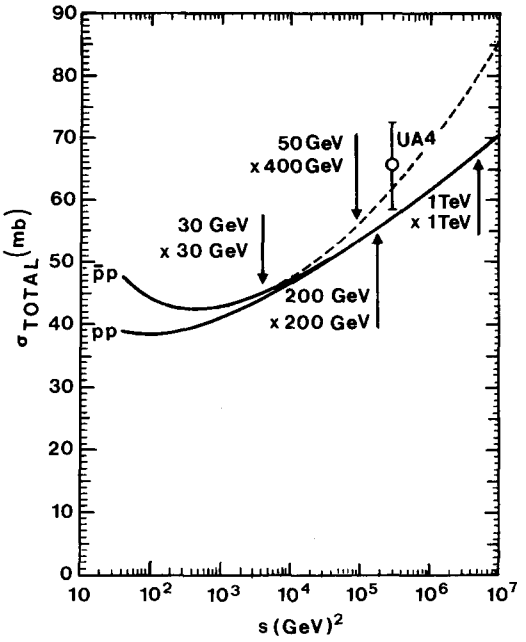

Fig. 1. Comparison of the prediction of rising total cross sections from ref. [6] with the recent UA4 data [8]. The solid lines correspond to $c' = 0$ and the dashed lines to $c' = 1$.

Both the total cross section from UA4 [8] and the slope parameters from UA1 [9] are in good agreement with the early impact-picture predictions. However,

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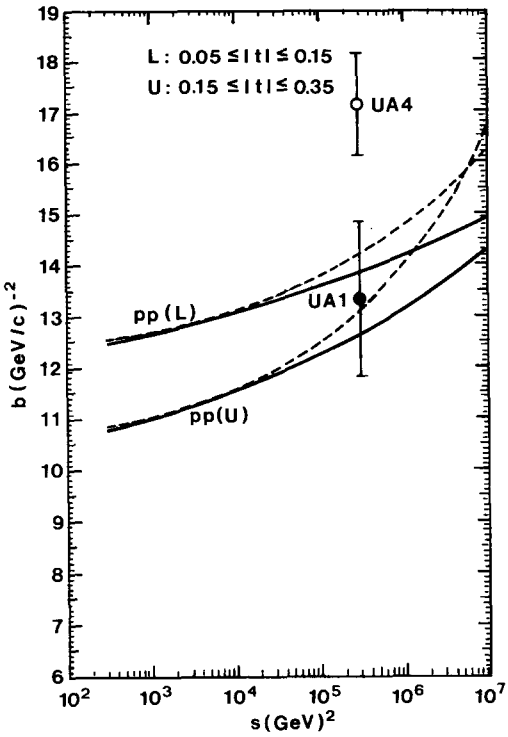

Fig. 2. Comparison of the prediction of the slope parameters from ref. [6] with the recent UA1 data [8] and UA4 data [9].

the slope parameter from UA4 [8] for smaller values of momentum transfer disagrees with the predictions. The UA4 slope parameter is much larger, as discussed in the last paragraph of ref. [8]. In order to get a better feeling of this discrepancy, the unnormalized differential cross section is compared directly in fig. 3. It is seen that there is no serious discrepancy between the data and the predictions. The cause of the large slope parameter of UA4 is due mainly to two data points at

Table 1
Comparison of predictions with data.

	Total cross section (mb)	Slope parameter $(GeV/c)^{-2}$	
		$0.05 < \|t\| < 0.19$ $(GeV/c)^2$	$0.14 < \|t\| < 0.26$ $(GeV/c)^2$
theory $c' = 0$ [46]	58	13.8	13.1
$c' = 1$ [6]	62	14.2	13.6
experiment UA1 [9]	–	–	13.3 ± 1.5
UA4 [8]	66 ± 7	17.2 ± 1.0	–

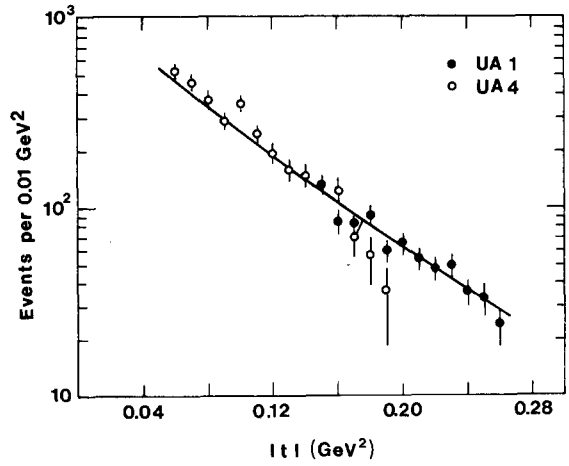

Fig. 3. $|t|$-distribution of elastic scattering events in the $|t|$-range from 0.05 to 0.26 $(GeV/c)^2$ taken from ref. [9] and compared to the $c' = 1$ prediction from ref. [6].

$|t| = 0.18$ and 0.19, which are in disagreement with the UA1 data. In other words, the discrepancy is entirely an experimental problem. We expect the UA4 slope parameter to be an overestimate.

The phenomenology of the impact-picture was improved [10] several years ago so far as polarization and Regge backgrounds are concerned. These improvements have no significant effect for small momentum transfers at these very high energies. The curve of fig. 3 is essentially unchanged.

It is clear that the impact-picture predictions of nearly a decade ago are very adequate to describe the data from the CERN $p\bar{p}$ collider for small momentum transfers. We look forward to many further comparisons in the near future.

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References

[1] H. Cheng and T.T. Wu, Phys. Rev. Lett. 24 (1970) 1456.
[2] H. Cheng and T.T. Wu, Phys. Rev. Lett. 22 (1969) 666; 23 (1969) 1311; 24 (1970) 759; Phys. Rev. 182 (1969) 1852; D1 (1970) 2775.

[3] H. Cheng, J.K. Walker and T.T. Wu, Impact-picture of very-high-energy hadron interactions (with numerical results), submitted to 16th Intern. Conf. on High energy physics (Batavia, IL., 1972).
[4] H. Cheng, J.K. Walker and T.T. Wu, Phys. Lett. 44B (1973) 97.
[5] U. Amaldi et al., Phys. Lett. 44B (1973) 112; S.R. Amednolia et al., Phys. Lett. 44B (1973) 119.
[6] T.T. Wu and H. Cheng, Fifth Intern. Conf. on High-energy collisions (Stony Brook, NY, 1973) AIP Conf. Proc. no 15 (AIP, New York) p. 54.
[7] T.T. Wu, Proc. 18th Intern. Conf. on High-energy physics (Tbilisi, USSR, 1976), Vol. 1, p. A5–23.
[8] UA4 Collab., R. Battiston et al., Phys. Lett. 115B (1982) 333.
[9] UA1 Collab., G. Arnison et al., Small angle elastic scattering at the CERN proton–antiproton collider, preprint CERN-EP/82-123, Proc. 21st Intern. Conf. on High-energy physics (Paris, 1982).
[10] C. Bourrely, J. Soffer and T.T. Wu, Phys. Rev. D19. (1979) 3249.