IS THERE AN 11 GeV STRUCTURE IN THE TOTAL $\pi^{\pm}$-p CROSS SECTIONS?

B. LAUTRUP
NORDITA, Nordisk Institut for Teoretisk Atomfysik, Copenhagen

and

P. MØLLER NIELSEN and P. OLESEN
Niels Bohr Institutet, Copenhagen

Received 15 October 1965

In previous works [1, 2] we have carried out a comparison of π-N forward dispersion relations with experiments in the 10 GeV region. The comparison consists of tests which are independent of the high energy behaviour of the total cross sections above machine-energies. Four of these tests are apparently in contradiction with the experimental information. As we have stressed before [1, 2], one cannot conclude that forward dispersion relations are in disagreement with the experiments because of the following possibilities:

a) In the above-mentioned work we have not taken into account the systematic errors in the real parts, which are given in ref. 3.
b) In the total cross sections the energy-spacing between the measured values is rather large ($\geq$ 1 GeV). Furthermore, there obviously are some discrepancies between the results of various groups. For a recent summary of cross sections between 6-20 GeV, see Galbraith et al. [4].

Hence, the present experimental situation does not exclude the possibility that some structure might be hidden between two measurements. Generally a structure in the total cross sections is coupled to a structure in the real part through forward dispersion relations. Experimentally, one finds [3] that there is a dip in the real part at 12 GeV. This could suggest a bump in the total cross section somewhere below 12 GeV.

In the present work we have explored the last possibility. We have modified the cross sections by means of the following expression

$$\Delta\sigma(E) = \begin{cases} \dfrac{(\Gamma^2/4W^2+1)\,H\frac{1}{4}\Gamma^2}{(E-E_0)^2+\frac{1}{4}\Gamma^2} - \dfrac{\Gamma^2}{4W^2}H & \text{for} \\ & -W \leq E-E_0 \leq W \\ 0 & \text{otherwise.} \end{cases}$$

This bump has the height H, and is in fact of the Breit-Wigner type. In order to get rid of logarithmic endpoint singularities, the bump is continuously joined to the unmodified cross section at $E = E_0 \pm W$. As one can modify both σ_- and σ_+, there are actually eight parameters in the modification of the cross sections.

We then try to find such a modification of the total cross sections that the tests given in [2] are all trivially satisfied. Because of the large number of parameters it is unfortunately not possible to determine all the points in the parameter space for which our tests are satisfied. This question is, however, not of much interest for the moment We have found two very different modifications which satisfy our tests.

The first of these is a very broad bump with the parameter values:

$$E_0^+ = E_0^- = 11 \quad \text{GeV}$$

$$\tfrac{1}{2}\Gamma_+ = \tfrac{1}{2}\Gamma_- = 2.1 \text{ GeV}, \text{ half-width} = 1.5 \text{ GeV},$$

$$W_+ = W_- = 3 \quad \text{GeV}$$

$$H_+ = 1 \text{ mb}, \quad H_- = 3 \text{ mb}.$$

The second is to our opinion much more interesting, because it is rather narrow and lies between 10 and 12 GeV. The parameter values are $H_+ = 0$, $E_0^- = 11$ GeV, $\frac{1}{2}\Gamma_- = 0.7$ GeV, $W_- = 1$ GeV, $H_- = 3.5$ mb, half-width = 0.5 GeV.

It should be remarked that, with the other parameter values kept fixed, this modification has the smallest possible height.

References

1. B. Lautrup and P. Olesen, Physics Letters 17 (1965) 62.
2. B. Lautrup, P. Møller-Nielsen and P. Olesen, Phys. Rev., to be published.
3. K. J. Foley et al., Phys. Rev. Letters 14 (1965) 862.
4. W. Galbraith et al., Phys. Rev. 138 (1965) B913.