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ON THE CHARACTER OF πN *AND* pp *SCATTERING IN THE REGION OF HIGH MOMENTUM TRANSFERS*

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THE first qualitative conclusions on the character of the dependence of the elastic scattering differential cross section on the energy in the region of high momentum transfers were reported in [1], in which elastic scattering of 2.8-BeV/c π^- mesons on nucleons was investigated. From the analysis of πN and pp scattering in that work, it was shown that the probability for a momentum transfer of > 1 BeV/c in elastic scattering decreases as the energy of the incident particle is increased. A similar conclusion was also reached by other workers. [2,3]

In several recent theoretical studies, [4-6] predictions have been made on the asymptotic behavior of the elastic scattering amplitude for strongly interacting particles in the high energy region. According to the results obtained, the elastic scattering differential cross section should be described by an expression of the form

$$d\sigma_{el} / dt = f(t)\, s^{2[l(t)-1]}, \qquad (1)$$

where t is the square of the 4-momentum transfer in the scattering, and s is the square of the c.m.s. total energy of the scattered particles.

For any pair of strongly interacting particles, the function $l(t)$ should be the same. For $t = 0$, the value of $l(0)$ takes on its highest value, equal to unity if σ_t = const. A basic feature of formula (1) is the strong dependence of the cross section $d\sigma_{el}/dt$ on s in the region of high momentum transfers t. The dependence is of such a nature that the probability for a given momentum transfer should decrease with increasing s (we note that in the case of diffraction scattering $d\sigma_{el}/dt$ is a function of only the momentum transfer t).

Since the theoretically predicted dependence of the differential cross section on the energy is in qualitative agreement with the experimental data, it is of interest to estimate numerically the value of $l(t)$ for various strongly interacting particles on the basis of the available experimental data.

The above-mentioned experiments, as well as all others with which we will be dealing, were carried out in the 2—20 BeV range. The question arises as to the applicability of the asymptotic formula (1) in this energy range. It can be hoped that the accuracy of the results obtained with it will be the same as in the case of the well-known theorem of Pomeranchuk, [7] derived under similar assumptions.

The experimental data on πN scattering available at the present time [1,8-11] are shown in Fig. 1.

Despite the large amount of work, the statistical accuracy of most of the experiments and the range of values of s and t are not sufficient to determine the function $l(t)$ on the basis of these data. It should also be noted that, in each of the experi-

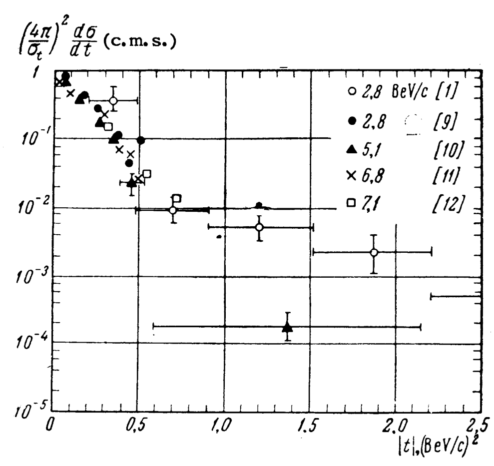

FIG. 1. C.m.s. differential cross section for πN elastic scattering plotted as a function of the momentum transfer t. The total cross section σ_t has been taken equal to 27 mb.

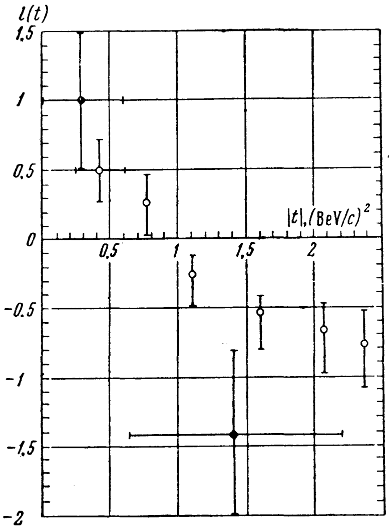

FIG. 2. Values of the function $l(t)$ from data on πN scattering (black circles) and pp scattering (open circles).

ments, elastic scattering was studied for one value of s. At the same time, comparison of the cross sections for different s, often obtained by different methods, entails considerable difficulty, owing to systematic errors in the determination of the absolute elastic scattering cross sections. Nevertheless, we estimated the numerical value of $l(t)$ for two intervals of t (Fig. 2). It is very tempting to find $l(t)$ independently from the data on pp scattering, since the theory predicts that the function $l(t)$ is universal for elastic scattering processes of all strongly interacting particles.

Of the available data on pp scattering, we used only the results of Cork et al[12] and Cocconi et al,[2] since: a) these experiments were made with counters, which give differential cross sections with the smallest statistical errors; b) Cork et al studied elastic scattering at three different energies ($s = 7.7$, 12, and 15 BeV^2) in the same experimental arrangement; c) Cocconi et al studied large momentum transfers t [$0.5-2.4$ $(BeV/c)^2$] up to values of $s = 52$ $(BeV)^2$.

The values of $l(t)$ calculated for six intervals of t are plotted in Fig. 2. It is seen from the figure that $l(t)$ decreases with increasing $|t|$ and changes sign at $|t| \sim 1$ $(BeV/c)^2$. It is also seen that, within the limits of the rather large errors, there is no contradiction between the data on pp and πN scattering.

In conclusion, the authors consider it their pleasant duty to thank A. I. Alikhanov, V. N. Gribov, B. L. Ioffe, I. Ya. Pomeranchuk, and A. P. Rudik for numerous discussions and valuable advice.

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