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PROPERTIES OF ELASTIC SCATTERING AMPLITUDES OF PIONS AND NUCLEONS AT HIGH ENERGIES

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Recently it has been shown that the ideas of Regge, originally developped within the framework of the Schrodinger theory, can be carried over the field theory|1|.

We have shown in the work quoted above that the system of equations|2| determining the asymptotic behaviour of the elastic amplitudes for $s \to \infty$ and $t \gtrsim -16$ (correspondingly, $t \gtrsim -9$ for NN and $\bar{N}N$ scattering) does in fact possess a solution of the type:

$$A(s,t) = \phi(u,t)\, s^{L(t)} , \qquad (1)$$

(here s , t , u are the usual Mandelstam's variables and we use a unit system, where $h = c = m_\pi = 1$; A is the scattering amplitude, summed and averaged over spins in the final and initial states, respectively). The function $\phi(u,t)$ is uniquely determined by $L(t)$ and the kinematics of the process. $L(t)$ in turn is determined be a Regge-pole in low-energy $\pi\pi$ - scattering*. The dependence on u is slow and in general can be neglected**.

Further it has been shown on the basis of an equation of the Chew-Mandelstam type|3| that A_ℓ , the partial wave amplitude of $\pi\pi$ scattering is a meromorphic function of ℓ . If one represents it in the form: $A_\ell = N_\ell D_\ell^{-1}$ then the poles in the ℓ - plane are determined by the roots of D_ℓ . Thus $L(t)$ can be found from the solution of the integral equation for D_ℓ .

From the equation (1) and from the fact that $L(t)$ is the same for all the elastic processes under consideration ($\pi\pi$, πN , NN , $\bar{N}N$ and their charge conjugates), one can draw some amusing conclusions.

1) If the differential cross section $d\sigma/dt$ of one and the same process is measured at different values of s , then from $d\sigma/dt = \phi^2 s^{2(L-1)}$, one simply obtains $L(t)$ for $t<0$:

$$L(t) = 1 + ½ \frac{\log \frac{d\sigma(s_1,t)}{dt} - \log \frac{d\sigma(s_2,t)}{dt}}{\log s_1 - \log s_2} \qquad (2)$$

and thus its general properties, established in|1| can be directly controlled experimentally.

2) In the approximation that ϕ is a constant, for any two process - say (a) and (b) - one has:

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* Let us remark that all of our results can be extended without any difficulty to processes with the participation of strange particles. In that case, e.g. for KN scattering, the Regge-pole of the πK amplitude comes in, etc.

** It is seen from the concrete form of ϕ that it is in general a rather slowly varying function and in a certain approximation it can be replaced by a constant.

$$\frac{d\sigma^{(a)}_{el}}{d\sigma^{(B)}_{el}} = \left[\frac{\sigma^{(a)}_{tot}}{\sigma^{(B)}_{tot}}\right]^2 \qquad (3)$$

(and analogously for the total elastic cross sections).

3) All the processes, having the same <u>total</u> cross sections in consequence of the Pomeranchuk theorem, have the same differential and total <u>elastic</u> cross sections.

4) Making some definite assumptions about the relative asymptotic behaviour of the amplitudes A and B of πN scattering, one obtains the following relation between total cross sections:

$$\sigma^2_{\pi N} = \sigma_{\pi\pi}\,\sigma_{NN}\,, \qquad (4)$$

$$\sigma_{KN}\,\sigma_{\pi N} = \sigma_{K\pi}\,\sigma_{NN}\,, \quad \text{etc.}$$

However, the assumption to be made in course of the derivation of eq. (4), contradicts the hypothesis about asymptotic γ_5 -invariance[5]. If the experimental data satisfy (4) then one has to renounce of this hypothesis. (In the opposite case, one cannot, of course, say anything on the basis of (4) only).

The available experimental data[6] satisfy eq. (2) with an error ~ 30%. (At present, the experimental verification of eq. (2) is difficult in view of the inaccuracies in the data about elastic cross sections). The relation (4) cannot at all compared with the experiment until we shall have reasonably accurate data about $\pi\pi$ and $K\pi$ interaction at high energies.

Details of these calculations together with numerical results will be published in a forthcoming paper.

In conclusion, the author wants to express his sincere thanks to prof. A.A. Logunov for some valuable discussions on the subjuct.

R e f e r e n c e s

1. G.F. Chew, S.C. Frautschi, S. Mandelstam. UCRL-9925 (1961). V.N. Gribov. JETP, <u>41</u>, 667, 1962 (1961). G. Domokos, ОИЯИ, preprint D-900 (1962).
2. G. Domokos. JETP (in print) .(ОИЯИ, preprint, D-773, 1961).
3. G.F. Chew, S. Mandelstam. Phys.Rev. <u>119</u>, 467 (1960).
4. G. Domokos. to be published.
5. A.A. Logunov, V.A. Meshcheryakov, A.N. Tavhelidze. DAN (Cr.Ac.USSR) <u>142</u>, 317(1962).
6. See e.g. the review article by V.S. Barashenkov and V.M. Maltsev, (ОИЯИ,preprint, R-724, 1961).

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