dopplerons. A discussion of these questions is outside the scope of the present article and will be given in a detailed paper.

In conclusion we note that the electromagnetic excitations in an uncompensated Bi plasma at $n_1 \geq n_2$ were investigated experimentally in [4]. It would be of interest to carry out analogous investigations of the new excitation (5).

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CONSTANCY OF TOTAL CROSS SECTIONS AND THE PROCESS $\pi^- p \to \eta n$

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A study of charge-exchange and regeneration processes is of interest because these are the four-particle reactions most sensitive to the model assumptions concerning the interaction mechanism.

In particular, when the question arose of the possible violation of the Pomeranchuk theorem in connection with the obtained Serpukhov-accelerator data on the total hadron-interaction cross sections [1], a number of papers were published [2, 3] devoted to a thorough analysis of these processes with an aim at verifying the Pomerahchuk theorem. The sources of information in these papers are the reactions $\pi^- p \to \pi^0 n$, $K_L A \to K_S A$ (A = matter), and $K^- p \to K^0 n$.

An additional source of information may be the reaction $\pi^- p \to \eta n$, which always accompanies the reaction $\pi^- p \to \pi^0 n$.

In addition, measurement of the reaction $\pi^- p \to \eta n$ can yield valuable information on the connection between this reaction and the charge-exchange reactions $\pi^- p \to \pi^0 n$ and $K^- p \to K^0 n$ within the framework of SU(3) symmetry, or in other words concerning the mechanism of exchange in the t-channel at high energies.

In this paper the amplitude of the process $\pi^- p \to \eta n$ is related with the amplitudes of the reactions $\pi^- p \to \pi^0 n$ and $K^- p \to K^0 n$ within the framework of SU(3) symmetry [4, 5]. The real part of the aforementioned amplitude is reconstructed assuming no contribution is made by the representations 27, 10, and $\overline{10}$ in t-channel, and using dispersion representations. The possible consequences of the constancy of the total cross sections of the elastic processes for the $\pi^- p \to \eta n$ reaction is investigaged. The results are compared with the predictions of the simple Regge-pole model.

Neglect of the contributions of the representations 27, 10, and $\overline{10}$ (in which there are no one-meson states) to the t-channel amplitudes is equivalent to assuming that no account is taken of the contribution made to the amplitude by the multi-meson exchanges contained in these representations. The relative smallness of the discarded terms is suggested by the fact that the amplitudes of the double charge exchange reactions, which are suppressed compared with the remaining reactions, are determined within the SU(3) symmetry framework precisely by the contributions of these representations. This circumstance leads to a simple relation between the spin-independent parts of the charge-exchange amplitudes

$$f_{\eta}^{ce}(E,0) = \sqrt{\frac{2}{3}}\left[\frac{1}{\sqrt{2}} f_{\pi^0}^{ce}(E,0) + f_{\bar{K}^0}^{ce}(E,0)\right], \qquad (1)$$

where

$$f_{\eta}^{ce} \equiv f(\pi^- p \to \eta n),\quad f_{\pi^0}^{ce} \equiv f(\pi^- p \to \pi^0 n) \text{ and } f_{\bar{K}^0}^{ce} \equiv f(K^- p \to \bar{K}^0 n).$$

The validity of (1) can be verified against the existing experimental data for all three reactions in the interval 5 - 13 GeV [6] and up to 18.2 GeV for $\pi^- p \to \pi^0 n$ and $\pi^- p \to \eta n$ (the data on $K^- p \to K^0 n$ beyond 13 GeV were taken in this case from the predictions of the dispersion relations [3]). Within the limits of the experimental errors, the data is in full agreement with (1).

We normalize the amplitudes such that

$$\frac{d\sigma}{dt} = \frac{1}{16\pi K^2}|f|^2 \text{ and } \sigma = \frac{1}{K}\,\mathrm{Im}\, f(E,0). \qquad (2)$$

From (1) we obtain the following expression for the differential forward cross section

$$\left.\frac{d\sigma_{\eta}(E)}{dt}\right|_{t=0} = \frac{1}{24\pi}(1+\beta_{\eta}^2)\left[\Delta\sigma_{K^-}(E) - \frac{1}{2}\Delta\sigma_{\pi}(E)\right]^2. \qquad (3)$$

Here $\Delta\sigma_{K^-} = \sigma(K^- p) - \sigma(K^- n)$, $\Delta\sigma_{\pi} = \sigma(\pi^- p - \sigma(\pi^+ p)$, and β_{η} is the ratio of the real part of the amplitude to the imaginary part, σ is the total cross section, and K is the meson momentum in the lab. Using the dispersion representations for $f_{\pi^0}^{ce}$ and $f_{K^0}^{ce}$, we can write

$$\sqrt{\frac{3}{2}}\,\frac{1}{E}\,\mathrm{Re}\, f_{\eta}^{ce}(E,0) = G_{\eta} - \frac{a_{\eta}}{E^2} + \frac{2EK}{\pi}\int_{3\,\mathrm{GeV}}^{\infty}\frac{\left[\Delta\sigma_{K^-}(E') - \frac{1}{2}\Delta\sigma_{\pi}(E')\right]dE}{K'[E'^2 - E^2]}. \qquad (4)$$

The following notation is used in (4): $G_{\eta} = G_{K^0} - G_{\pi^0}/2$, $a_{\eta} = a_{\pi^0}/\sqrt{2} - a_{K^0}$, and G_i and a_i are the subtraction constants and the value of the integral of the minimal momentum up to 3 GeV, respectively. The values of a_i are estimated, while the G_i are in essence determined from experiments at 6 - 18 GeV.

We consider two variants of fitting $\Delta\sigma_i$. The first is the simple two-parameter fitting

$$\Delta\sigma_i = d_i + \frac{b_i}{E}, \qquad (5)$$

where $d_{\pi} = 1.2$ mb, $b_{\pi} = 8$ mb-GeV^2, and $d_K = 1$ mb, $b_K = 7$ mb-GeV^2. The second parametrization is the best fitting for $\Delta\sigma_i$, i.e.,

$$\Delta\sigma_\pi(E) = 1.3 + 5.1(E^{-0.61} - 35^{-0.61})$$

for pions [2] and

$$\Delta\sigma_{K^-}(E) = 1.0 + 3\exp(-0.17E) \qquad (6)$$

for K mesons [3].

After reconstructing the real part of f_η^{ce}, we can use (4) to calculate the differential cross section of the forward process and β_η. We note that the results of the calculations are sensitive to changes in β_{π^0} and β_{K^0}. The value of β_0 can be regarded as sufficiently reliable, since experimental measurement data are available at medium energies. From the existing experiments it is difficult to determine a reliable value of β_{K^0}. We therefore used the averaged β_{K^0} from [3] for both fittings at E = 10 GeV.

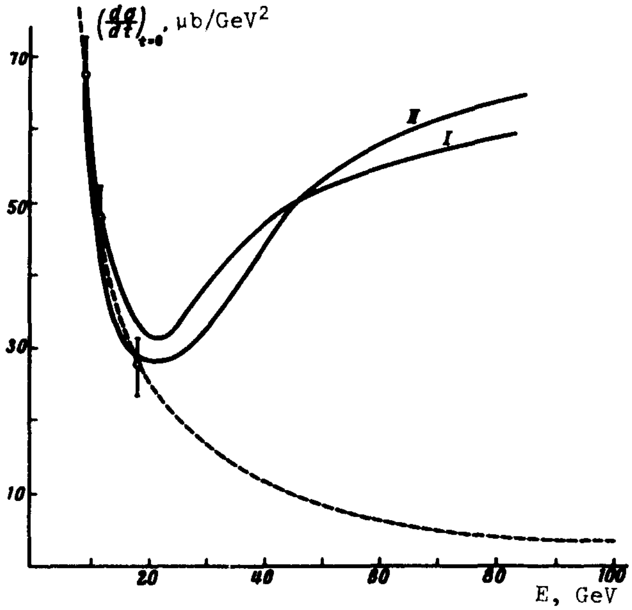
The results show that if the total cross sections do actually remain different at the existing energies, then the effect of the growth of the cross sections for the reaction $\pi^- p \to \eta n$ is quite appreciable within the framework of the model under consideration.

The Regge-pole model gives a strong decrease for the cross section of this process.

We note that the measurement of the differential cross section of this process can yield information on the value of the differential cross section of one more K-meson charge exchange. Within the framework of the considered relation we have

$$\frac{d\sigma}{dt}(K^- p \to \bar{K}^\circ n) + \frac{d\sigma}{dt}(K^+ n \to K^\circ n) \qquad (7)$$

$$= \frac{d\sigma}{dt}(\pi^- p \to \pi^\circ n) + 3\frac{d\sigma}{dt}(\pi^- p \to \eta n).$$



Differential cross section of the process $\pi^- p \to \eta n$ with allowance for the constancy of the total cross sections and in the simple Regge pole model (dashed line).

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THE REACTION $\gamma p \to \eta p$ AND THE DIP MECHANISM IN PHOTOPRODUCTION

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It is usually assumed that the amplitudes of the photoproduction of π^0 and η mesons on nucleons, $\gamma N \to \pi^0 N$ and $\gamma N \to \eta N$, are determined mainly by the contributions of the Regge poles of the ω and ρ mesons. The cross sections of both reactions (we have in mind the "nuclear part," excluding the Primakoff effect) have characteristic "dips," a fact naturally attributed to the vanishing of the residues of the ω and ρ poles as $t \to 0$. In addition, the cross section for π^0-meson photoproduction has a dip at $t \simeq -0.55$, which is well described [1] by the "nonsense" factor α in the residues of the ω and ρ poles. However, on going over to the η-meson photoproduction (the cross section of which has no dip at $t \simeq -0.55$), it is necessary to resort [2] to the artificial assumption that there is no factor α in the residues of the ω and ρ poles in the amplitude of the reaction $\gamma N \to \eta N$. As to the photoproduction of the π^0 mesons, in this case the inclusion of the factor α leads to contradictions. At $t \simeq -0.55$, where $\alpha \simeq 0$, the contributions of ω and ρ vanish, and the filling of the dip is due to the contribution of the B-meson pole, which leads, in contradiction to the experiment, to a deepening of the dip with increasing E and to a change in the sign of the asymmetry [1].

It was shown in [3] that the discrepancies with the experimental data on the photoproduction of π^0 mesons can be eliminated by assuming that the trajectories of the ω and ρ mesons become complex at $t < 0$ [4]. We shall show in this paper that when these very same assumptions are made for the photoproduction of η mesons it becomes possible to eliminate the contradiction and to reconcile the presence of the factor α in the residue of the poles with the absence of a dip in the cross section at $t \simeq -0.55$.

Since there are no polarization data at present, and only the differential cross section of the photoproduction of η on a proton has been measured, we shall use the simplest model that suffices to describe these data. We shall take into account only the contributions of the ω-meson pole. The contribution of the ω meson can be estimated by using the relations of SU(3) symmetry; however [3, 5], SU(3) gives an incorrect prediction for the ratio $[d\sigma(n)/dt]/[d\sigma(p)dt]$ in the reaction $\gamma N \to \pi^0 N$ (possibly owing to the violation of the factorization of the effective residues [6, 7]), and we do not consider it advisable to take into account the contribution of ω in the absence of data on the reaction $\gamma N \to \eta N$.

Out of the four helicity amplitudes describing the process $\gamma p \to \eta p$, we take into account only one, which we parametrize in the following manner [4, 7]:

$$-\frac{2}{k_t\sqrt{t}}\,\bar{f}^{+}_{\frac{1}{2}\frac{1}{2}10} = 2m\frac{i}{s}\left(a\alpha e^{-\frac{i\pi\alpha}{2}} s^{\alpha} + a^{*}\alpha^{*} e^{-\frac{i\pi\alpha^{*}}{2}} s^{\alpha^{*}}\right). \qquad (1)$$