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CONSTANCY OF TOTAL CROSS SECTIONS AT HIGH ENERGIES AND K-MESON CHARGE EXCHANGE

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Measurements of the total cross sections for the interaction between π^- and K^0 mesons with protons and deuterons in the IFVE (Institute for High-energy Physics) accelerator [1] have shown that, at least in the incident-meson energy region 25 - 65 GeV in the lab, the cross sections remain constant within the limits of experimental error and contradict the predictions of the Regge-pole model. Some consequences of such a behavior, which lead to violation of the Pomeranchuk theorem, were recently investigated [2] for the charge exchange of π^- mesons and for the regeneration of K mesons. We have made a detailed analysis for the charge exchange of K^- mesons with nucleons, $K^-p \to \bar{K}^0 n$. Verification of the predictions obtained here will ascertain whether the total cross sections $\sigma(K^-p)$ and $\sigma(K^-n)$ depend on the isospin at high energies or not.

Using isotopic invariance, we can relate the charge-exchange and elastic-scattering amplitudes. We normalize the amplitudes in such a way that

$$f^{ce} = -f_{el}(K^-p) + f_{el}(K^-n); \qquad \frac{d\sigma}{dt} = \frac{|f|^2}{16\pi K^2}; \quad \sigma = \frac{1}{K}\,\mathrm{Im} f, \tag{1}$$

where f is the amplitude of the process, K the meson momentum in the lab, and σ the total cross section.

From the dispersion relations for the elastic forward scattering [7, 10] and from the limitation ensuing from unitarity on the high-energy behavior of the amplitude [4, 5], it follows that at high energies

$$f^{ce}(\omega) = 2\omega \left\{ C - \frac{a}{\omega^2} + \frac{K^2}{\pi} \int_{3\,\mathrm{GeV}}^{\infty} \frac{\Delta\sigma(\omega')\,dK'}{\omega'[\omega'^2 - (\omega - i\epsilon)^2]} \right. , \tag{2}$$

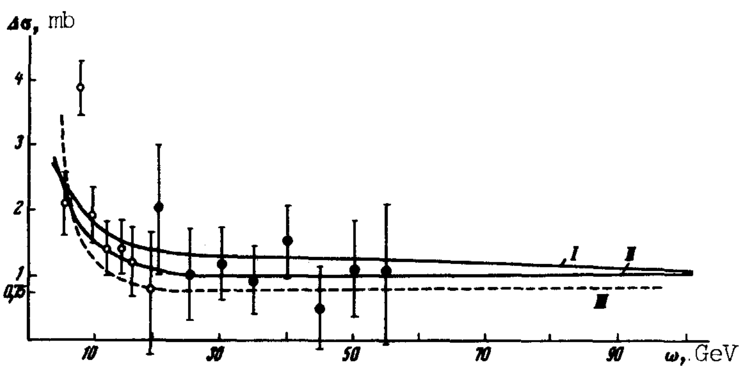

Fig. 1. Different parametrization of $\Delta\sigma = \sigma(K^-p) - \sigma(K^-n)$ (o - from [11], • - from [12]).

where ω is the meson energy in the lab, C is constant accurate to terms of order m_K^2/ω^2, and

$$a = \frac{1}{\pi} \int_{K_{min}}^{3\,\mathrm{GeV}} \frac{K'\,\Delta\sigma(\omega')}{\omega'(1 - \omega'^2/\omega^2)}\,dK' . \tag{3}$$

The contribution of a to the amplitude is small and it can be estimated from the sum rules at finite energies [8]. Such an estimate yields $a \approx 10$ mb-GeV^2.

To determine C, we can use the experimental value of the differential charge-exchange cross section at K = 9.5 GeV/c. In this case the sign of β (the ratio of the real part of the amplitude to its imaginary part) turns out to be indeterminate, owing to the large experimental errors. To determine the sign, we can use the dispersion relations.

The difference Δσ between the total cross sections was determined on the average with a 20% error. As a result, Δσ admits of a different parametrization. We have considered three parametrizations

$$\Delta\sigma = \begin{cases} 1 + \dfrac{7}{\omega} \\ 1 + 3\exp(-0.17\omega) \\ 0.75 + \dfrac{70}{\omega^2} \end{cases}, \qquad (4)$$

where the constants are in millibarns. The first parametrization lies above the experimental curves within the limits of error, the second passes through these points, and the third drops from the upper limits at 4 - 5 GeV to the lower limits of the errors at high energies (Fig. 1).

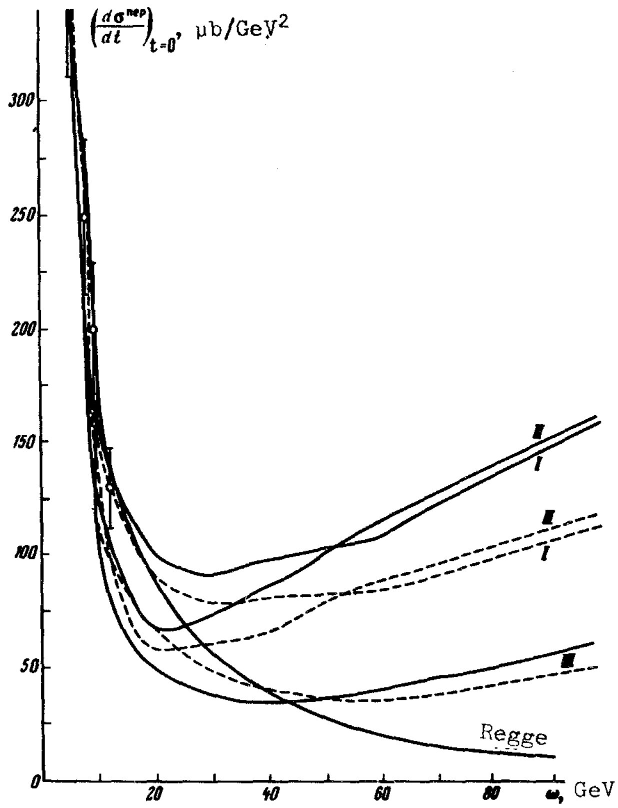

Fig. 2. Differential cross section of $K^-p \to \bar{K}^0 n$ forward for different parametrizations and in accordance with the Regge-pole model. Solid curve - β(10) = 0, dashed curve - β(10) = 0.2. The experimental points were taken from [6].

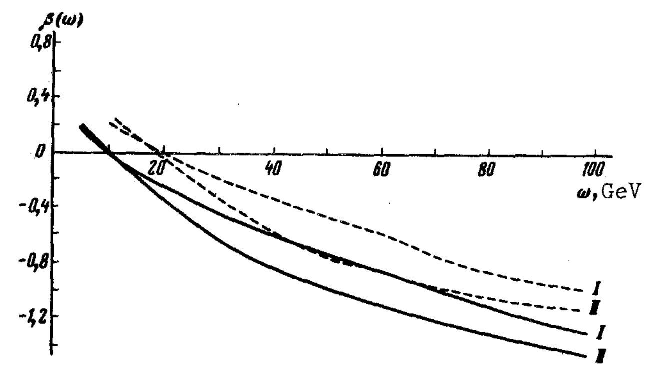

Fig. 3. Ratio of real part of the charge-exchange amplitude to its imaginary part. Solid curve - β(10) = 0, dashed curve - β(10) = 0.2.

The results of the calculations for the differential cross section are given in Fig. 2. The same figure shows a plot of the cross section as given by the Regge-pole model [3, 9]. We see from the figure that the assumed constancy of Δσ leads to a strong deviation of the differential charge-exchange cross section from the predictions of the Regge-pole model. We note that the third parametrization, while within the limits of errors, leads to differential cross section values lying much lower than the experimental value at K = 12.3 GeV, and to the contrary, above the experimental value at K ≤ 7 GeV. This parametrization was carried out to illustrate the utmost permissible case. Even errors of 20 - 30% at 40 - 50 GeV make it possible to discern a difference between the behaviors of the differential cross section in the case of the first and second parametrizations.

The differential cross section passes through a minimum in the region $\omega = 20 - 30$ GeV, and increases further like $\ln^2\omega$. To observe a significant difference in the behavior of the differential cross section it is therefore desirable to measure the cross section at energies $\omega \geq 40$ GeV.

The ratio of the real part of the amplitude to its imaginary part, which is larger than zero at $\omega = 10 - 20$ GeV, passes through zero in the region $\omega = 10 - 20$ GeV and approaches the limit $-2/\pi \ln \omega$ at larger ω.

The influence of the constancy of $\Delta\sigma$ on the behavior of the forward elastic KN scattering is much weaker than in the case of charge exchange. The changes are particularly small in the case of β_{el}. However, this influence could be observed in the differential elastic-scattering cross section if the measurement errors at $\omega > 50$ GeV were not to exceed 5 - 10%.

In conclusion, it is my pleasant duty to thank L.D. Solov'ev for suggesting the problem and for a discussion of the results.

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MULTIPHOTON PROCESSES INDUCED BY POWERFUL INTENSE LIGHT IN THE PRESENCE OF EXTERNAL ELECTRIC FIELDS. DETECTION OF IONS IN MEDIA

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We consider in this article the influence of external fields on multiphoton processes, and estimate the conditions under which external fields can greatly influence their probability, decreasing the necessary number of quanta. Practical applications of the processes under consideration are indicated.

It is known that the ionization of an atom in an intense light field $E_1\sin\omega t$, with a quantum energy much lower than the ionization potential ($\hbar\omega \ll I$), proceeds in different manners in two characteristic cases: