and ρ is a constant such that when $s \to \infty$ we have

$$A(s, 0) \geqslant \text{const}\, s^{1+\rho}.$$

In particular, if the amplitude of the elastic scattering has a Regge behavior [5], we obtain for the trajectory $\beta(t)$ the following lower limit

$$\max_{-4k^2 + a \leqslant t \leqslant -a} \beta(t) \geqslant 1 + \rho - (\epsilon - \rho)\Phi(\pi/2\sqrt{a/\gamma}).$$

For πN scattering, analyticity in t was proved at $\gamma = 1.83 m_\pi^2$. There are grounds for hoping, however, that γ reaches $4m_\pi^2$.

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VECTOR DOMINANCE, ω-φ MIXING, AND SUPPRESSION OF φ-MESON PHOTOPRODUCTION

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The purpose of the present paper is to show that the φ-meson photoproduction cross section at high energies is sensitive to a deviation of the ω-φ mixing angle from the "ideal" angle $\tilde{\theta} \simeq 35.3°$ customarily used in the calculations [3-6], and also to a possible violation of U-invariance of the electromagnetic hadron interaction. Allowance for these factors leads to an appreciable suppression of the φ-meson photoproduction process and helps decrease the disparity between experiment [9] and theory [3].

Let us consider the photoproduction of neutral vector mesons on nucleons in accordance with the model of vector dominance of the electromagnetic interaction of hadrons [1,2] (further references can be found in the reviews [3,4]). The amplitude of the process $\gamma + B \to V_j + B$ is written in the form

$$\langle V_j B | \gamma B \rangle = \sum_i G_{\gamma V_i} \langle V_j B | V_i B \rangle, \tag{1}$$

where $V_{j(i)} = \rho^0$, ω, or φ; B = P or N; and $G_{\gamma V_i}$ is the constant for the transition from the photon into a vector meson V_i.

Following [4-6], we shall use the additive quark model [7] for the parametrization of the amplitudes $\langle V_j B | V_i B \rangle$. If the spin dependence of the small-angle scattering amplitude is insignificant at high energies (E > 5 GeV), as is assumed here, then the amplitudes $\langle V_j B | V_i B \rangle$ can be expressed in terms of the amplitudes of scattering of pseudoscalar mesons by nucleons. The V-meson state vectors in the quark model are given by

$$|\rho^\circ\rangle = 1/\sqrt{2}\,|\bar{p}p - \bar{n}n\rangle,$$
$$|\omega\rangle = \cos\delta/\sqrt{2}\,|\bar{p}p + \bar{n}n\rangle - \sin\delta\,|\bar{\lambda}\lambda\rangle, \quad (2)$$
$$-|\phi\rangle = \cos\delta\,|\bar{\lambda}\lambda\rangle + \sin\delta/\sqrt{2}\,|\bar{p}p + \bar{n}n\rangle,$$

where p, n, and λ are the usual quark symbols, $\delta = \theta_V - \tilde{\theta}$, θ_V is the ω-φ mixing angle, and $\tilde{\theta}$ is the "ideal" mixing angle, $\tan\tilde{\theta} = 1/\sqrt{2}$. Taking into account (1) and (2) as well as the assumptions made concerning the parametrization of $\langle V_j B|V_i B\rangle$, we have

$$\langle\rho^\circ B|\gamma B\rangle = PG_{\gamma\rho} + 3A(G_{\gamma\omega}\cos\delta - G_{\gamma\phi}\sin\delta), \quad (3)$$

$$\langle\omega B|\gamma B\rangle = P(G_{\gamma\omega}\cos 2\delta - G_{\gamma\phi}\sin 2\delta) + 3AG_{\gamma\rho}\cos\delta + S(G_{\gamma\omega}\cos^2\delta + 1/2G_{\gamma\phi}\sin 2\delta), \quad (4)$$

$$\langle\phi B|\gamma B\rangle = -P(G_{\gamma\phi}\cos 2\delta + G_{\gamma\omega}\sin 2\delta) - 3AG_{\gamma\rho}\sin\delta + S(G_{\gamma\phi}\cos^2\delta + 1/2G_{\gamma\omega}\sin 2\delta), \quad (5)$$

where

$$P = 1/2\,(\langle\pi^+B|\pi^+B\rangle + \langle\pi^-B|\pi^-B\rangle), \quad (6)$$

$$A = 1/2\,(\langle K^+B|K^+B\rangle + \langle K^-B|K^-B\rangle - \langle K^\circ B|K^\circ B\rangle - \langle\bar{K}^\circ B|\bar{K}^\circ B\rangle), \quad (7)$$

$$S = 1/2\,(\langle K^+B|K^+B\rangle + \langle K^-B|K^-B\rangle + \langle K^\circ B|K^\circ B\rangle + \langle\bar{K}^\circ B|\bar{K}^\circ B\rangle). \quad (8)$$

We note that in the Regge-pole model the energy dependence of P(E) and S(E) is determined by the contributions of the Pomeranchuk poles, and W(E) is determined by the contributions of the Regge trajectories with exchange of isospin I = 1 in the t-channel (it is customary to assume that the main role is played at high energies by the A_2 trajectory).

Starting from (2), we obtain a relation between the constants $G_{\gamma V_i}$

$$G_{\gamma\rho} : G_{\gamma\omega} : G_{\gamma\phi} = 3 : (\cos\delta + \sqrt{2}x\sin\delta) : (\sqrt{2}x\cos\delta - \sin\delta). \quad (9)$$

In the derivation of (9) we assumed that

$$\langle\gamma|\bar{p}p\rangle : \langle\gamma|\bar{n}n\rangle : \langle\gamma|\bar{\lambda}\lambda\rangle = 2 : -1 : -x. \quad (10)$$

When x = 1 we obtain the usual octed structure of the current operator. Weakening of the electromagnetic interaction of the "strange" quarks (x < 1) as a possible model of the violation of U-invariance of the electromagnetic interactions was already discussed earlier [8]. The experimental small-angle photoproduction cross sections of the V-mesons are usually approximated by an expression of the form [9]

$$d\sigma/d\Delta^2 = a\exp(-b\Delta^2), \quad (11)$$

where Δ^2 is the square of the momentum transfer.

The table lists the ratios $r(V_iB) = a(V_iB)/a(\rho B)$ at E = 5 GeV, calculated with the aid of formulas (4) - (10) for several sets of values of δ and x, and also the experimental

	$r(\omega P)$	$r(\varphi P)$	$r(\omega N)$	$r(\varphi N)$
$\delta = 0 \quad x = 1$	0.18	0.031	0.056	0.035
$\delta = 0.08 \quad x = 1$	0.2	0.02	0.062	0.029
$\delta = 0.08 \quad x = 0.8$	0.19	0.011	0.062	0.017
Experiment [9]	0.21 ± 0.04	0.006 ± 0.0025	-	-

values $r_{exp}(V_i P)$. The amplitudes $\langle\pi(K), B \mid \pi(K), B\rangle$ in (6) - (8) for forward scattering were assumed to be pure imaginary and were calculated with the aid of the optical model. The value $\delta = 0.8$ corresponds to an angle $\theta_V \simeq 40°$ determined from the mass formula [10], and $x = 0.8$ was chosen in [8] to obtain agreement of the magnetic moment of the Λ hyperon with experiment. The inequality $r(\omega P) > r(\omega N)$ is attributed to the relatively large amplitude $A = A(E)$ at $E = 5$ GeV, which has, in accordance with (7), opposite signs for the proton and neutron. When $E \to \infty$, $A(E) \to 0$ $(A(E)/P(E) \sim E^{-0.6}$ in the Regge-pole model), and the ratio of the cross sections for the production of ρ^0 and ω mesons on nucleons approaches

$$\sigma(\rho^0) : \sigma(\omega) \simeq G^2_{\gamma\rho} : G^2_{\gamma\omega} \simeq 9 : 1, \tag{12}$$

which should be valid in the region of intermediate energies only for processes of coherent photoproduction on nuclei with zero isospin (D, He^4, O^{16}). In connection with the "non-ideal" ω-φ mixing angle, and by way of a further check on the vector-dominance model, great interest attaches to a search for the $\varphi \to \pi^0\gamma$ decay and to a comparison of its width with the width of the $\omega \to \pi^0\gamma$ decay.

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