LOWER LIMIT OF THE ELASTIC SCATTERING AMPLITUDE AT FIXED MOMENTUM TRANSFER, II

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It was shown in an earlier paper by one of the authors [1] that the rigorously proved analytic properties of the imaginary part A(s, t) of the elastic-scattering amplituded makes it possible to obtain the lower limit of this amplitude in a certain momentum-transfer interval $-\gamma < t < 0$. In the present paper we generalize the results obtained in [1] and establish a lower limit that is valid for all finite $t < 0$.

As is well known, A(s, t) is analytic in t in the Martin ellipse E_t with foci at the points $t = 0$ and $t = -4k^2$ with major semi-axis $2k^2 + \gamma$ for a certain constant $\gamma > 0$ (k = three-dimensional particle momentum in the c.m.s.), and for all values of t A(s, t) increases in this ellipse not faster than $\text{const}\cdot s^{1+\epsilon}$, with $\epsilon \leq 1$.

Let us consider two points $t_+ = -\alpha$ and $t_- = -4k^2 + \alpha$, for a certain $\alpha > 0$, and denote by W(t) the analytic function that maps conformally the ellipse E_t in the t plane into a certain ellipse E_w in the w plane, with foci at the points $w = \pm 1$, in such a way that the points $t_\pm$ are mapped into the foci ±1, respectively. We denote the mapping of the point $t = 0$ by w_0, and the major semi-axis of the ellipse E_w by a. The quantities w_0 and a depend on s, α, and γ.

The conformal mapping of an ellipse into a half-plane and of a half-plane into an ellipse were studied, for example, in [2]. Using the expressions given in [2] we can show that when $s \to \infty$

$$w_0 \approx 1 + \frac{8}{\pi^2}\frac{\gamma}{s}\text{arc cos}\left[\text{sh}^{-1}\left(-\frac{\pi}{2}\sqrt{a/\gamma}\right)\right]$$

$$a \approx 1 + \frac{2\gamma}{s}.$$

We now use the conformal mapping

$$\xi = w + \sqrt{w^2 - 1}$$

to transform the ellipse E_w into a ring with inside radius I and outside radius R

$$R = a + \sqrt{a^2 - 1},$$

following Cerulues and marting [3] (see also [1,4]). Using then the Hadamard three-circle theorem [1,3,4], we obtain a lower bound for the ratio f(s, t) = A(s, t)/A(s, 0)

$$\max_{-4k\ \ + a \leqslant t \leqslant -a}|f(s,t)| \geqslant s^{-(\epsilon-\rho)\Phi(\pi/2\sqrt{a/\gamma})},$$

where

$$\Phi(x) = \frac{\text{arc cos sh}^{-1}x}{\pi/2 - \text{arc cos sh}^{-1}x},$$

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

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

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 $\gamma = 1.83m_\pi^2$. There are grounds for hoping, however, that γ reaches $4m_\pi^2$.

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[1] Nguyen Van Hieu, ZhETF Pis. Red. 7, 391 (1968) [JETP Lett. 7, 308 (1968)].
[2] W. Koppenfels and F. Stahlmann, Practice of Conformal Mapping (Russ. Transl.) IIL, 1963.
[3] F. Cerulues and A. Martin, Phys. Lett. 8, 80 (1964).
[4] A. A. Logunov and M. A. Mestvirishvili, ibid. 24B, 583 (1967).
[5] V. N. Gribov, Zh. Eksp. Teor. Fiz. 41, 1962 (1961) [Sov. Phys.-JETP 14, 1395 (1962)].

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