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INVERSE PION ELECTROPRODUCTION AT HIGH ENERGIES - A SOURCE OF INFORMATION ON THE HADRON FORM FACTORS

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1. In the study of an electromagnetic structure of particles the knowledge of their form factor dependence on the time-like values of virtual photon "mass" (k^2) is of a special importance[1]. The possibility of receiving the model-independent information about pion and nucleon form factors at time-like k^2, changing practically from zero ($k^2 \geq 2m_e^2$), is due to the analysis of processes $\pi N \to e^+e^- N$ (inverse pion electroproduction - IPE)[2] and is ensured by such IPE properties in the first and second resonance region owing to which the IPE amplitude is given by its Born approximation at certain kinematical conditions[3-6]. However this method can be motivated only up to about the values of $k^2 \approx 14\, m_\pi^2$ (this corresponds to the total c.m. energy of πN system $w \approx 1500$ MeV)[6] because at higher energies the influence of the s- and d- wave resonances (D_{13} (1520), S_{11}(1535), S_{31}(1650), S_{11}(1700) causes to a considerable extent the interpretation of IPE to be dependent on a model. Thus, as far as the nucleon form factors are concerned, there still remains an enough wide range of the k^2 values (up to $4m_N^2$) where they cannot be measured directly in the experiments with the colliding beams: $e^+e^- \rightleftarrows N\bar{N}$.

In the present paper, proceeding from the features of processes $\gamma N \to \pi^{\pm} N$, $eN \to e\pi^{\pm} N$, $\pi N \to e^+e^- N$ and $\pi^- p \to \rho^0 n$ at high energies and small momentum transfer $|t|$ and the realistic model for their interpretation, a conclusion is drawn on the reduction of the rescattering effects with increasing k^2; thus the simple electric Born model (EBM) for the description of IPE (and $\pi^- p \to \rho^0 n$) is substantiated and it is concluded, that the data on IPE in the above kinematical region could extend the range of $k^2 > 0$, where the reliable determination of pion and nucleon form factors is possible. In the kinematical region of interest the description of the data on the process $\pi^- p \to \rho^\circ n$, which is simply related with IPE[7] due to ρ°-meson-photon analogy[8], may serve as a criterion of the reliability of the proposed model. In the papers[9-11] it is already offered to use IPE at high energies and small $|t|$ for studying hadrons e.m. structure and its experimental investigation (for pions with momentum 4 GeV/c)[12] enabled the $\rho-\gamma$ transition constant to be estimated.

2. The research of photo-, electroproduction and IPE in one-photon approximation is related with studying the amplitude of the process $\gamma^* N \rightleftarrows \pi N'$, $J_\mu(s,t,k^2)$, where s, t are usual Mandelstam variables and $k^2 = 0, <0, \geqslant 4m_e^2$ correspond to the above three processes, respectively.

Further we shall make use of the s-channel helicity amplitudes[10] $f_{\lambda',\lambda\lambda_\gamma}$, where λ_γ , λ and λ' are the helicities of γ^*-quantum, an incident and final nucleon, respectively. Let us cite the relations of the parity conserving s-channel amplitudes,

$$f_1^- = f_{1/2,1/2\,0}\,, \qquad f_3^\pm = f_{1/2,1/2\,1} \pm f_{-1/2,-1/2\,1}\,,$$
$$f_2^- = f_{-1/2,1/2\,0}\,, \qquad f_4^\pm = f_{-1/2,1/2\,1} \mp f_{1/2,-1/2\,1}\,, \tag{1}$$

with spin density matrix elements of the virtual photon γ^* $\rho_{\lambda_\gamma \lambda_{\gamma'}}$ [8,10,13] in the H-frame:

$$N\rho_{11} = |f_3^+|^2 + |f_4^+|^2 + |f_3^-|^2 + |f_4^-|^2,$$
$$N\rho_{1-1} = |f_3^+|^2 + |f_4^+|^2 - |f_3^-|^2 - |f_4^-|^2, \tag{2}$$
$$N\rho_{00} = 4\left(|f_1^-|^2 + |f_2^-|^2\right),$$

$$N\rho_{10} = -2\left(f_3^- f_1^{-*} + f_4^- f_2^{-*}\right),$$

where
$$\frac{d\sigma}{dt} = \frac{\alpha m^2}{4 s^2} N\,,$$
$$N = 4\left(|f_1^-|^2 + |f_2^-|^2\right) + 2\left(|f_3^+|^2 + |f_4^+|^2 + |f_3^-|^2 + |f_4^-|^2\right).$$

Let us also write (to the leading order in s) the relations of $f_i^\pm$ with the independent invariant amplitudes $\mathcal{A}_i(s,t,k^2)$[5,14] (i =1,...,6):

$$f_1^- = \sqrt{|k^2|}\,\frac{s}{2m}\left(\mathcal{A}_6 - \mathcal{A}_3\right), \quad f_2^- = -\frac{\sqrt{-|k^2|\,t}}{2m}\left(s\mathcal{A}_2 + \frac{t - m_\pi^2 + k^2}{2}\mathcal{A}_5\right),$$
$$f_3^- = \sqrt{-\frac{t}{2}}\,\frac{s}{m}\mathcal{A}_3\,, \qquad f_4^+ = -\frac{s}{\sqrt{2}\,m}\mathcal{A}_1\,, \tag{3}$$
$$f_3^+ = \sqrt{-\frac{t}{2}}\,\frac{s}{m}\mathcal{A}_4\,, \qquad f_4^- = -\frac{1}{\sqrt{2}\,m}\left(s\mathcal{A}_1 + st\mathcal{A}_2 + k^2 t\mathcal{A}_5\right).$$

In obtaining these formulas (3) it is taken into account that, as it follows from the relations of $\mathcal{A}_i$ with the t-channel helicity amplitudes and from the conventional procedure of Reggeization of the latter[15], we have at $s \to \infty$ and small $|t|$:

$$\mathcal{A}_i \sim s^{\alpha(t)-1} \ (i \neq 5), \qquad \mathcal{A}_5 \sim s^{\alpha(t)}.$$

3. As known[16], the most conspicuous features of charged pion photoproduction over the wide energy range above the resonance region ($s >$ 5 GeV^2) and at small $|t|$ ($|t| \lesssim 2m_\pi^2$) : the sharp forward peak in the differential cross section, the characteristic energy behaviour of the latter as s^{-2} , the approximate equality of the cross sections for photoproduction of positive and negative pions, - are all described by simple EBM and can be explained in a model-independent way in a sense.

The corresponding arguments are based upon the consideration of the finite energy sum rules (FESR)[17] for the two t -channel helicity amplitudes (g_3^- and g_4^+), which define $d\sigma/dt$ at $t=0$ [16]. Firstly, the consideration of FESR for isovector and isoscalar parts of these amplitudes[18] gives some model-independent confirmation for the dominance of the isovector component of photon in photoproduction at $|t| \lesssim 0.1\,(\mathrm{GeV}/c)^2$ explaining the approximate equality of cross sections for $\pi^\pm$ photoproduction. In the evaluation of integrals in the sum rules the imaginary parts of amplitudes are parametrized in accordance with the multipole analyses of photoproduction data in the resonance regions. Then the examination of FESR for the (-)-isospin parts of these amplitudes shows that in a saturation of the sum rules the Born terms of these amplitudes give the main contributions, but the resonance regions contributions at $t = 0$ are small as compared to the Born terms. Moreover the $P_{33}(1232)$ resonance gives the major contribution ($\approx 30\%$) into a correction to the Born term. The contributions of the resonances of the second and third resonance regions tend to the mutual cancellation at $t = 0$ and do not exceed 10% of the Born term. In the end, both amplitudes are defined by their Born terms to within about 20%. Thereby one substantiates EBM on the bases of results of the multipole analysis of the resonance regions data.

4. The specifics of the dynamics of charged pion photoproduction extends in a way to the processes with virtual γ^*-quantum provided the vector dominance model (VDM) is to be true[6,19]. It is convenient to formulate the vector dominance hypothesis in terms of the invariant Ball amplitudes $B_i(s,t,k^2)$ ($i = 1,\dots 8$) [15] (which are to be free of kinematical singularities) as the

conjecture of their "smoothness"[20,21]:

$$B_i(s,t,k^2) = F(k^2)\,\widetilde{B}_i(s,t,0)\,. \tag{4}$$

The kinematical condition of the realizibility of the conjecture (4) may be

$$s + t \gg 2m^2 + k^2\,, \tag{5}$$

since the k^2 -dependence enters in B_i also through the Mandelstam variable u .

Making use of the conjecture (4) one can express the six amplitudes of the virtual photoproduction $A_i(s,t,k^2)$ in terms of the four amplitudes $\widetilde{A}_i(s,t)$ of the process $\gamma N \to \pi N$ with the real γ -quantum as follows:

$$\underset{i=1,3,4.}{A_i(s,t,k^2) = \widetilde{A}_i(s,t)F(k^2)}, \qquad A_2(s,t,k^2) = \widetilde{A}_2(s,t)\frac{(t-m_\pi^2)F(k^2)}{t-m_\pi^2-k^2}, \tag{6}$$

$$A_5(s,t,k^2) = -\widetilde{A}_2(s,t)\frac{(s-m^2)F(k^2)}{t-m_\pi^2-k^2}, \quad A_6(s,t,k^2) = \frac{1}{2}\left[\widetilde{A}_3(s,t) - \widetilde{A}_4(s,t)\right]F(k^2). \tag{7}$$

The formulas (3), (6), (7) result immediately in the conclusion about the smoothness on k^2 (except for $F(k^2)$) of the transversal helicity amplitudes $f_3^\pm$ and $f_4^\pm$; the longitudinal amplitudes f_1^- and f_2^- have a factor $\sqrt{|k^2|}$. Then the model-independent considerations at $k^2 = 0$, based on the treatment of FESR, extend to the process with the virtual photon in the evident way, besides they mean that it is possible to describe in terms of EBM both the transversal parts of cross sections of processes $\gamma^* N \rightleftarrows \pi N$ ($k^2 \neq 0$) and the longitudinal part and the longitudinal-transverse interference, since eqs. (7) lead to the relations between the longitudinal (f_1^- and f_2^-) and transverse amplitudes[20,21]. Note that the conjecture (4) verifies in EBM at high s[21]. In the case of

$\pi^- p \to \rho^0 n$, EBM satisfactorily accounts for all available data on the ρ^0-meson density matrix at $|t| \lesssim 0.1\,(\mathrm{GeV/c})^2$ and $2\ \mathrm{GeV/c} < q_L < 12.2\ \mathrm{GeV/c}$ /22/.

For an applicability of the above treatment, apart from the condition (5), one imposes also the constraint

$$|t_{min}| \lesssim m_\pi^2 , \tag{8}$$

since the $|t|$-range, where the above processes are explained by the Born mechanism (from this consideration), is restricted at about $2m_\pi^2$. At larger $|t|$, but still below the values, at which the isoscalar component of photon begins to play a part ($|t| \lesssim 0.1\ (\mathrm{GeV/c})^2$), the inclusion of the absorption is essential for the description of these processes /23,24/.

In the paper /24/ one considers a model, based on fixed-t dispersion relations (DR), for the real photoproduction amplitudes, and the absorption is included by means of taking account of the baryon resonances contributions to the dispersion integrals. There it is shown, that while at $|t| \lesssim m_\pi^2$ the resonance contributions tend to cancell each other (this leads to EBM at $|t| \lesssim 2m_\pi^2$), then at $|t| \gtrsim 2m_\pi^2$ they add up, interfere with the Born terms and ensure the significant reduction of the increasing Born part of the cross section. In such reduction the P_{33} (1232) resonance plays a major part (as well as in the improved quantitative description at $|t| \lesssim 2m_\pi^2$). The similar effects have been demonstrated in the case of electroproduction in the works /10,25/, and for $\pi^- p \to \rho^0 n$ — in /10,21/.

5. Proceeding from what was said above as the first well defined variant of the model of the unified treatment of photo-, electroproduction, IPE and of the process $\pi^- p \to \rho^0 n$ at high s and small $|t|$, we shall assume that they are described by the real parts of the isovector amplitudes $A_i^{(-)}(s,t,k^2)$, for which we postulate fixed-t DR's without subtraction at the finite energy /5,11,14/:

$$A_i^{(-)}(s,t,k^2) = R_5^{(-)} + c_5 + R_i\left(\frac{1}{m^2-s} - \frac{\epsilon_i}{m^2-u}\right) + \frac{P}{\pi}\int_{(m+m_\pi)^2}^{\infty} ds'\, \mathrm{Im}\, A_i^{(-)}(s',t,k^2)\left(\frac{1}{s'-s} - \frac{\epsilon_i}{s'-u}\right), \tag{9}$$

where $\epsilon_{1,2,4} = -\epsilon_{3,5,6} = 1$,

$$R_1 = -\frac{g}{2}F_1^v(k^2), \qquad R_2 = \frac{g F_1^v(k^2)}{t-m_\pi^2-k^2},$$

$$R_3 = R_4 = -\frac{g}{2}F_2^v(k^2), \qquad R_5 = R_6 = 0, \tag{10}$$

$$R_5^{(-)} = \frac{2g}{k^2}\left[\frac{F_1^v(k^2)}{t-m_\pi^2-k^2} - \frac{F_\pi(k^2)}{t-m_\pi^2}\right]$$

with the following normalization of the form-factors: $F_1^v(0) = F_\pi(0) = 1$, $2mF_2^v(0) = 3.7$, and

$$c_5 = \frac{2}{m_\pi^2+k^2-t}\cdot\frac{1}{\pi}\int_{(m+m_\pi)^2}^{\infty}\frac{ds'}{s'-m^2}\lim_{t\to m_\pi^2+k^2}\left[(t-m_\pi^2-k^2)\,\mathrm{Im}\,A_5(s',t,k^2)\right]. \tag{11}$$

The terms $R_5^{(-)}$ and c_5 belong only to the amplitude $A_5^{(-)}$. For the spectral functions $\mathrm{Im}\,A_i^{(-)}(s',t,k^2)$ we shall suppose that they are defined by the magnetic excitation of the P_{33} (1232) resonance:

$$\mathrm{Im}\,A_i^{(-)}(s,t,k^2) = -\frac{4\pi}{3}\cdot\frac{G_M^v(k^2)\sin^2\delta_{33}(w)}{g\,m_\pi q^3[(w+m)^2-k^2]}\,a_i(w,t,k^2), \tag{12}$$

where $G_M^v = F_1^v + 2mF_2^v$, $w = \sqrt{s}$,

$$a_i(\omega,t,k^2)=\alpha_i(\omega;t)-k^2\beta_i(\omega), \qquad i=1,3,4,6, \qquad (13)$$

$$a_{2,5}(\omega,t,k^2)=\frac{\alpha_{2,5}(\omega;t)-k^2\beta_{2,5}(\omega)}{t-m_\pi^2-k^2}.$$

The explicit form of coefficients α_i, β_i is defined in [5]. The formulated model is an extension of the very similar models of $\pi^\pm$ photoproduction [23,25], electroproduction [25] and of the process $\pi^- p \to \rho^0 n$ [10] to arbitrary k^2 (including also $k^2>0$). Note a number of favourable facts (from the point of view of the particle structure investigation) in the interpretation of IPE at high s and small $|t|$.

From the beginning we shall demonstrate the derivation of EBM as $s\to\infty$ on the basis of fixed-t DR's, following [10]. The amplitudes $\mathcal{A}_1^{(-)}$, $\mathcal{A}_2^{(-)}$ and $\mathcal{A}_5^{(-)}$ are the most important ones in the considered kinematical region, while the crossing-odd amplitudes $\mathcal{A}_1^{(-)}$ and $\mathcal{A}_2^{(-)}$ behave as s^{-1} at high s (as is seen from (9) since the kinematical factors add up in the corresponding way), and their dispersion corrections do not mostly exceed 15%. The dispersion contribution to $\mathcal{A}_5^{(-)}$, which goes to a constant as $s\to\infty$, is negligible, because it behaves as s^{-2} due to the crossing-evenness. The $\mathcal{A}_4^{(-)}$ Born term, caused by the photon interaction with the nucleon magnetic moment distribution, almost cancells up with the dispersion integral, making $\mathcal{A}_4^{(-)}$ to be of the same order of magnitude as are crossing-even $\mathcal{A}_3^{(-)}$ and $\mathcal{A}_6^{(-)}$. The latter behave as s^{-2} and represent a few per-cent to the main amplitudes. The shown cancellation in $\mathcal{A}_4^{(-)}$ at high s can be explained by the realization of the superconvergent sum rule

$$gF_2^v(k^2)-\frac{2}{\pi}\int_{(m+m_\pi)^2}^{\infty}ds'\,Im\,\mathcal{A}_4^{(-)}(s',t,k^2)=0 \qquad (14)$$

which at $-m_\rho^2\lesssim k^2\lesssim m_\rho^2$ already by the P_{33} (1232) -contribution saturates within 5 ÷ 20% [10]. The magnetic part of the Born approximation contributes also to $\mathcal{A}_3^{(-)}$ which is small. The dispersion integrals influence more considerably to the non-leading amplitudes $\mathcal{A}_3^{(-)}$ and $\mathcal{A}_6^{(-)}$. (Note that the dispersion integrals, converging rather fast at the approximation (12), have the cut-off at $s=3$ (GeV)^2). Thus, one gets EBM with small dispersion corrections in the leading order of s.

In EBM for virtual photoproduction [9,10] the longitudinal part of the cross section $(\rho_{00}\frac{d\sigma}{dt})$ is proportional to $|F_\pi|^2$; the transversal part ,related with the perpendicular polarization of γ^*-quantum, $(\rho_{11}+\rho_{1-1})\frac{d\sigma}{dt}$, — $|F_1^v|^2$; and the asymmetry (ρ_{1-1}/ρ_{11}) is sensitive to the ratio F_1^v/F_π. That is, the various parts of the cross section are rather sensitive to the diverse quantities of interest separately.

Let us point out another one remarkable property related to the rescattering effect and explicitly shown by the dispersion model. To this end, consider the dispersion intergal in eq. (9) and at first the coefficients $a_i(\omega,t,k^2)$(13). In the latter the functions $\alpha_i(\omega;t)$ and $\beta_i(\omega)$ are of the same signs for each index i, to say, it is evident that there is a common tendency to increase the dispersion contributions in each amplitude $\mathcal{A}_i$ with raising space-like $|k^2|$ and, on the contrary, to their decreasing at going over to the time-like k^2. To estimate this effect we shall take the narrow resonance approximation for the π-N phase shift $\delta_{33}(\omega)$, that is to say, evaluating $a_i(\omega,t,k^2)$ we shall consider ω = =1.232 GeV; one can convince itself that the computations using more realistic phase shift $\delta_{33}(\omega)$ would practically not alter the obtained conclusions. It is necessary to exclude the possibility of the false effects and of the accidental cancellations in the observed quantities, for that it is most convenient to examine such combinations of $\mathcal{A}_i$ in which these amplitudes enter in the cross section through the helicity amplitudes $f_i^{\pm}$ (eqs. (3)). It is reasonable to discuss also the leading order in s. Then we get for the main amplitudes $f_4^{\pm}$ and f_2^{-} the following results. In $f_4^{+} \sim \mathcal{A}_1$ the vanishing of $a_1(\omega,t,k^2)$ at t = 0 takes place at about $k^2 \approx 0.54$ (GeV)^2 (that is to say, close to the ρ -meson mass), with $|t|$ this value decreases somewhat and at $t = -0.1$ (GeV/c)^2 it is 0.25. At larger k^2 the contribution of dispersion integral increases again. In f_4^{-} the dispersion contribution vanishes also at approximately m_ρ^2 ($k^2 \approx$ 0.56 GeV^2) and this result depends weakly on t. In amplitude f_2^{-} the dispersion integral contribution is practically independent of t and of k^2 (here it is important to take into account also c_5 (eq.(11)), however it is small in comparison with the Born term. In f_1^{-} and f_3^{-}, contributing to the next order in s, there is observed also the tendency to reducing the dispersion corrections mainly due to the numerator $[2(s'-m^2)+t-m_\pi^2-k^2]$ in the dispersion factor (9).

Thus one receives the motivation of EBM for IPE at k^2 in the vicinity of the ρ-meson mass as the result of the low energy saturation of the dispersion integrals. This conclusion is true at least up to $|t| \approx 0.08$ (GeV/c)^2. Therefore the constraint (8) can be made remarkably weaker. Though the limit $s \to \infty$ has been taken into account when doing calculations, yet the received results extend to rather low energies. So, at ω = 3 GeV, $t = -m_\pi^2$ and $k^2 = -0.3, 0, 0.3$ (GeV)^2 the dispersion contribution to the transversal cross section represents 40, 30, 15%, respectively/11/. Note also that the conclusion about the reduction of rescattering effects in considered processes is experimentally verified by the known fact that EBM improves successively the description of the data when going from the electroproduction to the photoproduction and so on to the process $\pi^- p \to \rho^0 n$ /19/.

A possible way to improve/11/ the model described is suggested by the results of ref./24/. The latter mean that a successive inclusion of isobars of the second and third resonance regions into the dispersion integral changes appropriately the deviations of calculations from the experimental data on photoproduction. However at $k^2 \neq 0$ including, in the spectral function, the π-N - resonance contributions which are parametrized in accordance with the "isobar model" we would meet a number of uncertainties due to the unknown k^2-dependence of the transition form factor of the nucleon resonances. This is unsatisfactory from the point of view of the reliable model construction. To overcome this difficulty, one can take advantage of the fact, that the considered kinematical region suits for the realization of the VDM conjectures, and use eqs. (6), (7). However, VDM is not an exactly defined hypothesis, and what is more, it cannot be exact in principle (although there is established the correspondence between their major predictions and the experimental data). Therefore we shall not touch by this assumption upon the main well established part of the model which is described above, but shall apply it to that correction part which is defined through the dispersion integral, saturated by the electrical and longitudinal excitation of P_{33} (1232), by the rest of resonances and by the high energy contribution. So, the dispersion integral in (9) will be broken into two parts:

$$\int ds'\left[\mathrm{Im}\,A_i^{(-)}(M_{1+,\mu})+\mathrm{Im}\,A_i^{corr.}(s',t,k^2)\right]\left(\frac{1}{s'-s}-\frac{\epsilon_i}{s'-u}\right), \quad (15)$$

where $\mathrm{Im}\,A_i^{(-)}(M_{1+,\mu})$ is taken according to eq. (12) and $\mathrm{Im}\,A_i^{corr.}(s',t,k^2)$ is evaluated by the formulas (6) and (7), in which the imaginary part of the real photoproduction amplitudes $\mathrm{Im}\,\mathcal{A}_i^{corr.}(s',t)$ is parametrized (except for the magnetic excitation of P_{33} (1232)) after the fashion of work[26], for example.

The absorption part of the amplitude at high s, the contribution of which can be of the same order of magnitude as is the supplementary dispersion correction, is taken according to eqs. (8) and (9).

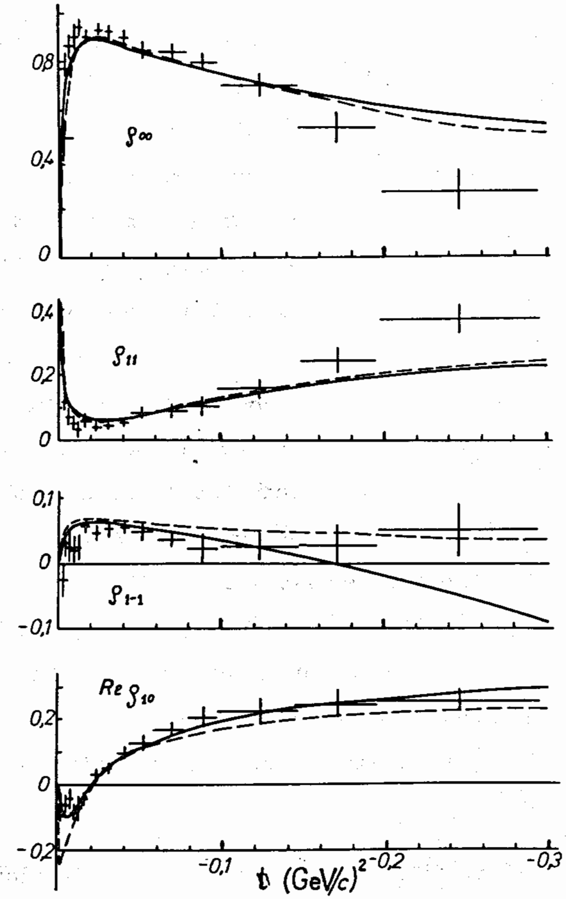
The form factor $F(k^2)$ in (8) and (9) in a vicinity of the ρ -meson mass is reasonable to be taken as

$$F(k^2)=f(k^2)\frac{m_\rho^2}{m_\rho^2-k^2-im_\rho\Gamma_\rho}, \quad (16)$$

where $f(k^2)$ is a smooth k^2 -function near to one.

Note that in the above described scheme with the corresponding change one can take into account the isoscalar part of the amplitude.

The figure shows the comparison of the calculation results based on the main well defined part of the model (eqs. (9) and (12)), for the ρ° -meson density matrix elements in the process $\pi^- p\to\rho^\circ n$ (solid line) with the experimental data at the pion laboratory momentum 15 GeV/c in the H -frame[27].



To compare with the corresponding evaluations in EBM[22] (dashed line), this calculation was carried out under the assumption of universality of the ρ -meson interaction $f_{\rho\pi\pi}=f_{\rho N\bar{N}}$. It is seen that the model describes ρ_{00} and ρ_{11} practically just as EBM, but it improves somewhat the account of ρ_{1-1} and $\mathrm{Re}\,\rho_{10}$.

6. Thus, taking as a basis the satisfactory description of pion photo-, electroproduction, and $\pi^- p\to\rho^\circ n$ and taking account of some favourable facts: the EBM domination in the interpretation of these processes, the reduction of the rescat-

tering effects with k^2 , the IPE cross section increase of about an order as compared to electroproduction /11/, a further improvement of the IPE model practically without adding new parameters against the photoproduction, - one must draw a conclusion about a reality of the task to extract practically model-independent values of the form factors $F_1^{v}(k^2)$ and $F_\pi(k^2)$ at time-like k^2 from IPE data at the energies above the resonance region and small $|t|$.

From this point of view, the k^2- range in a vicinity of the ρ -meson mass where EBM with the minimal corrections is motivated, is most advantageous. This result is due to the low energy saturation of the dispersion integrals mainly. In view of some model-independent substantiation of the last fact at small $|t|$, as discussed in sec. 3 and 4, one may think that the conclusion about the rescattering effect reduction with k^2 and about the k^2 -range, where the rescattering contributions reduce to a minimum ,has a more general, than model, character.

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Обратное электророждение пионов при высоких энергиях - источник информации о формфакторах адронов

В единой дисперсионной модели рассмотрены процессы $\gamma N \to \pi^{\pm} N$, $eN \to e\pi^{\pm} N$, $\pi N \to e^{+}e^{-}N$, $\pi^{-}p \to \rho^{0}n$ при высоких энергиях и малых передачах импульса. Делается вывод об уменьшении эффектов перерассеяния с ростом времениподобных значений "массы" виртуального фотона. Таким образом, обосновывается простая модель электрических борновских членов для описания процесса обратного электророждения /и $\pi^{-}p \to \rho^{0}n$/ в указанной кинематической области и делается заключение о возможности получения надежной информации о структуре адронов из экспериментальных данных по этому процессу.

Работа выполнена в Лаборатории теоретической физики ОИЯИ.

Сообщение Объединенного института ядерных исследований. Дубна 1991

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Inverse Pion Electroproduction at High Energies - a Source of Information on the Hadron Form Factors

Processes $\gamma N \to \pi^{\pm} N$, $eN \to e\pi^{\pm} N$, $\pi N \to e^{+}e^{-}N$, $\pi^{-}p \to \rho^{0}n$ are considered in the framework of the unified dispersive model at high energies and small momentum transfer. A conclusion is drawn on the reduction of the rescattering effects with increasing time-like values of virtual photon "mass". Thus simple electric Born model for the description of the process of inverse electroproduction (and $\pi^{-}p \to \rho^{0}n$) in indicated kinematic region is grounded and conclusion on the possibility of receiving reliable information on hadron structure from the experimental data on this process is drawn.

The investigation has been performed at the Laboratory of Theoretical Physics, JINR.

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