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I. Introduction.

Experiments on the deep inelastic scattering of high energy electrons on protons [1,2] have resulted in an essential progress in understanding the photon-hadron interactions. Scaling has been discovered, and it has been shown that in the deep inelastic region, the structure functions are of the order of unity.+)

The discovery of scaling stimulated development of a number of new trends in theoretical investigations: the parton model [4], automodel asymptotics in the local field theory [5], etc.

In this work ++) we discuss the results of analysis of all experimental data on the deep inelastic $e-p$ scattering.[1,2,6,7] We have used the method of analysis applied earlier for analysing the data on elastic $e-p$ scattering [8] and elastic $e-d$ scattering [9]. To determine the structure functions by this method

+) A possibility for such a behaviour of the structure functions was discussed by Markov [3] many years ago.

++) Preliminary results were submitted to the XVI Conference on High Energy Physics at Chicago, Batavia, September 1972.

it is necessary from the very beginning to parametrize them. The appropriate parameters are determined directly from the experimental data by minimizing the functional χ^2. At the analysis of data of various groups we introduced as variable parameters the norms, which take into account possible errors in the cross-section normalizations. This method makes it possible to use the whole set of experimental data for determining the structure functions.

The analysis has revealed that νW_2 scales for $W \geqslant 2.3$ GeV (W is the mass of finite hadrons).

Various parametrizations of the ratio R were considered. The results of analysis indicate that the available experimental data do not allow one to drop out those expressions for R which mean the violation of scaling of the function $2MW_1$ in the range of variables where the function νW_2 scales.

If we assume that νW_2 depends on the variable ω' proposed in paper /10/, the experimental data can be described for $W \geqslant 1.8$ GeV.

II. Cross section of the process. The method of data analysis.

It is well known that the cross section of the process

$$e + p \rightarrow e + \dots \tag{1}$$

for unpolarized initial particles in the one-photon approximation has the following general form (in lab. system):

$$\frac{d^2\sigma}{d\Omega\, dE'} = \left(\frac{d\sigma}{d\Omega}\right)_M \left[W_2 + 2 tg^2 \frac{\theta}{2} W_1 \right], \tag{2}$$

where

$$\left(\frac{d\sigma}{d\Omega}\right)_M = \frac{\alpha^2 \cos^2 \frac{\theta}{2}}{4E^2 \sin^4 \frac{\theta}{2}} . \tag{3}$$

Here E and E' are the electron initial and final energies, correspondingly; θ - the scattering angle, and W_1 and W_2 are functions of the scalars:

$$\nu = -\frac{1}{M} pq = E - E', \quad q^2, \tag{4}$$

where q and p are four-momenta of photon and proton , correspondingly; M - the proton mass. The functions W_1 and W_2 are determined by the hadron part of matrix element. Next, we have the following relation:

$$\sum \int \langle p' | J_\mu | p \rangle \langle p | J_\nu | p' \rangle \delta(p' - p - q) d\Gamma = \tag{5}$$
$$= \frac{e^2}{(2\pi)^6} \frac{M}{p_0} \left[W_1 \left(\delta_{\mu\nu} - \frac{q_\mu q_\nu}{q^2}\right) + \frac{1}{M^2} W_2 \left(p_\mu - \frac{pq}{q^2} q_\mu\right)\left(p_\nu - \frac{pq}{q^2} q_\nu\right)\right],$$

where J_μ is the operator of hadron electromagnetic current; p' - the total four-momentum of final hadrons.

The total cross sections for absorption of virtual photons with transverse and longitudinal polarizations σ_T and σ_S

are related to W_1 and W_2 as follows /11/:

$$\sigma_T = (2\pi)^2 \alpha \frac{1}{K} W_1 \tag{6}$$

$$\sigma_S = (2\pi)^2 \alpha \frac{1}{K} \left(-W_1 + \frac{q^2+\nu^2}{q^2} W_2\right) .$$

Here

$$K = \nu - \frac{q^2}{2M} \quad , \quad \alpha = \frac{e^2}{4\pi} \tag{7}$$

at $q^2 \to 0$

$$\begin{aligned} \sigma_T &\to \sigma_\gamma , \\ \sigma_S &\to 0 , \end{aligned} \tag{8}$$

where σ_γ is the total cross section of absorption of real photons with an energy ν by protons.

It follows from (6) that

$$2MW_1 = \omega \nu W_2 \frac{1 + \frac{q^2}{\nu^2}}{1 + R} , \tag{9}$$

where

$$R = \frac{\sigma_S}{\sigma_T} \tag{10}$$

and the variable ω is defined in the following way:

$$\omega = \frac{2M\nu}{q^2} . \tag{11}$$

As $R \geqslant 0$, then from (9) we find that

$$(1 + q^2/\nu^2)\,\omega \nu W_2 \geqslant 2MW_1 . \qquad (12)$$

To determine νW_2 and R (or νW_2 and $2MW_1$) by the method which we use, it is necessary to parametrize these functions. The corresponding parameters are then determined from all available data through minimizing the functional :

$$\chi^2 = \sum_{k} \sum_{i} \frac{1}{\Delta^2_{i,k}} \left(\sigma^{exp}_{i,k} - N_k \, \sigma^{theor}_{i} \right)^2 . \qquad (13)$$

Here $\sigma^{exp}_{i,k}$ is the differential cross section of the process at i -th point measured in k -th experiment, $\Delta_{i,k}$ is an error of $\sigma^{exp}_{i,k}$, $\sigma^{theor.}_{i}$ is the cross section at i -th point calculated by the formula (2) and N_k are the normalizing factors. Minimization of χ^2 is achieved through the linearization method[12], application of which is described in paper[13].

On the basis of current algebra Bjorken has shown [14] that at $q^2 \to \infty$, $\nu \to \infty$ and $\omega = \frac{2M\nu}{q^2}$ fixed the dimensionless functions νW_2 and $2MW_1$ depend on the variable ω only(scaling). From experiments on deep inelastic $e-p$ scattering it follows that scaling is in an agreement with the experimental data at $\sqrt{q^2}$ and ν of the order of 1 GeV already. We assume, first, scaling to be valid for νW_2 . When parametrizing this function we will take into account the threshold relation found in works /15,10/ which connects a behaviour of νW_2 at $\omega \to 1$ with that of the magnetic form factor of proton $G_M(q^2)$ at $q^2 \to \infty$. If we write down:

$$\nu W_2 \underset{\omega \to 1}{\sim} \left(1 - \frac{1}{\omega}\right)^p , \quad G_M(q^2) \underset{q^2 \to \infty}{\sim} \frac{1}{(q^2)^n} \tag{14}$$

then

$$p = n + 1 \tag{15}$$

follows as it is shown in /10,15/.

The analysis of elastic $e-p$ data gives $n = 2$. Thus, from (15) it follows:

$$p = 3 . \tag{16}$$

Further, from the Regge theory it follows that /16/

$$\nu W_2 \underset{\omega \to \infty}{\longrightarrow} const , \quad \frac{2MW_1}{\omega} \underset{\omega \to \infty}{\longrightarrow} const . \tag{17}$$

Now let us consider firstly the following expression for νW_2

$$\nu W_2 = \sum_i a_i \left(1 - \frac{1}{\omega}\right)^{i+3} \tag{18}$$

which satisfies eqs. (14), (16) and (17).

The function $2MW_1$ is connected with νW_2 and R through the relation (9). We will consider various expressions for the ratio R .

III. The results of analysis.

1. Let us suppose that

$$R = \frac{q^2}{\nu^2}. \tag{19}$$

Then as it is seen from (9) the functions $2MW_1$ and νW_2 are related as follows:

$$2MW_1 = \omega \nu W_2 . \tag{20}$$

As it is known this relation emerges in the parton model for the case when the parton spin is equal to 1/2 [17]. The same relation holds if the squared absolute values of matrix elements of photon absorption with transverse and longitudinal polarizations, summed over final states, are equal.

The results of analysis of SLAC-MIT data [12] indicate that for the case (19) a satisfactory description of experimental data is achieved when the mass of final hadrons $W \geqslant 2.5$ GeV. Note, that the variable W^2 relates to q^2 and ν in the following way:

$$W^2 = 2M\nu + M^2 - q^2. \tag{21}$$

And only the following three parameters in (18)

$$\begin{aligned} a_0 &= 1{,}12 \pm 0{,}07 \\ a_1 &= 1{,}00 \pm 0{,}20 \\ a_2 &= -1{,}98 \pm 0{,}14 \end{aligned} \tag{22}$$

differ from zero. ($\chi^2 / \overline{\chi^2} = \frac{162}{135}$, C.L. 5,5%).

2. It is possible to obtain such a relation between $2MW_1$ and νW_2 which agrees with experiment in larger range of the variable ω . We suppose that scaling holds both for νW_2 and $2MW_1$. This assumption means that the ratio $\frac{1+R}{1+\frac{q^2}{\nu^2}}$ depends on ω only. We expand this ratio into a series in $\frac{1}{\omega}$ and we obtain:

$$\frac{\omega \nu W_2}{2MW_1} = 1 + \frac{d}{\omega} + \frac{d_1}{\omega^2} + \dots \quad . \tag{23}$$

The analysis of experimental data has shown that it is sufficient to consider the term $\frac{d}{\omega}$ in this expansion. So, we have that:

$$2MW_1 = \omega \nu W_2 \left(1 + \frac{d}{\omega}\right)^{-1} . \tag{24}$$

By using (24) it is possible to fit the experimental data /1,2/ at $W \geq 2.3$ GeV. In the expansion (18) it is sufficient that only a_0 and a_2 are nonzero. We obtain the following values for parameters:

$$a_0 = 1.64 \pm 0.02$$
$$a_2 = -1.50 \pm 0.02$$
$$d = 0.63 \pm 0.09$$

(The ratio $\chi^2/\bar{\chi}^2$ = 162/150, C.L. = 2 3.9%).

3. As we see the experimental data [1,2] in the region $W \geqslant 2.3$ GeV are well described by means of the three parameters if scaling is assumed to hold both for νW_2 and $2MW_1$. However, it is possible to obtain good fit of experimental data with such parametrizations of R which mean the violation of scaling for $2MW_1$.

Let us consider the following expressions for R :

$$R = c_1 \frac{q^2}{M^2}, \tag{26.1}$$

$$R = c_2 \frac{q^2}{W^2}, \tag{26.2}$$

$$R = c_3 \frac{1}{\omega}, \tag{26.3}$$

$$R = const. \tag{26.4}$$

The first three expressions satisfy the condition $R = 0$ at $q^2 = 0$. Here we note that in the Bjorken limit ($q^2 \to \infty$, $\nu \to \infty$ ω - fixed) $R = c_1 \frac{q^2}{M^2} \to \infty$, $R = c_2 \frac{q^2}{W^2} \to c_2 (\omega - 1)^{-1}$. The expressions (26.1) and (26.4) were considered in the work [2].

The results of analysis of experimental data [1,2] in the region $W \geqslant 2.3$ GeV are listed in Table I. From Table I one can see that for satisfactory fit of the experimental data it is sufficient to consider only coefficients a_0 and a_2 to be nonzero in the expansion (18). Their values for different parametrizations of R coincide within errors. Note, that the absolute values of a_0 and a_2 are close to each other and signs are opposite. The value for c_1, which we have found, coincides with that obtained in the work [2] by another method.

At R =const. the description of experimental data improves essentially if one considers not only a_0 and a_2 but also a_1 to be nonzero.

4. We have also analysed the experimental data [1,2] parametrizing the functions νW_2 and $2MW_1$. For νW_2 we took the expression (18). For $2MW_1$ the following expression

$$2MW_1 = \omega \sum_i b_i \left(1 - \frac{1}{\omega}\right)^{i+3} \tag{27}$$

was taken. It is obvious that (27) satisfies (17).

The experimental data can be fitted by means of (18) and (27). It is sufficient to consider two terms in (18) and three terms in (27). As a result of analysing the experimental data in the region $W \geqslant 2.3$ GeV we find:

$$\begin{aligned} a_0 &= 1.68 \pm 0.02 \qquad & b_0 &= 0.72 \pm 0.14 \\ a_2 &= -1.57 \pm 0.04 \qquad & b_1 &= 1.35 \pm 0.42 \\ & & b_2 &= -1.84 \pm 0.31 \end{aligned} \tag{28}$$

($\chi^2 / \overline{\chi^2}$ = 154/148, C.L. = 35.6%).

The functions νW_2 and $2MW_1$ have to obey the unequality (12) which is equivalent to the condition $\sigma_S \geq 0$. Here we should note that for the latter case this unequality is fulfilled at some points within two standard deviations only.

5. Now let us discuss the results of analysis of all published experimental data on the deep inelastic e-p scattering. The results are given in Table II ($W \geq$ 2.3 GeV). The three last columns list the obtained values of norms: N_1 is the norm for the data of SLAC-MIT (153 points); N_2 and N_3 are those for the data of DESY, 1971 /7/ (83 points) and of DESY, 1969 /6/ (31 points), correspondingly.

From the results presented in Table II one may draw the conclusion that only the introduction of norms allows one to describe all available data on the deep inelastic e-p scattering. The values of norms at different parametrizations of R coincide within errors. And description of all available experimental data requires a substantial renormalization of results of paper /7/. A comparison of the results given in Table I and Table II reveals that the values of parameters found in analysing the data of papers [1,2] and of all world data coincide within errors.

6. Up to now we considered the expression (18) for the function νW_2. It is possible to fit the experimental data on deep inelastic $e-p$ scattering with other parametrizations of the structure function νW_2, as well. Let us consider the expression

$$\nu W_2 = \left(\frac{\omega^2-1}{\omega^2+\omega_0^2}\right)^3 \left(z_1 + z_2 \frac{1}{\sqrt{\omega}}\right), \tag{29}$$

where z_1, z_2 and ω_0^2 are variable parameters. This expression has been suggested in the paper [18] and is based on Regge theory. It is obvious that (29) satisfies both the threshold relation (14) and asymptotical condition (17). For R we have considered the same expressions as before. The results of analysis of data of the papers [1,2] are presented in Table III. ($W \geqslant 2.3$ GeV). As one can see from this Table, a rather good fit of the data is achieved for all the five parametrizations of R, which we have considered, if the expression (29) is used for νW_2. A comparison of the results given in Tables I and III shows that parameters of the expressions for R coincide within errors for both parametrizations of νW_2. Table IV presents the values of νW_2 calculated by formulae

(18) (the second and third columns) and (29) (forth and fifth columns). The second and forth columns give the values of νW_2 at $R = c_1 \frac{q^2}{M^2}$, the third and fifth columns give those at R = const. Figs. 1,2 show the dependence of νW_2 given by the formulae (18) and (29), correspondingly, at various parametrizations of R in the range of ω from 1 to 100. Throughout there were used the values of parameters found in analysing the experimental data of the papers /1,2/.

Analysing the results of SLAC-MIT/1,2/ we have seen that for $W \geq$ 2.3 GeV it is possible to describe all experimental data in the whole experimantally investigated region of q^2 ($0.25 \leq q^2 \leq 19.2 (GeV/c)^2$) by using three parameters.The variable ν changes from 1.87 GeV to 16.28 GeV, and the variable ω changes from 1.25 to 37.8. The values of ω higher than 20 correspond to the values of $q^2 \leq 1 (GeV/c)^2$.The question on a behaviour of νW_2 at large ω is of a considerable interest for the theory. We have carried out the separate analysis of the results of SLAC-MIT choosing the data with $q^2 \geq 0.5 (GeV/c)^2$; $q^2 \geq 1 (GeV/c)^2$ and $q^2 \geq 1.5 (GeV/c)^2$. The values of parameters found in this analysis are given in Tables V and VI.

7. The determination of νW_2 allows to calculate the integrals entering into the sum rules for this function. Let us consider firstly the Callan-Gross sum rule [19]

$$\int_1^\infty \nu W_2 \frac{d\omega}{\omega^2} = \sum_N \sum_{i=1}^N Q_i^2 \frac{1}{N} P_N . \tag{30}$$

Here Q_i is the charge of i -th parton, P_N -the probability of finding N partons in a proton. Using the values of a_0 and a_2 given in Table I for R =const. we obtain:

$$\int_1^\infty \nu W_2 \frac{d\omega}{\omega^2} = 0.162 \pm 0.001 . \tag{31}$$

If the values of a_0 and a_2 found for $R = c_1 \frac{q^2}{M^2}$ are used, then

$$\int_1^\infty \nu W_2 \frac{d\omega}{\omega^2} = 0.158 \pm 0.001 . \tag{32}$$

Finally, from the analysis of the data of SLAC-MIT at $q^2 \geq 1.5 (GeV/c)^2$ for $R = 0.26 \pm 0.04$ we obtain:

$$\int_1^\infty \nu W_2 \frac{d\omega}{\omega^2} = 0.166 \pm 0.002 . \tag{33}$$

Note that within the usual quark model the right hand side of (30) equals 1/3.

For the integral entering into the Gottfried sum rule[20] we have (for R =const. all q^2):

$$\int_1^{50} \nu W_2 \frac{d\omega}{\omega} = 0.97 \pm 0.01 . \tag{34}$$

8. Up to now we have supposed that νW_2 depends on ω only. We have seen that under very different assumptions on R it is possible to describe the whole set of data on the deep inelastic $e-p$ scattering. In order to estimate to what extent scaling can be violated, we have analysed the SLAC-MIT data assuming that νW_2 has the following form:

$$\nu W_2 = \sum_i a_i \left(1 - \frac{1}{\omega}\right)^{i+3} + \alpha \frac{M^2}{q^2}. \tag{35}$$

Obviously the second term of this expression vanishes in the Bjorken limit. We will suppose that the functions $2MW_1$ and νW_2 are connected through the relation (24). As a result of analysing the data of SLAC-MIT [1,2] we find that with $\frac{\chi^2}{\bar{\chi}^2} = \frac{150}{149}$

$$\begin{aligned} a_0 &= 1.65 \pm 0.02 & \quad d &= 0.61 \pm 0.08 \,, \\ a_2 &= -1.47 \pm 0.02 & \quad \alpha &= -0.02 \pm 0.01 \,. \end{aligned} \tag{36}$$

Comparing (36) with (25) we see that an addition of the term, which violates scaling, does not change the values of parameters a_0, a_2 and d within errors. The parameter α characterizing the violation of scaling equals zero within two errors.

9. In the paper [10] there was proposed the scale variable

$$\omega' = \frac{2M\nu + M^2}{q^2} \tag{37}$$

which coincides with ω at $2M\nu \gg M^2$. It has been shown that νW_2 is a function of ω' in a larger region of the variable W.

We have analysed the data of the papers /1,2/ parametrizing νW_2 in the following way:

$$\nu W_2 = \sum_i A_i \left(1 - \frac{1}{\omega'}\right)^{i+3}, \qquad (38)$$

where

$$\omega' = \frac{2M\nu + \beta}{q^2}. \qquad (39)$$

And here it turns out that immediately beyond the prominent resonance region ($W \geqslant 1.8$ GeV) all the present data can be described (see Table VII). In the expansion (38) it is sufficient that only three parameters A_0, A_1 and A_2 are nonzero. If one assumes that R =const. then for the parameters we obtain:

$$A_0 = 0.60 \pm 0.08 \qquad \beta = 0.91 \pm 0.07$$
$$A_1 = 1.96 \pm 0.17 \qquad R = 0.20 \pm 0.02 \qquad (40)$$
$$A_2 = -2.37 \pm 0.10$$

($\chi^2 / \overline{\chi^2}$ = 169/187).

In this analysis we have taken the data with $q^2 \geqslant 0.5 (\mathrm{GeV}/c)^2$. If this limitation is not put, then at $W \geqslant 1.8$ GeV by using (38) and (39) a satisfactory description of data is possible when one takes the expressions (26.2) and (26.3) for the ratio R, as it can be seen from the Table VII.

The values for A_i and β, which we have obtained, coincide within errors with those found in the paper [2].

If one considers that $2MW_1$ and νW_2 are related as follows:

$$2MW_1 = \omega' \nu W_2 \left(1 + \frac{\mathcal{D}}{\omega'}\right)^{-1} \qquad (41)$$

and νW_2 is given by (38), then for parameters we obtain the following values ($W \geq$ 1.8 GeV):

$A_0 = 0.50 \pm 0.08$ $\qquad \beta = 1.03 \pm 0.09$

$A_1 = 2.35 \pm 0.17$ $\qquad \mathcal{D} = 0.33 \pm 0.07$

$A_2 = -2.71 \pm 0.10$

($\chi^2/\overline{\chi^2}$ = 251/191, C.L. 11.5%).

To complete this section we would like to note that there are seven points in the papers [1,2] which provide large (larger than 9) contributions to χ^2 at all considered parametrizations. If these points are not included in the analysis of data, a description is improved essentially for all the cases.

IV. Conclusion.

We have analysed all available data on the deep inelastic e-p scattering. The analysis has been carried out separately for the data of SLAC-MIT [1,2] and for the world experimental data [1,2,6,7].

It has been shown that at $W \geqslant 2.3$ GeV the experimental data are fitted well under the assumption that the function νW_2 depends on the scale variable ω only. Various parametrizations of this function have been considered. We have introduced a violation of scaling of νW_2. It has been shown that the parameter characterizing the violation, differs from zero by two standard deviations only.

A number of expressions for the ratio R have been discussed. The data available allow no definite conclusions on R and on scaling of $2MW_1$. For an unambiguous determination of R one needs the data on cross sections of deep inelastic lepton-proton scattering in the larger region of kinematical variables.

We have tested in detail the validity of the relation $2MW_1 = \omega\nu W_2$ following from the parton model for the parton spin= 1/2. If this relation is modified through inserting an additional term, the contribution of which vanishes at large ω asymptotically, then all the data can be fitted well, as the analysis of data reveals.

If νW_2 is assumed to be a function of ω', then all the data can be described at $W \geqslant 1.8$ GeV.

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References

1. E.D.Bloom, D.H.Coward et al. Phys.Rev.Lett., 23,930 ,1969.
2. G.Miller, E.D.Bloom et al. Phys.Rev.,D5, 528, 1972.
3. M.A.Markov. JINR D-1269, Dubna, 1963.
4. R.P.Feynman. Phys.Rev.Lett., 23, 1415, 1969.
5. N.N.Bogolubov, A.N.Tavkhelidze, V.S.Vladimirov. JINR E2-6490, Dubna, 1972.
6. W.Albrecht, F.W.Brasse et al. DESY 69/7, 1969.
7. J.Moritz, K.H.Schmidt et al. DESY 71/61, 1971.
8. S.I.Bilenkaya, Yu.M.Kazarinov, L.I.Lapidus. JETP, 61,2225, 1971.
9. S.I.Bilenkaya, Yu.M.Kazarinov, L.I.Lapidus, E1-6647, Dubna, 1972.
10. E.Bloom, F.Gilman. Phys.Rev.Lett., 25, 1140, 1970; Phys.Rev., D4, 2901, 1974.
11. L.N.Hand. Phys.Rev., 129, 1834, 1963.
12. S.N.Sokolov, I.N.Silin. Preprint JINR, D-810, Dubna, 1961.
13. S.I.Bilenkaya, Yu.M.Kazarinov, L.I.Lapidus. JETP, 60,460, 1971.
14. J.D.Bjorken. Phys.Rev., 179, 1547, 1969.
15. S.Drell, T.M.Yan. Phys.Rev.Lett., 24, 181, 1970.
16. H.Abarbanel, M.L.Goldberger, S.B.Treiman. Phys.Rev.Lett., 22, 500, 1969.

17. C.G.Callan, D.J.Gross. Phys.Rev.Lett., 22, 156, 1969.

18. I.W.Moffat, V.G.Snell. Phys.Rev., D3, 2848, 1971.

19. C.G.Callan, D.I.Gross. Phys.Rev.Lett., 21, 311 (1968).

20. K.Gottfried. Phys.Rev.Lett., 18, 1174 (1967).

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T A B L E I.

The results of analysis of SLAC-MIT data[1,2] (parametrization (18))

	a_0	a_1	a_2		$\chi^{2}/\overline{\chi}^{2}$
$R = c_1 \frac{q^2}{M^2}$	$1,59 \pm 0,02$	-	$-1,44 \pm 0,02$	$c_1=0,035 \pm 0,004$	124/150
$R = c_2 \frac{q^2}{W^2}$	$1,61 \pm 0,02$	-	$-1,47 \pm 0,02$	$c_2=0,41 \pm 0,05$	145/150
$R = c_3 \frac{q^2}{2M\nu}$	$1,63 \pm 0,02$	-	$-1,48 \pm 0,02$	$c_3=0,82 \pm 0,09$	142/150
$R = const$	$1,57 \pm 0,02$	-	$-1,38 \pm 0,02$	$R=0,27 \pm 0,03$	181/150
$R = const$	$1,29 \pm 0,06$	$0,78 \pm 0,17$	$-1,90 \pm 0,12$	$R=0,23 \pm 0,03$	162/149

TABLE II.

The results of analysis of data [1,2,6,7] (parametrization(18))

	a_0	a_2		N_1	N_2	N_3	$\chi^2/\overline{\chi^2}$
$R = c_1 \frac{q^2}{M^2}$	$1,55 \pm 0,02$	$-1,42 \pm 0,02$	$c_1 = 0,038 \pm 0,004$	$1,041 \pm 0,005$	$0,755 \pm 0,010$	$0,997 \pm 0,053$	$\frac{249}{261}$
$R = c_2 \frac{q^2}{W^2}$	$1,58 \pm 0,02$	$-1,45 \pm 0,02$	$c_2 = 0,47 \pm 0,05$	$1,039 \pm 0,005$	$0,763 \pm 0,010$	$1,027 \pm 0,054$	$\frac{267}{261}$
$R = c_3 \frac{q^2}{2M\nu}$	$1,59 \pm 0,02$	$-1,46 \pm 0,02$	$c_3 = 0,91 \pm 0,09$	$1,040 \pm 0,005$	$0,761 \pm 0,010$	$1,074 \pm 0,057$	$\frac{266}{261}$
$R = const$	$1,54 \pm 0,02$	$-1,37 \pm 0,02$	$R = 0,31 \pm 0,03$	$1,039 \pm 0,005$	$0,759 \pm 0,010$	$1,147 \pm 0,062$	$\frac{303}{261}$ (C.L. 3.7%)
$2MW_1 = \frac{\omega \nu W_2}{1 + \frac{d}{\omega}}$	$1,61 \pm 0,02$	$-1,48 \pm 0,02$	$d = 0,70 \pm 0,08$	$1,038 \pm 0,005$	$0,765 \pm 0,010$	$1,121 \pm 0,060$	$\frac{286}{261}$

<u>T A B L E III.</u>

The results of analysis of SLAC-MIT data /1,2/ (parametrization(29), $W \geq 2,3$ GeV)

	z_1	z_2	ω_0^2		$\chi^2 / \overline{\chi^2}$
$R = c_1 \frac{q^2}{M^2}$	$0,11 \pm 0,01$	$0,69 \pm 0,03$	$0,68 \pm 0,03$	$c_1 = 0,036 \pm 0,004$	$\frac{131}{149}$
$R = c_2 \frac{q^2}{W^2}$	$0,11 \pm 0,01$	$0,67 \pm 0,03$	$0,59 \pm 0,03$	$c_2 = 0,56 \pm 0,06$	$\frac{148}{149}$
$R = c_3 \frac{q^2}{2M\nu}$	$0,10 \pm 0,01$	$0,72 \pm 0,03$	$0,69 \pm 0,03$	$c_3 = 0,88 \pm 0,10$	$\frac{144}{149}$
$2MW_1 = \frac{\omega\nu W_2}{1+\frac{d}{\omega}}$	$0,10 \pm 0,01$	$0,74 \pm 0,03$	$0,69 \pm 0,03$	$d = 0,67 \pm 0,10$	$\frac{161}{149}$
$R = const$	$0,12 \pm 0,01$	$0,71 \pm 0,03$	$0,78 \pm 0,03$	$R = 0,26 \pm 0,03$	$\frac{164}{149}$

TABLE IV.

ω	$R = 0,035\frac{q^2}{M^2}$	$R = 0,27$	$R = 0,036\frac{q^2}{M^2}$	$R = 0,26$
1,334	0,022±0,0005	0,024±0,0004	0,024±0,0002	0,023±0,0002
2,034	0,161±0,002	0,157±0,002	0,159±0,001	0,157±0,002
3,213	0,299±0,002	0,303±0,003	0,297±0,002	0,298±0,003
4,462	0,336±0,002	0,345±0,003	0,339±0,002	0,344±0,003
4,680	0,338±0,002	0,348±0,003	0,342±0,002	0,347±0,003
5,294	0,340±0,002	0,351±0,003	0,352±0,003	0,344±0,002
6,637	0,335±0,002	0,347±0,003	0,350±0,003	0,340±0,002
7,805	0,327±0,003	0,339±0,003	0,343±0,003	0,330±0,003
10,101	0,309±0,003	0,322±0,004	0,327±0,004	0,310±0,003
21,206	0,255±0,005	0,267±0,006	0,272±0,005	0,247±0,005
33,443	0,226±0,006	0,238±0,007	0,245±0,005	0,217±0,005

T A B L E V.

The results of analysis of SLAC-MIT data [1,2]

(parametrization(18) , $W \geqslant 2.3$ GeV)

$(q^2)_{min}$ (GeV/c)^2	0,5	1	1,5
a_0	1,54 $\pm$ 0,02	1,54 $\pm$ 0,02	1,53 $\pm$ 0,002
a_2	-1,34 $\pm$ 0,02	-1,32 $\pm$ 0,03	-1,30 $\pm$ 0,03
R	0,26 $\pm$ 0,03	0,26 $\pm$ 0,03	0,26 $\pm$ 0,04
$\chi^2/\overline{\chi^2}$	145/148	128/141	110/132
a_0	1,59 $\pm$ 0,02	1,59 $\pm$ 0,02	1,59 $\pm$ 0,03
a_2	-1,42 $\pm$ 0,03	-1,43 $\pm$ 0,03	-1,44 $\pm$ 0,04
c_2 ($R = c_2\, q^2/W^2$)	0,37 $\pm$ 0,05	0,38 $\pm$ 0,05	0,37 $\pm$ 0,05
$\chi^2/\overline{\chi^2}$	125/148	117/141	107/132

T A B L E VI

The results of analysis of SLAC-MIT data [1,2]

(parametrization(29), $W \geqslant 2.3$ GeV).

$(q^2)_{min}$ $(GeV/c)^2$	0,5	1,0	1,5
τ_1	0,15 ± 0,01	0,18 ± 0,02	0,21 ± 0,03
τ_2	0,62 ± 0,03	0,56 ± 0,04	0,50 ± 0,06
ω_0^2	0,72 ± 0,03	0,67 ± 0,04	0,64 ± 0,04
R	0,25 ± 0,03	0,26 ± 0,03	0,26 ± 0,04
$\chi^2/\overline{\chi^2}$	130/147	116/140	107/131
τ_1	0,15 ± 0,01	0,18 ± 0,02	0,20 ± 0,02
τ_2	0,58 ± 0,03	0,52 ± 0,04	0,46 ± 0,05
ω_0^2	0,54 ± 0,03	0,50 ± 0,04	0,46 ± 0,04
c_2 $(R=c_2\frac{q^2}{W^2})$	0,55 ± 0,06	0,54 ± 0,06	0,50 ± 0,06
$\chi^2/\overline{\chi^2}$	112/147	100/140	88/131

T A B L E VII

The results of analysis of SLAC-MIT data[1,2] (parametrization(38))

	A_0	A_1	A_2	$C_{1,2,3}$	β	χ^2	C.L.
$R = c_1 \frac{q^2}{M^2}$	$0{,}93 \pm 0{,}11$	$1{,}38 \pm 0{,}23$	$-2{,}18 \pm 0{,}13$	$0{,}028 \pm 0{,}004$	$0{,}63 \pm 0{,}07$	$\frac{246}{191}$	0,4%
$R = c_2 \frac{q^2}{W^2}$	$0{,}98 \pm 0{,}11$	$1{,}22 \pm 0{,}23$	$-2{,}06 \pm 0{,}13$	$0{,}37 \pm 0{,}04$	$0{,}76 \pm 0{,}07$	$\frac{230}{191}$	2,68%
$R = c_3 \frac{q^2}{2M\nu}$	$0{,}70 \pm 0{,}09$	$1{,}91 \pm 0{,}19$	$-2{,}48 \pm 0{,}11$	$0{,}61 \pm 0{,}07$	$0{,}65 \pm 0{,}07$	$\frac{223}{191}$	5,48%

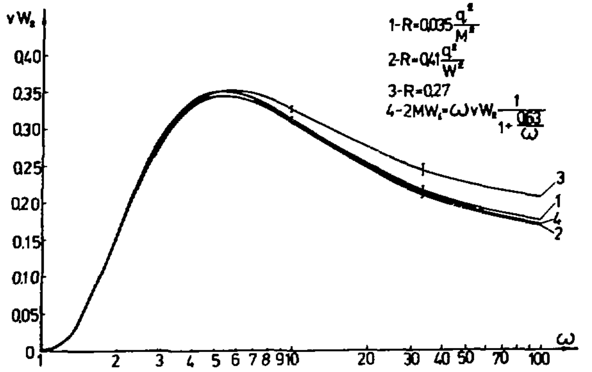
vW₂
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
1-R=0.035 q²/M²
2-R=0.41 q²/W²
3-R=0.27
4-2MW₁=ωvW₂ 1/(1+0.63/ω)
ω
1
2
3
4
5
6
7
8
9
10
20
30
40
50
70
100

Fig. 1.

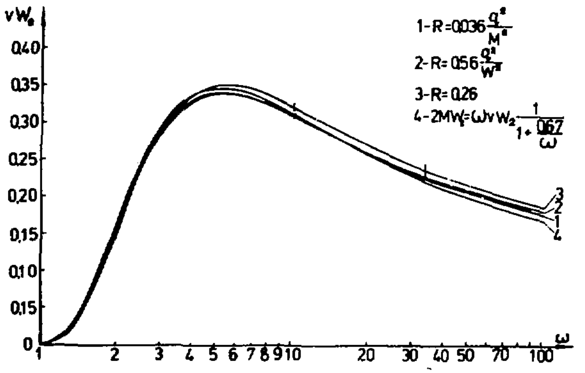
vW₂
0.40
0.35
0.30
0.25
0,20
0,15
0,10
0,15
0
1-R=0.036 q²/M²
2-R=0.56 q²/W²
3-R=0.26
4-2MW₁=ωvW₂ 1/(1+0.67/ω)
ω
1
2
3
4
5
6
7
8
9
10
20
30
40
50
70
100

Fig. 2.