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DETERMINATION OF HIGHER VECTOR MESONS FROM DATA ON KAON ELECTROMAGNETIC FORM FACTORS BY MEANS OF THE UNITARIZED ANALYTIC VDM MODEL

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At present, there is a large amount of papers consecrated to the construction of various models of the pion electromagnetic (e.m.) form factor (ff); however, little has been done for e.m. ff 's of kaons up to now. The main reason for the latter was, first, the existence (unlike the pion ff) of a broad unphysical region $0 < t \leq 4\,m_K^2$ unattainable experimentally in which the dominating resonances ρ (770), ω (783) and φ (1020) of kaon ff 's are spread out, and secondly, shortage of reliable and compact experimental information outside the interval $0 < t \leq 4\,m_K^2$. So, almost all existing attempts to analyse the kaon ffs were restricted either to general problems, like in the paper [1], or to determination [2,3] of the corresponding kaon charge radii only. Exceptions are the papers [4,5] in which particular modifications of the VDM model were proposed, chiefly for the description of structures of the kaon ff 's in the time-like regions. Whereas in the paper [4] the method consists in a standard extension of the zero-width VDM model to a superposition of the Breit-Wigner forms only; in ref. [5] an energy dependent ρ -meson propagator is constructed in a more refined way by using unitarity and analyticity. The latter allows one to reproduce the data without any consideration of excited states of ρ , ω and φ mesons. However, since the radially excited states of vector mesons have a natural explanation [6,7] in the framework of the quark model of hadrons, one cannot ignore their existence. All the more, some of them are by now confirmed [8] experimentally.

In this paper we do unitarization of the VDM model for kaon ff's compatibly with the analyticity and reality condition. The obtained explicit formulae can in principle include an arbitrary number of vector mesons. They also contain the effective nonresonant background which seems to be important in the determination of correct parameters of the underlying resonances.

As the unitarized analytic VDM model has previously shown to be powerful in the analysis of the pion [9] and nucleon [10] e.m. ff's we further apply it also to determine higher vector meson resonances from the experimental information on the charge and neutral kaon ff's which is substantially improved [11-21].

The construction of the model consists in the following . As a consequence of particular transformation properties of the kaon e.m. current with respect to rotations of the isotopic spin space, the ff's of the K^+ and K^0 can be split into an isoscalar and an isovector part

$$F_{K^+}(t) = F_K^S(t) + F_K^V(t) \quad , \quad F_{K^0}(t) = F_K^S(t) - F_K^V(t) \tag{I}$$

with the following normalization conditions:

$$F_{K^+}(0) = 1 \quad , \quad F_{K^0}(0) = 0 \quad , \tag{2a}$$

$$F_K^S(0) = F_K^V(0) = \frac{1}{2} \; . \tag{2b}$$

In agreement with the idea of the zero-width VDM model [22], each of $F_K^{S,V}$ in (I) is expressed in the form

$$F_K^S(t)_0 = \sum_{s=\omega,\varphi,\varphi'} \frac{m_s^2\,(f_{sK\bar{K}}/f_s)}{m_s^2 - t} \quad , \quad F_K^V(t)_0 = \sum_{v=\rho,\rho',\rho''} \frac{m_v^2\,(f_{vK\bar{K}}/f_v)}{m_v^2 - t} \; , \tag{3}$$

where $t = -Q^2$ is the four-momentum transfer squared and m_i ($i = s, v$) are masses of the considered vector mesons. The corresponding ratios of the coupling constants are constrained by the equations

$$\sum_{s=\omega,\varphi,\varphi'} (f_{sK\bar{K}}/f_s) = \sum_{v=\rho,\rho',\rho''} (f_{vK\bar{K}}/f_v) = \frac{1}{2} \; . \tag{4}$$

The subindex zero in the ff's (3) means the model with zero-width approximation. The summation in (3) and (4) is carried out in the isoscalar and isovector case over the vector mesons ω (783), φ (1020), φ'(1680) and ρ (770), ρ''(1600) respectively which are fixed in the last table of elementary particles [8]. There is added also ρ' (1250) in the isovector case because serious indications of its existence have appeared recently [9,23,24], however, at the slightly higher mass value.

In what follows we incorporate into (3) the two-square-root analytic branch-cut structure of $F_K^{S,V}$ which leads to a more realistic model of K^+ and K^0 ff's, enabling one not only to describe the existing data but also to predict the behaviours of ff's outside the regions where the data do exist.

It is well known that the lowest branch point of $F_K^S(t)$ and $F_K^V(t)$ are $t_0^S = 9m_\pi^2$ and $t_0^V = 4m_\pi^2$, respectively, which

will be taken to be of a square-root form. There are also other square-root branch points $t_{inl}^S > t_0^S$ and $t_{inl}^V > t_0^V$ incorporated into $F_K^{S,V}(t)$ ff's, taken to be free in a position, in order to simulate contributions of higher opened channels effectively. As a result, every $F_K^{S,V}(t)$ is defined on the four-sheeted Riemann surface in the t-variable. In order to find an explicit form of kaon ff's with these analytic properties, we use the transformations

$$r = \left[(t - 9m_\pi^2)/9m_\pi^2\right]^{1/2} , \quad q = \left[(t - 4m_\pi^2)/4m_\pi^2\right]^{1/2} \tag{5}$$

which map the four-sheeted Riemann surfaces of the t-variable into two-sheeted Riemann r and q -surfaces. The effective branch points t_{inl}^S and t_{inl}^V are then each transformed into two points as follows:

$$r_{inl} = \pm\left[(t_{inl}^S - 9m_\pi^2)/9m_\pi^2\right]^{1/2} , \quad q_{inl} = \pm\left[(t_{inl}^V - 4m_\pi^2)/4m_\pi^2\right]^{1/2} . \tag{6}$$

Finally, by using the inverse Zhukovsky transformations

$$V(t) = i\,\frac{[r_{inl} + r]^{1/2} - [r_{inl} - r]^{1/2}}{[r_{inl} + r]^{1/2} + [r_{inl} - r]^{1/2}} \tag{7}$$

$$W(t) = i\,\frac{[q_{inl} + q]^{1/2} - [q_{inl} - q]^{1/2}}{[q_{inl} + q]^{1/2} + [q_{inl} - q]^{1/2}}$$

the two-sheeted Riemann r- and q -surfaces are transformed into the V- and W-planes. The physical sheets of the t-variable are then brought to the left- half of the unit disc with $t = \pm\infty$ transformed into V = -1 and W = -1. The second sheets are mapped onto the right half of the unit disc with $t = \pm\infty$ transformed into V = +1 and W = +1, and the third and fourth sheets onto the left and right half-planes outside the unit disc, respectively.

Now relations (5) give

$$t = 9(r^2 + 1) \quad , \quad t = 4(q^2 + 1) \tag{8}$$

where we have put $m_\pi = 1$ for simplicity. Further, if we denote the positions of the zero-width VDM poles in the r- and q -planes by r_{s0} and q_{v0}, respectively, one can write the following expressions for the mass of isoscalar and isovector mesons in (3):

$$m_S^2 = 9\,(r_{S0}^2 + 1) \quad , \quad m_V^2 = 4\,(q_{V0}^2 + 1)\,. \tag{9}$$

Substituting (8) and (9) into relations (3), we obtain

$$F_K^S(t)_0 = \sum_{S=\omega,\varphi,\varphi'} \frac{r_{S0}^2 - r_N^2}{r_{S0}^2 - r^2}\,(f_{SK\bar{K}}/f_S)$$

$$F_K^V(t)_0 = \sum_{V=\rho,\rho',\rho''} \frac{q_{V0}^2 - q_N^2}{q_{V0}^2 - q^2}\,(f_{VK\bar{K}}/f_V)\,, \tag{10}$$

where the normalization points $t = 0$ in the r- and q planes have been denoted by r_N and q_N, respectively. The same normalization points expressed in the V and W planes

$$V_N = i\,\frac{[r_{inl}+r_N]^{1/2} - [r_{inl}-r_N]^{1/2}}{[r_{inl}+r_N]^{1/2} + [r_{inl}-r_N]^{1/2}} \tag{11}$$

$$W_N = i\,\frac{[q_{inl}+q_N]^{1/2} - [q_{inl}-q_N]^{1/2}}{[q_{inl}+q_N]^{1/2} + [q_{inl}-q_N]^{1/2}}$$

together with the positions of the zero-width VDM poles

$$V_{S0} = i\,\frac{[r_{inl}+r_{S0}]^{1/2} - [r_{inl}-r_{S0}]^{1/2}}{[r_{inl}+r_{S0}]^{1/2} + [r_{inl}-r_{S0}]^{1/2}} \tag{12}$$

$$W_{V0} = i\,\frac{[q_{inl}+q_{V0}]^{1/2} - [q_{inl}-q_{V0}]^{1/2}}{[q_{inl}+q_{V0}]^{1/2} + [q_{inl}-q_{V0}]^{1/2}}$$

lead to the following expressions for r^2, r_N^2, r_{S0}^2 and q^2, q_N^2, q_{V0}^2:

$$r^2 = r_{inl}^2\left[1 - \left(\frac{1+V^2}{1-V^2}\right)^2\right],\quad r_N^2 = r_{inl}^2\left[1 - \left(\frac{1+V_N^2}{1-V_N^2}\right)^2\right],\quad r_{S0}^2 = r_{inl}^2\left[1 - \left(\frac{1+V_{S0}^2}{1-V_{S0}^2}\right)^2\right]$$

$$q^2 = q_{inl}^2\left[1 - \left(\frac{1+W^2}{1-W^2}\right)^2\right] \;,\; q_N^2 = q_{inl}^2\left[1 - \left(\frac{1+W_N^2}{1-W_N^2}\right)^2\right]$$

$$q_{V0}^2 = q_{inl}^2\left[1 - \left(\frac{1+W_{V0}^2}{1-W_{V0}^2}\right)^2\right] \tag{13}$$

which in combination with (IO) give

$$F_K^S[V(t)]_0 = \left(\frac{1-V^2}{1-V_N^2}\right)^2 \sum_{S=\omega,\varphi,\varphi'} \frac{(V_N-V_{S0})(V_N+V_{S0})(V_N-V_{S0}^{-1})(V_N+V_{S0}^{-1})}{(V-V_{S0})(V+V_{S0})(V-V_{S0}^{-1})(V+V_{S0}^{-1})}\,\frac{f_{SK\bar{K}}}{f_S} \tag{14}$$

$$F_K^V[W(t)]_0 = \left(\frac{1-W^2}{1-W_N^2}\right)^2 \sum_{V=\rho,\rho',\rho''} \frac{(W_N-W_{V0})(W_N+W_{V0})(W_N-W_{V0}^{-1})(W_N+W_{V0}^{-1})}{(W-W_{V0})(W+W_{V0})(W-W_{V0}^{-1})(W+W_{V0}^{-1})}\,\frac{f_{VK\bar{K}}}{f_V}\,.$$

Further we arrange (14) into such a form that their reality property will be exhibited explicitly. To do this we have to know the relation of the corresponding vector meson mass values to t^S_{inl} and t^V_{inl}. By a successive experience in analysing kaon e.m. ff data we knew that

$$m_\omega^2, m_\varphi^2 < t^S_{inl} \quad , \quad m_{\varphi'}^2 > t^S_{inl} \tag{15a}$$

and

$$m_\rho^2 < t^V_{inl} \quad , \quad m_{\rho'}, m_{\rho''} > t^V_{inl}\,. \tag{15b}$$

Then

$$V_{\omega 0} = -V_{\omega 0}^* \;,\; V_{\varphi 0} = -V_{\varphi 0}^* \;,\; V_{\varphi' 0} = V_{\varphi' 0}^{*-1}$$

$$V_{\rho 0} = -V_{\rho 0}^* \;,\; W_{\rho' 0} = W_{\rho' 0}^{*-1} \;,\; W_{\rho'' 0} = W_{\rho'' 0}^{*-1} \tag{16}$$

and expressions (14) can be rewritten in the form

$$F^S_K[V(t)]_0 = \left(\frac{1-V^2}{1-V_N^2}\right)^2 \left[\sum_{s=\omega,\varphi} \frac{(V_N-V_{s0})(V_N-V^*_{s0})(V_N-V^{-1}_{s0})(V_N-V^{*-1}_{s0})}{(V-V_{s0})(V-V^*_{s0})(V-V^{-1}_{s0})(V-V^{*-1}_{s0})}\cdot\frac{f_{sK\bar K}}{f_s} + \right.$$

$$\left. + \frac{(V_N-V_{\varphi'0})(V_N-V^*_{\varphi'0})(V_N+V_{\varphi'0})(V_N+V^*_{\varphi'0})}{(V-V_{\varphi'0})(V-V^*_{\varphi'0})(V+V^*_{\varphi'0})(V+V_{\varphi'0})}\cdot\frac{f_{\varphi'K\bar K}}{f_{\varphi'}}\right]$$

$$F^V_K[W(t)]_0 = \left(\frac{1-W^2}{1-W_N^2}\right)^2 \left[\frac{(W_N-W_{\rho 0})(W_N-W^*_{\rho 0})(W_N-W^{-1}_{\rho 0})(W_N-W^{*-1}_{\rho 0})}{(W-W_{\rho 0})(W-W^*_{\rho 0})(W-W^{-1}_{\rho 0})(W-W^{*-1}_{\rho 0})}\,\frac{f_{\rho K\bar K}}{f_\rho} + \right. \qquad (17)$$

$$\left. + \sum_{v=\rho',\rho''}\frac{(W_N-W_{v0})(W_N-W^*_{v0})(W_N+W_{v0})(W_N+W^*_{v0})}{(W-W_{v0})(W-W^*_{v0})(W+W_{v0})(W+W^*_{v0})}\cdot\frac{f_{vK\bar K}}{f_v}\right],$$

where the reality property is easily seen. Finally, introducing nonzero vector meson widths $\Gamma_s \neq 0$, $\Gamma_v \neq 0$ by means of the substitution

$$r_{s0} \longrightarrow r_s = \left[\frac{(m_s - i\Gamma_s/2)^2 - 9}{9}\right]^{1/2} \quad \text{for } s=\omega,\varphi,\varphi'$$

$$q_{v0} \qquad q_v = \left[\frac{(m_v - i\Gamma_v/2)^2 - 4}{4}\right]^{1/2} \quad \text{for } v=\rho,\rho',\rho'' \qquad (18)$$

one obtains the expressions

$$F^S_K[V(t)] = \left(\frac{1-V^2}{1-V_N^2}\right)^2 \left[\sum_{s=\omega,\varphi} \frac{(V_N-V_s)(V_N-V^*_s)(V_N-V^{-1}_s)(V_N-V^{*-1}_s)}{(V-V_s)(V-V^*_s)(V-V^{-1}_s)(V-V^{*-1}_s)}\cdot\frac{f_{sK\bar K}}{f_s} + \right.$$

$$\left. + \frac{(V_N-V_{\varphi'})(V_N-V^*_{\varphi'})(V_N+V_{\varphi'})(V_N+V^*_{\varphi'})}{(V-V_{\varphi'})(V-V^*_{\varphi'})(V+V_{\varphi'})(V+V^*_{\varphi'})}\cdot\frac{f_{\varphi'K\bar K}}{f_{\varphi'}}\right] \qquad (19)$$

$$F^V_K[W(t)] = \left(\frac{1-W^2}{1-W_N^2}\right)^2 \left[\frac{(W_N-W_\rho)(W_N-W^*_\rho)(W_N-W^{-1}_\rho)(W_N-W^{*-1}_\rho)}{(W-W_\rho)(W-W^*_\rho)(W-W^{-1}_\rho)(W-W^{*-1}_\rho)}\cdot\frac{f_{\rho K\bar K}}{f_\rho}\right.$$

$$\left. + \sum_{v=\rho',\rho''}\frac{(W_N-W_v)(W_N-W^*_v)(W_N+W_v)(W_N+W^*_v)}{(W-W_v)(W-W^*_v)(W+W_v)(W+W^*_v)}\cdot\frac{f_{vK\bar K}}{f_v}\right]$$

which are real analytic functions defined on the four-sheeted Riemann surface, with the poles on the unphysical sheets. They conserve the normalization conditions (4) of the zero-width VDM model and possess the asymptotic behaviour compatible with the quark model predictions for kaons

$$F^S_K[V(t)] \sim t^{-1}\big|_{t\to\pm\infty}$$

$$F^V_K[W(t)] \sim t^{-1}\big|_{t\to\pm\infty} \qquad (20)$$

which is ensured by the normalized factors in front of the square brackets, or strictly speaking by the power "2" of the latter.

Formulae (19) along with (I) represent the unitarized analytic VDM model for the e.m. structure of kaons which will be used for the analysis of all experimental data on charge and neutral kaon ff's in the space-like and time-like regions simultaneously. It depends on the following 20 free parameters with clear physical meaning: t^s_{in}, t^v_{in}, m_ω, Γ_ω, $f_{\omega K\bar K}/f_\omega$, m_φ, Γ_φ, $f_{\varphi K\bar K}/f_\varphi$, $m_{\varphi'}$, $\Gamma_{\varphi'}$, $f_{\varphi' K\bar K}/f_{\varphi'}$, m_ρ, Γ_ρ, $f_{\rho K\bar K}/f_\rho$, $m_{\rho'}$, $\Gamma_{\rho'}$, $f_{\rho' K\bar K}/f_{\rho'}$, $m_{\rho''}$, $\Gamma_{\rho''}$, $f_{\rho'' K\bar K}/f_{\rho''}$. They are reduced to 18 by the relations (4) and in the analysis of the data we choose $f_{\rho' K\bar K}/f_{\rho'}$ and $f_{\varphi' K\bar K}/f_{\varphi'}$ to be expressed through $f_{\rho K\bar K}/f_\rho$, $f_{\rho'' K\bar K}/f_{\rho''}$ and $f_{\omega K\bar K}/f_\omega$, $f_{\varphi K\bar K}/f_\varphi$, respectively. Further, there are no experimental data on kaon ff's in the region of the ground state resonances ρ (770) and ω (783) and we cannot expect to be able to determine them in our analysis with a sufficient accuracy. On the other hand, however, they rank among the well and rather precise determined resonances /8/. Therefore, we fix the mass and width of ρ (770) and ω (783) resonances at the world averaged values /8/ and concentrate ourselves further on the determination of excited states of vector mesons, which are (at least those included into (19)) expected to be found in the region of existing data on kaon e.m. ff's. The determined values of φ (1020) mesons parameters (this resonance is situated just on the border of the existing data) will be a verification of our model to some extent because they are determined with a high accuracy /8/ too.

The results of the analysis of 100 experimental points on charge kaon ff in the space-like /11,12/ (25 data) and time-like /13-19/ (75 data) regions and 17 experimental points on neutral kaon ff in the time-like region /14,20,21/ only, by means of the unitarized analytic VDM model given by (I) and (19) are presented in the Table and figs. 1a,b and 2a,b, where also the predictions for behaviours of the corresponding ff's outside the existing data are given.

Table

The results of a simultaneous fit of all data on charge and neutral kaon ff's by means of the unitarized analytic VDM model for e.m. structure of kaons

$\chi^2/\mathrm{n.f.} = 146/103$

$t^s_{inl} = 1.68\ \mathrm{GeV}^2$	$t^v_{inl} = 1.72\ \mathrm{GeV}^2$
$m_\omega = 782.6$ MeV, $\Gamma_\omega = 9.8$ MeV } fixed at the world averaged values /8/	$m_\rho = 770$ MeV, $\Gamma_\rho = 153$ MeV
$f_{\omega K\bar K}/f_\omega = 0.200 \pm 0.005$	$f_{\rho K\bar K}/f_\rho = 0.569 \pm 0.012$
$m_\varphi = 1019.4 \pm 0.7$ MeV $\Gamma_\varphi = 4.3 \pm 0.8$ MeV $f_{\varphi K\bar K}/f_\varphi = 0.333 \pm 0.005$	$m_{\rho'} = 1314.9 \pm 182.8$ MeV $\Gamma_{\rho'} = 245 \pm 167$ MeV $f_{\rho' K\bar K}/f_{\rho'} = -0.032$ – calculated from $f_{\rho K\bar K}/f_\rho$ and $f_{\rho'' K\bar K}/f_{\rho''}$ by using the relation (4) in the text.
$m_{\varphi'} = 1659.7 \pm 21.2$ MeV $\Gamma_{\varphi'} = 158.3 \pm 37.5$ MeV $f_{\varphi' K\bar K}/f_{\varphi'} = -0.033$ – calculated from $f_{\omega K\bar K}/f_\omega$ and $f_{\varphi K\bar K}/f_\varphi$ by using the relation (4) in the text.	$m_{\rho''} = 2114.4 \pm 39.8$ MeV $\Gamma_{\rho''} = 150.1 \pm 103.9$ MeV $f_{\rho'' K\bar K}/f_{\rho''} = -0.037 \pm 0.011$

One can read from the Table the following results:

By means of the unitarized analytic VDM model applied to the description of the data on kaon e.m. ff's we really reproduce the world averaged values of φ (1020) meson parameters /8/. The latter is substantially raising confidence also in other results obtained by means of the unitarized analytic VDM model.

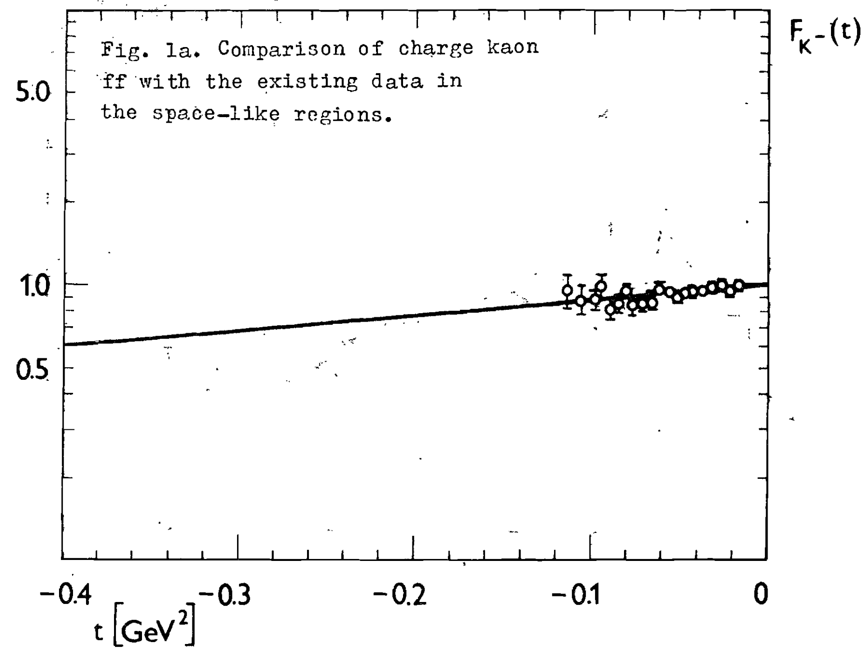

Fig. 1a. Comparison of charge kaon ff with the existing data in the space-like regions.

In compatibility with the results of the analysis of the $e^+e^- \to \pi^+\pi^-$ /9,23/ and $e^+e^- \to \pi^0\omega$ /24/ reactions the first radial excitation of ρ (770) meson at the mass value $m_{\rho'} = 1315 \pm 183$ MeV is revealed also in the $e^+e^- \to K\bar K$ processes.

The existence of the φ' (1680) resonance is confirmed from the simultaneous fit of the data on the $e^+e^- \to K^+K^-$ and $e^+e^- \to K^0\bar K^0$ processes in agreement with the generally accepted /8/ values of parameters within error bars.

Unlike the $e^+e^- \to \pi^+\pi^-$ process, the contribution of the ρ'' (2150) resonance to $e^+e^- \to K\bar K$ with the parameters $m_{\rho''} = 2114.4 \pm 39.8$ MeV, $\Gamma_{\rho''} = 150.1 \pm 103.9$ MeV is favoured prior to the ρ'' (1600) one by the existing data on charge and neutral kaon e.m. ff's.

There is a well-known SU(3) relation (see e.g. ref. /5/) among the coupling constants $f_{\omega K\bar K}$, $f_{\rho K\bar K}$ and $f_{\rho\pi\pi}$ of the form

$$f_{\omega K\bar K} \approx f_{\rho K\bar K} \approx \frac{1}{2} f_{\rho\pi\pi} \qquad (21)$$

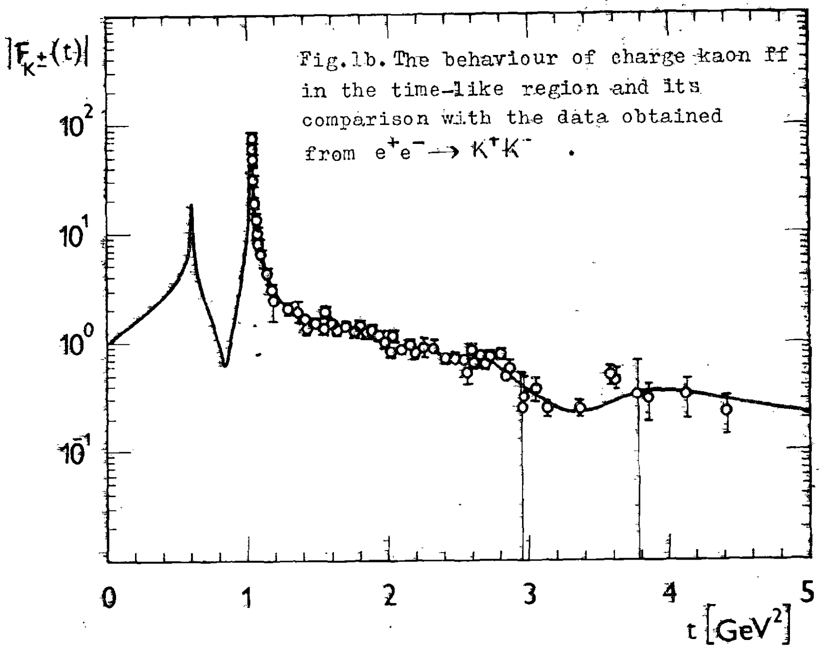

Fig.1b. The behaviour of charge kaon ff in the time-like region and its comparison with the data obtained from $e^+e^- \to K^+K^-$.

which was noticed [25] to be violated by one order of magnitude under the assumption that the kaon isoscalar charge is saturated only by ω and φ mesons. Further we show that it is not the case with the results obtained by means of the unitarized analytic VDM model. Really, using for the calculation of the universal vector meson coupling constants $f_V^2/4\pi$ the relation

$$\frac{f^2_{V\pi\pi}}{4\pi} = \frac{\alpha^2}{3}\,\frac{m_V}{\Gamma(V\to e^+e^-)}, \tag{22}$$

where $\Gamma(V\to e^+e^-)$ for ρ, ω are taken from Review of Particle Properties [8], we find

$$\frac{f_\rho^2}{4\pi} = 1.98 \pm 0.09; \qquad \frac{f_\omega^2}{4\pi} = 21.06 \pm 1.28 \tag{23}$$

Then, as a consequence of (23), we obtain from the Table

$$f_{\rho K\bar{K}} = 3.25 \pm 0.13; \qquad f_{\omega K\bar{K}} = 2.84 \pm 0.10\,. \tag{24}$$

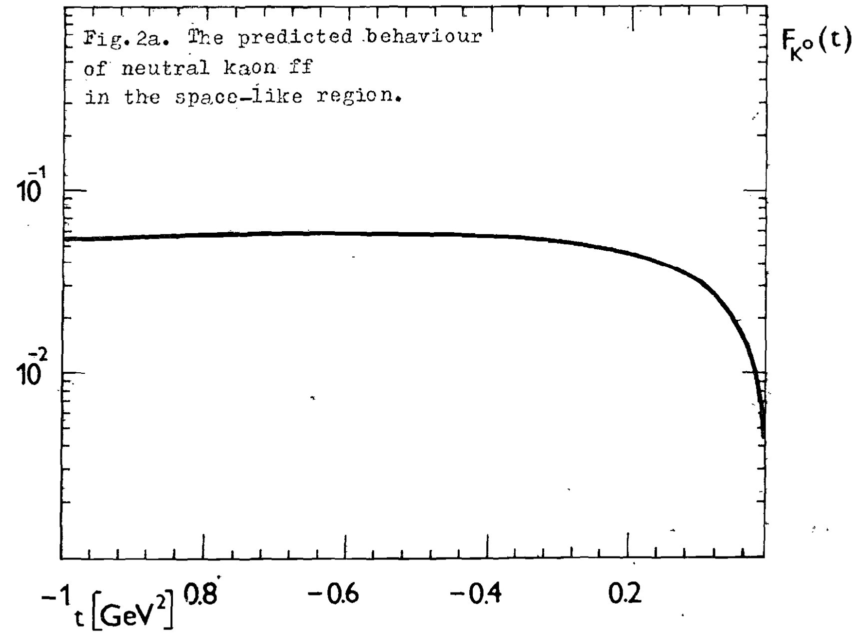

Fig. 2a. The predicted behaviour of neutral kaon ff in the space-like region.

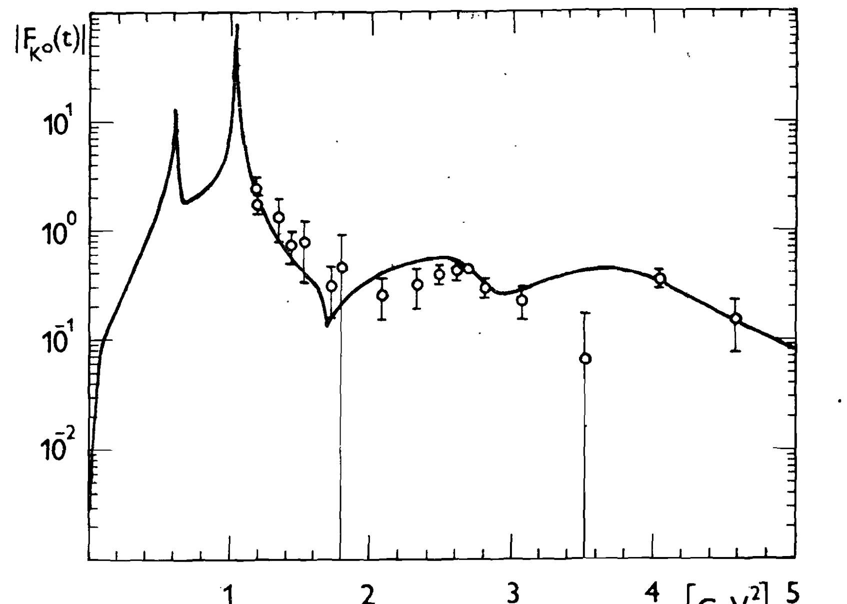

Fig. 2b. The behaviour of neutral kaon ff in the time-like region and its comparison with the data obtained from $e^+e^- \to K^0\bar{K}^0$

Further, taking into account the value

$$f_{\rho\pi\pi} = 5.09 \pm 0.16 \qquad (25)$$

following from our previous analysis /9/ on the $e^+e^- \to \pi^+\pi^-$ data we find the SU(3) relation (21) to be approximately satisfied.

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Определение высших состояний векторных мезонов из данных по электромагнитным формфакторам каонов с помощью унитаризованной аналитической модели МВД

Сделана унитаризация модели МВД для изоскалярных и изовекторных частей электромагнитных формфакторов каона, с объединением в ее рамках аналитических свойств формфакторов с ненулевой шириной векторных мезонов совместимо с условием реальности. Полученная модель позволяет анализировать все существующие данные по формфакторам заряженных и нейтральных каонов и определить присутствие высших состояний векторных мезонов в процессе $e^+e^- \to K\bar{K}$. Кроме мезона $\varphi'(1680)$, первое возбуждение мезона $\rho(770)$ обнаружено при значении массы $m_{\rho'} = 1315 \pm 183$ МэВ в согласии с результатами анализа реакции $e^+e^- \to \pi^+\pi^-$. В отличие от последней, в процессе $e^+e^- \to K\bar{K}$ заметный вклад дает не резонанс $\rho''(1600)$ а $\rho'''(2150)$.

Работа выполнена в Лаборатории теоретической физики ОИЯИ.

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Determination of Higher Vector Mesons from Data on Kaon Electromagnetic Form Factors by Means of the Unitarized Analytic VDM Model

Unitarization of the VDM model of isoscalar and isovector parts of kaon electromagnetic form factors is accomplished by incorporating analytic properties and nonzero values of vector meson widths in compatibility with the reality condition. The resultant model enables one to carry out a simultaneous fit of all the existing form factor data on charge and neutral kaons and to determine higher vector meson states in the $e^+e^- \to K\bar{K}$ processes. In agreement with the results on the $e^+e^- \to \pi^+\pi^-$ analysis, the first radial excitations of $\rho(770)$ meson at the mass value $M_{\rho'} = 1315 \pm 183$ MeV is revealed besides $\varphi'(1680)$ in $e^+e^- \to K\bar{K}$. However, unlike the $e^+e^- \to \pi^+\pi^-$ process the contribution of the $\rho'''(2150)$ resonance to $e^+e^- \to K\bar{K}$ is favoured prior to the $\rho''(1600)$ one by the experimental data.

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

Communication of the Joint Institute for Nuclear Research. Dubna 1988