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THE STRUCTURE OF WAVE FUNCTION OF π (k) MESONS IN AN INSTANTON VACUUM

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ՄԵԶՈՆՆԵՐԻ ԱԼԻՔԱՅԻՆ ՖՈՒՆԿՑԻԱՅԻ ԿԱՌՈՒՑՎԱԾՔԸ $\pi(K)$ ԻՆՍՏԱՆՏՈՆԱՅԻՆ ՎԱԿՈՒՈՒՄՈՒՄ

Ինստանտոնային վակուումի մոդելում հաշված է բիլոկալ հոսանքների մատրիցական տարրերը: Վերլուծվել է հոսանքների դասակարգումը ըստ վակուումային դաշտերի հետ կապի բնույթի: Ցույց է տրված, որ աքսիալ ուղիում էական են ուղղակի ինստանտոն-հակաինստանտոնային ներդրումները, որոնք հարթում են մեզոններում քվարկների ըստ իմպուլսների բաշխման խիստ անհամաչափությունը:

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СТРУКТУРА ВОЛНОВОЙ ФУНКЦИИ $\pi(K)$ МЕЗОНОВ В ИНСТАНТОННОМ ВАКУУМЕ

В модели инстантонного вакуума вычислены матричные элементы билокальных токов. Проанализирована классификация токов по характеру связи с вакуумными полями. Показано, что в аксиальном канале существенны прямые инстантон-антиинстантонные вклады, которые сглаживают сильную асимметрию в распределении по импульсам кварков в мезонах.

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THE STRUCTURE OF WAVE FUNCTION OF π (K) MESONS IN AN INSTANTON VACUUM

The matrix elements of bilocal currents are calculated in instanton vacuum model. The classification of currents according to the nature of coupling with vacuum fields is analyzed. It is also shown that in the axial channel the direct instanton-antiinstanton contributions that smoothed out strong asymmetry in quark momenta distribution in mesons are essential.

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The main object with the help of which a wide class of exclusive processes in QCD is described is the meson wave function $\varphi(x)$ which in the infinite momentum frame has the physical meaning of the amplitude probability for the meson to decay to a quark-antiquark pair with initial longitudinal momentum fractions X and $1-x$, respectively (see, for example [1]). This function structure is defined by long distance interactions and cannot be calculated in perturbative QCD theory.

There exist different approaches to determine the properties of these functions: semi-phenomenological - based on the QCD dispersion sum rules (DSR) QCD [2, 3] , phenomenological - the relativistic quark model (RQM), based on analysis of the low-energy experimental data of light mesons [4, 5] . It should be emphasized that wave function structure in these two approaches differs essentially: if in the case of the RQM the axial projection of the pion wave function $\varphi_A(x)$ is close to the asymptotic one, $\varphi_A^{ac}(\xi)=\frac{3}{4}(1-\xi^2)f_\pi$ $\xi=2x-1$, then in DSR QCD method the corresponding function has zero (at $\xi=0$)

$\varphi_A(\xi) = \frac{15}{4} f_\pi \, \xi^2 (1-\xi^2)$ and/or oscillates [6] . Recall, that formfactors values at high Q^2 essentially depend just on $\varphi_A(\xi)$ structure.

On the other hand, lately we have essential progress in understanding of mechanism of spontaneous breakdown of chiral symmetry (SBCS) [7] and as consequence of this, in the understanding of physics of particles of pseudoscalar octet [8] . Instanton "fluid" vacuum model allowed to describe low-energy characteristics of (π, K) mesons in good agreement with experimental data [9, 10]. Algorithm proposed there for calculating the correlation functions allows to investigate more thoroughly the structure of $\pi\,(K)$ mesons wave functions by the non-perturbative theory method. Consider the matrix elements of the bilocal operators in Euclidean space:

$$\langle 0 \,|\, j_\mu^A(z,-z) \,|\, \pi(P) \rangle = -i P_\mu (-P\cdot z) + 2 z_\mu \tilde{\varphi}_A(-P\cdot z) \tag{1}$$

$$\varphi_A(0) = f_\pi \qquad \tilde{\varphi}_A(0) = \tilde{f}_A$$

$$\langle 0 \,|\, j^P(z,-z) \,|\, \pi(P) \rangle = \varphi_P(-P\cdot z) \qquad \varphi_P(0) = f_P \tag{2}$$

$$\langle 0 \,|\, j_{\mu\nu}^T(z,-z) \,|\, \pi(P) \rangle = -2i\, \varepsilon_{\mu\nu\alpha\beta} P_\alpha z_\beta \varphi_T(-P\cdot z) \tag{3}$$

$$\varphi_T(0) = f_T$$

where

$$j_\mu^A(z,-z) = \Psi_d^+(z)\gamma_\mu\gamma_5\Psi_u(-z) \qquad j^P(z,-z) = \Psi_d^+(z)\gamma_5\Psi_u(-z)$$

$$j_{\mu\nu}^T(z,-z) = \Psi_d^+(z)\sigma_{\mu\nu}\Psi_u(-z) \qquad \text{at } z^2 \to 0$$

which define the axial, pseudoscalar and tensor projections of the pion wave function (see, e.g. [1])

$$\varphi_I(\xi) = \frac{1}{2\pi}\int_{-\infty}^{+\infty} e^{-i\xi z\cdot P}\varphi_I(P\cdot z)\,d(P\cdot z)$$

$$f_I = \int_{-1}^{1}\varphi_I(\xi)\,d\xi \qquad I = A, P, T \tag{4}$$

The axial projection $\varphi_A(\xi)$ defines the pion formactor asymptotics in the perturbative QCD, the pseudoscalar and tensor projections define the power corrections to the asymptotic (the term $\sim 1/Q^4$). In vacuum model under consideration all the three wave functions projections differ from zero in seeming contradiction with results of [11,12] . Therefore, it seems necessary to give a comment on currents classification by character of their couplings to vacuum fields. Let's recall the instanton selection rules from [11] . Direct contributions from Fig. 1a are the important elements of classification, channels which allow them are exclusive, and the statement that the corresponding quantum numbers of currents are $J^P = 0^{\pm}$ has a character of a theorem. In ansatz under consideration we have (see below) dominant contributions with $J^P = 1^-, 0^{\pm}$. To understand this difference, let us examine a chain of arguments leading to the proof of the theorem. The main points are as follows: polarization operator $\Pi^{\alpha\beta\cdots\mu\nu}_{\alpha'\beta'\cdots\mu'\nu'}$ of local colorless currents with arbitrary Lorentz structure and quark contents $j_{\alpha\beta\cdots\mu\nu}[q(x)]$

$$\Pi^{\alpha\beta\ldots\mu\nu}_{\alpha'\beta'\ldots\mu'\nu'}(q) = \int d^4x\, e^{iq\cdot x}\langle 0|T\, j_{\alpha\beta\ldots\mu\nu}(x),\ j_{\alpha'\beta'\ldots\mu'\nu'}(0)|0\rangle$$

is factorized over Lorentz spins of incoming currents, that automatically means that there are only direct contributions with spin zero (currents under consideration do not contain covariant derivatives). It is really so if contributions from diagrams of Fig.1b type are absent. These diagrams in axial $J^P = 1^-$ channel are proportional to $\delta_{\mu\nu}$ and because of swelling of instantons effectively turn into side fluctuation of Fig.2 type, which is relatively small. But in the discussed model in thermodynamic limit $\frac{N}{V}$ = const, $\frac{N}{2}$ is the number of instantons (equal to the number of antiinstantons), V - four-dimensional volume, pseudoparticles are in equilibrium and because of effective repulsion cannot swell [13,14] , i.e. contribution of Fig. 1b to $\Pi_{\mu\nu}$ is essential, corresponds to direct instantons and is of the same order as from diagrams of Fig.1a $\sim P_\mu P_\nu / P^2$. Their joint contributions in leading order in medium packing parameter ρ/R ($\rho = \frac{1}{600\,\text{MeV}}$ is average size, and $R = \frac{1}{200\,\text{MeV}}$ is average density of singularities) approximation and for current quark mass m_q equal to zero, reconstructs transverse polarization operator in channel $J^P = 1^-$ [8]:

$$\Pi^5_{\mu\nu} = -f^2_\pi \left(\delta_{\mu\nu} - \frac{P_\mu P_\nu}{P^2}\right).$$

However such interplay of two types of contributions seems not so evident when quark current masses are switched on. In connected diagrams the pole is changed by a meson mass, while the disconnected diagrams give an old result with overall change of $f_\pi(m_q)$. Using explicit form of fermion propagator [10]

$$S = \frac{\hat{p} + im}{p^2 + m^2} - \frac{\hat{p} + i\left(m - \frac{p^2}{M}\right)}{p^2 + \left(m - \frac{p^2}{M}\right)^2}$$

for $\Pi^5_{\mu\nu}$ we have

$$\Pi^5_{\mu\nu} = -\frac{f_M^2}{p^2 + m_M^2}\left(p^2 \delta_{\mu\nu} - p_\mu p_\nu\right) - \frac{m_M^2 f_M^2}{p^2 + m_M^2}\delta_{\mu\nu}, \qquad (5)$$

where the axial constants of mesons f_M, the chiral condensate $\langle \bar{\Psi}\Psi \rangle$ and effective mass $M(P)$ had been obtained earlier [7-10] (ibidem see details of calculations). Additional argument in favor of self-consistency of connected and disconnected diagrams in axial channel is a correlation between $\Pi^5_{\mu\nu}$ and

$$\Pi^5_\mu = \int d^4x\, e^{ip\cdot x} \langle 0 | T j^5_\mu(x) j^5(0) | 0 \rangle$$

which at $m_q \neq 0$ directly connects both types of diagrams

$$p_\mu \Pi^5_{\mu\nu} = -2im\Pi^5_\nu . \qquad (6)$$

In the approximation under study ($\rho M \ll 1$, $m/M \ll 1$) disconnected diagrams for Π^5_μ equal zero and hence we have

$$\Pi^5_\mu = \frac{2i\langle \bar{\Psi}\Psi \rangle}{p^2 + m_M^2} p_\mu$$

Using a relation

$$m_M^2 = \frac{-2(m_1 + m_2)}{f_M^2} \langle \bar{\Psi}\Psi \rangle \qquad (7)$$

we restore (6) from (5).

Note, that nondual ansatz under consideration does not possess $SU(2)_{col.} \times SU(2)_{space}$ symmetry and so the fact that the currents in the definition $\Pi^{\alpha\beta\cdots\mu\nu}_{\alpha'\beta'\cdots\mu'\nu'}$ are colorless does not lead to selection rule for space spin ($S=0$).

Instanton-antiinstanton ansatz in the leading over approximation contains equal quantity of pseudoparticles with isotropic distributions in color space and has definite charge-parity $C=+1$. From here immediately follows suppression (confirmed by direct calculations) of correlators of local currents for vector and tensor channels.

Thus, above analysis shows the presence of direct contributions at $J^P = 1^-$, which must smooth out strong asymmetry in quark momenta distribution, stipulated by the presence of side fluctuations, i.e. in vacuum model under consideration axial channel has structure which essentially differs from the one obtained in DSR QCD, and values for wave functions moments (n=1,2)

$$\langle \xi^{2n} \rangle = \int_{-1}^{1} d\xi \, \frac{\varphi_A(\xi)}{f_\pi} \xi^{2n} \qquad n = 0,1,2,\ldots$$

must be shifted toward diminution. Remind that $\langle \xi^2 \rangle \simeq 0.43$, $\langle \xi^4 \rangle = 0.24$ [2] . Direct estimates below bring to smaller values of $\langle \xi^{2n} \rangle (n=1,2)$.

Further study we'll carry out in the leading order in ρ/R in the limit $m_q \to 0$ (mass correction gives only redefinition of $f_{\pi(K)}(m_q)$ [10]). Matrix elements (1,2,3) may be connected with correlator (Fig.3):

$$\Pi(x,u,v) = \langle 0 | T\, \Psi^+(u) B \Psi(v), \quad \Psi^+(x)\, \gamma_5\, \Psi(x) | 0 \rangle =$$

$$= \int \frac{d^4 P}{(2\pi)^4} e^{iP(x-\frac{u+v}{2})} \Pi(z,P) \qquad z = \frac{v-u}{2}$$

by extraction of amplitude of pion generation from vacuum

$$\Pi(z,P) = \frac{-2\langle\bar\Psi\Psi\rangle}{f_\pi} \frac{1}{P^2} \langle 0 | d^\Gamma(z,-z) | \pi(P) \rangle$$

$$d^\Gamma = d^A_\mu \, , \; d^P , \; d^T_{\mu\nu} \tag{8}$$

Making recalculations [8,10] , namely replacing Ψ by zero modes

$$(S_I - S_0)(x,y) = - \frac{\Psi_I(x)\Psi_I^+(y)}{im}$$

averaging over positions and orientations of pseudoparticles, summing connected diagrams, extracting the pion pole we have

$$\langle 0 | d^\Gamma(z,-z) | \pi(P) \rangle = \frac{-2N_c}{f_\pi} [B_I(z,P) - B_{\bar I}(z,P)]$$

$$B_I(z,P) = \int \frac{d^4 q_1 \, d^4 q_2}{(2\pi)^4} \delta(q_1 - q_2 - P) e^{i(q_1+q_2)z} \tag{9}$$

$$\frac{\sqrt{M_1 M_2}}{(q_1^2+M_1^2)(q_2^2+M_2^2)} Sp\, B(\hat q_2 + iM_2) \frac{1+\gamma_5}{2} (\hat q_1 + iM_1)$$

For antiinstantons $B_{\bar I}$ must be replaced $\gamma_5 \to -\gamma_5$. Here $M_i = M(q_i^2)$. Using the parametrization $q_{1,2} = K \pm \frac{P}{2}$ we obtain for projections $\varphi_I(z \cdot P)$:

$$\varphi_A(P\cdot z) = \frac{4N_c}{f_\pi}\int \frac{d^4K}{(2\pi)^4}\, e^{2iK\cdot z}\sqrt{M_1M_2}\;\frac{M_1+M_2}{(q_1^2+M_1^2)(q_2^2+M_2^2)}$$

$$\varphi_p(P\cdot z) = \frac{8N_c}{f_\pi}\int \frac{d^4K}{(2\pi)^4}\, e^{2iK\cdot z}\sqrt{M_1M_2}\;\frac{q_1\cdot q_2+M_1M_2}{(q_1^2+M_1^2)(q_2^2+M_2^2)} \tag{10}$$

$$z_\mu\varphi_T(P\cdot z) = \frac{i4N_c}{f_\pi}\int \frac{d^4K}{(2\pi)^4}\, e^{2iK\cdot z}\sqrt{M_1M_2}\;\frac{K_\mu}{(q_1^2+M_1^2)(q_2^2+M_2^2)}$$

Integrating over angular variables (rejecting terms P^2 , z^2), using

$$\int \frac{d\Omega}{2\pi^2}\, e^{2iK\cdot z}\, f(K^2+P\cdot K)\, g(K^2-P\cdot K) =$$

$$= \frac{1}{iPz}\,\frac{1}{2\pi i}\oint \frac{du}{u^2}\, e^{iP\cdot zu}\, f\left[K^2\left(1-\frac{1}{u}\right)\right] g\left[K^2\left(1+\frac{1}{u}\right)\right]$$

we obtain ($\nu = P\cdot z$, $s = K^2$) $M_0 \equiv M(0)$

$$\varphi_A(\nu) = \frac{1}{\nu}\int_0^\infty a(s)\sin\nu\,\frac{s}{s+M_0^2}\,ds$$

$$a(s) = \frac{4N_c}{f_\pi}\left[M(-M_0^2)M(M_0^2+2s)\right]^{1/2}\frac{M(-M_0^2)+M(M_0^2+2s)}{16\pi^2(s+M_0^2)} \approx \tag{11}$$

$$\underset{\rho M\ll 1}{\approx}\quad \frac{4N_c}{f_\pi}\left[M_0M(2s)\right]^{1/2}\frac{M_0+M(2s)}{16\pi^2(s+M_0^2)}$$

Recall that in logarithmic accuracy [9]

$$f_\pi^2 \approx \frac{N_c}{\pi} M^2(0) \ln \frac{1}{\rho M} \approx 137\,\mathrm{MeV}$$

$$M(0) \approx 300\,\mathrm{MeV}$$

i.e.

$$\varphi_A(0) = \int_0^\infty \frac{S\,a(S)}{S+M_0^2}\,dS \approx f_\pi$$

In the approximation under consideration it is necessary to substitute $M(S)$ by $M(0)$, and the integral is determined by parametrically small momenta $K \leqslant \frac{1}{\rho}$.

Similarly, for $\varphi_P(\nu)$ and $\varphi_T(\nu)$ we have

$$\varphi_P(\nu) = \frac{1}{\nu}\int_0^\infty b(S)\sin\nu\frac{S}{S+M_0^2}\,dS \qquad b(S) = \frac{N_c}{2\pi^2 f_\pi}\left[M_0 M(2S)\right]^{1/2} \tag{12}$$

$$\varphi_P(0) = f_P = -\frac{2\langle\bar\Psi\Psi\rangle}{f_\pi}$$

$$\varphi_T(\nu) = -\frac{1}{2\nu^2}\int_0^\infty b(S)\left(1-\cos\nu\frac{S}{S+M_0^2}\right)dS \tag{13}$$

$$\varphi_T(0) = f_T = -\frac{1}{4} f_P$$

The well-known [5] connection is obtained from (7) and (12):

$$f_P = \frac{m_\pi^2}{m_u + m_d} f_\pi \approx 0.23\ \mathrm{GeV}^2, \qquad m_u + m_d \approx 11\ \mathrm{MeV}$$

Passing to the Fourier-transform according to (4) for $\Phi_I(\xi)=\varphi_I(\xi)/\xi$ we finally find

$$\Phi_A(\xi)=\frac{1}{2f_\pi}\int_0^\infty a(s)\left[\theta\left(\xi+\frac{s}{s+M_0^2}\right)-\theta\left(\xi-\frac{s}{s+M_0^2}\right)\right] \tag{14}$$

$$\Phi_A(0)=\frac{1}{2}+O(\rho/R)$$

$$\Phi_P(\xi)=\frac{1}{2f_P}\int_0^\infty b(s)\left[\theta\left(\xi+\frac{s}{s+M_0^2}\right)-\theta\left(\xi-\frac{s}{s+M_0^2}\right)\right]ds \tag{15}$$

$$\Phi_P(0)=\frac{1}{2}+O(\rho/R)$$

$$\Phi_T(\xi)=-\frac{1}{4f_T}\int_0^\infty b(s)\left(\frac{s}{s+M_0^2}-|\xi|\right)\theta\left(\frac{s}{s+M_0^2}-|\xi|\right) \tag{16}$$

$$\Phi_T(0)=1+O(\rho/R)$$

Functions $\Phi_I(\xi)$ go to zero at $|\xi|\geqslant 1$ and are symmetric when replacement $\xi\to-\xi$ takes place. When $\xi>0$, they can be presented in the form:

$$\Phi_A(\xi)=\frac{1}{2}-\frac{1}{2f_\pi}\int_0^{\frac{M_0^2\xi}{1-\xi}} a(s)ds\approx\begin{cases}\frac{1}{2} & \xi\ll 1\\ 6\left(\frac{1-\xi}{2}\right)^{3/2} & 1-\xi\ll 1\end{cases} \tag{17}$$

$$\Phi_P(\xi)=\frac{1}{2}-\frac{1}{2f_P}\int_0^{\frac{M_0^2\xi}{1-\xi}} b(s)ds\approx\begin{cases}\frac{1}{2} & \xi\ll 1\\ 3\left(\frac{1-\xi}{2}\right)^{1/2} & 1-\xi\ll 1\end{cases} \tag{18}$$

$$\phi_T(\xi) = 2(1-\xi)\,\phi_P(\xi) \tag{19}$$

$$\phi_T(\xi) = \begin{cases} 1-\xi & \xi \ll 1 \\ 8\left(\frac{1-\xi}{2}\right)^{3/2} & 1-\xi \ll 1 \end{cases} \tag{20}$$

Plots of these functions are given in Fig.4. In derivation of asymptotes (17, 18, 20) there was used the asymptotic value [6] :

$$M(S) \approx \frac{36\,M(0)}{(\rho^2 S)^3} \qquad \rho^2 S \gg 1$$

and relation (19). Obtained function $\phi_A(\xi)$ makes it possible to estimate $\langle \xi^2 \rangle$ and $\langle \xi^4 \rangle$:

$$\langle \xi^2 \rangle = \frac{1}{3f_\pi} \int_0^\infty \left(\frac{S}{S+M_0^2} \right)^3 a(s)\,ds < \frac{1}{3}$$

$$\langle \xi^4 \rangle = \frac{1}{5f_\pi} \int_0^\infty \left(\frac{S}{S+M_0^2} \right)^5 a(s)\,ds < \frac{1}{5}$$

Restrictions from above are connected with the following properties of $\phi_A(\xi)$: symmetry, monotony of functions at $\xi > 0$ ($\xi < 0$) and absence of dips. These properties are common for all projections and are connected with positivity of $M(P)$ function. Indeed, as $\xi/1-\xi$ is a monotonously rising function at $0 < \xi < 1$, and the integrands in (16)-(18) are positive, the integrals grow and functions $\phi_I(\xi)$ cannot have *minima*.

The axial projection of $\phi_A(\xi)$ is close to the asymptotic function, the pseudoscalar of $\phi_P(\xi)$ has more wide distribution, $\phi_T(\xi)$ is essentially narrower and its derivative at $\xi = 0$ undergoes a jump. A similar behavior have projections of wave functions for K mesons.

The values of $\phi_I(\xi)$ numerically are not correct for intermediate values of ξ , though catch correctly the functions behavior in the whole domain. The adopted approximation gives exact description only in two regions of ξ : $|\xi| \ll 1$, $1 - |\xi| \ll 1$ corresponding to regions of small $\rho p \ll 1$ and high $\rho p \gg 1$ relative quark momenta, since in the studied model of approximated Green function in field of one instanton it is impossible to have a claim on exact calculations in region $\rho p \sim 1$ [7].

Thus, in the model of instanton-based vacuum consisting of a superposition of instanton-antiinstanton fluctuations quark momentum distribution in π and K mesons is close to predictions of RQM, symmetric and is essentially different from results of DSR QCD.

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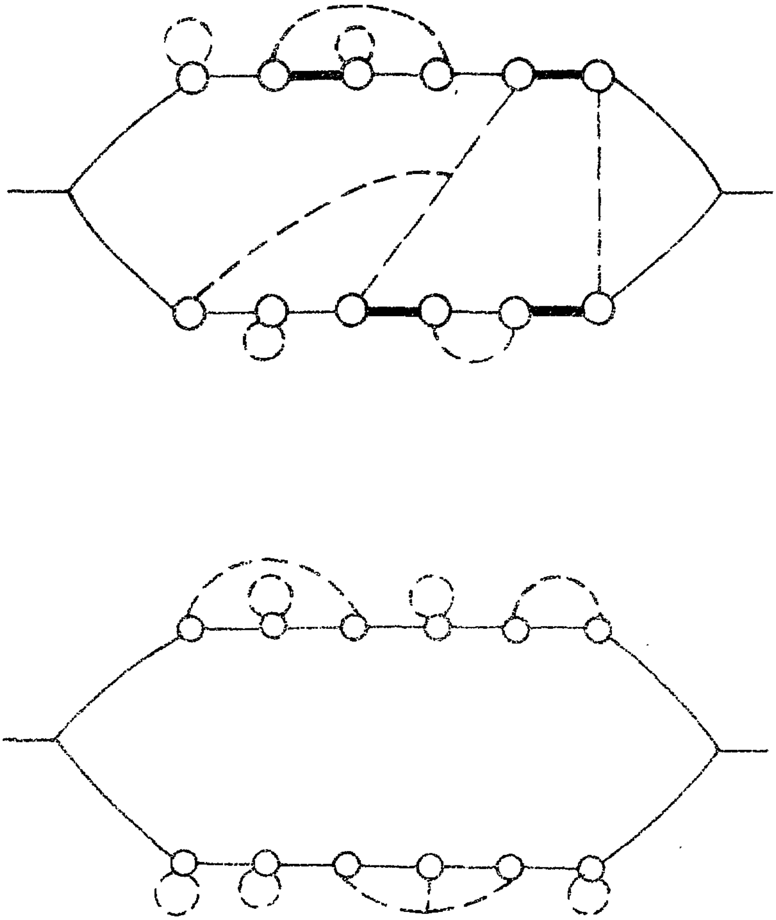

Fig.1

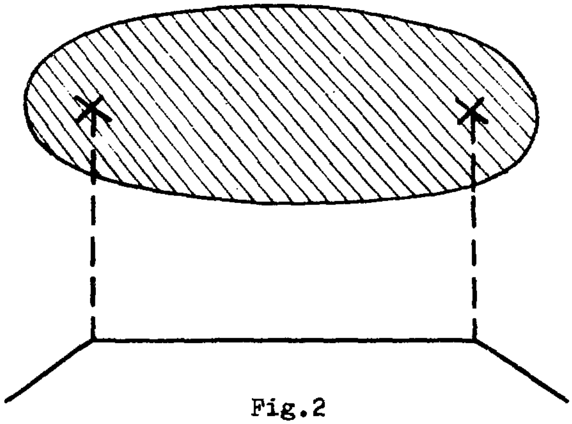

Fig.2

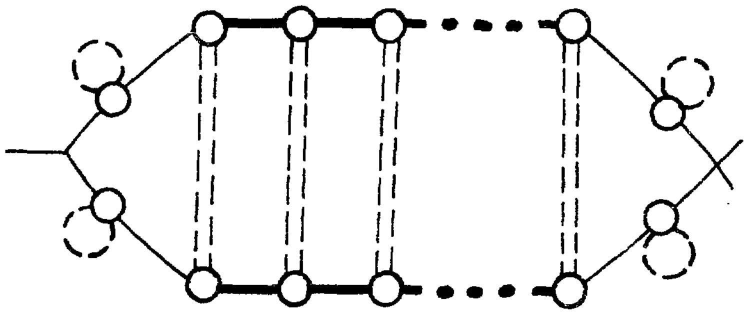

Fig.3

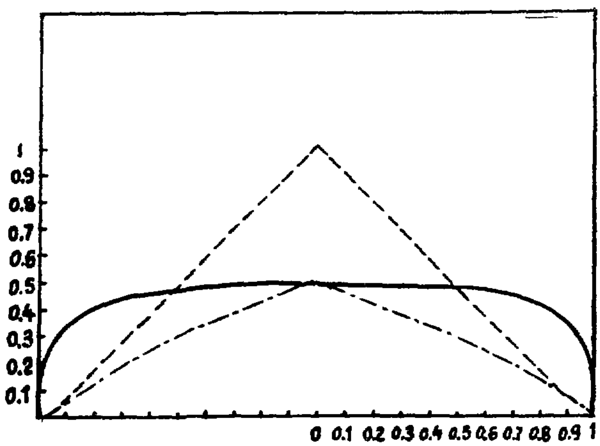

Fig.4

Figure Captions

Fig.1a. Types of connected planar graphs for two-point correlation function. Thin lines refer to the overlap integral, thick ones - exact Green function, circles - $\frac{1}{im}$. Dashed line implies averaging over positions and orientations of the corresponding pseudoparticles and summing over the number $N_{\pm} = \frac{N}{2}$ of such pseudoparticles.

Fig.1b. Types of disconnected planar graphs.

Fig.2. "Side" nonperturbative interaction.

Fig.3. Diagrams determining $\varphi_I(\xi)$. The crosses denote bilocal currents.

Fig.4. Normalized pion wave functions $\varphi_I(\xi)/f_\pi$ $I = A, P, T$ The axial projection (dash-dotted curve), the pseudoscalar projection (solid curve), the tensor projection (dashed curve). In plotting $\phi_{P,T}(\xi)$ we used the value of f_P obtained by numerical estimations from formula (15). All functions are normalized up to corrections of the order of $O(\rho/R)$ which would increase the values of $\phi_I(0)$.

REFERENCES

1. Черняк В.Л. Асимптотическое поведение эксклюзивных амплитуд в кварковой хромодинамике. Материалы XУ школы ЛИЯФ, Ленинград, 1980.
2. Chernyak V.L., Zhitnitsky A.L. Exclusive decays of heavy mesons. - Nucl.Phys., 1981, V.B201, p.492-526.
3. Chernyak V.L., Zhitnitsky A.R., Zhitnitsky I.R. Meson wave functions and SU(3) symmetry breaking. - Nucl.Phys., 1982, V.B204, p. 477-484.
4. Азнаурян И.Г., Багдасарян А.С., Тер-Исаакян Н.Л.Релятивистская модель кварков в системе бесконечного импульса и статистические свойства нуклонов. ЯФ, 1982, т.36, вып.5(II), с.1278-1289.
5. Багдасарян А.С., Есайбегян С.В., Тер-Исаакян Н.Л. Волновые функции мезонов и поведение формфакторов при малых и промежуточных q^2 в релятивистской кварковой модели. ЯФ, 1985, т.42, вып.2(8), с.440-452.
6. Brann V.M., Filyanov I.E. QCD sum rules in exclusive kinematics and pion wave function. - Preprint LNPI 1446, 1988.
7. Дьяконов Д.И., Петров В.Ю. Пропагатор кварка и киральный конденсат в инстантонном вакууме. ЖЭТФ, 1985, т.89, вып.2(8), с.361-379.
8. Дьяконов Д.И., Петров В.Ю. Корреляторы мезонных токов в инстантонном вакууме. ЖЭТФ, 1985, т.89, вып.3(9), с.751-762.
9. Dyakonov D.I., Petrov V.Yu. A theory of light quarks in the instanton vacuum. - Preprint LNPI-1053, 1985, p.52; Nucl. Phys., 1986, V.B271, N.3, p.457-491.

10. Есайбегян С.В., Тамарян С.Н. Массовые поправки к функциям Грина в модели инстантонного вакуума и статические характеристики псевдоскалярных мезонов. ЯФ, 1989, т.49, вып.9, с.815-822.

11. Вайнштейн А.И., Захаров В.И., Новиков В.А., Шифман М.А. Квантовая хромодинамика и масштабы адронных масс. ЭЧАЯ, 1982, т.13, вып.3, с.542-612.

12. Geshkenbein B.V., Ioffe B.L. The role of instantons in generation of mesonic mass spectrum. - Nucl.Phys., 1980, V.B166, p.340-364.

13. Dyakonov D.I., Petrov V.Yu. Instanton-based vacuum from Feynman variational principle. - Nucl.Phys., 1984, V.B245, N.2, p.259-292.

14. Shuryak E.V. The role of instantons in quantum chromodynamics. - Nucl.Phys., 1982, V.B203, N.1, p.93-140.

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СТРУКТУРА ВОЛНОВОЙ ФУНКЦИИ $\pi(K)$ МЕЗОНОВ В ИНСТАНТОННОМ ВАКУУМЕ

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