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REAL AND VIRTUAL $p^{\pm} \leftrightarrow K^{\pm}$ MESON VACUUM TRANSITIONS (OSCILLATIONS) IN THE MASS MIXINGS SCHEME AND PARTICLE TRANSITIONS IN THE CHARGE MIXINGS SCHEME

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1 Introduction

The vacuum oscillation of neutral K mesons is well investigated at the present time [1]. This oscillation is the result of d, s quark mixings and is described by Cabibbo-Kobayashi-Maskawa matrices [2]. The angle mixing θ of neutral K mesons is $\theta = 45^O$ since $K^o, \bar{K}^o$ masses are equal (see CPT theorem). Besides, since their masses are equal, these oscillations are real, i.e. their transitions to each other go without suppression. Oscillations of two particles having the masses overlapping their widths were discussed in works [3]. In the framework of the model of dynamical analogy of Cabibbo-Kobayashi- Maskawa matrices [4] in the diagram approach we computed the $K^o \leftrightarrow \bar{K}^o$ oscillations [5]. Then we calculated probabilities of $\pi \leftrightarrow K$ oscillations in the approach where the phase volume of particles at these transitions is taken into account [6, 7] and in the diagram approach in the standard model [8] and in the model of dynamical analogy of Cabibbo-Kobayashi- Maskawa matrices [9].

This work is devoted to consideration and analysis of $\pi \leftrightarrow K$ oscillations in the framework of mass mixing scheme in diagram and phase volume approaches, to study mixings of heavy carriers of the weak interactions, to detailed consideration of the transition of virtual K mesons on their mass shell through strong interactions and to consideration of particle oscillations in the framework of so named charge mixings scheme.

At first, we will consider the general elements of the theory of oscillations in mass mixing scheme, consider and analyse the obtained results in diagram and phase volume approaches for $\pi \leftrightarrow K$ transitions, study mixings of heavy carriers of the weak interactions, then come to more detailed consideration of the transition of virtual K mesons on their mass shell through strong interactions. In the end we discuss particle oscillations in the charge mixings scheme.

Let us consider the general elements of the theory of oscillations in the mass mixings scheme.

2 Probabilities of Real and Virtual Vacuum $\pi \leftrightarrow K$ Oscillations (Transitions) in the Mass Mixings Scheme

The mass matrix of π and K mesons has the following form:

$$\begin{pmatrix} m_\pi & 0 \\ 0 & m_K \end{pmatrix}. \tag{1}$$

Due to the presence of strangeness violation in the weak interactions, a nondiagonal term appears in this matrix and then this mass matrix is transformed in the following nondiagonal matrix:

$$\begin{pmatrix} m_\pi & m_{\pi K} \\ m_{\pi K} & m_K \end{pmatrix}, \tag{2}$$

which is diagonalized by turning through the angle β and then

$$\begin{pmatrix} m_\pi & m_{\pi K} \\ m_{\pi K} & m_K \end{pmatrix} \rightarrow \begin{pmatrix} m_1 & 0 \\ 0 & m_2 \end{pmatrix} \tag{3}$$

where

$$tg 2\beta = \frac{2m_{\pi K}}{\mid m_\pi - m_K \mid},$$

$$sin^2 2\beta = \frac{(2m_{\pi K})^2}{(m_\pi - m_K)^2 + (2m_{\pi K})^2}, \tag{4}$$

$$m_{1,2} = \frac{1}{2}((m_\pi + m_K) \pm \sqrt{(m_\pi - m_K)^2 + 4(m_{\pi K})^2}).$$

It is interesting to remark that expression (4) can be obtained from the Breit-Wigner distribution [10]

$$P \sim \frac{(\Gamma/2)^2}{(E - E_0)^2 + (\Gamma/2)^2} \tag{5}$$

by using the following substitutions:

$$E = m_K, \;\; E_0 = m_\pi, \;\; \Gamma/2 = 2m_{\pi K}, \tag{6}$$

where $\Gamma \equiv W(...)$.

If the mass matrix contains masses in a squared form, then oscillations (or mixings) will be described by the expressions (3)-(6) with the following substitutions:

$$m_\pi \to m^2_\pi, m_K \to m^2_K, m_{\pi K} \to m^2_{\pi K}$$

Here two cases of π, K oscillations [6] take place: real and virtual oscillations.

1. If we consider the real transition of π into K mesons, then

$$sin^2 2\beta \cong \frac{4m^2_{\pi K}}{(m_\pi - m_K)^2}. \tag{7}$$

How can we interpret this real $\pi \to K$ transition?

If $2m_{\pi K} = \frac{\Gamma}{2}$ is not zero, then it means that the mean mass of π meson is m_π and this mass is distributed by $sin^2 2\beta$ (or by the Breit-Wigner formula) and the probability of the $\pi \to K$ transition differs from zero. So, this is a solution of the problem of origin of mixing angle in the theory of vacuum oscillations.

In this case the probability of $\pi \to K$ transition (oscillation) is described by the following expression:

$$P(\pi \to K, t) = sin^2 2\beta sin^2 \left[\pi t \frac{m^2_K}{2p}\right], \tag{8}$$

where p is a momentum of the π meson.

The probability of the real transition of π mesons into K mesons through weak interactions is very small since $m_{\pi K}$ is very small [6-9].

$$sin^2 2\beta \cong 0. \tag{9}$$

2. If we consider the virtual transition of π into K meson, then, since $m_K = m_\pi$,

$$tg 2\beta = \infty,$$

i.e. $\beta = \pi/4$, then

$$sin^2 2\beta = 1. \tag{10}$$

In this case the probability of $\pi \longrightarrow K$ transition (oscillation in the diagram approach) is described by the following expression:

$$P(\pi \rightarrow K, t) = sin^2\left[\pi \frac{L}{L_{osc}}\right], \qquad (11)$$

where $L = vt$, v- is a velocity of the π meson, at $v \cong c$ $L \cong ct$,

$$L_{osc} = \frac{2.48 p_\pi (MeV)}{\mid m_1^2 - m_2^2 \mid (eV^2)} m. \qquad (12)$$

3 Probability of $\pi \stackrel{B}{\longleftrightarrow} K$ Virtual Oscillations with Account of π Decays in the Mass Mixings Scheme

A. The Phase Volume Approach in the Standard Model and the Model of Dynamical Analogy of Cabibbo-Kobayashi-Maskawa Matrices

A.1. The Phase Volume Approach in the Standard Model [6]

If at $t = 0$ we have the flow $N(\pi, 0)$ of π mesons, then at $t \neq 0$ this flow will decrease since π mesons decay, and then we have the following flow $N(\pi, t)$ of π mesons:

$$N(\pi, t) = exp(-\frac{t}{\tau_0})N(\pi, 0), \qquad (13)$$

where $\tau_0 = \tau'_0 \frac{E_\pi}{m_\pi}$.

One can express the time $\tau(\pi \leftrightarrow K)$ through the time of τ_0, then

$$\tau(\pi \stackrel{W sin\theta}{\longrightarrow} K) = \tau_0 (\frac{m_\mu}{m_u + m\bar{d}})^2 \frac{1}{tg^2\theta}. \qquad (14)$$

The expression for the flow $N(\pi \leftrightarrow K, t)$, i.e. probability of π to K meson transitions at time t, has the form

$$N(\pi \rightarrow K, t) = N(\pi, t) sin^2\left[\frac{\pi t}{\tau(\pi \stackrel{W}{\longrightarrow} K)}\right] =$$

$$= N(\pi, 0) exp(-\frac{t}{\tau_0}) sin^2 \left[\frac{\pi t}{\tau_0} \frac{tg^2\theta}{(\frac{m_\mu}{m_u + m_{\bar{d}}})^2} \right]. \qquad (15)$$

Since $\tau(\pi \to K) >> \tau_0$ at $t = \tau(\pi \to K)$ nearly all π mesons will decay, therefore to determine a more effective time (or distance) for observation of $\pi \to K$ transitions it is necessary to find the extremum of $N(\pi \to K, t)$, i.e. Eq. (15):

$$\frac{dN(\pi \to K, t)}{dt} = 0. \qquad (16)$$

From Eqs. (15) and (16) one obtain the following equation:

$$\frac{2\pi tg^2\theta}{(\frac{m_\mu}{m_u + m_{\bar{d}}})^2} = tg \left[\frac{t\pi tg^2\theta}{\tau_0 (\frac{m_\mu}{m_u + m_{\bar{d}}})^2} \right]. \qquad (17)$$

If one takes into account that the argument of the right part of (17) is a very small value, one can rewrite the right part of (17) in the form

$$tg \left[\frac{t\pi tg^2\theta}{\tau_0 (\frac{m_\mu}{m_u + m_{\bar{d}}})^2} \right] \cong \frac{t\pi tg^2\theta}{\tau_0 (\frac{m_\mu}{m_u + m_{\bar{d}}})^2}. \qquad (18)$$

Using (17) and (18) one obtains that the extremum of $N(...)$ takes place at

$$\frac{t}{\tau_0} \cong 2 \qquad or \qquad t \cong 2\tau_0. \qquad (19)$$

And the extremal distance R for observation of $\pi \to K$ oscillations is

$$R = tv_\pi \cong 2\tau_0 v_\pi, \qquad (20)$$

and the equation for $N(\pi \to K, 2\tau_0)$ has the following form:

$$N(\pi \to K, 2\tau_0') = N(\pi, 0) exp(-2) sin^2 \left[2\pi \frac{tg^2\theta}{(\frac{m_\mu}{m_u + m_{\bar{d}}})^2} \right] \cong \qquad (21)$$

$$\cong N(\pi, 0) 5.1 \ 10^{-6},$$

where $m_u + m_{\bar{d}} \cong 15$ MeV, $tg^2\theta \cong 0.048$.

From Eq.(15) we see that the length of oscillations L_{osci} is

$$L = vt,$$

$$L_{osci} = v\tau_o \frac{(\frac{m_\mu}{m_u + m_{\bar{d}}})^2}{tg^2\theta} \cong v\tau_o \cdot 10^3 \quad (22)$$

where v-is a velocity of the π meson,

$$v = \frac{p}{m_\pi \gamma}, \quad (23)$$

and probability of $\pi \to K$ transitions is

$$N(\pi \to K, t) = N(\pi, t) sin^2 \left(\pi \frac{L}{L_{osci}}\right). \quad (24)$$

A.2. The Phase Volume Approach in the Model of Dynamical Analogy of Cabibbo-Kobayashi- Maskawa Matrices [7]

In this model the transitions between π and K mesons are realized through B boson exchanges. At the low energy the expression for transitions (oscillations) is like the previous one (13)-(21) (see [7]). The relation between Fermi constants of $G_{F,W}$ and $G_{F,B}$ bosons is

$$G_{F,B} = G_{F,W} sin\theta, \qquad \frac{G_{F,W}}{\sqrt{2}} = \frac{g^2}{8m_W^2}. \quad (25)$$

The length of oscillations is

$$L_{osci} = v\tau_o \frac{(\frac{m_\mu}{m_u + m_{\bar{d}}})^2}{(\frac{m_W^2}{m_B^2})}. \quad (26)$$

The probability of $\pi \to K$ transitions is given by the following expression:

$$N(\pi \to K, t) = N(\pi, t) sin^2 \left(\pi \frac{L}{L_{osci}}\right). \quad (27)$$

B. The Diagram Approach in the Standard Model and the Model of Dynamical Analogy of Cabibbo-Kobayashi- Maskawa Matrices

B.1. The Diagram Approach in the Standard Model [8]

If at $t = 0$ we have the flow $N(\pi, 0)$ of π mesons, then at $t \neq 0$ this flow will decrease because of π mesons decay and then we have the following flow $N(\pi, t)$ of π mesons:

$$N(\pi, t) = exp(-\frac{t}{\tau_0'})N(\pi, 0), \tag{28}$$

where $\tau_0' = \tau_0 \frac{E_\pi}{m_\pi}$.

The expression for the flow $N(\pi \leftrightarrow K, t)$, i.e. probability of $\pi \leftrightarrow K$ meson transitions at time t, has the following form

$$N(\pi \rightarrow K, t) = N(\pi, t)P(\pi \rightarrow K, L) \tag{29}$$

where

$$P(\pi \leftrightarrow K, L) = sin^2 \left[\pi \frac{L}{L_{osc}}\right], \tag{30}$$

$$L_{osc} = \frac{2.48 p_\pi (MeV)}{\mid m_1^2 - m_2^2 \mid (eV^2)} m. =\cong 4.43 \cdot 10^{-11} p_\pi (GeV) cm \tag{31}$$

and

$$m_1^2 - m_2^2 = f_\pi^2 m_\pi^2 \frac{G_F}{\sqrt{2}} sin\theta.$$

In the approach where the phase volume is taken into account the expression for the probability of $\pi \rightarrow K$ oscillations $P(\pi \rightarrow K, t)$ has the following form [6]:

$$N(\pi \leftrightarrow K, t) = N(\pi, t) sin^2 \left[\frac{\pi t}{\tau(\pi \xrightarrow{W} K)}\right] =$$

$$= N(\pi, 0) exp(-\frac{t}{\tau_0}) sin^2 \left[\frac{\pi t}{\tau_0} \frac{tg^2\theta}{(\frac{m_\mu}{m_u + m_{\bar{d}}})^2}\right]. \tag{32}$$

In the case of real oscillations the probability of $\pi \rightarrow K$ transitions (oscillations) is described by the following expression:

$$P(\pi \leftrightarrow K, t) = sin^2 2\beta sin^2 \left[\pi t \frac{m_K^2}{2p}\right],$$

where [8]

$$sin^2 2\beta \cong \frac{\Delta m_{12}^2}{m_K^2} = \frac{\left(f_\pi^2 m_\pi \frac{G_F}{\sqrt{2}} sin\theta\right)^2}{m_K^2} \cong 0. \quad (33)$$

B.2. The Diagram Approach in the Model of Dynamical Analogy of Cabibbo-Kobayashi-Maskawa Matrices [9]

In this model the transitions between π and K mesons is realized through B boson exchanges. At the low energy the expression for transitions (oscillations) is like to the previous ones (28)-(31) (see [9]). The relation between Fermi constants of $G_{F,W}$ and $G_{F,B}$ bosons is given by expression (25).

The kinematics of the process of the virtual K meson transition on its mass shell is given in work [6]. Let us discuss this problem.

4 Analysis of the Two Above Approach to consideration of $\pi \leftrightarrow K$ Transitions (Oscillations)

Above we have used the two approaches to consider $\pi \leftrightarrow K$ transitions (oscillations), namely, the phase volume and diagram ones. In these approaches two very different results have been obtained. In the first case the length of oscillations is determined by Ex.(22) and in the second case the length of oscillations is determined by Ex.(31) and it is a very small value. If to average Ex.(31) on the distances the following value is obtained:

$$P(\pi \leftrightarrow K) = \frac{1}{2}.$$

It is difficult to coordinate this result with the available experimental results (it is interesting to remark that the diagram approach is often used in theoretical calculations). Probably, it is necessary to continue studying these approaches to solve the following problem: which of these ones is accetable to describe the $\pi \leftrightarrow K$ oscillations? Although, from the general reasons it is obvious that the phase volume approach is more adequate to solve this problem.

5 Boson mixings in the Mass Mixings Scheme

In the model of dynamical analogy of Cabibbo-Kobayashi- Maskawa matrices besides the W bosons, ther B, C, D, E bosons appear. In principle, mixings can exist between these bosons. We consider mixings of W and B bosons. The mass matrix of B, W bosons has the following form:

$$\begin{pmatrix} m_B^2 & 0 \\ 0 & m_W^2 \end{pmatrix}. \tag{34}$$

To get mixings between B, W we must introduce a nondiagonal mass term. Since we consider the maximal mixing (i.e. we suppose that the nondiagonal mass terms are equal to W boson mass), then the mass matrix (34) is converted into the following mass matrix:

$$\begin{pmatrix} m_B^2 & m_W^2 \\ m_W^2 & m_W^2 \end{pmatrix}. \tag{35}$$

We diagonalize this matrix by using a standard procedure and obtain that angle mixing $sin2\theta$ is

$$sin2\theta \cong \frac{2m_W^2}{m_B^2}$$

or

$$sin\theta \cong \frac{m_W^2}{m_B^2}.$$

It is interesting to remark that this relation is the same relation which we used in our model of dynamical analogy and the angle θ is also equal to Cabibbo angle. Probability of B, W transitions is determined by the following expression:

$$P(B \leftrightarrow W) = sin^2 2\theta sin^2(\pi L/L_o), \tag{36}$$

where $L = vt$ and L_o is

$$L_o = \frac{2.48 P_B(MeV)}{m_B^2(eV^2)} m.$$

6 Kinematics Processes of K Meson Creation and Probability of Virtual K Meson Transition on Own Mass Shell via Strong Interactions

1. Kinematics Processes of K Meson Creation

So, if one has π mesons, then with the probability determined by Eq. (19) they virtually transit into K mesons, and if these virtual K mesons participate in quasielastic strong interactions then they become real K mesons. Then through K meson decays one can verify this process.

The energy threshold $E_{thre,\pi}$ of the quasielastic reaction $\pi^+ + p \rightarrow K^+ + p$ is

$$E_{thre,\pi} = 0.61\ GeV.$$

Besides, this quasielastic reaction of π mesons can produce K mesons in inelastic reactions. An example of this inelastic reaction (if target is a nucleus) is the following reaction:

$$\pi^+ + n \rightarrow K^+ + \Lambda. \tag{37}$$

The energy threshold $E^{inel}_{thre,\pi}$ is

$$E^{inel}_{thre,\pi} = 0.91\ GeV.$$

To avoid the problem with K mesons produced in the inelastic reaction, one must take energies E_π of π mesons less than 0.91 GeV, i.e. E_π must be

$$0.61 \leq E_\pi \leq 0.91\ GeV. \tag{38}$$

The optimal distances for observation of $\pi \leftrightarrow K$ oscillations in the phase volume approach can be computed by using Eqs.(16)-(20).

2. A Theoretical Estimation of Relative Probability of Virtual K Meson Transitions on Own Mass Shell via Strong Interactions

Since we consider the strong interaction at low energies, we can confine by consideration of meson exchanges. Then the cross section of elastic scattering of π mesons on p will be reversely proportional to π meson mass in square (we take into account only π exchanges)

$$\sigma(\pi + p \to \pi + p, Q^2 \geq 0) \cong \frac{c}{m_\pi^2}. \tag{39}$$

The threshold of transition of virtual K meson (K meson is on mass shell of π meson) on own mass shell is defined by the following value $Q^2 \cong m_K^2$ therefore the cross section of K transition on own mass shell is reversely proportional to K meson mass in square

$$\sigma(K + p \to K + p, Q^2 \geq m_K^2) \cong \frac{c}{m_K^2}. \tag{40}$$

Then relative probability α of K meson transition on own mass shell is

$$\alpha = \frac{\sigma(K + p \to K + p, Q^2 \geq m_K^2)}{\sigma(\pi + p \to \pi + p, Q^2 \geq 0)} \cong \frac{m_\pi^2}{m_K^2} \cong 0.1. \tag{41}$$

3. Estimation of Relative Probability of Virtual K Meson Transitions on Own Mass Shell via Strong Interactions from Experiment on π, p Elastic Scattering

Virtual K mesons (π mesons are transformed in K mesons via the weak interactions) will be transformed in real K mesons beginning the threshold when the transfer momentum admits such a transition. This threshold in the laboratory system is defined be t which is

$$t_{thresh,lab} = (p_\pi - p'_K)^2 = m_\pi^2 + m_K^2 - 2m_K E_\pi, \tag{42}$$

where $p_\pi = (E_\pi, p_\pi), p'_K = (m_K, 0)$.

The same value for π meson in the center mass system is

$$t_{thresh,center} = (p_\pi^* - p_\pi'^*)^2 = 2m_\pi^2 - 2p_\pi^{*2}(1 - cos\theta^*), \tag{43}$$

Since t is invariant, then $t_{thresh,lab} = t_{thresh,center}$, then using this equality we obtain the threshold (or angle scattering) when real K mesons production begin

$$m_\pi^2 + m_K^2 - 2m_K E_\pi = 2m_\pi^2 m_K^2 - 2p_\pi^{*2}(1 - cos\theta^*), \qquad (44)$$

From (44) we obtain

$$1 - cos\theta^* = \frac{-m_K^2 + m_\pi^2 + 2m_K E_\pi}{2p_\pi^{*2}} \qquad (45)$$

where

$$p_\pi^{*2} = \frac{p_\pi^2 m_p^2}{s}, \quad s = (p_\pi + p_p)^2 = m_\pi^2 + m_p^2 + 2m_p E_\pi. \qquad (46)$$

Put Eq.(46) in Eq.(45) we obtain

$$cos^* \cong 1 - (\frac{m_K}{m_p})\frac{(2\sqrt{p_\pi^2 + m_\pi^2} - m_K)(2\sqrt{p_\pi^2 + m_\pi^2} - m_\pi)}{2p_\pi^2}. \qquad (47)$$

$cos\theta^*$ is the threshold angle for K meson transition on the own mass shell and a p_π is π meson momentum in the laboratory system.

The threshold angle $cos\theta^*$ in the center mass system for K transition on the own mass shell for the elastic $\pi + p$ reaction at $p_\pi = 0.895 GeV/c$ [11] (below the threshold of $\pi^- + p \to K^o + \Lambda$ reaction) is obtained from Eq.(47) and it is

$$cos\theta^* = -0.192. \qquad (48)$$

Elastic cross section σ of $\pi + p$ reaction below and above this threshold from [11] is

$$\sigma(..., cos\theta^* \le -0.192) = 4.53 mb,$$
$$\sigma(..., cos\theta^* > -0.192) = 16.44 mb, \qquad (49)$$

and then the relation between these cross sections is

$$\alpha = 0.27. \qquad (50)$$

This value is a relative probability of transition of the virtual K meson the on own mass shell.

Probably, a considerable deference between α in (41) and (50) is caused with the deposit of resonance canals in the cross section of π, p elastic scattering.

7 Particle Oscillations in the Charge Mixings Scheme

Above we discussed two approaches where $\pi \leftrightarrow K$ transitions were considered in the framework of the mass mixings scheme. In this scheme the mass matrix contains masses of π, K mesons in the diagonal and nondiagonal terms which were responsible for mixings. However, this scheme can not realize in all cases. A concrete example of another scheme of two particle mixings realizes in the vector dominance model [12] where the transitions (mixings) realize via charges and then mixing angles of $\gamma - \rho, \gamma - Z^o, \rho - Z^o$ are determined through couple constants of the corresponding interactions. For example, the angle of $\gamma - \rho$ mixing is

$$sin\phi \cong \frac{e}{\sqrt{G^2 + e^2}} \cong \frac{e}{G},$$

where e, G are couple constants of the electromagnetic and strong interactions. The mixings of quarks and leptons can occur in the similar manner. It is supposed that the quarks or leptons are mixed via weak interactions and therefore if we consider charge mixings of two particles-a, b, then the angle mixings must be

$$sin\theta \cong \frac{g_w(a)}{\sqrt{g_w^2(a) + g_w^2}} \cong \frac{1}{\sqrt{2}},$$

since $g_w(a) \cong g_w(b)$, where $g_w(a), g_w(b)$ are weak couple constants of a, b particles.

Quarks and leptons, besides the weak couple constant, have masses and other characteristics. Since the weak interactions are left-sided, the quarks and leptons cannot obtain the masses through weak interactions [13] (usually it is supposed that they obtain masses through Higgs mechanism [14]). Probably, for defects of Higgs mechanism which are noted in [9, 15], it is more realistic to suppose that at small distances there is a new left-right symmetrical interaction which generates quark and lepton masses. Then the quark or lepton mixing angles can be determined by couple constants of the new interaction and the angle mixing is

$$sin\theta \cong \frac{G_(a)}{\sqrt{G^2(a) + G^2(b)}},$$

where $G(a), G(b)$ are couple constants of particle a, b. These oscillations are virtual since particle b does not transit on the own mass shell while oscillations. We can transit particle b on his mass shell through quasielastic or inelastic strong interactions (see above Section 6) in the case of quarks (or through quasielastic or inelastic weak interactions in the case of leptons).

So, a fundamental distinction of these (charge) mixings from the mass mixings at virtual oscillations is that in the first case the mixing angles are determined by constant couples and in the second case these angle equal to $\pi/4$.

8 Conclusion

In this work we have considered and analyzed of the real and virtual $\pi \leftrightarrow K$ vacuum transitions (oscillations) in the framework of mass mixing scheme in the diagram and phase volume approaches. Mixings of heavy carriers of the weak interactions were considered. The detailed consideration of the transition of virtual K mesons on their mass shell through strong interactions was made. The particle oscillations in the framework of the so-called charge mixings scheme were studied.

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Реальные и виртуальные $p^{\pm} \leftrightarrow K^{\pm}$ мезон вакуумные переходы (осцилляции) в схеме массового смешивания и переходы частиц в схеме зарядового смешивания

Проводится рассмотрение и анализ реальных и виртуальных $p \leftrightarrow K$ мезон вакуумных переходов (осцилляций) в рамках схемы массового смешивания в диаграммном и фазово-объемном подходах. Рассматриваются смешивания тяжелых носителей слабого взаимодействия. Детально изучается переход виртуальных K-мезонов на собственную массовую поверхность через сильное взаимодействие. Рассматриваются осцилляции частиц в рамках схемы зарядового смешивания.

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Real and Virtual $p^{\pm} \leftrightarrow K^{\pm}$ Meson Vacuum Transitions (Oscillations) in the Mass Mixings Scheme and Particle Transitions in the Charge Mixings Scheme

In this work consideration and analysis of the real and virtual $p \leftrightarrow K$ meson vacuum transitions (oscillations) in the framework of mass mixings scheme in the diagram and phase volume approaches are fulfilled. Mixings of heavy carriers of the weak interactions are considered. The detailed consideration of the transition of virtual K mesons on their mass shell through strong interactions is made. The particle oscillations in the framework of the so-called charge mixings scheme are studied.

The investigation has been performed at the Laboratory of Particle Physics, JINR and at the Scientific Research Institute of Applied Mathematics and Automation of the Kabardino-Balkarian Scientific Centre of RAS, Nalchik.

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