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ON A SYSTEMATICS OF ELEMENTARY PARTICLES IN VIEW OF POSSIBLE PROPERTIES OF THE D^0 -MESON

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Since it was reported on the D^{+}-meson[1] increasing attention has been given to the analysis of some 'surprising' decays of various unstable particles observed earlier.[2]

One may think that D^{+}-meson really exists, has the mass of the order of 750 MeV and decays via the scheme

$$D^{+} \rightarrow K^{+}_{0} + \pi^{0}_{+} \qquad (1)$$

According to the well-known Gell-Mann-Nishijima scheme[3] D^{+}-meson is most likely to be an isotopic singlet with strangeness +2. Then there must exist its antiparticle $-D^{-}$-meson with strangeness −2 which has approximately the same mass and decays like (1) :*

$$D^{-} \rightarrow K^{\bar{0}}_{-} + \pi^{0}_{-} \qquad (2)$$

Thus, of the boson- isotopic singlets predicted by the Gell-Mann-Nishijima scheme there remains only ρ_0 -meson which is not yet found. The problem of its existence and properties as well as the methods of its experimental detection was often discussed in literature[4].

We should like to draw the attention to the fact that from time to time in literature there appears some information concerning the observation of neutral particle decays by the modes

$$D^{0} \rightarrow K^{\pm} + \pi^{\mp} \qquad (3)$$

with $m_{D^0} \sim 650-700$ MeV[5,6]. There are indications that there exists a neutral unstable particle le with the mass and decay modes analogous to those of the $D^{\pm}$-mesons.

Now let us be concerned with the systematics of elementary particles. As is well-known all of them are only different variants of the displaced charge isotopic multiplet scheme. The ultimate aim of these schemes is to establish the relationship between the magnitude of the electric charge of a particle $\frac{Q}{e}$ and that of the third component of the isotopic spin I_z /or τ_3 /. This relationship in the Gell-Mann-Nishijima scheme is of the form

$$\frac{Q}{e} = I_z + \frac{n}{2} + \frac{S}{2}$$

where n is the nuclear charge, whereas S is the strangeness quantum number. The Salam-Polkinghorne scheme[7] leads to

$$\frac{Q}{e} = \tau_3 + \mu_3$$

while B. d'Espagnat and J. Prentki[9] variant yields an analogous relation

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* Decays of the mode $D \rightarrow K + \mu + \nu$ are not, of course, excluded.

$$\frac{Q}{e} = I_z + \frac{U}{2}$$

where U – is the isofermion charge.

One may easily see that these schemes are identical, provided

$$\frac{n}{2} + \frac{S}{2} = \mu_3 = \frac{U}{2}$$

Therefore, without specifying a type of the classification we are able to make up a table for bosons and fermions in accordance with their transformation properties in the isotopic space /$P = e^{i\mu_3\pi}$ is the parity in the isotopic space/.

Table 1.

Transformation properties in isospace	Particles	τ_3	μ_3	P
Isospinor of the 1st kind	$N^+, K^+; N^0, K^0$	$+\frac{1}{2}; -\frac{1}{2}$	$+\frac{1}{2}$	$+i$
Isospinor of the 2nd kind	$\Xi^0, \bar{K}^0; \Xi^-, K^-$	$+\frac{1}{2}; -\frac{1}{2}$	$-\frac{1}{2}$	$-i$
Isopseudovector	$\Sigma^+, \pi^+; \Sigma^0, \pi^0; \Sigma^-, \pi^-$	$+1;\ 0;\ -1$	0	$+1$
Isoscalar	Λ^0, D^0	0	0	$+1$
Isopseudoscalar	$Z^+, D^+; \quad \Omega^-, D^-$	0	$+1; \quad -1$	-1

It can be seen from the Table that three isotopic singlets D^+, D^0, D^- may be treated as three components of a vector in the μ-isospace.

But then one may think that the properties of these particles are identical.

If this is assumed, then the D^0 -meson in this Table and the D^0-particle mentioned above are the same. Thus, we arrive to a conclusion that the isotopic singlet D^0 with strangeness 0 which may quickly decay into pions/8/ ($\Delta S = 0$ provided) undergoes a slow decay, as a result of which the products of strangeness ± 1 appear.

But this assertion contradicts the original assumptions according to which the above-mentioned systems were constructed.

So, in the classifications of elementary particles now accepted there is no room for a meson with the decay scheme of type (3) if a special forbiddeness is not imposed for quick transitions of type $D^0 \to n\pi$ or $\Sigma^0 \to \Lambda^0 + \gamma$. If, on the other hand, a classification like that given in the Table is accepted, the main principles on the basis of which such classifications are constructed should be analized.

Generally, it can be seen from Table 1, that the quick decay D^0 is forbidden by the following empirical rule:

A quick transition of any single particle of Table 1 to any particles with other transformation properties in the isotopic space is forbidden.

In view of this assertion it is important to determine experimentally the time of the $\Sigma^0 \to \Lambda^0$ transition.

The most probable reaction for the generation of the D^0 -meson is

$$\pi^- + p \rightarrow N + D^0$$

the threshold $E_{\pi\,kin}$ being 0.7 –0.8 BeV, as well as the photoproduction which is investigated in/10/.

With a view to the systematic search for neutral unstable particles whose characteristics are different from those of Λ^0 and θ^0-particles it would be of interest to look through the materials obtained with track chambers by exposing them to the beams of negative pions with momenta larger than 1 BeV/c.

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