An alternative model of particle composition and interactions

Józef Kajfosz

Institute of Nuclear Physics, Cracow, Poland

Institute of Nuclear Physics, Řež, Czech Republic

(Retired)

Abstract: A phenomenological model developed independently of most of the recent theoretical concepts is presented, the process of its development is described, its affinity with the quark model is shown, and its properties and some of their consequences are discussed.

1. Introduction

In this contribution we describe an attempt to formulate on the basis of a few very simple fundamental assumptions a new model of particle composition. The idea had its origin in some dissatisfaction with the present state of art in particle physics and in the conviction that the true story has to be simpler, more general and more beautiful. But surely minor changes seem to be insufficient. Therefore only a radical, challenging proposal, no matter how hopeless and unpopular at first, may possibly clear the way to finding the right solution.

2. Basic assumptions

Basic assumptions of the model are the following:

1) There are four fundamental components of particles: A^{++}, B^{+-}, C^{--}, D^{-+}, where the superscripts belong to the electric charge Q and the baryon number B. Their values are ±½ ε, where ε is the electric charge of the positron, and ±½ β, where β is the baryon number unit.

2) Each particle is composed of a certain number of the four fundamental components. In all decays and interactions the total number of components of each kind is strictly conserved.

The composition of a particle can be expressed as [*abcd*], where a is the number of components A^{++}, b the number of B^{+-}, etc. The charges Q and B of a particle are thus:

$$Q = ½\,(a+b-c-d) \quad \text{and} \quad B = ½\,(a-b-c+d). \tag{1}$$

The total number of components of each particle is always even. The sum $s = a+b+c+d$ can thus be 2, 4, 6, etc. One can expect that the pairs of components are fermions with spin ½ $\hbar$ and that the bosons are composed of an even number of such pairs. Hence, for fermions s can be 2, 6, 10, etc., and for bosons 4, 8, 12, etc.

The conservation law can be expressed as:

$$\Sigma a_L = \Sigma a_R\,,\ \Sigma b_L = \Sigma b_R\,,\ \Sigma c_L = \Sigma c_R\,,\ \Sigma d_L = \Sigma d_R\,, \qquad (2)$$

where the sum is over all the particles entering (at the left side) and outgoing (at the right side) the process.

In order to fulfill this conservation law the following additional assumption appears to be necessary:

3) There exist neutral field bosons (or background bosons) E, W and $\tilde{W}$ with negligible masses, energies and momenta, which participate in the interactions. E enters the electromagnetic and strong processes and W or $\tilde{W}$ enters the weak processes. Higher order (less probable) processes are those with the participation of EE, EEE, etc., or WE, $\tilde{W}E$, WEE, $\tilde{W}EE$, etc., respectively. The compositions of the three background bosons are:

$$E \equiv [1111],\ \ W \equiv [2020], \text{ and }\ \tilde{W} \equiv [0202]. \qquad (3)$$

3. Particle assignments

Possible compositions of particles for the lowest s values (limited to charges 0, ±1) are presented in Table 1.

Table 1 Compositions [*abcd*] of particles and their assignments

	Q=+1	Q=0	Q=0	Q=–1		Q=+1	Q=0	Q=0	Q=–1
s=2, B=0 leptons	1100 e^+	1010 ν_μ	0101 $\tilde{\nu}_\mu$	0011 e^-	s=6, B=±1 baryons	4020 —	—	—	2040 —
s=4, B=0 mesons	1201 π^+	1111 π^0	1111 γ	1021 π^-		1311 $\tilde{\Sigma}^+$	1221 $\tilde{\Sigma}^0$	2112 Σ^0	2022 Σ^-
	2110 K^+	2020 K^0	0202 $\tilde{K}^0$	0112 K^-		2202 Σ^+	2112 Λ	1221 $\tilde{\Lambda}$	1131 $\tilde{\Sigma}^-$
s=6, B=0 leptons	1302 μ^+	1212 $\tilde{\nu}_e$	2121 ν_e	2031 μ^-		2220 $\tilde{\Xi}^+$	2130 $\tilde{\Xi}^0$	1203 Ξ^0	1113 Ξ^-
	2211 —	2121 —	1212 —	1122 —		3111 p	3021 n	0312 $\tilde{n}$	0222 $\tilde{p}$
	3120 τ^+	3030 $\tilde{\nu}_\tau$	0303 ν_τ	0213 τ^-		0402 —	—	—	0204 Ω^-

The shown assignments of individual compositions to known particles are the result of a considerable amount of investigation and computer experiments, for which the input data was a list of observed decay modes of "ordinary" particles with their branching ratios. (The decay modes of K^0_S and K^0_L were ascribed to K^0, until a study of the particle mixing will be carried out.) All data used in this investigation (particle masses, decay modes and their branching ratios) were taken from ref. [1]. The assignments for τ^+, τ^-, ν_τ and $\tilde{\nu}_\tau$ were added later.

It was easily possible to find particle compositions which would match all observed hadronic decay modes while for every particle assignment some of the leptonic decay modes remained unmatched. This model thus requires a revision of the identity of neutrinos in some of the decay modes, and hence a modification of the lepton number conservation laws. Only after carrying out the transformations $\nu_\mu \leftrightarrow \tilde{\nu}_\mu$ or $\nu_e \leftrightarrow \tilde{\nu}_e$ in some of the leptonic decays a full agreement between particle compositions and the list of decays could be reached.

Table 2 Classical and 4C decay schemes of "ordinary" particles. (The decay schemes altered by interchange of neutrinos are marked by an asterisk in the *ΔN* column.)

No.	Br. ratio %	Classical scheme	*ΔN*	4C scheme
1	98.500000	$\mu^- \rightarrow e^- \nu_\mu \tilde{\nu}_e$	1	$\tilde{W}0\ \mu^- \rightarrow e^- \nu_\mu \tilde{\nu}_e$
2	1.400000	$\mu^- \rightarrow e^- \nu_\mu \tilde{\nu}_e \gamma$	1	$\tilde{W}1\ \mu- \rightarrow e^- \nu_\mu \tilde{\nu}_e \gamma$
3	.003400	$\mu^- \rightarrow e^- \nu_\mu \tilde{\nu}_e e^+ e^-$	2	$\tilde{W}1\ \mu^- \rightarrow e^- \nu_\mu \tilde{\nu}_e e^+ e^-$
4	99.987700	$\pi^+ \rightarrow \mu^+ \nu_\mu$	*0	$\tilde{W}0\ \pi^+ \rightarrow \mu^+ \tilde{\nu}_\mu$
5	.020000	$\pi^+ \rightarrow \mu^+ \nu_\mu \gamma$	*0	$\tilde{W}1\ \pi^+ \rightarrow \mu^+ \tilde{\nu}_\mu \gamma$
6	.012300	$\pi^+ \rightarrow e^+ \nu_e$	0	$W0\ \pi^+ \rightarrow e^+ \nu_e$
7	.000001	$\pi^+ \rightarrow e^+ \nu_e \gamma$	0	$W1\ \pi^+ \rightarrow e^+ \nu_e \gamma$
8	.000001	$\pi^+ \rightarrow e^+ \nu_e \pi^0$	0	$W1\ \pi^+ \rightarrow e^+ \nu_e \pi^0$
9	.000001	$\pi^+ \rightarrow e^+ \nu_e e^+ e^-$	1	$W1\ \pi^+ \rightarrow e^+ \nu_e e^+ e^-$
10	98.798000	$\pi^0 \rightarrow \gamma\ \gamma$	0	$E0\ \pi^0 \rightarrow \gamma\ \gamma$
11	1.198000	$\pi^0 \rightarrow e^+ e^-\ \gamma$	1	$E0\ \pi^0 \rightarrow e^+ e^-\ \gamma$
12	0.003140	$\pi^0 \rightarrow e^+ e^-\ e^+ e^-$	2	$E0\ \pi^0 \rightarrow e^+ e^-\ e^+ e^-$
13	63.440000	$K^+ \rightarrow \mu^+ \nu_\mu$	0	$\tilde{W}0\ K^+ \rightarrow \mu^+ \nu_\mu$
14	20.920000	$K^+ \rightarrow \pi^+ \pi^0$	0	$\tilde{W}0\ K^+ \rightarrow \pi^+ \pi^0$
15	5.590000	$K^+ \rightarrow \pi^+ \pi^+ \pi^-$	0	$\tilde{W}1\ K^+ \rightarrow \pi^+ \pi^+ \pi^-$
16	4.980000	$K^+ \rightarrow \pi^0 e^+ \nu_e$	*0	$\tilde{W}1\ K^+ \rightarrow \pi^0 e^+ \tilde{\nu}_e$
17	1.757000	$K^+ \rightarrow \pi^+ \pi^0 \pi^0$	0	$\tilde{W}1\ K^+ \rightarrow \pi^+ \pi^0 \pi^0$
18	.620000	$K^+ \rightarrow \mu^+ \nu_\mu \gamma$	0	$\tilde{W}1\ K^+ \rightarrow \mu^+ \nu_\mu \gamma$
19	.001600	$K^+ \rightarrow e^+ \nu_e$	*0	$\tilde{W}0\ K^+ \rightarrow e^+ \tilde{\nu}_e$
20	.001520	$K^+ \rightarrow e^+ \nu_e \gamma$	*0	$\tilde{W}1\ K^+ \rightarrow e^+ \tilde{\nu}_e \gamma$
21	69.200000	$K_S{}^0 \rightarrow \pi^+ \pi^-$	0	$\tilde{W}0\ K^0 \rightarrow \pi^+ \pi^-$
22	30.690000	$K_S{}^0 \rightarrow \pi^0 \pi^0$	0	$\tilde{W}0\ K^0 \rightarrow \pi^0 \pi^0$
23	.179000	$K_S{}^0 \rightarrow \pi^+ \pi^- \gamma$	0	$\tilde{W}1\ K^0 \rightarrow \pi^+ \pi^- \gamma$
24	.070400	$K_S{}^0 \rightarrow \pi^+ e^- \tilde{\nu}_e$	*0	$\tilde{W}1\ K^0 \rightarrow \pi^+ e^- \nu_e$
25	.070400	$K_S{}^0 \rightarrow \pi^- e^+ \nu_e$	*0	$\tilde{W}1\ K^0 \rightarrow \pi^- e^+ \tilde{\nu}_e$
26	.046900	$K_S{}^0 \rightarrow \pi^+ \mu^- \tilde{\nu}_\mu$	0	$\tilde{W}1\ K^0 \rightarrow \pi^+ \mu^- \tilde{\nu}_\mu$
27	.046900	$K_S{}^0 \rightarrow \pi^- \mu^+ \nu_\mu$	0	$\tilde{W}1\ K^0 \rightarrow \pi^- \mu^+ \nu_\mu$
28	.004690	$K_S{}^0 \rightarrow \pi^+ \pi^- e^+ e^-$	1	$\tilde{W}1\ K^0 \rightarrow \pi^+ \pi^- e^+ e^-$
29	.000271	$K_S{}^0 \rightarrow \gamma\, \gamma$	0	$\tilde{W}0\ K^0 \rightarrow \gamma\, \gamma$
30	.000035	$K_S{}^0 \rightarrow \pi^+ \pi^- \pi^0$	0	$\tilde{W}1\ K^0 \rightarrow \pi^+ \pi^- \pi^0$
31	.000005	$K_S{}^0 \rightarrow \pi^0 \gamma\ \gamma$	0	$\tilde{W}1\ K^0 \rightarrow \pi^0\ \gamma\ \gamma$
32	20.280000	$K_L{}^0 \rightarrow \pi^+ e^- \tilde{\nu}_e$	*0	$\tilde{W}1\ K^0 \rightarrow \pi^+ e^- \nu_e$
33	20.280000	$K_L{}^0 \rightarrow \pi^- e^+ \nu_e$	*0	$\tilde{W}1\ K^0 \rightarrow \pi^- e^+ \tilde{\nu}_e$
34	13.502000	$K_L{}^0 \rightarrow \pi^+ \mu^- \tilde{\nu}_\mu$	0	$\tilde{W}1\ K^0 \rightarrow \pi^+ \mu^- \tilde{\nu}_\mu$
35	13.502000	$K_L{}^0 \rightarrow \pi^- \mu^+ \nu_\mu$	0	$\tilde{W}1\ K^0 \rightarrow \pi^- \mu^+ \nu_\mu$
36	19.510000	$K_L{}^0 \rightarrow \pi^0 \pi^0 \pi^0$	0	$\tilde{W}1\ K^0 \rightarrow \pi^0 \pi^0 \pi^0$
37	12.540000	$K_L{}^0 \rightarrow \pi^+ \pi^- \pi^0$	0	$\tilde{W}1\ K^0 \rightarrow \pi^+ \pi^- \pi^0$

No.	Br. ratio %	Classical scheme	ΔN	4C scheme
38	.196600	$K_L^0 \to \pi^+ \pi^-$	0	$\tilde{W}0\ K^0 \to \pi^+ \pi^-$
39	.086400	$K_L^0 \to \pi^0 \pi^0$	0	$\tilde{W}0\ K^0 \to \pi^0 \pi^0$
40	.190000	$K_L^0 \to \pi^+ e^- \tilde{\nu}_e \gamma$	*0	$\tilde{W}2\ K^0 \to \pi^+ e^- \nu_e \gamma$
41	.190000	$K_L^0 \to \pi^- e^+ \nu_e \gamma$	*0	$\tilde{W}2\ K^0 \to \pi^- e^+ \tilde{\nu}_e \gamma$
42	.028200	$K_L^0 \to \pi^+ \mu^- \tilde{\nu}_\mu \gamma$	0	$\tilde{W}2\ K^0 \to \pi^+ \mu^- \tilde{\nu}_\mu \gamma$
43	.028200	$K_L^0 \to \pi^- \mu^+ \nu_\mu \gamma$	0	$\tilde{W}2\ K^0 \to \pi^- \mu^+ \nu_\mu \gamma$
44	.002600	$K_L^0 \to \pi^0 \pi^+ e^- \tilde{\nu}_e$	*0	$\tilde{W}2\ K^0 \to \pi^0 \pi^+ e^- \nu_e$
45	.002600	$K_L^0 \to \pi^0 \pi^- e^+ \nu_e$	*0	$\tilde{W}2\ K^0 \to \pi^0 \pi^- e^+ \tilde{\nu}_e$
46	67.800000	$\Omega^- \to \Lambda K^-$	0	$W0\ \Omega^- \to \Lambda K^-$
47	23.600000	$\Omega^- \to \Xi^0 \pi^-$	0	$W0\ \Omega^- \to \Xi^0 \pi^-$
48	8.600000	$\Omega^- \to \Xi^- \pi^0$	0	$W0\ \Omega^- \to \Xi^- \pi^0$
49	0.560000	$\Omega^- \to \Xi^0 e^- \tilde{\nu}_e$	*0	$W1\ \Omega^- \to \Xi^0 e^- \nu_e$
50	0.043000	$\Omega^- \to \Xi^- \pi^+ \pi^-$	0	$W1\ \Omega^- \to \Xi^- \pi^+ \pi^-$
51	99.887000	$\Xi^- \to \Lambda \pi^-$	0	$W0\ \Xi^- \to \Lambda \pi^-$
52	0.056300	$\Xi^- \to \Lambda e^- \tilde{\nu}_e$	*0	$W1\ \Xi^- \to \Lambda e^- \nu_e$
53	0.035000	$\Xi^- \to \Lambda \mu^- \tilde{\nu}_\mu$	0	$W1\ \Xi^- \to \Lambda \mu^- \tilde{\nu}_\mu$
54	0.012700	$\Xi^- \to \Sigma^- \gamma$	0	$W0\ \Xi^- \to \Sigma^- \gamma$
55	0.008700	$\Xi^- \to \Sigma^0 e^- \tilde{\nu}_e$	*0	$W1\ \Xi^- \to \Sigma^0 e^- \nu_e$
56	99.523000	$\Xi^0 \to \Lambda \pi^0$	0	$W0\ \Xi^0 \to \Lambda \pi^0$
57	0.333000	$\Xi^0 \to \Sigma^0 \gamma$	0	$W0\ \Xi^0 \to \Sigma^0 \gamma$
58	0.117000	$\Xi^0 \to \Lambda \gamma$	0	$W0\ \Xi^0 \to \Lambda \gamma$
59	0.027000	$\Xi^0 \to \Sigma^+ e^- \tilde{\nu}_e$	*0	$W1\ \Xi^0 \to \Sigma^+ e^- \nu_e$
60	0.000490	$\Xi^0 \to \Sigma^+ \mu^- \tilde{\nu}_\mu$	0	$W1\ \Xi^0 \to \Sigma^+ \mu^- \tilde{\nu}_\mu$
61	51.570000	$\Sigma^+ \to p \pi^0$	0	$W0\ \Sigma^+ \to p \pi^0$
62	48.310000	$\Sigma^+ \to n \pi^+$	0	$W0\ \Sigma^+ \to n \pi^+$
63	0.123000	$\Sigma^+ \to p \gamma$	0	$W0\ \Sigma^+ \to p \gamma$
64	0.045000	$\Sigma^+ \to n \pi^+ \gamma$	0	$W1\ \Sigma^+ \to n \pi^+ \gamma$
65	0.002000	$\Sigma^+ \to \Lambda e^+ \nu_e$	0	$W1\ \Sigma^+ \to \Lambda e^+ \nu_e$
66	99.500000	$\Sigma^0 \to \Lambda \gamma$	0	$E0\ \Sigma^0 \to \Lambda \gamma$
67	0.500000	$\Sigma^0 \to \Lambda e^+ e^-$	1	$E0\ \Sigma^0 \to \Lambda e^+ e^-$
68	99.848000	$\Sigma^- \to n \pi^-$	0	$W0\ \Sigma^- \to n \pi^-$
69	0.101700	$\Sigma^- \to n e^- \tilde{\nu}_e$	*0	$W1\ \Sigma^- \to n e^- \nu_e$
70	0.046000	$\Sigma^- \to n \pi^- \gamma$	0	$W1\ \Sigma^- \to n \pi^- \gamma$
71	0.045000	$\Sigma^- \to n \mu^- \tilde{\nu}_\mu$	0	$W1\ \Sigma^- \to n \mu^- \tilde{\nu}_\mu$
72	0.005730	$\Sigma^- \to \Lambda e^- \tilde{\nu}_e$	0	$\tilde{W}1\ \Sigma^- \to \Lambda e^- \tilde{\nu}_e$
73	63.900000	$\Lambda \to p \pi^-$	0	$W0\ \Lambda \to p \pi^-$
74	35.800000	$\Lambda \to n \pi^0$	0	$W0\ \Lambda \to n \pi^0$
75	0.175000	$\Lambda \to n \gamma$	0	$W0\ \Lambda \to n \gamma$
76	0.084000	$\Lambda \to p \pi^- \gamma$	0	$W1\ \Lambda \to p \pi^- \gamma$
77	0.083200	$\Lambda \to p e^- \tilde{\nu}_e$	*0	$W1\ \Lambda \to p e^- \nu_e$
78	0.015700	$\Lambda \to p \mu^- \tilde{\nu}_\mu$	0	$W1\ \Lambda \to p \mu^- \tilde{\nu}_\mu$
79	99.310000	$n \to p e^- \tilde{\nu}_e$	0	$\tilde{W}1\ n \to p e^- \tilde{\nu}_e$
80	0.690000	$n \to p e^- \tilde{\nu}_e \gamma$	0	$\tilde{W}2\ n \to p e^- \tilde{\nu}_e \gamma$

The right side of Table 2 presents the interpretation of the decay schemes in terms of this new Four-component (or 4C) Model. Here *W1* stands for *W E*, $\tilde{W}2$ for $\tilde{W}$ *E E*, etc. The quantity ΔN

is defined as $N_R - N_L$, where N_R is the number of particles at the right, and N_L at the left side of the scheme. The correspondent compositions of individual particles are not shown in Table 2 since they can be easily checked with the help of Table 1, as seen from the following example:

$$\begin{array}{cccccc} \tilde{W} & E & n \;\rightarrow & p & e^{-} & \tilde{\nu}_e \end{array}$$

$$[0202]+[1111]+[3021]=[3111]+[0011]+[1212]. \qquad (4)$$

Table 1 does not contain the compositions of particles with s=2, β=±1 and s=4, β=±1 because no assignment to any known particle was found for them.

4. Affinity with the quark model

Some similarities between the two models can be seen at the first glance. In both of them mesons are composed of two fermions (quarks or pairs of components) and baryons of three such fermions. It is not possible to link individual pairs of components of the 4C model with individual quarks because the values of their individual quantities (like electric charge, baryon number, strangeness, etc.) are different. However, individual light quarks d, u, s and their antiquarks $\tilde{d}, \tilde{u}, \tilde{s}$ can be expressed as linear combinations of the 4C model components:

$$\begin{aligned} d &= A - \tfrac{1}{3} B + C + \tfrac{1}{3} D \\ u &= A + \tfrac{2}{3} B + \tfrac{1}{3} D \\ s &= \tfrac{2}{3} B + 4/3\, D \\ \tilde{d} &= 4/3\, B + \tfrac{2}{3} D \\ \tilde{u} &= \tfrac{1}{3} B + C + \tfrac{2}{3} D \\ \tilde{s} &= A + \tfrac{1}{3} B + C - \tfrac{1}{3} D. \end{aligned} \qquad (5)$$

With the help of these equations the quark compositions of all seven mesons, nine baryons, and eight antibaryons listed in Table 1 can be transformed to their correspondent 4C compositions as listed in the same table. As an example, for the proton one gets:

$$p \equiv u+u+d = 2(A+\tfrac{2}{3} B+\tfrac{1}{3} D) + A-\tfrac{1}{3} B+C+\tfrac{1}{3} D = 3A+B+C+D \equiv [3111]. \qquad (6)$$

The inverse transformation is likewise possible:

$$\begin{aligned} A &= u - \tfrac{1}{2} \tilde{d} \\ B &= \tilde{d} - \tfrac{1}{2} s \\ C &= \tilde{u} - \tfrac{1}{2} s \\ D &= s - \tfrac{1}{2} \tilde{d} \end{aligned} \qquad (7)$$

but the expressions in eq. (7) are not unique due to the fact that the 4C compositions of the six quarks are not independent quantities; they are interrelated by the formula

$$d+\tilde{d} = u+\tilde{u} = s+\tilde{s} = A+B+C+D \equiv [1111]. \qquad (8)$$

With the help of eq. (7) and (8) the quark compositions of mesons and baryons can be obtained from the 4C model compositions. The equations (5) and (7) transform also correctly the correspondent properties (flavors) of quarks (±⅓ and ±⅔ charges) to those of the 4C components (±½ charges) and vice versa.

By means of the transformation (7) also the composition of leptons can be expressed in terms of the quark model. The following are the simplest examples:

$$
\begin{aligned}
e^{+} &\equiv [1100] \equiv A + B = u + \tfrac{1}{2}\,\tilde{d} - \tfrac{1}{2}\,s \\
e^{-} &\equiv [0011] \equiv C + D = \tilde{u} - \tfrac{1}{2}\,\tilde{d} + \tfrac{1}{2}\,s \qquad (9)\\
\nu_{\mu} &\equiv [1010] \equiv A + C = \tfrac{1}{2}\,d + \tfrac{1}{2}\,\tilde{s} \\
\tilde{\nu}_{\mu} &\equiv [0101] \equiv B + D = \tfrac{1}{2}\,\tilde{d} + \tfrac{1}{2}\,s.
\end{aligned}
$$

This can be regarded as an attempt of a formal generalization of the quark model.

5. The particle – antiparticle inversion

Initially the electric charge inversion [*abcd*] ↔ [*dcba*], the baryonic inversion [*abcd*] ↔ [*badc*], and the combined inversion [*abcd*] ↔ [*cdab*] were under consideration. From the quark model, however, a different inversion emerged, namely

$$[abcd] \leftrightarrow [\tfrac{1}{2}s-a, \tfrac{1}{2}s-b, \tfrac{1}{2}s-c, \tfrac{1}{2}s-d], \qquad (10)$$

where s is the total number of components of the particle. For leptons and mesons this inversion is equivalent to the electric charge inversion but for baryons the difference is profound.

This new kind of inversion can be understood in terms of the 4C model only by concluding that the two charges (electric and baryonic) are not the only properties of the four components and that at least one more "charge" has to be ascribed to them. A straightforward candidate is the property (flavor) of strangeness which characterizes the s and $\tilde{s}$ quarks. From eq. (7) the following values of strangeness S of the 4C components can be easily obtained:

$$S_A = 0,\ \ S_B = \tfrac{1}{2},\ \ S_C = \tfrac{1}{2},\ \ S_D = -1, \qquad (11)$$

hence the strangeness of a particle is:

$$S = \tfrac{1}{2}\,b + \tfrac{1}{2}\,c - d \qquad (12)$$

In a similar way the quark flavor I_z (the isospin z-component) can be viewed as a "charge" of the fundamental 4C components with the values:

$$I_{z\,A} = \tfrac{1}{4},\quad I_{z\,B} = \tfrac{1}{2},\quad I_{z\,C} = -\tfrac{1}{2},\quad I_{z\,D} = -\tfrac{1}{4}, \qquad (13)$$

and the I_z of a particle is thus:

$$I_z = \tfrac{1}{4}\,a + \tfrac{1}{2}\,b - \tfrac{1}{2}\,c - \tfrac{1}{4}\,d. \qquad (14)$$

In the proper particle – antiparticle inversion all charges change their signs while their absolute values remain unchanged. The addition of the values of S according to eq. (11) and the values of I_z according to eq. (13) to the characteristics of the 4C components leads to the necessity of the inversion from eq. (10) which was applied in Table 1. This is due to the fact that $S_A + S_B + S_C + S_D = 0$ (and similarly for Q, B, and I_z), hence every entity of the form [*xxxx*] for arbitrary *x* has all its charges equal to zero, and that the sum of the compositions of a particle and its antiparticle is such an entity: [*abcd*] + [½*s*–*a*,½*s*–*b*,½*s*–*c*,½*s*–*d*] = [½*s*,½*s*,½*s*,½*s*]. It is also worth noticing that two particles with compositions [*abcd*] and [*a*+*x*, *b*+*x*, *c*+*x*, *d*+*x*] have the same values of all their charges.

Are strangeness and the isospin z-component the only charges which have to be added as properties of the 4C components? Maybe there exist some others? Let us assume tentatively that also the quark $\tilde{d}$ has a specific property D which perhaps has to be taken into account. From eq. (7) we obtain for the 4C components the following values of it:

$$D_A = -½,\ \ D_B = 1,\ \ D_C = 0,\ \ D_D = -½. \tag{15}$$

Let us, moreover, introduce tentatively a "charge" C (not to be mixed-up with the charm flavor) with the values:

$$C_A = ½,\ \ C_B = -½,\ \ C_C = ½,\ \ C_D = -½. \tag{16}$$

Since these "charges" also meet the condition

$$X_A + X_B + X_C + X_D = 0, \tag{17}$$

their addition does not affect the applied inversion. The conservation law of eq.(2) grants also automatically the conservation of all charges which meet the condition (17), even if they have no physical meaning, since they are linear combinations of the number of the four fundamental components. The isospin I, however, does not fulfill this condition and therefore it cannot be regarded as a valid "charge" and hence its conservation is not granted.

It is worth noticing that only three "charges" Q, B, and C are independent quantities. All others, especially D, S, and I_z can be expressed as linear combinations of them:

$$\begin{aligned} D &= ½\,Q - B - ½\,C \\ S &= ½\,Q - B + ½\,C \\ I_z &= ¾\,Q - ¼\,C. \end{aligned} \tag{18}$$

From the last two equations the well-known formula

$$Q = I_z + ½\,(\,B + S\,) \tag{19}$$

can be obtained.

In addition to the notation [*abcd*] which reflects the 4C composition of a particle, let us introduce the notation {$Q\ B\ C\ D\ S\ I_z$} which reflects its interaction characteristics. In this notations the four fundamental 4C components can be expressed as:

$$
\begin{aligned}
A &\equiv [1000] = \{\ \tfrac12\ \ \tfrac12\ \ \tfrac12\ -\tfrac12\ \ 0\ \ \tfrac14\} \\
B &\equiv [0100] = \{\ \tfrac12\ -\tfrac12\ -\tfrac12\ \ 1\ \ \tfrac12\ \ \tfrac12\} \\
C &\equiv [0010] = \{-\tfrac12\ -\tfrac12\ \ \tfrac12\ \ 0\ \ \tfrac12\ -\tfrac12\} \\
D &\equiv [0001] = \{-\tfrac12\ \ \tfrac12\ -\tfrac12\ -\tfrac12\ -1\ -\tfrac14\}.
\end{aligned}
\tag{20}
$$

6. The structure of particles

The application of the inversion found leads to important consequences. First of all, individual 4C components do not have individual anti-components. Moreover, not all combinations of components have their anti-combinations. This limitation may be essential for the study of the structure of particles in the 4C model. One has to search for combinations of components which are invertible, i.e. which have their anti-combinations with all charges of the same absolute value but of the opposite sign. The results of such a search, i.e. the simplest invertible groups of components found are the following:

$$
\begin{aligned}
\boldsymbol{c} &\equiv CD \equiv [0011] = \{-1\ \ 0\ \ 0\ -\tfrac12\ -\tfrac12\ -\tfrac34\} \\
\tilde{\boldsymbol{c}} &\equiv AB \equiv [1100] = \{\ 1\ \ 0\ \ 0\ \ \tfrac12\ \ \tfrac12\ \ \tfrac34\} \\
\boldsymbol{n} &\equiv BD \equiv [0101] = \{\ 0\ \ 0\ -1\ \ \tfrac12\ -\tfrac12\ \ \tfrac14\} \\
\tilde{\boldsymbol{n}} &\equiv AC \equiv [1010] = \{\ 0\ \ 0\ \ 1\ -\tfrac12\ \ \tfrac12\ -\tfrac14\} \\
\boldsymbol{b} &\equiv AD \equiv [1001] = \{\ 0\ \ 1\ \ 0\ -1\ -1\ \ 0\} \\
\tilde{\boldsymbol{b}} &\equiv BC \equiv [0110] = \{\ 0\ -1\ \ 0\ \ 1\ \ 1\ \ 0\}.
\end{aligned}
\tag{21}
$$

The obtained set consists of three fermions and their anti-fermions. One can introduce their identification as $\boldsymbol{c}, \tilde{\boldsymbol{c}}$ (charged), $\boldsymbol{n}, \tilde{\boldsymbol{n}}$ (neutral), and $\boldsymbol{b}, \tilde{\boldsymbol{b}}$ (baryonic). They are pairs of the four fundamental components. There exist four other pairs of fundamental components, namely *AA*, *BB*, *CC*, and *DD*, but they are not invertible in the above-given sense. Some similarity with the quark composition exists. Mesons consist of two such pairs and baryons of three of them. The pair- (*pp*) and quark- (*qq*) compositions of the "ordinary" particles with the sets of their "charges" are shown in Table 3.

Table 3. The composition of particles presented as a set of invertible pairs of the fundamental 4C components (*pp*). The quark composition (*qq*) is also shown. For hadrons the values of "charges" are the same for both *qq* and *pp* compositions.

No.	P.	*pp*	*qq*	$Q\ B\ C\ D\ S\ I_z$	Ap.	*pp*	*qq*	$Q\ B\ C\ D\ S\ I_z$
1	$\tilde{\nu}_\mu$	$\boldsymbol{n}$		0 0 –1 ½ –½ ¼	ν_μ	$\tilde{\boldsymbol{n}}$		0 0 1 –½ ½ –¼
2	e^-	$\boldsymbol{c}$		–1 0 0 –½ –½ –¾	e^+	$\tilde{\boldsymbol{c}}$		1 0 0 ½ ½ ¾
3	π^0	$\boldsymbol{n}\tilde{\boldsymbol{n}}$	$u\tilde{u}$	0 0 0 0 0 0	γ, E	$\tilde{\boldsymbol{n}}\boldsymbol{n}$	$\tilde{u}u$	0 0 0 0 0 0
4	π^-	$\boldsymbol{c}\tilde{\boldsymbol{n}}$	$\tilde{u}d$	–1 0 1 –1 0 –1	π^+	$\tilde{\boldsymbol{c}}\boldsymbol{n}$	$u\tilde{d}$	1 0 –1 1 0 1

5	K^-	***cn***	*ũs*	–1 0 –1 0 –1 –½	K^+	***c̃ñ***	*us̃*	1 0 1 0 1 ½
6	$\tilde{K}^0,\tilde{W}$	***nn***	*d̃s*	0 0 –2 1 –1 ½	K^0,W	***ññ***	*ds̃*	0 0 2 –1 1 –½
7	$\tilde{\nu}_e$	***nnñ***		0 0 –1 ½ –½ ¼	ν_e	***ññn***		0 0 1 –½ ½ –¼
8	$\tilde{\nu}_\tau$	***nnn***		0 0 –3 3/2 –3/2 ¾	ν_τ	***ñññ***		0 0 3 –3/2 3/2 –¾
9	μ^-	***cññ***		–1 0 2 –3/2 ½ –5/4	μ^+	***c̃nn***		1 0 –2 3/2 –½ 5/4
10		***cnñ***		–1 0 0 –½ –½ –¾		***c̃ñn***		1 0 0 ½ ½ ¾
11	τ^-	***cnn***		–1 0 –2 ½ –3/2 –¼	τ^+	***c̃ññ***		1 0 2 –½ 3/2 ¼
12	*p*	***bc̃ñ***	*uud*	1 1 1 –1 0 ½	$\tilde{p}$	***b̃cn***	*ũũd̃*	–1 –1 –1 1 0 –½
13	*n*	***bññ***	*udd*	0 1 2 –2 0 –½	$\tilde{n}$	***b̃nn***	*ũd̃d̃*	0 –1 –2 2 0 ½
14	Λ	***bnñ***	*uds*	0 1 0 –1 –1 0	$\tilde{\Lambda}$	***b̃ñn***	*ũd̃s̃*	0 –1 0 1 1 0
15	Σ^+	***bc̃n***	*uus*	1 1 –1 0 –1 1	$\tilde{\Sigma}^-$	***b̃cñ***	*ũũs̃*	–1 –1 1 0 1 –1
16	Σ^0	***bnñ***	*uds*	0 1 0 –1 –1 0	$\tilde{\Sigma}^0$	***b̃ñn***	*ũd̃s̃*	0 –1 0 1 1 0
17	Σ^-	***bcñ***	*dds*	–1 1 1 –2 –1 –1	$\tilde{\Sigma}^+$	***b̃c̃n***	*d̃d̃s̃*	1 –1 –1 2 1 1
18	Ξ^0	***bnn***	*uss*	0 1 –2 0 –2 ½	$\tilde{\Xi}^0$	***b̃ññ***	*ũs̃s̃*	0 –1 2 0 2 –½
19	Ξ^-	***bcn***	*dss*	–1 1 –1 –1 –2 –½	$\tilde{\Xi}^+$	***b̃c̃ñ***	*d̃s̃s̃*	1 –1 1 1 2 ½
20	Ω^-	*DD**nn***	*sss*	–1 1 –3 0 –3 0	$\tilde{\Omega}^+$		*s̃s̃s̃*	1 –1 3 0 3 0

7. Predictions of the model and supplementary rules

The next step was the investigation of the predictions of the 4C model. With the compositions of particles according to Table 1 and with the known masses of particles used as input data one can get a list of all decays consistent with the conservation law (2). At the first glimpse the result appears to be discouraging since the model permits much more decay modes than desired. Evidently, the introduction of some additional limiting rules is necessary. Looking closer at the really existent decay modes some of such rules can be easily seen. Let them discuss shortly below.

a) First of all, the fast electromagnetic and strong processes initiated by the capture of *E, EE,* etc. have to be limited by a rule that the *E* boson cannot split arbitrarily and pass its components to other particles but can only produce a gamma-ray (or a π^0 if the energy is sufficient), or (less probably) an e^+e^- pair. Hence, electromagnetic processes are apparently limited to transitions between systems with the same composition, or, in other words, to transitions between different mass states of the same system. This applies only to such schemes as $E\ \pi^0 \to \gamma\ \gamma$; $E\ \pi^0 \to \gamma\ e^+e^-$; $E\ \Sigma^0 \to \Lambda\ \gamma$; $E\ \Sigma^0 \to \Lambda\ e^+\ e^-$;

$E\,(e^+e^-) \rightarrow \gamma\,\gamma$; $E\,E(e^+e^-) \rightarrow \gamma\,\gamma\,\gamma$. In strong decays the *E* bosons can pass their components to other hadrons but apparently never to neutrinos.

b) For the weak decays a similar rule seems to be appropriate. Apparently gamma-rays cannot be formed out of the components of the decaying particle but rather only from the components of the background bosons which entered the process, preferably from the components of the *E* boson.

c) It can be seen that most probable are decays for which $\Delta N = 0$. With increasing ΔN the decay rates rapidly decrease.

Further development of this model may lead to more precise and straightforward limiting rules formulated in terms of the components and their mechanisms of regrouping. Together with the multiplicative conservation laws they shall provide the appropriate selection.

Generally speaking, no serious obstacles were found which could endanger the validity of the law of conservation of the four fundamental 4C components. Some detailed questions are addressed in the sections below.

8. Some general questions

a) At the first glimpse it seems impossible to accept the idea that the pairs $\boldsymbol{c}$, $\tilde{\boldsymbol{c}}$ and $\boldsymbol{n}$, $\tilde{\boldsymbol{n}}$ are the constituents of both the light particles like electrons and neutrinos, and the heavy ones like mesons and hadrons. It could be understood, however, if one would assume that this entities exist at least in two different mass states: i) the light or "leptonic" state, and ii) the heavy or "hadronic" state. It can be imagined that in the low-mass state the two components of the pair are less compact (of some 2.8 fm diameter) and therefore outside of the range of the strong forces, with only the electric, and perhaps the baryonic charges active or "switched on". In the massive state, on the other hand, components are more compressed and therefore (at a diameter of less than 1.5 fm) within the range of the strong forces, where also the other charges like strangeness (and maybe some others) are active or "switched on". In other words, one can imagine that the potential between the two components of a pair has two local minima, one lower at larger distance, and the second, much higher one at a smaller distance.

b) If the invertible pairs of components exist in more than one mass state, as suggested above in a), then a large portion of particle decays could be viewed as transitions between the hadronic and the leptonic states of some of the pairs participating in the particular decay. This process, however, cannot apparently be caused by the absorption of the *E* bosons alone. Supposedly, a W or $\tilde{W}$ boson is necessary to trigger such a process by playing the role of an "intermediate boson". On the other hand, production of heavy particles in collisions would consist essentially of pumping energy into the pairs of components by squeezing them to a smaller size. Hence, matter could be viewed as a huge deposit of explosives. Fortunately, we lack fuses necessary to blow them up.

c) In Table 2 the most straightforward conclusion from the obtained results is drawn, that namely in the correspondent decays (marked by an asterisk) indeed an interchange of the identity of neutrinos takes place. But this may not necessarily be the only explanation. Another possibility would be that the W or $\tilde{W}$ boson, the absorption of which triggers the decay process, plays in some cases only the role of a catalyst for the E boson to disintegrate and to pass its components to the resultant particles. Hence, some of the decays may possibly take the form e.g. $W\,E\,\pi^- \rightarrow \mu^-\ \tilde{\nu}_\mu\ W$ instead of $W\,\pi^- \rightarrow \mu^-\ \nu_\mu$ as assumed in Table 2. The same mechanism could also explain or even be necessary in order to explain some decay modes of some of the charmed hadrons.

d) The *pp* composition of the entity [1111] is not unique; it can be expressed as ***nñ*** or as ***cc̃***, or even as ***bb̃***. This has to be taken into account in the study of the structure of such particles as π^0, γ, E, ν_e , $\tilde{\nu}_e$, Λ , $\tilde{\Lambda}$, Σ^0 , and $\tilde{\Sigma}^0$. This ambiguity may also be a clue to the explanation of the existence of the $I_z = Q = S = 0$ singlet resonances η and η'(958) and their excited quantum states. It can also be one of possible explanations of the difference between Σ^0 and Λ hyperons which have the same 4C (as well as the $q\tilde{q}$) composition.

e) There exist some affinity between two particles the composition of which differs by the entity [1111]. Since all charges of this entity are equal to zero, both such particles have the same set of charges. This affinity exists particularly for such pairs of particles as $\nu_e\ \nu_\mu$, $\tilde{\nu}_e\ \tilde{\nu}_\mu$, $e^+\ x^+$, and $e^-\ x^-$, where x^+ and x^- denote the “missing” leptons from row 10 of Table 3. Remarkably, the same affinity applies to individual non-invertible pairs of components and individual baryons (or antibaryons). In particular, $AA \equiv$ [2000] corresponds to [3111] which is the proton, BB to $\tilde{\Sigma}^+$, CC to $\tilde{\Sigma}^-$, and DD to Ξ^- . The practical meaning of this affinity is yet to be found out.

f) The examination of the decay schemes of particles with non-zero values of the flavors of charm and/or bottomness indicates that unlike the flavors of S and I_z it is not possible to interpret these flavors as “charges” of the 4C components, neither can the heavy quarks unlike the light ones be expressed as linear combinations of the 4C components. Instead, the compositions of the charmed and bottomed particles seem to resemble the compositions of appropriate ordinary mesons and baryons, respectively. Particularly, the compositions of D’s resemble that of the pions, the D_s’s the kaons, Λ_c^+ the proton, Ξ_c’s the Σ’s, and Ω_c^0 the Ξ^0. This means that from the viewpoint of the 4C model the existence of those massive particles does not require the introduction of any new entities but only some kind of modification of the ordinary ones. One possible approach could be the expression of the compositions of these particles by means of the baryonic ($B = \pm1$) pairs of components only, i.e. instead of *AB BD* to assume *AD BB*; instead of *AB AC* to assume *AA BC*; instead of *AD AB AC* to assume *AD AA BC*, etc. This renders the possibility of having a number of yet another mass states without increasing the number of the existent compositions.

Another approach, maybe the most promising one, could be to assume the existence of yet one more massive state of the invertible pairs of components ***n***, ***ñ***, ***c***, ***c̃***, and perhaps also ***b***, ***b̃***, as suggested in the paragraph a) above. But if such states exist, why then these massive particles do not decay strongly into their lighter mass states? Again, because apparently for the transitions between different mass states of the same pair of components the absorption of a W or $\tilde{W}$ boson is needed in order to unlock them and to trigger the decay.

g) As seen from Table 3, the flavor I_z does not make sense for the leptons. The values of ±¼, ±¾, and $\pm^5/_4$ are evidently not useful for establishing the multiplets. For mesons and baryons listed in Table 3 the values of this quantity agree with the common expectations but in the 4C model these multiplets appear as a mere consequence of the compositions. As will be shown in the next section, there are also some other reasons for abandoning the quantity I_z . In the 4C model it seems to be redundant.

9. Differences between the quark and the 4C models

Although the 4C and the quark models are mathematically equivalent, they are not physically equivalent because the flavors or charges are distributed among the fermionic components of particles (pairs or quarks) differently. Hence, the two models cannot be regarded as mutually supplementary but rather as competing ones. Consequently, only one of them can be ultimately found valid. The verdict demands finding their differences and examining them experimentally. Let us have a closer look at some of them.

a) As seen from Table 1, there exists a legitimate 4C composition for the particle Ω^- [0204] but this composition is not invertible. First, because it contains the non-invertible pair *DD*, and second, because the resultant composition of its antiparticle $\tilde{\Omega}^+$ would be [3,1,3,–1] which is illegitimate because of the negative *d* value. The most straightforward conclusion would be that in the 4C model $\tilde{\Omega}^+$ does not exist. But perhaps one can guess that particles of such non-invertible compositions can absorb an E boson and hence appear instead as having the compositions [1315] and [4240], respectively. This $s = 10$ objects can be expressed as composed of five pairs ***bcnnn*** and ***b̃c̃ñññ***, respectively, and hence they would be invertible 4C particles, a baryon and an antibaryon.

b) From the quark model the existence of a ½$^+$ octet and a $^3/_2{}^+$ decuplet of baryons has been derived. Let us examine them from the viewpoint of the 4C model. Within the limits of $-1 \leq Q \leq 1$ for the electric charge we obtain the particles the compositions of which are listed at the right side of Table 1. Apart from the eight baryons of the octet there are four more charged particles, two baryons and two antibaryons. All they are non-invertible. One of them is Ω^- which we discussed in the paragraph a) above. The existence of Ω^- permits us to suppose that also the three others may exist. Among them the baryon [4020] is of particular interest. Let us call it tentatively X^+\{1 1 3 -2 1 0\}. Its strangeness is $S = +1$. The quark model does not predict its existence since its quark composition as derived from eq. (7) would be $2u + 2d - s$. The only possibility to explain its existence in the quark model would be to apply the procedure described in par. a) above (i.e. to let it absorb the E boson). Then we would have $(2u + 2d - s) + (s + \tilde{s}) = 2u + 2d + \tilde{s}$, i.e. a pentaquark $uudd\tilde{s}$.

c) The remaining two non-invertible particles in Table 1 are the antibaryons [0402] and [2040]. The first one appears to be a legitimate quark model antiparticle $\tilde{d}\tilde{d}\tilde{d}$ called $\tilde{\Delta}^+$. But, surprisingly, in the 4C model this particle is non-invertible, i.e. it does not have a regular antiparticle Δ^- (predicted by the quark model as ddd) because its composition would be [3–131]. Like $\tilde{\Omega}^+$ it could only exist as a penta-pair structure [4042] ≡ $\boldsymbol{bc\tilde{n}\tilde{n}\tilde{n}}$. The [2040] with strangeness +2 would have the quark composition $2\tilde{u} - d + 2\tilde{s}$ and hence could also exist only as a pentaquark $\tilde{u}\tilde{u}\tilde{d}\tilde{s}\tilde{s}$.

d) More differences between the predictions of the two models can be found among particles with multiple electric charges. The entire picture is shown in Table 4. At the left side of the particle symbol the status codes of this particle for both the 4C and the quark models are given. Their meaning is the following:

3 — a regular, ordinary, invertible particle predicted by the model in question.

2 — a non-invertible particle (applicable in the 4C model only).

1 — a particle which cannot exist according to the model in question, except as a penta-quark or penta-pair structure.

0 — a particle which does not belong to any of the previous classes.

In Table 4 names are given to all particles which are supposed to exist at least according to one of the two models.

Table 4. Status codes in the 4C and quark models and 4C compositions of $B = \pm 1$ baryons						
B	S	$Q = S - B$	$Q = S$	$Q = S + B$	$Q = S + 2B$	$Q = S + 3B$
+1	+1	11 □ 4–130	21 X^{+} 4020	21 X^{++} 4110	21 X^{+++} 4200	10 □ 43–10
–1	–1	11 □ –1403	11 □ –1313	11 □ –1223	11 □ –1133	10 □ –1043
+1	0	13 Δ^{-} 3–131	33 Δ^{0} 3021	33 Δ^{+} 3111	33 Δ^{++} 3201	11 □ 33–11
–1	0	23 $\tilde{\Delta}^{+}$ 0402	33 $\tilde{\Delta}^{0}$ 0312	33 $\tilde{\Delta}^{-}$ 0222	33 $\tilde{\Delta}^{--}$ 0132	21 $\tilde{\Delta}^{---}$ 0042
+1	–1	11 □ 2–132	33 Σ^{-} 2022	33 Σ^{0} 2112	33 Σ^{+} 2202	11 □ 23–12
–1	+1	21 $\tilde{\Sigma}^{++}$ 1401	33 $\tilde{\Sigma}^{+}$ 1311	33 $\tilde{\Sigma}^{0}$ 1221	33 $\tilde{\Sigma}^{-}$ 1131	21 $\tilde{\Sigma}^{--}$ 1041
+1	–2	10 □ 1–133	31 Ξ^{--} 1023	33 Ξ^{-} 1113	33 Ξ^{0} 1203	11 □ 13–13
–1	+2	20 $\tilde{\Xi}^{+++}$ 2400	31 $\tilde{\Xi}^{++}$ 2310	33 $\tilde{\Xi}^{+}$ 2220	33 $\tilde{\Xi}^{0}$ 2130	21 $\tilde{\Xi}^{-}$ 2040
+1	–3	10 □ 0–134	20 Ω^{---} 0024	21 Ω^{--} 0114	23 Ω^{-} 0204	11 □ 03–14
–1	+3	10 □ 340–1	10 □ 331–1	11 □ 322–1	13 $\tilde{\Omega}^{+}$ 313–1	11 □ 304–1

From among the particles with $Q = \pm 2$ especially Ξ^{--} and $\tilde{\Xi}^{++}$ seem to be suitable for proving the validity of the 4C model predictions. First, because they are void of the non-invertibility problem, and second, because in high energy collisions they shall be produced simultaneously.

e) There are also other differences which may be found useful. Unlike in the quark model, in the 4C model particles with $B = \pm 2$ composed of three of invertible pairs of components are legitimate entities. They are $\boldsymbol{bb\tilde{c}}$, $\boldsymbol{bbc}$, $\boldsymbol{bb\tilde{n}}$, $\boldsymbol{bbn}$, and their antiparticles are $\boldsymbol{\tilde{b}\tilde{b}c}$, $\boldsymbol{\tilde{b}\tilde{b}\tilde{c}}$, $\boldsymbol{\tilde{b}\tilde{b}n}$, and $\boldsymbol{\tilde{b}\tilde{b}\tilde{n}}$. In the 4C model also mesons with $B = \pm 1$ may exist. Their compositions would be $\boldsymbol{b\tilde{c}}$, $\boldsymbol{bc}$, $\boldsymbol{b\tilde{n}}$, $\boldsymbol{bn}$, and those of their antiparticles $\boldsymbol{\tilde{b}c}$, $\boldsymbol{\tilde{b}\tilde{c}}$, $\boldsymbol{\tilde{b}n}$, and $\boldsymbol{\tilde{b}\tilde{n}}$. In the quark model the Q and B values of similar particles would be fractional. These kinds of particles have their values of I_z equal to ±¼ and ±¾ which seems to support the view that the significance of this flavor is limited.

10. Some consequences

The presented model approximately correctly interprets the observed lifetimes of particles and the branching ratios of their decay modes. Decays of higher order are less probable and the probability decreases also rapidly with increasing ΔN. Whenever a large discrepancy is observed, the involvement of an additional rule can be expected. The stability of the proton is an obvious result of the conservation law (2).

This model seems to be a natural cure for the problems with the conservation laws in weak decays. Since the strangeness of the weak interaction field bosons W and $\tilde{W}$ is +1 and –1, respectively, the absorption of them in weak decays explains the seeming non-conservation of this flavor in them. Similarly also other problems with weak decays may be solved.

The field bosons E, W and $\tilde{W}$ are present with a certain density in "vacuum" or move with a certain velocity as a flux. The density or flux of the weak interaction bosons is roughly by ten orders of magnitude smaller than the density or flux of the E bosons. Since the speed of the decay processes increases with the increasing mass of the decaying particles, the conclusion that massive particles attract the field bosons seems to be justified. Since the density of the field bosons in the vicinity of a massive particle is higher, the probability of the capture of a boson by this particle is higher too, and therefore the lifetime of such a particle is shorter.

The dependence of the decay rates on the density of the field bosons may influence the results of the isotopic dating methods since this density may not necessarily be constant, especially in a long-range, cosmic time scale.

In this model the phenomenon of particle mixing is evidently not caused by the interactions of particles between themselves but rather by their interactions and exchange of components with the background bosons. Particularly, the mixing of K^0 and $\tilde{K}^0$ can be readily explained by the existence of an exchange reaction $\tilde{W} K^0 \rightarrow \tilde{K}^0 W$ or $W \tilde{K}^0 \rightarrow K^0 \tilde{W}$. Also the mixing among neutrinos can be explained by assuming the existence of interactions between them and the field bosons.

The extremely small absorption cross sections of neutrinos in matter can be easily explained by the necessity of a simultaneous capture of the W or $\tilde{W}$ boson (and in some cases also the E boson) in the process of their absorption. The tenet that the emission of a particle is equivalent to the absorption of its antiparticle is generally not consistent with the 4C model.

Since according to this model the decays are not "spontaneous" but are caused by the capture of the background boson(s), the acceptance of this model would necessitate a revision of some basic theoretical concepts. But for a real progress in our understanding of the fundamental structure of matter this seems to be not only acceptable but also highly desirable.

11. Conclusion

In the present early stage of development many unanswered questions and unaddressed issues remain. The 4C model is by now rather only a loose proposal or a very raw concept. But even at this stage its properties and possibilities seem to be remarkable and therefore certainly worth attention.

In order to fully evaluate the usefulness of it a great amount of investigation is necessary. Especially its ability to explain the observed masses of particles will be crucial.

This model was formulated by a physicist who is neither a theoretician nor a particle expert. Some general physical knowledge was sufficient for it. But such a knowledge is certainly not sufficient for a full evaluation of its usefulness and for its further development. This has to be done by the experts.

Acknowledgments

I highly appreciate the attentive support, fruitful suggestions and a constant encouragement of many of my colleagues from the two institutes of my previous work as well as from a number of other persons. I would like to express also my gratitude to my wife Emilia for her patience and support during my work at home and to our daughter and son-in-law Irena and Maciej Wilkosz for their improvement of my English and for their kind encouragement.

References

[1] W.-M. Yao et al. (Particle Data Group), J. Phys., G 33 (2006).

The first version of this paper was written and published in 2008.
The present second version was published in 2013.