Part IV

Simple Subatomic Model

1. Sub Chemistry—Six Building Blocks

The Standard Model of particle physics regards all the six known quarks and all the six known leptons as non-composite particles. Investigation of the subatomic data, ***with no a priori assumptions about the relevant dynamics,*** suggests that nine of these twelve fermions and their nine antiparticles are certain compositions of the other three fermions and their three antiparticles. The composite fermions are the five quarks other than the up-quark and the four leptons of the second and the third generations. The other three fermions and their three antiparticles are the **fundamental fermions**, they are: the up-quark, the up-antiquark, the electron, the positron, the electron-neutrino, and the electron-antineutrino.

Table 1 — the Fundamental Fermions

$$\begin{matrix} u & e^- & \nu_e \\ \bar{u} & e^+ & \bar{\nu}_e \end{matrix}$$

Table 2 — Designating the Fundamental Fermions by Indexes

$$\begin{matrix} f_1 & f_2 & f_3 \\ \bar{f}_1 & \bar{f}_2 & \bar{f}_3 \end{matrix}$$

Fundamental fermions are annihilated or produced only together with their antiparticles; unless annihilated, fundamental fermions are eternally stable.

Consequently, the following ultimate conservation rule holds true:

Conservation of Single Fundamental Fermions
In a closed system, the number of single fundamental fermions of each kind is conserved.

The number of single fundamental fermions of a certain kind in a system is the difference between the number of fundamental particle-constituents of that kind and the number of fundamental antiparticle-constituents of that kind: $\#si(f_i) = \# f_i - \# \bar{f}_i$

The conservation of baryon/lepton quantum-numbers is a direct consequence of the conservation of single fundamental fermions. Fundamental fermions and only fundamental fermions carry baryon/lepton quantum numbers. The up-quark and the up-antiquark, and only them, carry baryon quantum-number (one third and minus one third, respectively). The electron, the electron-neutrino, their antiparticles, and only them, carry electron-lepton quantum-number (plus one for the electron and for the electron-neutrino, minus one for the positron and for the electron-antineutrino). Three units of electron-lepton number in one lepton is one unit of muon-lepton number. Five units of electron-lepton number in one lepton is one unit of tau-lepton number. Consequently, the muon-lepton number and the tau-lepton number are not necessarily conserved in all reactions (see neutrino oscillations hereafter). Quark "flavor" quantum numbers (strangeness, charm, bottomness, and topness) are carried by certain combinations of fundamental pairs; these quantum numbers are not necessarily conserved in all reactions.

The conservation of electric charge is also a direct consequence of the conservation of single fundamental fermions. The up-quark, the up-antiquark, the electron, and the positron, and only them, are electrically charged. The up-quark and the up-antiquark carry electric charges of $2/3$ elementary unit and $-2/3$ elementary unit, respectively. The electron and the positron carry electric charges of -1 elementary unit and 1 elementary unit, respectively.

Let us apply the conservation of single fundamental fermions to the basic beta minus process: $d \rightarrow u + e^- + \overline{\nu}_e$

The products of this process are three single fundamental fermions; thus, these three fermions are necessarily the single fundamental constituents of the down-quark. Fundamental pairs can be additional constituents, that are annihilated during disintegration. Fundamental pair constituents, however, result in high instability, which is not the case for the down-quark, thus: [1]

$$d \equiv ue^-\overline{\nu}_e$$

In the beta plus process $u \rightarrow d + e^+ + \nu_e$ one single fundamental fermion is involved, an up-quark. This process is a fusion process which requires the production of two pairs: e^-e^+ and $\nu_e\overline{\nu}_e$. In terms of fundamental fermions:

$$u \rightarrow ue^-\overline{\nu}_e + e^+ + \nu_e$$

- Lepton fundamental pairs of zero lepton-number are constituents of all the composite quarks. Quarks fundamental pairs of zero baryon-number are constituents of all the composite leptons. The two kinds of fundamental pairs are the constituents of W-bosons. The view according to which the W-bosons, all the quarks, and all the leptons are non-composite particles is derived from the misleading "strong interaction" dynamics which spoils the interpretation of the subatomic observations.

- The fundamental constituents of composite quarks and of composite leptons interact only internally between themselves. This is the reason that the composite nature of composite quarks and of composite leptons cannot be experimentally demonstrated. However, any unstable massive particle is necessarily a composite particle no matter whether or not this can be experimentally demonstrated.

[1] Pairs of "sea quarks" result from the misleading "strong interaction" hypothesis; they do not exist.

It is convenient to describe the fundamental composition of sub-atomic particles by the Fundamental Fermions quasi tensor $\underset{\substack{i=1,2,3\\ j=1,2}}{F_{ij}}$. Each of the three columns F_i corresponds to one fundamental fermion, in the order given in Table 1. The first entry of the i_{th} column is the number of single fundamental fermions of the i_{th} kind: $F_{i1} = \# f_i - \# \bar{f}_i$

The second entry of the i_{th} column is the number of fundamental pairs of the i_{th} kind: $F_{i2} = \# pair_i = \dfrac{\# f_i + \# \bar{f}_i - \left|\# f_i - \# \bar{f}_i\right|}{2}$

The FF quasi tensors of the fundamental fermions are:

$$F(u) = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad F(e^-) = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad F(\nu_e) = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \end{pmatrix}$$

$$F(\bar{u}) = \begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad F(e^+) = \begin{pmatrix} 0 & -1 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad F(\bar{\nu}_e) = \begin{pmatrix} 0 & 0 & -1 \\ 0 & 0 & 0 \end{pmatrix}$$

The fundamental composition of hadrons is represented by detailed FF quasi tensors in which each quark is displayed separately, some examples:

$$F(p) = F(uud) = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 1 & 1 & -1 \\ 0 & 0 & 0 \end{pmatrix}$$

$$F(n) = F(udd) = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 1 & 1 & -1 \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 1 & 1 & -1 \\ 0 & 0 & 0 \end{pmatrix}$$

$$F(\pi^-) = F(\bar{u}d) = \begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 1 & 1 & -1 \\ 0 & 0 & 0 \end{pmatrix}$$

The fundamental compositions of composite quarks and of composite leptons are attained by applying the conservation of single fundamental fermions to observations. In each up-type quark there is one single fundamental fermion—an up-quark. In each down-type quark there are three single fundamental fermions: an up-quark, an electron, and an electron-antineutrino. In each second-generation lepton there are three single fundamental fermions: an electron and two electron-neutrinos in the muon, and three electron-neutrinos in the muon-neutrino (three units of electron-lepton number in one composite lepton are one unit of muon-lepton number). In each third-generation lepton there are five single fundamental fermions: an electron and four electron-neutrinos in the tauon, and five electron-neutrinos in the tau-neutrino (five units of electron-lepton number in one composite lepton are one unit of tau-lepton number). The other constituents of the composite quarks and of the composite leptons (not including the down-quark) are fundamental pairs. A modification of the Leptons-Quarks Symmetry associates a fourth generation up-type quark, the **awesome-quark**, to the currently known leptons and quarks. It is explained hereafter.

Table 3 — Compositions of Composite Quarks

$$F(c)=\begin{pmatrix}1 & 0 & 0\\ 2 & 1 & 1\end{pmatrix}\quad F(t)=\begin{pmatrix}1 & 0 & 0\\ 3 & 1 & 2\end{pmatrix}\quad F(a)=\begin{pmatrix}1 & 0 & 0\\ 4 & 1 & 3\end{pmatrix}$$

$$F(d)=\begin{pmatrix}1 & 1 & -1\\ 0 & 0 & 0\end{pmatrix}\quad F(s)=\begin{pmatrix}1 & 1 & -1\\ 1 & 0 & 1\end{pmatrix}\quad F(b)=\begin{pmatrix}1 & 1 & -1\\ 2 & 0 & 2\end{pmatrix}$$

Table 4 — Compositions of Composite Charged Leptons

$$F(\mu^-)=\begin{pmatrix}0 & 1 & 2\\ 1 & 0 & 0\end{pmatrix}\quad F(\tau^-)=\begin{pmatrix}0 & 1 & 4\\ 2 & 0 & 0\end{pmatrix}$$

Table 5 — Compositions of Composite Neutrinos

$$F(\nu_\mu)=\begin{pmatrix}0 & 0 & 3\\ 1 & 0 & 0\end{pmatrix}\quad F(\nu_\tau)=\begin{pmatrix}0 & 0 & 5\\ 2 & 0 & 0\end{pmatrix}$$

The content of the Leptons-Quarks Symmetry in the Standard Model is: To each pair of a charged lepton and its neutrino, there correspond the down-type quark and the up-type quark of their generation. This rule is modified:

Leptons-Quarks Modified Symmetry

To each neutrino there corresponds the charged lepton and the down-type quark of its generation and the up-type quark of the successive generation.

The electron-antineutrino and the electron first appear in the down and the charm quarks (1, 1, 2, 4 fundamental leptons correspondingly). To the muon-neutrino there correspond the muon, the strange-quark, and the top-quark (3, 3, 4, 6 fundamental leptons correspondingly). To the tau-neutrino there correspond the tauon, the bottom-quark, and the awesome-quark (5, 5, 6, 8 fundamental leptons correspondingly). All the sub-atomic particles involved in this symmetry have leptonic fundamental constituents. Up-quark, the fundamental quark, is "out of this game".

The rules that govern the compositions of quarks and leptons are introduced below. The index n denotes the generation.

Table 6 — Composition Rules of Quarks and Leptons

$$F(uptype_1) = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \qquad F(\underset{n\geq 2}{uptype_n}) = \begin{pmatrix} 1 & 0 & 0 \\ n & 1 & n-1 \end{pmatrix}$$

$$F(downtype_n) = \begin{pmatrix} 1 & 1 & -1 \\ n-1 & 0 & n-1 \end{pmatrix}$$

$$F(ch\arg lep_n) = \begin{pmatrix} 0 & 1 & 2n-2 \\ n-1 & 0 & 0 \end{pmatrix}$$

$$F(neutrino_n) = \begin{pmatrix} 0 & 0 & 2n-1 \\ n-1 & 0 & 0 \end{pmatrix}$$

The question of whether there are more than three generations of quarks and leptons should be answered experimentally. The hypothetical existence of fourth-generation fermions should not be a priori excluded. Hypothetical reactions whose products are fourth-generation leptons are introduced here after. The products of the meson composed of a bottom-quark and an up-antiquark are a charged-lepton of the fourth generation and its anti-neutrino (reaction 3 p.79). The products of the third "oscillation" of the electron-neutrino are a fourth-generation neutrino and two muon-antineutrinos (p.87). The products of the second "oscillation" of the muon-neutrino are a fourth-generation neutrino, one muon-antineutrino, and one electron-antineutrino (p.87). Subatomic Chemistry predicts also that a meson composed of a fourth-generation quark and its anti-particle can be annihilated to two gamma photons.

Table 7 — Rules of Leptons-Quarks Modified Symmetry

$$F(\nu_n) + F(e_1) - F(\nu_1) = F(e_n)$$

$$F(e_n) + F(u_1) - (n-1)F(\nu_1) + nF(\bar{\nu}_1) = F(d_n)$$

$$F(d_n) + 2F(u_1\bar{u}_1) + F(\bar{e}_1) + F(\nu_1) = F(u_{n+1})$$

Mesons
Each quark carries one third baryon-number and each antiquark carries minus one third baryon-number. Quarks and antiquarks constitute particles of +1, 0, or -1 baryon-numbers. Three quarks or three antiquarks can, correspondingly, compose a baryon or an antibaryon. A meson is a massive boson which is composed of a quark and an antiquark. Mesons are of zero baryon-number and their electric charge is +1 elementary unit for an up-type quark composed of a down-type antiquark, -1 elementary unit for the opposite composition, and zero for a mono-type composition.

W-bosons
The Standard Model wrongly regards bosons that appear at intermediate stages of "weak" reactions as elementary particles which "mediate" the

“weak interaction”. [2] This view is derived from the superfluous rule, which excludes the coexistence of quarks and leptons in one subatomic particle, and from the misleading conviction that all interactions are mediated. It is shown hereafter, by many examples of “weak” reactions, that W-bosons, like any other unstable massive particles, are composite particles. W-bosons are involved in intermediate stages of “weak” reactions, and each one of them splits to a fermion and an antifermion. The intermediate stages of “weak” reactions are the reason that these reactions are slower than “strong” reactions which are performed in one stage. The single fundamental constituents of W^- are an electron and an electron-antineutrino. The single fundamental constituents of W^+ are a positron and an electron-neutrino. The fission of a W-boson requires internal annihilation of at least one $pair_1$. The number of up-quark—up-antiquark pairs in the composition of a W-boson is its generation; this number is also the number of lepton fundamental pairs in the composition of this W-boson.

Table 8 — the Composition Rule of W-bosons

$$F(W_n) = \begin{pmatrix} 0 & 1 & -1 \\ n & 0 & n-1 \end{pmatrix}$$

The following rule holds true: $F(W_n) = F(d_n) + F(\overline{u}_1)$

The so-called “Z-bosons” own their “existence” to the false conviction that all interactions are mediated. The elastic and inelastic collisions between neutrinos and electrons do not require mediators. Apparent observations of Z-bosons are observations of **Z-mesons** which disintegrate into pairs of a charge lepton and its antiparticle. The term Z-mesons refers here to mesons which are composed of a quark and its antiparticle (usually referred as quarkonium). There are no single fundamental constituents in Z-mesons, their baryon quantum number and their electric charges vanish, and unless disintegrated to fermion-antifermion, they are annihilated to two photons. This means that a composite quark/antiquark interacts as one particle with

[2] W-bosons do not interact with detectors; their existence is deduced from their products.

the other quarks/antiquarks in its hadron. The index n in Table 9 designates the generation of the quark involved.

Table 9 — Composition Rules of Z-mesons (quarkoniums)

$$F(Z_1^{up}) = F(\overline{u}_1 u_1) = \begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

$$F(\underset{n\geq 2}{Z_n^{uptype}}) = F(\overline{u}_n u_n) = \begin{pmatrix} -1 & 0 & 0 \\ n & 1 & n-1 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 \\ n & 1 & n-1 \end{pmatrix}$$

$$F(Z_n^{downtype}) = F(\overline{d}_n d_n) = \begin{pmatrix} -1 & -1 & 1 \\ n-1 & 0 & n-1 \end{pmatrix}\begin{pmatrix} 1 & 1 & -1 \\ n-1 & 0 & n-1 \end{pmatrix}$$

The particle observed in the LHC in 2012 that is claimed to be the hypothetical Higgs boson might be a Z-meson of a generation that has not been observed before. A high-generation Z-meson can assume such high rest-energy, and still be annihilated to two photons. This particle might also be a high-generation lepton-onium.

Fusion of composite leptons from W-mesons [3]

1) $\pi^- \to \mu^- + \overline{\nu}_\mu$ $\quad (\overline{u}_1 d_1 \to \underset{1,0,1}{\overline{U}^{\,1}} d_2 \to W_3 \to e_2 + \overline{\nu}_2)$

$$\begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 1 & 1 & -1 \\ 0 & 0 & 0 \end{pmatrix} \to \begin{pmatrix} -1 & 0 & 0 \\ 1 & 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & 1 & -1 \\ 1 & 0 & 1 \end{pmatrix} \to \begin{pmatrix} 0 & 1 & -1 \\ 3 & 0 & 2 \end{pmatrix} \to \begin{pmatrix} 0 & 1 & 2 \\ 1 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -3 \\ 1 & 0 & 0 \end{pmatrix}$$

In the first intermediate stage of this fusion, the down-quark of the reacting pion is extended to a strange-quark and the up-antiquark is extended by a

[3] A W-mesons Is composed of an up-antiquark and a down-type quark; Its fundamental constituents are the same as those of a W-boson of the generation of the down-type quark.

strange-boson (one $pair_1$ and one $pair_3$). In the second intermediate stage the strange-quark and the extended up-antiquark are fused together to a third generation W-boson. In the final stage one $pair_1$ is internally annihilated and the W-boson splits to a muon and a muon-antineutrino.

2) $K^- \to \tau^- + \bar{\nu}_\tau$ $\qquad$ $(\bar{u}_1 d_2 \to \underset{2,0,2}{\bar{U}}^1 d_3 \to W_5 \to e_3 + \bar{\nu}_3)$

$$\begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 1 & 1 & -1 \\ 1 & 0 & 1 \end{pmatrix} \to \begin{pmatrix} -1 & 0 & 0 \\ 2 & 0 & 2 \end{pmatrix}\begin{pmatrix} 1 & 1 & -1 \\ 2 & 0 & 2 \end{pmatrix} \to \begin{pmatrix} 0 & 1 & -1 \\ 5 & 0 & 4 \end{pmatrix} \to \begin{pmatrix} 0 & 1 & 4 \\ 2 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -5 \\ 2 & 0 & 0 \end{pmatrix}$$

Similarly, to the former fusion, the K-meson (kaon) which is composed of a strange-quark and an up-antiquark is fused to a tauon and to its antineutrino.

In the hypothetical third reaction in this sequence, a fourth-generation charged lepton and its antineutrino are produced:

3) $\bar{u}_1 d_3 \to \underset{3,0,3}{\bar{U}}^1 d_4 \to W_7 \to e_4 + \bar{\nu}_4$

$$\begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 1 & 1 & -1 \\ 2 & 0 & 2 \end{pmatrix} \to \begin{pmatrix} -1 & 0 & 0 \\ 3 & 0 & 3 \end{pmatrix}\begin{pmatrix} 1 & 1 & -1 \\ 3 & 0 & 3 \end{pmatrix} \to \begin{pmatrix} 0 & 1 & -1 \\ 7 & 0 & 6 \end{pmatrix} \to \begin{pmatrix} 0 & 1 & 6 \\ 3 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -7 \\ 3 & 0 & 0 \end{pmatrix}$$

The general reaction of this sequence is:

$$\bar{u}_1 d_n \to \underset{n,0,n}{\bar{U}}^1 d_{n+1} \to W_{2n+1} \to e_{n+1} + \bar{\nu}_{n+1}$$

$$\begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 1 & 1 & -1 \\ n-1 & 0 & n-1 \end{pmatrix} \to \begin{pmatrix} -1 & 0 & 0 \\ n & 0 & n \end{pmatrix}\begin{pmatrix} 1 & 1 & -1 \\ n & 0 & n \end{pmatrix} \to \begin{pmatrix} 0 & 1 & -1 \\ 2n+1 & 0 & 2n \end{pmatrix} \to \begin{pmatrix} 0 & 1 & 2n \\ n & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -(2n+1) \\ n & 0 & 0 \end{pmatrix}$$

It might be that a modified reaction of the above sequence is wrongly interpreted as an experimental demonstration of the existence of the hypothetical $W^\pm$ intermediate vector boson (Arnison, 1983) (in modified reactions more fundamental pairs are annihilated at the last stage, and the products are an electron and its antineutrino or a muon and its antineutrino). W-bosons are intermediate stages in the so called "weak" reactions; they can be detected only by their products. The mass of a W-boson of a certain generation is about $80GeV/c^2$, this W-boson had been chosen because its energy fits the predictions of the electro-weak theory. There are no gauge bosons other than photons. Subatomic reactions occur due to the principle of attaining the lowest possible rest-mass under the rules of the internal mode of gravitation and electricity (see Chapter 2 hereafter).

"Weak" reactions of quarks

In the following descriptions quarks appear as virtually free particles. This, of course, is a simplification; quarks cannot be observed directly, but only indirectly as constituents of hadrons. "Weak" reactions of quarks are performed in three steps:

1. Fundamental pairs are produced and integrated with the reacting quark to form an **extended quark** $\underset{i,j,k}{U^n}/\underset{i,j,k}{D^n}$ (the capital letter denotes the type of the quark, the upper index is its generation, and the bottom indexes denote the numbers of produced pairs).
2. A W-boson/W-antiboson is ejected, which reduces the extended quark to a quark of the other type.
3. The W-boson/W-antiboson splits to a lepton and antilepton or to a quark and an antiquark. The splitting of a W-boson/W-antiboson involves internal annihilation of fundamental pairs (at least of one $pair_1$).

$d_1.1)\quad d \rightarrow u + e^- + \overline{\nu}_e \qquad (d_1 \rightarrow \underset{1,0,0}{D^1} \rightarrow u_1 + W_1 \rightarrow u_1 + e_1 + \overline{\nu}_1)$

$$\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\rightarrow\begin{pmatrix}1&1&-1\\1&0&0\end{pmatrix}\rightarrow\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}+\begin{pmatrix}0&1&-1\\1&0&0\end{pmatrix}\rightarrow\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}+\begin{pmatrix}0&1&0\\0&0&0\end{pmatrix}+\begin{pmatrix}0&0&-1\\0&0&0\end{pmatrix}$$

In this fission a down-quark is disintegrated to its fundamental constituents. In the process one $pair_1$ is produced and annihilated.

$u_1.1)\quad u \rightarrow d + e^+ + \nu_e \qquad (u_1 \rightarrow \underset{1,1,1}{U^1} \rightarrow d_1 + \overline{W_1} \rightarrow d_1 + \overline{e}_1 + \nu_1)$

$$\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix} \rightarrow \begin{pmatrix}1&0&0\\1&1&1\end{pmatrix} \rightarrow \begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix} + \begin{pmatrix}0&-1&1\\1&0&0\end{pmatrix} \rightarrow \begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix} + \begin{pmatrix}0&-1&0\\0&0&0\end{pmatrix} + \begin{pmatrix}0&0&1\\0&0&0\end{pmatrix}$$

In this reaction a down-quark is fused from an up-quark. This fusion requires the production of three fundamental pairs, one of each kind. In the last stage one $pair_1$ is annihilated.

$d_2.1)\quad s \rightarrow u + e^- + \overline{\nu}_e \qquad (d_2 \rightarrow \underset{1,0,0}{D^2} \rightarrow u_1 + W_2 \rightarrow u_1 + e_1 + \overline{\nu}_1)$

$$\begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix} \rightarrow \begin{pmatrix}1&1&-1\\2&0&1\end{pmatrix} \rightarrow \begin{pmatrix}1&0&0\\0&0&0\end{pmatrix} + \begin{pmatrix}0&1&-1\\2&0&1\end{pmatrix} \rightarrow \begin{pmatrix}1&0&0\\0&0&0\end{pmatrix} + \begin{pmatrix}0&1&0\\0&0&0\end{pmatrix} + \begin{pmatrix}0&0&-1\\0&0&0\end{pmatrix}$$

The strange quark, d_2, is disintegrated to its single fundamental constituents. For the creation of a second-generation W-boson, one $pair_1$ is produced. Then, in the disintegration process of this boson two $pair_1$ and one $pair_3$ are annihilated. The energy released in internal annihilations does not directly generate gamma rays but is delivered to the products. This energy exits the hadron in which the process takes place which results in gamma emission.

$d_2.2)\quad s \rightarrow c + e^- + \overline{\nu}_e \qquad (d_2 \rightarrow \underset{2,1,0}{D^2} \rightarrow u_2 + W_1 \rightarrow u_2 + e_1 + \overline{\nu}_1)$

$$\begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix} \rightarrow \begin{pmatrix}1&1&-1\\3&1&1\end{pmatrix} \rightarrow \begin{pmatrix}1&0&0\\2&1&1\end{pmatrix} + \begin{pmatrix}0&1&-1\\1&0&0\end{pmatrix} \rightarrow \begin{pmatrix}1&0&0\\2&1&1\end{pmatrix} + \begin{pmatrix}0&1&0\\0&0&0\end{pmatrix} + \begin{pmatrix}0&0&-1\\0&0&0\end{pmatrix}$$

In this reaction two $pair_1$ and one $pair_2$ are produced; at the last stage one $pair_1$ is annihilated.

$d_2.3)\quad s \rightarrow u + \overline{u} + d \qquad (d_2 \rightarrow \underset{1,0,0}{D^2} \rightarrow u_1 + W_2 \rightarrow u_1 + \overline{u}_1 + d_1)$

$$\begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix} \rightarrow \begin{pmatrix}1&1&-1\\2&0&1\end{pmatrix} \rightarrow \begin{pmatrix}1&0&0\\0&0&0\end{pmatrix} + \begin{pmatrix}0&1&-1\\2&0&1\end{pmatrix} \rightarrow \begin{pmatrix}1&0&0\\0&0&0\end{pmatrix} + \begin{pmatrix}-1&0&0\\0&0&0\end{pmatrix} + \begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}$$

In this fission of the strange-quark one $pair_3$ is annihilated and one $pair_1$ is produced and annihilated.

$u_2.1)\quad c \to s + e^+ + \nu_e \qquad (u_2 \to \underset{0,0,1}{U^2} \to d_2 + \overline{W_1} \to d_2 + \overline{e}_1 + \nu_1)$

$$\begin{pmatrix}1&0&0\\2&1&1\end{pmatrix} \to \begin{pmatrix}1&0&0\\2&1&2\end{pmatrix} \to \begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix} + \begin{pmatrix}0&-1&1\\1&0&0\end{pmatrix} \to \begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix} + \begin{pmatrix}0&-1&0\\0&0&0\end{pmatrix} + \begin{pmatrix}0&0&1\\0&0&0\end{pmatrix}$$

In this fission of the charm-quark one $pair_1$ is annihilated and one $pair_3$ is produced.

$u_2.2)\quad c \to s + \mu^+ + \nu_\mu \qquad (u_2 \to \underset{2,0,3}{U^2} \to d_2 + \overline{W_3} \to d_2 + \overline{e}_2 + \nu_2)$

$$\begin{pmatrix}1&0&0\\2&1&1\end{pmatrix} \to \begin{pmatrix}1&0&0\\4&1&4\end{pmatrix} \to \begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix} + \begin{pmatrix}0&-1&1\\3&0&2\end{pmatrix} \to \begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix} + \begin{pmatrix}0&-1&-2\\1&0&0\end{pmatrix} + \begin{pmatrix}0&0&3\\1&0&0\end{pmatrix}$$

In this fission of the charm-quark two $pair_1$ and three $pair_3$ are produced. One $pair_1$ is annihilated in the disintegration of the W-antiboson.

$u_2.3)\quad c \to s + u + \overline{d} \qquad (u_2 \to \underset{1,0,2}{U^2} \to d_2 + \overline{W_2} \to d_2 + u_1 + \overline{d}_1)$

$$\begin{pmatrix}1&0&0\\2&1&1\end{pmatrix} \to \begin{pmatrix}1&0&0\\3&1&3\end{pmatrix} \to \begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix} + \begin{pmatrix}0&-1&1\\2&0&1\end{pmatrix} \to \begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix} + \begin{pmatrix}1&0&0\\0&0&0\end{pmatrix} + \begin{pmatrix}-1&-1&1\\0&0&0\end{pmatrix}$$

$u_2.4)\quad c \to d + e^+ + \nu_e \qquad (u_2 \to \underset{0,0,1}{U^2} \to d_1 + \overline{W_2} \to d_1 + \overline{e}_1 + \nu_1)$

$$\begin{pmatrix}1&0&0\\2&1&1\end{pmatrix} \to \begin{pmatrix}1&0&0\\2&1&2\end{pmatrix} \to \begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix} + \begin{pmatrix}0&-1&1\\2&0&1\end{pmatrix} \to \begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix} + \begin{pmatrix}0&-1&0\\0&0&0\end{pmatrix} + \begin{pmatrix}0&0&1\\0&0&0\end{pmatrix}$$

In this rather rare fission of the charm-quark two $pair_1$ are annihilated. One $pair_3$ is produced and annihilated.

$d_3.1)\quad b \to c + e^- + \bar{\nu}_e \qquad (d_3 \to \underset{2,1,0}{D^3} \to u_2 + W_2 \to u_2 + e_1 + \bar{\nu}_1)$

$$\begin{pmatrix} 1 & 1 & -1 \\ 2 & 0 & 2 \end{pmatrix} \to \begin{pmatrix} 1 & 1 & -1 \\ 4 & 1 & 2 \end{pmatrix} \to \begin{pmatrix} 1 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix} + \begin{pmatrix} 0 & 1 & -1 \\ 2 & 0 & 1 \end{pmatrix} \to \begin{pmatrix} 1 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix} + \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -1 \\ 0 & 0 & 0 \end{pmatrix}$$

In this fission of the bottom-quark one $pair_2$ is produced, and one $pair_3$ is annihilated.

$d_3.2)\quad b \to c + \mu^- + \bar{\nu}_\mu \qquad (d_3 \to \underset{3,1,1}{D^3} \to u_2 + W_3 \to u_2 + e_2 + \bar{\nu}_2)$

$$\begin{pmatrix} 1 & 1 & -1 \\ 2 & 0 & 2 \end{pmatrix} \to \begin{pmatrix} 1 & 1 & -1 \\ 5 & 1 & 3 \end{pmatrix} \to \begin{pmatrix} 1 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix} + \begin{pmatrix} 0 & 1 & -1 \\ 3 & 0 & 2 \end{pmatrix} \to \begin{pmatrix} 1 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix} + \begin{pmatrix} 0 & 1 & 2 \\ 1 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -3 \\ 1 & 0 & 0 \end{pmatrix}$$

$d_3.3)\quad b \to c + \tau^- + \bar{\nu}_\tau \qquad (d_3 \to \underset{5,1,3}{D^3} \to u_2 + W_5 \to u_2 + e_3 + \bar{\nu}_3)$

$$\begin{pmatrix} 1 & 1 & -1 \\ 2 & 0 & 2 \end{pmatrix} \to \begin{pmatrix} 1 & 1 & -1 \\ 7 & 1 & 5 \end{pmatrix} \to \begin{pmatrix} 1 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix} + \begin{pmatrix} 0 & 1 & -1 \\ 5 & 0 & 4 \end{pmatrix} \to \begin{pmatrix} 1 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix} + \begin{pmatrix} 0 & 1 & 4 \\ 2 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -5 \\ 2 & 0 & 0 \end{pmatrix}$$

In this fission of the bottom-quark four $pair_1$, one $pair_2$ and three $pair_3$ are produced.

$d_3.4)\quad b \to c + d + \bar{u} \qquad (d_3 \to \underset{2,1,0}{D^3} \to u_2 + W_2 \to u_2 + d_1 + \bar{u}_1)$

$$\begin{pmatrix} 1 & 1 & -1 \\ 2 & 0 & 2 \end{pmatrix} \to \begin{pmatrix} 1 & 1 & -1 \\ 4 & 1 & 2 \end{pmatrix} \to \begin{pmatrix} 1 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix} + \begin{pmatrix} 0 & 1 & -1 \\ 2 & 0 & 1 \end{pmatrix} \to \begin{pmatrix} 1 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix} + \begin{pmatrix} 1 & 1 & -1 \\ 0 & 0 & 0 \end{pmatrix} + \begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

In this fission of the bottom-quark, one $pair_1$ and one $pair_2$ are produced, and one $pair_3$ is annihilated.

$d_3.5)\quad b \to c + s + \bar{u} \qquad (d_3 \to \underset{3,1,1}{D^3} \to u_2 + W_3 \to u_2 + d_2 + \bar{u}_1)$

$$\begin{pmatrix}1 & 1 & -1\\2 & 0 & 2\end{pmatrix}\to\begin{pmatrix}1 & 1 & -1\\5 & 1 & 3\end{pmatrix}\to\begin{pmatrix}1 & 0 & 0\\2 & 1 & 1\end{pmatrix}+\begin{pmatrix}0 & 1 & -1\\3 & 0 & 2\end{pmatrix}\to\begin{pmatrix}1 & 0 & 0\\2 & 1 & 1\end{pmatrix}+\begin{pmatrix}1 & 1 & -1\\1 & 0 & 1\end{pmatrix}+\begin{pmatrix}-1 & 0 & 0\\0 & 0 & 0\end{pmatrix}$$

This fission of the bottom-quark requires five pair-productions: three $pair_1$, one $pair_2$ and one $pair_3$.

$u_3.1)\quad t\to b+e^{+}+\nu_e \qquad (u_3\to \underset{0,0,1}{U^3}\to d_3+\overline{W_1}\to d_3+\bar{e}_1+\nu_1)$

$$\begin{pmatrix}1 & 0 & 0\\3 & 1 & 2\end{pmatrix}\to\begin{pmatrix}1 & 0 & 0\\3 & 1 & 3\end{pmatrix}\to\begin{pmatrix}1 & 1 & -1\\2 & 0 & 2\end{pmatrix}+\begin{pmatrix}0 & -1 & 1\\1 & 0 & 0\end{pmatrix}\to\begin{pmatrix}1 & 1 & -1\\2 & 0 & 2\end{pmatrix}+\begin{pmatrix}0 & -1 & 0\\0 & 0 & 0\end{pmatrix}+\begin{pmatrix}0 & 0 & 1\\0 & 0 & 0\end{pmatrix}$$

In the simplest fission of the top-quark one $pair_1$ is annihilated and one $pair_3$ is produced.

$u_4.1)\quad a\to d_4+e^{+}+\nu_e \qquad (u_4\to \underset{0,0,1}{U^4}\to d_4+\overline{W_1}\to d_4+\bar{e}_1+\nu_1)$

$$\begin{pmatrix}1 & 0 & 0\\4 & 1 & 3\end{pmatrix}\to\begin{pmatrix}1 & 0 & 0\\4 & 1 & 4\end{pmatrix}\to\begin{pmatrix}1 & 1 & -1\\3 & 0 & 3\end{pmatrix}+\begin{pmatrix}0 & -1 & 1\\1 & 0 & 0\end{pmatrix}\to\begin{pmatrix}1 & 1 & -1\\3 & 0 & 3\end{pmatrix}+\begin{pmatrix}0 & -1 & 0\\0 & 0 & 0\end{pmatrix}+\begin{pmatrix}0 & 0 & 1\\0 & 0 & 0\end{pmatrix}$$

In this fission of the hypothetical awesome-quark one $pair_1$ is annihilated and one $pair_3$ is produced. The product quark is the hypothetical fourth generation down-type quark.

Disintegrations of composite charged leptons

A $E^n_{2n-3}-fermion$ is fused of a composite n_{th} generation charged lepton and a $(2n-3)\,pair_1$ $(2n-3)\,pair_3$ boson.

$$\underset{n\geq 2}{F(E^n_{2n-3})}=\begin{pmatrix}0 & 1 & 2n-2\\n-1 & 0 & 0\end{pmatrix}\cup\begin{pmatrix}0 & 0 & 0\\2n-3 & 0 & 2n-3\end{pmatrix}=\begin{pmatrix}0 & 1 & 2n-2\\3n-4 & 0 & 2n-3\end{pmatrix}$$

A $E^{n}_{2n-3} - fermion$ is the first intermediate stage in the fission of a composite charged lepton to its neutrino and to the lower generation charged lepton and its antineutrino. All the lepton quantum numbers are conserved in E-fermions fissions.

$e_2.1)\quad \mu^- \to \nu_\mu + e^- + \bar{\nu}_e \qquad (e_2 \to E^2_1 \to \nu_2 + W_1 \to \nu_2 + e_1 + \bar{\nu}_1)$

$$\begin{pmatrix}0&1&2\\1&0&0\end{pmatrix} \to \begin{pmatrix}0&1&2\\2&0&1\end{pmatrix} \to \begin{pmatrix}0&0&3\\1&0&0\end{pmatrix} + \begin{pmatrix}0&1&-1\\1&0&0\end{pmatrix} \to \begin{pmatrix}0&0&3\\1&0&0\end{pmatrix} + \begin{pmatrix}0&1&0\\0&0&0\end{pmatrix} + \begin{pmatrix}0&0&-1\\0&0&0\end{pmatrix}$$

$e_3.1)\quad \tau^- \to \nu_\tau + \mu^- + \bar{\nu}_\mu \qquad (e_3 \to E^3_3 \to \nu_3 + W_3 \to \nu_3 + e_2 + \bar{\nu}_2)$

$$\begin{pmatrix}0&1&4\\2&0&0\end{pmatrix} \to \begin{pmatrix}0&1&4\\5&0&3\end{pmatrix} \to \begin{pmatrix}0&0&5\\2&0&0\end{pmatrix} + \begin{pmatrix}0&1&-1\\3&0&2\end{pmatrix} \to \begin{pmatrix}0&0&5\\2&0&0\end{pmatrix} + \begin{pmatrix}0&1&2\\1&0&0\end{pmatrix} + \begin{pmatrix}0&0&-3\\1&0&0\end{pmatrix}$$

$e_4.1)\qquad\qquad e_4 \to E^4_5 \to \nu_4 + W_5 \to \nu_4 + e_3 + \bar{\nu}_3$

$$\begin{pmatrix}0&1&6\\3&0&0\end{pmatrix} \to \begin{pmatrix}0&1&6\\8&0&5\end{pmatrix} \to \begin{pmatrix}0&0&7\\3&0&0\end{pmatrix} + \begin{pmatrix}0&1&-1\\5&0&4\end{pmatrix} \to \begin{pmatrix}0&0&7\\3&0&0\end{pmatrix} + \begin{pmatrix}0&1&4\\2&0&0\end{pmatrix} + \begin{pmatrix}0&0&-5\\2&0&0\end{pmatrix}$$

A $E^{n}_{2n-5} - fermion$ is fused of a composite n_{th} generation charged lepton and a $(2n-5)\,pair_1$ $(2n-5)\,pair_3$ boson.

$$F(\underset{n\geq 3}{E^{n}_{2n-5}}) = \begin{pmatrix}0&1&2n-2\\n-1&0&0\end{pmatrix} \cup \begin{pmatrix}0&0&0\\2n-5&0&2n-5\end{pmatrix} = \begin{pmatrix}0&1&2n-2\\3n-6&0&2n-5\end{pmatrix}$$

A $E^{n}_{2n-5} - fermion$ is the first intermediate stage in the fission of a composite charged lepton (from the third generation on) to its neutrino and to the second lower generation charged lepton and its antineutrino.

$e_3.2)\quad \tau^- \to \nu_\tau + e^- + \bar{\nu}_e \qquad (e_3 \to E^3_1 \to \nu_3 + W_1 \to \nu_3 + e_1 + \bar{\nu}_1)$

$$\begin{pmatrix}0&1&4\\2&0&0\end{pmatrix}\to\begin{pmatrix}0&1&4\\3&0&1\end{pmatrix}\to\begin{pmatrix}0&0&5\\2&0&0\end{pmatrix}+\begin{pmatrix}0&1&-1\\1&0&0\end{pmatrix}\to\begin{pmatrix}0&0&5\\2&0&0\end{pmatrix}+\begin{pmatrix}0&1&0\\0&0&0\end{pmatrix}+\begin{pmatrix}0&0&-1\\0&0&0\end{pmatrix}$$

$e_4.2$) $e_4 \to E_3^4 \to \nu_4 + W_3 \to \nu_4 + e_2 + \bar{\nu}_2$

$$\begin{pmatrix}0&1&6\\3&0&0\end{pmatrix}\to\begin{pmatrix}0&1&6\\6&0&3\end{pmatrix}\to\begin{pmatrix}0&0&7\\3&0&0\end{pmatrix}+\begin{pmatrix}0&1&-1\\3&0&2\end{pmatrix}\to\begin{pmatrix}0&0&7\\3&0&0\end{pmatrix}+\begin{pmatrix}0&1&2\\1&0&0\end{pmatrix}+\begin{pmatrix}0&0&-3\\1&0&0\end{pmatrix}$$

Neutrino capture

$$n+\nu_e \to p+e^- \qquad (udd+\nu_e \to u\overset{0,0,1}{D}d \to uud+e^-)$$

$$\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}+\begin{pmatrix}0&0&1\\0&0&0\end{pmatrix}\to\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&0\\0&0&1\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\to$$
$$\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}+\begin{pmatrix}0&1&0\\0&0&0\end{pmatrix}$$

Electron capture

$$p+e^- \to n+\nu_e \qquad (uud+e^- \to u\overset{0,1,0}{\underset{0,0,1}{U}}d \to udd+\nu_e)$$

$$\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}+\begin{pmatrix}0&1&0\\0&0&0\end{pmatrix}\to\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&0\\0&0&1\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\to$$
$$\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}+\begin{pmatrix}0&0&1\\0&0&0\end{pmatrix}$$

Fusions and fissions of neutrinos (neutrino "oscillations")

A $N_{2m}^{n}-fermion$ is fused of a n_{th} generation neutrino and a $2m\cdot pair_1$ $2m\cdot pair_3$ boson.

$$\underset{n,m=1,2,3...}{F(N_{2m}^{n})} = \begin{pmatrix} 0 & 0 & 2n-1 \\ n-1 & 0 & 0 \end{pmatrix} \cup \begin{pmatrix} 0 & 0 & 0 \\ 2m & 0 & 2m \end{pmatrix} = \begin{pmatrix} 0 & 0 & 2n-1 \\ n-1+2m & 0 & 2m \end{pmatrix}$$

N-fermions are the intermediate stages of fusions of neutrinos to higher generation neutrinos. It is typical of N-fermions and of composite neutrinos that each one of them splits into three neutrinos. Unlike the electron-lepton number, which is conserved in any closed system, the muon-lepton number and the tau-lepton number are not conserved in neutrino "oscillations".

$\nu_1.1)\quad \nu_e \to \nu_\mu + \bar{\nu}_e + \bar{\nu}_e \qquad (\nu_1 \to N_2^1 \to \nu_2 + \bar{\nu}_1 + \bar{\nu}_1)$

$$\begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \end{pmatrix} \to \begin{pmatrix} 0 & 0 & 1 \\ 2 & 0 & 2 \end{pmatrix} \to \begin{pmatrix} 0 & 0 & 3 \\ 1 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -1 \\ 0 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -1 \\ 0 & 0 & 0 \end{pmatrix}$$

$\nu_1.2)\quad \nu_e \to \nu_\tau + \bar{\nu}_\mu + \bar{\nu}_e \qquad (\nu_1 \to N_4^1 \to \nu_3 + \bar{\nu}_2 + \bar{\nu}_1)$

$$\begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \end{pmatrix} \to \begin{pmatrix} 0 & 0 & 1 \\ 4 & 0 & 4 \end{pmatrix} \to \begin{pmatrix} 0 & 0 & 5 \\ 2 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -3 \\ 1 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -1 \\ 0 & 0 & 0 \end{pmatrix}$$

$\nu_1.3)\qquad \nu_1 \to N_6^1 \to \nu_4 + \bar{\nu}_2 + \bar{\nu}_2$

$$\begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \end{pmatrix} \to \begin{pmatrix} 0 & 0 & 1 \\ 6 & 0 & 6 \end{pmatrix} \to \begin{pmatrix} 0 & 0 & 7 \\ 3 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -3 \\ 1 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -3 \\ 1 & 0 & 0 \end{pmatrix}$$

$\nu_2.1)\quad \nu_\mu \to \nu_\tau + \bar{\nu}_e + \bar{\nu}_e \qquad (\nu_2 \to N_2^2 \to \nu_3 + \bar{\nu}_1 + \bar{\nu}_1)$

$$\begin{pmatrix} 0 & 0 & 3 \\ 1 & 0 & 0 \end{pmatrix} \to \begin{pmatrix} 0 & 0 & 3 \\ 3 & 0 & 2 \end{pmatrix} \to \begin{pmatrix} 0 & 0 & 5 \\ 2 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -1 \\ 0 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -1 \\ 0 & 0 & 0 \end{pmatrix}$$

$\nu_2.2)\qquad \nu_2 \to N_4^2 \to \nu_4 + \bar{\nu}_2 + \bar{\nu}_1$

$$\begin{pmatrix} 0 & 0 & 3 \\ 1 & 0 & 0 \end{pmatrix} \rightarrow \begin{pmatrix} 0 & 0 & 3 \\ 5 & 0 & 4 \end{pmatrix} \rightarrow \begin{pmatrix} 0 & 0 & 7 \\ 3 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -3 \\ 1 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -1 \\ 0 & 0 & 0 \end{pmatrix}$$

$\nu_2.3)\quad \nu_\mu \rightarrow \nu_e + \nu_e + \nu_e \qquad\qquad (\nu_2 \rightarrow \nu_1 + \nu_1 + \nu_1)$

$$\begin{pmatrix} 0 & 0 & 3 \\ 1 & 0 & 0 \end{pmatrix} \rightarrow \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \end{pmatrix}$$

$\nu_3.1)\quad \nu_\tau \rightarrow \nu_\mu + \nu_e + \nu_e \qquad\qquad (\nu_3 \rightarrow \nu_2 + \nu_1 + \nu_1)$

$$\begin{pmatrix} 0 & 0 & 5 \\ 2 & 0 & 0 \end{pmatrix} \rightarrow \begin{pmatrix} 0 & 0 & 3 \\ 1 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \end{pmatrix}$$

$\nu_3.2) \qquad\qquad \nu_3 \rightarrow N_2^3 \rightarrow \nu_4 + \overline{\nu}_1 + \overline{\nu}_1$

$$\begin{pmatrix} 0 & 0 & 5 \\ 2 & 0 & 0 \end{pmatrix} \rightarrow \begin{pmatrix} 0 & 0 & 5 \\ 4 & 0 & 2 \end{pmatrix} \rightarrow \begin{pmatrix} 0 & 0 & 7 \\ 3 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -1 \\ 0 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -1 \\ 0 & 0 & 0 \end{pmatrix}$$

$\nu_3.3) \qquad\qquad \nu_3 \rightarrow N_4^3 \rightarrow \nu_5 + \overline{\nu}_2 + \overline{\nu}_1$

$$\begin{pmatrix} 0 & 0 & 5 \\ 2 & 0 & 0 \end{pmatrix} \rightarrow \begin{pmatrix} 0 & 0 & 5 \\ 6 & 0 & 4 \end{pmatrix} \rightarrow \begin{pmatrix} 0 & 0 & 9 \\ 4 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -3 \\ 1 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & -1 \\ 0 & 0 & 0 \end{pmatrix}$$

Neutral kaons

Mesons which are composed of a strange quark/antiquark and a first-generation antiquark/quark are called kaons. The neutral kaons, when expressed in terms of quarks, are apparently two different particles:

$$K^0 = d\overline{s} \qquad \overline{K}^0 = s\overline{d}$$

However, neutral kaons behave as superpositions of neutral kaons and their antiparticles. An anti-phase superposition yields a short-life neutral kaon, and an in-phase superposition yields a long-life neutral kaon. The strange behavior of the neutral kaons is explained by evaluating the fundamental compositions of the neutral kaon and of its antiparticle; these two fundamental compositions are identical:

$$F\left(K^0\right)=F\left(d\bar{s}\right)=\begin{pmatrix}1 & 1 & -1\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 1 & 0 & 1\end{pmatrix}$$

$$F\left(\overline{K}^0\right)=F\left(s\bar{d}\right)=\begin{pmatrix}1 & 1 & -1\\ 1 & 0 & 1\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 0 & 0 & 0\end{pmatrix}$$

$$F^{d+\bar{s}}=F^{s+\bar{d}}=\begin{pmatrix}0 & 0 & 0\\ 2 & 1 & 2\end{pmatrix}$$

The type of a quark is determined by its single fundamental fermions, which are the same for all the quarks of the same type (and of opposite signs for all the antiquarks of the same type). The generation of quarks and antiquarks is determined by their fundamental pairs, which are the same for a quark and its antiquark (the compositions of the first-generation quarks include no fundamental pairs). A neutral kaon is a superposition of two states: in one state the second-generation fundamental pairs (**strange-boson**) are affiliated with the down-type antiquark, and in the other they are affiliated with the down-type quark.

In the case of the anti-phase superposition the disintegration is performed at one stage:

$$\frac{d\bar{s}-s\bar{d}}{\sqrt{2}}=K_S^0\rightarrow\pi^++\pi^-$$

$$\frac{1}{\sqrt{2}}\left[\begin{pmatrix}1 & 1 & -1\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 1 & 0 & 1\end{pmatrix}-\begin{pmatrix}1 & 1 & -1\\ 1 & 0 & 1\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 0 & 0 & 0\end{pmatrix}\right]\rightarrow\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 0 & 0 & 0\end{pmatrix}+\begin{pmatrix}1 & 1 & -1\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}-1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}$$

$$F^{\pi^++\pi^-}=\begin{pmatrix}0 & 0 & 0\\ 2 & 1 & 1\end{pmatrix}$$ One $pair_3$ is annihilated in this process.

Due to the phase difference, a W-boson cannot be generated, and the system stays at the quark-composed level and cannot develop to a lower level.

In the in-phase superposition the disintegration is performed in two stages and a proceeding virtual preliminary stage:

$$\frac{d\overline{s}+s\overline{d}}{\sqrt{2}} = K_L^0 \to Z_1^{downtype} + S^{boson} \to \pi^+ + W_2^- \to \pi^+ + e^- + \overline{\nu}_e$$

$$\frac{1}{\sqrt{2}}\left[\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}-1&-1&1\\1&0&1\end{pmatrix}+\begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix}\begin{pmatrix}-1&-1&1\\0&0&0\end{pmatrix}\right]\to\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}-1&-1&1\\0&0&0\end{pmatrix}+\begin{pmatrix}0&0&0\\1&0&1\end{pmatrix}\to\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}-1&-1&1\\0&0&0\end{pmatrix}+\begin{pmatrix}0&1&-1\\2&0&1\end{pmatrix}$$

$$\to\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}-1&-1&1\\0&0&0\end{pmatrix}+\begin{pmatrix}0&1&0\\0&0&0\end{pmatrix}+\begin{pmatrix}0&0&-1\\0&0&0\end{pmatrix}$$

$F^{\pi^+ + e^- + \overline{\nu}_e} = \begin{pmatrix}0&0&0\\1&1&1\end{pmatrix}$ One $pair_1$ and one $pair_3$ are annihilated in this process.

The charge conjugative process of the above process occurs at slightly higher rates. This is not due to CP violation, but due to the fact that both processes are detected by matter devices.

Neutral B-mesons

$B^0 = d\overline{b}$ $\quad\quad$ $\overline{B}^0 = \overline{d}b$

In the oscillations of neutral B-meson a virtual **bottom-boson** oscillates inside a first generation down-type Z-meson, and alternately increases and reduces the generation of the down-type quark/antiquark from the first generation to the third generation and backward:

$$F(B^0 \leftrightarrow \overline{B}^0) = virtual\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}-1&-1&1\\0&0&0\end{pmatrix}+virtual\begin{pmatrix}0&0&0\\2&0&2\end{pmatrix}$$

$$\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}-1&-1&1\\2&0&2\end{pmatrix}\begin{matrix}\to\\\leftarrow\end{matrix}\begin{pmatrix}1&1&-1\\2&0&2\end{pmatrix}\begin{pmatrix}-1&-1&1\\0&0&0\end{pmatrix}$$

Neutral B-s-mesons are composed of a bottom-antiquark/quark and a strange-quark/antiquark: $B_s^0 = s\overline{b}$ $\overline{B}_s^0 = \overline{s}b$

In the oscillations of B-s-mesons a virtual strange-boson and a virtual bottom-boson are involved; they alternately replace each other:

$$F(B_s^0 \leftrightarrow \overline{B}_s^0) = vir\begin{pmatrix} 1 & 1 & -1 \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} -1 & -1 & 1 \\ 0 & 0 & 0 \end{pmatrix} + vir\begin{pmatrix} 0 & 0 & 0 \\ 1 & 0 & 1 \end{pmatrix} + vir\begin{pmatrix} 0 & 0 & 0 \\ 2 & 0 & 2 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 1 & -1 \\ 1 & 0 & 1 \end{pmatrix}\begin{pmatrix} -1 & -1 & 1 \\ 2 & 0 & 2 \end{pmatrix} \begin{matrix} \rightarrow \\ \leftarrow \end{matrix} \begin{pmatrix} 1 & 1 & -1 \\ 2 & 0 & 2 \end{pmatrix}\begin{pmatrix} -1 & -1 & 1 \\ 1 & 0 & 1 \end{pmatrix}$$

Neutral D-mesons

$D^0 = \overline{u}c$ $\overline{D}^0 = u\overline{c}$

In these oscillations a virtual **charm-boson** is involved:

$$F(D^0 \leftrightarrow \overline{D}^0) = virtual\begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} + virtual\begin{pmatrix} 0 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix}$$

$$\begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix} \begin{matrix} \rightarrow \\ \leftarrow \end{matrix} \begin{pmatrix} -1 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

Fissions and an annihilation of a Z-meson (quarkonium)

$$b\overline{b} = Z_3^{downtype} \rightarrow \tau^- + \tau^+, \mu^- + \mu^+, e^- + e^+, \gamma + \overline{\gamma}$$

$$\begin{pmatrix} 1 & 1 & -1 \\ 2 & 0 & 2 \end{pmatrix}\begin{pmatrix} -1 & -1 & 1 \\ 2 & 0 & 2 \end{pmatrix} \rightarrow \begin{pmatrix} 0 & 1 & 4 \\ 2 & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & -1 & -4 \\ 2 & 0 & 0 \end{pmatrix}$$

$$\begin{pmatrix}1 & 1 & -1\\ 2 & 0 & 2\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 2 & 0 & 2\end{pmatrix}\to\begin{pmatrix}0 & 1 & 2\\ 1 & 0 & 0\end{pmatrix}+\begin{pmatrix}0 & -1 & -2\\ 1 & 0 & 0\end{pmatrix}$$

$$\begin{pmatrix}1 & 1 & -1\\ 2 & 0 & 2\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 2 & 0 & 2\end{pmatrix}\to\begin{pmatrix}0 & 1 & 0\\ 0 & 0 & 0\end{pmatrix}+\begin{pmatrix}0 & -1 & 0\\ 0 & 0 & 0\end{pmatrix}$$

$$\begin{pmatrix}1 & 1 & -1\\ 2 & 0 & 2\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 2 & 0 & 2\end{pmatrix}\to\gamma+\bar{\gamma}$$ [4]

Strangeness-antistrangeness production

1) $\pi^- + p \to K^0 + \Lambda^0 \quad (\bar{u}d + uud \to \bar{s}d + usd)$

$$\begin{pmatrix}-1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}1 & 1 & -1\\ 0 & 0 & 0\end{pmatrix}+\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}1 & 1 & -1\\ 0 & 0 & 0\end{pmatrix}\to\begin{pmatrix}-1 & -1 & 1\\ 1 & 0 & 1\end{pmatrix}\begin{pmatrix}1 & 1 & -1\\ 0 & 0 & 0\end{pmatrix}+\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}1 & 1 & -1\\ 1 & 0 & 1\end{pmatrix}\begin{pmatrix}1 & 1 & -1\\ 0 & 0 & 0\end{pmatrix}$$

2) $\pi^+ + p \to K^+ + \Sigma^+ \quad (u\bar{d} + uud \to u\bar{s} + uus)$

$$\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 0 & 0 & 0\end{pmatrix}+\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}1 & 1 & -1\\ 0 & 0 & 0\end{pmatrix}\to\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 1 & 0 & 1\end{pmatrix}+\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}1 & 1 & -1\\ 1 & 0 & 1\end{pmatrix}$$

3) $\bar{p} + p \to K^- + K^0 + \pi^+ + \pi^0 + \pi^0 \quad (\bar{u}\bar{u}\bar{d} + uud \to \bar{u}s + d\bar{s} + u\bar{d} + u\bar{u} + d\bar{d})$

$$\begin{pmatrix}-1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}-1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 0 & 0 & 0\end{pmatrix}+\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}1 & 1 & -1\\ 0 & 0 & 0\end{pmatrix}\to\begin{pmatrix}-1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}1 & 1 & -1\\ 1 & 0 & 1\end{pmatrix}+\begin{pmatrix}1 & 1 & -1\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 1 & 0 & 1\end{pmatrix}$$
$$+\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 0 & 0 & 0\end{pmatrix}+\begin{pmatrix}1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}-1 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}+\begin{pmatrix}1 & 1 & -1\\ 0 & 0 & 0\end{pmatrix}\begin{pmatrix}-1 & -1 & 1\\ 0 & 0 & 0\end{pmatrix}$$

[4] The concept of antiphotons is introduced in Part II.

Strangeness "evaporation"

1) $K^+ \to \pi^+ + \pi^- + \pi^+$

$$K^+ \equiv u\bar{s} \to u\bar{d} + d\,\underset{1,0.0}{\overline{D}}{}^2 \to u\bar{d} + d\bar{u} + \overline{W}_2 \to u\bar{d} + d\bar{u} + u\bar{d} \equiv \pi^+ + \pi^- + \pi^+$$

$$\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}-1&-1&1\\1&0&1\end{pmatrix} \to \begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}-1&-1&1\\0&0&0\end{pmatrix} + \begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}-1&-1&1\\2&0&1\end{pmatrix} \to \begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}-1&-1&1\\0&0&0\end{pmatrix} + \begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}-1&0&0\\0&0&0\end{pmatrix} + \begin{pmatrix}0&-1&1\\2&0&1\end{pmatrix} \to$$

$$\to \begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}-1&-1&1\\0&0&0\end{pmatrix} + \begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}-1&0&0\\0&0&0\end{pmatrix} + \begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}-1&-1&1\\0&0&0\end{pmatrix}$$

2) $\Lambda^0 \to p^+ + \pi^-$

$$\Lambda^0 \equiv uds \to ud\,\underset{1,0,0}{D}{}^2 \to udu + W_2 \to udu + \bar{u}d \equiv p^+ + \pi^-$$

$$\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix} \to \begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\2&0&1\end{pmatrix} \to \begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix} + \begin{pmatrix}0&1&-1\\2&0&1\end{pmatrix} \to$$

$$\to \begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix} + \begin{pmatrix}-1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}$$

3) $\Lambda^0 \to n^0 + \pi^0$

$$\Lambda^0 \equiv uds \to ud\,\frac{1}{\sqrt{2}}[\underset{1,1,1}{D}{}^1 + \underset{1,0,0}{D}{}^1] \to \frac{1}{\sqrt{2}}[(udd + d\bar{d}) + (udd + u\bar{u})] \equiv n^0 + \pi^0$$

4) $\Lambda^0 \to p^+ + e^- + \bar{\nu}_e$

$$\Lambda^0 \equiv uds \to ud\,\underset{1,0,0}{D}{}^2 \to udu + W_2 \to udu + e^- + \bar{\nu}_e \equiv p^+ + e^- + \bar{\nu}_e$$

$$\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix}\to\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\2&0&1\end{pmatrix}\to\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}+\begin{pmatrix}0&1&-1\\2&0&1\end{pmatrix}\to$$

$$\to\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}+\begin{pmatrix}0&1&0\\0&0&0\end{pmatrix}+\begin{pmatrix}0&0&-1\\0&0&0\end{pmatrix}$$

Charmonium-pentaquark

$$\Lambda_b^0 \to P_c^+ + K^- \to p^+ + J/\psi + K^-$$

$$(udb \to uduc\bar{c} + \bar{u}s \to udu + c\bar{c} + \bar{u}s)$$

$$\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\2&0&2\end{pmatrix}\to\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&0&0\\2&1&1\end{pmatrix}\begin{pmatrix}-1&0&0\\2&1&1\end{pmatrix}+\begin{pmatrix}-1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix}\to$$

$$\to\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\0&0&0\end{pmatrix}\begin{pmatrix}1&0&0\\0&0&0\end{pmatrix}+\begin{pmatrix}1&0&0\\2&1&1\end{pmatrix}\begin{pmatrix}-1&0&0\\2&1&1\end{pmatrix}+\begin{pmatrix}-1&0&0\\0&0&0\end{pmatrix}\begin{pmatrix}1&1&-1\\1&0&1\end{pmatrix}$$

In this process two quark-pairs are produced, and a bottom-quark is generation-reduced to a strange-quark. The five quarks and the two antiquarks are firstly rearranged to a charmonium-pentaquark and a charged kaon; then the pentaquark disintegrates to a proton and a charmonium Z-meson. Another possibility is that a "weak" reaction is involved in this process. But, due to lake of an electron-positron pair, disintegration of a regular W-boson cannot create a second generation up-type particle. Thus, only if enriched W-bosons exist, the following reaction is possible:

$$b \to c + \overset{enriched}{W} \to c + \bar{c} + s$$

In this case the bottom-quark undergoes the following process:

$$b \rightarrow \underset{5,2,1}{D^3} \rightarrow c + \overset{enriched}{W_5} \rightarrow c + \bar{c} + s$$

$$\begin{pmatrix} 1 & 1 & -1 \\ 2 & 0 & 2 \end{pmatrix} \rightarrow \begin{pmatrix} 1 & 1 & -1 \\ 7 & 2 & 3 \end{pmatrix} \rightarrow \begin{pmatrix} 1 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix} + \begin{pmatrix} 0 & 1 & -1 \\ 5 & 1 & 2 \end{pmatrix} \rightarrow \begin{pmatrix} 1 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix} + \begin{pmatrix} -1 & 0 & 0 \\ 2 & 1 & 1 \end{pmatrix} + \begin{pmatrix} 1 & 1 & -1 \\ 1 & 0 & 1 \end{pmatrix}$$

And the whole process is:

$$udb \rightarrow ud\underset{5,2,1}{D^3} \rightarrow udc + \overset{enriched}{W_5} \rightarrow uduc\bar{c} + \bar{u}s \rightarrow udu + c\bar{c} + \bar{u}s$$

2. Subatomic Dynamics—the Internal Mode

An interaction other than gravitation and electricity does not exist. Inside atoms, ions, and subatomic composite particles the two interactions operate at their internal mode. The internal mode is governed by the following principle:

Principle of Internal Mode

The independent variable on which the internal influence on a participant depends is its variable charge. Inside a composite quark/lepton the participants are its fundamental constituents; inside a quark-composed particle/leptonic-shell the participants are its quarks/leptons; inside an atom/ion the participants are its nucleus and its leptonic-shell. [5]

Inside atoms and composite subatomic particles "distance between the constituents" has no physical significance. In this domain the independent variables of interactions are the variable charges of the participants. Thus, the variant-rate time is not the only fundamental quantity that is not known to Modern Physics; the other is the variable charge. The variable charge of a participant in an internal interaction varies such that the different internal influences on this participant assume an extremum or a local extremum. The variable charge of a quark is not the sum of the variable charges of its fundamental constituents; the variable charge of a nucleus is not the sum of the variable charges of its quarks. Shell leptons interact individually with external particles/photons, but internally they form one leptonic shell that interacts as one participant with the baryonic nucleus. [6] The spatial components of all the wave-functions of an atom/subatomic particle are at one quanta of space. They differ in their quantum numbers, in their variable charges, and in their w-components (the last difference is relevant only to interactions with external particles/photons).

[5] Quark-composed particles are mesons, nucleons, nuclei, and hyperons.

[6] The leptonic shell of an atom in a molecule includes, in a superposition, the leptons it shares with other atoms.

Inside atoms and inside composite subatomic particles, gravitation is not geometry, and electricity is not a force field. The energy that corresponds to internal interactions is the energy of rest-mass increments. ***Internal "work" generates negative rest-mass increments; it converts rest-mass to higher-entropy forms of energy. When "work" is done against internal interactions, positive rest-mass increments are generated; higher-entropy forms of energy are converted to rest-mass.*** Internal "work" is done in the following reactions: radioactive reactions, thermonuclear fusions, nuclear and subatomic fissions, and transitions of excited atoms or nuclei to lower energy levels. "Work" is done against internal interactions in the following reactions: recycling processes of heavy nuclei back to hydrogen (Part II), creation of higher-generation sub-atomic particles, and transitions of atoms and nuclei to higher energy levels (only the rest-mass produced in recycling processes is of a stable nature). The rest-mass of a composite atomic/subatomic particle is the sum of the rest-masses of its participants plus the total rest-mass increments due to internal interactions (which is negative for stable particles) plus contributions due to the internal kinetic energy of the participants. Orbital angular momentum in this case is not generated by motion in space but by motion in the w-space. Internal kinetic energy is, for any external frame, an indispensable part of the inertial energy.

The magnitude of a participant's contribution to the total rest-mass increment due to the "attractive" internal influences of the other participants is inversely proportional to its squared variable charge. The magnitude of a participant's contribution to the total rest-mass increment due to the "repulsive" internal influences of the other participants is proportional to its squared variable charge. In most cases, the sum of all the internal influences on each participant includes at least one "attractive" influence and at least one "repulsive" influence. Thus, in most cases, the magnitude of the total internal influence on each participant has an extremum in which the "attractive" and the "repulsive" influences balance each other. That extremum determines the magnitude of the contribution of that participant to the total rest-mass increment. The value of the variable charge in that extremum is the value of the participant's variable charge in the composition under consideration. Except for total annihilations, the variable charge of a participant does not vanish even when all the internal interactions on it are attractive. In these cases (e.g., the down-quark in a free proton, or the up-quark in a free neutron) the variable charge drops to a minimal non-zero magnitude. Participants, between which all the internal interactions are repulsive, do not enter the internal mode and do not constitute together a subatomic composite particle (e.g., a proton and a positron).

$F_i(Q_j)$ is a composite function of the interaction's level of the quantum state of the affected ith participant, and of the quantum state of the affecting jth participant. The function $F_i(Q_j)$ determines the sign of the ith contribution to the total rest-mass increment and together with the variable charge of the ith participant determines the magnitude of this contribution. In most cases $F_i(Q_j)$ is negative. It is positive for participants at non-ground energy levels in quarks/leptons of non-first generations. At excited states of subatomic composite particles or of atoms, the function $F_i(Q_j)$ of each non-ground level participant varies such that the excited particle's rest-mass assumes discrete values that are higher than its rest-mass at the ground state. According to the principle of gravitational mass, the gravitational mass of an excited particle does not depend on its energy content, and its magnitude is always proportional to the particle's time-symmetric rest-mass at the ground state.

The variant matter-quantities, inertial mass, and variable charge have the same sign for matter and for its antimatter. The variable charge of quarks, antiquarks, nuclei, and anti-nuclei is designated by a positive sign, while the variable charge of leptons and antileptons is designated by a negative sign. Two internal participants whose variable charges are of the same sign gravitationally "attract" each other; two internal participants whose variable charges are of opposite signs gravitationally "repel" each other. Unless it is annihilated by its antiparticle, the variable charge of a fundamental fermion never vanishes. Fissions of composite particles may involve internal annihilations of fundamental pairs. In such annihilations the energy of the annihilated particles is delivered to the products and not emitted as gamma photons (when this energy excites a nucleus, gamma rays are emitted in a secondary reaction). A clear indication that a sub-atomic particle is a composite particle is the appearance of massive products at least in some of the reactions with its antiparticle. Only fundamental fermions are always entirely annihilated by their antiparticles. Composite quarks might be entirely annihilated by their antiparticles but can also undergo partial annihilation.

Let us consider an internal interaction of N participants. A participant can be subject to four different kinds of internal influences that determine its contribution to the total rest-mass increment. The rest-mass of the ith participant is denoted M_i, m_i is its gravitational mass, and e_i is its electric charge. The following is a crude and simplified description of the possible different internal influences on the ith participant:

An "attractive" gravitational influence when g_i and g_j, the corresponding variable charges, are of the same sign:

$$\frac{M_i}{N-1}(F_i(Q_j)G_{at}|m_i m_j|g_i^{-2})$$

A "repulsive" gravitational influence when g_i and g_k, the corresponding variable charges, are of different signs:

$$\frac{M_i}{N-1}(F_i(Q_j)G_{re}|m_i m_k|g_i^{2})$$

An "attractive" electric influence when e_i and e_l, the corresponding electric charges, are of different signs:

$$-\frac{M_i}{N-1}(F_i(Q_j)E_{at}e_i e_l g_i^{-2})$$

A "repulsive" electric influence when e_i and e_m, the corresponding electric charges, are of the same sign:

$$\frac{M_i}{N-1}(F_i(Q_j)E_{re}e_i e_m g_i^{2})$$

G_{at} , G_{re} , E_{at} , and E_{re} are universal constants. The gravitational mass of the i[th] fundamental constituent is denoted m_i. The gravitational mass of an internal participant is an invariant quantity whose magnitude is proportional to the participant's time-symmetric rest-mass. $F_i(Q_j)$ is a function of the quantum state of the ith participant; its independent variable is the quantum state of the jth participant. This function determines the sign of the contribution of the ith participant to the total rest-mass increment. The contribution is negative when internal "work" was done on the ith participant, and it is positive when "work" was done on the ith participant against internal interactions. $F_i(Q_j)$ is also involved in determining the magnitude of the ith contribution. The expressions in brackets are pure numbers. The mathematical expressions in this section are reflections of the hypothesis of internal-mode dynamics; they are drafts, and as such should be examined and be elaborated in light of the empirical data.

The above four preliminary terms are summed up in Equation IV.1 for the contribution of the ith participant to the total rest-mass increment due to "work" done by internal interactions or against them. The ith contribution is the extremum of the resultant internal influence of all the other participants. In the first case the change is negative, and the extremum is a maximum; in the second case the change is positive, and the extremum is a minimum.

$$\Delta M_i = \frac{M_i}{N-1} \cdot Exterm \sum_{j \neq i}^{N} F_i(Q_j) \left(G_{at}^{\frac{1+\frac{g_i g_j}{|g_i g_j|}}{2}} G_{re}^{\frac{1-\frac{g_i g_j}{|g_i g_j|}}{2}} |m_i m_j| (g_i)^{-2\frac{g_i g_j}{|g_i g_j|}} + E_{at}^{\frac{1-\frac{e_i e_j}{|e_i e_j|}}{2}} E_{re}^{\frac{1+\frac{e_i e_j}{|e_i e_j|}}{2}} |e_i e_j| (g_i)^{2\frac{e_i e_j}{|e_i e_j|}} \right) \tag{IV.1}$$

To avoid ambiguity in cases of vanishing electric charge(s), we add the following definition:

$$e_i, e_j = 0 \rightarrow \quad \frac{e_i e_j}{|e_i e_j|} \equiv 1$$

The variable charge of internal participants vanishes only in the case of a total annihilation; $F_i(Q_j)$ in this case is a kind of Dirac's delta for each of the two particles involved $\Delta M_i = -M_i$.

Let us consider an internal-mode composite particle (in the ground state); it can be an atom, a nucleus, a baryon, a meson, a composite quark/lepton, a W-boson, a N-fermion, or their antiparticles. The particle is composed of *N* participants. Each participant interacts with all the other participants, and these interactions determine the total rest-mass increment of the relevant composite particle. The rest-mass of an atom or of a composite sub-atomic particle is

$$M_{co.p} = \sum_{i=1}^{N}\left(M_i + \Delta M_i + \frac{1}{c^2}K_i\right) \qquad \text{(IV.2)}$$

Where K_i denotes the internal kinetic energy of the *ith* participant.

It seems that the best system to start with in testing the internal-mode hypothesis is the hydrogen atom. This system is of just two participants, and of rich data. Applying Equation (IV.1) to the hydrogen atom, we get:

$$\Delta M_p = Exterm M_p F_p(Q_e)(G_{re} m_p m_e g_p^2 + E_{at}|e_p e_e| g_p^{-2})$$

$$\Delta M_e = Exterm M_e F_e(Q_p)(G_{re} m_e m_p g_e^2 + E_{at}|e_e e_p| g_e^{-2})$$

$$\frac{d}{dg_p}\Delta M_p = M_p F_p(Q_e)(2G_{re} m_p m_e g_p - 2E_{at}|e_p e_e| g_p^{-3}) = 0$$

$$\Rightarrow g_p = \sqrt[4]{\frac{E_{at}|e_p e_e|}{G_{re} m_p m_e}}$$

$$\frac{d}{dg_e}\Delta M_e = M_e F_e(Q_p)(2G_{re}m_e m_p g_e - 2E_{at}\left|e_e e_p\right|g_e^{-3}) = 0$$

$$\Rightarrow g_e = -\sqrt[4]{\frac{E_{at}\left|e_e e_p\right|}{G_{re}m_e m_p}}$$

Thus, in the hydrogen atom (also in excited states) the magnitude of the variable charge of the electron equals to the magnitude of the variable charge of the proton. Let us define the variable charge of the proton in the hydrogen atom as one unit of variable charge.

This definition yields: $\frac{E_{at}}{G_{re}} = \frac{m_p m_e}{e^2}$

And from Equation (IV.2) we get:

$$M_H = M_p + M_e + \Delta M_p + \Delta M_e + \frac{1}{c^2}K_e$$

$$\Delta M_p + \Delta M_e = M_p F_p(Q_e)(G_{re}m_p m_e g_p^2 + E_{at}\left|e_p e_e\right|g_p^{-2}) + M_e F_e(Q_p)(G_{re}m_e m_p g_p^2 + E_{at}\left|e_e e_p\right|g_e^{-2})$$

$$\Delta M_p + \Delta M_e = M_p F_p(Q_e)(G_{re}m_p m_e + E_{at}\left|e_p e_e\right|) + M_e F_e(Q_p)(G_{re}m_e m_p + G_{re}\frac{m_p m_e}{e^2}e^2)$$

$$\Delta M_p + \Delta M_e = M_p F_p(Q_e)(G_{re}m_p m_e + G_{re}\frac{m_p m_e}{e^2}e^2) + M_e F_e(Q_p)(G_{re}m_e m_p + G_{re}\frac{m_p m_e}{e^2}e^2)$$

$$\Delta M_p + \Delta M_e = 2G_{re}m_p m_e(M_p F_p(Q_e) + M_e F_e(Q_p))$$

In an annihilation of a fundamental fermion (and a composite quark sometimes) with its antiparticle only "attractive" influences exist, the variable charge vanishes, and the total energy of the system is converted completely to photons or delivered to the other internal participants in case of internal annihilations. Electric energy, in this case, is attractive also in the macro mode (except for neutrinos), which pushes the system to pass into the internal mode. In an annihilation of a composite particle, which is not a quark, with its antiparticle also repulsive influences are involved. Due to this fact proton and antiproton, for example, are transformed into mesons and not directly to gamma rays. Neutrinos do not interact electrically and their internal-mode gravitational interactions, due to their tiny gravitational mass, are small; these facts explain their extremely weak interaction with matter.

Energy levels

Rules for the occupation of energy levels in quarks, leptons, and intermediate-stage particles (first level composite particles):

1. Each energy level of these particles should be populated by an odd number of fundamental fermion(s).
2. A fundamental fermion and its antiparticle cannot share the same energy-level and should be separated by at least one energy-level.

A first-generation W-boson is composed of four fundamental fermions. Two of them are an up-quark and its antiparticle. The electron-antineutrino of this W-boson should be used for separation; this and the exclusion on two fundamental fermions at one energy-level results in four energy-levels each occupied by one fundamental fermion. The composition of a muon differs from the composition of a first-generation W-boson by two neutrinos instead of one antineutrino. The additional neutrino of the muon occupies the second energy-level and enables three fundamental fermions in the ground energy-level, and just three energy levels. The above two rules also explain why the rest-energies of the up-type quarks of the second and third generation are greater than the rest-energies of their corresponding down-type quarks. Composite up-type quarks have two more fundamental constituents than the down-type quarks of their generation. Consequently, the fundamental constituents of a composite up-type quark occupy two more energy-levels than the fundamental constituents of its down-type partner.

Interaction properties of sub-atomic particles

All the fundamental fermions interact in the internal mode. These interactions create composite quarks and composite leptons. Quarks internally interact between themselves to create baryons, nuclei, and mesons. It seems that the reason that a free quark has not been detected is that quarks interact *only* in the internal mode. Nuclei, including single proton nuclei, internally interact with their shell charged leptons to create atoms and ions. Nuclei and ions interact also in the contact-mode and at the length-dependent mode. It seems that mesons do not interact internally with other particles. Unlike up-quarks, electrons interact at the three modes of interactions. The same is probably true for neutrinos.

Earth's furnace

Collisions of primary cosmic rays with nuclei in the upper layers of Earth's atmosphere produce secondary cosmic rays. In the most common process, one primary proton produces two antipions, one pion, and one neutron.

$$p \to \pi^+ + \pi^+ + \pi^- + n \qquad\qquad (uud \underset{collision}{\to} u\overline{d} + u\overline{d} + \overline{u}d + udd)$$

After very short travels, the antipions and the pions are fused to antimuons, muon-neutrinos, muons, and muon-antineutrinos. Muons and antimuons are highly penetrable, and due to their relatively long lifetime (2.2 microseconds) and the relativistic time-dilation effect, most of them disintegrate only when they are at Earth's core. The energy released in disintegrations, and the energy released in the consequent electron-positron annihilations, is delivered to the hot core of the planet. Through each square meter of Earth's surface, about ten thousand muons pass per minute. Inside the planet, their energy (about 5 Gev each) is completely converted to heat, and this preserves the temperature of the planet's core, which is of the order of the Sun's surface temperature. No matter how thick Earth's crust is, it can only slow down the outward flow of heat; to preserve a hot core for billions of years, there should be energy supply. Observations of muons deep inside Earth show a clear shadow of the Moon. These observations indicate that the cosmic rays, which generate the muons, are pointed towards Earth's core. Thus, the appearance of cosmic rays is a controlled process, which in this case is designed to stabilize the inner hot temperature of Earth. The sources of that heat supply are thought to be only radioactive processes and inner friction, but the crucial-for-life energy supply to Earth's core is guaranteed in a much more elegant and everlasting way.

The continuous flow of cosmic rays, which are mainly protons, continually transfers positive electric charge into Earth's core (the process results in an excess of positrons which annihilate electrons of Earth's core). The positively charged core accounts for Earth's magnetosphere. But this process should have some compensatory processes that keep the positive charge at some constant level. This is probably done by the charged particles that generate the aurora (polar lights), which are mostly electrons. These electrons are part of the solar wind, but the solar thermonuclear process does not create excess electrons. These electrons are probably the electrons missing from the radial cosmic rays that "visit" the sun for cooling down (by numerous collisions) and are then sent to earth to penetrate it mainly through the polar region where life is minimal. The whole process is supremely designed and controlled; it is not an accidental process.

Mixed particles

Mixed particles are subatomic composite particles of the second and third level of internal interaction which contain matter and antimatter participants. Subatomic composite particles of the first level of internal interaction are not mixed particles even though they contain matter and antimatter participants. Examples of mixed particles are positronium and antiprotonic-helium. The wave-function of a mixed particle is a superposition of two states; in one state the gravitational mass of the mixed particle is positive, in the other state it is negative. [7] The squared amplitudes of each state are proportional to the contributions of the matter/antimatter participants to the particle's rest mass.

The massive-substance universal constant

The massive substance in the observable universe is of two groups: the matter group and the antimatter group. The massive substance of each group is concentrated in galaxies/antigalaxies. The combination of the two kinds of galaxies turns the universe into a gravitational crystal. Huge potential barriers totally prevent the exchange of massive substance between the two groups. Conversions of matter/antimatter to their orthogonal forms are compensated by conversions of 'matter'/'antimatter' to matter/antimatter.

[7] Principle of Gravitational Mass; see Part II of this book.

Thus, each group is practically a closed system in which the conservation of single fundamental fermions practically holds true. Let N_c be the quasi-constant total number of single antineutrinos of the matter group (at each absolute present). Then the total fundamental fermions quasi tensors of the two groups at each absolute present are as follows:

$$F(allmatter) = \begin{pmatrix} 3N_c & 2N_c & -N_c \\ \text{var} & \text{var} & \text{var} \end{pmatrix}$$

$$F(allantimatter) = \begin{pmatrix} -3N_c & -2N_c & N_c \\ \text{var} & \text{var} & \text{var} \end{pmatrix}$$

The total number of fundamental pairs varies during processes. N_c is a universal constant—the **massive-substance universal constant**. Note that N_c is also the total baryon number and the total lepton number of the matter group. If the entire massive substance in the two groups is hydrogen/antihydrogen, then N_c would be the number of atoms/antiatoms in each group.

Appendix: Rutherford's atom and the "strong mistake"

The gold foil experiment yields probabilities for the different interactions between nuclei in a gold foil and a beam of alpha particles. This data is about the interaction properties between gold nuclei and alpha particles but tells nothing about the internal geometry of the atom, and nothing about the internal interactions between the atom's constituents. Treating sub-atomic particles as miniatures of solid macroscopic particles is a classical, state-invariant, approach which does not fit the quantum level. At the time of Rutherford's interpretation of this experiment, Quantum Mechanics was not known, but strangely enough his method of interpretation had a profound, century-long, misleading impact on subatomic physics. Distances inside atoms and inside subatomic particles have no physical significance. Experiments which are wrongly interpreted as evidence for spatial structures of atoms and of subatomic particles are evidence for the structure of the wave-functions involved and should be reinterpreted. The strong force that is derived from Rutherford's misleading interpretation is nothing but a strong mistake. The abandonment of Rutherford's picture of the atom and all its consequent false concepts is the starting point of the Simple Model of Subatomic Particles.

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