GEOMETRIC MODEL OF ELEMENTARY PARTICLES

Ilya A. Boldov

independent researcher

RUSSIA, Krasnodar Region, Ust-Labinsk district, village Vimovets, Batokhina str,31.

ilboldov@yandex.ru

The paper shows that the essence of mass as a physical phenomenon in N–dimensional space is a consequence of its extension in N+1 space. Leptons and quarks correspond to the symmetry groups of regular polyhedra in three-dimensional space and their mass is given by the volume of the corresponding polyhedron or the sum of the volumes of the corresponding polyhedrons for hadrons. When the particles decay due to the weak interaction, it is possible that one or more quark-antiquark pairs are born, and the symmetry group changes in the form of quark-lepton oscillation. The formulas for the decays of particles are given in a strict form without magical transformations. An attempt is made to systematize all known elementary particles into tables of quark combinations. The masses of all known elementary particles are calculated from the combined polyhedra.

Keywords: elementary particles, three-dimensional space, gravity, mass.

Extensive research into the physics of the microcosm in the 20th century led to the creation of a new direction – Elementary Particle Physics (EPP). Within its framework, the Standard Model (SM) was created - a theoretical construction describing the electromagnetic, weak and strong interaction of all elementary particles. The modern formulation of the SM was completed in the mid-70s after experimental confirmation of the existence of quarks. The discovery of the top quark (1995), the bottom quark (1977), and the tau neutrino (2000) strengthened the belief in the correctness of the SM.

SM is not a theory of everything, as it does not describe dark matter, dark energy, and does not include gravity. Experimental confirmation of the existence of intermediate vector bosons in the mid-80s completed the construction of the SM and its acceptance as the main and non-alternative one. The need for a minor expansion of the model arose in 2002 after the discovery of neutrino oscillations, and the confirmation of the existence of the Higgs boson in 2012 completed the experimental detection of elementary particles predicted by the Standard Model.

One of the cornerstones of the Elementary Particle Physics (EPP) was the postulate that the concepts and laws of the macrocosm are categorically inapplicable to the physics of the microcosm.

Meanwhile, no one has ever given a justification for a certain size that separates microphysics and macrophysics. Speaking about the inapplicability of approaches and concepts of the macrocosm to the objects of the microcosm, theoretical physicists rely either on the shaky basis of the convenience of certain mathematical formulas that allow them to reconcile what is observed in experiments with invented constructions and hypotheses, or the possibility of observing something with modern tools and equipment.

But very often in mathematics (especially higher), one problem can be solved in several ways, and the technologies and equipment of physical experiments in general in science and in EPP tend to develop. Thus, neither the mathematics used, nor the equipment and technologies of the EPP, provide a justification for establishing a certain size that separates macro from microphysics.

The absence of such a clearly defined boundary makes it possible for a certain dimensional gap to exist within which it is permissible to use the techniques and concepts of both macro and microphysics. But attempts to justify the boundaries of this area will again not find a theoretical justification. Thus, the categorical ban on the use of approaches and concepts for describing the objects of the macrocosm for the objects of the microcosm is not justified by anything. Therefore, it is quite acceptable to consider the objects of the microcosm in terms of the concepts of the macrocosm.

Within the SM framework, there are two groups of particles with half-integer spin. These are quarks and leptons. It would seem that why would nature create two groups of almost identical particles ? It is quite possible to make both mesons and baryons from leptons with whole electric charges. But in the framework of the SM, this is considered impossible, since leptons do not participate in the so-called "strong interaction". Under this term, it is considered to be the occurrence of forces that hold the nucleons in the atomic nucleus and the defect of their mass, which is formed in this case. Using the formula $E=mc^2$, the "strong interaction" energy of the order of 7-8 MeV per nucleon is obtained.

These two phenomena are usually considered cause and effect, since they occur simultaneously in one local place.

Yes, the simultaneity and locality of two physical processes are necessary conditions for establishing a causal relationship between them, but not sufficient. It is quite possible that these two physical processes are both consequences of the third, (and maybe the fourth...).

Moreover, this statement in the form of a causal relationship, which formed the basis of the so-called "strong interaction of quarks", does not meet the Popper criterion, since it can neither be verified nor falsified, due to the invented confinement, i.e., the inability to experimentally detect quarks with non-integer charges outside of baryons.

As an analogy of two processes occurring both locally and simultaneously: a flash of light radiation and an acoustic shock observed during rain. They could be considered cause and effect. But the development of physics and the understanding of various physical processes have revealed that both of these phenomena are the consequences of an electric discharge caused by the ionization of the atmosphere caused by the solar wind and the presence of the Earth's magnetic field on the planet, which is a consequence of the metal core of the planet…

So with the holding forces and the mass defect. They may well be not related, as cause and effect, but separately manifestations of certain processes rejected by the SM or not considered at all by the physics of physics of elementary particles and the atomic nucleus.

Thus, the existence of the so-called "strong interaction" can be considered as unknown, and leptons can be considered as quarks with whole electric and other charges.

An additional argument for this conclusion is the internal structure of the nucleons. According to the SM, quarks with both positive and negative fractional charges must exist inside each lepton. The experimentally established structure of the neutron agrees with this assumption. But in the structure of the proton, negatively charged regions of space are not observed. [1]

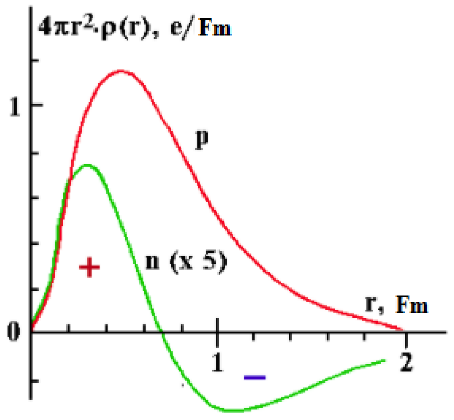

Fig.1 Distribution of the electric charge in the proton and neutron.

About the forces that hold nucleons in the nucleus, will be written in the section on the structure of atomic nuclei, but with the mass and its participation in the structure of elementary particles, we will focus in more detail.

Mass is one of the most ancient concepts used by human civilization. On the one hand, it is almost daily used, but not fully understood. Here is the definition from Wikipedia :

"Mass is a scalar physical quantity that determines the inertial and gravitational properties of bodies in situations where their speed is much less than the speed of light [2]. In everyday life and in the physics of the XIX century, mass is synonymous with weight[3].

Being closely related to such concepts of mechanics as "energy" and "momentum", mass manifests itself in nature in two qualitatively different ways, which gives grounds for dividing it into two varieties:

the inert mass characterizes the inertia of bodies and appears in the expression of Newton's second law: if a given force in the inertial frame of reference accelerates different bodies equally, they are assigned the same inert mass;

the gravitational mass (passive and active) shows with what force the body interacts with the external fields of gravity[4] and what gravitational field this body itself creates [5]. It is included in the law of universal gravitation and is the basis for measuring mass by weighing.»

In GR and SRT, the distortion of space is derived as a consequence of the effect of gravity on it, and is described by tensors. A lot of works are devoted to this, for example [6], in which proofs are given in the form of complex mathematical formulas.

Let's try to get the same conclusion more simply, without higher mathematics and in relation to the masses of elementary particles.

In modern physics, there are three physical concepts whose magnitude cannot have negative values in Euclidean space :

1. Weight;

2. Energy;

3. Volume;

The first two are related by the well-known formula $E=mc^2$. The author considers it possible to compare the mass with the volume for the minimum indivisible masses of matter in the form of elementary particles, through a certain conditional density pm, which is a constant for the space of our universe.

$$m = \rho_m V; \tag{1}$$

Then a certain mass will be located in space, accessible to the sense and measurement of its inhabitants. I will immediately make a reservation that (1) is true only for elementary particles.

Let us consider as an example a certain one-dimensional space E1 c with zero density $p_0=0$.

Fig. 2.

A one-dimensional body will occupy a length L in the space E1 with a density p_L

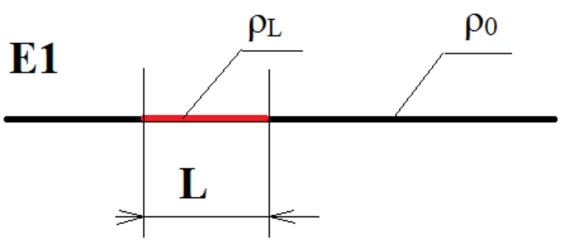

Fig.3

In the framework of one-dimensional space, a one-dimensional observer will not be able to understand why bodies in the form of straight lines are attracted as gravitational masses, and resist movement as inertial ones. But in fact, this body L is also located in the space E2, causing the curvature of the one-dimensional space in the second dimension.

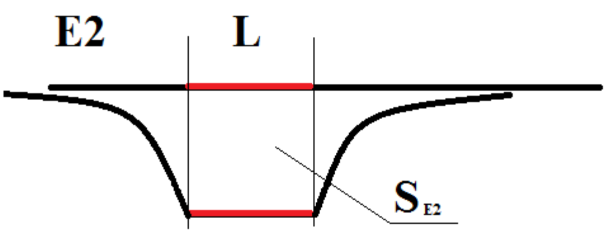

Fig.4.

The inhabitants of one-dimensional space cannot detect this curvature due to their one-dimensionality. But a one-dimensional body, in addition to its length, will be present in a two-dimensional one with a corresponding area of SE2 ; the rest energy of such a one-dimensional body will be defined as :

$$E_L = \rho_L * L * c^2; \quad (2)$$

Replacing $c^2 = S_{E2} * t^{-2}$, we get:

$$E_L = \rho_L * L * S_{E2} * t^{-2}; \quad (3)$$

The energy will be equal to the length of a one-dimensional body multiplied by its linear density and the square of the speed of light, or the product of the density, one-dimensional and the area of the conjugate two-dimensional space per unit time each.

For two-dimensional :

$$E_L = \rho_S * S * c^2 = \rho_L * S * S_{E2} * t^{-2}; \quad (4)$$

And for a three-dimensional body :

$$E_v = mc^2 = \rho_v * V * c^2 = \rho_v * V * S_{E2} * t^{-2}; \quad (5)$$

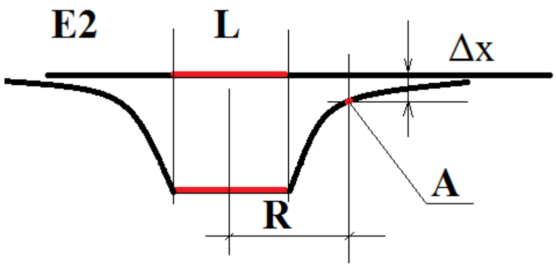

Fig.5

Obviously, for point A, the curvature of space Δx will be defined as :

$$\Delta x = K * L / R^2; \quad (6)$$

Where K is the elasticity of a two-dimensional space.

If a certain area of space is subjected to curvature from several bodies, then these curvatures add up, causing distortions in two-dimensional space, which causes forces acting in the direction of these distortions.

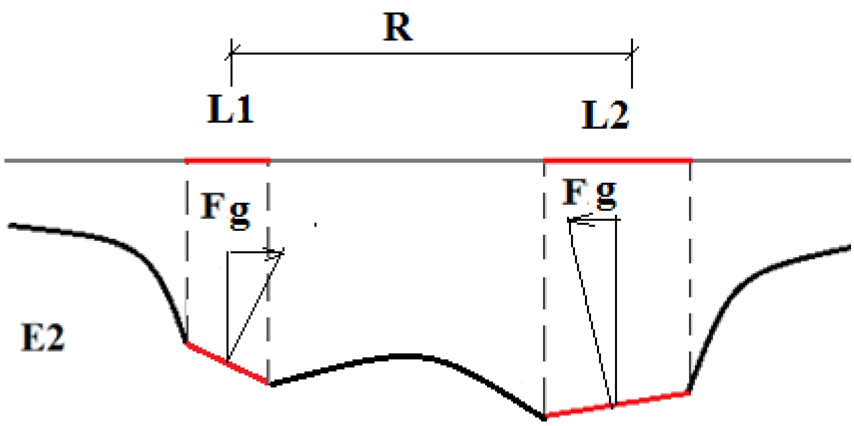

Fig.6

These forces, in this case, will be perceived by the inhabitants of the one-dimensional world as a gravitational manifestation of mass.

The "gravitational" forces acting in a one-dimensional world on one-dimensional bodies will obviously be calculated as :

$Fg = K^* \, m_1 m_2/R^2 = K \, \rho_L^2 \, (L1^*L2)/R^2;$ (7)

For two-dimensional :

$Fg = K^* \, m_1 m_2/R^2 = K^* \, \rho_S^2 \, (S1^*S2)/R^2;$ (8)

And for a three-dimensional body :

$Fg = K^* \, m_1 m_2/R^2 = K^* \rho_V^2 \, (V1^*V2) \, /R^2;$ (9)

An attempt to move a body in one-dimensional space will result in a force that prevents this movement.

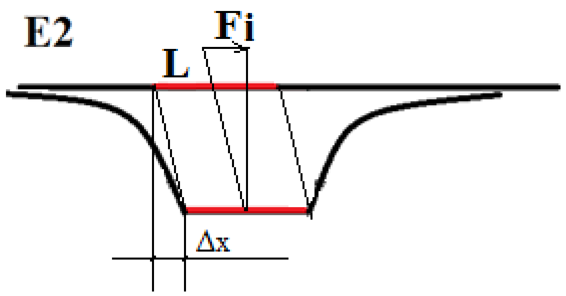

Fig.7

This force will be perceived as an inertial manifestation of the mass of a one-dimensional body and will depend on the length of the body.

Then, for a one-dimensional world, we get :

$F \, i = \rho_L \, L^* \, \Delta x/t^{-2}$; (10)

For two-dimensional :

$F\ i = \rho_S\ S^*\ \Delta x^2/t^{-2}$; (11)

And for a three-dimensional body :

$F\ i = \rho_V\ V^*\ \Delta x = m^*\ \Delta x/t^{-2}$; (12)

In general terms combining the gravitational forces and the inertial forces we get for a body of mass m1:

$F = Fg + F\ i\ = m_1(G^*m_2\ /R^2 - \Delta x/t^{-2})$; (13)

In the absence of alien gravity m2=0, the first term becomes zero, in the absence of movement of the body in space Δx=0, the second term becomes zero.

In the presence of gravity of several bodies in the amount of 1...n, the formula will have the form :

$F = \Sigma_1^{\ n}\ Fg_n + Fi\ = m_1(G\ ^*\Sigma_1^{\ n}\ (m_n\ /R^2_{\ n}) - \Delta x/t^{-2})$; (14)

Where $G=6{,}6740^*10^{-11}$ $м^3/кг^*с^2$, there is a gravitational constant that has the smsr: acceleration of the specific volume of three-dimensional space. The physical meaning of its function is the coefficient of the impact of the movement of a body in two-dimensional space on three-dimensional space.

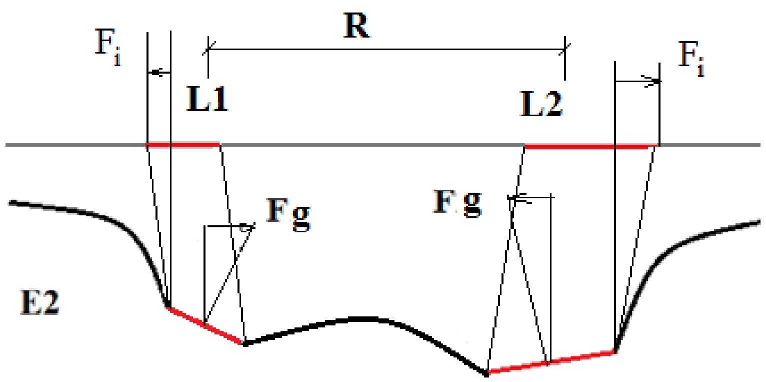

Fig.8

In general, it is probably necessary to bring the formula (14) to a vector form. Then it will be more consistent with the realities of our space, when the body experiencing the gravitational influence also has an inertia that opposes it. Perhaps in this case, we will get that the gravitational forces are much greater than is commonly believed, just their main value is "eaten up" by the inertia of a body moving in the field of gravity.

Of course, in this case, a variant of a one-dimensional body with a conditional constant one-dimensional density is considered. But let's say that there is another body inside one body, as it is really possible in three-dimensional space.

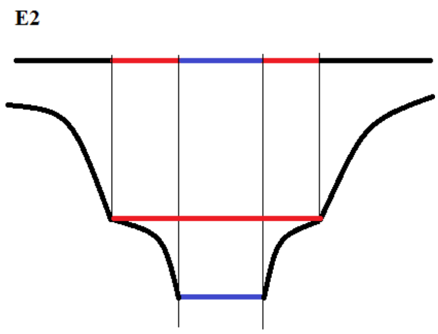

Fig.8

Obviously, in the case of a one-dimensional space, for an external observer, the total distortion of the conjugate two-dimensional space will be the sum of the distortions of the first and second bodies. For three-dimensional space, this means that if there are material volumes embedded in each other in a certain region of space, then both the gravitational and inertial forces of such a complex body will be equivalent to the sum of these mass volumes.

Thus, it is proved that the mass in our three-dimensional world is equivalent to the volume. Let's try to determine the value of this density using the example of an electron.

The mass of the electron m_{e-}= 9,7 $*10^{-31}$ kg. [7]. The electron size is Ve-about 10-18 m. [7]. Then the electron density will be defined as :

$$\rho_{e-} = m_e / V_{e-} = 9{,}7 * 10^{-31} / 10^{-54} = 9{,}7 * 10^{23}\ kg/m^3; \qquad (15)$$

Which is comparable to the density of black holes.

The resulting conclusion about mass as a function of the volume of a body in three-dimensional space gives an answer - why Gravity does not fit into the CM framework and it is impossible to create a theory of quantum gravity. Because the curvature of a four-dimensional space by a three-dimensional volume has no quantum of action. And the Higgs boson mathematical curiosity SM.

At the same time, abrupt changes in the position and distribution of masses in space, such as the explosion of a supernova or, conversely, the collapse of a star into a neutron or black hole, will cause far-divergent changes in the distortion of space or "gravitational waves", in the form of "shaking" of our space, which is detected by instruments.

Of course, all of the above concerning the relation of mass to the volume of a material body is true only for elementary particles. Even an atomic nucleus will have a different density, equal to about 1017 kg / m3, since the nucleons in the nucleus are located at some distance from each other, separated by "empty" space.

Thus, it is proved that the mass in our three-dimensional world is proportional to the volume of the body occupied in space, and from physics we can safely remove such a delusional theory as the formation of mass by the field and the Higgs boson.

1. Masses / volumes of elementary particles

The SM is based on a mathematical apparatus describing three groups of symmetry. These are the unitary groups SU(3),SU(2), and SU(1). At the same time, it is assumed that for weak interactions that cause the decay of particles, the combined symmetry is not preserved.

The author believes that just as any geometric construction or space can be described by a mathematical formula, so any mathematical formula or theory has a geometric meaning.

In the geometry of three-dimensional space, there are many bodies that have symmetry, also described in group theory. Thus, the finite subgroups of the proper rotations of a three-dimensional space are exhausted by the list: C_n, D_n, C, O, Y.

The list contains two series C_n, D_n with an arbitrary n. The remaining C, O, Y are sporadic symmetry groups of regular polyhedra that are not included in any series.

If we consider the table of regular convex polyhedra (tel. Plato), all faces of which are congruent regular polygons, then you can notice its similarity to the beginning of the table of elementary particles.

№	Polihedron	faces	vertices	edges
1	Tetrahedron	4	4	6
2	Octahedron	8	6	12
3	Cube	6	8	12
4	Icosahedron	12	20	30
5	Dodecahedron	20	12	30

Table 1. Regular convex polyhedra

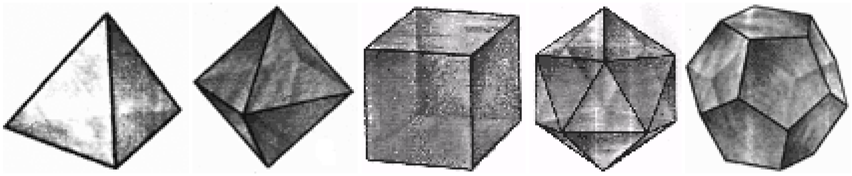

Fig.9.

Tetrahedron (γ) Octahedron (ν_e) Hexahedron (e^-) Icosahedron (ν_μ) Dodecahedron (μ^-)

№	Particle	Mass, MeV	Q	Q_L
1	γ	~ 0	0	0
2	ν_e	2,2E-6	0	+1 e
3	e-	0,511	-1	+1 e
4	ν_μ	< 0,17	0	+1μ
5	μ-	105,66	-1	+1μ

Table 2.

Photon and Leptons

Let's make a hypothesis:

1. Leptons are polyhedra in shape. The mass of a particle is determined by the volume of the corresponding polyhedron (or set of polyhedra) and depends on the length of the edge (s).

The properties of the particle are determined by the shape (structure) of the polyhedron and its symmetry. Manifestations of various laws of conservation of nonphysical charges (lepton, baryon, oddity, etc.) are consequences of the law of conservation of the structure of a polyhedron, expressed in its axes of symmetry and the number of edges.

In Table 1, there is one polyhedron that is dual to itself. It's a tetrahedron. In Table 2, it corresponds to a Photon. Since a photon is both a particle and an antiparticle, we can assume that half of its edges and faces are positive, and half are negative.

There are also two groups of polyhedra that are dual, i.e. one can be obtained from the other if the centers of the faces of one are taken as the vertices of the other, and which have the same symmetry group. These are the pairs of Hexahedron (cube) and Octahedron, Dodecahedron and Icosahedron. Each of these pairs has the same number of edges, and the number of vertices and faces are swapped. We can assume that these are pairs connected by lepton charges, then the first pair is an Electron (Hexahedron or Cube) and an electron neutrino (Octahedron). The second pair is the Dodecahedron (Muon) and the Icosahedron (Muon neutrino).

Note that the particles-polyhedra with faces-regular triangles move at the speed of light. Bravo Dynamic Triangulation!!! In contrast, polyhedra formed from a square (Electron) and a pentagon (Muon) have a significant rest mass and do not move at the speed of light.

The electric charge can be represented as the reaction of space to the structure of a polyhedron in which the ratio of edges to vertices is 3/2.

We assume that the edges of elementary particle polyhedra in a discrete three-dimensional space are also discrete (quantized) and form a series :

$$X_N = l_{min} * N ; \tag{16}$$

Where l_{min} is a certain minmial length N – a series of natural integers.

Then the minimum volume of space occupied by the mass of an elementary particle is denoted as V_{min}.

The volume of the cube-electron Vc with side a=1* l_{min} will be defined as :

$$V_c = a^3 = 1* V_{min}; \tag{17}$$

The volume of the Muon-dodecahedron with the side equal to a=3 will be :

$$V \mu= a^3(15+7\sqrt{5}) /4= 206,9 * V_{min}. \tag{18}$$

The obtained value of the mass / volume of the Muon is only 0.6% different from the table value (206.77 em), which cannot be explained by a simple coincidence.

The lepton charge can be explained by the duality of the particles, or, more precisely, by the same number and arrangement of the axes of symmetry, or by the same number of Planckeon dyads-the edges of polyhedra. In Table 1, these are the electron lepton charge and the muon lepton charge, respectively.

The decay of the Muon, according to the proposed hypothesis, is represented as the "collapse" of the Dodecahedron into a Cube, Icosahedron and Octahedron. This preserves the total number of edges of polyhedra (Planckeon dyads) before and after the decay.

Since Plato's bodies have exhausted the regular polyhedra, then we must look for other polyhedra for the role of two more leptons. If the electron faces are squares, and the muon faces are pentagons, then it is logical to assume that there will be hexagons among the taon faces. In addition to Plato's bodies, prisms are also the simplest polyhedra. And the first candidate for Taon is a hexagonal prism (two faces of hexagons and six squares), the volume of which with side a=11 will be equal.

$$V\tau= (3\sqrt{3}\ a^3)/2= 3458,39; \tag{19}$$

If we compare the obtained value in em with the reference mass of the Taon in EM equal to 3477.143, we get an error of 0.6 %, which also cannot be explained by a simple coincidence.

The dual polyhedron (Tau-neutrino) to the hexagonal prism will be a double hexagonal pyramid. The only difference between the taon and other neutrinos will be that its triangular faces will be isosceles triangles. Just as with Plato's bodies, the dual hexagonal prism and the twin pyramid (Taon and its neutrino) will have the same number of edges, and the number of vertices and faces will change places.

2. Quarks are also polyhedra with integer charges (Coulomb and Baryon).

In fact, the Letonic charge and the Baryonic charge are the same thing, it is the sum of quarks and antiquarks. Only in the lepton charge, this is also the conservation in the decay particles of the internal symmetry group of the original particle.

						Leptons				SM Quark		
Polihedron	faces	vertices	edges	Q	Jp	Leptobs	mc2, MeV	Quark *	Polihedron Volume **	mc2, MeV (Standard Model)	Quark *	Polihedron Volume**
Cube	6	8	12	-1	1/2	e–	0,511	d1	0,511	4,72÷4,84	d2	4,088
Octahedron	8	6	12	0	1/2	ν_e	<2,2e–6	u1	0,24	1,5 ÷ 3	u2	1,92
Dodecahedron	12	20	30	-1	1/2	μ	105,66	s3	105,73	70÷130	s3	105,73
Icosahedron	20	12	30	0	1/2	ν_μ	<0,19	c1	2,182	1160÷1340	c10	1114,85
6–face prism	8	12	18	-1	1/2	τ	1776,84	b11	1767,06	4130÷4270	b15	4480,71
two 6–pyramids	12	8	18	0	1/2	ν_τ	<18,2	t1	0,89	174200÷3300	t58	172689,3

Table 3. Polyhedra : Leptons \ Quarks

* The number after the quark type designation is the discrete (quantized) edge length of the polyhedron.

** Polyhedron volume * 0.511 MeV.

So we get that quarks of the same generation have one symmetry group.

The author suggests to designate them as "d,s,b" according to the notation of quarks associated with leptons.

Leptons	group d		group s		group b	
Q	-1	0	-1	0	-1	0
quark	e-(d)	ν_e (u)	μ-(s)	ν_μ(c)	τ-(b)	ν_τ(t)
Jp ħ	1/2	1/2	1/2	1/2	1/2	1/2
mass MeV/s2	0.511	<2 e-6	105.658	<0.19 e-6	1776.84	<18.2 e-6
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Table 4. Comparison of quarks and leptons in symmetry groups.

The hadrons in the proposed model have the same quark composition as in the CM, with the only difference that Baryons have one or two quarks that are antiquark, and therefore have a Baryon charge of +1 or -1.

For example, the π-meson in CM has a quark combination dû.
Its electric charge in CM consists of the charges of the quark d(e^-) and the antiquark û($\tilde{\nu}_e$).

Standard model :

$$Q_{\pi -} = q_d + q_{\hat{u}} = (-1/3) + (-2/3) = -1; \qquad (20)$$

Geometric model :

$$Q_{\pi -} = q_d + q_{\hat{u}} = -1 + 0 = -1; \qquad (21)$$

Polyhedron quarks are included in hadrons with different mass / volume, while maintaining their internal symmetry.

Naturally, the mass of such quarks will also be determined by the quantized length of their edges. And the mass of hadrons in this case will consist of the masses of their constituent quarks-polyhedra.

The size of quarks in hadrons will be indicated by a number after specifying the type of quark. This number is the number of lmin.the components of the edge of a given quark-polyhedron. For example, a π-meson will have the notation û5d6, which denotes an antiquark û (octahedron) with edge length =5 and a quark d (cube) with edge length =6.

The particle decay reactions in the proposed theory occur in the form of a change in the internal symmetry of the quark –polyhedron (flavor) by the weak interaction. To do this, as a rule, one or more quark-antiquark pairs are born.

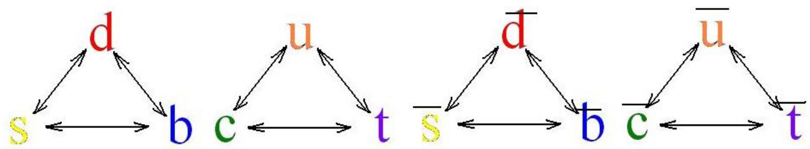

Fig. 10 Quark oscillations in weak interaction reactions
u-c-t : neutrino oscillations;
d-s-b : other quark \ lepton oscillations;

Equations of particle decays in the proposed model :

In the left part of the equation, in parentheses without specifying the particle, we will indicate the quark-antiquark pair that was born. In parentheses, next to the particle, we will indicate the corresponding quark or a set of quarks and antiquarks. After the formula, in curly brackets, we indicate the quark oscillations (change in flavor).

Note that the oscillations are possible only for quarks and antiquarks having the same electric charge.

Then the decay of the muon will take place according to the following formulas :

$$\mu^-(s) + (u\hat{u}) \rightarrow e^-(d) + \tilde{\nu}_e(\hat{u}) + \nu_\mu(c); \qquad \{s \rightarrow d\}\{u \rightarrow c\} \qquad (22)$$

$$\mu^-(s) + (c\hat{c}) \rightarrow e^-(d) + \tilde{\nu}_e(\hat{u}) + \nu_\mu(c); \qquad \{s \rightarrow d\}\{\hat{c} \rightarrow \hat{u}\} \qquad (23)$$

Taon Decays:

τ^- (b) + (uû) → e^- (d) + $\nu_e^{\sim}$(û) + ν_τ (t); {b→ d}{u→ t} (24)

τ^- (b) + (uû) → μ^- (s) + $\nu_e^{\sim}$(ĉ) + ν_τ (t); {b→ s}{ û→ ĉ }{u→ t} (25)

τ^- (b) + (cĉ) → μ^- (s) + $\nu_e^{\sim}$(ĉ) + ν_τ (t); {b→ s}{c→ t} (26)

τ^- (b) + (tt˜) → μ^- (s) + $\nu_e^{\sim}$(ĉ) + ν_τ (t); {b→ s}{t˜→ ĉ} (27)

The hadrons-mesons in the proposed EPP model also consist of two quarks (quark and antiquark) as in the SM and have exactly the same quark combination.

The decays of Mesons in this case are written as :

π^0 (uû) →2 γ; (28)

π^+(uđ)→μ^+ (ŝ)+ ν_μ (c); {đ→ŝ}{u→ c} (29)

K^+ (uŝ)+(uû)→ π^+ (uđ) + π^0(uû); {ŝ →đ} (30)

K^+(uŝ)+(uû)+(dđ) → π^+ (uđ) + π^+ (uđ) +π^- (ûd); {ŝ →đ} (31)

K^0(dŝ)+(uû)+(uû)→ π^+(uđ)+ π^- (ûd)+ π^0(uû); { ŝ →đ} (32)

K^0 (dŝ)+ (uû) →π^-(ûd)+ μ^+(ŝ) + ν_μ (c); {u→ c} (33)

η^0(cĉ)+(uû)+(uû)→ π^0(uû)+π^0(uû)+π^0(uû); {c→u}{ĉ→û} (34)

η^0(cĉ)+(uû)+(dđ)→ π^+(uđ)+π^-(dû)+π^0(uû); {c→u}{ĉ→û} (35)

Consider the decay of π- (dû) →μ- (s)+ $\nu^{\sim}_\mu$ (ĉ) in the masses/volumes of the participating quarks:

π- (d6û5) →μ- (s3)+ $\nu^{\sim}_\mu$ (ĉ3) ; (36)

d6 (216) →s3(206.9); {d→s} (37)

û5 (58.93) → ĉ 3 (58.91); {û →ĉ} (38)

A complete list of mesons with indications of quark combinations is given in Appendix 1.

The error in calculating the sum of the masses of quarks-polyhedra was usually less than 1 MeV. Also, calculations have shown that mesons that are considered a mixture of other mesons, like the p^0 meson ($\frac{u\hat{u}-d\bar{d}}{\sqrt{2}}$), are most likely a tetraquark with a quark combination dđuû. And the n-meson ($\frac{u\hat{u}+d\bar{d}+s\hat{s}}{\sqrt{6}}$) and other mesons with the same quark composition are respectively the hexaquark of dđuûsŝ.

Mezons qq˜				
Q	0	-1	+1	0
Group	2 aroma combination			
s2	J/Ψ (cc˜)	D^-(sc˜)	D^+(s˜c)	φ (ss˜)
s1d1	D^0(cu˜)	D^-(dc˜)	K^+(s˜u)	K^0 ˜(sd˜)
s1d1	$D^{0\sim}$(c˜u)	K^- (su˜)	D^+(d˜c)	K^0 (s˜d)
d2	π^0 (uu˜)	π^- (du˜)	π^+(d˜u)	π^0(dd˜)
d1b1	ut˜	B^-(bu˜)	d˜t	B^0(db˜)
d1b1	u˜t	dt˜	B^+(b˜u)	$B^{\sim 0}$(d˜b)
b2	η^0_t(tt˜)	bt˜	b˜t	Υ (bb˜)
b1s1	tc˜	st˜	b˜c	sb˜
b1s1	t˜c	bc˜	s˜t	s˜b

Table 5 . Quark combinations of mesons

Decays of baryons according to the proposed model: Neutron decay :

n (udđ) + (uû) → p (uuđ) + e- (d) + $\tilde{\nu}_e$ (û); (39)

Similarly, the decay of the antineutron occurs :

ñ (dûđ) + (uû) → $\tilde{p}$ (dûû) + e+ (đ) + ν_e (u); (40)

The sums of quarks, antiquarks, and particle quarks (taking into account the birth of the uû pair) before and after the decay are equal. The proton decay is possible only by the birth of a quark-antiquark pair (dd) according to the scheme :

p(uuđ) + (dđ) → n (duđ) + e^+ (đ) + ν_e (u); (41)

But such a decay channel is possible only with enough energy to create massive charged quarks (dđ) and in normal cases does not occur, which actually determines the stability of protons outside the nucleus.

When particles collide with each other at high energies, other quark-antiquark pairs are also born.

The construction of particles from quarks-leptons in the proposed version also provides an explanation for the baryon charge. If we take the baryon charge of a quark +1 and the antiquark -1, then the sum of the baryon charges of the quarks gives the baryon charge of the particle.

For example, for a proton p (uuđ) and a neutron n (duđ), the baryon charge is +1+1-1=+1.

For the antiproton p (dđ) and the antineutron n (dđđ), the baryon charge is+ 1-1-1 = -1.

In fact, the lepton and baryon charges are the same-the law of conservation of the number of particles and antiparticles, quarks and antiquarks, and the symmetry of the particles-quarks.

Let us check the correspondence of the proposed quark composition to other observed schemes of particle decays. The birth of strange particles occurs when two protons collide. The high energy that the protons encounter leads to the formation of a quark-antiquark pair (sŝ).

Here, too, on the left side of the equation, in parentheses without specifying the particle, we will also indicate the quark-antiquark pair that was born.

p (uuđ) + p (uuđ) + (sŝ) → p (uuđ) + Λ^0 (suđ) + K^+ (uŝ) ; (42)

Further decay of the resulting strange K^+ and Λ^0 hyperons is possible according to two schemes, also with the birth of quark-antiquark pairs:

The first variant of disintegration:

Λ^0 (suđ) + (uû) → n (udđ) + π^0 (uû);	{s→d}	(43)
n (duđ) + (uû) → p (uuđ) + e^- (d) + $\tilde{\nu}_e$ (û);		(44)
π^0 (uû) →2 γ;	// from 43	(45)
K^+ (uŝ) + (uû) →π^+ (uđ) + π^0 (uû);	{ŝ →đ}	(46)
π^0(uû) →2 γ;	// from 46	(47)
π^+(uđ) → μ^+ (ŝ)+ ν_μ (c);	{đ→ŝ}{u→ c}	(48)
μ^+(ŝ) + (uû) → e^+ (đ) + ν_e (u)+ $\tilde{\nu}_\mu$ (ĉ);	{ŝ→đ}{û→ĉ}	(49)

In total, we get that the sums of quarks before the decay and finally after all the decays in the first case:

uuđ + uuđ → uuđ + uuđ + d + û+ 2 γ+2 γ+ đ + u+ ĉ+c ; (50)

By reducing the quark-antiquark pairs, we get :

uuđ + uuđ → uuđ + uuđ; (51)

The second variant of disintegration :

Λ^0 (suđ) + (uû) → p (uuđ) + π^- (dû); {s→d} (52)

π^- (dû) → μ^- (s)+ $\tilde{\nu}_\mu$ (ĉ); {d→s} {û→ĉ} (53)

μ^- (s) + (uû) →e^- (d) + $\nu_e\tilde{}$ (û) + ν_μ (c); {s→d}{u→ c} (54)

K^+ (uŝ) → μ^+ (ŝ) + ν_μ (c); {u→c} (55)

μ^+ (ŝ) + (uû) → e^+(đ) + ν_e (u)+ $\tilde{\nu}_\mu$ (ĉ); {ŝ→đ} {û→ĉ} (56)

Total quarks before decay and finally after, in the second case:

uuđ + uuđ → uuđ +uuđ + d + û + ĉ + đ + u + ĉ + c + c ; (57)

By reducing the quark-antiquark pairs, we get that in this case, the sums of quarks before the reaction and after also coincide.

uuđ + uuđ → uuđ + uuđ; (58)

Consider the decay of the Ω^-_s hyperon:

Ω^-_s (ssŝ) +(uû) → Ξ^0 (suŝ) + π^- (dû); {s →d} (59)

We will also describe further transformations of the quarks of the particles:

π^- (dû) → μ- (s)+ $\tilde{\nu}_\mu$ (ĉ); // from 59 {d →s}{û→ĉ} (60)

Ξ^0 (suŝ) +(uû) → Λ^0(suđ) + π^0(uû); {ŝ→ đ} (61)

π^0 (uû) →2 γ; // from 61 (62)

Λ^0(suđ) +(uû) → p (uuđ) + π - (dû); {s→ d} (63)

π- (dû) → μ^- (s)+ $\tilde{\nu}_\mu$ (ĉ); // from 63 {d →s}{û→ĉ} (64)

μ^- (s) + (uû) → e^- (d) + $\nu_e\tilde{}$ (û) + ν_μ (c); // from 60 {s→d}{u→c} (65)

μ^- (s) + (uû) →e^- (d) + $\nu_e\tilde{}$ (û)+ ν_μ (c); // from 64 {s→d}{u→c} (66)

Consider other variants of the decay of the Ω-hyperon.

Ω^-_s (ssŝ) +(uû) → Λ^0 (suđ)+ K- (sû); {ŝ→ đ} (67)

Ω^-_s (ssŝ) +(uû) →Ξ^-(dsŝ) + π^0 (uû); {s→ d} (68)

Ω^-_s (ssŝ) +(uû) → Ξ^0 (suŝ) + e^- (d) + $\nu_e\tilde{}$ (û); {s→ d} (69)

Ω^-_s (ssŝ) +(uû) → Λ^0 (suđ)+ π - (dû); {s→ d} {ŝ→ đ} (70)

The difference between the proposed quark combinations and the CM is only in one case -for a family of particles of type Σ^{++} with a double electric charge.

The decay of particles from the family Σ^{++} occurs according to the formula:

Σ^{++} → p(uuđ) + π^+(uđ) ; (71)

If we assume that the composition of Σ^{++}(uuu), then the decay into a proton and a positive pion should give two more electrons in the decay, which does not happen.

Σ^{++}(uuu) +(dđ)+(dđ) → p (uuđ) + π^+(uđ) + e^-(d) +e^-(d); (72)

Hence, the structure Σ^{++}(uđđ). Then the decay formula Σ^{++} will look like this :

Σ^{++} (uđđ) +(uû) +(uû) → p (uuđ) + π^+(uđ) + $\nu_e\tilde{}$ (û) + $\nu_e\tilde{}$ (û) ; (73)

This means that when Σ^{++} decays, there must be two more electron antineutrinos.

Most likely, that Σ^{++} is a pentaquark (uuuđđ), then its structure fits into the Standard Model due to the presence of three quarks (uuu) and corresponds to the proposed Geometric Model.

The above allows us to make the assumption that baryons composed of only quarks u, c, t that do not have an electric charge, for example : uuu,uuc,ucc,ccc .... ttt, or are not detected, or cannot form stable (relatively) particles , or can only be part of tetra or pentaquarks.

Barions qqq˜						
Q =	0	+1	0	-1	0	+1
Jp	3/2 ?	1/2	1/2	3/2	1/2	1/2
Group	3 aroma combination					
s1d1b1	cbd˜	ucb˜	std˜	Ξ^-_b(bd˜s)	Ξ^0_b(usb˜)	uts˜
s1d1b1	tcu˜	ctd˜				
Group	1,2 aroma combination					
s3	ccc˜	Ξ^+ (ccs˜)	Ω^0 (css˜)	Ω^{--} (sss˜)		
s2 d1	ccu˜	Ξ^+_c(ucs˜)	Ξ^0 (uss˜)	Ξ^- (dss˜)	Ξ^0_c (csd˜)	ccd˜
s1 d2	cuu˜	Σ^+ (uus˜)	$\Sigma^0\Lambda^0$(usd˜)	Σ^-s (dds˜)	(cdd˜)	Δ^+c(cud˜)
d3	uuu˜	p (uud˜)	n (udd˜)	Δ^- (ddd˜)		
d2 b1	uut˜	utd˜	tdd˜	Σ^-_b (ddb˜)	Σ^0_b(udb˜)	Σ^+_b uub˜
d1 b2	utt˜	ttd˜	tdb˜	Ξ^- dbb˜	Ξ^0 ubb˜	utb˜
b3	ttt˜	ttb˜	tbb˜	Ω^- bbb˜		
b2 s1	ttc˜	ctb˜	cbb˜	Ω^- (bb˜s)	tsb˜	tts˜
b1 s2	tcc˜	ccb˜	bcs˜	Ω^-(bss˜)	tss˜	tcs˜

Table 6 Quark combinations of Baryons

We should also mention the theoretical possibility of obtaining Baryons-nucleons with different quark combinations of u and d quarks. They can be summarized in such a table :

Table 7. Quark combinations of the nucleon group.

Q	-3	-2	-1	0	+1	+2	+3
Q_b \ Jp	3/2	1/2	1/2	1/2(3/2)	1/2	1/2	3/2
+1			Δ-(duû)	n (dđu)	p (đuu)		
-1			p~(dûû)	n~(dđû)	Δ+ (đuû)		
+3	ddd	Δ¯¯`(ddu)	Δ-``(duu)	uuu			
+1		Δ¯¯(ddû)	ddđ	uuû	Δ+`(đuu)		
-1			Δ-`(dûû)	uûû	dđđ	Δ++ (đđu)	
-3				ûûû	Δ+``(đûû)	Δ++`(đđû)	đđđ

Tetraquarks :

Tetraquark decays:

Z$^+$ 4430 (uđcĉ) → e$^+$(đ) + ν$_e$ (u)+ π^0 (uû); (74)

The X5568 tetraquark is produced by the collision of two protons :

p(uuđ)+ p˜ (ûûd)+(sŝ)→ X5568$^+$(uđbŝ)+ π$^-$(ûd)+ π^0(uû); {s→b} (75)

Further disintegration of the tetraquark :

X5568$^+$ (uđbŝ) → B$_s^0$(bŝ)+ π$^+$ (uđ); (76)

B$_s^0$(bŝ)+ (cĉ) → J/w (cĉ)+ φ(sŝ); {b→s} (77)

J/w (cĉ) +(sŝ) → μ- (s)+ ν$_\mu$(c)+ μ$^+$ (ŝ)+ ν˜$_\mu$ (ĉ); (78)

φ(sŝ)+(uû) → K$^+$(uŝ)+K$^-$(ûs); (79)

Tetraquarts qq˜qq˜									
Q	+1	0	+2	+1	-1	-2	0	-1	0
Group	4 aroma combination								
2d2s	Z^{+}4430 ud˜cc˜	ud˜sc˜	ud˜s˜c	ud˜ss˜	˜udcc˜	u˜dsc˜	u˜ds˜c	u˜dss˜	φ^{0} uu˜ss˜
3d1s	ud˜cu˜	ud˜dc˜	ud˜s˜u	ud˜s˜d	u˜dcu˜	u˜ddc˜	u˜ds˜u	u˜dsd˜	
3d1s	ud˜c˜u	ud˜su˜	ud˜d˜c	ud˜s˜d	u˜dc˜u	u˜dsu˜	u˜dd˜c	u˜ds˜d	
4d	ud˜uu˜	$\eta^{0}h^{0}f^{0}b^{0}$ ud˜du˜	ud˜d˜u	ud˜dd˜	u˜duu˜	u˜ddu˜	$\rho^{0}\omega^{0}a^{0}$ u˜dd˜u	u˜ddd˜	
3d1b	ud˜ut˜	ud˜bu˜	ud˜d˜t	ud˜d˜b	u˜dut˜	u˜dbu˜	u˜dd˜t	u˜ddb˜	
3d1b	ud˜u˜t	ud˜dt˜	ud˜b˜u	ud˜d˜b	u˜du˜t	u˜ddt˜	u˜db˜u	u˜dd˜b	
2d2b	ud˜tt˜	ud˜bt˜	ud˜b˜t	ud˜bb˜	u˜dtt˜	u˜dbt˜	u˜db˜t	u˜dbb˜	
2d2b	ud˜tc˜	ud˜st˜	ud˜b˜c	X+5568 ud˜s˜b	u˜dtc˜	u˜dst˜	u˜db˜c	u˜dsb˜	
2d1s1b	ud˜t˜c	ud˜bc˜	ud˜s˜t	ud˜sb˜	u˜dt˜c	u˜dbc˜	u˜ds˜t	u˜ds˜b	

Table 8. Quark combinations of Tetraquarks

Pentaquarks :

Reactions of production and decomposition of pentaquarks:

Λ^{0}_{b}(uđb) +(uû)+(cĉ) → Pc(4450)$^{+}$(uuđcĉ)+ K^{-} (sû); {b→s} (80)

Pc(4450)$^{+}$(uuđcĉ) → p (uuđ)+ J/w(cĉ); (81)

J/w (cĉ) +(sŝ) → μ- (s)+ ν_{μ} (ĉ)+ μ+ (ŝ)+ $\tilde{\nu}_{\mu}$ (ĉ); (82)

Another option for obtaining a pentaquark :

p(uuđ) + n(uddđ) + (uû)+(sŝ) → Θ^{+}1540 (uuđdŝ) + K^{-}(sû) + p(uuđ); (83)

Θ^{+}1540 (uudđŝ) → n(udđ) +K^{+}(uŝ); (84)

Θ^{+}1540 (uudđŝ) → p(uuđ) +K^{0}(dŝ); (85)

P5^{--} (ddsŝû) → Ξ^{-} (dsŝ) + π^{-} (ûd); (86)

P5^{--} (ddsŝû) → Σ^{-} (ddđ) + K^{-} (sû); {s→d} (87)

P5^{+}(uusŝđ) →Ξ^{0} (usŝ) + π^{+} (uđ); (88)

P5^{+}(uusŝđ) →Σ^{+} (uuŝ) + K^{0} ˜(sđ); (89)

Pentaquarks qqq˜ +qq˜						
Q	-1	+1	0	+2	+1	-1
Group	5 aroma combination					
3d2s	uu˜dcc˜	P_c4450$^+$ uud˜cc˜	uud˜sc˜	B2420^{++} uud˜s˜c	uud˜ss˜	uu˜dss˜
4d1s	uu˜dcu˜	uud˜cu˜	uud˜dc˜	uud˜s˜u	uud˜sd˜	uu˜dsd˜
5d	uu˜dc˜u	uud˜c˜u	uud˜su˜	Σ_c^{++} uud˜d˜c	Θ^+1540 uud˜s˜d	uu˜ds˜d
5d	uu˜duu˜	uud˜uu˜	Δ^0 uud˜du˜	Δ^{++} uud˜d˜u	Δ^+ uud˜dd˜	Δ^- uu˜ddd˜
5d			N^0 udd˜dd˜	Σ^{++} uud˜d˜u	N^+ uud˜dd˜	N^- uu˜ddd˜
5d	uu˜dut˜	uud˜ut˜	uud˜bu˜	uud˜d˜t	uud˜db˜	uu˜ddb˜
4d1b	uu˜du˜t	uud˜u˜t	uud˜dt˜	uud˜b˜u	uud˜d˜b	uu˜dd˜b
3d2b	uu˜dtt˜	uud˜tt˜	uud˜bt˜	uud˜b˜t	uud˜bb˜	uu˜dbb˜
3d1s1b	uu˜dtc˜	uud˜tc˜	uud˜st˜	uud˜b˜c	uud˜sb˜	uu˜dsb˜
3d1s1b	uu˜dt˜c	uud˜t˜c	uud˜bc˜	uud˜s˜t	uud˜s˜b	uu˜ds˜b

Table 8. Quark combinations of Pentaquarks

The author suggests that it is possible that the neutron decay also goes through the Pentaquark stage.

n (udđ) + (uû) $\rightarrow$ p5(uûudđ) $\rightarrow$ p(uuđ) + W^-(ûd); (90)

W^-(ûd) $\rightarrow e^-$ (d) + $\nu^{\sim}_e$(û); (91)

In this case, $W^{\pm}$ Z^0 are just massive variants of π mesons, as well as π (1300), π(1400), ... n,ω,a,b,f, h. The quark composition is the same, but the volumes-masses of the multi-sided quarks are different.

In 2014, the d-Star hexaquark (dibaryon) - d* (2380) was discovered in the Julich Center, in the reactions pn→d $\pi^0\pi^0$; pn→d $\pi^+\pi^-$ It is assumed to consist of three lower and three upper quarks, i.e. uuuddd.

Based on the assumption that this particle is a candidate for antimatter, then its baryon and Coulomb charges should be equal to zero. Therefore, three of the components are antiquarian. And based on the pairs of Pi mesons obtained in the decay: π^0(uû), π^+(uđ), π^-(ûd), it turns out that d* consists of the variants d*(uûuûdđ) or d*(uûdđdđ).

The dibaryon H in the form of the structure H (uûdđsŝ) is also neutral and can be considered a combination of two hyperons Λ^0(suđ)+ и $\Lambda^{0\sim}$(ŝud),

Considering quarks as polyhedra with an axis of symmetry and an axis of proper rotation makes it possible to interpret the color of quarks as the spatial orientation of this axis. And the RGB quark colors can be correlated with the three orthogonal XYZ axes. Then, by virtue of the law of conservation of the total angular momentum of quarks in a particle, a change in the position of the axis of rotation of one of the quarks (a change in color) will cause a change in the axis of rotation of the other quark, and restore the" colorless " state of the particle.

The proper rotation along the XYZ axes of three nested quarks-polyhedra in nucleons, may well generate a magnetic field that pulls them together in the nucleus.

And in conclusion, it is worth mentioning the gluon-preon theory. Despite the fact that neither one nor the other has been experimentally detected, it is quite possible to consider the vertices as preons, quarks-polyhedra, and gluons as one-dimensional vectors inside baryons.

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