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Structure of the Atomic Nuclei in the Universe Model with Minimal Initial Entropy

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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Original Research Article

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ABSTRACT

In this paper we show on the base of new ideas about the origin and evolution of the Universe, that in three-dimensional space the fundamental particles should have electric charges equal to 0, ±e, ±2e, ±3e, what corresponds to the neutron and three pairs of light stable nuclei (hydrogen, helium, lithium). All heavy ($Z \geq 4$) cores are presented in the form of molecular structures consisting of light nuclei; there are shown the reasons of instability of the nuclei in the ground and excited states. The hierarchy of bosons which are responsible for the interaction between particles in different hierarchical layers of fiber space Super-Universe is given.

Keywords: Heavy cores; light stable nuclei; excited states; hierarchy of bosons; three-dimensional space.

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1. INTRODUCTION

The process of our Universe origin as the part of the Super-Universe was described in detail in the article [1] on the basis of the Law of similarity [2] and the Law of unity.

Our Universe is a part of the Super-Universe. At the same time, the Super-Universe is layered space [3] where adjacent layers change the space dimensionality by one. Usual for us three-dimensional space (four-dimensional (3 + 1) Universe) has a border with two-dimensional space of quarks [4]. Two-dimensional space has a border with one-dimensional space of diones, that are found to be Planck particles. Finally, one-dimensional space has a border with zero-dimensional space of scalar Field-time. There is an information interaction among adjacent spaces through a single delocalized point. A zero-dimensional space of Field-time can interact with all other spaces and can dictate the program of the Universe evolution.

Field brings energy subsequently first into one-dimensional, then into two-dimensional and finally, after $\Delta t = 3 \cdot 10^{-5}$ s, into three-dimensional space. As a result in three-dimensional space cold neutron energy is created, which has initial density similar to nuclear density. Neutrons decay leads to protons and electrons creation in equal quantity, making Universe electrically neutral.

In this paper, the mechanisms of particles and atomic nuclei creation in our four-dimensional (3 + 1) Universe will be revealed using the same Laws.

A lot of models of atomic nucleus structure have been discussed in the literature. One of these models included in all textbooks on nuclear physics, presents the nucleus as the set of protons and neutrons with the configuration which provides the minimum energy of nucleus. It is assumed that, despite of the α-activity of heavy nuclei, α-particles are absent in the nuclear structure as defined clusters. Among these models there is also cluster (molecular) model [2,5-6].

Cluster model (or the model of nucleon associations) treats the structure of some nuclei as a kind of molecule consisting of α-particles, deuterium (D), tritium (T), and others. For example, $^{12}C=3\alpha$, $^{16}O=4\alpha$, $^{6}Li=\alpha+D$, $^{7}Li=\alpha+T$ and so on.

Model of nucleon associations is a model of atomic nucleus based on nucleus representation as a system of clusters, or nucleon associations of a certain type, usually, α-clusters. The simplest version of this model (α-cluster model) was formulated in 1937 by J. A. Wheeler. This model has arisen from the fact that the stability of nuclei is increased if the core has an even number of protons and neutrons, like in α-particle. Therefore such nuclei were described as clusters of α-particles. Among these nuclei there are ^{8}Be, ^{12}C, ^{16}O, ^{20}Ne and similar nuclei (at n = 2, 3, 4, 5). For these nuclei an enormous amount of energy E_n is needed to remove a neutron. For nearest nucleus with odd number of neutrons this energy decreases by 10-15 MeV. Meanwhile the energy which is needed to remove an α-particle (E_α) is rather small. ^{8}Be nucleus is unstable as for the decay into two α-particles ($E_\alpha<0$), and as a result this nucleus does not exist. For other nuclei of this row the binding energy of the α-particles increases (in a nucleus of ^{12}C the energy E_α = 7 MeV, in ^{16}O E_α= 16 MeV).

There was experimentally established the following law: nuclei consisting of α-particles can easily emit them in nuclear reactions. Moreover, it has been shown that these nuclei have excited states with abnormally large width of α-transitions. This means that α-particles exist on nucleus surface as separate clusters.

For such nuclei, the nucleus wave function can be written as a product of the antisymmetrized wave function ψ_α, describing the internal motion of the nucleons in the individual α-cluster, and the wave function χ, describing the motion of the clusters with respect to each other.

$$\psi\left({}^{8}Be\right)=\hat{A}\,\psi_{\alpha 1}(r_1)\psi_{\alpha 2}(r_2)\chi_L(R_1-R_2),$$

where $R_i=\sum_{i=1}^{4} r_i/4$ is the radius-vector of the center of mass of the α-cluster, L is total the orbital angular momentum of the nucleus, $\hat{A}$ is the antisymmetrization operator on the nucleons belonging to different clusters.

However, it has been found that such wave function can satisfactorily describe the behavior of ^{8}Be and ^{12}C, but it can not describe ^{16}O, ^{20}Ne, etc.

The cluster model is used to describe the nuclear reactions. The most common approach here is the so-called resonating group method which is similar to the method of valence bonds for the description of the molecules [7].

The cluster model of heavy clusters is frequently used to describe nuclei. For example, ^{24}Mg nucleus is described as a "molecule", consisting of two ^{12}C nuclei separated in space. In this case, wave functions $\psi_{^{12}C}$ instead of ψ_{α} are written for nucleus.

It is interesting, that a quark model of nucleons is analogue of the cluster model of nucleus (nucleon is considered as a 3-quark cluster and it is also assumed the existence of multiquark configurations: 6- and 9-quark clusters).

The cluster model proved to be useful for the description of a nucleon fragmentation processes in the nuclear reactions taking place under an action of high-energy heavy ions.

Thus, we have a confirmation of the molecular structure of nuclei. The only difference between cluster models used in experimental and theoretical studies from our model is that they are empirical, unproved. Our presentation naturally arises from the new methodological basis of the World cognition.

2. PARTICLES OF FOUR-DIMENSIONAL UNIVERSE

According to the statements of Victor Kulish [2] our Manifested World has 4 dimensions and Hidden World has only 3 ones. Together we have 7 dimensions: 3 dimensions for the quarks and four dimensions for the nucleons, electrons, atoms, matter, fields.

Four-dimensional World of particles is produced by the three-dimensional World because of quarks are glued together by gluon into particles. These quarks are in the Hidden World, while corresponding particles are in the Manifest World [1-2].

The charges of quarks are –(⅓)*e* and +(⅔)*e* (opposite signs for antiquarks), *e* is the minimum charge of the particle in four-dimensional space-time.

It means that quarks charges are formed by the dimension of the World: ±(⅓)*e* for each coordinate. Thus, all types of quarks are two-dimensional (since the space has two dimensions, all the particles in this space should move only in two directions) which is allowed by the dimensionality of space. So, it can be assumed, that in Hidden space the charges 0, ±(⅓)*e* and ±(⅔)*e* can exist.

Comparing these conclusions with the data in Table 1 it can be concluded that for the quarks only charge -(⅓)*e* and +(⅔)*e* are realized, and opposite charges are for antiquarks. This result can be understood taking into account that the birth of the Universe is presented as a vortex (and as a result tightening in gravity [8] and time [9] takes place). At the same time, the 3 projections of charge are realized as stationary states in the World-3, see Fig. 1.

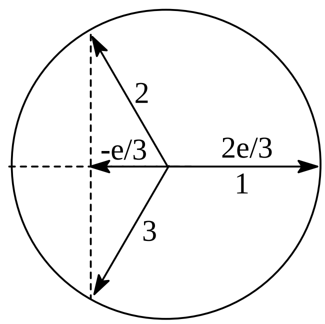

Fig. 1. Three projections of charge in the World-3. Two types of charge -(⅓)*e* should be different by additional quantum numbers (helicity). Mirror reflection with respect to the vertical *y*-axis (or in inversion point) gives the charges of antiparticles

To determine the charge in the World-4 it is necessary to use a sphere rotation (Fig. 2).

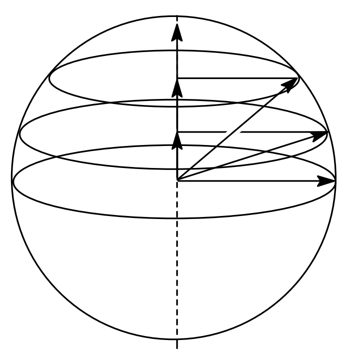

Fig. 2. Four projections of a charge in the World 4. Mirror reflection in the plane *xy* (or in reversal point) will give the charges of antiparticles

Table 1. Quarks

Type (flavor) of quark	Electric charge	Spin	Colour	Mass (calculation)
d	-(1/3)e	ħ/2	Yellow, blue, red	~7 MeV/c^2
u	+(2/3)e		–″–	~5 MeV/c^2
s	–(1/3)e		–″–	~150 MeV/c^2
c	+(2/3)e		–″–	~1,5 GeV/c^2
b	–(1/3)e		–″–	~4,5 GeV/c^2
t	+(2/3)e		–″–	~175 GeV/c^2

It is necessary to note another important detail: all particles of World-4 have been formed due to the transfer of information from a quarks cluster while the heavy nuclei are formed from the particles of World-4 whose quarks do not have a border. This is worth also to remember during the consideration of the fusion reaction of helium nucleus formation from the nuclei of hydrogen and lithium or deuterium, when the quarks of complex core do not border each other. And only due to virtual pairs participation (a proton-antiproton, etc.) the α-particle of World-4 is formed from a complex helium nucleus.

The dimensionality of the World is changing during the transition from the Hidden World to the Manifested World, and hence the magnitude of a charge. The dimensionality of the Manifested World requires a combination of quark charges to create a charge ± *e*.

On the other hand, charges 0, ±*Q*/4, ±2*Q*/4, ±3*Q*/4 should exist in the Manifested World. Here, the value of ±*Q* corresponds to the charge of the next five-dimensional World where our space is generating (and probably hidden).

As a result, $Q = 4q = 4e$ is an elementary charge of the next Manifested World where our particles will be quarks-4.

It is also should be noted, that according to Fig. 2 stable charges ±*e*, ±2*e*, ±3*e*, and 0 should exist in our space.

Nuclei of hydrogen correspond to the first particle (proton and deuteron), nuclei of helium correspond to the second particle (${}^{3}_{2}He$ and ${}^{4}_{2}He = {}^{4}_{2}\alpha$), the third particle corresponds to lithium nuclei [1]. Of course, particles and antiparticles corresponding to particles with opposite charges should exist. However, the Manifested World has electrons with charge –*e* to stabilize atoms and to provide the electrical neutrality of the Universe.

Table 2. Particles of four-dimensional World (World-4)[2]

Charge	Particles	The total content of isotopes in the universe
-e	*e*	
0	${}^{1}_{0}n$	
+e	${}^{1}_{1}H$, ${}^{2}_{1}D$	0.65 [2,10]
+2*e*	${}^{3}_{2}He$, ${}^{4}_{2}He$	0.24 [2,10]
+3*e*	${}^{6}_{3}Li$, ${}^{7}_{3}Li$	$6.5\cdot10^{-5}$ [11]

Note: The concentrations of charged particles in the World-4 are following:

$[{}^{2}_{1}D] = 1.56\cdot10^{-4}\cdot[{}^{1}_{1}H]$, when contribution of ${}^{1}_{1}H$ particles in the Universe equals to 65%;

$[{}^{3}_{2}He] = 1.38\cdot10^{-6}\cdot[{}^{4}_{2}He]$, when contribution of ${}^{4}_{2}He$ particles in the Universe equals to 24%;

$[{}^{6}_{3}Li] = 8.1\cdot10^{-2}\cdot[{}^{7}_{3}Li]$, when contribution of ${}^{7}_{3}Li$ particles equals to $2\cdot10^{-10}$ in the Universe and $6.5\cdot10^{-5}$ on Earth.

Since among the particles of the World-4 a rapid process of exchange interaction (p↔p, n↔n, n↔p) takes place, it is necessary to assume that each element of these particles is a result of averaging, i.e. all the elements of particles are identical, and the particles of World-4 are indivisible. In such way they will perform for particles of brane in the World -5.

Since the particles of the World-4 act as indivisible, it is better to present them using a quark structure:

[1] This suggests an interesting parallel: three pairs of quarks and three pairs of particles of World-4. For the second and third pairs of quarks the top quark is more massive, and for the first pair an opposite situation takes place. Similar relationships can be observed for propagation of particles in World-4.

[2] Using the presentation of the particles of the World-4, shown in Figure 2, we can find a product of the length of corresponding circle on the height of the segment of a circle, and then can find the ratio of these values. It turns out that it is equal to 1: 0.6285: 0.2484: 0; i.e. corresponds to the concentration of the relevant charges in the Universe.

$^{1}_{1}H$ = 2u + d ≡ u^2d ,

$^{2}_{1}D$ = 3u + 3d ≡ u^3d^3 ,

$^{3}_{2}He$ = 5u + 4d ≡ u^5d^4 ,

$^{4}_{2}He$ = 6u + 6d ≡ u^6d^6 ,

$^{6}_{3}Li$ = 9u + 9d ≡ u^9d^9 ,

$^{7}_{3}Li$ = 10u + 11d ≡ $u^{10}d^{11}$.

So, we have a stable structure containing three quarks, 6 quarks, 9 quarks, 12 quarks, 18 quarks and 21 quarks. There are no structures containing 15 quarks ($^{5}_{2}He$ or $^{5}_{3}Li$) in the World-4 (negative binding energy of proton or neutron with $^{4}_{2}He$ [12]).

Thus, during the transition from the Hidden World-3 into the Manifested World-4 a formation of particles from quarks takes place, i.e. the real Manifested World. That is why quarks are in the Hidden World, and hadrons are in the Manifested World and there is an information interaction between them.

As other nuclei and atoms of our World are formed as a result of a combination of a family of particles of World-4, it should be assumed that with the formation of other nuclei and atoms the Manifest World-4 received the fifth coordinate (it becomes the brane of four-dimensional space), which began to increase in time, leading to the birth of matter, planets, stars etc., causing the expansion of the Universe.

So, we are living in the swelling brane of the World-5.

Moving in the opposite direction, we shall understand that a generating two-dimensional World should exist for the hidden for us three-dimensional World providing the possibility of ±1/2 charges of a quark-3. For the World-4 these charges are equal to ±*e*/6. These quarks-2 will generate all possible quarks-3. It was shown in [1] that quarks-2 should be diones having both electric and magnetic charges. During the transition to the spaces of higher dimensionality magnetic charges cause the appearance of the spin of elementary particles.

A lot of quantum numbers of quarks are lost at the birth of the World-4, and in particular color. Therefore, we can assume that in the two-dimensional World there are some characteristics, which are lost at the transition to the World-3 (including the abovementioned magnetic charges). Thus, two particles of World - 2 have a wide set of quantum numbers, which are lost during the transitions to the Worlds of higher dimensionality.

The Fields-time coordinates are common for all spaces, so two spatial dimensions of quarks and one spatial dimension constituent quarks (diones) from the previous World should be added for our four-dimensional World. Totally it will be 7 dimensions. However, 3 of them have various degrees of secrecy (2 for the nearest Hidden World and 1 for the remote one).

There are photons in the World-4. They appear, in particular, during particles-antiparticles annihilations. But there are particles (for example, π^o), which have quark-antiquark type structure. This results in a disintegration of such particles into γ-quants in the World-4, while the quark-antiquark annihilation has to give 2 two-dimensional photons specific for World-3. Types of these photons are discussed in [1].

3. PARTICLES OF WORLD-5. THE HIERARCHY OF BOSONS

In our World-5, all other nuclei (Z ≥ 4) are combinations of "elementary" particles of World-4 and can decay into these "basic" particles.

First, let’s consider nuclei structures as combinations of neutrons and "elementary" particles of World-4. We assume that contribution of some combination of "elementary" particles of World-4 depends on concentration of these particles in the Universe. For example, according to Table 2, there is very small amount of $^{6}_{3}Li$ nuclei in the Universe. That is why the number of combinations containing $^{6}_{3}Li$ should be also small. Then we extend the list of "elementary" particles of World-4 introducing heavy isotopes ($^{3}_{1}T$, $^{6}_{2}He$, $^{9}_{3}Li$) to better describe structure of heavy nuclei.

So, combinations of “elementary” particles are following:

$^{3}_{1}T \rightarrow ^{2}_{1}D + ^{1}_{0}n$, - unstable (β^- - active) nucleus due to the contribution of the neutron;

$^{8}_{3}Li \rightarrow ^{7}_{3}Li + ^{1}_{0}n,$ - the nucleus is β^- - active;

${}^{9}_{4}Be \rightarrow {}^{7}_{3}Li + {}^{2}_{1}D,$ - the nucleus is stable, but quite rare because there are not enough lithium and deuterium in the Universe;

${}^{10}_{4}Be \rightarrow {}^{7}_{3}Li + {}^{2}_{1}D + {}^{1}_{0}n \leftrightarrow {}^{7}_{3}Li + {}^{3}_{1}T,$ - the nucleus is β^{-} - active;

${}^{10}_{5}B \rightarrow {}^{4}_{2}\alpha + {}^{6}_{3}Li,$ - the nucleus is stable; but less than ${}^{11}_{5}B$, because $\left[{}^{6}_{3}Li\right] < \left[{}^{7}_{3}Li\right],$

${}^{11}_{5}B \rightarrow {}^{4}_{2}\alpha + {}^{7}_{3}Li,$ - the nucleus is stable, but quite rare because there is not enough lithium in the Universe;

${}^{12}_{5}B \rightarrow {}^{4}_{2}\alpha + {}^{7}_{3}Li + {}^{1}_{0}n,$ - the nucleus is β^{-} - active, ${}^{12}_{6}C$ is formed in an excited state, which decays into three α-particles.

${}^{11}_{6}C \rightarrow 2\,{}^{4}_{2}\alpha + {}^{2}_{1}D + {}^{1}_{1}H,$ or ${}^{11}_{6}C \rightarrow 2\,{}^{4}_{2}\alpha + {}^{3}_{2}He,$ small contribution of the second combination, the first one is β^{+} - active (the proton in the field of nuclear forces is unstable),

${}^{12}_{6}C \rightarrow 3\,{}^{4}_{2}\alpha,$ or ${}^{12}_{6}C \rightarrow 2\,{}^{6}_{3}Li$, - the nucleus is stable, but the probability of the reaction of the second type is very small, because of the lack of ${}^{6}_{3}Li$ in the Universe;

${}^{13}_{6}C \rightarrow {}^{6}_{3}Li + {}^{7}_{3}Li,$ - nucleus is stable, but the amount of these nuclei is small (1%).

${}^{14}_{6}C \rightarrow 2\,{}^{7}_{3}Li$, or ${}^{14}_{6}C \rightarrow {}^{7}_{3}Li + {}^{4}_{2}\alpha + {}^{2}_{1}D + {}^{1}_{0}n$, or ${}^{14}_{6}C \rightarrow 3\,{}^{4}_{2}\alpha + 2\,{}^{1}_{0}n$, - unstable nucleus ($\beta^{-}$-active) as a result of the contribution of the neutron, due to big amount of ${}^{4}_{2}\alpha$;

${}^{12}_{7}N \rightarrow 2\,{}^{4}_{2}\alpha + {}^{3}_{2}He + {}^{1}_{1}H,$ - the nucleus is β^{+}-active, ${}^{12}_{6}C$ is formed in an excited state, with following decay into three α-particles.

${}^{13}_{7}N \rightarrow 3\,{}^{4}_{2}\alpha + {}^{1}_{1}H,$ - the nucleus is β^{+} - active,

${}^{14}_{7}N \rightarrow 3\,{}^{4}_{2}\alpha + {}^{2}_{1}D,$ or ${}^{14}_{7}N \rightarrow 2\,{}^{4}_{2}\alpha + {}^{6}_{3}Li,$ - the nucleus is stable,

${}^{15}_{7}N \rightarrow 2\,{}^{4}_{2}\alpha + {}^{7}_{3}Li,$ - the nucleus is stable, but the amount of these nuclei is small (0.365%),

${}^{16}_{7}N \rightarrow 2\,{}^{4}_{2}\alpha + {}^{7}_{3}Li + {}^{1}_{0}n,$ - the nucleus is β^{-} - active, it transforms into ${}^{16}_{8}O$ in the excited state, which emits one α-particle,

${}^{16}_{8}O \rightarrow 4\,{}^{4}_{2}\alpha,$ or ${}^{16}_{8}O \rightarrow 2\,{}^{6}_{3}Li + {}^{4}_{2}\alpha,$ - the nucleus is stable in ground state[3]; small contribution of the second combination, because of the lack of ${}^{6}_{3}Li$ in the Universe.

${}^{17}_{8}O \rightarrow {}^{4}_{2}\alpha + {}^{7}_{3}Li + {}^{6}_{3}Li,$ - such nuclei should be a rare case, because of small amount of ${}^{7}_{3}Li$ and even smaller amount of ${}^{6}_{3}Li$ in the Universe [$N\left({}^{4}_{2}\alpha\right) >> N\left({}^{7}_{3}Li\right) \rangle\rangle N\left({}^{6}_{3}Li\right)$].

${}^{18}_{8}O \rightarrow {}^{4}_{2}\alpha + 2\,{}^{7}_{3}Li$, - the nucleus is stable; its amount is smaller than ${}^{16}_{8}O$ (because $N\left({}^{4}_{2}\alpha\right) >> N\left({}^{7}_{3}Li\right)$), but 6 times bigger than ${}^{17}_{8}O$.

${}^{19}_{8}O \rightarrow {}^{4}_{2}\alpha + 2\,{}^{7}_{3}Li + {}^{1}_{0}n,$ - the nucleus is β^{-} - active,

${}^{18}_{9}F \rightarrow 4\,{}^{4}_{2}\alpha + {}^{2}_{1}D,$ or ${}^{18}_{9}F \rightarrow 3\,{}^{4}_{2}\alpha + {}^{6}_{3}Li,$ ${}^{18}_{9}F \rightarrow 2\,{}^{4}_{2}\alpha + {}^{7}_{3}Li + {}^{2}_{1}D + {}^{1}_{1}H,$ - only the later combination provides β^{+}- activity, so the reaction is slow (109.7 min),

${}^{19}_{9}F \rightarrow 3\,{}^{4}_{2}\alpha + {}^{7}_{3}Li,$ - the nucleus is stable,

${}^{20}_{9}F \rightarrow 3\,{}^{4}_{2}\alpha + {}^{7}_{3}Li + {}^{1}_{0}n,$ - the nucleus is β^{-} - active (11.56 s),

${}^{19}_{10}Ne \rightarrow 4\,{}^{4}_{2}\alpha + {}^{2}_{1}D + {}^{1}_{1}H,$ ${}^{19}_{10}Ne \rightarrow 4\,{}^{4}_{2}\alpha + {}^{3}_{2}He,$ - the nucleus is β^{+} - active, small contribution of the second combination,

${}^{20}_{10}Ne \rightarrow 5\,{}^{4}_{2}\alpha,$ - the nucleus is stable[4] (90.92%),

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[3] Below much more structures for the core ${}^{16}_{8}O$ providing its stability in the ground state will be presented.
[4] In fact, this nucleus has much more structures, how it will be shown below for ${}^{16}_{8}O$.

${}^{21}_{10}Ne \rightarrow 3\,{}^{4}_{2}\alpha + {}^{7}_{3}Li + {}^{2}_{1}D$, - the nucleus is stable, but the amount of these nuclei is small (0.257%)

${}^{22}_{10}Ne \rightarrow 2\,{}^{4}_{2}\alpha + 2\,{}^{7}_{3}Li$, - the nucleus is stable (8.82%),

${}^{23}_{10}Ne \rightarrow 2\,{}^{4}_{2}\alpha + 2\,{}^{7}_{3}Li + {}^{1}_{0}n$, - the nucleus is β^{-} - active.

${}^{22}_{11}Na \rightarrow 5\,{}^{4}_{2}\alpha + {}^{2}_{1}D,\ 4\,{}^{4}_{2}\alpha + {}^{6}_{3}Li,\ 3\,{}^{4}_{2}\alpha + {}^{7}_{3}Li + {}^{3}_{2}He,$
${}^{4}_{2}\alpha + 2\,{}^{7}_{3}Li + {}^{3}_{2}He + {}^{1}_{1}H,\ 2\,{}^{7}_{3}Li + {}^{6}_{3}Li + 2\,{}^{1}_{1}H,$
the nucleus is β^{+} - active tacking into account last configurations,

${}^{23}_{11}Na \rightarrow 4\,{}^{4}_{2}\alpha + {}^{7}_{3}Li$, the nucleus is stable,

${}^{24}_{11}Na \rightarrow 4\,{}^{4}_{2}\alpha + {}^{7}_{3}Li + {}^{1}_{0}n$, the nucleus is β^{-} - active.

* * * * * * * * * *

${}^{55}_{25}Mn \rightarrow 5\,{}^{4}_{2}\alpha + 5\,{}^{7}_{3}Li,$

${}^{54}_{26}Fe \rightarrow 10\,{}^{4}_{2}\alpha + 2\,{}^{7}_{3}Li,\ 7\,{}^{4}_{2}\alpha + 2\,{}^{7}_{3}Li + 2\,{}^{6}_{3}Li,$
the nucleus is stable (5.84%), small contribution of the second combination,

${}^{55}_{26}Fe \rightarrow 10\,{}^{4}_{2}\alpha + 2\,{}^{7}_{3}Li + {}^{1}_{0}n,\ 7\,{}^{4}_{2}\alpha + 3\,{}^{7}_{3}Li + {}^{6}_{3}Li,$
$6\,{}^{4}_{2}\alpha + 4\,{}^{7}_{3}Li + {}^{3}_{2}He$,
in this case, the experiment shows *K*-electron capture with a conversion into a stable nucleus ${}^{55}_{25}Mn$. Thus, it is necessary to assume that the contribution of the last configuration is a main one, while the first is very small. In the field of nucleus ${}^{3}_{2}He$ there is a reduction of the number of neutrons, which results in *K*-electron capture with a conversion it into tritium nucleus. And tritium nucleus combination with α-particle produces ${}^{7}_{3}Li$ nucleus, which corresponds to the ${}^{55}_{25}Mn$ nucleus configuration.

Proceeding in the same manner to the heavy nuclei, we draw an attention to the fact that the protons-neutrons number relation for nuclei with number up to No. 50 can be described by combinations of ${}^{7}_{3}Li$, ${}^{4}_{2}He$ etc. But after this number the contribution of neutrons increases. Moreover, at the transition from ${}^{208}_{82}Pb$ to ${}^{238}_{92}U$ 10 protons and 20 neutrons should be added [13]. So, ${}^{3}_{1}T$, ${}^{6}_{2}He$, ${}^{9}_{3}Li$ should be included into the consideration. Such nuclei really exist, but, they are β^{-} - active with the lifetime $3.87\cdot10^{8}$ s = 12.262 years, 0.797 s and 0.176 s respectively.

Neutrons in a free state are also β^{-}- active, but all nuclei contain them. The interaction between nucleons much faster makes a transformation of a neutron into a proton, than it would decay.

So, these three heavy nuclei can stably exist in nuclei, where the number of neutrons is twice higher than the number of protons. The need for such nuclei should be grounded on intranuclear interaction.

The bosons are always responsible for the interaction between particles. The gluons are responsible for strong interaction between quarks; the bosons partially in the World-3 and partially in the World-4 are responsible for weak interaction $W(^{\pm})$ и Z^{o} [14]. $\pi(^{\pm})$ and π^{o} bosons can not be neglected in the consideration. They are responsible for the transfer of the interaction between nucleons in three groups of particles in the four-dimensional World. Bosons of the World-4 should provide the interaction between the particles of the World-4. α-particle and boson, consisting of two coupled neutron Y(2n) can play this role. For example:

$${}^{7}_{3}Li + {}^{3}_{1}T \leftrightarrow {}^{3}_{1}T + X\left({}^{4}_{2}\alpha\right) + {}^{3}_{1}T \leftrightarrow {}^{3}_{1}T + {}^{7}_{3}Li$$
$${}^{9}_{3}Li + {}^{1}_{1}H \leftrightarrow {}^{7}_{3}Li + Y(2n) + {}^{1}_{1}H \leftrightarrow {}^{7}_{3}Li + {}^{3}_{1}T \quad \text{(Fig. 3).}$$

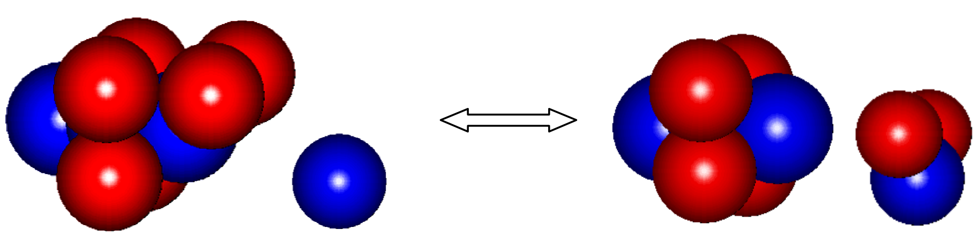


Fig. 3. Intranuclear interactions due to Y(2n) boson transfer

$$ {}^{9}_{3}Li + {}^{4}_{2}He \leftrightarrow {}^{7}_{3}Li + Y(2n) + {}^{4}_{2}He \leftrightarrow {}^{7}_{3}Li + {}^{6}_{2}He $$
$$ {}^{6}_{2}He + {}^{1}_{1}H \leftrightarrow {}^{4}_{2}He + Y(2n) + {}^{1}_{1}H \leftrightarrow {}^{4}_{2}He + {}^{3}_{1}T $$

In this case, it becomes clear that twice higher contribution of neutrons (in comparison with protons) required in heavy nuclei.

Since it is considered that boson X(α) is much heavier than boson Y(2n), it should provide a much stronger interaction. However, a reality shows that α-particles are poorly connected to the rest of the nucleus fragments, because they have a large electrical charge. As a result, α-particle is not able to provide interaction between components of a nucleus. Moreover, if α-particle participated in the formation of nuclei with Z > 50, the protons-neutrons correlation 1:2 would be different. So the interaction via X(α) bosons has to be excluded from the consideration.

So, it is clear now that ${}^{8}_{4}Be \rightarrow 2\,{}^{4}_{2}\alpha$ can not exist and should immediately decay into two α-particles. In the present case, it is impossible to arrange the transfer of two neutrons. A resonant exchange by Y(2n)-bosons is only possible. But, in this situation it is necessary to take off two neutrons from α-particles, and then put two other neutrons on their place. If the last reaction seems simple enough, the first one requires a lot of effort and its implementation looks problematic.

In the case of ${}^{12}_{6}C \rightarrow 3 \cdot {}^{4}_{2}\alpha$ the nucleus can be imagined only in excited state, which leads to its decay on 3 α-particles. The ground state can be provided by the configuration ${}^{12}_{6}C \rightarrow {}^{9}_{3}Li + 3\,{}^{1}_{1}H \leftrightarrow {}^{7}_{3}Li + 2\,{}^{1}_{1}H + {}^{3}_{1}T$. The "Molecular" structure is following (Fig. 4).

As boson, which transports interaction, is virtual, the particle can emit it and absorb it at once (Fig. 5). This phenomenon is described in detail in quantum electrodynamics.

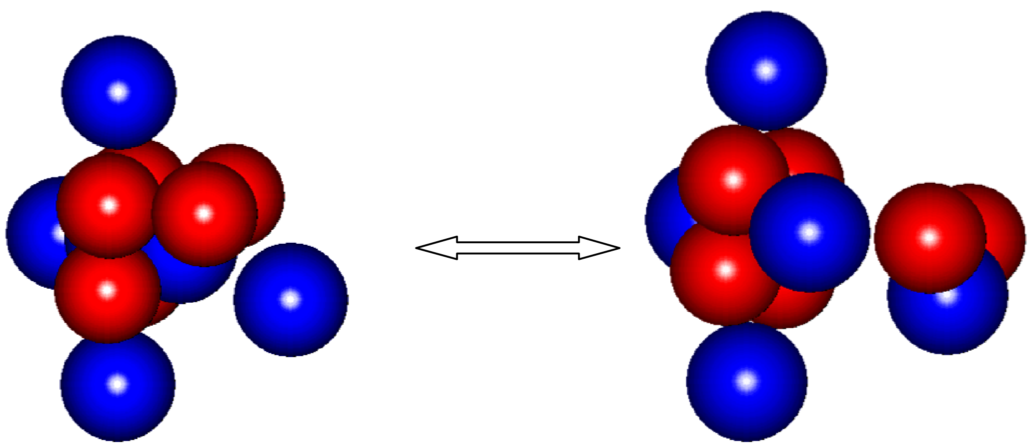
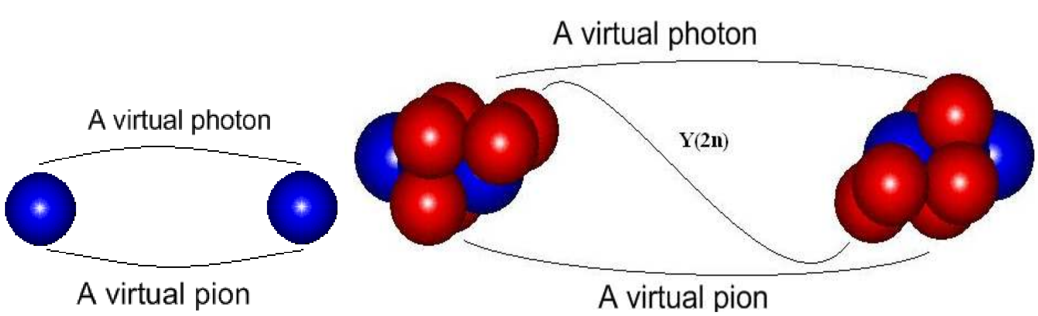


Fig. 4. The "Molecular structure" of carbon nucleus ${}^{12}_{6}C$



(a) **(b)**

Fig. 5. A particle surrounded by virtual bosons: *a* - proton, *b* - ${}^{9}_{3}Li$

There is leak of information in the literature concerning bineutron, which is treated in this manuscript as boson of World-4. It is only known, that neutrons have huge interactions between each other by exchange of neutral pions. The same processes should take place in biproton. But in such case electrostatic repulsion between protons (≈ 1 MeV) leads to resulting binding energy in biprotons equal to -0.5 MeV. So, strong interaction energy, caused by transfer of neutral pion between neutrons, is equal to 0.5 MeV [15, 16]. But, neutron decays due to processes of weak interaction after ~881 s [17]. After comparing half-decay periods of β^- - active nucleus (e.g. $T_{½}(^{16}N)$ = 7.14 s and $T_{½}(^{18}N)$ = 0.63 s; $T_{½}(^{20}F)$ = 11.56 s and $T_{½}(^{22}F)$ = 4.0 s [13]), we could make following conclusion: period of neutron half-decay could be decreased in 1-2 orders with increasing neutrons quantity in cluster. But this time is much longer than period of half-decay of strong interaction bosons (pions).

So, as a result of the processes of boson radiation-absorbing a spatial orientation or shape of nucleus components can continuously change. This is important in the cases when a nucleus of 5-dimensional World brane contains more than two particles-4. For example, ${}^{12}_{6}C$ nucleus contains 4 particles-4 (${}^{9}_{3}Li+3^{1}_{1}H$ or ${}^{7}_{3}Li+2^{1}_{1}H+{}^{3}_{1}T$). In this case, the transfer of Y(2n)-boson is equally probable for all three nucleus protons. Thus, after transfer Y(2n)-boson, the wave function of the nucleus will contain equal contributions from all three protons.

Similarly, for oxygen-16 nucleus: ${}^{16}_{8}O \rightarrow 4{}^{4}_{2}\alpha$ - such state is a highly excited. The presence of the four α-particles provides more opportunities for the organization of ground and lower excited states; the lowest excited state emits only one α-particle, turning into a carbon-12 nucleus.

$${}^{16}_{8}O \rightarrow {}^{9}_{3}Li+{}^{4}_{2}\alpha+3^{1}_{1}H ,$$
$${}^{16}_{8}O \rightarrow {}^{9}_{3}Li+{}^{3}_{1}T+4^{1}_{1}H ,$$
$${}^{16}_{8}O \rightarrow {}^{7}_{3}Li+2^{3}_{1}T+3^{1}_{1}H ,$$
$${}^{16}_{8}O \rightarrow {}^{6}_{2}He+{}^{7}_{3}Li+3^{1}_{1}H ,$$
$${}^{16}_{8}O \rightarrow {}^{6}_{2}He+{}^{4}_{2}\alpha+{}^{3}_{1}T+3^{1}_{1}H .$$

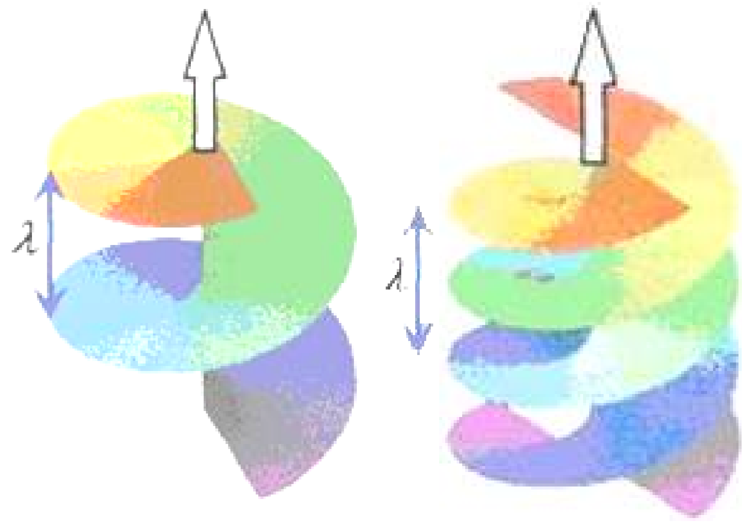
According to the principle of similarity, the nucleus has to be built as a set of three pairs of particles of World-4 like molecules are built of atoms. A virtual photon acts as the boson, which determines the interaction between electron and nucleus in atom [18]. At the same time, a *pair of electrons in singlet state, being surrounded by a coat of virtual photons, plays a role of boson, which defines the interaction of atoms in a molecule*. This pair of electrons is in continuous motion around the interacting atoms.

Similarly, bineutron (i.e. two neutrons) in a coat of neutral pions acts as a boson, which is responsible for the interaction between particles of the World-4 in nuclei of chemical elements. Therefore it is logical to assume that complex nuclei have a certain geometric structure which is similar to structure of atoms in molecules. In this case, for ${}^{16}_{8}O \rightarrow {}^{9}_{3}Li+{}^{4}_{2}\alpha+3^{1}_{1}H$ ${}^{9}_{3}Li$ nucleus is surrounded along three sides by protons and the interaction in this structure is due to Y(2n)-bosons. The interaction of this structure with a boson ${}^{4}_{2}\alpha$ will be weakened, and as a result α-particle will be emitted out of the nucleus, this is observed at the excitation of ${}^{16}_{8}O$ nucleus.

The state ${}^{16}_{8}O \rightarrow {}^{6}_{2}He+{}^{7}_{3}Li+3^{1}_{1}H$ will be almost resonant with the previous state, if the both of them have the same geometric structure. However, in this state, ${}^{6}_{2}He$ is assumed to be an active particle. Consequently, the structure may be different from the previous one and there are more variants of interaction via Y(2n) boson transfer. This can lead to corresponding reduction in the energy and stabilization of the nucleus.

The structure ${}^{16}_{8}O \rightarrow {}^{6}_{2}He+{}^{4}_{2}\alpha+{}^{3}_{1}T+3^{1}_{1}H$ where two transfer of Y(2n)-bosons takes place should have much lower energy. A little bit lower the state that corresponds to the structures ${}^{16}_{8}O \rightarrow {}^{9}_{3}Li+{}^{3}_{1}T+4^{1}_{1}H$ and its resonant (identity) state ${}^{16}_{8}O \rightarrow {}^{7}_{3}Li+2^{3}_{1}T+3^{1}_{1}H$ (where 2 Y(2n)-bosons are transferred) are located. All these structures are stable states of ${}^{16}_{8}O$ nucleus.

Let's come back to the virtual photons and gravitons. It is necessary to find a mechanism that guarantees repulsion of two electric charges of the same sign and attraction of opposite sign charges. If the virtual particle is a usual plane-polarized photon, it is impossible to satisfy the specified requirements for the interaction between charges. So a virtual photon must be circularly polarized (Fig. 6a).



(a) **(b)**

Fig. 6. Circular right-hand polarized photon (*a*) and the graviton (*b*)

It should be taken into account that the virtual particle is coupled with emitting particle, i.e. a virtual particle is localized in a potential well.

Because a virtual boson can be presented as the boson coupled with a particle (Fig. 7), the total energy of a particle with its virtual particles should be slightly higher (otherwise there will not be interaction between the particles) then the energy of the particles themselves[5], but much smaller than the sum of the energies of the particles and released boson.

If we consider the electrically charged particles, it has to be considered that positive charges emit a circularly polarized photon of the first type (for instance, right-hand polarized one; but it is necessary to establish this), while negative charges emit photons of the second type. Absorption with the attraction between particles takes place, if the particle gets a virtual photon which is of different type than the particle emits. So the electron will not absorb the virtual photon emitted by other electrons. The scattering with repulsion will take place. Similar situation is observed for proton. Its own virtual photon after particles removal is reflected back to a potential well with a change of its direction of circular polarization (odd wave function). Then such photon will be absorbed by particle which was emitted it.

The proposed mechanism exhaustively describes the electrostatic interaction in experimental data.

Now let's take a look on gravitons. The main property of the gravitational field: there is an attraction between masses and there is no repulsion. However, according to the law of gravitational interaction, the mass will repel the negative mass (if there is a hypothetical negative mass). This is the first condition. And the second condition is: the graviton must be a boson with the spin s = 2.

These requirements can be met if a graviton is a double helix (Fig. 6b), like a DNA double helix. Because the wave function of the virtual graviton is supposed to be even, after a reflection it does not change the direction of circular polarization and can be absorbed by mass which was emitted it. If a graviton radiated by a negative mass, circular polarization changes a direction. Such negative graviton will be absorbed by a negative mass, but will be scattered by a usual mass. Thus, it will provide a repulsion of a usual mass from a negative mass.

Virtual pair of particles generated by the physical vacuum is different from a virtual photon near an electric charge because both particles in the pair (electron-positron or a virtual pair of other particles) are virtual, so they are situated in a deep potential well. This virtual pair annihilates without photon emission, because the total energy of a virtual pair is zero up to the

[5] *In this case a particle is in a coat of vacuum particles (bosons with zero energy).*

uncertainty relation. However, such a virtual pair can interact with a real pair. As a result the wave function of a real particle can be complex leading to a strange behavior of particles.

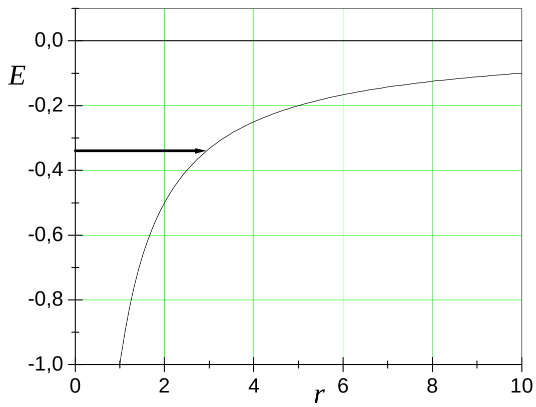


Fig. 7. Virtual particles in the vicinity of radiating particles

4. CONCLUSIONS

On the base of new ideas about the creation of the Universe and using of the Laws of similarity and unity in the Universe a description of the structure for the heavy (Z ≥ 4) cores and hierarchies of boson interaction was provided. In particular:

1. The classification of charges of elementary particles in different layers of the fiber space of Super-Universe was introduced. It was shown that diones with an electric charge ±*e*/6 should exist in the one-dimensional space, charges ±*e*/3 and ± 2*e*/3 should exist in the two-dimensional World (World of quarks), charges 0, ±*e*, ±2*e* and ± 3*e* should exist in the three-dimensional space.
2. The model of the molecular structure of nuclei has been proposed and the reasons for instability of nuclei in ground and excited states have been shown.
3. The hierarchy of bosons which are responsible for the interaction between particles in different hierarchical layers of the fiber space of Super-Universe has been analyzed.
4. New bosons have been proposed to explain the interaction between the elements of atomic nuclei. It has been shown that coupled neutron pairs (bineutrons) play the role of these bosons.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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