Original Research Article

STRUCTURE OF THE ATOMIC NUCLEI IN THE UNIVERSE MODEL WITH MINIMAL INITIAL ENTROPY

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, $\pm e$, $\pm 2e$, $\pm 3e$, 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.

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 ^8Be, ^{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 $E_\alpha = 7$ MeV, in ^{16}O $E_\alpha= 16$ 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 functions 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.

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

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 ^8Be 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 nucleus 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 analogues to 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.

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.

91   Four-dimensional World of particles is produced by the three-dimensional World by
92 quarks gluing by gluon into particles. These quarks are in the Hidden World, while
93 corresponding particles are in the Manifest World. [1-2]
94   The charges of quarks are $-(\frac{1}{3})e$ and $+(\frac{2}{3})e$ (opposite signs for antiquarks), e is the
95 minimum charge of the particle in four-dimensional space-time.
96   It follows that quarks charges are formed by the dimension of the World: $\pm(\frac{1}{3})e$ for
97 each coordinate. Thus, all types of quarks are two-dimensional (since the space has two
98 dimensions, all the particles in this space should move only in two directions) which is
99 allowed by the dimensionality of space. So, it can be assumed, that in Hidden space the
100 charges 0, $\pm(\frac{1}{3})e$ and $\pm(\frac{2}{3})e$ can exist.
101   Comparing these conclusions with the data in Table 1 it can be concluded that for the
102 quarks only charge $-(\frac{1}{3})e$ and $+(\frac{2}{3})e$ are realized, and opposite charges are for antiquarks.
103 This result can be understood taking into account that the birth of the Universe is presented as
104 a vortex (and as a result tightening in gravity [8] and time [9] takes place). At the same time,
105 the 3 projections of charge are realized as stationary states in the World-3, see Figure 1.
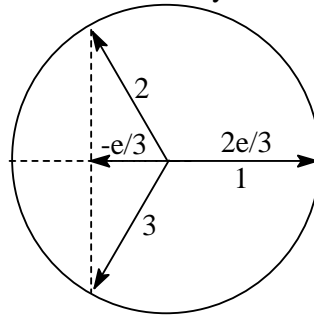

106
107   Fig.1. Three projections of charge in the World-3. Two types of charge $-(\frac{1}{3})e$ should be
108 different by additional quantum numbers (helicity). Mirror reflection with respect to the
109 vertical y-axis (or in inversion point) gives the charges of antiparticles.

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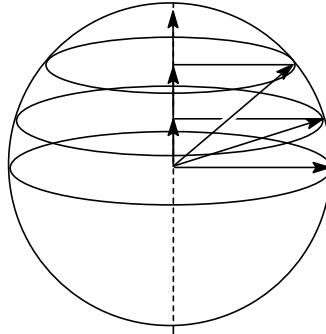

111
112   Fig.2. Four projections of a chage in the World 4. Mirror reflection in the plane xy (or
113 in reversal point) will give the charges of antiparticles.

114   Table 1. Quarks.

Type (flavor) of quark	Electric charge	Spin	Colour	Mass (calculation)
d	$-(1/3)e$	$\hbar/2$	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

115
116   It is necessary to note another important detail: all particles of World-4 have been
117 formed due to the transfer of information from a quarks cluster while the heavy nuclei are
118 formed from the particles of World-4 whose quarks do not have a border. This is worth also
119 to remember during the consideration of the fusion reaction of helium nucleus formation
120 from the nuclei of hydrogen and lithium or deuterium, when the quarks of complex core do
121 not border each other. And only due to virtual pairs participation (a proton-antiproton, etc.)
122 the α-particle of World-4 is formed from a complex helium nucleus.
123   The dimensionality of the World is changing during the transition from the Hidden
124 World to the Manifested World, and hence the magnitude of a charge. The dimensionality of
125 the Manifested World requires a combination of quark charges to create a charge $\pm e$.
126   On the other hand, charges 0, $\pm Q/4$, $\pm 2Q/4$, $\pm 3Q/4$ should exist in the Manifested
127 World. Here, the value of $\pm Q$ corresponds to the charge of the next five-dimensional World
128 where our space is generating (and probably hidden).
129   As a result, $Q = 4q = 4e$ is an elementary charge of the next Manifested World where
130 our particles will be quarks-4.
131   It is also should be noted, that according to Figure 2 stable charges $\pm e$, $\pm 2e$, $\pm 3e$, and 0
132 should exist in our space.
133   Nuclei of hydrogen correspond to the first particle (proton and deuteron), nuclei of
134 helium correspond to the second particle (^3_2He and $^4_2He = ^4_2\alpha$), the third particle corresponds
135 to lithium nuclei[1]. Of course, particles and antiparticles corresponding to particles with
136 opposite charges should exist. However, the Manifested World has electrons with charge $-e$
137 to stabilize atoms and to provide the electrical neutrality of the Universe.

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

Charge	Particles	The total content of isotopes in the Universe
-e	E	
0	^1_0n	
+e	^1_1H , ^2_1D	0,65 [2,10]
+2e	^3_2He , ^4_2He	0,24 [2,10]
+3e	^6_3Li , ^7_3Li	6,5·10^{-5} [11]

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[1] This suggests an interesting parallel: three pairs of quarks and three pairs of particuls 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.

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

140        $[{}_{1}^{2}D]$ = 1,56·10^{-4}·$[{}_{1}^{1}H]$, the last one is 65% of the mass of Universe,

141        $[{}_{2}^{3}He]$ = 1,38·10^{-6}·$[{}_{2}^{4}He]$, the last one is 24% of the mass of Universe,

142        $[{}_{3}^{6}Li]$ = 8,1·10^{-2}·$[{}_{3}^{7}Li]$, the last one is 2·10^{-10} of the mass of Universe, 6,5·10^{-}

143   ^{5} in the Earth.

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

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

150        ${}_{1}^{1}H\ =\ 2u + d \equiv u^{2}d$,

151        ${}_{1}^{2}D\ =\ 3u + 3d \equiv u^{3}d^{3}$,

152        ${}_{2}^{3}He\ =\ 5u + 4d \equiv u^{5}d^{4}$,

153        ${}_{2}^{4}He\ =\ 6u + 6d \equiv u^{6}d^{6}$,

154        ${}_{3}^{6}Li\ =\ 9u + 9d \equiv u^{9}d^{9}$,

155        ${}_{3}^{7}Li\ =\ 10u + 11d \equiv u^{10}d^{11}$.

156   So, we have a stable structure containing of three quarks, 6 quarks, 9 quarks, 12 quarks,
157   18 quarks and 21 quarks. There are no structures containing of 15 quarks ($_{2}^{5}He$ or $_{3}^{5}Li$) in the
158   World-4 (negative binding energy of proton or neutron with $_{2}^{4}He$ [12]).

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

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

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

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

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

181   The Fields-time coordinates are common for all spaces, so two spatial dimensions of
182   quarks and one spatial dimension constituent quarks (diones) from the previous World should
183   be added for our four-dimensional World. Totally it will be 7 dimensions. However, 3 of

<div style="text-align: left">184 them have various degrees of secrecy (2 for the nearest Hidden World and 1 for the remote
185 one).
186   There are photons in the World-4. They appear, in particular, during particles-
187 antiparticles annihilations. But there are particles (for example, π^o), which have quark-
188 antiquark type structure. This results in a disintegration of such particles into γ-quants in the
189 World-4, while the quark-antiquark annihilation has to give 2 two-dimensional photons
190 specific for World-3. Types of these photons are discussed in [1].</div>

191   Particles of World-5. The hierarchy of bosons.

192   In our World-5, all other nuclei ($Z \geq 4$) are combinations of "elementary" particles of
193 World-4 and can decay into these "basic" particles. These combinations are:

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

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

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

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

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

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

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

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

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

208     $_{6}^{13}C \rightarrow _{3}^{6}Li + _{3}^{7}Li$, - nucleus is stable, but its abundance is very small (1%).

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

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

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

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

215     $_{7}^{15}N \rightarrow 2\,_{2}^{4}\alpha + _{3}^{7}Li$, - the nucleus is stable, but its abundance is very small (0,365%),

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

218     $_{8}^{16}O \rightarrow 4\,_{2}^{4}\alpha$, or $_{8}^{16}O \rightarrow 2\,_{3}^{6}Li + _{2}^{4}\alpha$, - the nucleus is stable,[3]; the second contribution is
219 small, due to the lack of $_{3}^{6}Li$.

220     $_{8}^{17}O \rightarrow _{2}^{4}\alpha + _{3}^{7}Li + _{3}^{6}Li$, - the quantity of such nuclei is small, since
221 $N\left(_{2}^{4}\alpha \right) >> N\left(_{3}^{7}Li \right) \rangle\rangle N\left(_{3}^{6}Li \right)$.

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[3] Below much more structures for the core $_{8}^{16}O$ providing its stability in the ground state will be presented.

222   $^{18}_{8}O \to {}^{4}_{2}\alpha + 2\,{}^{7}_{3}Li$, - the nucleus is stable; but the quantity of these nuclei is less than of

223   $^{16}_{8}O$, because $N\left({}^{4}_{2}\alpha\right) \gg N\left({}^{7}_{3}Li\right)$, but is bigger than of $^{17}_{8}O$ in 6 times.

224   $^{19}_{8}O \to {}^{4}_{2}\alpha + 2\,{}^{7}_{3}Li + {}^{1}_{0}n$, - the nucleus is β^{-} - active,

225   $^{18}_{9}F \to 4{}^{4}_{2}\alpha + {}^{2}_{1}D$, or $^{18}_{9}F \to 3{}^{4}_{2}\alpha + {}^{6}_{3}Li$, $^{18}_{9}F \to 2{}^{4}_{2}\alpha + {}^{7}_{3}Li + {}^{2}_{1}D + {}^{1}_{1}H$, - only the later

226 combination provides β^{+}- activity, so the reaction is slow (109,7 min),

227   $^{19}_{9}F \to 3{}^{4}_{2}\alpha + {}^{7}_{3}Li$, - the nucleus is stable,

228   $^{20}_{9}F \to 3{}^{4}_{2}\alpha + {}^{7}_{3}Li + {}^{1}_{0}n$, - the nucleus is β^{-} - active (11,56 s),

229   $^{19}_{10}Ne \to 4{}^{4}_{2}\alpha + {}^{2}_{1}D + {}^{1}_{1}H$, $^{19}_{10}Ne \to 4{}^{4}_{2}\alpha + {}^{3}_{2}He$, - the nucleus is β^{+} - active, small contribution

230 of the second combination,

231   $^{20}_{10}Ne \to 5{}^{4}_{2}\alpha$, - the nucleus is stable [4] (90,92%),

232   $^{21}_{10}Ne \to 3{}^{4}_{2}\alpha + {}^{7}_{3}Li + {}^{2}_{1}D$, - the nucleus is stable, but the amount of these nuclei is small

233 (0,257%)

234   $^{22}_{10}Ne \to 2{}^{4}_{2}\alpha + 2{}^{7}_{3}Li$, - the nucleus is stable (8,82%),

235   $^{23}_{10}Ne \to 2{}^{4}_{2}\alpha + 2{}^{7}_{3}Li + {}^{1}_{0}n$, - the nucleus is β^{-} - active.

236   $^{22}_{11}Na \to 5{}^{4}_{2}\alpha + {}^{2}_{1}D$, $4{}^{4}_{2}\alpha + {}^{6}_{3}Li$, $3{}^{4}_{2}\alpha + {}^{7}_{3}Li + {}^{3}_{2}He$, ${}^{4}_{2}\alpha + 2{}^{7}_{3}Li + {}^{3}_{2}He + {}^{1}_{1}H$, $2{}^{7}_{3}Li + {}^{6}_{3}Li + 2{}^{1}_{1}H$,

237 the nucleus is β^{+} - active tacking into account last configurations,

238   $^{23}_{11}Na \to 4{}^{4}_{2}\alpha + {}^{7}_{3}Li$, the nucleus is stable,

239   $^{24}_{11}Na \to 4{}^{4}_{2}\alpha + {}^{7}_{3}Li + {}^{1}_{0}n$, the nucleus is β^{-} - active.

240   *   *   *   *   *   *   *   *   *   *

241   $^{55}_{25}Mn \to 5{}^{4}_{2}\alpha + 5{}^{7}_{3}Li$,

242   $^{54}_{26}Fe \to 10{}^{4}_{2}\alpha + 2{}^{7}_{3}Li$, $7{}^{4}_{2}\alpha + 2{}^{7}_{3}Li + 2{}^{6}_{3}Li$, the nucleus is stable (5,84%), small

243 contribution of the second combination,

244   $^{55}_{26}Fe \to 10{}^{4}_{2}\alpha + 2{}^{7}_{3}Li + {}^{1}_{0}n$, $7{}^{4}_{2}\alpha + 3{}^{7}_{3}Li + {}^{6}_{3}Li$, $6{}^{4}_{2}\alpha + 4{}^{7}_{3}Li + {}^{3}_{2}He$,   in   this   case,   the

245 experiment shows K-electron capture with a convertion into a stable nucleus $^{55}_{25}Mn$. Thus, it

246 is necessary to assume that the contribution of the last configuration is a main one, while the

247 first is very small. In the field of nucleus $^{3}_{2}He$ there is a reduction of the number of neutrons,

248 which results in K-electron capture with a convertion it into tritium nucleus and its

249 combination with α-particle gives $^{7}_{3}Li$, nucleus, corresponding to the $^{55}_{25}Mn$ nuclei

250 configuration.

251   Proceeding in the same manner to the heavy nuclei, we draw an attention to the fact that

252 the protons-neutrons number relation for nuclei with number up to No. 50 can be described

253 by combinations of $^{7}_{3}Li$, $^{4}_{2}He$ etc. But after this number the contribution of neutrons

254 increases. Moreover, at the transition from $^{208}_{82}Pb$ to $^{238}_{92}U$ 10 protons and 20 neutrons should

255 be added [13]. So, $^{3}_{1}T$, $^{6}_{2}He$, $^{9}_{3}Li$ should be included into the consideration. Such nuclei really

256 exist, but, they are β^{-} - active with the lifetime $3.87 \cdot 10^{8}$ s = 12.262 years, 0.797 s and 0.176 s

257 respectively.

258   Neutrons in a free state are also β^{-}- active, but, all nuclei are containing them. The

259 interaction between nucleons much faster makes a transformation of a neutron into a proton,

260 than it would decay.

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[4] In fact, this nucleus has much more structures, how it will be shown below for $^{16}_{8}O$.

261 So, these three heavy nuclei can stably exist in nuclei, where the number of neutrons is
262 twice higher than the number of protons. The need for such nuclei should be grounded on
263 intranuclear interaction.
264   The bosons are always responsible for the interaction between particles. The gluons are
265 responsible for strong interaction between quarks; the bosons which are partly in the World-
266 3, and partly in the World-4 are responsible for weak interaction $W(^{\pm})$ и Z^o [14]. $\pi(^{\pm})$ and π^o
267 bosons can not be neglected in the consideration. They are responsible for the transfer of the
268 interaction between nucleons in three groups of particles in the four-dimensional World.
269 Bosons of the World-4 should provide the interaction between the particles of the World-4. α-
270 particle and boson, consisting of two coupled neutron Y(2n) can play this role. For example:
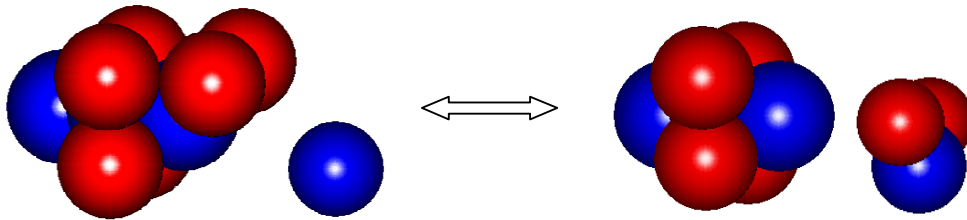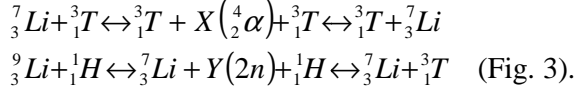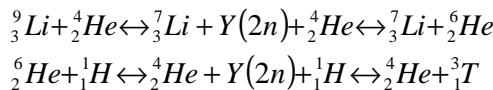
271 $$\,^{7}_{3}Li + \,^{3}_{1}T \leftrightarrow \,^{3}_{1}T + X\left(\,^{4}_{2}\alpha\right) + \,^{3}_{1}T \leftrightarrow \,^{3}_{1}T + \,^{7}_{3}Li$$

272 $$\,^{9}_{3}Li + \,^{1}_{1}H \leftrightarrow \,^{7}_{3}Li + Y(2n) + \,^{1}_{1}H \leftrightarrow \,^{7}_{3}Li + \,^{3}_{1}T \quad \text{(Fig. 3)}.$$

273
274
275   Fig. 3. Intranuclear interactions due to Y(2n) boson transfer.

276 $$\,^{9}_{3}Li + \,^{4}_{2}He \leftrightarrow \,^{7}_{3}Li + Y(2n) + \,^{4}_{2}He \leftrightarrow \,^{7}_{3}Li + \,^{6}_{2}He$$

277 $$\,^{6}_{2}He + \,^{1}_{1}H \leftrightarrow \,^{4}_{2}He + Y(2n) + \,^{1}_{1}H \leftrightarrow \,^{4}_{2}He + \,^{3}_{1}T$$

278   In this case, it is becomes clear a presence of doubled number of neutrons (in
279 comparison with protons) in heavy nuclei.
280   Since it is considered that boson X(α) is much heavier then boson Y(2n), it should
281 provide a much stronger interaction. However, a reality shows that α-particles are poorly
282 connected to the rest of the nucleus fragments, because they have a large electrical charge. As
283 a result, α-particle is not able to provide interaction between components of a nucleus.
284 Moreover, if α- particle participate in the formation of nuclei with Z> 50, the protons-
285 neutrons number relation 1:2 can not be suttisfied. So the interaction via X(α) bosons has to
286 be excluded from the consideration.
287   So, it is clear now that $\,^{8}_{4}Be \rightarrow 2\,^{4}_{2}\alpha$ can not exist and should immediately dacay into two
288 α-particles. In the present case, it is impossible to arrange the transfer of two neutrons. A
289 resonant exchange by Y(2n)-bosons is only possible. But, in this situation it is necessary to
290 take off two neutrons from α-particles, and then put two other neutrons on their place. If the
291 last reaction seems simple enough, the first one requires a lot of effort and its implementation
292 looks problematic.
293   In the case of $\,^{12}_{6}C \rightarrow 3 \cdot \,^{4}_{2}\alpha$ the nucleus can be imagined only in excited state, which
294 leads to its decay on 3 α-particles. The ground state can be provided by the configuration
295 $\,^{12}_{6}C \rightarrow \,^{9}_{3}Li + 3\,^{1}_{1}H \leftrightarrow \,^{7}_{3}Li + 2\,^{1}_{1}H + \,^{3}_{1}T$. The "Molecular" structure is following (Figure 4):
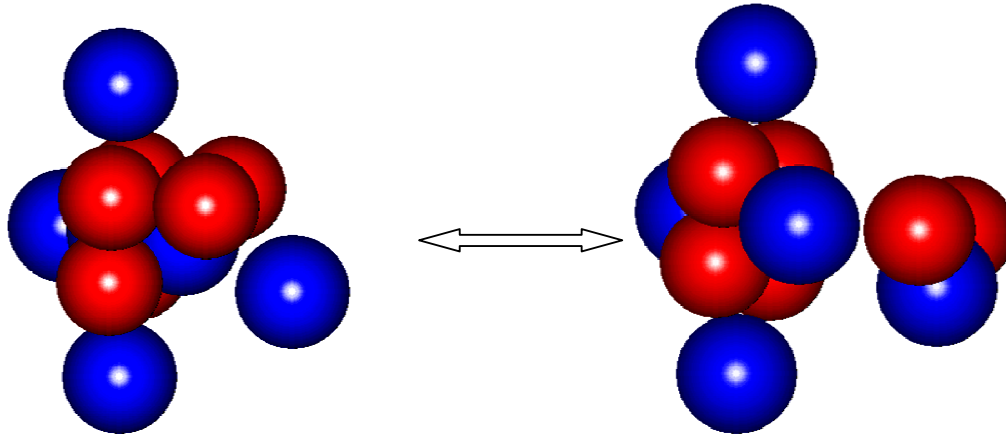
296
297 Fig.4. The "Molecular structure" of carbon nucleus $^{12}_{6}C$.

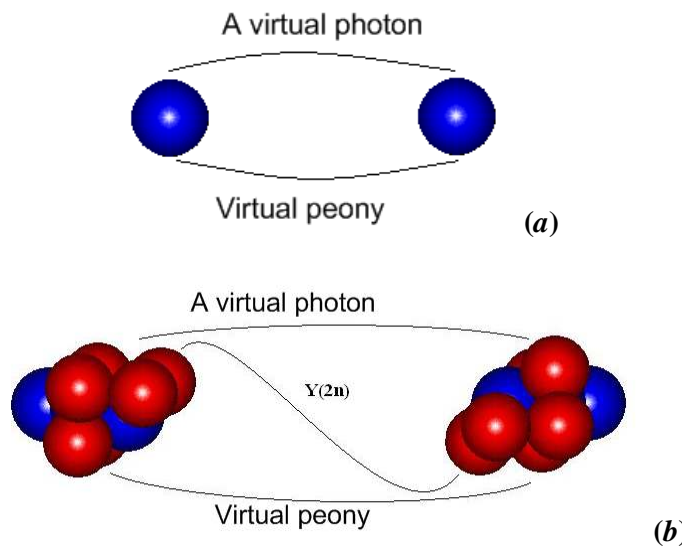298 (*a*)

299 (*b*)

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

301   Since the boson barring the interaction is virtual, the particle can emit it and absorb it at
302 once (Figure 5). This phenomenon is described in detail in quantum electrodynamics.
303   There is leak of information in the literature concerning bineutron, which is treated in
304 this manuscript as boson of World-4. It is only known, that neutrons have huge interactions
305 between each other by exchange of neutral pions. The same processes should take place in
306 biproton. But in such case electrostatic repulsion between protons ($\approx$ 1 MeV) leads to
307 resulting binding energy in biproton equal to -0.5 MeV. So, strong interaction energy, caused
308 by transfer of neutral pion between neutrons, is equal to 0.5 MeV [15, 16]. But, neutron
309 decays because of processes of weak interaction after ~881 s [17]. After comparing half-
310 decay periods of β^- - active nucleus (e.g. $T_{1/2}(^{16}N)$ = 7.14 s i $T_{1/2}(^{18}N)$ = 0.63 s; $T_{1/2}(^{20}F)$ =
311 11.56 s and $T_{1/2}(^{22}F)$ = 4.0 s [13]), we could make following conclusion: period of neutron
312 half-decay could be decreased on 1-2 orders with increasing neutrons quantity in cluster. But
313 this time is much longer than period of half-decay of strong interaction bosons (pions).
314   So, as a result of the processes of boson radiation-absorbing a spatial orientation or
315 shape of nucleus components can continuously change. This is important in the cases when a
316 nucleus of 5-dimensional World brane contains more than two particles-4. For example, $^{12}_{6}C$

9

317 nucleus contains 4 particles-4 ($_3^9Li+3_1^1H$ or $_3^7Li+2_1^1H+_1^3T$). In this case, the transfer of
318 Y(2n)-boson is equally probable for all three nucleus protons. Thus, after transfer Y(2n)-
319 boson, the wave function of the nucleus will contain equal contributions from all three
320 protons.

321   Similarly, for oxygen-16 nucleus: $_8^{16}O \rightarrow 4_2^4\alpha$ - such state is a highly excited. The
322 presence of the four α-particles provides more opportunities for the organization of ground
323 and lower excited states, the lowest excited state emitting only one α-particle, turning into a
324 carbon-12 nucleus.

325 $$_8^{16}O \rightarrow _3^9Li+_2^4\alpha +3_1^1H ,$$

326 $$_8^{16}O \rightarrow _3^9Li+_1^3T +4_1^1H ,$$

327 $$_8^{16}O \rightarrow _3^7Li +2_1^3T +3_1^1H ,$$

328 $$_8^{16}O \rightarrow _2^6He+_3^7Li +3_1^1H ,$$

329 $$_8^{16}O \rightarrow _2^6He+_2^4\alpha+_1^3T +3_1^1H .$$

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

336   Similarly, **bineutron** (i.e. two neutrons) **in a coat of neutral pions** acts as a boson,
337 which is glo for the interaction between particles of the World-4 in nuclei of chemical
338 elements. Therefore it is logical to assume that complex nuclei have a certain geometric
339 structure which is similar to structure of atoms in molecules. In this case, for
340 $_8^{16}O \rightarrow _3^9Li+_2^4\alpha +3_1^1H$ $_3^9Li$ nucleus is surrounded along three sides by protons, and the
341 interaction in this structure is due to Y(2n)-bosons. The interaction of this structure with a
342 boson $_2^4\alpha$ will be weakened, and as a result α-particle will be emitted out of the nucleus, this
343 is observed at the excitation of $_8^{16}O$ nucleus.

344   The state $_8^{16}O \rightarrow _2^6He+_3^7Li +3_1^1H$ will be almost resonant with the previous state, if the
345 both of them have the same geometric structure. However, in this state, $_2^6He$ is assumed to be
346 an active particle. Consequently, the structure may be different from the previous one and
347 there are more variants of interaction via Y(2n) boson transfer. This can lead to
348 corresponding reduction in the energy and stabilization of the nucleus.

349   The structure $_8^{16}O \rightarrow _2^6He+_2^4\alpha+_1^3T +3_1^1H$ where two transfer of Y(2n)-bosons takes place
350 should have much lower energy. A little bit lower is situated the state corresponding to the
351 structures $_8^{16}O \rightarrow _3^9Li+_1^3T +4_1^1H$ and its resonant (identity) state $_8^{16}O \rightarrow _3^7Li +2_1^3T +3_1^1H$, where
352 two Y(2n)-bosons have transferred together. All these structures are stable states of $_8^{16}O$
353 nucleus.

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

359
360   (*a*)   (*b*)
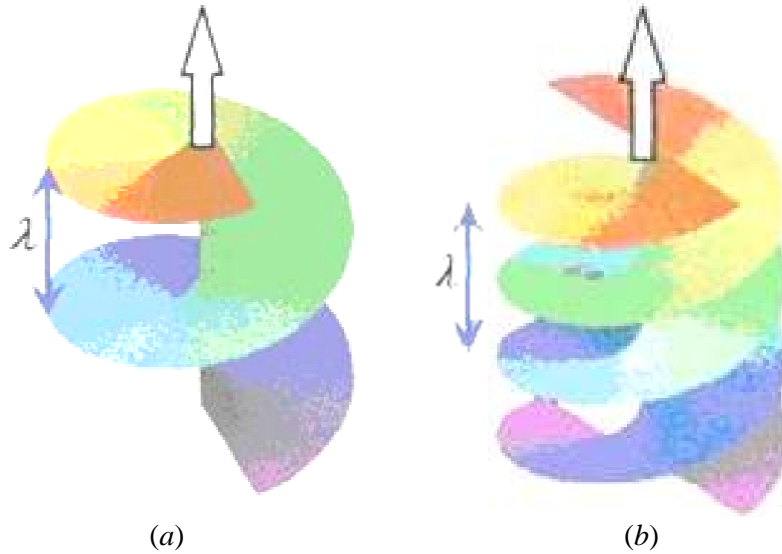361   Fig. 6. Circular right-hand polarized photon (*a*) and the graviton (*b*).

362   It should be taken into account that the virtual particle is coupled with emitting particle,
363   i.e. a virtual particle is localized in a potential well.
364   Because a virtual boson can be presented as the boson coupled with a particle (Figure
365   7), the total energy of a particle with its virtual particles should be slightly higher (otherwise
366   there will not be interaction between the particles) then the energy of the particles themself[5],
367   but much smaller than the sum of the energies of the particles and released boson.
368   If we consider the electrically charged particles, it has to be considered that positive
369   charges emit a circularly polarized photon of the first type (for instance, right-hand polarized
370   one; but it is necessary to establish this), while negative charges emit photons of the second
371   type. Absorption with the attraction between particles takes place, if the particle gets a virtual
372   photon which is of different type than the particle emits. So the electron does not want to
373   absorb the virtual photon emitted by other electrons. The scattering with repulsion will take
374   place. Similar situation is observed for proton. Its own virtual photon after particles removal
375   is reflected back to a potential well with a change of its direction of circular polarization (odd
376   wave function). Then such photon will be absorbed by particle which was emitted it.
377   The proposed mechanism exhaustively describes electrostatic interaction experimental
378   data.
379   Now take a look on gravitons. The main property of the gravitational field: there is an
380   attraction between masses and there is no repulsion. However, according to the law of
381   gravitational interaction, the mass will repel the negative mass (if there is a hypothetical
382   negative mass). This is the first condition. And the second condition is: the graviton must be a
383   boson with the spin s = 2.
384   These requirements can be met if a graviton is a double helix (Figure 6-b), like a DNA
385   double helix. Because the wave function of the virtual graviton is supposed to be even, after a
386   reflection it does not change the direction of circular polarization and can be absorbed by
387   mass which was emitted it. If a graviton radiated by a negative mass, circular polarization
388   changes a direction. Such negative graviton will be absorbed by a negative mass, but will be
389   scattered by a usual mass. Thus, it will provide a repulsion of a usual mass from a negative
390   mass.

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

391   Virtual pair of particles generated by the physical vacuum is different from a virtual
392 photon near an electric charge because both particles in the pair (electron-positron or a virtual
393 pair of other particles) are virtual, so they are situated in a deep potential well. This virtual
394 pair annihilates without photon emission, because the total energy of a virtual pair is zero up
395 to the uncertainty relation. However, such a virtual pair can interact with a real pair. As a
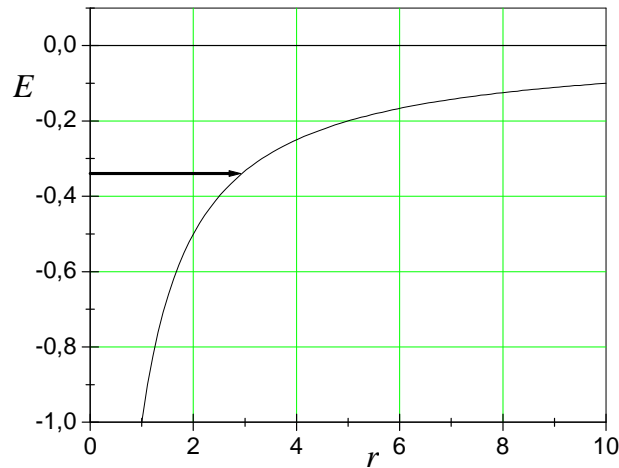396 result the wave function of a real particle can be complex leading to a strange behavior of
397 particles.

398
399   Fig.7. Virtual particles in the vicinity of radiating particles.

400

401

Conclusions

403   On the base of new ideas about the creation of the Universe and using of the Laws of
404 similarity and unity in the Universe the description of the structure for the heavy ($Z \geq 4$)
405 cores and hierarchies of boson interaction is provide. In particular:
406   1. The classification of charges of elementary particles in different layers of the fiber
407 space of Super-Universe was introduced. It was shown that diones with an electric charge
408 $\pm e/6$ should exist in the one-dimensional space, charges $\pm e/3$ and $\pm 2e/3$ should exist in the
409 two-dimensional World (World of quarks), charges 0, $\pm e$, $\pm 2e$ and $\pm 3e$ should exist in the
410 three-dimensional space.
411   2. The model of the molecular structure of nuclei has been proposed and the reasons for
412 unstability of nuclei in ground and excited states have been shown.
413   3. The hierarchy of bosons which are responsible for the interaction between particles in
414 different hierarchical layers of the fiber space of Super-Universe has been analyzed.
415   4. New bosons have been proposed to explain the interaction between the elements of
416 atomic nuclei. It has been shown that coupled neutron pairs (bineutrons) play the role of these
417 bosons.
418

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