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Strong Interactions in the Model of the Universe with Minimum Initial Entropy

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Abstract: *The article considers the nature of the strong interaction in the Standard Model and in the model of the Universe with minimal initial entropy. It is shown that many of the shortcomings of the theory of the strong interaction, adopted in the Standard Model, are eliminated in the model of the Universe with minimal initial entropy. The new model is based on the fact that each particle in the fiber bundle of Super-Universe, with its mass is also the carrier of a Scalar Field. This Field is fully controls the emission and absorption of gluons, the birth of virtual pairs of particles from vacuum, a taking part of gluons and virtual particle pairs in the strong interaction processes. In the vicinity of hadrons or groups of hadrons with the same electric charges Scalar Field can produce only neutral pions. At the birth of the virtual pion* π^o *in the neighborhood of nucleon the energy Fields of the nucleon decreases. Moving to another nucleon pion is accompanied to the displacement of Field energy in the opposite direction. Return of the pion in the vacuum state recovers energy of nucleon Fields. The process of creation and recombination of virtual pairs is oscillatory process, which is repeated endlessly. The total scalar Field of the proton and the neutron has the ability to initiate a virtual pair* ($\pi^-\pi^+$), *that in the World-3 means the simultaneous formation of two quark virtual pairs* ${}^{-1/2}d(\alpha){}^{1/2}\bar{d}(\bar{\alpha})$ *and* ${}^{-1/2}u(\alpha){}^{1/2}\bar{u}(\bar{\alpha})$ *and their polarization in the Coulomb field of the proton and their conversion into two charged virtual pairs* ${}^{-1/2}u(\alpha){}^{1/2}\bar{d}(\bar{\alpha})$ *and* ${}^{-1/2}d(\alpha){}^{1/2}\bar{u}(\bar{\alpha})$, *the first of which corresponds to* π^+, *while the second -* π^-.

Keywords: *model of the Universe with minimal initial entropy, elementary particles of vacuum, Scalar Field, virtual pairs of particles, strong interaction.*

In the article [1] on the basis of the law of similarity and unity a model of our Universe appearance with a minimum of initial entropy has been proposed by author. At the same time our Universe is a part of the Super-Universe [2]. In turn, the Super-Universe is presented by fiber space, with adjacent layers of different dimensionality of space per unit. Habitual for us three-dimensional space (four-dimensional (3 + 1) Universe) is bordered with a two-dimensional space of quarks. Likely the two-dimensional space is bordered with a one-dimensional space of diones that are found to be Planck particles. Finally, the one-dimensional space is bordered with a zero-dimensional space of the scalar Field-time. Between adjacent spaces the information interaction exists through a single delocalized point. A zero-dimensional space of the Field-time has the ability to interact with other spaces and set the program the evolution of the Universe.

Scalar Field subsequently fills all dimensions, producing complex of particles (that have no charge and other quantum numbers) in each of these dimensions. Such particles are represented by neutron pairs or clusters of neutron pair in singlet state in the World-4, by complexes of quarks in form of neutron pairs in the World-3 and by complexes of diones with appropriate characteristics in the World-2.

This structure of Super-Universe causes an appearance of hadrons in the Universe (World-4) as a result of interaction between the quarks in the World-3 and transmission of information on this interaction into the World-4. Thus, a single particle of the World-4 can be assigned to a group of World-3 quarks, which counts in the zero approximation two or three quarks. At the same time between the quarks and hadrons the strong interaction exists, which is under investigation in detail since 1935.

Strong intranuclear interaction was first described by the Japanese physicist Yukawa in 1935 using the exchange particles ─ mesons. The quantum chromo dynamics gives the modern description of strong interaction. Quantum chromo dynamics is a part of the so-called Standard Model, which represents the sum of modern ideas about the structure of the microcosm, although it can not claim to be finalized knowledge, because it does not explain the results of some experiments and does not include the theory of gravity.

According to the model of Yukawa a strong interaction in the World-4 shows itself in result of the fact that one nucleon emits a π-meson, and the second one consumes it in a time $t \sim 10^{-23}$ seconds. Such particles are called virtual. To make these particles are real, they must be free from the interaction with nucleons. To do this, you need to provide pion energy to overcome the work function and produce kinetic energy (the analog of the photoelectric effect).

Probably, for the refined calculations of hadron interactions and related characteristics the several such groups of quarks must be taken into account. The confirmation of this assumption consists in the birth of a considerable number of elementary particles at inelastic collisions of high-energy particles. It is not surprising that in the monograph [3] it was maintained that about 6000 particles of Hidden World corresponds to hadron. Therefore, to describe the properties of the proton in the zero approximation it is necessary to take into account three quarks, and along with increase of the level of accuracy their number should increase significantly (up to 6000).

This resembles the polar molecules dissolved in water, around which the solvation shell is formed of several water molecules and exist a far zone of molecules, whose influence can be taken into account using macroscopic solvent averaged parameters.

Thus, the nucleon can be associated with up to 6000 the quarks and the quarks that can be associated with 2000 nucleons.

So now in the frame of Standard Model the connection between quarks and hadrons has been found.

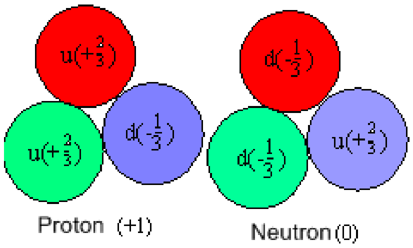
In this paper we study the strong interaction within the framework of a new model of creation and evolution of the Universe, characterized by minimum of initial entropy [1].

For further discussion of the material we shall take into attention a hypothesis about the nature and structure of the physical vacuum discussed in [3]: **at the annihilation of particle-antiparticle pairs they do not disappear but merge into a system called as elementary particle of vacuum** (EPV). In EPV at the unexcited state in our lab space all quantum numbers are zero. The basis of the physical vacuum, according to [3] consists of a proton-antiproton (p^+p^-) vacuum. The concentration of EPV in this form of vacuum is equal to $1{,}54541 \cdot 10^{39}$cm^{-3}, while the concentration of EPV in the electron-positron vacuum is equal to $1{,}73009 \cdot 10^{29}$ cm^{-3}, that is 10 orders of magnitude smaller. In addition, all EPVs form all stable particles of the World-3 and World-4. In the author's paper[4] there are described the properties of the scalar Field of the World-1, which explain the reason of the vacuum particles appearance.

Other known interactions can't produce vacuum particles. That is why these interactions are missed in the Standard Model. Herewith vacuum is characterized by set of states that should match additional requirements. In particular, physicists had to introduce new concept of "vacuum corrections" to explain correction for the magnetic moment of the electron (found experimentally) and bias of level of thing structure in the Hydrogen atom. Physicists continue to add to vacuum explanation more and more stricter postulates. For example it is considered that if one influenced on physical vacuum (PV) by particle birth operator, one would get real particle from empty PV. And there is no explanation of this mechanism for this process.

1. THE STRONG INTERACTION IN THE STANDARD MODEL

All particles which are composed of quarks belong to a class of hadrons. Some of them consist of a quark and an antiquark, others consist of three quarks. The most famous of the last are the proton and neutron.



Quark charges as part of a proton combined to 1 (in elementary charge units) and for a neutron to 0.

Quarks are held together due to the gluons, i.e. quanta of the field of strong interaction.

Quarks have their own kind of charge, which is called "color". At any time, quark can be in one of three states or colors: r, b, g (red, blue, green). At the absorption or emission of gluons a quark color can vary, for example

$$u(b) \rightarrow g\left(b, \bar{r}\right) + u(r)$$

$$d(r) + g\left(b, \bar{r}\right) \rightarrow d(b) \tag{1}$$

However, other quantum numbers of quarks and its flavor[1] does not change.

Of the three colors (r, b, g) and three anti colours ($\bar{r}$, $\bar{b}$, $\bar{g}$) it is possible to create a table of possible combinations of gluons (Table 1).

Gluon has spin 1 as the photon and has two spin states, it is electrically neutral and has a color charge $r\bar{r}, g\bar{g}, b\bar{b}, r\bar{g}, g\bar{r}, r\bar{b}, b\bar{r}, g\bar{b}, b\bar{g}$[2].

Table1.*Combinations of colors and anti-colors, which carry gluons*

	R	B	g
$\bar{r}$	$\bar{r}r$	$\bar{r}b$	$\bar{r}g$
$\bar{b}$	$\bar{b}r$	$\bar{b}b$	$\bar{b}g$
$\bar{g}$	$\bar{g}r$	$\bar{g}b$	$\bar{g}g$

In fact, such an exchange of gluons between quarks is able to describe interquark interaction. However, in the quantum chromo dynamics, likely to quantum mechanics, description of the interaction is carried out using the wave functions, the symmetry of which must correspond to local space symmetry. So the linear combinations of the wave functions will be finding first, which satisfy the conditions of the problem. Among the elements situated out of diagonal in Table. 1, you can create 6 different color combinations:

$$g_1 = \left(\bar{r}b + \bar{b}r\right)/\sqrt{2}, g_2 = -i\left(\bar{r}b - \bar{b}r\right)/\sqrt{2},$$

$$g_4 = \left(\bar{r}g + \bar{g}r\right)/\sqrt{2}, g_5 = -i\left(\bar{r}g - \bar{g}r\right)/\sqrt{2}, \tag{2}$$

$$g_6 = \left(\bar{b}g + \bar{g}b\right)/\sqrt{2}, g_7 = -i\left(\bar{b}g - \bar{g}b\right)/\sqrt{2}.$$

At using of the three elements arranged on the diagonal ($\bar{r}r$, $\bar{b}b$, $\bar{g}g$), you can build 3 independent colorless (white) combinations. Two of them:

$$g_3 = \left(\bar{r}r - \bar{b}b\right)/\sqrt{2}, g_8 = \left(\bar{r}r + \bar{b}b - 2\,\bar{g}g\right)/\sqrt{6} \tag{3}$$

are carriers of the interaction, and the third

$$\left(\bar{r}r + \bar{b}b + \bar{g}g\right)/\sqrt{3} \tag{4}$$

is completely symmetrical with respect to colors and represents a colorless color singlet. It is believed that the particle with has a such color combination can not be a carrier of the color interaction between the quarks [5, 6].

It is clear that these combinations can be cyclically ($r \rightarrow g \rightarrow b \rightarrow r$) swapped. At this action a description for all quarks will be changed excepted for fully symmetrical ones.

Three recent wave functions of quark are taken similarly to view of three wave functions of the interacting atoms (e.g., iodine).Thus the fully symmetrical combination gives the minimal energy of

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[1] Flavor is the common name for a series of quantum numbers characterizing the type of quark or lepton.

[2] There are given the charges of gluons, which are in the field of low symmetry. The symmetry of the free gluon is described within the framework of the $SU(3)$.

molecules, while the anti symmetric (g_3) combination is corresponding to lack of binding energy between the atoms and consequently leaves energy of component sun changed, and the third (g_8) anti bonding combination characterizes the increased energy state.

To binding has occurred, it is necessary that the energy of a quark plus the energy of the virtual gluon will be exceeding the quark energy. It must be considered that in the case of gluons with the fully symmetrical wave function the total energy does not differ from the quark energy, i.e. **fully symmetrical combination corresponds to the vacuum elementary particle**. In this case, full symmetric gluon will not be able to provide binding between quarks. And the lack of interaction would not be seen in the color combination but in the total energy of the quark and virtual gluon. Quarks g_3 and $g_8$also do not transmit the color but providea binding. It is possible to consider all 8 gluons combinations as the excited states of the basic fully symmetrical state what allows them to participate in the strong interaction.

Thus, the first two symmetrical combination (g_3 and g_8) together with the six off-diagonal combinations represent 8 types of gluons wave functions as carriers of strong color interaction.

It is easy to see that the wave functionsg_1 and g_2 provide interaction between the red and blue quarks,g_4 and g_5 - between red and green, g_6 and g_7- between blue and green.g_3 function describes the interaction of red and blue quarks without color change. Similarly, g_8 function describes the interaction of all three quark colors without change of color.

Since gluons, unlike photons, have color, the theory assumes that the processes of gluons emission by gluons and interaction between gluons are possible for gluons. However, this effect is possible rather for virtual gluons than for real gluons. Therefore, such interaction has not detected at any experiment.

The interaction with gluons participation is responsible for holding quarks inside a hadron. Unlike the constant of electromagnetic interaction, strong color interaction constant increases with increasing distance between the quarks.

Gluons play a significant role in the formation of the internal structure of hadrons. The processes of deep inelastic scattering of particles by nucleons yield to about one half of the nucleon energy belong to gluons.

The existence of quarks fully explains the presence of the magnetic moment of the proton ($2.79275\cdot\mu_p$) and the neutron ($-1.93\cdot\mu_p$).

While the magnitude of the electromagnetic interaction is characterized by a constant which is equal to 1/137.03597 (that is a square of the amplitude (-0.08542455) absorption or emission of a virtual photon by electron), the value of the strong interaction is determined by the gluon constant g, significantly higher than the value of the constant of electromagnetic interaction.

The strong interaction between hadrons can be described using the exchange by pions, the structure of which is represented by a quark and an antiquark which carry color and anti colours. So, pions are colorless particle with zero spin (bosons).

Pions are unstable particles.

Bosons obey Bose - Einstein: an unlimited number of particles with identical quantum numbers can be in a single quantum state. Bosons include the hypothetical **graviton** (spin 2), the **photon** (spin 1), the W and Z - **bosons** (spin 1) and **gluons** (spin 1), **mesons** and **meson resonances** (spin 0) and antiparticles of all these particles.

Based on the uncertainty relation

$$\Delta t\cdot\Delta E\geq h \tag{5}$$

We find the distance of virtual boson motion during time Δt

$$r=c\Delta t=\frac{ch}{\Delta E}=\frac{ch}{m_{\acute{a}}c^2}=\frac{h}{m_{\acute{a}}c}=\lambda_c \tag{6}$$

This distance is the radius of the particle interaction. If the boson is the pion ($m_{\pi\pm}$ = 273 m_e), then $r = 8{,}9\cdot10^{-15}$m.

In the case of weak interaction ($W^{\pm}$-boson) $r = 1.5\cdot10^{-17}$m. Such a small distance pre-determines the weak interaction. Therefore, the neutron lifetime reaches 881 sec [7]. That is why the neutrino interacts weakly with a matter.

Baryons and mesons together form a group of hadrons. In this case, it is important for us that nucleons and pions have the following quark structure $\pi^0 = u\bar{u} - d\bar{d}$, $\pi^+ = u\bar{d}$, $\pi^- = \bar{u}d$, $p = uud$, $n = udd$..

The lifetime of π^+ and π^- mesons are $2.0\cdot10^{-8}$ s, and for π^0-meson is $0.8\cdot10^{-16}$s [8].

The strong interaction between nucleons is manifested by result of the fact that one nucleon emits a virtual π-meson (pion) and the second absorbs it over time $t \sim 10^{-23}$ seconds.

In a result of virtual processes nucleon is covered by a coat from pions:

$p \leftrightarrow (n + \pi^+)$,

$n \leftrightarrow (p + \pi^-)$,

$p \leftrightarrow (p + \pi^o)$, (7)

$n \leftrightarrow (n + \pi^o)$,

forming a field of nuclear forces. Details of pion birth are not described in theory. It is simply assumed that all processes take place in the framework of the uncertainty relation.
Absorption of these pions by other nucleons leads to the interaction between nucleons, which is the manifestation of nuclear forces:

$p + n \leftrightarrow (n + \pi+) + n \leftrightarrow n + (\pi++ n) \leftrightarrow n + p$

$n + p \leftrightarrow (p + \pi^-) + p \leftrightarrow p + (p + \pi^-) \leftrightarrow p + n$

$p + p \leftrightarrow (p + \pi^o) + p \leftrightarrow p + (p + \pi^o) \leftrightarrow p + p$ (8)

$n + n \leftrightarrow (n + \pi^o) + n \leftrightarrow n + (n + \pi^{\mathbf{o}}) \leftrightarrow n + n$

Now look at interaction between nucleons at the quark level. The interaction between the proton and the neutron is looking so:

$$uud + udd \leftrightarrow \left(udd + u\bar{d}\right) + udd \leftrightarrow udd + \left(u\bar{d} + udd\right) \leftrightarrow udd + uud. \tag{9}$$

Here, virtual pion π^+ is born in the field of proton next this pion is transferred to the neutron with a transformation it into a proton due to the annihilation of a quark of neutron d and an anti quark $\bar{d}$ of pion. There u-quark, the remainder of pion, is a member of the newly formed protons. Since this is a pion in a virtual state, this annihilation is not accompanied by the release of energy, there is no radiation of gamma-rays.

In more details the interaction between the proton and the neutron $n = ({}^{-\frac{1}{2}}d(r) + {}^{\frac{1}{2}}u(g) + {}^{\frac{1}{2}}d(b))$with the participation of gluons is described in the Standard Model as follows.

a) The emission of gluons with quarks change color:

${}^{\frac{1}{2}}u(g) \rightarrow {}^{1}g(g,\bar{r}) + {}^{-\frac{1}{2}}u(r)$

${}^{\frac{1}{2}}d(g) \rightarrow {}^{1}g(g,\bar{r}) + {}^{-\frac{1}{2}}d(r)$ (10)

b) The absorption of gluon by another quark with a change of color:

${}^{-\frac{1}{2}}u(r) + {}^{1}g(g,\bar{r}) \rightarrow {}^{\frac{1}{2}}u(g)$

${}^{-\frac{1}{2}}d(r) + {}^{1}g(g,\bar{r}) \rightarrow {}^{\frac{1}{2}}d(g)$. (11)

Consequently, the gluons transfer occurs only in the singlet quark pair. In this case the spin of the quark (-½) and its color are rigidly fixed and transferred simultaneously. Thus, the spin is transferred from the first to the second quark, from second to third and from third to first, and so on around the circle. This rapid exchange of spin projections reserves total spin constant and equal to ½.

c) Conversion of the virtual boson (gluon) to the virtual quark-anti quark color pair in the triplet state (the total spin = 1):

$$^{1}g(b,\bar{r}) \rightarrow {}^{1}[{}^{\frac{1}{2}}d(b) + {}^{\frac{1}{2}}\bar{d}(\bar{r})]. \qquad (12)$$

Here the question arises: can a virtual gluons turn into a colored quark pair in the triplet virtual state? The new model of such a reaction is not possible. Rather, the virtual pair of quarks (pion) can only be a colorless (white) boson.

d) Sequential reaction (11) and (12) the quark $^{\frac{1}{2}}d(b)$, emitting a gluon $^{1}g(b,\bar{r})$, became a quark $^{-\frac{1}{2}}d(r)$. Consequently, in this case it has two identical quark $^{-\frac{1}{2}}d(r)+{}^{\frac{1}{2}}u(g)+{}^{-\frac{1}{2}}d(r)$.***It is clear that such a quark structure of the nucleon is not possible***. Therefore, conversion to a virtual gluon emitted color quark-anti quark pair in the triplet state is ***impossible***[3]. However, the Standard Model bypass this issue by introducing separation of one of the two identical quarks $^{-\frac{1}{2}}d(r)$, which then communicates with the quark $^{\frac{1}{2}}d(b)$, which is part of a virtual pair, i.e. combined with an antiquark$^{\frac{1}{2}}\bar{d}(\bar{r})$, forming a virtual pion in π^{o} singlet state. Released quark $^{\frac{1}{2}}d(b)$is attached to the other two, completing three quarks $^{\frac{1}{2}}d(b)+{}^{\frac{1}{2}}u(g)+{}^{-\frac{1}{2}}d(r)$with a total spin ½.

e) pion $\pi^{o}({}^{-\frac{1}{2}}d(r)+{}^{\frac{1}{2}}\bar{d}(\bar{r}))$ is transferred to the proton $p^{+} = ({}^{\frac{1}{2}}d(g)+{}^{-\frac{1}{2}}u(r)+{}^{\frac{1}{2}}u(b))$. As between the quarks that make up protons a constant exchange of gluons occurs, the quark spins are constantly changing. Next pion $\pi^{o}({}^{-\frac{1}{2}}d(r)+{}^{\frac{1}{2}}\bar{d}(\bar{r}))$ interacts with a quark $^{\frac{1}{2}}d(g)$[4].At the same time as a result of the exchange of quarks released quark $^{-\frac{1}{2}}d(r)$,which becomes an integral part of the proton, and a pair of virtual quarks $({}^{\frac{1}{2}}\bar{d}(\bar{r})+{}^{\frac{1}{2}}d(g))$ becomes colored in the triplet state, with the result that turns into a gluon $^{1}g(g,\bar{r})$,converting $^{-\frac{1}{2}}d(r)$on $^{\frac{1}{2}}d(g)$. This complex process is introduced in order to provide symmetrical processes of gluons conversion into the pair of quarks and conversion of a pair of quarks into gluons.

So, gluon is transferred into a pair of quarks and the quarks pair is transferred into gluons. And what will cause a strong interaction? Probably, this is a time from the birth of gluons to absorption of gluons after the transfer of pion. In this case, in order to maintain the strong interaction at the constant level it is need to be born a new cycle of pion exchange immediately after the pion was exchanged.

If the gluon in the reaction *c*) splits into a pair of *u* - quarks

$$^{1}g(b,\bar{r}) \rightarrow {}^{1}[{}^{\frac{1}{2}}u(b) + {}^{\frac{1}{2}}\bar{u}(\bar{r})],$$

Then the union $^{-\frac{1}{2}}d(r) + {}^{\frac{1}{2}}\bar{u}(\bar{r})$will pion π^{-}, and instead of neutron a proton is formed

$$^{-\frac{1}{2}}d(r)+{}^{\frac{1}{2}}u(g)+{}^{\frac{1}{2}}u(b) = p^{+}.$$

The pion π^{-} transferred into a proton p^{+}, turning it into a neutron *n*.

Through similar analysis on the example of a proton, it is easy to establish the possibility of creating pions π^{+} and the conversion of a proton into a neutron. The pion π^{+} transferred to the neutron *n*, turning it into a proton p^{+}.

Thus, the above scheme explains in the framework of the Standard Model the strong interaction between quarks in the nucleon and between nucleons (colorless particles) in the nucleus. Unacceptable places in this scheme correspond to the reactions of pion production from gluon and vice versa. Both reactions are to be unlikely, or even improbable. However, experiments show that the neutral and charged pions are easily formed as in the interaction of cosmic rays with the Earth's atmosphere, as well as in the laboratory.

Now consider additional aspects of the criticism of the Standard Model of strong interaction. The first thing that arises that is discrepancy between the exchange interaction model and potentials which describe the strong interaction between the hadrons. The potentials found by theorists did not follow from metabolic processes in hadrons. In addition, it seems that the gluons somehow know in what direction they must radiate. From what this knowledge, when anything besides gluons between

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[3] In the quantum mechanics the probability of a quantum transition is expressed by integral in which the function under sign of integral contains the wave functions of initial and final states as well as the operator of quantum transition. The quantum transition is impossible because the final state is impossible.

[4] What causes a such exchange it is not understanding.

hadrons do not exist? The exchange interaction in the model described above should rather be chaotic, and not strictly deterministic. What directs the virtual gluons, providing deterministic interaction between hadrons? It seems incredible and hypothetical mechanism of conversion of virtual gluons into the quarks pair.

2. STRONG INTERACTION IN THE MODEL OF THE UNIVERSE WITH MINIMAL INITIAL ENTROPY

The law similarity acts in the nature. Therefore, the interaction between quarks via bosons (gluons) can be considered as an example of interaction between the atoms by using a pair of electrons (also bosons) in the singlet state. The guiding force for the movement of these bosons will be an electromagnetic field. Consequently, the movement of gluons should provide by the appropriate Field.

Let's change the scheme of the strong interaction, so that it will be consistent with the new model of the Universe birth as an integral part of the Super-Universe.

In this case, the quarks and gluons are in the World-3, and nucleons and pions in the World-4. This approach has been used when we considered the weak interaction [9]. Now we use it to describe the details of the strong interaction between quarks and hadrons.

As the quarks and nucleons are both **carriers of the Field** [4].

It is possible to accept as basis the cyclic transfer of gluons among the three quarks [${}^{½}d(g)+{}^{½}u(r)+{}^{-½}u(b)$] in the case of a proton or triple [${}^{½}d(g)+{}^{-½}d(r)+{}^{½}u(b)$] in the case of the neutron. At the same time the gluon with spin projection 1 is transferred to the quark whose spin is equal to (-½), and vice versa if the gluon spin projection is opposite. In addition, the color composition of the gluons should correspond to the colors of the quarks, between which it is transferred. This exhausts the strong color interaction between quarks.

Strong colorless interaction between nucleons takes place simultaneously in the World-3 and World-4. In the World-4 we have a standard Yukawa scheme of virtual pion transfer between nucleons. Virtual pions in the World-3 are born by way of the excitation by energy of Field of the quarks of polarized vacuum particles [(${}^{1/2}d(\alpha)^{-1/2}\overline{d}(\overline{\alpha})$]or [${}^{1/2}u(\alpha)^{-1/2}\overline{u}(\overline{\alpha})$], where $\alpha = r, g, b$. Consequently, the energy of Field of quark originates from the vacuum particles in low symmetry only neutral quark-anti quark pair which corresponds to the neutral pions in the World-4. If this pair is born among the three quarks that are constituents of a neutron, it should have the quark structure $\pi^0 = {}^{-1/2}u(\alpha)^{1/2}\overline{u}(\overline{\alpha})$, and in the proton $\pi^0 = {}^{-1/2}d(\alpha)^{1/2}\overline{d}(\overline{\alpha})$ This neutral pions in the World-4 are born of polarized by Field nucleons of vacuum particles of World-4 due to the energy of the same Fields.

In all cases from the vacuum particles the colorless virtual quark pair are being produced primarily in the World-3 and neutral pions (themselves are particles and antiparticles), which consist of a quark and an anti quark in the singlet state. **The energy system of quarks that make up the nucleon is reduced by the amount of excitation of the virtual neutral pion**. This virtual pair has the ability to interact with the trio of quarks that spawned it (as in the World-3 and in the World-4), or return to the vacuum state. In the latter case, recovering the energy Fields of the nucleon occurs.

Virtual pair (pion π^0) has the ability to move to another nucleon, causing colorless strong interaction between nucleons. Moving virtual pion between nucleons causes movement in the opposite direction of the energy of Field which caused the birth of virtual pair[5]. After moving the virtual pion will return back to vacuum state. The energy of the nucleon Fields will increase to the standard state. **Overlapping of scalar Fields of interacting nucleons and reducing total energy of Fields determines a direction of movement of the virtual boson, and the interaction between nucleons** (Fig. 1). Consequently, the role of the Field in the interaction between nucleons with taking part of bosons is similar to the role of the electromagnetic field in the interaction between the atoms with a taking part of the pair of electrons in the singlet state.

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[5] Moving the pion resembles a ship moving through the narrow channel between two small ponds. The ship displaces the water from the reservoir in which it is located. Moving the ship in the second body of water causes the flow of water from the second reservoir to the first.

After giving birth of virtual pion $\pi^0 = {}^{-1/2}u(\alpha)^{1/2}\bar{u}(\bar{\alpha})$ in the neutron is possible the quarks exchange without changing their colors.

$$ {}^{-1/2}d(\alpha) + \pi^0 = {}^{-1/2}d(\alpha)^{1/2}\bar{u}(\bar{\alpha}) + {}^{-1/2}u(\alpha) = \pi^- + {}^{-1/2}u(\alpha). \qquad (13)$$

At the same time the neutron emits the pion π^-, and the neutron transfers into a proton.

Similarly, the reaction is going in the proton. In this case, the exchange of quarks occurs

$$ {}^{-1/2}u(\alpha) + \pi^0 = {}^{-1/2}u(\alpha) + {}^{-1/2}d(\alpha)^{1/2}\bar{d}(\bar{\alpha}) = {}^{-1/2}u(\alpha)^{1/2}\bar{d}(\bar{\alpha}) + {}^{-1/2}d(\alpha) = \pi^+ + {}^{-1/2}d(\alpha) \qquad (14)$$

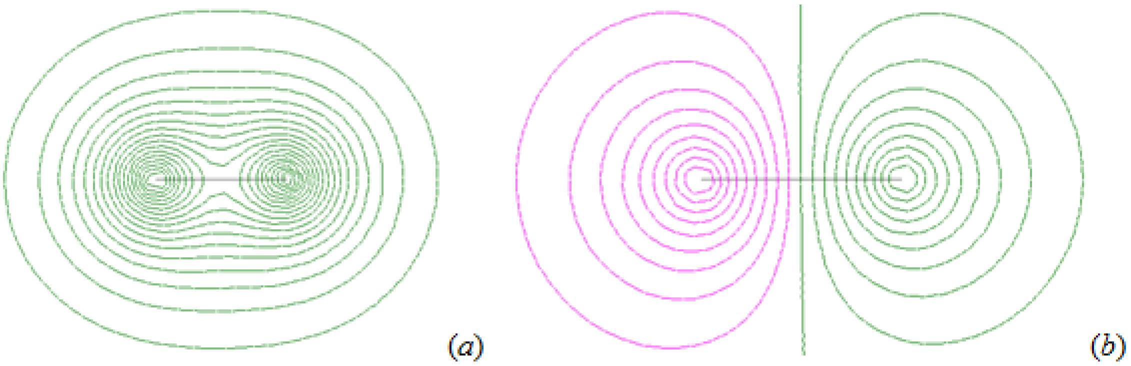

Fig1. *Overlapping of scalar Fields of interacting nucleons*

So, a pion p^+ flies out of proton and proton is converted into a neutron. It can be expected that the exchange of quarks with a virtual neutral pion will require additional energy from the Fields of quarks.

Movement of charged pion to the nucleon-partner requires reverse reaction of conversion the charged pion into the neutral pion and a relaxation of the latter into the vacuum state. In all processes of transformation the anti quark which is part of the original virtual particles remains as a part of the virtual particles.

The process of the virtual particle creation and its relaxation into virtual state resembles an oscillatory process. Therefore, this process takes place continuously, ensuring constancy of the interaction between quarks and between nucleons.

There is an **additional opportunity** for the manifestation of the strong interaction between nucleons. World 4-pion π^+ is the antiparticle to the pion π^-. Consequently, the energy of the total Field of the neutron and the proton may create the virtual pair ($\pi^-\pi^+$). In the electrostatic field of the proton this virtual pair is polarized, then pion π^- interacts with a proton and a pion π^+ with a neutron:

$$p^+ + \pi^- \rightarrow n + \pi^0,$$

$$n + \pi^+ \rightarrow p^+ + \pi^0. \qquad (15)$$

The last process in the reactions (15) is the return of the neutral pion in the vacuum state.

In the World-3 a creation of the virtual pair ($\pi^-\pi+$) means the simultaneous production of virtual pairs of quarks ${}^{-1/2}d(\alpha)^{1/2}\bar{d}(\bar{\alpha})$ and ${}^{-1/2}u(\alpha)^{1/2}\bar{u}(\bar{\alpha})$. In the field of the quarks group that makes up protons and neutrons, the polarization of pairs of quarks and sharing in their structures occurs:

$$ {}^{-1/2}d(\alpha)^{1/2}\bar{d}(\bar{\alpha}) + {}^{-1/2}u(\alpha)^{1/2}\bar{u}(\bar{\alpha}) \rightarrow {}^{-1/2}u(\alpha)^{1/2}\bar{d}(\bar{\alpha}) + {}^{-1/2}d(\alpha)^{1/2}\bar{u}(\bar{\alpha}), \qquad (16)$$

What in the World-4 corresponds to the formation of pions π^+ and π^-.

The first of the formed pairs has the charge "+", and the second has "-". The group of quarks which are the component of neutron makes a combination with the first pair:

$$({}^{-½}d(r) + {}^{½}u(g) + {}^{½}d(b)) + ({}^{-1/2}u(r)^{1/2}\bar{d}(\bar{r})) \rightarrow ({}^{-½}u(r) + {}^{½}u(g) + {}^{½}d(b)) + ({}^{-1/2}d(r)^{1/2}\bar{d}(\bar{r})). \qquad (17)$$

As a result, two groups of quarks are formed that make up protons and neutral pion.

Similarly, a group of quarks that make up protons, combined with the second pair:

$$({}^{-1/2}u(r)+{}^{1/2}u(g)+{}^{1/2}d(b)) + ({}^{-1/2}d(\alpha){}^{1/2}\overline{u}(\overline{\alpha})) \rightarrow ({}^{-1/2}d(r)+{}^{1/2}u(g)+{}^{1/2}d(b)) + ({}^{-1/2}u(\alpha){}^{1/2}\overline{u}(\overline{\alpha})). \qquad (18)$$

Now the group of quarks is formed constituting neutron and a neutral pion.

It is important to note that at consideration of the interaction of two protons or two neutrons, reaction (16) is not possible. Consequently, interaction between the same nucleons is possible only through the exchange by neutral pions. In turn, this leads to impossibility of formation for a stable nucleus of helium-2, which consisted only of the two protons (biproton).

It is known that binding energy between protons in biproton equals to -0.5 MeV. As electrostatic repulsion energy is about 1 MeV, so binding energy, caused by transfer of neutral pion between neutrons, equals to 0.5 MeV [10, 11]. The same processes should take place in bineutron. But neutron decays due to processes of weak interaction.

From the other side, binding energy in deuteron equals to 2.22457 MeV [12], because it caused by transfer of charged pions pair (i.e. much higher binding energy).

Let's mention one more important detail. In common state deuteron and bineutron have spin 1. If spin value equals to 0, then binding energy between nucleons decreases by 1 order of magnitude. The reason for this could be easily understood looking on Fig.1. Positive amplitude of the Field corresponds to particular spin direction, when negative – to opposite direction. In such case, amplitudes are summed together in triplet state, producing the channel for pion transfer (Fig.1, left side). In singlet state the channel is approximately absent (Fig. 2, right side). But from the quantum chemistry theory it is known, that the system could be in fully covalent bond only in triplet state, when in singlet state it is ionic bond that is always mixed up [13]. Using this analogy it could be understood, that bineutron should have weak binding channel in singlet state. Herewith several mechanisms of such binding could exist, e.g. spins precession in magnetic field of other spin and oscillatory processes of quarks moving within bineutron. Energy of such binding in bineutron equals to around 70 KeV [11]. But the Field uses bineutrons in singlet state for the Universe and atoms creation.

The relaxation of the virtual neutral pions formed by the reactions (17) and (18) in the vacuum state promotes to the birth of the next pair of virtual pions. And so on to infinity in time. This scheme easy gives explanation to the appearance of charged pions at the interaction of cosmic rays with the Earth's atmosphere.

The interaction between quarks, which are included in the structure of charged or neutral pions takes place only with the participation of gluonsg_3 and g_8(i.e. $r\overline{r}, g\overline{g}, b\overline{b}$), which do not change the color and flavor of quarks, but the exchange of the spins occurs. In these quark pairs the birth of a neutral pair of virtual quarks with the same color charges is also possible.

Since the neutral pion itself is the antiparticle, its lifetime is very small (see above). Quite another thing is a charged pion, which is composed of a quark and an anti quark with different flavors. Such a pair of quarks can not be annihilated, and that is why its lifetime is increased by more than 8 orders of magnitude. This is due to the fact that the charged pion must first exchange by quarks with the surrounding environment of the quark to create a neutral pion, which then annihilates.

Thus, considering the strong interaction in the framework of a model of the Universe with minimal initial entropy looks simply and convincingly. And it is clear that there must be a purposeful transfer of boson between quarks and between nucleons. And this trend provides by a scalar Field, which is proper for all particle with a mass. The overlap between the distribution Fields of two neighboring quarks and nucleons allows the formation of a bridge for the transfer of bosons are responsible for the strong interaction.

It is important to understand that the excitation of the virtual bosons from the vacuum state is provided solely by the presence of Field in the vicinity of all the particles having mass. At the same time the birth of the virtual boson or a pair of virtual bosons is possible only within the interacting quarks and nucleons.

3. CONCLUSIONS

On the base of consideration of the strong interaction in the Standard Model and in the model of the Universe with minimal initial entropy there are shown the next.

1) There are many complaints about the physics of strong interaction, adopted in the Standard Model: a) forming a reaction with colored gluon quark pair in the triplet state, and vice versa must be unlikely, or improbable; b) there is an imbalance of the exchange interaction model with potentials that describe the strong interaction between hadrons; c) is not known from gluons know in which direction to move them to the appearance of strong interactions.
2) In the new model, each quark and each hadron is simultaneously the carrier of a scalar Field. This Field is fully controls the emission and absorption of gluons, the birth of virtual pairs of particles from vacuum, a taking part of gluons and virtual particle pairs in the strong interaction processes.
3) Transfer of gluons between quarks is completely deterministic: it is going between the quarks with a change of spin per unit; the colored characteristic of gluons is matched with the colors of the quarks, between which the transfer of gluons occurs. Features gluons and transfer direction are defined by the scalar Field.
4) Gluon can not be transferred into a virtual pair of colored quarks and can not spontaneously decay into gluons.
5) The processes of production of virtual quark pairs in the World-3 are fully synchronized with the birth of pions in the World-4. As virtual pairs of quarks and virtual pairs of pions have birth by way of the excitation of the respective vacuum particles by energy of a scalar Field localized on mass particles (respectively, quarks and nucleons). Birth of quark-anti quark pairs in the World-3 corresponds to the creation of a neutral pion π^o in the World-4. Transfer of pion π^o between nucleons makes a contribution into a strong interaction between them. At the birth of the virtual pion π^o in the neighborhood of nucleon the energy Fields of the nucleon decreases. Moving of pion to another nucleon is accompanied by the displacement of the Field energy in the opposite direction. Return of the pion in the vacuum state recovers energy of nucleon Fields. The process of creation and recombination of virtual pairs is oscillatory process, which is repeated endlessly.
6) The total scalar Field of the proton and the neutron has the ability to initiate a virtual pair (p^-p^+), that in the World-3 means the simultaneous formation of two quark virtual pairs $^{-1/2}d(\alpha)^{1/2}\overline{d}(\overline{\alpha})$ and $^{-1/2}u(\alpha)^{1/2}\overline{u}(\overline{\alpha})$, their polarization in the Coulomb field of the proton and the conversion into two charged virtual pairs $^{-1/2}u(\alpha)^{1/2}\overline{d}(\overline{\alpha})$ and $^{-1/2}d(\alpha)^{1/2}\overline{u}(\overline{\alpha})$, the first of which corresponds to π^+, while the second corresponds toπ^-. The first virtual pair turns the neutron into a proton, and the second pair trasfers a proton into a neutron. As a result of such processes in both cases a virtual neutral pion has formed, which is converted into a vacuum particle. This process provides a much greater contribution to the strong interaction than in the case of the birth of the virtual neutral pion.
7) The strong interaction between two protons or two neutrons realizes only as a result of the transfer of a neutral pion. However, such interaction can not overcome the Coulomb repulsion between protons in a hypothetical helium-2 nucleus, in result such a nucleus does not exist.
8) The interaction between quarks, which are the components of the pion, is going due to the exchange by gluons, which do not change the color and flavor of quarks.
9) The increased stability of the charged free pions compared with neutral pions is explained by the need of reactions of quarks exchange $^{-1/2}u(\alpha)\leftrightarrow{}^{-1/2}d(\alpha)$ with the environment. At this reaction the neutral pions appear which quickly annihilate.

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