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Possible Modular Structure of Matter Based on the “YY Model” Approach

—An Overview of the Construction Rules for Quarks and Atomic Nuclei with Configurative Examples for Neutron, Proton, Deuteron and Dineutron

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Abstract

The newly developed YY model contains a set of constitutive rules to describe the structures of atomic nuclei and subatomic particles, by using two elementary sub-quark particles, the Yin and Yang fermions of charge 1/3 forming all the particles of the Standard Model. This model suggests a modular structure of the universe, in which two elementary constituents recursively form all the matter. The advantage of this hypothesis is that it provides a total symmetry and a noticeably clear conceptual understanding. Moreover, it justifies the cosmological formation of a limited number of atoms, e.g., H and Li with their isotopes, considering that matter can be produced as a free agglomerate of semi-stable neutrons, which would lead to the feeding of baryonic matter in the universe. In this current article, some further theoretical aspects are proposed as an evolution of the YY model. They cover correlation paths between interacting quarks, the considerations of color forces between yin-yang elementary elements. Moreover, an agreement of the YY model with the Teplov approach based on harmonic quarks and oscillators is established, and the mass of Yin and Yang is considered. Two example nuclei are used for the analysis: a radioactively stable deuteron (containing a neutron and a proton) and a possible semi-stable dineutron (roughly “consisting of two neutrons”), which is purely theoretical, represent a very natural and legal nuclear state within YY model. Based on the results obtained here, some indications are given for a possible simple experimental verification providing proof for the stability or instability of the dineutron.

Keywords

YY Model Approach, Color Confinement Aggregate State CCAS, Quark Correlation Path, Color Forces, Constituent Quarks, Harmonic Oscillator,

Harmonic Quark Mass

1. Introduction

This is not the first time that a sub-quark structure has been used to understand matter. Starting from the YY model, a structural new method for building matter is proposed here, quantitatively augmented by Teplov's harmonic oscillating quarks to form a consistent model of the universe. Since the YY model for atomic nuclei is relatively new and uses the Yin and Yang, two hypothetical elementary symmetric particles, we first give a summary of the basic concept already published with examples (Section 2), in particular for its constituents for building subatomic particles (quarks, electron and positron) and atomic nuclei (neutron, proton and deuteron). This also includes main construction rules to ensure that nuclear aggregate states are logically and physically consistent (in the construction of units for electrical and color charges) and remain compliant with knowledge artifacts from the standard model and standard experimental physics.

Beyond the structural nature of a nucleus, the manifestation of quantum colors on its Yins and Yangs play an important role. Based on previously published results on the "color confined aggregate state" (CCAS), which can be considered as a color confined snapshot reflecting invariant symmetry with the fundamental energy level of the aggregate, and using deuteron as an example, correlation paths between the constituent quarks are identified. They are invariant units in transformations between different CCAS (Section 3). They are interpreted here as the linearized axes of the interactions for the strong forces. This is also another theoretical result in the development of the YY model.

Unresolved so far is the "triple charge binding" of the YY model: why three Yins (arithmetically all with −1/3 electrical charge unit) bind in one vertex to a whole negatively charged node, just as three Yangs (arithmetically all with +1/3 electrical charge unit) bind in one vertex to a whole positively charged node. "Color forces" (not necessarily in the sense of existing formulations) are treated between a pair of two Yins, of two Yangs, or of Yin-Yang depending on colors (Section 4). This is another approach to linearizing the strong forces, which is simple but can be combined with a particular correlation path of two quarks for a quantum field treatment. Probably two or three specific parts relating to these color forces need to be introduced into the Hamiltonian and Lagrangian setup. We believe that this would lead to simpler and more precise quantum field solutions than previously done.

A conceptual overview of harmonic quarks, harmonic oscillators and their masses is given by O. A. Teplov (Section 5)—in particular, the inherent mechanism of their recursive composition (Section 6). Using this approach and our extension by "down-exciting" the harmonic quarks, the masses of the particles in the Standard Model can be accurately determined (Section 7). While the Teplov approach provides a universal, precise mass composition, the YY model, by corresponding Yin and Yang with harmonic quarks, complements this composition with a structural view that includes the interactions of color and electrical charges.

A nucleus model for dineutron is given (Section 8), derived purely by following the constituent rules, initially without reference to existing theories and experiments on dineutron. In its constitution, a dineutron and a deuteron are very similar. In preparation for a future quantitative calculation, all quark correlation paths for the dineutron are given, allowing a detailed comparison with the deuteron. An experimental scenario involving transmutation of deuterons (bombarded with neutrons) to dineutrons is considered (Section 9), rather than the usual assumption of neutron absorption. In addition to the collision of neutrons with deuteron, a collision scenario of neutrons with tritons (tritium nucleus) is also considered.

Before the last part with conclusion and outlook, we give the conformal nuclear models for possible trineutron, tetraneutron and more (Section 10) without performing any investigation.

2. Constitution of Atomic Nuclei with the YY Model and Conservation Rules

As an architectural approach to the modelling of the interior structure of atomic nuclei, the YY model was first published in the summer of 2020 (Ref. [1]). It has mainly descriptive character and allows rule-based modelling of atomic nuclei and their isotopes with detailed internal structures, which is lacking in the standard model. In this section, we roughly summarize some constituent aspects of the YY model to provide a knowledge base for rapid understanding.

Starting from an up quark, which according to the standard model has an electricity of +2/3 charge unit and a mass of 1/3 of the atomic unit (Ref. [2]), is considered in the YY model as an aggregate state shown on the left panel of **Figure 1**. In contrast, a down quark, which has an electricity of −1/3 charge unit and a mass of 1/3 of the atomic unit, is an aggregate state, as shown on the right panel of **Figure 1**.

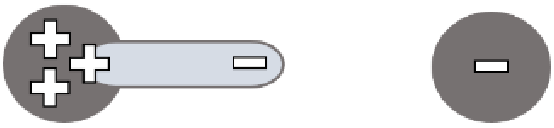


Figure 1. Up quark and down quark state model.

According to the smallest electrical charge unit of one third, Yin with the symbol "−" and Yang with the symbol "+" were introduced, which serve as more elementary constituents for particles than used in the standard model. The shading symbolizes the energetic and materialized states and stands for a certain amount of mass (e.g., one third of an atomic mass unit). The handle for the up quark, consisting of a Yin-Yang pair, is called "Pairing Space Link" (PSL), which is a construct for the exchange of gluons with quarks. The construction rules make use of the following formalism, corresponding **Figure 1**:

Up quark: u or (++<+−>); Down quark: d or (−)

The origin of electrical charges in the YY model is based on "triple charging": three Yangs bind to form a charged node with a positive electrical unit, while three Yins bind to form a charged node with a negative electrical unit, **Figure 2**.

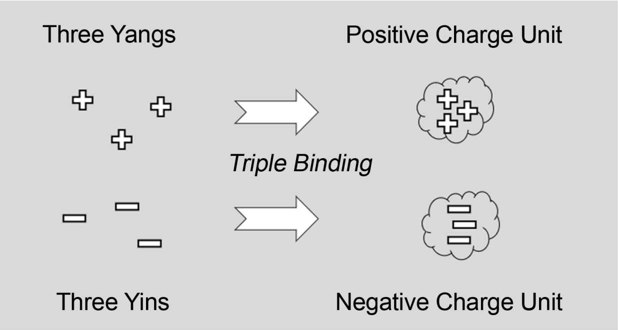


Figure 2. Triple bonds to electrical charges.

The mechanism for the triple bond is discussed as an effect of color forces in Section 4. A triple charged node is the base for an electron or a positron, this is expressed as follows:

Electron (e^-) => (−)(−)(−) or (− − −);

Positron (e^+) => (+)(+)(+) or (+ + +).

While the positively charged node is considered a permanent bond, the negatively charged node is decomposable and can recombine (asymmetric behavior in transmutations).

In all subatomic transmutation processes, the total number of Yins and Yangs and thus the charges of each Yin and each Yang must be universally conserved. Yin and Yang are elementary entities of the architectural model. They are permanent carriers of charges, but spontaneous carriers of quantum colors. The YY model attempts to build a universe in which all matter and particles emerge from them. As we will see later, Yin and Yang find their counterpart in the harmonic quarks in the sense of Teplov. They are recursively involved in the construction of the mass and structure and obey the clearly defined rules of behavior for the harmonic oscillators as well as for the color and electrical charge interactions

According to the known artifacts of the standard model, a neutron consists of one up and two down quarks and a proton consists of two up and one down quarks (Ref. [3]), **Figure 3**, left panel. The strong forces holding the individual quarks together are symbolized in each case by the star in the center of the figure parts. In contrast, the description of the YY model uses the tubular PSLs to connect the integer charged triple nodes, **Figure 3**, right panel.

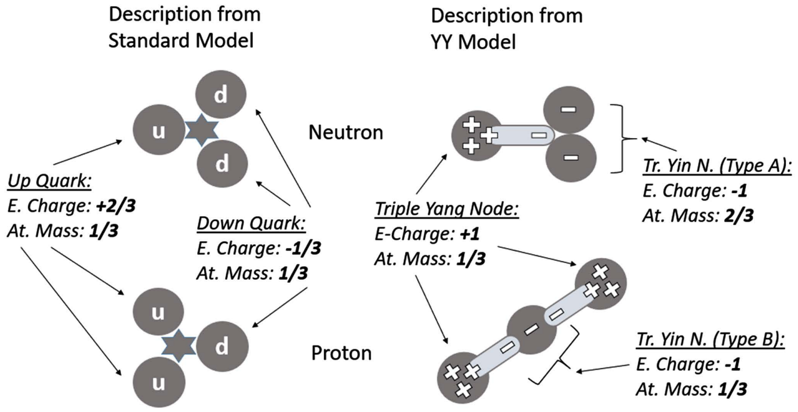


Figure 3. Description models for neutron and proton.

The total electrical charge within a neutron or a proton resulting from the YY model corresponds to the quantity in the standard model, the difference to the description in the standard model is the use of integer (triple) charged nodes by Yin and Yang entities. The construction makes use of the following formalism:

Neutron (udd): (++<+−>)(−)(−); Proton (udu): (++<+−>)(−)(<−+>++).

The paring-space link PSL and the triple-space link TSL, which is the "Y particle" predicted by the YY model, form fundamental gluon- and pion-conformal constructs (Ref. [4] [5] [6]) that serve as exchange particles within the nucleus, **Figure 4**.

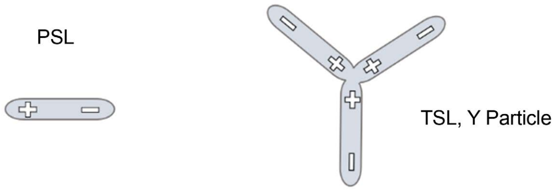


Figure 4. Pairing Space Link (PSL) and Triple Space Link (TSL).

TSLs are involved in the constitution of complex atomic nuclei, e.g., in the building of deuteron (deuterium nucleus) by fusion of a neutron and a proton, **Figure 5**. In this paper, deuteron is used as the reference model.

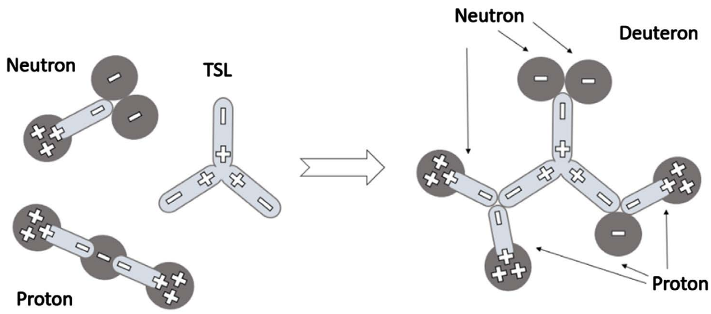


Figure 5. Deuterium nucleus as a result of fusion of neutron, proton and TSL.

Combining the standard symbols (u—up quark, d—down quark) with the TSL (=> Y), we obtain the following charming symbolic for a deuteron—which is an equivalent expression to the right part of **Figure 5**, but using quarks and their interaction linkage TSL:

dd du
Y
uu

Many fusion processes from simple nuclei to a complex require TSLs from the environment, lead to recombination of their constituent quarks following the basic rules of the YY model and yield one or more resulting aggregates. All the original up and down quarks are "stretched" in their distances from each other, but still indirectly connected to form neutrons and protons. TSLs are themselves a byproduct of the electron-positron annihilation during nuclear fusion – this is also a prediction of the YY model, as an extension of the familiar annihilation description from the standard model: in addition to producing gamma photons, the YY model restores a TSL as the original constitutive state, taking into account the Yang and Yin conservation rule, **Figure 6** (The resulting TSL as a particle is the difference from the standard model description).

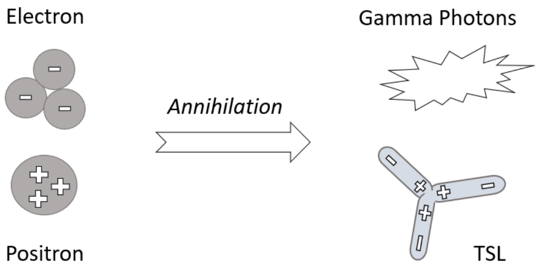


Figure 6. Annihilation of electron-positron pair described by the YY model.

The transmutation is thus expressed as: $e^- + e^+ \rightarrow 2\gamma + \mathrm{TSL}$.

In addition to bonding, TSL itself serves as a universal particle with a very basic physical state from which various other fundamental particles emerge under the conservation of yang and yin. Under high energy density, TSLs can be transformed into states for one up quark and two down quarks, **Figure 7** (=> origin of quarks).

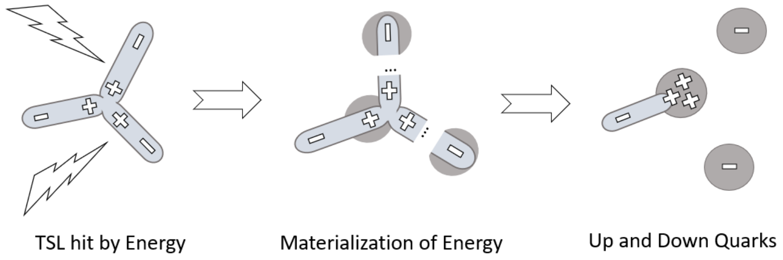


Figure 7. Conversion of a TSL into an up quark and two down quarks.

Moreover, under certain energy conditions and in a chain of transmutations, a TSL can also be split into an electron-positron pair, as shown in Figure 8.

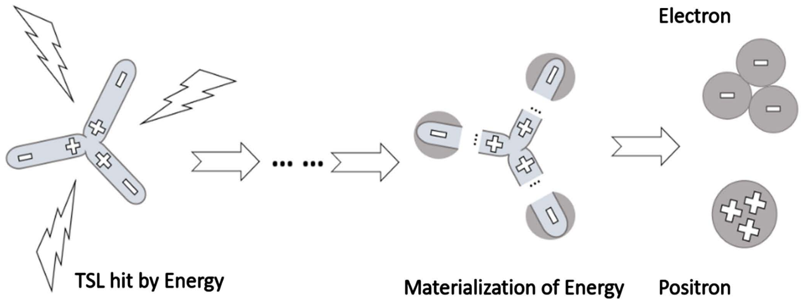


Figure 8. Conversion of a TSL into a positron-electron pair according to the YY model.

Moreover, as a bonding structure for quarks, the TSL itself can change state into a pair of up and anti-up quarks or a pair of down and anti-down quarks, taking into account color aspects.

Not least for the theoretical basis, the "internal charge balance (ICB) rule" states that within a nuclear aggregate, the constituent TSLs (electrically positively charged triple nodes ) must be numerically balanced by electrically negatively charged triple nodes (). ICB is important for the stability of aggregate structures, and the underlying mechanism remains to be investigated mathematically and physically. In the example of deuterium (Figure 3, right panel), a TSL in the center is balanced by the one triple node on the left, which is negatively charged.

The "vertex element rule" requires that all surrounding vertices of a nuclear aggregate must be one of the so-called "neutronhead", "protonhead" or "nucleonhead" (called "protonid" in our early publication), see also Figure 9.

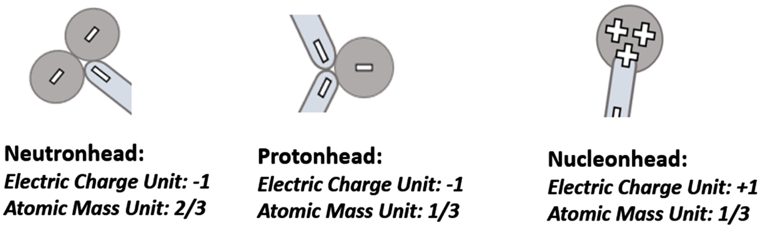


Figure 9. Neutronhead, protonhead and nucleonhead; Their charges and masses.

Each neutronhead requires a corresponding nucleonhead to build a neutron within a nuclear aggregate. Each protonhead requires two corresponding nucleonheads to form a proton within the same nuclear aggregate, refer also Figure 5, right part. The implication is that the occurrence of down quarks (double or single) determines the number of neutrons and protons within a nucleus, while the occurrence of nucleonheads serves only to satisfy the requirements from the occurrence of protonheads and neutronheads.

Thus, the net electrical charges of an atomic nucleus result from the summation of all built outer vertices—all up and down quarks combinations. Figure 10 gives the vertex notations for the deuterium nucleus.

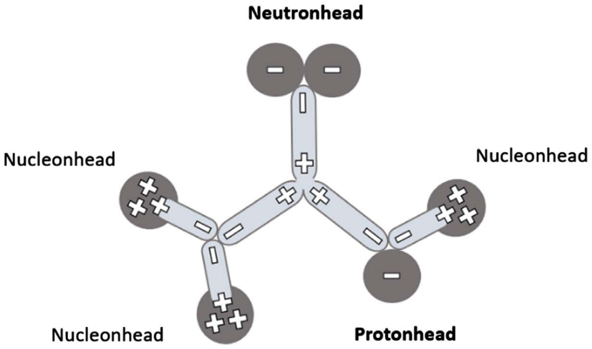


Figure 10. Notation of neutronhead, protonhead and nucleonhead for a deuterium.

3. Quantum Color Manifestation and Quark Correlation Path

The manifestation of quantum colors (Ref. [7]) was published last fall, based on the description of the YY model. We first give a rough summary about it and report here on a more developed aspect called "quark correlation path".

A consideration of quantum color dynamics QCD in the structural descriptions of YY model revealed a particular aspect as "Color Confined Aggregate State" (CCAS): a nuclear aggregate occupies a set of CCAS. Each CCAS means that all triple nodes are colored white (from the colors red, green and blue) and all PSLs are color-balanced (the two poles Yang and Yin are evenly colored, either red, green, or blue). Figure 11 shows three examples of CCAS for the deuterium nucleus (The YY model considers a quantum color—e.g., "red"—as manifested on a Yang node, whereas its anti-color—anti-red—is just the application of red on a Yin node).

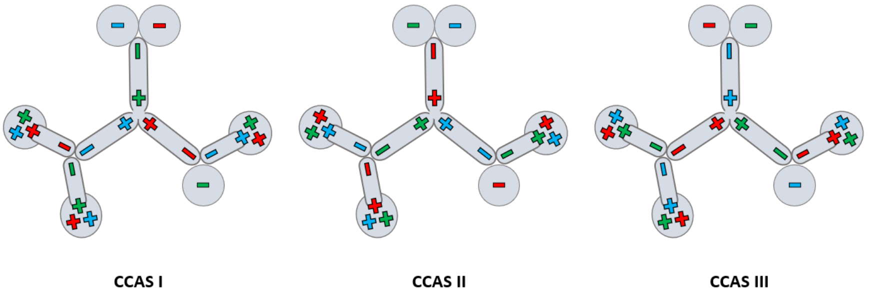


Figure 11. Three examples of CCAS for the deuterium nucleus.

The determining mechanism for the CCAS is not yet fully understood. But it seems that CCAS is closely related to chiral symmetry (Ref. [8] and [9]) and is an important stability factor for the atomic nucleus. Due to vertex-based separations of the constituent quarks for neutrons and protons, we need to reconsider the spins and the implication of the Pauli exclusion principle within a nucleus built according to the YY model. But for now, very clear and deterministic "quark correlation paths" can be derived from each constituent quark to its corresponding partner quark. They are invariant with respect to CCAS. To do this, consider an arbitrarily chosen CCAS I from Figure 11 and redraw it in Figure 12 by labeling the individual quarks with indices.

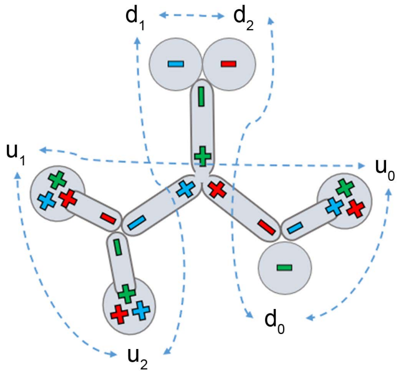


Figure 12. Selected CCAS I from Figure 11 with all quarks and correlation paths denoted.

Starting from the blue colored down quark d1 (=> anti-blue), entering the triple node TSL via the green colored PSL, and following a blue/green alternating path ("tumbling"), the correlation path ends on the green colored up quark u2 (=> anti-green). This correlation path can be denoted as (with r—red, ř—anti-red, g—green, ĝ—antigreen, b—blue, ƀ—antiblue):

d1 – blue/green – u2 => **d1**(ƀ) <ĝ g> <b ƀ> **u2**(ĝ).

The up quark u2 can take the same path back to d1 (symmetric bidirectional path). In addition, it has a second, alternative correlation path (green/red), which leads to the red colored up quark u1:

u2 – green/red – u1 => **u2**(ĝ) **u1**(ř).

Furthermore, if u1 follows its alternative path back (red/blue path), it ends up on the blue colored up quark u0:

u1 – red/blue – u0 => **u1**(ř) <ƀ b> <r ř> **u0**(ƀ).

Continuing this scheme, the tracing yields the other three correlation paths:

u0 – blue/green – d0 => **u0**(ƀ) **d0**(ĝ);

d0 – green/red – d2 => **d0**(ĝ) <ř r> <g ĝ> **d2**(ř);

d2 – red/blue – d1 => **d2**(ř) **d1**(ƀ).

The entire correlation path closes on the start quark, regardless of which start quark is chosen as the starting point and the direction of the tracking. All vertex-quark pairs have a short correlation path within themselves. "Remotely connected" quark pairs always take a path through a TSL node.

By using the Yin-Yang symbols for quarks (u) => (++<+−>) and (d) => (−), by assigning them with colors, we obtain the equivalent, more accurate expressions for all correlation paths (symbol "Y" stands for positively charged triple-yang node—TSL, and Ŷ for negatively charged triple-yin node) in Table 1.

Table 1. All quark correlation paths of deuteron in different expressions.

<table>
<tr><th></th><th></th><th></th></tr>
<tr><td>d1 – b/g – u2</td><td>(ƀ) Ŷ<ĝ g>Y<b ƀ>Ŷ (<ĝ g>ƀ|r)</td><td>(−) Ŷ <− +> Y <+ −> Ŷ (<− +> +|+)</td></tr>
<tr><td>u2 – g/r – u1</td><td>(b|r<g ĝ>) Ŷ (<r ř>g|b)</td><td>(+|+ <+ −>) Ŷ (<+ −> +|+)</td></tr>
<tr><td>u1 – r/b – u0</td><td>(g|b<r ř>) Ŷ<ƀ b>Y<r ř>Ŷ (<ƀ b>r|g)</td><td>(<+|+<+ −> Ŷ <− +> Y <+ −> Ŷ (<− +>+|+)</td></tr>
<tr><td>u0 – b/g – d0</td><td>(r|g<b ƀ>) Ŷ (ĝ)</td><td>(+|+<+ −>) Ŷ (−)</td></tr>
<tr><td>d0 – g/r – d2</td><td>(ĝ) Ŷ <ř r> Y <g ĝ> Ŷ (ř)</td><td>(−) Ŷ <− +> Y <+ −> Ŷ (−)</td></tr>
<tr><td>d2 – r/b – d1</td><td>(ř) Ŷ (ƀ)</td><td>(−) Ŷ (−)</td></tr>
</table>

Correlation paths as linearized force axes allow to form simplified Hamiltonians for analysis—further investigations must be carried out in the future. In a sense, the quantum fields become a superposition of all these correlation paths. Each PSL is traversed twice (back and forth) and each TSL is touched three times (as a paired input-output combination).

As will be seen, the dineutron as a bound state has a very similar set of properties as a deuteron. Even the transmutations between these two nuclei are easily possible.

4. Acting Forces

So far, the answer to the question of what the holding forces for the triple bond of three Yins are and for that of three Yangs has been omitted, so that an electron or a positron can be formed on the basis of this bond (Figure 2 and Figure 8, right part). There is also the question of how a PSL can take the "tubular form", a path-like state. In this section, two simple assumptions—attractive and repulsive color forces—are made, which become effective immediately when the colors are assigned to the Yin-Yang elements:

- **Attractive Color Force**: A pair of adjacent Yins with different colors exerts an attractive force on each other; a pair of adjacent Yangs with different colors also exerts an attractive force on each other. Thus, the triple bond is the result of attractive color forces between three adjacent Yin's or between three adjacent Yang's, Figure 13, left. These bonding states also correspond to the "white" states because three different colors of red-green-blue (or of anti-red-antigreen-antiblue) must be involved for this to occur.

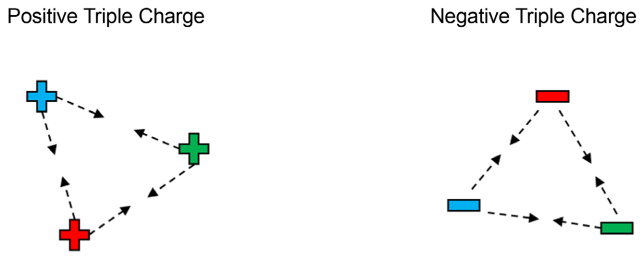


Figure 13. Attractive color forces.

- **Repulsive Color Force**: A Yin-Yang pair of the same color (=> color-balanced PSL) repels from each other, Figure 14.

Figure 14. Repulsive color force.

- **Coulomb Forces**: In contrast to the color forces, a Yin (electrically charged in the fraction −1/3) and a Yang (electrically charged in the fraction +1/3) exert an attractive electrically conditioned force on each other. Two adjacent Yins repel each other electrically. Similarly, two neighboring Yangs also repel each other electrically.

Overall Force Balance: Within a certain differential space region, the color forces and the electric forces are balanced, so that in the case of Figure 13, the triple nodes (TSL nodes) do not collapse, and in the case of Figure 15, a Yin-Yang pair can form a stable tubular structure corresponding to a Pairing Space Link PSL. We will show later (Section 5) that the physical background is the "quasi-annihilating quark and anti-quark pair", which has its own harmonic oscillation mass in the sense of Teplov theory.

Considering the whole nuclear aggregate, an overall equilibrium of all forces must be reached on each correlation path between two quarks to achieve a stable path state: These include the color forces and the Coulomb forces resulted from the charges of Yin's and Yang's, as shown in Figure 15 based on the first correlation path of Table 1.

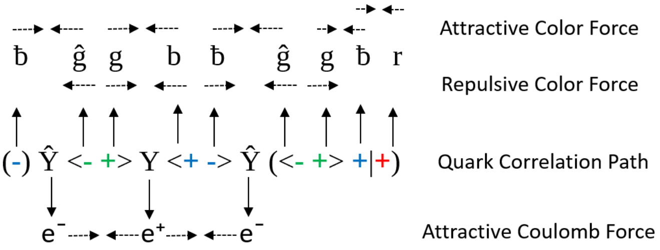


Figure 15. Overall force balance on a quark correlation path.

Although the terminology "strong forces" of quantum field theory is not directly used here, the YY model considers the color forces described above as an interpretation of the strong forces. The advantage of the acting forces discussed here lies in their clarity and simplicity: The overall effect of the forces is always a balance of color forces and electric force.

5. Harmonic Quarks According to O. A. Teplov, Coincidence of the YY Model with the Teplov Approach and Further Extensions

Between 2002 and 2005, O. A. Teplov introduced the concept of harmonic quark oscillators based on a quark-antiquark pair and developed the formalism for calculating the exact masses of harmonic quark oscillators (Ref. [10] [11] [12] [13]). According to this approach, the quark mass is understood as the physical rest mass of the single particle state of an interacting quantum field. The flavor quantum number (reflecting quark production) is essentially a reflection of the quark's internal energy—its physical mass. The quark mass model with a multiplicative pattern in the mass transformation between quark flavors focuses on the quark-antiquark interaction and its outcome: either a meson (e.g., a vector boson) or complete annihilation of the pair with the birth of photons or lower mass quarks or other particles is produced.

Consider flavor changes in the weak fundamental interaction of quarks as expressed in the following terms (n is the quark generation number, ν is the neutrino):

$$\mathrm{Q}_{(n)} + \mathrm{W}_{+/-} \sim \mathrm{Q}_{(n+1)} \tag{1}$$

$$\mathrm{Q}_{(n)} + \mathrm{e}_{+/-} \sim \mathrm{Q}_{(n+1)} + \nu \tag{2}$$

Teplov derived the formula for calculating the mass of harmonic quarks based on a multiplicative pattern:

$$m_{(n+1)} = \frac{\pi}{4-\pi} \times m_{(n)} \tag{3}$$

The mass of the quark oscillator of generation n+1 can be determined exactly by the mass of its lower generation n, starting from a hypothetical initial mass of the generation 0 quark. Moreover, for a given quark, its two neighbors can be considered as having an upward excitation (the quark with the larger mass) and a downward excitation (the quark with the smaller mass), with the electric charges of the two excitations being the same. According to Teplov, such harmonic oscillators form a series of quarks, starting with the lightest down quark (with a harmonic oscillator mass of 28.815 MeV), which are considered below as successive up excitations, see **Table 2**.

Using these harmonic quark masses, Teplov gave a mass composition model for some leptons and baryons—numerically very accurate. The research of O. A. Teplov reveals a deep fact of the quark generation model, which essentially states that a quark generation of $n + 1$ results from the quark generation n by binding an electron or positron of its own flavor (its own generation), as expressed in Formula (2). In particular, the masses (harmonic quark masses) can be accurately calculated between these two generations according to a simple Formula (3).

Teplov treated the down quark with a harmonic oscillator mass of 28.815 MeV as the "lower limit" of his series described in **Table 2**. However, he also mentioned a possible "down excitation" quark with a harmonic oscillator mass of about 7.87 MeV (Ref. [11]), calculated from 28.815/π(4 − π). But he did not pursue this idea further. This is made up for in our current work, as calculated in the following **Table 3**.

Table 2. The masses of harmonic quarks after Teplov.

Harmonic quark defined by Teplov	down	up	strange	charm	bottom	top	b'
Harmonic quark mass (MeV)	28.815	105.456	385.95	1412.5	5169.4	18919	69239
Notation with generation index	Q1	Q2	Q3	Q4	Q5	Q6	Q7

Table 3. The masses of (pseudo) harmonic quarks after "down excitation" using Formula (3).

Harmonic quark defined by Teplov	-	-	-	-	-	-	-	?
Harmonic quark mass (MeV)	0.00089	0.00328	0.0120	0.0439	0.161	0.588	2.151	7.87
Notation with generation index	Q-7	Q-6	Q-5	Q-4	Q-3	Q-2	Q-1	Q 0

Teplov treated in his series of articles the structure formation of subatomic particles and atomic nuclei from the quarks. But his focus was essentially on a decomposition into harmonic pairs. We will show in the next two sections that a decomposition must take into account not only the harmonic pairing, but also the asymmetric "remote" pairing of the quarks themselves. We will show by examples that all these harmonic quarks from Table 2 and Table 3 are together "primary" and "discrete" building blocks of any particle in mass and electric charge.

It should also be mentioned that these "Teplov quarks" or synonymously "harmonic quarks" are theoretical in nature, unlike the "physical quarks" of the Standard Model, which have already been well treated in both fundamental theories and experiments.

First of all, we point out that a Yin or Yang in the YY model so far mainly represents a "summed up" charge part (one third charge unit): Yin: −1/3 and Yang +1/3. We only claim that they have a certain mass quantum. We will show in this section how Yin and Yang obtain their masses. We will also show that there is a very good correspondence of Yin (Yang) with Teplov harmonic quarks as well as with their grouping states in the conservation of charge quantum. Moreover, there is a very simple explanation of PSL (Pairing Space Link) when considering the harmonic quark pairs. This is also true for TSL (Triple Space Link).

To this end, we first give a numerical approach to the Teplov mass Formula (3), using a very close approximation of π ~ 355/113 (=**3.14159**292, Ref. [14]), as follows:

$$m_{n+1} = \frac{\pi}{4-\pi} \times m_n = \frac{355}{97} \times m_{(n)}$$

which expresses the ratio between the Teplov quark mass of generation $n + 1$ and generation n. By applying the Teplov algorithm for successive down calculations:

$$m_{(n)} = \frac{355}{97} \times m_{(n-1)}$$

$$m_{(n-1)} = \frac{355}{97} \times m_{(n-2)}$$

$$m_{(n-2)} = \frac{355}{97} \times m_{(n-3)}$$

We obtain the following numerical mass series of harmonic quarks over five generations:

$$m_{(n+1)} = 3m_{(n)} + 2m_{(n-1)} + m_{(n-2)} + \left(167750635/88529281\right) \times m_{(n-3)}$$

Considering the coefficient in the last term (≈1.89) as an approximate factor of 2—also because the mass of $m_{(n-3)}$ is smaller than that of $m_{(n-2)}$ by a factor of 3.66—we obtain the following expression, with an inaccuracy of minus $0.11 \times m_{(n-3)}$:

$$m_{(n+1)} = 3m_{(n)} + 2m_{(n-1)} + m_{(n-2)} + 2m_{(n-3)} \tag{4}$$

The physical interpretation of factor of 3 in Formula (4) is the "triple binding" of Yins or Yangs (**Figure 2** and **Figure 14**) to give a "Teplov electron/positron" with a whole electric charge unit (−1 or +1). The factor of 2 in Formula (4) represents a charge-neutral "quasi-annihilating harmonic quark pair", while the factor of 1 represents an up- or down-harmonic quark that compensates against the Teplov electron/positron so that the total state has a total electric charge unit of −1/3 or +2/3—becoming a next "higher" down-or "higher" up-harmonic quark.

This leads to a modular structure of matter: it states that the mass of a Teplov quark is composed of three Teplov quarks excited downward $3 \times m_{(n)}$, plus two harmonic oscillators $2 \times m_{(n-1)}$ and $2 \times m_{(n-3)}$, and another Teplov quark excited downward by three generations $m(n - 2)$. Figuratively speaking, this corresponds to the following construction (Q stands for a Teplov quark and the index n stands for a certain generation) (**Figure 16**):

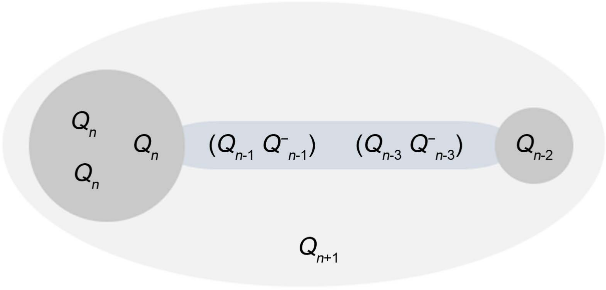


Figure 16. Teplov harmonic quark composition (generation $n + 1$ of n, $n - 1$, $n - 2$ and $n - 3$).

According to the YY model, Yin (−) and Yang (+) would correspond exactly to a harmonic Teplov quark, namely Yin to a down quark and Yang to an anti-down quark, both in a certain generation. This in turn results in a more precise form for the YY modeling—namely the cascading up excitations from a down quark (Yin) to an up quark and further to a down quark of the next generation (Yin), see Figure 17.

The harmonic oscillating quark pairs are symbolized by ~. According to Teplov, they are "almost" or "quasi" annihilating, but cannot because the binding states exist with their neighbors.

Similarly, cascading up excitations from an anti-down quark (Yang) to an anti-up quark and further to an anti-down quark of the next generation (Yang), see Figure 18.

Note that Figure 17 represents a set of harmonic quarks, while Figure 18 represents a set of harmonic anti-quarks. The triple-bonded Yins and Yangs in Figure 17 and Figure 18 correspond to the "Teplov electrons" and "Teplov positrons" of different generations, respectively, which are also expressed in Formula (2).

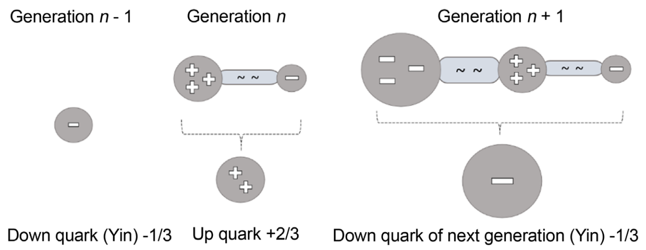


Figure 17. Two up excitations from a Yin turns a Yin of next generation.

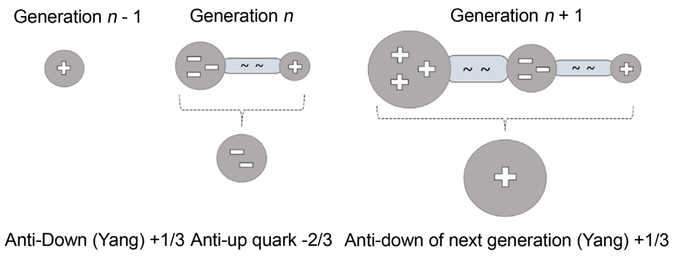


Figure 18. Two up excitations from a Yang turns a Yang of next generation.

To generalize the correspondence of Yin Yang with Teplov quarks, we claim that any Teplov quark representing a particular harmonic mass (in Table 2 and Table 3)—for example, 28.81 MeV—can be charged with both −1/3 and +1/3 to serve as a down or anti-down quark. The same Teplov quark can also be charged with both +2/3 and −2/3 to serve as an up and anti-up quark. Consequently, the composite (up-excited) Teplov quark can also be charged with −1/3, +1/3, −2/3, or +2/3. For example, the combination of one aggregate $m_{(n\text{-}2)}$ charged with −1/3 and three $m_{(n)}$ each charged with +1/3 will result in an aggregate $m_{(n+1)}$ with charge +2/3. From the aggregate of $m_{(n\text{-}2)}$ charged with +2/3 and from three $m_{(n)}$

each charged with −1/3, an aggregate $m_{(n+1)}$ with a charge of −1/3 is formed.

We also see that harmonic oscillating quark pairs play an important role in the link between a Teplov quark and a Teplov electron or positron. In the YY model, this corresponds to the PSL (Pairing Space Link). In other words, the harmonic oscillating quark pairs are a kind of "load-bearing assembly" of the tubular structure of the PSL in the YY model, they constitute a large part of the mass, as described in Formula (4). We will show that the CCAS and the color forces described in Section 4, which balance the electric forces, are the determining factor for the tubular structure of PSL.

Based on these results, we can compose an arbitrary particle described by the Standard Model from both harmonic Teplov quarks and the YY model. We will see that the YY model has the advantage here of describing the deep binding mechanism based on color confinement (CCAS).

It should be mentioned that an alternative derivation of Formula (4) and thus an alternative interpretation of the modular structure of matter is also interesting:

$$m_{(n+1)} = \frac{\pi}{4-\pi} m_{(n)} = \left(355/97\right) m_{(n)} = 4m_{(n)} - \left(33/97\right) m_{(n)}$$

With an inaccuracy of 0.007 factor of $m_{(n)}$, the following formula expresses the quantitative relationship for the masses of two neighbor generations:

$$m_{(n+1)} = 4m_{(n)} - \frac{1}{3} m_{(n)} \tag{4a}$$

The structural setup resulting from 4a is comparable to Figures 16-18. The physical explanation for this could be: the mass of a Teplov harmonic quark results from the sum of the four constituent harmonic quarks of the next lower generation minus one third of this mass. This minus part of the mass will be interesting for future research to find out its relationship to the "binding energy" of a harmonic quark.

6. Examples of Harmonic Quark Construction by Down-Excited Harmonic Quarks

Let us first consider how a heavy Teplov harmonic up quark (Q2, Table 2) is itself composed of other down-excited Teplov harmonic quarks, in particular in terms of numerical mass. A mass composition for a harmonic quark can be easily derived purely numerically. Based on the numerical composition, a suitable structural composition is obtained as follows (the following calculation is rounded to two decimal places).

Harmonic up quark (charge +2/3, theoretical mass 105.456 MeV and calculated 105.512 MeV below):

mass composition:3 × 28.815 + 2 × 7.87 + 2.151 + 2 × 0.588;

quark composition: (Q1 Q1 Q1) ($Q0^-$ Q0) Q-1 ($Q\text{-}2^-$ Q-2).

The following configuration (Figure 19) reflects the correspondence between the description of the YY model and the mass decomposition from the point of view of harmonic Teplov quarks:

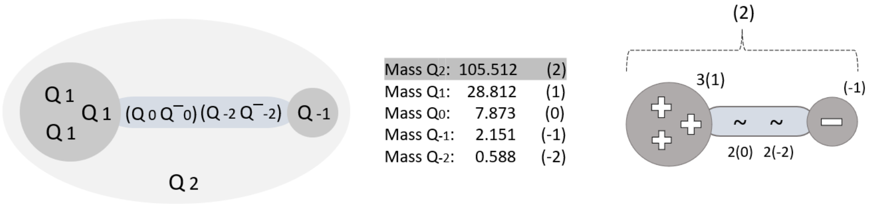


Figure 19. A heavy harmonic up quark, its composition of down-exicited harmonic quarks.

In the Figure above, the notation 3(1), for example, represents three Teplov quarks of generation 1. The up quark consists of a Teplov positron of generation 1 and a down quark of generation −1 (right part), between which there are two harmonic quark pairs:

Triple Yangs (+++) ⇔ (Q1 Q1 Q1), Ending Yin (−) ⇔ Q-1;

PSL (tuples) ⇔ (Q0⁻ Q0) (Q-2⁻ Q-2), composed of two harmonic quark pairs.

It should be mentioned that all calculations here and in the following are rough, because the compositions are done in a rough way. Nevertheless, the power of harmonic quarks is obvious.

Next, we consider how a heavy Teplov harmonic down quark (Q3, Table 2) is composed of other down-excited Teplov harmonic quarks, especially in terms of masses:

Harmonic down quark (charge −1/3, theoretical mass 385.95 MeV and calculated 386.17 MeV below).

mass composition: 3 × 105.456 + 2 × 28.815 + 7.87 + 2 × 2.151;

quark composition: (Q2 Q2 Q2) (Q1⁻ Q1) Q0 (Q-1⁻ Q-1);

This results in the following configuration (Figure 20):

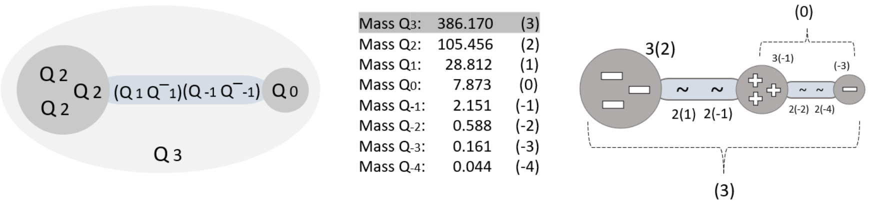


Figure 20. A heavy harmonic down quark, its composition of down-exicited harmonic quarks.

In the Figure above, the notation 3(2), for example, represents three quarks of generation 2. Thus, the down quark is composed of a generation 2 Teplov electron and a generation 0 up quark, which in turn is composed of a generation -1 Teplov positron and a generation −3 down quark (right part):

Triple Yins (---) ⇔ (Q2 Q2 Q2), Ending up quark (++) ⇔ Q0;

PSL (tuples) ⇔ (Q1⁻ Q1) (Q-1⁻ Q-1), composed of only harmonic quark pairs.

Third, we consider how a harmonic down quark of intermediate weight (Q1,

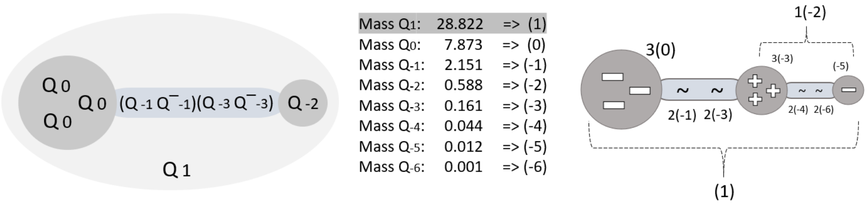
Table 2) is composed of downward excited harmonic quarks, in particular at masses:

Harmonic down quark (charge −1/3, theoretical mass 28.815 MeV and calculated 28.822 MeV below).

mass composition: 3 × 7.87 + 2 × 2.151 + 0.588 + 2 × 0.161;

quark composition: (Q0 Q0 Q0) (Q-1^{-} Q-1) Q-2 (Q-3^{-} Q-3);

The resulting configuration is shown in Figure 21:



Mass Q1:	28.822	=> (1)
Mass Q0:	7.873	=> (0)
Mass Q-1:	2.151	=> (-1)
Mass Q-2:	0.588	=> (-2)
Mass Q-3:	0.161	=> (-3)
Mass Q-4:	0.044	=> (-4)
Mass Q-5:	0.012	=> (-5)
Mass Q-6:	0.001	=> (-6)

Figure 21. A harmonic down quark of middle weight, its composition of harmonic quarks.

In the Figure above, the notation 3(0), for example, represents three quarks of generation 0. Thus, the down quark is composed of a generation 0 Teplov electron and a generation −2 up quark, which in turn is composed of a generation −3 Teplov positron and a generation −5 down quark (right part):

Triple Yins (---) ⬄ (Q0 Q0 Q0), Ending Yang (++) ⬄ Q-2;

PSL (tuples) ⬄ (Q-1^{-} Q-1) (Q-3^{-} Q-3), composed of only harmonic quark pairs.

From a structural point of view, the generation 0 down quark at 28.812 MeV (Figure 21) has the same structure or decomposition as the generation 2 down quark at 386.95 MeV (Figure 20)—an inherent recursion that also applies to up quarks.

In the same way, each harmonic quark in the Teplov series can be considered as a composition of its downward excited harmonic quarks. They all follow the same rules for mass and composition (Formula (4) and Figure 16). A very important aspect of this matter building rule is "recursive" or "fractal": Contrary to the understanding of the Standard Model, there are no "final particles" that compose everything.

7. Examples of Particles of the Standard Model Decomposed into Harmonic Quarks

As distinguished from the Section above (harmonic Teplov quarks), in this section we consider the building of the Standard Model particles—quarks, leptons and baryons (neutron and proton)—through the composition of harmonic Teplov quarks by mass and charge. The YY model plays an important role in structural considerations. The deuteron nucleus and a (hypothetical) dineutron are also considered. The conceptual universality of our architectural model becomes clearer.

Let us start here with a simple structure case, namely the strange quark, which is described in the Standard Model as an elementary particle (The mass calculation here is accurate and the structural configuration is shown in Figure 22):

Strange quark (electrical charge −1/3 e, bare mass 95.00 MeV and calculated mass 94.315 MeV below).

harmonic mass composition: 3 × 28.815 + 7.87;

harmonic quark composition: (Q1 Q1 Q1) Q0;

structural and charge composition:

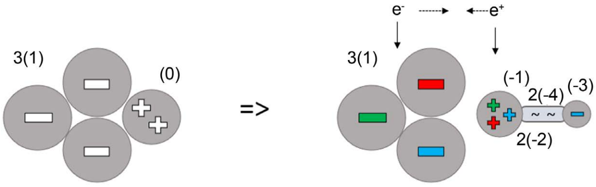


Figure 22. Strange quark of standard model, its compositing harmonic quarks and their colors.

The relevant spectrum of harmonic quark generations is spanned between (−4) and (1). The binding of the aggregate is based on the generation 1 Teplov electron and the generation −1 Teplov positron (both color-confined) and two harmonic quark pairs (~ ~) terminating at a down quark of generation −3. As a strange quark, the total aggregate takes on an (anti-)blue color—note that this strange quark does not exist "alone", as it is embedded in a higher-level context aggregate by being adjacent to other neighboring down or up quarks.

The next case concerns the electron with its harmonic quarks all in the downward excited region from Table 3, with exact mass calculation.

Electron (electrical charge −1e, bare mass 0.511 MeV and calculated mass 0.511 MeV below).

mass composition: 3 × 0.161 + 2 × 0.012 + 0.0033 + 0.001;

quark composition: (Q-3 Q-3 Q-3) (Q-5^{-} Q-5) Q-6 Q-7;

structural and charge (Figure 23):

Figure 23. Electron, its composition of harmonic quarks.

This is a more accurate description of the electron composite structure shown in Figure 2. The *δ*-part (right part of Figure 23) is an "appendage" to the Teplov electron of generation −3. Its role is not explained here. However, Teplov has made an interpretation for a muon (see below), whose approach can be considered for the electron in the future.

A further sample is given for the muon, an elementary particle of the standard model with a short lifetime.

Muon (electrical charge −1e, bare mass 105.658 MeV and calculated mass 105.661 MeV below).

mass composition: 105.456 + 0.161 + 0.044;

quark composition: Q2 Q-2 Q-4;

structural and charge (Figure 24):

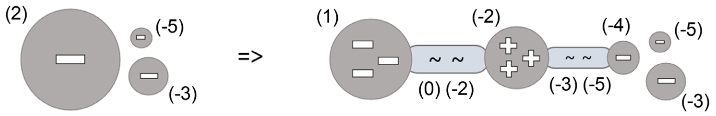


Figure 24. Muon and its harmonic quark composition.

Remark: The further down-exciting gives the following more detailed compositions for muon (=> 105.656 MeV):

mass composition: 3 × 28.815 + 2 × 7.87 + 2.151 + 2 × 0.588 + 3 × 0.044 + 0.012;

quark composition: (Q1 Q1 Q1) ($Q0^-$ Q0) Q-1 ($Q\text{-}2^-$ Q-2) (Q-4 Q-4 Q-4) Q-5.

In explaining the small difference in mass between a harmonic u quark and a lepton muon, Teplov pointed out that: "… *muon is a successful attempt of Nature to explicitly fix the single u-quark mass state as a lepton suppressing color and fractional charge*."

Now we turn to the consideration of the "well-known" up- and down-quarks of the standard model and the decay process $d \text{ -> } u + e^- + ve^-$.

Up quark (electrical charge +2/3 e, bare mass 2.3 MeV and calculated mass 2.303 MeV below).

mass composition: 3 × 0.588 + 2 × 0.161 + 0.161 + 0.044 + 0.012;

quark composition: (Q-2 Q-2 Q-2) ($Q\text{-}3^-$ Q-3) Q-3 $Q\text{-}4^-$ Q-5;

structural and charge (Figure 25):

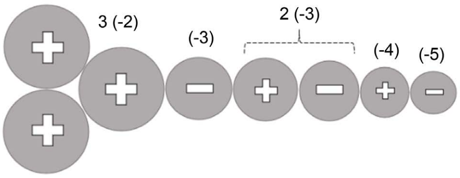


Figure 25. Standard model up quark, its composition of Teplov harmonic quarks.

The mass of the up quark is close to the mass of the harmonic quark of generation −1 (Q-1 in Table 3).

Down quark (electrical charge −1/3 e, bare mass 4.8 MeV and calculated mass 4.795 MeV below).

Mass composition: 2 × 2.303 + 0.161 + 2 × 0.012 + 0.0033 + 0.001;

Quark composition: ($u^{-\prime}$ u') Q-3 ($Q\text{-}5^-$ Q-5) Q-6 Q-7;

Structural and charge (Figure 26):

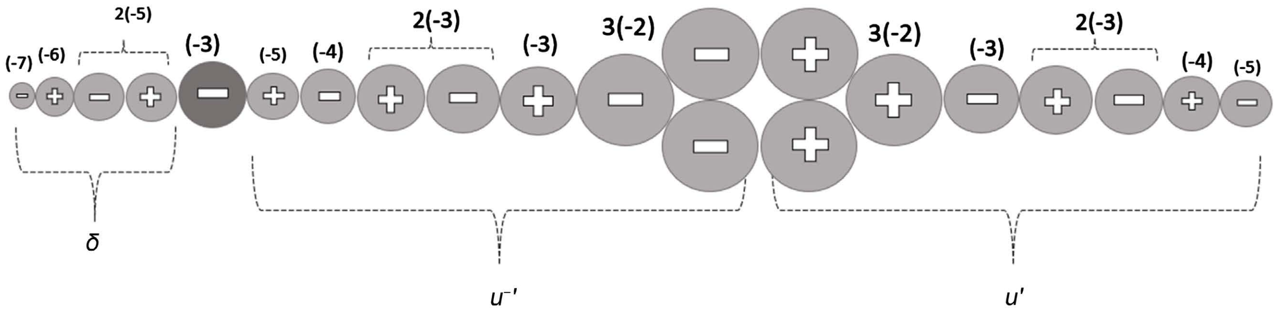


Figure 26. Standard model down quark, its composition of Teplov harmonic quarks.

From the structural point of view, the down quark can be considered as a compound of three parts: an up-quark u' (see also **Figure 25**), an anti-up quark $u^{-'}$, a down quark of generation −3, and a charge-neutral aggregate *δ*. The quark-antiquark pair (u' $u^{-'}$) is "almost" annihilating but cannot because of the binding state with the neighboring down quark (−3) and the *δ*-part, which is identical to the *δ*-part in an electron (**Figure 23**).

Thus, the decay process (d -> $u + e^{-} + ve^{-}$) is simply a separation of the up quark u' and a transmutation of the anti-up quark $u^{-'}$, the down quark (−3), and *δ* into an electron and an electron antineutrino (annihilation), as shown in the following **Figure 27**.

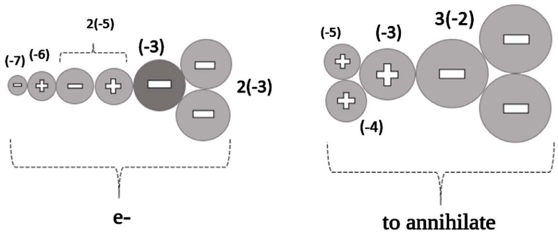


Figure 27. Transmutation of *δ*, (−3) and $u^{-'}$ into an electron and electron antineutrino.

In the following, further examples of particles from the Standard Model are given neutron, proton, deuteron and finally a possible dineutron.

Neutron, electrical charge 0, bare mass 939.565 MeV and calculated mass 939.61 MeV below:

mass composition: 105.456 + 2 × 385.95 + 2 × 28.815 + 2 × 2.151 + 2 × 0.161;

quark composition: Q2 ($Q3^-$ Q3) ($Q1^-$ Q1) Q-1 Q-1 ($Q\text{-}3^-$ Q-3);

structural and charge (**Figure 28**):

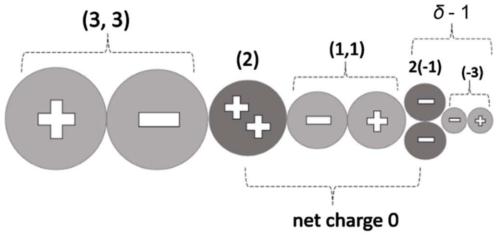


Figure 28. Neutron and its composition of harmonic quarks.

Proton, electrical charge +1e, bare mass 938.272 MeV and calculated mass 938.313 MeV below:

Mass composition: 105.456 + 2 × 385.95 + 2 × 28.815 + 2.151 + 2 × 0.588;

Quark composition: Q2 (Q3$^-$ Q3) (Q1$^-$ Q1) Q-1 (Q-2$^-$ Q-2);

Structural and charge (Figure 29):

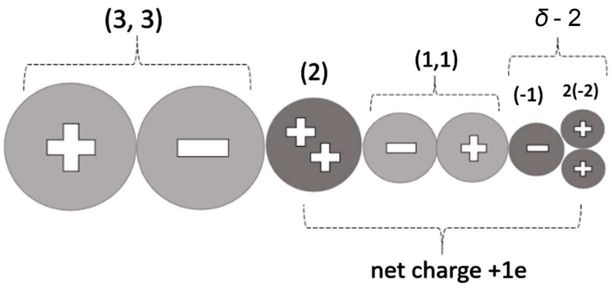


Figure 29. Proton and its composition of harmonic quarks.

The decay of a free neutron into a proton (N -> $P + e^- + ve^-$) is considered here as a transmutation of the small right part δ-1 in Figure 28 into the small right part δ-2 in Figure 29. It is mainly created by the decay of one harmonic quark Q-1 with 2.151 MeV into its downward excited harmonic quarks, recombing with the harmonic quark pair (Q-3$^-$ Q-3) and finally emitting an electron with 0.511 MeV and an electron antineutrino with an energy of about 0.769 MeV.

Experiments (CLAS Collaboration) have shown the existence of strange and anti-strange quark pairs in the proton's mass structure by shooting electron beams into liquid hydrogen, scattering K$^+$-mesons and Λ-hyperons (refs. [15] and [16]). At least part of the products, the K$^+$-meson with a bare mass of 493.667 MeV, can be calculated here almost directly by adding the harmonic quark masses (105.456 + 385.95 + 2.151 = 493.557 MeV, splitting two harmonic pairs of generation 3 and 1, respectively, in Figure 29).

Deuteron, electrical charge +1e, composed of a neutron and a proton as follows, using a TSL with vanishingly small mass (Figure 30):

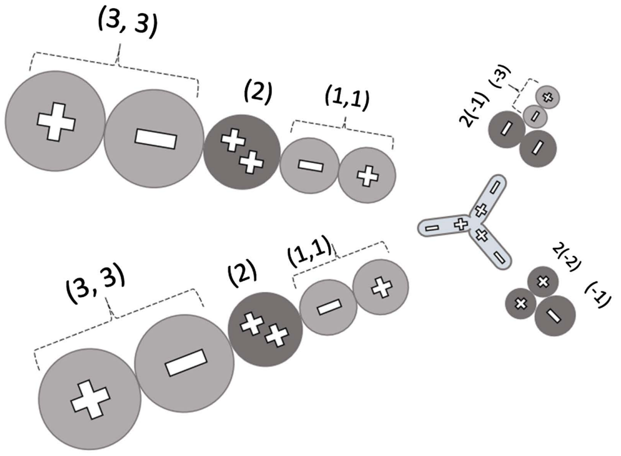


Figure 30. Deuteron and its composition of harmonic quarks.

In contrast to a single neutron, a bound neutron in a deuteron does not have the tendency to decay, since this would change the charge of the total system from +1e to +2e, which would imply an excess of positive charges.

8. A Possible Bounded Aggregate Model for Dineutron

In the past, the dineutron has been studied in some theoretical and experimental works (Ref. [17]-[24]). In particular, the existence of dineutron has been observed experimentally [19]. In general, it is considered as a semi-stable construction—in the sense of being short-lived and, above all, conditional occurrence. The YY model gives the aggregate state for it very simply, like deuteron, as nuclear fusion of two single neutrons and by consumption of a free TSL, which is a product of electron-positron annihilation in the same fusion environment, **Figure 31**.

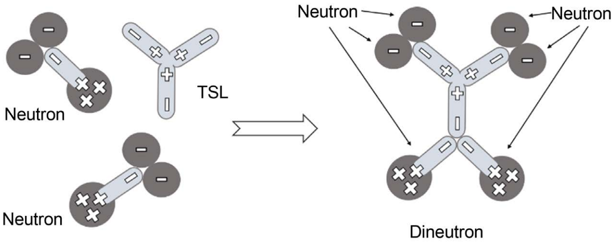


Figure 31. Dineutron nucleus fused from two neutrons by consuming one TSL.

By using the standard symbols (u—up quark, d—down quark) with the TSL (=> Y) we get the expression for a dineutron:

$$\begin{array}{c} dd \quad dd \\ Y \\ uu \end{array}$$

For a QCD consideration for the dineutron, **Figure 32** below shows three selected CCAS (the left panel gets its all-constituent quarks are noted in the left panel):

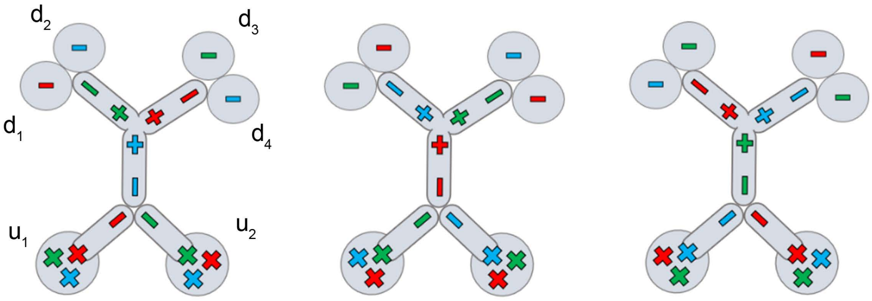


Figure 32. Three CCAS of a dineutron.

Selecting the first CCAS on the left panel of **Figure 33**, all correlation paths are given in **Table 4** below:

Table 4. All quark correlation paths of dineutron in different expressions.

d1 – r/g – d3	(ř) Ŷ <ĝ g> Y <r ř > Ŷ (ĝ)	(−) Ŷ <− +> Y <+ −> Ŷ (−)
d3 – g/b – d4	(ĝ) Ŷ (ƀ)	(−) Ŷ (−)
d4 – b/r – u1	(ƀ) Ŷ<ř r> Y <b ƀ> Ŷ (<ř r>b|g)	(−) Ŷ <− +> Y <+ −> Ŷ (<− +>+|+)
u1 – r/g – u2	(b|g<r ř>) Ŷ (<ĝ g>r|b)	(+|+<+ −>) Ŷ (<− +>+|+)
u2 – g/b – d2	(r|b<g ĝ>) Ŷ < ƀ b> Y <g ĝ> Ŷ (ƀ)	(+|+<+ −>) Ŷ <− +> Y <+ −> Ŷ (−)
d2 – b/r – d1	(ƀ) Ŷ (ř)	(−) Ŷ (−)

For a more detailed description including the mass consideration, the composition model for dineutron is presented as follows, using a TSL with vanishingly small mass:

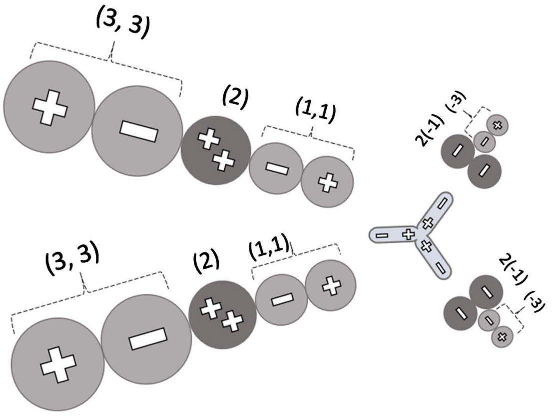


Figure 33. Possible dineutron and its composition of harmonic quarks.

The structure is symmetric—it is slightly different from the detailed model for the deuteron in **Figure 30**. There can easily be a decay of a neutron into a proton, which converts the aggregate from a dineutron to a deuteron by emitting an electron and an electron antineutrino.

This aggregate for dineutron is a legal atomic nucleus state which obeys all constitutional rules described by the YY model, for example the rule "Internal Charge Balance". It is electrically neutral as a whole because the surrounding parts are also electrically charge balanced. There is no electron orbiting around it. In this sense, a dineutron is also an atom in its own right that does not tend to bond with other atoms due to the lack of chemical valence. The mass of a dineutron has two atomic mass units. As for collisions with matter, their behavior can be related to that of the single neutron and is closely related to deuteron.

From the point of view of the transmutation process, there is no difference between the formation of a dineutron (**Figure 33**) and the formation of a deuteron (**Figure 30**). The physical conditions for them may differ, but they may also exist simultaneously. The mere existence of neutrons within a stellar fusion state

(Ref. [25] and [26]) is sufficient to assert, that dineutrons will be formed there (e. g., in the interior of the Sun) as byproducts – the TSLs are produced there, in the electron-positron annihilations, and are thus available.

Moreover, from the point of view of the holding forces for the nucleons, the mechanism is the same in the case of a dineutron and in the case of a deuteron: they are strong forces described by the standard model or as reinterpreted by the YY model, the superposition of all correlation paths.

The Pauli exclusion principle does not allow a legal bound state of two neutrons. However, a dineutron according to the YY model is not this constellation it is a bound state of two pairs of down quarks and one pair of up quarks. This constellation must lead to a reconsideration of the spin states of all the sub-particles involved without violating the Pauli exclusion principle (In this paper, we will not investigate this further). The question how stable a free dineutron is can be related to the stability of a deuteron: The two nuclear aggregates have an internal charge balance (ICB) of "one-positive to one-negative". Compared to the deuteron's external charge balance of "three-positives to two-negatives", the dineutron must have a strong structural bond because its external charge balance has a ratio of "two-positives to two-negatives", resulting in little repulsions.

The Bethe-Weizsäcker formula and its refined variants (Ref. [27] [28] [29]) for calculating nuclear binding energies are generally not suitable for treating small nuclei such as a deuteron or a dineutron. F. C. Hoh has made insightful considerations of the binding energies of a twin nucleon system (Ref. [30]), which included the aspects of spin orientation, electrostatic confinement, and the distance range of the quarks involved. Based on plausible model configurations, he calculated the binding energy for a deuteron (closely matching the measured 2.23 MeV) and for a dineutron (1.78 MeV). Although the binding energy of a dineutron is weaker than that of a deuteron, he concluded that a triplet dineutron is electromagnetically bound and is a stable nucleus, similar to a triplet deuteron, which is also electromagnetically bound. F. C. Hoh pointed out that a dineutron can energetically decay into a deuteron by neutron beta decay—this is no surprise. He predicted a decay time to be half of the neutron decay time or 440 sec.

We therefore prefer the term "semi-stable" for the stability of a dineutron.

9. Dineutron and Possible Transmutations

Furthermore, the close relationship between a dineutron and a deuteron is also evident in their transmutations into each other, possibly under the condition of collisions. We describe such scenarios to provide clues for experimental evidence that can support the finding of dineutrons with light nuclei.

A natural decay of a dineutron (**Figure 33**) to a deuteron (**Figure 30**) emitting an electron and an electron anti-neutrino is mostly possible:

$\mathrm{NN} \rightarrow \mathrm{H\text{-}2} + \mathrm{e}^{-} + \nu_{\mathrm{e}^{-}}$ ("NN" stands for the dineutron).

A collision of neutron and deuteron can lead to a transmutation into a proton and a dineutron, **Figure 34**, formulated as: $\mathrm{N} + \mathrm{H\text{-}2} \rightarrow \mathrm{p} + \mathrm{NN}$.

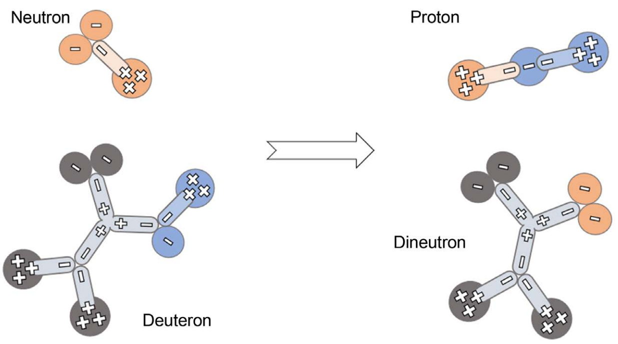


Figure 34. Collision of a neutron with a dineutron and their outcomes.

Theoretically, a fusion of neutron and deuteron can also produce a triton – tritium nucleus—(Ref. [31] [32] [33]). This would require a nuclear fusion condition and is not considered here. The products of a neutron-deuteron collision are usually considered to be a scattered proton plus two individual neutrons, each of which subsequently decays into a proton and an electron plus an electron antineutrino (beta decay). Assuming a dineutron does not decay, unlike a single neutron, a significant shortage of protons and electrons (and electron-antineutrinos) can be detected experimentally by observing the total particle balance: absorbed neutrons—actually part of them—are bounded to truncated deuterons—to dineutrons. Only the transmutation from deuteron to hydrogen nucleus will be dominant. Detection by such an experiment would mean detection of stably bound dineutrons—without participation of large nuclei.

The dineutrons produced in the above transmutation can also be subsequently hit by other firing neutrons, producing single neutrons ($\mathrm{N}+\mathrm{NN}\rightarrow 3\mathrm{N}$). In this case, much more nuclear binding energies will be released because the early fused hadron state for the deuteron is dissolved—corresponding to a nuclear fission reaction.

Similarly, a collision of neutron and tritium nucleus can lead to a transmutation into a deuteron and a dineutron, **Figure 35** (The tritium nucleus has already been described in our first paper on the YY model), formulated as: $\mathrm{N}+\text{H-3}\rightarrow\text{H-2}+\mathrm{NN}$.

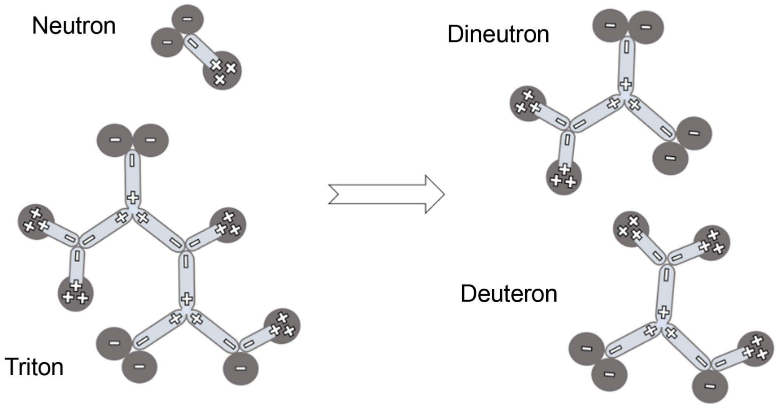


Figure 35. Collision of a neutron with a tritium nucleus and their outcomes.

If the experiment is designed as bombardment of a tritium medium with neutrons, the subsequent hit of the previously split deuteron by a following neutron must also be taken into account.

10. Possible Bounded State for Trineutron, Tetraneutron and More

When considering atomic aggregates containing multiple neutrons with zero electrical charge (Ref. [34]), more complex legal aggregate states can be obtained. For example, a model state representing a trineutron (three neutrons aggregated together, **Figure 36**). It is fused from three single neutrons by consuming three TSLs that hold the resulting structure together.

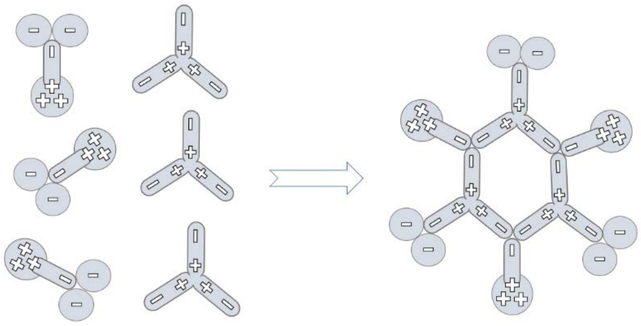


Figure 36. Trineutron core fused from three neutrons and three TSLs.

A trineutron has three atomic mass units, is electrically charge neutral. It can also be a fusion byproduct during the stellar fusion process, if there are enough "ingredients". Here no conclusion can be drawn about the stability. If it would be and participates in a collision with another atomic nucleus, it is mostly decomposed into its composite neutrons.

A tetraneutron (consisting of four neutrons) can be fused from a dineutron and a trineutron. This transmutation releases a single neutron (**Figure 37**).

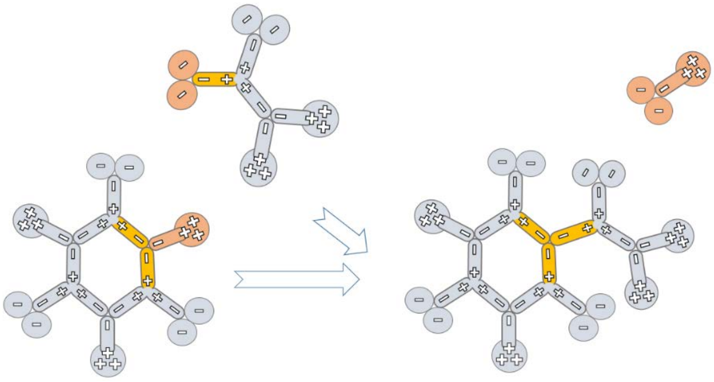


Figure 37. Tetraneutron plus a single neutron transmuted from a dineutron and a trineutron.

Theoretically, the fusion of di- and trineutrons can occur at a single docking site of the involved aggregates, as colored in Figure. At the docking site of trineutron, the up quark is released. At the docking site of dineutron, two down quarks are released. The three "open" PSLs bind together to form a negatively charged node, which links the two (reduced) participating aggregates together. The released double down quarks and the released-up quark combine to form a free neutron.

Due to the symmetric structure of the trineutron, the fusion described in Figure 38 can take place at three different docking sites, resulting a sixfold neutron aggregate by fusion with three dineutrons together. This process will release three single neutrons, Figure 38.

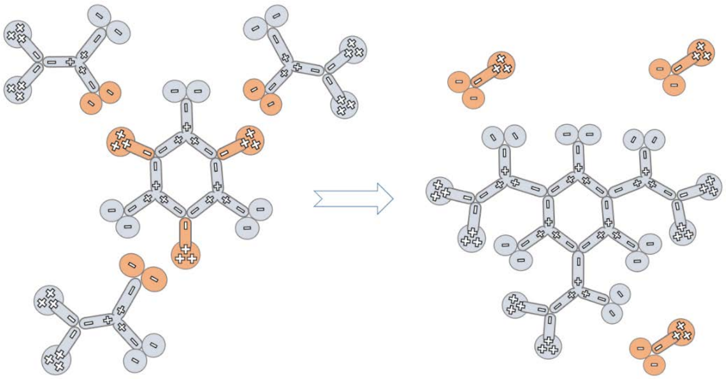


Figure 38. Fusion of a trineutron with three dineutrons, releases a sixfold neutron and three single neutrons.

On the one hand, if we consider the color aspect, the resulting sixfold neutron also has a valid set of CCAS. On the other hand, in this case the question of structural stability becomes more complex. We cannot give an answer to this question.

11. Conclusions and Outlook

Quark correlation path, color forces and mass composition concept are considered theoretically in this article and represent three new aspects as a further development of the YY model approach. They have been examined using examples of deuteron and dineutron. Future research should combine more of the recent results from the field of QCD (Ref. [35] and [36]). Despite the structural refinement of the constituent quarks—in recursive or fractal form of the lower generations—it is still useful to describe the overall structure initially with only Yins and Yangs of the higher generations, without including details. The constituent masses of low generations play an important role for subsequent investigation approaches. In the future, the distribution of them must be more in the focus of the investigation. Relevant approaches in research, for example [37] may play a role.

Early work by others on the dineutron had quite different starting points than here—for example, in the use of large elementary constituents in theory and large atomic nuclei in experiment. Thus, early conclusions about the dineutron, especially about the stability of bound states, could be reconsidered by performing the proposed collision of neutrons with deuterons and by analyzing the scattering products: The emergence of net protons in the absence of beta decay suggests the formation of dineutrons, rather than the usual neutron absorption theory. This happens only when the dineutron state is stable enough for their occurrence to be determined.

Along the quark correlation path, the further future work can simplify the mathematical basis based on quantum field theory. For this purpose, some parameters for the attractive and repulsive color forces have to be defined and determined based on empirical values. This quantitative calculation would possibly provide more closed-form solution formulas or more accurate calculation results than with the standard approach. However, the really interesting part is a better theoretical foundation of fundamental artifacts in the standard model, such as spin states in terms of Yin-Yang constituents. The manifestation of energy and matter in constituted quarks and anti-quarks (in the sense of Teplov harmonic oscillators) is another interesting aspect of development for the YY model. The structural constitution of a quark or an anti-quark enforces the "center and distribution" of the expected mass mounts. For example, an anti-up quark consists of two Yins and an energetic bond between them. The center of mass must be near the energetic region. Further work is needed for a more sophisticated view.

A close relationship between the universal TSL (Y particle) in the YY model and photons, neutrinos, and anti-neutrinos forms another interesting research topic for the future. These particles have significant wave-particle duality and cannot be constituted as easily as is possible for particle with short-range interactions. Nevertheless, one might consider participation of the TSL, in transformed form, in the formation of the photon and neutrinos. Beta decay and inverse beta decay have some points that support this consideration.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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