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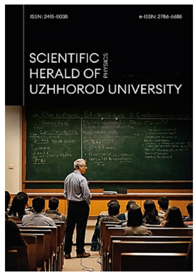

Quantum manifolds and the standard model

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Abstract

Relevance. This study is relevant because it addresses the long-standing problem of unifying general relativity (GR) and quantum field theory (QFT) by focusing on the essential concepts of discreteness and continuity.

Purpose. The purpose of this work is to introduce and explore the concept of a quantum set (q-set), which provides a framework for defining quantum manifolds (QM) that are equivalent to infinite hyperalgebras.

Methodology. The approach involves defining a specific symmetry for hyper-algebras, which restricts the solution space to a unique hyperalgebra. This hyperalgebra combines both matter and spacetime in a unified structure, allowing for the derivation of observable physical phenomena.

Results. The application of the q-set framework leads to several significant findings. It predetermines spacetime to be locally Minkowski without relying on the assumptions of special relativity. The framework successfully generates the fundamental fermionic and bosonic fields of the Standard Model. The introduction of 0-generation particles, which supplement the three known generations, provides a possible explanation for the nature of Dark Matter. At the Planck scale, the framework describes gravity as being mediated by ten-gauge vector fields, with three of these fields being massive and short-range, while one represents a repulsive force. The study also gives a possibility of the consideration of the Pre-Big Bang Universe structure.

Conclusions. The concept of QM within the framework of a q-set provides a unified description of both matter and spacetime. This new approach successfully connects the Standard Model of particle physics with a novel view of gravity and the universe's early structure.

Keywords: minimal length; quantum set; hypercomplex algebra; Standard Model; Dark Matter; Big Bang.

Introduction

Regarding the problem of general relativity (GR) and quantum field theory (QFT) unification, we pay attention to the notions of discreteness and continuity as the main essentials in this discourse [1-3]. The opposition of these two notions in the context of QFT is not too critical: discreteness (or quantumness), in the simplified way, refers too often to the enumeration of different solutions for equations of a type (1):

$$H\psi_a(x) = E_a\psi_a(x), x \in M_n \qquad (1)$$

More difficulties appear when some quantumness is suspected in the manifold structure M_n due to the Planck length l_p resulting in the combination of gravity and quantum ideas. The mainstream in solving this problem is the direct application of quantum procedures (by one or another technique) immediately to a metric $g_{\mu\nu}$ as a kind of field constituents. It supposes a manifold to be the pre-existence essence being a priori [4]. At the same time, being an abstract mathematical structure, a manifold may be considered second as the continuous approximation for some discrete structure. In terms of combinatorial topology, it looks like (2) [5-7]:

$$M_n = \lim K_n^i, K^{i+1} = Bd(K_n^i) \qquad (2)$$

where K_n^i is an abstract n-dim simplicial complex, and Bd is a combinatorial operation of subdivision.

In this context, consider two statements:

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A. Physical space possesses a minimal length l_0 (inspired by l_p).

B. A description of spacetime is a mathematical structure of a manifold M_n.

Statements A and B are incompatible: constructed in a way of Eq. (2), a manifold M_n does not contain a minimal length l_0. Adhering to the idea of a minimal length to be true, the temptation to look at M_n as a physical phenomenon in such a way is a failure. The ontological status of A and B is different: A refers to physical space immediately, while B is a mental construction being a human invention.

To eliminate the above contradiction, one should assume that discreteness and continuity are "two sides of a medal": everyone supposes the existence of its opposite, but they are not sequences of one another. Continuing in these terms, a minimal length (discreteness, quantum) is elementary continuity, while general continuity compounds these elementary constituents.

To formalize these general speculations, notice that the simplicial structure is equivalent to a countable locally finite partially ordered set (3),

$$K_n \sim (X,<), \tag{3}$$

in which elements $x_a \in X$ are vertices of K_n, and simplices are linearly ordered subsets of X.

Due to its generality ("<" is the simplest relation supposed in X), a partial order remains tempting for further constructions. In more detail, a partially ordered set (4):

$$X \text{ is a system } (X,\cup,\cap,\Delta,<), \tag{4}$$

where Δ is a set-theory operation of symmetrical difference.

Propose a transformation "→" meaning (5):

$$\begin{gathered} 1.\, \Delta \to \otimes \\ 2.\, (x<y) \sim (x \otimes y \neq 0), \\ 3.\, (x\neg< y) \sim (x \otimes y = 0) \end{gathered} \tag{5}$$

Using multiplication ⊗ permits new notes (6):

$$\begin{gathered} 1. Simplex\ s = (x_{a_1} < \dots < x_{\alpha_k}) \to \otimes\, x_{\alpha_r}, r = 1-k, \\ 2.\, (s_a \Delta s_a) = \emptyset \to (\otimes_{\alpha_k})^2 = x_0, \\ 3.\, x_0^2 = x_0, x_0 = 1 \end{gathered} \tag{6}$$

Though the usage of ⊗ formally looks equivalent to Δ, a complex K_n appears closed relative to multiplication (7):

$$1. K_n \otimes K_n = K_n,\ 2. Bd(K_n) = K_n \tag{7}$$

Condition 2 in Eq. (7) means that the representation of M_n by the infinite sequences in Eq. (2) is impossible.

Paradoxically, the contradiction of statements A and B vanishes due to the elimination of the same subject of consideration, manifold M_n.

Nevertheless, the intention to introduce some continuity is achieved by supplementing, besides the multiplication ⊗, a formal addition ⊕. In a physical context, it means quantum superpositions, the essential feather of quantum conception. As a result, instead of a partially ordered set, Eq. (4), we receive an algebraic system $(X, \otimes, \oplus)$.

Summarizing, introduce the notion of *quantum functor* Q transforming classical structures to their quantum analogies.

More definitely, it looks like (8):

$$Q: finite\ set\ \to finite\ q-set\ \downarrow Q: M_n \to QM_n \tag{8}$$

This scheme touches a set as the simplest mathematical notion. The definition of an action of quantum functor on different structures is made axiomatically in the body text. In a QM, a minimal length and QM structure are compatible.

The first half of the study contains the explicit definition of QM including the Standard Model extending it to the Dark Matter and quantum gravity vector fields at the Planck scale. Since QM immediately does not contain scalar fields, fermionic and bosonic fields remain massless.

The second part presents a mathematical structure referring to the Pre-Big Bang Universe. Due to the novelty of a subject, some additional and unproved suppositions are attracted (not spoiling the general idea of the approach). In particular, it explains the cause of the Big Bang, baryonic asymmetry, and the appearance of the scalar Higgs field responsible for massive fields.

Q-sets

Finite q-sets

Let H_n be a finite set of elements (9),

$$H_n = \{h_k\}, k = 1-n,\ and\ Ah_n = 2^{H_n}, h_\alpha \subset H_n, h_\alpha \in Ah_n \tag{9}$$

There is an equivalency between Ah_n and a set of n-sequences of indices (10),

$$h_\alpha \sim a = (\alpha_1, \dots, \alpha_n), \alpha_k = 0,1, |\alpha| = 2^n\ (h_k \in h_\alpha) \equiv (\alpha_k = 1) \tag{10}$$

The set-theory operation of the symmetrical difference of two sets (11):

$$h_a \Delta h_\beta = h_\beta \Delta h_\alpha = h_\gamma \gamma_k = \alpha_k \beta_k \tag{11}$$

where we mean 0×0=0, 0×1=1×0=1, 1×1=0.

Definition 1

A finite q-set is Ah_n obeying:

Axiom 1

Multiplication (12):

$$\begin{gathered} a.\, h_a h_\beta \equiv h_\alpha \Delta h_\beta = h_\gamma \in Ah_n \\ b.\, h_k h_s = (-1)^{ks} h_s h_k, h_k \in H_n \end{gathered} \tag{12}$$

Axiom 2

Addition (quantum superposition) (13):

$$(\lambda_a h_\beta + \lambda_\beta h_\beta) \in Ah_{n'} \lambda \in C \tag{13}$$

Def. 1 establishes the equivalence of finite q-sets and hyperalgebras with a finite number of basis units.

An algebra Ah_n is a product of commutative $Ah_{p,0}$ (even) and anticommutative $Ah_{0,q}$ (odd) subalgebras (14):

$$Ah_n = Ah_{p,0}Ah_{0,q} = Ah_{p,q}, p + q = n \quad (14)$$

Definition 2

An algebra is symmetrical if it is the product of an equal number of even and odd algebras of the type Ah_2, (15a-c):

$$Ah_n = \otimes Ah_2^k, k = 0 - (2m - 1), \quad (15a)$$
$$Ah_2^k = (h_1^k, h_2^k), h_1^k h_2^k = (-1)^k h_2^k h_1^k, \quad (15b)$$
$$n = 4m, Ah_n = Ah_{2m,2m},$$
$$Ah_{2m,2m} = \otimes Ah_{2,2}, k = 0 - (m - 1) \quad (15c)$$

Instead of the commutative rule in Eq. 12, we use another indication (15b).

Axiom 3

In decomposition, Eq. 15c (16),

$$Ah_{2,2}^k \ is\ over\ a\ complex\ field\ C^k,$$
$$C^k = \{a + i_k b\}, a, b \in R, i_k i_r = -i_r i_k. \quad (16)$$

Definition 3 (17):

$$a. A\ semi-conjugation\ J_1,$$
$$J_1(h_p^k) = -h_p^k, J_1(i_k) = +i_k$$
$$b. A\ semi-conjugation\ J_2, \quad (17)$$
$$J_2(h_p^k) = +h_p^k, J_2(i_k) = -i_k. J_1 J_2 = J_3.$$

Hypermatrices

An algebra $Ah_{0,q}$ is not associative and may not be represented by matrices. The exception is $Ah_{0,2}$.isomorphic to an algebra of Pauli matrices $\{\sigma_k\}$. To receive such an isomorphism in a general case, we generalize the standard matrices to hypermatrices depicted in multidimensional spaces.

Since the correspondence, Eq. 10, each unit $h_\alpha \in Ah_n$ is equivalent to the vertex of the n-dim cube in R_n.

Definition 4

a) Matrix pattern P_n is an elementary n-dim cube in R_n Vertex α is said to be the cell of P_n.

b) n-dim hypermatrix H is a pattern P_n with numbers λ_α in cells α.

c) A hypermatrix $H = \{\lambda_\beta\}$ is a one-point hypermatrix $h_\alpha, if \lambda_\beta = \delta_{\alpha\beta}$.

An arbitrary hypermatrix is the sum of one-point matrices (18):

$$H = \oplus \lambda_\alpha h_\alpha, |\alpha| = 2^n. \quad (18)$$

d) Multiplication of hypermatrices is accounted for by the products of one-point matrices that are the same as for basic hyper units, Def. 1.

Therefore, a set of hypermatrices $\{H(P_n)\}$ and hyperalgebra are Ah_n isomorphic.

This identity motivates the introduction of the linear space R_n generated by an abstract hyperalgebra Ah_n (q-set) giving the geometrical realization of hyperalgebras by hypermatrices. R_n is said to be a supportive space of Ah_n (19).

$$R_n = Sup(Ah_n) \quad (19)$$

Let C_{Ah} and C_R be Categories of hyperalgebras and real linear spaces.

Definition 5

Quantum functor Q is a map (20),

$$Q: C_R \to C_{Ah}$$
$$Q(R_n) = Ah_n,$$
$$R_n = Sup(Ah_n),$$
$$Q(R_n + R_m) = Ah_n Ah_m = Ah_{n+m} \quad (20)$$

For example, the hypermatrix representation of the simplest odd algebra $Ah_{0,2}$ (21a):

$$h_0 = (0\ 1\ 0\ 0\ ) h_1 = (1\ 0\ 0\ 0\ ) h_2 = (0\ 0\ 0\ 1\ ) h_3 = (0\ 0\ 1\ 0\ ) \quad (21a)$$

Due to (15b) in Def. 2, the multiplication rule for these matrices differs from the usual. At the same time, the set is isomorphic to Pauli matrices for which we take notations $\{h_k\}$ (21b):

$$\sigma_0 = (1\ 0\ 0\ 1\ ) \sigma_1 = (i\ 0\ 0\ -i\ ) \sigma_2 = (0\ 1\ -1\ 0\ ) \sigma_3 = (0\ i\ i\ 0\ ) \quad (21b)$$
$$\sigma_1\sigma_2 = -\sigma_2\sigma_1 = \sigma_3, \sigma_k^2 = -\sigma_0, k = 1,2,3$$
$$h_k \sim \sigma_k \quad (21c)$$

Fundamental hyperalgebra

Neglecting complex structure, $Ah_n = R_{N'}, N = 2^n$, due to Def. 5 (22):

$$Q(Ah_n) = Q(R_N) = Ah_{N^*} \quad (22)$$

For symmetrical hyperalgebra $Ah_{2m,2m} = Ah_{m,m}^0 Ah_{m,m}^1$. $h_\alpha \in Ah_{m,m}^0$ let be an arbitrarily chosen even unit. Denote $Ah_{m-1,m}^+ = (Ah_{m,m}^0\ without\ h_\alpha, Ah^-{}_{m-1,m} = h_\alpha Ah_{m-1,m}^+, Ah_{m,m}^0 = Ah_{m-1,m}^+ + Ah_{m-1,m}^-$

Definition 6

Symmetrical algebra is fundamental if it obeys (23):

$$Q(Ah_{m-1,m}^+) = Ah_{2m,2m}$$
$$\text{or } 2^{2m-1} = 4m \quad (23)$$

That is possible only for m=2. Therefore, fundamental algebra is (24):

$$Ah_{4,4} = Ah_{2,2}^0 Ah_{2,2}^1 \quad (24)$$

It is the product of the two simplest symmetrical algebras.

Infinite q-sets

An infinite q-set AH_n (hyperalgebra) is the union of an endless number of isomorphic Ah_n^α algebras (25a).

$$AH_n = UAh_n^\alpha \quad (25a)$$

The structure AH_n depends on the intersection scheme of different Ah_n^α. To avoid this uncertainty, propose a continuous approximation.

Definition 7

In the continuous approximation, an infinite locally finite q-set is a fibered space (25b),

$$AH_n = (M_n, Ah_n, \pi), \quad (25b)$$

in which a base M_n is an n-dim manifold (supportive), its tangent space $T_n = Sup(Ah_n)$, and π is a projection, $(\pi^{-1}(x) = Ah_n, x \in M_n$.

Def. 7 generalizes a quantum functor Q for the action on a manifold (26):

$$Q: M_n \to AH_n. \quad (26)$$

Definition 8

QM is a fundamental infinite q-set $AH_{4,4}$ (27).

$$QM = (M_8, Ah_{4,4}, \pi), T_8 = Ah^{+}_{1,2} \subset Ah^{0}_{2,2} \quad (27)$$

Geometry

Special notations

Special notations of hyper-units should be introduced using physical terms to implement hyperalgebras in physical content (Table 1).

Table 1. Hierarchy of fundamental hyper-units

$Ah^0_2 = (w^-, t^-_0)$	$t^-_0 w^- = w^- t^-_0$	weak and temporal units	
$Ah^1_2 = (t^+_1, t^+_2)$	$t^+_1, t^+_2 = -t^+_2, t^+_1$	tangent units	$over\ C(i_0)$
$Ah^2_2 = (c_1, c_2)$	$c_1, c_2 = c_2, c_1 = c_3$	color units	
$Ah^3_2 = (g_1, g_2)$	$g_1, g_2 = -g_2, g_1$	generation units	$over\ C(i_0)$

Source: compiled by the author.

In the splitting, Eq. 11a, $Ah_{4,4} = Ah^0_2 Ah^1_2 Ah^2_2 Ah^3_2$.

Special notations

- For odd complex algebras (28):

$$t^+_0 = h^1_0 = 1, t^+_\mu = h^1_\mu\ g_0 = h^3_0 = 1, g_q = h^3_q, \mu, q = 0-3, t^+_1 t^+_2 = t^+_{3'} (t^+_\mu)^2 = -1\ g_1 g_2 = g_{3'} g^2_q = -1. \quad (28)$$

- For even algebras (29):

$$t^+_0 = w^+ = h^0_0 = 1, w^- = h^0_1, t^-_0 = h^0_2\ c_0 = h^2_0 = 1, c_p = h^2_p, p = 1-3. \quad (29)$$

Modified multiplication

In (28), introduce dimension constants (30):

$$t^+_\mu = a_0 h^1_\mu, t^+_1 t^+_2 = a_0 t^+_3, \mu = 1-3. g_q = a_1 h^3_q, g_1 g_2 = a_1 g_3, q = 1-3. a_0 = l_0 - minimal\ length\ (a_0 a_1)^2 = n -\ Planck\ constant \quad (30)$$

Suppose that minimal length coincides with Planck length $l^2_p = GM/c^3$ then $a^2_1 = c^3/G$.

In such a way, fundamental constants l_0 and $\hbar$ are numeral parameters in the multiplication table.

The cross and scalar products

Definition 9

A. Cross product (31):

$$In\ Ah^k_2, cross\ product$$

$$a. h^k_r \times h^k_s = \left(\frac{1}{2}\right)(h^k_r h^k_s + (-1^k) h^k_s h^k_r) = \left(\frac{1}{2}\right)[h^k_r, h^k_s]_\pm$$

$$r, s = 1,2,3$$

$$b. h^0_s \times h^k_r = \left(\frac{1}{2}\right)[h^0_s, h^k_r]_+$$

$$Scalarproduct\ (h^k_r, h^k_s) = h^k_r h^k_s - h^k_r \times h^k_s \quad (31)$$

Let be $T_4 = Ah^1_2$ a 4-dim space with basis vectors (t^+_0, t^+_μ) then (32):

$$Ah_{4,4} = \oplus\ h^0_r h^2_p h^3_q T_4 = \oplus\ T^{rpq}_4, r, p, q = 0-3. \quad (32)$$

Relations in Def. 9 realize $Ah_{4,4}$ splitting into 64 parallel spaces.

The model of M8

Denote 4-dim linear spaces (33):

$$T^+_4 = \{t^+_\mu\}, T^-_4 = t^-_0 T^+_4 \quad (33)$$

Definition 10

Complexified $Ah_{1,2}(\varphi) = T^+_4 \times S_1, S_1 = exp\ (i_0 t^-_0 \varphi), \varphi \in R$

Basis vectors $e_\mu(\varphi) = l_0 t^+_\mu exp\ (i_0 t^-_0 \varphi), \mu = 0-3$.

The pair (T^+_4, T^-_4) is equivalent to the composition of homomorphisms $(T^+_4, T^-_4) \sim (t^\pm{}_0: T^+_3 \to T^-_3)$.

Due Def. 9, T_8 is a pair of parallel *3-dim* spaces $T^\pm{}_3$ and one orthogonal space $T^0_2 = (t^+{}_0, t^-_0)$.

Cross products (34):

$$e_1 \times e_2 = e_0 \times e_3 \quad (34)$$

And squire lengths (35):

$$|e_\mu|^2 = e_\mu e^*_\mu = -l^2_0, \mu = 1,2,3, |e_0|^2 = +l^2_0 \quad (35)$$

$Ah_{1,2}(\varphi)$ is equivalent to $R_{1,3}$ Minkowski space with a signature (+,–,–,–), in which basis vectors have the hidden symmetry U_1.

Therefore, an auxiliary (36):

$$M_8 \sim M_{1.3}\ with\ a\ tangent\ space\ R_{1,3}. \quad (36)$$

Let $\{x_\mu\}$ be local orthogonal coordinates in $M_{1.3}$ associated with vectors $\{e_\mu\}$.

Then the angel φ is a function (37),

$$\varphi = \varphi(x_\mu) \quad (37)$$

Along with fundamental constants l_0 and $\hbar$ entering in the modified multiplication table, Eq, 24, define minimal time and fundamental frequency (38).

$$\tau_0 = \frac{l_0}{c}, \omega_0 = \frac{2\pi}{\tau_0}, where\ c\ is\ the\ light\ speed. \quad (38)$$

For the fixed spacious coordinates (39),

$$\varphi = \omega_0 x_0 \quad (39)$$

The temporal intervals acquire discrete values (40).

$$\Delta\tau = n\tau_0; n \in Z \quad (40)$$

Eq. (40) does not contradict the x_0 fluency since the intermediate angle $2\pi n < \varphi < 2\pi(n+1)$ determine quantum superpositions of spaces T_4^+ and T_4^-, Def. 10.

The decomposition of QM

Local $Ah_{4,4}$ is the sum of parallel linear spaces (41),

$$Ah_{4,4} = \bigoplus T_4^\beta = \sum \pi^\beta R_{1,3}, \pi^\beta = w^\alpha g_q c_p, \beta = (\alpha, q, p), \alpha = \pm, p, q = 0-3. \quad (41)$$

Denote new imaging units: $j_0 = i_0 j_q = i_0 i_1, q = 0-3$.

Different complexities of spaces T_4^β are accounted for by the introduction of their new basis vectors (42):

$$T_4^\beta : s_0^\beta = (\tfrac{1}{2})\pi^\beta(1 + j_q t_1^+), s_1^\beta = t_2^+ s_0^\beta, s_{2,3}^\beta = t_0^- s_{0,1}^\beta \quad (42)$$

The exception is a space $T_4^{+00} = R_{1,3}$ for which basis vectors are remained old $e_\mu = t_\mu^+ exp\,(j_0 t_0^- \varphi), \mu = 0-3\backslash)$

As a result, by the splitting of a fiber, QM turns into the sum of its submanifolds (43).

$$QM = UU^\beta, U^\beta = (M_{1,3}, T_4^\beta, \pi) \quad (43)$$

Propose the names for the submanifolds using the following definition.

Definition 11

a. Quantum spacetime (QST or the Apeiron space)
$QST(AP) = U^{+00} \cup U^{-00} \equiv (M_{1,3}, Ah_{2,2}^0, \pi), U^{\pm 00}$ $are\ down(+)\ and\ up(-)\ Apeiron\ spaces$

b. The Dark Matter Space DM, $DM = UU^{\pm,0,p}, q = 0, p = 1,2,3$

c. 0-generation space, $Gen_0 = AP \cup DM = UU^{\pm,0,p}, color\ p = 0-3$

d. Standard Matter (SM) q-generation spaces
$Gen_q = UU^{\pm,q,p}, generations\ q = 1,2,3$
$SM = UGen_q, q = 1,2,3, QM = AP \cup DM \cup SM$

Spin functions

The total wave function $\Psi(x)$ is a section (44a).

$$\Psi(x) = \pi^{-1}(x) \in Ah_{4,4}, x \in M_{1,3} \quad (44a)$$

Using the splitting, Eq. (41),

$$\Psi(x) = \bigoplus \psi_k^\beta, \beta = (\pm, q, p), k, q, p = 0-3 \quad (44b)$$

Introduce the linear order of basis vectors (45):

$$\Delta^\beta = (s_0^\beta < s_1^\beta < s_2^\beta < s_3^\beta) \quad (45)$$

The direct consideration shows that the left action of tangent units $t_\mu^+\ t_\mu^-, and\ J_3 - conjugation$ in a frame Δ^β is equivalent to the action of matrices (46):

$$J_3 \sim j_q\sigma_{01}, t_0^- \sim -j_q\sigma_{03}, t_\mu^+ \sim \sigma_{\mu 0^0}\mu = 1-3. \quad (46)$$

Gamma-matrices (47).

$$\gamma_\mu = \sigma_{\mu 1} \sim t_\mu^J = (t_\mu^+ J_3)\, \gamma_0 = \sigma_{02} \sim t_0' = (t_0^- J_3)\, \gamma_4 = \otimes\, \gamma_\mu = j_q\sigma_{03}, \mu = 0-3. \quad (47)$$

Spaces T_4^β realize the irreducible representation of the Lorentz group in $R_{1,3}$.

Introduced γ_4 corresponds to the usual γ_5. Pauli matrices are given in the representation (21b).

The right/left projections (48):

$$\pi_{L,R} = (1/2)(1 \pm \gamma_4) = (1/2)(1 \pm t_0^-) \quad (48)$$

The right/left splitting of $R_{1,3}$ (49).

$$\pi_{R,L} R_{1,3}(\varphi) = ((1/2)[R_{1,3}(\varphi) - i_0 R_{1,3}(\varphi \pm \pi/2)]) \quad (49)$$

Therefore, the right spacetime is the average $R_{1,3}$ of and its shift in the future on the angle $\varphi = +\pi/2$ and the left spacetime is the average in the past direction. It shows a fundamental correlation between the right/left and future/past directions.

Since time flow has no two opposite directions simultaneously, we mean (50)

$$R_{1,3} = R_{1,3}^L, R_{1,3}^R = 0. \quad (50)$$

Suggested correspondence between fermionic particles of the Standard Model and spinorial spaces T_4^β (Table 2).

Table 2. Fermionic particles of the Standard Model and their associated spinorial spaces

Gen_3^-	τ^-	t		
Gen_3^+	v_τ	b		
Gen_2^-	μ^-	c		
Gen_2^+	v_μ	s		
Gen_1^-	e^-	u		
Gen_1^+	v_e	d		
Gen_0^-	U^0	U^1		
Gen_0^+	$R_{1,3}$	D^1		
color	c_0	c_1	c_2	c_3

Source: compiled by the author.

Remarks.

1. In our terms, leptons are colorless quarks, $c = c_0 = 1$.
2. The empty cells of a table correspond to quarks with other colors.
3. The wave functions of DM and SM are over different complex numbers fields C^0, C^1. So, DM particles are electrically neutral.
4. Antiparticles are complex conjugated wave functions. In particular, for a tetrad $\{e_\mu(\varphi)\}^* = \{e_\mu(-\varphi)\}$ the same tetrad with the opposite time flow. In more detail, it will be considered in the next sections.

Bosonic fields

Boson fields $B(x)$ are connections in QM. Let $Sym(Ah_{4,4}) = \{\sigma_A\}$ be an algebra of a symmetry group of a space $Ah_{4,4}$, where A enumerates generators.

Then, QM (51):

$$QM = (M_{1,3}\Psi(x), B(x)),\\ B(x) = \sum B_\mu^A(x)\sigma_A, \mu = 0-3. \quad (51)$$

The following definitions permit the representation in a short form.

Definition 13

Let A be an n-dim matrix and B be an *m-dim* one.

The embedding of A in B is an *nm-* matrix received by inserting A in each cell α of B and multiplied on an element $\lambda\alpha$ (52).

$$(\lambda A) \odot B = A \odot (\lambda B)\ (\lambda_1 A_1 + \lambda_2 A_2) \odot B = \lambda_1 A_1 \odot B + \lambda_2 A \odot B, (A_1 \odot B_1)(A_2 \odot B_2) = (A_1 B_1) \odot (A_2 B_2) \quad (52)$$

Definition 14.

Let $C_N = C_2 \odot \ldots \odot C_2$ be an embedding (n times) of complex 2-dim spaces $C_2, dimC_N = 2^n$.

Symmetry algebras are (53):

$$a. Sym(C_2) = \Sigma_1 = ASU_2 = \{\sigma_p\},\\ b. Sym(C_N) = \Sigma_n = \Theta\Sigma_1 = \{\sigma_{p_1} \odot .. \odot \sigma_{p_n}\} = \sigma_A, p_k = 0-3, A = (p_1, \ldots, p_n)\\ c. Sym(C_1) = \Sigma_0 = AU_1. \quad (53)$$

Matrices are generators of σ_A angular momentum in space C_N.

Gamma- matrices is a set Γ (54):

$$\Gamma = \{\Gamma_\alpha\}, \Gamma_\alpha \in \Sigma_n\\ a. \Gamma_\alpha\Gamma_\beta + \Gamma_\beta\Gamma_\alpha = 2\delta_{\alpha\beta}\\ b. 2 \wedge \Gamma = \Sigma_n \quad (54)$$

$Ah_{4,4}$ splits into the embedding of linear spaces (55),

$$Ah_{4,4} = C_2^s \odot C_2^t \odot C_2^w \odot C_4^C \odot C_4^F, C_2^s = (s_0, s_1), C_2^t = (t_0^+, t_0^-), C_2^w = (t_0^+, w), C_4^C = \{c_p\}, C_4^F = \{g_q\}, p, q = 0-3. \quad (55)$$

So, due to Def. 14 (56),

$$Sym(Ah_{4,4}) = \Sigma_7 = \{\sigma_A\}, A = (p_1 p_2 p_3 p_4 p_5 p_6 p_7) \quad (56)$$

Matrices are in the 128-*dim* σ_A frame of linearly ordered vectors.

Since the intermixture of factor spaces in *Eq. 55* is meaningless, the symmetry algebra splits into the sum of its subalgebras (57a),

$$\Sigma_7 \to \Sigma_1(s) + \Sigma_1(t) + \Sigma_1(w) + \Sigma_2(C) + \Sigma_2(F). \quad (57a)$$

To this set, one should add (57b),

$$\Sigma_0^0\ in\ Gen, \Sigma_0^1\ in\ Gen_q \quad (57b)$$

Introduce special notations representing matrices in a linearly ordered frame (58) (Table 3).

$$\Sigma_{G^1} = SymC_2(s),\\ = (p_1, 0,0,0,0,0,0), gravity^1, (spacious)\\ \Sigma_{G^2} = SymC_2(t), A = (0, p_2, 0,0,0,0,0), gravity^2, (temporal)\\ \Sigma_W = SymC_2(w), A = (0,0,p_3,0,0,0,0), weak,\\ \Sigma_C = SymC_4(C), A = (0,0,0,p_4,p_5,0,0), color,\\ \Sigma_F = SymC_4(F), A = (0,0,0,0,0,p_6,p_7), flavor,\\ \Sigma_y^{0,1} = (0,0,0,0,0,0,0), hypercharge. \quad (58)$$

Table 3. The correspondence between symmetry algebras and gauge vector fields

$\Sigma_y^{0,1}$	Σ_{G^1}	Σ_{G^2}	Σ_W	Σ_C	Σ_F
$Y^{0,1}$ hypercharge	$B^{1,p}$ gravity[1]	$B^{2,p}$ gravity[2]	W^p gravity[1]	G_{pq} color fields	F_{pq} flavor fields

Source: compiled by the author.

Fields $B^{1,p}$ and $B^{2,p}$ are gravity by definition.

In our terms, leptons are colorless quarks. To exclude the intermixture of leptons and color quarks, *0*-rows and *0*-columns in all color matrices should be zero. As a result, we receive a correspondence (59):

$$\sigma_{22}, \sigma_{33} \to \lambda_1, \sigma_{23}, \sigma_{32} \to \lambda_2, \sigma_{03}, \sigma_{13} \to \lambda_4, \sigma_{02}, \sigma_{12} \to \lambda_5, \sigma_{30}, \sigma_{31} \to \lambda_6, \sigma_{21}, \sigma_{20} \to \lambda_7, \sigma_{00} \to \lambda_9, \quad (59)$$

Matrices λ_3, λ_8 are linear combinations of the reduced $\sigma_{10}, \sigma_{01}, \sigma_{11}$, where $\{\lambda\}$ are eight Gell-Mann matrices.

Gen_0 and Gen_4 are of different complexities and do not intermix. So, the same procedure is for flavor matrices. As a result (60),

$$\Sigma_C \to ASU(3)_{color}, \Sigma_F \to ASU(3)_{flavor} \quad (60)$$

The local symmetry group of QM (61)

$$G = U^0 \times U^1 \times SU(2)_{G^1} \times SU(2)_{G^2} \times SU(2)_w \times SU(3)_C \times SU(3)_F. \quad (61)$$

Pre- and Past-Big Bang Universes

Supposing that QM is a compact space, introduce a length (62):

$$L = dicm\ QM, L > I_0 \quad (62)$$

Definition 15

1 The Pre-Big Bang Universe is $QM^0, diam\ QM^0 < L_0$

2 The Past-Big Bang Universe is $QM^1, diam\ QM^1 > L_0$

Axiom 4 (63):

$$QM^0 = A\mathcal{H}_{4,4}, A\mathcal{H}_{4,4} = AH_{2,2}^{0+} \wedge_2 AH_{2,2}^{0-} \quad (63)$$

Locally, a topological space $AH_{2,2}^{0+}$ *is* $Ah_{2,2}^{0} \subset Ah_{4,4}$. $AH_{2,2}^{0-} = J_1(AH_{2,2}^{0+}), J_1 - complexconj, Def.3$. ∧ means a topological product. The notation $QM^0 = A\mathcal{H}_{4,4}$ stresses the structural similarity with a fundamental $AH_{4,4}$.

In more detail (64):

$$Ah^{0+2} = \bigoplus \pi^{\pm}\pi_{L,R}(s_0, s_1) = \bigoplus S_{\alpha}^{+}, \alpha = (\pm, L/R).$$
$$Ah_{2,2}^{0-} = (\bigoplus J_1\pi^{\pm}J_1\pi_{L,R})J_1(s_0, s_1) = \bigoplus \pi^{\pm}\pi_{L,R}(s_0^*, s_1^*) = \bigoplus S_{\alpha}^{-}\ since\ J_1(\pi^{+,-}) = \pi^{-,+}, J_1(\pi_{L,R}) = \pi_{R,L}, J_1(s_{0,1}) \sim J_2(s_{0,1}) = s_{0,1}^*. \quad (64)$$

where we use $s_0 = (1/2)(1 + j_0 t_1^+)$, $s_1 = t_2^+ s_0$, $(1/2)(1 \pm w^-) = \pi_{L,R} = (1/2)(1 \pm t_0^-)$.

The sketch of QM^0

Topology

Let (65):

$$a. N_{\alpha}^{\pm}\ be\ closed\ 2-dim\ topological\ spaces\ with\ local\ S_{\alpha}^{\pm}.$$
$$(N_{\alpha}^{-} = J_1(N_{\alpha}^{+}).$$
$$b. Topological\ sum\ N^{+} = UN_{\alpha}^{+}, N^{-} = J_1(N^{+}).$$
$$c. Topological\ product\ N = N^{+} \times N^{-}.$$
$$d. D = diag\ N = \{x_1 J_1(x)\}, x \in N^{+}.$$
$$dimD = dimN^{\pm}$$
$$QM^0 = D. \quad (65)$$

Proposition.

1. Spaces $\{N_{\alpha}^{\pm}\}$ are topologically equivalent.
2. Spaces $N_{\alpha}^{\pm}$ $N^{\pm}$ are many dim. analogies of n-times screwed Mobius strip S_n.
3. Homeomorphic spaces are physically equivalent.

Let $A^{\pm} = \{a_r^{\pm}\}$ be the sets of topological invariants of $N^{\pm}$ correspondingly,

a. There is a one-to-one correspondence between $A^{\pm}$ and symmetry groups $\{G_r\}$.

b. A space D has an internal direction J_3 and corresponding $G_x: N^{+} \leftrightarrow N^{-}$.

c. Supposing the symmetry of directions**,** the number of "screws" for different directions is the same number *n*. Therefore (66),

$$a^{\pm} = a^{\pm}(n) \quad (66)$$

d. Since the length of one "screw" equals l_0 (67),

$$diamD = nl_0. \quad (67)$$

4. Remark. The last speculations are mainly intuitive. For a more rigid representation, one may propose

D-structures to be the embeddings $D = OS_n^r, where\ S_n^r$ are n-times screwed Mobius strips corresponding to r-direction.

5. Introduce notations

$|n >= N^{+}(n), < n| = N^{-}(n), |n >< n| = D(n)$.

Hilbert spaces

$H^{+} = \{|\ n >\}, H^{-} = \{< n\ |\}. H^{T} = \{|n >< n|\}$.

It supposes the existence of formal linear combinations.

$\lambda_n|n\rangle + \lambda_m|m\rangle \in H^{+}, simoilar\ to\ H^{-}\ and\ H^{I}$

Hamiltonian

Spaces $N^{\pm}$ and D have no spacious and temporal variables. So, the compilation of the standard differential equations starts to be impossible. Instead of differential structures, we deal with infinite Hilbert spaces in which basis vectors are spaces. In this connection, we propose a new technical approach by which

1. A one-to-one correspondence between linear operators $N_r^{\pm}$ (partial Hamiltonians) and $r^{\pm}$-directions in $H_r^{\pm} \leftrightarrow r^{\pm} \leftrightarrow G_r^{\pm}$
2. In more detail, in $N^{\pm}, directions\ r^{\pm}: H_W^{\pm}, H_{G^1}^{\pm}, H_{G^2}^{\pm}, internal\ directions\ r_{0'}, r_X: H_{Y^0}H_X$.
3. $Vectors\ |n >< n|\ are\ eigenvectors\ of\ H_r^{\pm}|n >< n| = E_{r,n}^{\pm}|n >< n|$.By definition, eigenvalues $E_{r,n}^{\pm}$ are energies and functions on corresponding in variants $a_r^{\pm}$
4. $Denote\ H^{+} = \bigoplus H_r^{+}, H^{-} = \bigoplus H_r^{-}, H_{int} = H_{Y^0} + H_X\ (interaction). The\ Total\ Hamiltonian\ H^{T} = H^{+} + H^{-} + H_{int}$.

Proposition (70):

$$For\ any\ n, H^{T}|n >< n| = (E_n^{+} + E_n^{-} + E_{int,n})|n >< n| = 0. \quad (70)$$

Asymmetry in QM^0

We have $Sup(Ah_{4,4}) = R_8 \to C_4$. There are two possibilities for C_4.

$$1. C_4 = AP^{+} = (\pi^{+}\pi_L(s_0, s_1), \pi^{+}\pi_R(s_0, s_1)), \frac{down\ left}{right\ Apeiron}.$$
$$2. C_4 = (AP^{+}) *, with\ (s_0, s_1)^*, \frac{down\ left}{right\ Apeiron}.$$

Since these may not be supportive spaces simultaneously, by the agreement, we choose (71, 72).

$$Sup(Ah_{4,4}) = (AP^{+})^*. \quad (71)$$
$$E_n^{+} > 0, E_n^{-} < 0. \quad (72)$$

Relation (73) means that AP^{+} and $(AP^{+})^*$are not homeomorphic, and we choose additionally

$$(AP^{+})^* = \pi_0(s_0, s_1)^* + \pi_1(s_0, s_1)^*, (right\ +\ left),$$
$$AP^{+} = \pi_1(s_0, s_1), (left). \quad (73)$$

From *Eqs*. (72, 74),

$$E_{trt,n} > 0. \quad (74)$$

Since E_{int} is the result of the action of repulsive force (anti-gravity) H_0 and attractive H_X, Eq. 76 means that attractive forces exceed repulsive ones.

Emergent spacetime

The splitting of QM^0

In our description, the dependence $E(r, n)$ remains unknown.

Proposition.

1. $E_{int,n} > 0, n \leq n_0, E_{int,n} < 0, n > n_0. E_{int} = 0\ is\ impossible$.

The number n_0 corresponds to (75):

$$L_0 = diam|n_0 >< n_0|\ inDef.15. \quad (75)$$

2. The source of energy E is number *0* divided into positive and negative parts, $0 = E + (-E)$. It is equivalent to (76):

$$1 = exp\,(0) = exp\,(+j_0 t_0^- \varphi) exp\,(-j_0 t_0^- \varphi), \varphi = E x_0 / h_1 \quad (76)$$

where h is a Planck constant and x_0 is the *appearing* time variable. Therefore (77),

$$|n >< n| = (exp\,(+j_0 t_0^- \varphi))|n >< n| exp\,(-j_0 t_0^- \varphi) \quad (77)$$

$N^{\pm}$ constituents may have the opposite time flows, but the whole QM^0 does not.

3. For $n > n_0$, anti-gravity H_0 exceeds H_X, the diagonal product splits into components (78).

$$|n >< n| \to \lambda_n^+ \, exp\, exp\,(+j_0 t_0^- \varphi) \;\; | n > + < n| \lambda_n^- \; exp\, exp\,(-j_0 t_0^- \varphi) \quad (78)$$

4. Baryonic asymmetry.

In Eq. 78, $|E_n^+| < |E_n^-|$, supposing $|E_{int}| \ll |E^{\pm}|$ amplitudes $\lambda^{\pm}$ are slightly different, $|\lambda^+| > |\lambda -|$. It means that $| \, n > (Matter)\ dominates\ over < n \, | \, (anti - Matter)$.

At the same time (79),

$$AP^+\ remains\ to\ be\ left, \quad (AP^+)^*\ is\ right + left. \quad (79)$$

5. Due to *Def.* 15, the length $L_0(n_0 \to n_0 + 1)$ is large enough to introduce a tangle frame (80).

$$\{(s_0, s_1), (s_0, s_1)^*\} \to t_\mu^+ exp\,(\pm j_0 t_0^- \varphi) = (e_\mu, e_\mu^*). \quad (80)$$

The transformation (82) concerns the down Apeirons and anti-Apeirons (supportive space) while other spaces remain spinorial.

Vectors e_μ and e_μ^* differ on the sign of $\varphi = E^{\pm} x_0 / l$. When $E^- \to -E^-\ and\ x_0 \to -x_0$ we receive the standard conception of anti-particles with the opposite temporal flow.

6. The splitting (80) is not equality. It means “a phase transition” (81):

$$QM^0 \to QM^1, \quad (81)$$

by which take place:

a. the rebuilding $\{s_k\} \to \{e_\mu\}, k = 0,1, \mu = 0 - 3.$ $S^{\pm} \to M_{1,3}\ where\ S^{\pm}\ are\ down\ (anti)Apeiron\ spaces.$

b. the appearance of DM + SM (the Dark and Standard Matter) by the account of the set free energy. Therefore (82),

$$QM^1 = (M_{1,3}, \Psi, B), \Psi = \oplus \Psi^{\beta}, \beta = (\alpha, p, q). \quad (82)$$

Higgs field

After the splitting, Eq. 78, we have two manifolds: $M_{1,3} = \{e_\mu^L\} - left, M_{1,3}^* = \{e_\mu^*\} = Sup(AH_{4,4}) - left + right.$

Accounting for the physical meaning of these spaces, they may not exist simultaneously. In addition, from a mathematical viewpoint, a manifold $M_{1,3}$, should be excluded, since by Eq. 73 only $Q(M_{1,3})^* = QM^1$.

There is a natural way to exclude $M_{1,3}$ from the mathematical structure following propositions.

1. Compose a Table 4 of spaces entering into the QST sector. Instead of a formal α, use its direct meanings left/right, and up/down for evidence.

Table 4. Spaces in the QST Sector

$\frac{N^{up}}{L}$	$\frac{N^{up}}{R}$	$\frac{N^{up*}}{L}$	$\frac{N^{up*}}{R}$
$\frac{N^{d}}{L}$	0	$\frac{N^{d^*}}{L}$	$\frac{N^{d^*}}{R}$

Source: compiled by the author.

2. Hypothesis

a) For $n > n_0$ spaces (83)

$$D_H^- = N_R^{up} \wedge (N_L^d)^*, D_H^+ = N_L^d \wedge (N_R^{up})^* \quad (83)$$

remain unbroken. Repulsive antigravity is not too large for these pairs of spaces to overcome hypothetical X-forces.

b. The scalar Higgs field Φ is the up/down doublet of compound Apeiron spaces (84),

$$\Phi(x) = (\tfrac{\varphi^-}{\varphi^+}), \varphi^{\pm} \in D_{H'}^{\pm}, x \in M_{1,3}^R \quad (84)$$

The down anti-Apeiron space starts to be fully right due to the absorption of its left part in the appearing Higgs field, and the down Apeiron space entirely vanishes.

As a result, the QST sector contains only the left-up Apeiron, right-up anti-Apeiron, and the Higgs field.

The right-down anti-Apeiron is a manifold $M_{1,3}{}^*$ (in vector representation).

In our terms, if Matter is “matter”, then physical space is “anti-space”. Symbolically, the Big Bang process looks like (85):

$$A\mathcal{H}_{4,4} \to AH_{4,4} + D_H^{\pm} + AH_{4,4}^* \quad (85)$$

It means that the Pre-Big Bang Universe does not split into two independent “Past-Universe” and “Past-anti-Universe”. It contains spaces $D_H^{\pm}$ entering into these parts and gathering them together.

Quantum gravity

The QM model allows all interactions from a single viewpoint to be local gauge fields. This is possible because the components of spin functions are coordinates in spin spaces, similar to spacetime in spin representation. After the “Big Bang”, the structure of QM is a collection of fields spread over a *4-dim* manifold (86),

$$QM^1 = (M_{1,3}{}', \Psi, B, \Phi) \quad (86)$$

Further, for simplicity of notations, we use $M_{1,3}$ instead of $M_{1,3}{}^*$. Denote (87):

$$QM^{pq} = (M_{1,3}, S^{pq}, \pi), S_8^{pq} = \oplus_\alpha S_2^{\beta}, \beta = (\alpha, p, q). \quad (87)$$

QM is the sum of submanifolds (88),

$$QM^1 = UQM^{pq}. \quad (88)$$

Submanifolds QM^{pq} are natural structural units in the field's family corresponding to (pq)-cell in Table 2 (89):

$$[(pq) - quark] + [hypercharge\ Y^{0,1} + gravity\ B^{1,2} + weak\ W + Higgs\ \Phi]. \quad (89)$$

In concise form, the Lagrangian density of fields restricted to QM^{pq} (90).

$$L = \Psi^*(D\Psi) + (1/4)FF + \Psi^*\Phi\Psi + L_\Phi \quad (90)$$
$$\Psi = \Psi_k^{\alpha,pq}, \alpha = +,-\ (down, up), k = 0 - 3.$$

Covariant derivatives:
$$D = \oplus D_\mu, D_\mu = \Gamma_\mu(\partial/\partial x_\mu - j_q k_A B^A \sigma_A)\ \sigma_A = \{\sigma_{p_1 00}, \sigma_{0p_2 0}, \sigma_{0p_3}\}, p_k = 1,2,3, \Gamma_\mu = \gamma_\mu O \sigma_0.$$

Strength tensors:
$$F_{\mu\nu}^A = \oplus\left(F_{\mu\nu}^a = \partial_\mu B_\nu^a - \partial_\nu B_\mu^a + k_A f^{abc} B_\mu^b B_\nu^c\right), a, b, c \in A. FF = F_{\mu\nu}^A F_A^{\mu\nu}. \quad (91)$$

The essential feature differing from the Standard Model is the presence of 0-generation and introduced gravity fields named spacious and temporal.

The collection of fields, Eq. 89, supposes the unification of entering fields in the unified electroweak-gravity interaction.

- The QST sector.

Accounting for the above propositions, in QM^{00}

1. Spin functions $\Psi^0 = (\Psi_L^{up}), \Psi^{0^*} = (\Psi_R^{up*}\ \Psi_R^{d*})$ where Ψ_R^{d*} is the down anti-Apeiron = a tangent space for $M_{1,3}$ in-spin representation.
2. The left/right symmetry is broken. So in QST, $B_\mu^{2,r} = 0, r = 1,2,3.$

In QST, there is no principal mathematical difference between $SU^1(2)$ and $SU^W(2)$.

3. Therefore, in the QST sector, weak interaction may W_μ^r be treated as a kind of gravity.

One may perceive a similarity with a system of fields in the electroweak theory (EWT) [8], if one takes the exchange $Y^1 \to Y^0, e_0 \to l_0, j_1 \to j_0$. The following speculations are based on the ideas of the EWT with a spontaneous symmetry breaking.

a. The Lagrangian density of the Higgs field (92):

$$L_\Phi = |D\Phi|^2 - V(\Phi), \quad (92)$$

where $V(\Phi)$ is the quartic self-interaction term (93),

$$V(\Phi) = \mu^2\Phi^2 - \lambda\Phi^4, and\ \mu, \lambda\ are\ constants. \quad (93)$$

In the next step, we take the simplest case supposing that gravity $B_\mu^{1,p}$ does not participate in the formation of the new field's combinations and it is enough to construct the field's combinations repeating corresponding relations of EWT.

New fields (94):

$$B^{1,0} = +Y^0 cos\ \theta_g + W^1 sin\ \theta_g\ B^0 = -Y^0 sin\ \theta_g + W^1 cos\ \theta_g\ B^\pm = (1/\sqrt{2})(W^2 \pm j_0 W^3) \quad (94)$$

θ_g is the analogy of the Wienberg angle θ_w.

$$tg(\theta_g) = k_{Y^0}/k_{W'}, sin\ (\theta_g) = k_{Y^0}/k_{0'}, cos\ (\theta_g) = k_W/k_{0'}, and\ k_0^2 = k_{Y^0}^2 + k_W^2.$$

Taking the same relations as in EWT, new fields in the Lagrangian acquire masses (95).

$$M(B^\pm) = (1/2)vk_{W'}M(B^0) = (1/2)vk_{x_0} = M(B^\pm)/cos\ (\theta_g)$$
$$M(B^{1,0}) = 0. \quad (95)$$

$v = \lambda/\mu^2$ the Higgs field's vacuum expectation. The masses of the up Apeiron U^0 and down D^0 (in the notations of Table 2) (96).

$$M(V^0) \sim v, M(D^0) = 0. \quad (96)$$

Therefore, QST is under the action of

1. three massive fields B^0, $B^\pm$ (short range).
2. four massless fields $B^{1,0}, B^{1,r}$, r = 1,2,3.

In this context, vector fields $B^\pm$ gather Apeirons in wholeness, while repulsive B^0 prevents them from falling in singularity. Due to (95), the effective radius $r(B^0) < r(B^\pm)$.

These results strengthen the ${M_{1,3}}^*$ conception to be an auxiliary space (its points enumerate different samples of local ${Ah_{4,4}}^x$ to form an infinite q-set). The "true stuff" of spacetime is the massive up Apeiron under the action of seven gravity fields. The possible attraction of spacious gravity into new field combinations may remain the principle's physical picture.

- The Dark Matter

Color Dark Matter spaces $M^{p0} \subset Gen_0, colors\ p = 1,2,3$ contain a full collection of fields: $[\Psi^{up,d},\ _{L,R}] + [Y^0, B^{1,2}, W]$.

We assume that boson fields form new combinations of a type Eq. 94. So, one should expect quark masses $M\left(\frac{U^p}{D^p}\right) > 0$, three massive fields $B^0, B^\pm$, seven massless fields $B^{1,0}, B^{1,r}, B^{2,r}, r = 1,2,3.$

The 0-generation sector, besides gravity fields B, also contains color gluon fields G providing the interaction of color spaces QM. Though the values of strength constants k are unknown in the model, we take a proposition: at "normal" conditions, repulsive (antigravity) forces surplus attractive color forces, and color dark quarks do not form hadrons, contrary to the Standard matter quarks for which antigravity is absent. More general question: can QM possess not before-seen geometrical and natural conditions establishing the stiff correlation between the strength constants? If so, this way should answer a fine-tuning constant $\alpha \approx 1/137$.

- QM and GR

Comparing GR and QM structures, $GR: (M_{1,3}, g_{\mu\nu}, T_{\mu\nu}), QM: (M_{1,3}, \Psi, F, \Phi)$.

We should seek the transition $OM \to GR$. In this study, we take the consideration of this problem aside restricting ourself by observation (97):

$$G_{\mu\nu} = \Lambda g_{\mu\nu} + T_{\mu\nu} \quad (97)$$

This equation accounts for 0-generation (98):

$T_{\mu\nu} = T^{D}_{\mu\nu}(DM) + T^{S}_{\mu\nu}(SM), DM\ and\ SM$ are the Dark and Standard Matter in a sense of Def.12 (98)

The gravity constant is omitted here. It should appear as the relation of scales $G \sim (a_0/a_1)^2$ in the modified multiplication.

The cosmological constant $\wedge$ is the energy density of antigravity B^0.

Due to the different complexities, the transitions (99):

$$Gen_0 \leftrightarrow Standard\ matter \quad (99)$$

are forbidden. That is accompanied by the comparatively large energy gap between them, which is accounted for by the difference in coupling constants in these sectors. This circumstance provides stability of matter, preventing its "falling" in spacetime. At the same time, if attractive gravity fields are large enough, as in the vicinities of collapsing masses, these forces violate the condition (99).

Conclusions

Represented a model of the quantum continuum based on rethinking the correlation between discreteness and continuity taken as abstract categories. This causes a reference to the simplest mathematical notion, a finite set. We take the notion of the q-set as the generalization of a set in the Set theory. The essential feature of the q-set is a quantum superposition of set points that brings quantumness to a base level of consideration. A formal representation of q-set concerns the structures of hypercomplex algebras leading to certain restrictions in possible constructions.

The clue point formulates the demand for hyperalgebra to be fundamental, choosing the single, unique hyperalgebra satisfying these conditions. Surprisingly, it includes the structures of the Standard Model in the content (by the appropriate physical interpretation) and gives possibilities to look beyond. The generalization of a q-set to q-manifolds leads to the following.

- Spacetime and Matter are unified. It is the sequence that both are different hypermatrices of the same matrix pattern.
- Macroscopic spacetime (locally) is a 4-dimensional Lorentz space that follows algebraic conditions and does not refer to special relativity considerations. At the same time, it explains 3-*dim* of space.
- QM allows the treatment of Time to be a purely quantum process like the manifestation of dual symmetry in space: $R^+ \leftrightarrow R^-$ giving a more profound correlation between space and time compared with a simple union $R_3 + iR_1 = R_{1,3}$.
- Besides known three particle generations, the model contains 0-generation associated with so-called Dark Matter.
- QM possesses local gauge symmetries generating gauge vector fields. Besides known electroweak and color symmetries, it contains additional symmetry $G = U^0_1 SU^1_2 SU^2_2$.
- QM delivers two kinds of structures, QM^0 and QM^1 referred to as the Pre-Big Bang and Past-Big Bang epochs correspondingly. In these terms, the Big Bang is a phase transition $QM^0 \rightarrow QM^1$ caused by innate mathematical QM^0 asymmetry. Also, it explains baryonic asymmetry.

Summarizing, a formulated conception of a QM effectively describes physical phenomena. Shortly, the Universe is a fundamental (self-inductive) q-set. Regarding physical constituents, it has a single elementary object, the Apeiron (the quantum of spacetime continuity), while other elementary constituents, such as quarks, are algebraic modifications of Apeirons.

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There are none.

Conflict of Interest

There are none.

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Квантові многовиди та стандартна модель

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Анотація

Актуальність. Це дослідження актуальне, оскільки воно стосується давньої проблеми об’єднання загальної теорії відносності (ЗТВ) і квантової теорії поля (КТП), зосереджуючись на основних концепціях дискретності та неперервності.

Мета. Метою цієї роботи є введення та дослідження концепції квантової множини (q-множини), яка забезпечує структуру для визначення квантових многовидів (QM), еквівалентних нескінченним гіпералгебрам.

Методологія. Підхід передбачає визначення конкретної симетрії для гіпералгебр, яка обмежує простір розв’язків унікальною гіпералгеброю. Ця гіпералгебра поєднує матерію і простір-час в одній структурі саме у спосіб, що відповідає спостережуваним фізичним складовим

Результати. Застосування структури q-set призводить до кількох важливих висновків. Це наперед визначає простір-час як локально Мінковський, не покладаючись на припущення спеціальної теорії відносності. Структура успішно генерує фундаментальні ферміонні та бозонні поля Стандартної моделі. Введення частинок 0-го покоління, які доповнюють три відомі покоління, дає можливе пояснення природи темної матерії. У масштабі Планка система описує гравітацію як опосередковану десятьма калібрувальними векторними полями, причому три з цих полів є масивними та короткодіючими, тоді як одне представляє силу відштовхування. Дослідження також дає можливість розглянути структуру Всесвіту до Великого вибуху.

Висновки. Концепція QM в рамках q-множини забезпечує єдиний опис як матерії, так і простору-часу. Цей новий підхід успішно поєднує Стандартну модель фізики елементарних частинок з новим поглядом на гравітацію та ранню структуру Всесвіту.

Ключові слова: мінімальна довжина, квантова множина, гіперкомплексна алгебра, Стандартна модель, темна матерія, Великий вибух.