# Link of Physical Constants with Space Geometry $R_6^{(3,3)}$

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In the article we suggest an interpretation of several constants both from the point of view of their physical meaning and from the point of view of space geometry of space-time $R_6^{(3,3)}$. Mathematical and visual interpretation of the constants is given. Conditional space-time construction in the framework of our suggested approach is described.

## 1. Introduction

Physical constants loom large in modern physical theories. Lately in connection with numerous attempts of the construction of unified theories the problem arises of clearing-up the nature and the explanation of physical numerical magnitudes. As the basis for the suggested theory of the six-dimensional space-time $R_6^{(3,3)}$ [1], we select two fundamental dimensionless constants. One of them is the Sommerfeld constant (fine structure constant):

$$\alpha(1)=\frac{e^2}{4\pi\varepsilon_0\hbar c_2} \tag{1.1}$$

The other constant expresses the relationship between the gravitational forces and the forces of electromagnetism (for the electron):

$$\frac{F_G}{F_{EM}}=\left(\frac{\tilde{m}}{\tilde{e}}\right)^2\approx 10^{-39}, \tag{1.2}$$

where $\tilde{e}=\sqrt{\frac{1}{4\pi\varepsilon_0}}\cdot e$, $\tilde{m}=\sqrt{G}\cdot m$.

As was shown in [1], the basis of the suggested theory is the concept the six-dimensional space $R_6^{(3,3)}$ which is from the physical point of view a sum total of fundamental elements (current rings or strings). As the concept of space-time extension (continuum) is inseparable from the concept of energy-impulse [duality of coordinates and (extensions) and impulses], there arises the necessity of the taking into consideration the 12-dimensional phase space which is a direct product of the coordinate and the impulse spaces $R_6^{(3,3)}\times R_6^{(3,3)*}$. The most common group of transformations (enveloping symmetry group) of this new space will be the group $GL(6,R)\times GL(6,R)^*$. As the structure of the groups of transformations of the coordinate and the impulse spaces is similar, we may not distinguish these groups, but consider that the group $GL(6,R)\times GL(6,R)$ of functions in the mentioned phase space, and it can be identified with the group of global symmetries.

In [1] it was shown that the dimensionality of the space-time $R_6^{(3,3)}$ is necessary for the observation of energy-impulse conservation laws, the moment of momentum, and the charge separately. As is known, these laws are closely connected with space-time symmetries. In the spaces of higher dimensionality conservation laws will not take place by themselves, and consequently, homogeneity, isotropic and scale invariance will be broken. Furthermore, action in these spaces is also not conserved. The fundamental objects are both elements (points), space-time itself, and component elements of matter.

Let us separate the fundamental objects from one another, namely, the elements of space-time (vacuum) and then matter in view of the energy-impulse scale. Let us note that in a vacuum we will understand the objects having the energy scale $E\le E_R$, and in matter – the scale $E>E_R$. The meaning of energy $E_R$ corresponds to characteristic energy of the relict photons. For the description of fundamental objects, a number of functional integrals [1] were introduced where the constants (1.1), (1.2) were used as decomposition constants. The term $S(0)$ [1] of the functional series reflects the properties of observed space-time to remain fixed by the transformations of the global symmetries $GL(6,R)\times GL(6,R)$ of every sort and kind.

## 2. Interpretation of the Sommerfeld Constant

Let us consider the first term $S(1)$ of the functional series of action [1] which describes the fundamental element and its performance under the impact of various symmetries. Because of the duality requirements and the equivalence of the coordinate and the impulse spaces, the necessity arises of a history of the functional integral $S(1)$ in the symmetrical mode:

$$S=S_0+S_M=\int\left(\frac{1}{h_0}p_k a(x)_j^k+\frac{1}{h}\cdot P_\chi A(X)_\beta^\chi\Lambda(x,X)_j^\beta\right)dx^j \tag{2.1}$$

where $G_\beta^\alpha$ are certain matrices connected with transformation of string symmetry (choice of a reference frame), $h$ is Planck's constant (quantum of action for matter), $h_0$ is the quantum of action for a vacuum. The quantum of action for a vacuum is analogous to the Planck's constant as there is no reason to think that $h_0=h$ holds. The values $g_j^i$ and $G_\beta^\alpha$ are connected with symmetry transformations by the expressions as follows:

$$g_j^i=a(p)_k^i\,a(x)_j^k,\ G_\beta^\alpha=A(P)_\chi^\alpha A(X)_\beta^\chi \tag{2.2}$$

where $A(P)_\beta^\alpha$, $A(X)_\beta^\alpha$ are the symmetry transformation matrices of the impulse and the coordinate spaces of strings, $a(p)_k^i$, while the $a(x)_k^i$ are the symmetry transformation matrices of the impulse and the coordinate spaces of space-time (vacuum).

The matrix $\Lambda_j^\beta(X,x)_i^\beta = \frac{\partial X^\beta}{\partial x^j}$ is connected with transition from characteristics of matter to characteristics of vacuum; in that case, the needed gauge potentials of the kind $A_i = P_\beta a_i^j \Lambda_j^\beta$ .may be taken into consideration. The impulses $p_i$ and $P_\alpha$ are determined by means of expressions:

$$p_i = a(p)_i^j \frac{\partial S_O}{\partial x^j} \text{ and } P_i = A(P)_i^\alpha \frac{\partial S_M}{\partial X^\alpha} \tag{2.3}$$

The values $\frac{\partial S_O}{\partial x^j}$ and $\frac{\partial S_M}{\partial X^\alpha}$ are interpreted as charges, as their meanings are determined in the following way

$$e_i = \frac{\partial S_0}{\partial x^i} = \frac{\partial(\tilde{a}_k^j a_j^k)}{\partial x^i} = \frac{\partial^2 \tilde{x}^j}{\partial x^i \partial x^j},\ E_\alpha = \frac{\partial S_M}{\partial X^\alpha} = \frac{\partial(\tilde{A}_\chi^\beta A_\beta^\chi)}{X^\alpha} = \frac{\partial^2 \tilde{X}^\beta}{\partial X^\alpha \partial X^\beta} \tag{2.4}$$

The transformation matrices $a(x)_j^i$, $a(p)_j^i$, $A(X)_j^i$, $A(P)_j^i$ take the form as follows:

$$a(x)_j^i = \frac{\partial x^i}{\partial x^j},\ a(p)_j^i = \frac{\partial p^i}{\partial p^j},\ A(X)_j^i = \frac{\partial X^i}{\partial X^j},\ A(P)_\beta^\alpha = \frac{\partial P^\alpha}{\partial P^\beta}. \tag{2.5}$$

It is easy to see that the transformation matrices $a(x)_j^i$, $a(p)_j^i$, $A(X)_j^i$, $A(P)_j^i$ are related as transformation matrices of a vector and a covector.

The components describing the vacuum and the current ring (string) satisfy the duality relations:

$$x^i p_j = g_j^i h_0,\ X^\alpha P_\beta = G_\beta^\alpha h, \tag{2.6}$$

These, for the case $g_j^i = \delta_j^i$ and $G_\beta^\alpha = \Delta_\beta^\alpha = \delta_\beta^\alpha$ are equivalent to Heisenberg uncertainty relations.

Let us introduce into consideration a covariant derivative

$$\nabla_i S = p_j a_i^j + P_\beta A_\alpha^\beta \frac{\partial X^\alpha}{\partial x^i} = p_j a_i^j + P_\beta A_\alpha^\beta \Lambda(x,X)_i^\alpha \tag{2.7}$$

Supposing that $\alpha(1) = \frac{h_0}{h}$ and additionally by determining the impulses, the expression (2.2) may be written in the form:

$$S = \frac{\alpha(1)}{h} \cdot \int \left( p_j a_i^j + P_\beta A_\alpha^\beta \frac{\partial X^\alpha}{\partial x^i} \right) dx^i = \frac{\alpha(1)}{h} \cdot \int (\nabla_i S) dx^i \tag{2.8}$$

Comparing the constant $\alpha(1) = \frac{h_0}{h}$ with the expression (1.1), $h_0$ will be determined by:

$$h_0 = \frac{e^2}{4\pi\varepsilon_0 c} \approx 7.6 \cdot 10^{-37} \text{ J} \cdot \text{sec} \tag{2.9}$$

It is easy to see that $\alpha(1)$ may be expressed in the form

$$\alpha(1) = \frac{h_0}{h} = \frac{p_i dx^i}{P_\alpha dX^\alpha} = \tan^2 \phi_0, \tag{2.10}$$

Then $\phi_0 \approx 4{,}87^\circ$. Thus, the Sommerfeld constant (fine structure constant) is from the physical point of view a ratio of two fundamental moments (quanta of action). From the geometrical point of view it can be interpreted as the back tangent of the vector of matter the state relative to the vector of the vacuum state.

It should be noted that attempts to discover the physical meaning of the fine structure constant have been made earlier. Thus, in the works of Kozyrev [2] the Sommerfeld constant is determined as the ratio of two fundamental velocities:

$$\alpha(1) = \frac{c_1}{c_2}, \tag{2.11}$$

where $c_2$ is the light velocity. On the other hand, to our mind, (2.10) more fully reflects the physical meaning of the constant under discussion. Let us also note that there is a work of N. Kosinov [3], in which the fundamental quantum of action is introduced $h_u = e^2 c\mu = 7.69558071 \cdot 10^{-37}$ J·sec where, $\mu$ is the vacuum permeability, and $c$ is light velocity.

## 3. Interpretation of the Weinberg Angle

Let's consider the transformation matrices (2.5). As the structure of these matrices is similar, we will only examine the matrix of transformation of coordinate space $a(x)_j^i$ in the general case:

$$a(x)_j^i = \begin{pmatrix} \frac{\partial\tilde{t}^1}{\partial t^1} & \frac{\partial\tilde{t}^2}{\partial t^1} & \frac{\partial\tilde{t}^3}{\partial t^1} & \frac{\partial\tilde{x}^1}{\partial t^1} & \frac{\partial\tilde{x}^2}{\partial t^1} & \frac{\partial\tilde{x}^3}{\partial t^1} \\ \frac{\partial\tilde{t}^1}{\partial t^2} & \frac{\partial\tilde{t}^2}{\partial t^2} & \frac{\partial\tilde{t}^3}{\partial t^2} & \frac{\partial\tilde{x}^1}{\partial t^2} & \frac{\partial\tilde{x}^2}{\partial t^2} & \frac{\partial\tilde{x}^3}{\partial t^2} \\ \frac{\partial\tilde{t}^1}{\partial t^3} & \frac{\partial\tilde{t}^2}{\partial t^3} & \frac{\partial\tilde{t}^3}{\partial t^3} & \frac{\partial\tilde{x}^1}{\partial t^3} & \frac{\partial\tilde{x}^2}{\partial t^3} & \frac{\partial\tilde{x}^3}{\partial t^3} \\ \frac{\partial\tilde{t}^1}{\partial x^1} & \frac{\partial\tilde{t}^2}{\partial x^1} & \frac{\partial\tilde{t}^3}{\partial x^1} & \frac{\partial\tilde{x}^1}{\partial x^1} & \frac{\partial\tilde{x}^2}{\partial x^1} & \frac{\partial\tilde{x}^3}{\partial x^1} \\ \frac{\partial\tilde{t}^1}{\partial x^2} & \frac{\partial\tilde{t}^2}{\partial x^2} & \frac{\partial\tilde{t}^3}{\partial x^2} & \frac{\partial\tilde{x}^1}{\partial x^2} & \frac{\partial\tilde{x}^2}{\partial x^2} & \frac{\partial\tilde{x}^3}{\partial x^2} \\ \frac{\partial\tilde{t}^1}{\partial x^3} & \frac{\partial\tilde{t}^2}{\partial x^3} & \frac{\partial\tilde{t}^3}{\partial x^3} & \frac{\partial\tilde{x}^1}{\partial x^3} & \frac{\partial\tilde{x}^2}{\partial x^3} & \frac{\partial\tilde{x}^3}{\partial x^3} \end{pmatrix} \tag{3.1}$$

For the matrices (2.5), (3.1) holds the factorization

$$a(x)_j^i = \delta_j^i + m_j^i + l_j^i,\quad A(x)_\beta^\alpha = \Delta_\beta^\alpha + M_\beta^\alpha + L_\beta^\alpha. \tag{3.2}$$

Thus, the matrices $\delta_j^i$, $m_j^i$, $l_j^i$ have the form

$$\delta(0)_j^i = \begin{pmatrix} \delta_{t_1}^{t_1} & 0 & 0 & 0 & 0 & 0 \\ 0 & \delta_{t_2}^{t_2} & 0 & 0 & 0 & 0 \\ 0 & 0 & \delta_{t_3}^{t_3} & 0 & 0 & 0 \\ 0 & 0 & 0 & \delta_{x_1}^{x_1} & 0 & 0 \\ 0 & 0 & 0 & 0 & \delta_{x_2}^{x_2} & 0 \\ 0 & 0 & 0 & 0 & 0 & \delta_{x_3}^{x_3} \end{pmatrix}, \tag{3.3}$$

$$m_j^i = \begin{pmatrix} 0 & m_{t_2}^{t_1} & -m_{t_3}^{t_1} & 0 & -m_{x_2}^{t_1} & m_{x_3}^{t_1} \\ -m_{t_1}^{t_2} & 0 & m_{t_1}^{t_2} & m_{x_1}^{t_2} & 0 & -m_{x_3}^{t_2} \\ m_{t_1}^{t_3} & -m_{t_2}^{t_1} & 0 & -m_{x_1}^{t_3} & m_{x_2}^{t_3} & 0 \\ 0 & -m_{t_2}^{x_1} & m_{t_3}^{x_1} & 0 & -m_{x_2}^{x_1} & m_{x_3}^{x_1} \\ m_{t_1}^{x_2} & 0 & -m_{t_3}^{x_2} & m_{x_1}^{x_2} & 0 & -m_{x_3}^{x_2} \\ -m_{t_1}^{x_3} & m_{t_2}^{x_3} & 0 & -m_{x_1}^{x_3} & m_{x_2}^{x_3} & 0 \end{pmatrix}, \tag{3.4}$$

$$l_j^i = \begin{pmatrix} 0 & 0 & 0 & q_{x_1}^{t_1} & 0 & 0 \\ 0 & 0 & 0 & 0 & q_{x_2}^{t_2} & 0 \\ 0 & 0 & 0 & 0 & 0 & q_{x_3}^{t_3} \\ -q_{t_1}^{x_1} & 0 & 0 & 0 & 0 & 0 \\ 0 & -q_{t_2}^{x_2} & 0 & 0 & 0 & 0 \\ 0 & 0 & -q_{t_3}^{x_3} & 0 & 0 & 0 \end{pmatrix}$$

For the case of a homogeneous and the isotropic vacuum the elements of these matrices are identities and the factorizations are obtained:

$$\begin{aligned} a(x)_j^i &= \frac{1}{\sqrt{3}}\delta_j^i + \frac{1}{2\sqrt{3}}m_j^i + \frac{1}{\sqrt{3}}l_j^i \\ &= \tan 30^\circ \delta_j^i + \frac{1}{2}\tan 30^\circ m_j^i + \tan 30^\circ l_j^i \end{aligned} \qquad (3.5)$$

$$\begin{aligned} a(p)_j^i &= \frac{1}{\sqrt{3}}\delta_j^i + \frac{1}{2\sqrt{3}}m_j^i + \frac{1}{\sqrt{3}}l_j^i \\ &= \tan 30^\circ \cdot \delta_j^i + \frac{1}{2}\tan 30^\circ m_j^i + \tan 30^\circ l_j^i \end{aligned} \qquad (3.6)$$

As is easy to see, using (3.5) and (3.6), the first of the matrices (2.2) will have identical elements

$$\begin{aligned} g_j^i &= a(p)_k^i a(x)_j^k = \delta_j^i = \delta_k^i \delta_j^k \\ &= \frac{1}{3}\delta_k^i\delta_j^k + \frac{1}{3}l_k^i l_j^k + \frac{1}{12}\left(m_k^i m_j^k + m_k^i l_j^k + l_k^i m_j^k\right) + \frac{1}{3}\left(\delta_k^j l_j^k + l_k^i \delta_j^k\right) \end{aligned} \qquad (3.7)$$

Analogous factorizations are obtained for the matrices $G_\beta^\alpha$. Thus, from the point of view of an observer in the relevant frame of reference, the identical transformation of space-time into itself takes place. The angle $\phi_f = 30^\circ$ can be identified with the fundamental angle of rotation associated with the continuous application of the action symmetry transformation. In the case that a relevant reference frame connected with vacuum was chosen, the matrices $G_\beta^\alpha$ cannot be brought to the diagonal form. Also taking also into consideration that the numerical values of the introduced angle is very close to experimental value of the Weinberg angle from the theory of electroweak interactions, and these angles can be identified. Moreover, decay of particles can be interpreted as transformation of rotation by a fundamental angle in phase space.

## 4. Graphic Interpretation of the Connection of Space-time Geometry & Physical Constants

Let us consider the functional integral (2.8) in a simplified form without separating vacuum and matter:

$$S(1) = \frac{\alpha(1)}{h}\cdot\int\left(p_j a(x)_i^j\right)dx^i = \frac{\alpha(1)}{h}\cdot\int\left(a(p)_j^k e_k a(x)_i^j\right)dx^i \qquad (4.1)$$

In the six-dimensional space-time the charge vector will be written in the form

$$e_i(e_1, e_2, e_3, m_1, m_2, m_3) \qquad (4.2)$$

The elements of the matrix $g_j^j = a(p)_i^k a(x)_k^j$ by general rotations will be either the product of functions of the form $\tan\phi$, $\cot\phi$, $\tanh\psi$, $\coth\psi$, or their inverses $\operatorname{atan}\phi$, $\operatorname{acot}\phi$, $\operatorname{atanh}\psi$, $\operatorname{acoth}\psi$. Let us choose certain units of charge and length. From the definition of the charge it is clear that if we take dimensionality with a length $L$, so the charge dimensionality will be $L^{-1}$. Thus, the functional integral is invariant (stable) relative to symmetry transformation, and it follows that the [the action conservation law (of the 6-dimensional moment)]:

$$a(p)_j^k e_k a(x)_k^j dx^i = 0 \qquad (4.3)$$

By selecting certain standards of length and charge their observed values will be completely determined by transformations of phase space. The transformations should not change the action conservation law. Knowing the form of the transformation functions, it is easy to realize that the conservation law (3.3) will be determined by the two cases which correspond to intersection points of the functions graphs (Fig. 4.1) $\operatorname{atan}\phi$ and $\frac{\pi}{2}\tanh\phi$, or $\tan\phi$, and $\frac{\pi}{2}\operatorname{atanh}\phi$.

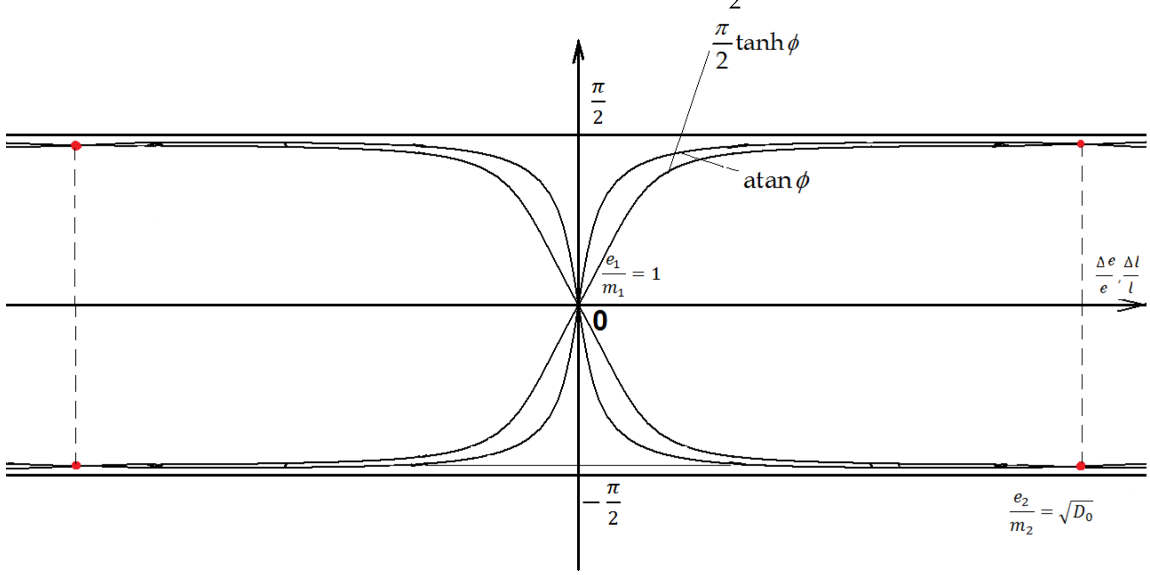


**Fig. 4.1.** Graphic interpretation of the link of the space-time geometry and physical constants

It is also clear from the graphs that there are two such points and that they are determined by the solutions of the equation

$$\frac{2\cdot \operatorname{atan}\phi}{\pi\cdot \tanh\psi}=1\text{, or }\frac{2\cdot \tan\phi}{\pi\cdot \operatorname{atan}\psi}=1 \tag{4.4}$$

Let us choose some standards for measurement of the charge and extension: $e_э$ and $l_э$ respectively. Let us set up a ratio of the kind

$$\frac{e_i-e_э}{e_э}=\frac{\Delta e_i}{e_э}\text{, and }\frac{dx^i-l_э}{l_э}=\frac{\Delta l_i}{l_э}, \tag{4.5}$$

where $e_i$ and $dx^i$ are experimentally measured components of the charge and extension. Let us take $e_э=1$ and $l_э=1$. Consequently, the behavior of the values $\Delta e_i$ and $\Delta l_i$, which directly enter the action conservation law, will be similar to the behavior of the said trigonometric functions, i.e.

$$\Delta e_i=a(p)_i^j\,e_j\text{ and }\Delta l^i=a(x)_j^i\,l^j \tag{4.6}$$

We can always take $e_j=e_э$ and $l^i=l_э$. As follows from the graph, the action conservation law will hold if for the values $e_э$ and $l_э$, $e_i$ and $l_i$ which follows from the graph, and the following are relations are satisfied:

$$\frac{e_i}{e_э}=1,\ \frac{l_i}{l_э}=1,\ \frac{e_i}{e_э}=\sqrt{D_0},\ \frac{l_i}{l_э}=\sqrt{D_0}, \tag{4.7}$$

where $D_0$ is a large number.

The component in the vector (2.2) $e_1$ conforms to the electric (time) component of the gravitational charge, $e_2$ – to the electric (time) component prescribing electromagnetic interactions, $e_3$ – to the electric (time) component of the baryonic charge, $m_1$ conforms to the magnetic (space) component of the gravitational charge (mass), $m_2$ – to the magnetic (space) component prescribing electromagnetic interactions (electronic mass), $m_3$ – to the magnetic (space) component (baryonic mass). Applying (4.7) to the components (4.3), we obtain the following possible relation between the components of the charge vector:

$$e_1=m_1, \tag{4.8}$$

which conforms to the equality of the gravitational and the inertial mass (equivalence principle). In turn, the ratio

$$\frac{e_2}{m_2}=\sqrt{D}=\sqrt{10^{39}} \tag{4.9}$$

is a ratio of characteristics of the electric charge and the mass for the electron.

Thus, the number $D$ is a peculiar *criterion of similarity in the Universe*. This demonstrates that the concept of small and large scales, generally speaking, is without any sense. In view of certain ratios for the physical constants, the physical picture for large scales is similar to the physical picture for small scales.

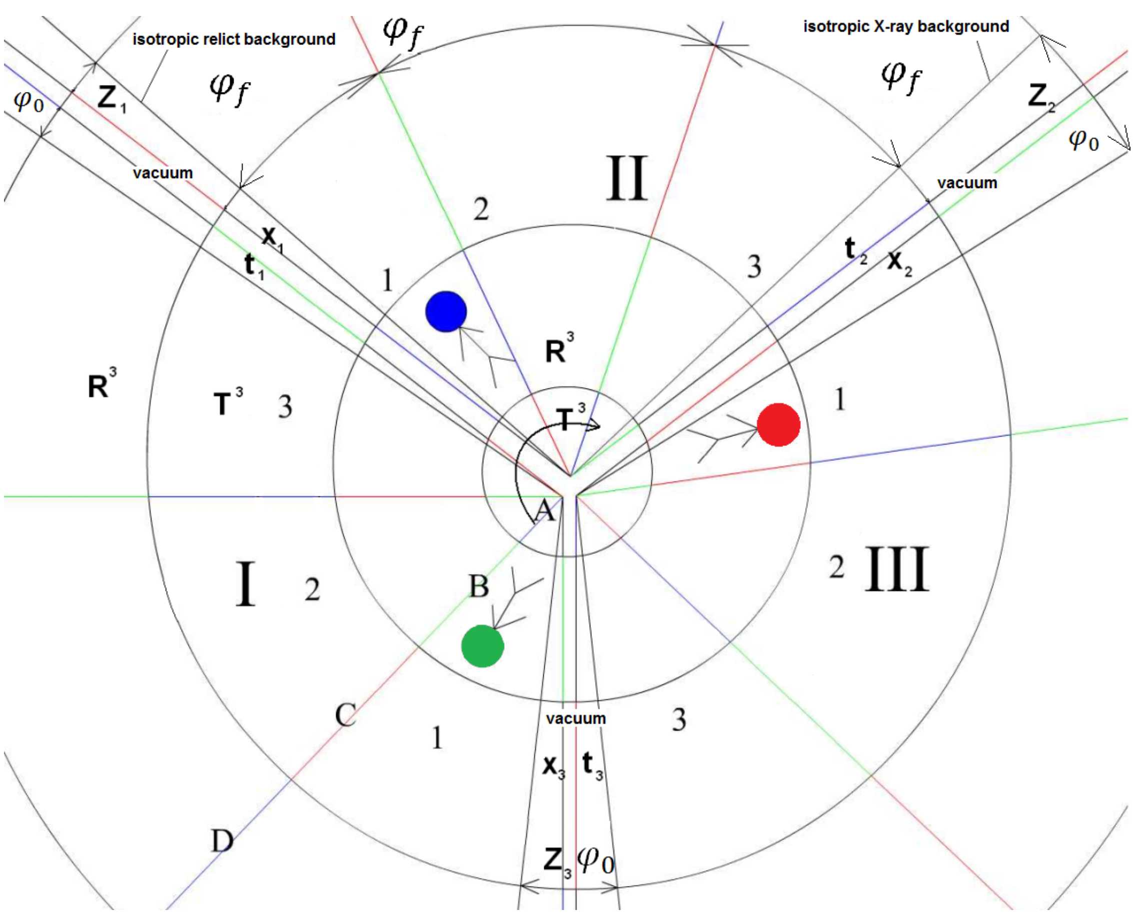


**Fig. 5.1.** Structure of six-dimensional space-time

## 5. Conclusion

Thus, the observed Universe possesses scaling (scaling invariance) (Fig. 5.1). As it was stated in [1], the baryonic asymmetry observed in nature is a consequence of this scaling invariance.

In [1] we have compared three color charges known to quantum chromodynamics with three introduced charges. Strong interactions scramble the types of the charges and interactions, but the correlations between the charges remain unchanged.

For instance, in zone **II** (Fig. 5.1) integration takes place at the expense of the mixing of the three time extensions which coincide with the gravitational time $t_1$ [interaction of three parallel currents (impulses)]:

$$e_1 = m_1 = m_2 = m_3 = m_{\mathrm{II}}\,,\ \frac{e_2}{m_{\mathrm{II}}} = \sqrt{D} = \sqrt{10^{39}}\,,\ \frac{e_2}{e_3} = D = 10^{39}$$

In zone **II** the structure of space-time is four-dimensional, the relevant components will be $x^i\left(t^1, x^1, x^2, x^3\right)$, and the metrics will be $\left(ds^2\right)^x_{\mathrm{II}} = g_{ij}dx^i dx^j$.

In zone **III** consolidation comes about electromagnetic time:

$$e_2 = m_1 = m_2 = m_3 = m_{\mathrm{III}}\,,\ \frac{e_3}{m_{\mathrm{III}}} = \sqrt{D} = \sqrt{10^{39}}\,,\ \frac{e_2}{e_3} = D = 10^{39}$$

In this zone there exists a four-dimensional space-time with the components $x^i\left(t^2, x^1, x^2, x^3\right)$ and the metrics $\left(ds^2\right)^x_{\mathrm{III}} = g_{ij}dx^i dx^j$.

In zone **I** consolidation comes along around baryon time:

$$e_3 = m_1 = m_2 = m_3 = m_{\mathrm{I}}\,,\ \frac{e_1}{m_{\mathrm{I}}} = \sqrt{D} = \sqrt{10^{39}}\,,\ \frac{e_1}{e_2} = D = 10^{39}$$

Here we have a four-dimensional space-time with the components $x^i\left(t^3, x^1, x^2, x^3\right)$ and the metrics $\left(ds^2\right)^x_{\mathrm{I}} = g_{ij}dx^i dx^j$.

The analogous picture is also observed for the time-like zone. Let us note that it is also necessary to take into consideration the inversion. This leads in turn to splitting of each of the considered zones (Fig. 5.1) in two.

Thus, as a result we have two areas (sheets) of the Universe (Universes) with twelve observers. As in all zones, the physical phenomena are the same due to compliance with the relations described in the article, and the observer will not be able to determine in which of the twelve zones he is at any instant of time.

In view of this, one must conclude that the absolute value of the physical magnitudes yielded by some numerical values with some dimensionality makes no sense for a real Universe. For a Universe the only important numbers are the dimensionless ratios of physical magnitudes. Consequently, various theories in which computation of fundamental interactions is linked to a certain scale of energy or masses are erroneous. The theories which are linked to dimensional parameters are erroneous as well. The link to certain scales and parameters gives a correct account by such physical theories of the real world for only a very narrow spectrum of physical phenomena and is of an approximate nature.

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