Infinity, Spacetimes and the Origin of Nature

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Abstract: Most fruitful method to formulate a perfect theory should start from induction and via deduction lead to reduction if necessary. To eliminate the dichotomy of infinity i.e. the infinity understood as both a simple continuum without any boundaries or the ever-increasing sequence, we must introduce pieces of space. Infinity as a number has no sense and leads to incoherent theories. Applied mathematics should be defined as mathematical methods starting from pieces of space placed in the infinite nothingness. Since in such theory, information is not lost so such theory is mathematically coherent, simple and reversible. There do not appear physical singularities and infinities. Our cosmos, and many others, appeared due to inelastic collision of two or more very big pieces of space composed of smaller pieces. Only granular/discrete and kinetic geometry can be the foundations of coherent description of Nature. Here are formulated the fundamental axioms as the foundations of ontology. Entanglement of the Einstein-spacetime components leads to both psychology and particle physics. Due to the very different properties of fields associated with Gravity and Standard-Model/Quantum-Physics, unification of these two basic theories within the same methods is impossible.

1. Introduction

We can define infinity as something without any limit or as the ever-increasing sequence i.e. $1, 2, 3$, and so on, proposed by George Lakoff. But these definitions suggest that infinity is a metaphor i.e. is expressed by means of a figure of speech. It is the basic metaphor of infinity (BMI). On the other hand, to eliminate the dichotomy of infinity, i.e. the infinity understood as both a simple continuum without any boundaries or the ever-increasing sequence, L. Kronecker developed area called finitism [1].

Generally, infinity understood as the ever-increasing sequence leads to incoherent theories. Assume that we have a field in which force is inversely proportional to squared distance from a source of the field. In the inverse-square force laws, for $r = 0$ we obtain singularity, for example, infinite density, and we obtain infinity, for example, infinite energy of the field. In such description there does not appear a structure of the source of the field. Just in such description we lose information about the source of the field. Moreover, there can appear some phase transitions for strictly defined distances r_i. It causes that infinity understood as the

ever-increasing sequence is defective i.e. non-logic. The problem of an infinite regress argument is described here [2].

In physics should be applied only the useful applied mathematics. There are different definitions of applied mathematics. It is obvious that in useful applied mathematics should not appear singularities, infinities and free parameters. There should not appear division by zero that leads to singularity, sum of infinite series that leads to infinity and division by infinity leading to zero because in such operation we lose information about the numerator i.e. such operation is non-reversible. Useful applied mathematics should be defined as mathematical methods starting from pieces of space placed in the infinite nothingness without any limit. Axioms in such mathematics should concern the pieces of space, the local mean distance between them and their local mean speed. Such axioms eliminate the singularities, infinities and non-reversibility. Mathematical description of the infinite nothingness and static space is useless.

2. Most fruitful method to formulate a perfect theory

If, for example, in some moment in an infinite-regress time is an unknown phase transition then the initial thesis is defective.

Most useful is method starting from induction i.e. from the empirical method that leads from experimental data to generalized laws and next to some hypothetical initial conditions. Next we should apply deduction, i.e. we should seek coherent mathematical description that leads from the hypothetical initial conditions to experimental data. If it is impossible then we should seek next initial conditions and/or try to modify them. A modification should look as reduction i.e. we should seek axioms more fundamental than the first initial conditions. The new axioms should lead to the previous initial conditions and new admissible laws that should make the formulated theory more coherent. In such method there should appear admissible phase transitions in an infinite-regress time. There, for example, can appear some stable cosmic object after the era of inflation but before the observed expansion of the Universe. Applying such method there was formulated the Scale-Symmetric Theory (SST) i.e. the lacking part of ultimate theory [3].

We can apply the gauge method to compare theories in which to obtain theoretical results are applied different methods. For example, two different theories can lead to the same ratio for different values of a physical quantity. Of course, both theories should be consistent with experimental data. Since in such theories physical quantities differ by some constant factor then such theories are invariant under the constant-factor gauge of physical quantities. Then the better theory is a theory that contains less initial conditions and/or describes more phenomena.

The definition of a physical theory we can find in many places – we cite the definition placed here [4]

"Physical theory is an attempt to explain a certain class of physical phenomena by deducing them as necessary consequences of some primitive assumptions."

"The value of a theory depends on both the success with which it coordinates a wide range of presently known facts and its fertility in suggesting places to look for presently unknown phenomena."

The Scale-Symmetric Theory that was formulated according to above remarks, shows that due to the law of conservation of spin and the saturation of interactions via the initial pieces of space, there appear the succeeding phase transitions of the initial field composed of the moving pieces of space (it is the non-gravitating superluminal Higgs field). The succeeding

phase transitions lead to new symmetries and new formulae that follow from them – there appears a cascade of phase transitions so there appear the next and next symmetries and associated with them new formulae. SST is the very fruitful theory because it starts from 7 parameters only (there does not appear free parameters as it is in the mainstream theories) and till now within this theory we calculated a thousand of basic physical quantities consistent or very close to experimental data.

Moreover, fertility of this theory in suggesting places to look for presently unknown phenomena is very high:

2.1

If our Cosmos has boundary (SST shows that should have) then the base of the natural logarithm applied in physics should be a little smaller than the mathematical constant $e = 2.71828\ldots$ – we can test it [5].

2.2

There should be in existence the non-annihilating neutrino-antineutrino pairs with very high number density about $1.65 \cdot 10^{94}$ pairs per cubic meter [3A].

2.3

Mass of stable neutrinos should be non-relativistic and very small i.e. about $3.335 \cdot 10^{-67}$ kg [3A].

2.4

Quantum entanglement should be superluminal and the ratio of the non-gravitating energy frozen inside stable neutrino (it is the unobservable energy predicted within Quantum Mechanics) to the gravitational mass of the neutrino (it is the observed energy) should be about $0.6 \cdot 10^{119}$ [3A].

2.5

There should not be in existence the gravitational waves and gravitons [3A].

2.6

The bare particles must have sizes not equal to zero and very rich internal structure [3A].
And so on.

3. The coherent mathematics and physics

Nature must be described by granular and kinetic geometry. The symbol $\rightarrow P_{P,size>0}$ represents moving internally structureless piece of space or a physical point of space whereas $V_{P,i}$ are their volumes. The symbol $P_{U,size>0}$ represents an unphysical point that is placed in the nothingness whereas $V_{U,i}$ are their volumes. The sum $\Sigma\, V_{U,i} = \infty$ and it is the infinity without any limit. It is the infinite nothingness. Since the volumes of the pieces of space have surface, i.e. boundaries, so sum of finite volumes cannot be infinite: $\Sigma\, V_{P,i} \neq \infty$. Here, infinity is defined as something without any boundaries so without internal boundaries as well i.e. infinity is a single unphysical continuum. If there are some internal boundaries then we never can obtain a single physical continuum without any boundaries. Such definition leads to conclusion that there cannot be in existence an infinite number so following sum has no meaning: $\infty + 1$.

Volume of a piece of space cannot be equal to zero. The sentence: "Infinite number of divisions of finite volume V of space leads to set composed of infinite number of sizeless points of space." is incorrect. The total volume of the sizeless points, even of their "infinite number", is equal to zero whereas should be V. Just, due to the succeeding divisions without any limit we obtain infinitesimal volumes not equal to zero. If we assume that formula $V / \infty = 0$ is correct then we lose information about the initial volume V. It follows from the fact that even infinity multiplied by zero must be zero: $\infty \cdot 0 = 0$. We can see that formula V / ∞

$= 0$, leads to non-reversible theories so incoherent as well. Each element of infinity understood as the ever-increasing sequence multiplied by zero gives zero so the sum of the products is equal to zero also.

In mathematics and physics we frequently apply following formula $0 = a / \infty$. This formula has no physical meaning. Infinite number of divisions of a segment which length, for example, is equal to 1 leads to the infinite set composed of sizeless points. The reversible formula looks as follows: $0 \cdot \infty = 0$. It is because due to the transition from the segment to the infinite number of sizeless points we lose information about the length of the segment. In physical world information cannot be lost. Just such transition causes that we obtain incoherent theory. To fit the theoretical results to experimental data within the non-reversible theories (there appear the singularities and infinities) as, for example, within the Quantum Theory of Fields (QTFs), we apply approximations, mathematical tricks and free parameters.

Following formula $\infty - \infty = a \neq 0$, has no sense because infinity is not a number. Such formula is applied in, for example, QED so such theory is mathematically incoherent. In reality, since the QED leads to theoretical results consistent with experimental data, the applied formula proves that the bare fermions are not sizeless particles. The elimination from the QED the internal structures of the bare fermions causes that this theory is incomplete.

There is the difference between the real Nature composed of the objects $\rightarrow P_{P,size>0}$ (they are the physical pieces of space) and $P_{U,size>0}$ and the binary-system digital-world composed of the abstract numbers 1 and 0.

4. Fundamental space and spacetimes; the Planck length

There can be two states of an infinitesimal volume: nothingness or fully-filled. Define the space as the components of the fundamental spacetime. They can be fully-filled but they can be porous as well. Define the X as the ratio of volume of space to the total volume i.e. to the sum of volumes of nothingness and space. There are the three possibilities:

$X = 0$: it is the nothingness i.e. the timeless volume,

$X = 1$: it is the timeless space if non-porous,

$0 < X < 1$: it can be the living spacetime when the pieces of space are moving.

Time follows from collisions of the moving pieces of space.

The Scale-Symmetric Theory [3A] shows that today the X is $X = 1.3245 \cdot 10^{-58}$. The mean speed of the pieces of space is $2.386344 \cdot 10^{97}$ m/s [3A]. Only such initial conditions lead to experimental data.

The nothingness is infinite. In the nothingness are placed the pieces of space. There are the motions of the pieces of space in a field composed of the pieces of space. Due to the dynamic viscosity of the pieces of space, mean size of them increases when their mean speed decreases. This means that there can be spacetimes surrounded by timeless non-porous space. There can be tremendous number of separated spacetimes with different initial conditions. Timeless spaces are fruitless.

Theories including sizeless points/bare-particles are mathematically and physically incoherent. Only granular/discrete and kinetic geometry can coherently described Nature.

Define phase space of a differential equation as the set of all possible solutions of the differential equation. To find the solutions we need some initial conditions. A set of some initial conditions/elements we will refer to as the phase space. Generally, the phase spaces contain coordinates and quantities which define positions, shapes and motions. What elements should contain the phase space of the fundamental spacetime?

We assumed that there can be only three orthogonal axes: $X, Y,$ and Z (the bold letters denote vectors). But there is the other more generalized possibility. There are the three

orthogonal directions and each direction is defined by two tagged semi-axes. We can define a 3-directional orthogonal reference frame in such a way that the unit vector (versor) x is tagged with linear-velocity versor v of a mathematical point i.e. $x = -v$, that the versor y is tagged with the radius versor r of the mathematical point i.e. $y = -r$, and that the versor z is tagged with the angular-velocity versor of the mathematical point i.e. $z = -\omega$. We can see that fundamental phase space should have 6 elements.

We will call the gravitationally massless objects, i.e. objects that have broken contact with the Principle-of-Equivalence particles, the imaginary objects. We can assume that our cosmos appeared due to expansion of a liquid-like space (the inflation). Due to the constancy of the fundamental physical constants, our Cosmos must be surrounded by timeless space. Our Cosmos can be destroyed due to some big collision of the timeless layer that surrounds our Cosmos with a big piece of space. Then, there can appear a crack that will connect our cosmos with some other cosmos with different initial conditions. Such event can change the initial conditions in our cosmos in such a way that the Einstein-spacetime components (i.e. the neutrino-antineutrino pairs) will decay. Their size is close to the Planck length [3A].

The Planck scale appeared during the inflation because of the two first phase transitions of the non-gravitating superluminal Higgs field [3A].

5. The fundamental axioms and interpretations
The fundamental axioms from which Nature should start are as follows.

5.1
Only granular/discrete and kinetic geometry can coherently describe Nature.

5.2
There are only two states of not sizeless points: nothingness or space. Coherent theories must start from pieces of space. There are only two types of energy of the pieces of space i.e. rotational and linear/kinetic. Mathematical description of the nothingness and its relations with the space (physical) is not needed.

5.3
There are in existence the pieces of space that shape and size can be described by using of the Euclidean space. The pieces of space are the non-gravitating/non-relativistic objects. The relativistic and quantum objects and the Principle-of-Equivalence particles and fields appear on higher levels of Nature due to the phase transitions of the fundamental-spacetime/superluminal-Higgs-field.

5.4
The pieces of space cannot emit spontaneously any objects so they do not create radiation fields, for example, gravitational field, i.e. they have inertial mass/volume but they are the gravitationally massless pieces/volumes. Such spacetime is beyond the General Theory of Relativity. The Einstein spacetime composed of the Principle-of-Equivalence particles appears due to the first two phase transitions of the fundamental spacetime.

5.5
Mean-times between successive collisions of pieces-of-space/non-gravitating-tachyons define the local units of the relativistic time that appears in General Relativity. The local units of time depend on mean distance between the pieces of space. SST shows that higher gravitational-mass densities produce fields with lower inertial-mass density so time is going

slower. It is not true that temporal axis must be simultaneously orthogonal/perpendicular to all spatial axes.

5.6

Particles on higher level of Nature can perceive the grainy fundamental spacetime as a single-real-continuum – it is satisfied when time of interaction of a particle is longer than the time that is needed the pieces of space at least once occupied each point of the nothingness. Then, for example, we can use the Noether theorem defining the relation between symmetry of laws of motion of physical system and laws of conservation of adequate physical quantities.

5.7

The fundamental spacetime is independent of any observer.

5.8

Due to the pieces of space, there is upper limit for inertial mass density of fundamental spacetime. This means that there cannot appear singularities. Due to the collisions of the pieces of space, no field can have infinite range.

5.9

Volumes of pieces of space that define their inertial mass cannot be transformed into pure energy and vice versa. This means that we must change the interpretation of the Einstein formula $E = mc^2$. This formula is valid only for Principle-of-Equivalence fields/spacetime and is associated with flows in the Einstein spacetime that increase or decrease local gravitational-mass densities. It is possible due to vortices of pure energy (it is the rotational energy carried by the neutrino-antineutrino pairs) which decrease local pressure in the Einstein spacetime. An increase in mass m of a vortex is equal to pure energy E of the vortex.

5.10

Ontology of Nature is as follows. The pieces of space exist. Between the pieces of space is the truly nothingness. There is only one category of existing things i.e. the pieces of space. When the pieces of space are moving (so colliding as well) we can say about living spacetime. Static spaces and nothingness are dead. Due to the succeeding phase transitions of the Higgs field there arise many various levels of Nature filled with different particles. There are the five basic levels of Nature [3A]. The third level that appears due to the two first phase transitions, concerns the Planck scale characteristic for the Einstein spacetime. The observed particles and dark-matter structures are built of the Einstein-spacetime components [3A], [3B]. Due to the phase transitions, there appear the phase spaces containing 10 (for the closed strings) and 26 (for the neutrinos) elements [3A]. It is not true that these numbers define dimensions of spacetime. Due to the viscosity of the space, each existing object consists of the bound moving pieces of space. It concerns the mental world as well [3C]. There dominates the classical and statistical determinism that follows from the structure of nucleons [3A]. But some war of the mental solitons of domination in our mind leads to the mental world and free will [3C].

5.11

There are valid following fundamental formulae and conclusions resulting from phase transitions of the non-gravitating superluminal Higgs field [3A].

Assume that a closed string is composed of K^2 adjoining tachyons (the square of the K means that calculations are far simpler). The stable objects created during the succeeding phase transitions of the Higgs field should contain K^2, K^4, K^8, K^{16} tachyons (the K^{16} tachyons is the upper limit that follows from the size of our Cosmos) – that saturates the interactions of stable objects via the Higgs field. The mass of the stable objects are directly proportional to the number of closed strings. This means that the stable objects contain the following number of closed strings: K^0, K^2, K^6, K^{14}, and means that the mass of the stable objects are directly proportional to $K^{2(d-1)}$, where $d=1$ for closed strings, $d=2$ for neutrinos which consist of the binary closed strings (the binary closed strings are the superluminal entanglons responsible for the quantum entanglement), $d=4$ for the cores of baryons which consist of the luminal neutrino-antineutrino pairs), and $d=8$ for cosmic objects which consist of the nucleons – they appeared after the inflation (it created the Cosmos) but before the 'soft' big bangs of the universes (in the Cosmos there are many universes). The cosmic objects defined by $d=8$ we will refer to as the protoworlds. The early Universe arose inside the Protoworld as the double cosmic loop. The evolution of the protoworlds leads to the dark matter, dark energy, and to the expanding universes.

Surface mass densities for all stable objects should have the same value. Furthermore, Nature immediately repairs any damages to stable objects – so they are the stable objects. We can see that the radii of the stable objects should be directly proportional to $K^{(d-1)}$.

The mean radii of the tori of stable objects are

$$r_d = r_1 K^{d-1}, \tag{1}$$

whereas the rest masses of the tori of the stable objects are

$$m_d = m_1 K^{2(d-1)}, \tag{2}$$

where r_1 and m_1 are for the closed string.

Properties of the pieces of space in our Universe cause that spin of the stable objects, i.e. of the stable bare fermions, is half-integral

$$m \, v \, r = \hbar / 2 = constant. \tag{3}$$

In a static system, formula (3) is the axiom but there are the other initial conditions that lead to a dynamic system. In the dynamic system, formula (3) is the theorem. The succeeding phase transitions of the fundamental spacetime are based on the half-integral-spin constancy.

The $v = c = 299,792,458$ m/s is characteristic for the Einstein-spacetime components. They are the neutrino-antineutrino pairs. In reality, the observed neutrino "oscillations" are the exchanges of the free neutrinos for the neutrinos in the Einstein-spacetime components. The quantum particles are the excitations of the Einstein spacetime. They appear due to spin polarization and flows of energy and mass in this spacetime. It is possible due to the superluminal entanglement characteristic for the luminal Einstein-spacetime components.

The bare fermions have internal helicity. Since the total internal helicity of the fundamental spacetime must be zero so the loops arise as the binary systems of loops in which the two components of a loop have opposite internal helicity and each component has half-integral spin. Such loops we can refer to as the loop-antiloop pairs. Such pairs are more stable when spin of such pairs is unitary. Such pairs can transform into fermion-antifermion pairs. Spin of the loop-antiloop pairs defines following formula

$$E_{pair}\, T_{lifetime} = \hbar = constant, \tag{4}$$

where E_{pair} is energy of a pair whereas $T_{lifetime}$ is the period of spinning. When we accelerate a baryon then its spin speed decreases so energy of produced vector loops by the baryon decreases as well. This means that running coupling for the strong interactions decreases when energy increases [3A].

The constancy of spin causes that there can appear many virtual vector loops or/and fermion-antifermion pairs that differ by energy and lifetime. This leads to the Uncertainty Principle. Due to the atom-like structure of baryons and different interactions, some energies and lifetimes dominate but due to the Uncertainty Principle, we can say about the central values only.

Since the pieces of space have linear and rotational energies so the bare fermions that arose due to the phase transitions of the fundamental spacetime, must have internal helicity. In left-handed vortices composed of the Einstein-spacetime components, production of neutrons was preferred because the neutrons have the left-handed internal helicity also. From such vortices can arise the protoworlds [3A], [3B]. The antiprotoworlds are built of the antineutrons. The Protoworld created the early Universe. The expansion of the early Universe started due to the phase transition of the core-of-Protoworld into new neutrino. Just the non-gravitating energy frozen inside each neutrino is equal to the gravitational mass of the core-of-Protoworld. The dark matter is the remnant of the core-of-Protoworld→neutrino phase transition. It is not true that in very high temperature there can appear a baryon-antibaryon asymmetry.

In very high temperatures as, for example, inside the baryons, there are the symmetrical decays of the virtual and real bosons. Due to the symmetrical decays of bosons created on equator of the core of baryons, there is valid the Titius-Bode law for the strong interactions

$$R_d = A + dB, \tag{5}$$

where A is the radius of the core and $d = 0, 1, 2, 4$ ($A / B = 1.3898$).

5.12

The Planck critical density $\rho_P = 5.15531 \cdot 10^{96}$ kg/m^3 is close to the ratio of the maximum rotational energy of the neutrino-antineutrino pair expressed in kg

$$m = E / c^2 = h \nu / c^2 \approx \hbar / (c\, r_{neutrino}) = 3.1451 \cdot 10^{-8} \text{ kg} \tag{6a}$$

to volume of the pair

$$V \approx 4\, \pi\, r_{neutrino}^{\,3} / 3 = 5.8605 \cdot 10^{-105} \text{ m}^3, \tag{6b}$$

i.e.

$$\rho_{P,Theory} = m / V = 5.367 \cdot 10^{96} \text{ kg/m}^3 . \tag{6c}$$

5.13

The two different arrangements of spins of the entangled neutrino-antineutrino pairs lead to both the charges of particles (spins are perpendicular to surface defined by quantum entanglement) and mental solitons (spins are aligned along line defined by quantum entanglement) [3C].

5.14

Why the Universe is flat? It follows from the fact that mass density of the two-component spacetime (the Higgs field plus the Einstein spacetime) is much higher than the observed energy/mass density of the Universe. The free tachyons have broken contact with the rest of Nature whereas the ground state of the Einstein spacetime is invariant – it causes that only some indirect observations lead to conclusion that there indeed is the two-component spacetime. Quantum entanglement and/or confinement of the neutrino-antineutrino pairs cause that there are produced the observed particles. There cannot be free motions of pure energy. The pure energy (i.e. the rotational energies), i.e. the photons and gluons are carried by the neutrino-antineutrino pairs that ground state is invariant so the ground state of the Einstein spacetime behaves as truly empty volume – it is the reason that theories assuming existence of massless photons and massless gluons act correctly.

5.15

Due to the very different properties of fields associated with Gravity (the non-gravitating superluminal Higgs field) and Standard-Model/Quantum-Physics (the luminal Einstein spacetime composed of the neutrino-antineutrino pairs), unification of these two basic theories within the same methods is impossible.

6. Summary

Infinite cosmos starts from two states of infinitesimal volumes: nothingness and moving fully-filled pieces of space. Both the nothingness and the interiors of fully-filled volumes are timeless.

Our cosmos arose due to inelastic collision of very big pieces of space composed of smaller pieces. During the inflation/superluminal-expansion, the inflation field (the liquid-like field composed of non-gravitating tachyons i.e. the Higgs field) partially transformed into the luminal Einstein spacetime composed of the neutrino-antineutrino pairs that define the Planck scale. The stable neutrinos are the smallest-gravitational-mass particles and they are the smallest Principle-of-Equivalence particles. Scales that are smaller than the Planck length are beyond the General Relativity and cannot be observed directly.

During the inflations there can appear some phase transitions. Some of such spacetimes can be surrounded by timeless space. Then, at the end of the inflations there are fixed some stable initial conditions concerning the created spacetimes. In some local cosmoses the pieces of space can be superluminal. They are the non-gravitating tachyons.

Our cosmos is surrounded by timeless space so the initial conditions are invariant. In our cosmos, the ratio of the sum of the volumes of the all tachyons (i.e. of the all free and bounded tachyons) to the volume of our cosmos is $X = 1.3245 \cdot 10^{-58}$.

The succeeding phase transitions of the non-gravitating Higgs field based on the half-integral-spin constancy and the Titius-Bode law for the strong interactions which follows from the symmetrical decays of bosons in very high temperatures, lead to origin of Nature [3]. There appear the physical constants and mathematical constants applied in physics. There appear psychology and particle physics and precursors of the DNAs. There appear the dark energy and dark matter. In our Cosmos can be many universes that look the same as our Universe. In our Cosmos, due to the expanding dark matter and dark energy, universes expand as well. In the region occupied by our Universe there could be many, many prior universes.

Gravitational fields are directly associated with the non-gravitating superluminal Higgs field whereas the Standard-Model fields are directly associated with the luminal Einstein spacetime composed of the neutrino-antineutrino pairs. The very different properties of these two fields cause that unification of the Quantum Physics and Gravity within the same methods is impossible. The fact that the Standard Model does not include gravity shows that we do not

understand the origin of Nature. Our incompetence concerns the internal structure and interactions of spacetime and bare fermions. Origin of the basic physical constants is as well associated with properties of spacetime and bare fermions. We know that the gauge theories follow from constancy of the charges. This means that within such theories we never will be able to describe origin of the charges. The lacking part of ultimate theory, i.e. the Scale-Symmetric Theory, solves all unsolved basic problems.

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