General Relativity in Quantum Physics and Chaos Theory

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Abstract: The Kasner solutions of the Einstein equations within the General Relativity, i.e. (0, 0, 1) and (2/3, 2/3, -1/3), concern the gravitationally massless superluminal entanglement of the Einstein-spacetime components. For entanglement are responsible the superluminal zero-helicity vector particles/entanglons. The new interpretation of the Einstein formula E = mcc leads to conclusion that Nature using the matter, i.e. the Einstein-spacetime components, "copies" the non-gravitational objects in bigger scales so there appear the cores of baryons, electrons and new cosmology. In such phase transitions appear the spinors applied in the Quantum Physics. The entanglons appeared during the inflation in the first phase transition of the modified Higgs field and both fields, i.e. the modified Higgs field and the field composed of the exchanged entanglons in some structure satisfy all initial conditions for the Kasner solutions. The Kasner solutions define many properties of the spinors. The Kasner solution (0, 0, 1) describes spinning loop composed of the exchanged entanglons that entangle the Einstein-spacetime components whereas the generalized Kasner solution (2/3, 2/3, -1/3) describes binary system of tori composed of the exchanged entanglons. The two tori have parallel spins and the directions of spin overlap but their internal helicities are opposite. We can partially unify the gravity and quantum physics via the Kasner solutions. The basic mathematical method applied in Quantum Physics, i.e. the action of some orthogonal groups on column vector that leads to the spin representations, is some generalization of action of matrix of rotation of a circle around the z-axis on circle on xy plane defined parametrically and written as a column – such action leads to the parametric equations for torus. The Kasner solutions as well lead to the holography. The symmetrical decays of multi-loops lead to the Theory of Chaos.

1. Introduction

I will prove that the modified Higgs field and field composed of exchanged superluminal binary systems of closed strings (i.e. entanglons) [1], [2], both satisfy the initial conditions for the partially symmetric both the Kasner solution (0, 0, 1) and generalized Kasner solution (2/3, 2/3, -1/3). I will try to show the physical meaning of both Kasner solutions. The generalized solution leads via the new interpretation of the Einstein formula $E = mc^2$ to many properties of binary systems of spinors whereas the Kasner solution leads to spinning loops composed of entangled Einstein-spacetime (Es) components [1], [2].

The massless photons and gluons are the non-gravitational rotational energies E = hν of the Es components. They can be entangled via entanglement of their carriers i.e. the Es components. The field responsible for the entanglement consists of the entanglons. Using the fundamental bricks of matter, i.e. the Es components, Nature "copies" at larger scales the non-gravitational structures composed of the entanglons (i.e. tori and loops) so there appear the cores of baryons, electrons and protoworlds that lead to the new cosmology [1]. Just there appear the phase transitions of the modified Higgs field [1]. The lower limit for range of entanglement (that leads to the most stable objects) of the Es components is 2π times greater than outer radius of the two components of any Es component.

The entangled structures composed of the Es components and the exchanged entanglons decrease local pressure of the Einstein spacetime so there are the inflows of the Es components. The mass of the additional Es components is the measured mass. In some vortex, the gravitationally massless energy E is equal to the measured mass mc^2 – such is the correct interpretation of the Einstein formula $E = mc^2$.

Emphasize that the Kasner solutions are for spacetime without matter so they concern the non-gravitational fields i.e. the modified Higgs field and the fields composed of the exchanged (between the Es components) the entanglons.

The Es components were produced during the inflation due to the Higgs mechanism [2].

We can partially unify the gravity and quantum physics via the Kasner solutions and the phase transitions of the modified Higgs field [1].

The symmetrical decays of multi-loops composed of 2^n loops, where n = 0, 1, 2, 3, …, lead to the Theory of Chaos.

2. The torus i.e. the ring torus possessing a single hole [3] (the single-holed ring torus)

Let the radius from the centre of the hole to the centre of the torus tube be *R*, and the radius of the tube be *r*. For a torus radially symmetric about the z-axis, in Cartesian coordinates is

$$\left(R - \sqrt{x^2 + y^2}\right)^2 + z^2 = r^2, \quad (1)$$

A physical torus is most stable for *R* = 2*r* [1].

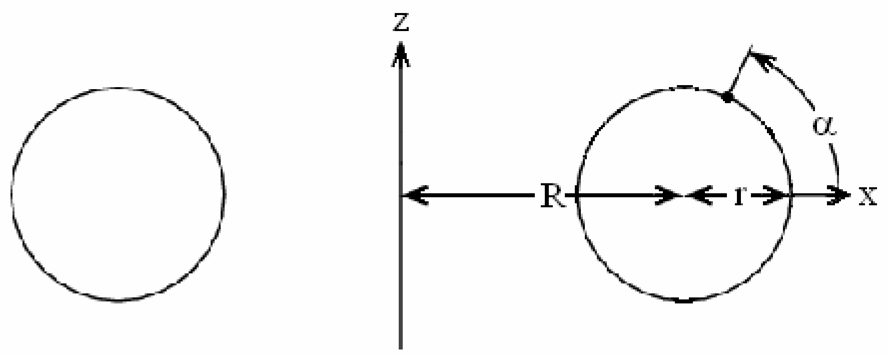
A torus can be defined parametrically by

$$x(\alpha, \beta) = (R + r \cos \alpha) \cos \beta,$$

$$y(\alpha, \beta) = (R + r \cos \alpha) \sin \beta,$$

$$z(\alpha, \beta) = r \sin \alpha,$$

where *R* (major radius) is the distance from the centre of the tube to the centre of the torus whereas *r* (minor radius) is the radius of the tube, β is the angle of rotation around the z-axis of a circle on the xy plane.



Define the inner I and outer/external/equatorial O radii of a torus
$I = R - r$,
$O = R + r$.
Define following "action"

$$\begin{bmatrix} \cos\beta & -\sin\beta & 0 \\ \sin\beta & \cos\beta & 0 \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} R + r\cos\alpha \\ 0 \\ r\sin\alpha \end{bmatrix} = \begin{bmatrix} (R + r\cos\alpha)\cos\beta \\ (R + r\cos\alpha)\sin\beta \\ r\sin\alpha \end{bmatrix} \qquad (2)$$

The matrix at the front of the above expression is the matrix of rotation around the z-axis. The three-component column in the middle represents a circle defined parametrically whereas the column on the right side represents a torus defined parametrically. We can say that the "action" of the matrix of rotation on a circle leads to the torus. It is some analogy to the generalized action of orthogonal groups on column vector that leads to the spin representations – it is the one of basic mathematical methods applied in the quantum physics. It suggests that internal structure of the spinors and circles/loops is associated with theory of tori. The same we can say about the generalized Kasner solution – it as well leads to shape and proportions of the fundamental spinor and some loop.

We can partially unify the gravity and the quantum physics via the Kasner solutions.

Formula (2) describes a left-handed torus. We will need some description of binary system of tori in which spins are parallel and their directions overlap whereas internal helicities are opposite. The angle β changes from 0 to 2π and the changes in β define spin of a torus and its spin/toroidal direction. Since spins are parallel so for both tori is $\Delta\beta > 0$. The changes in α angle define the chirality of a torus and its chiral/poloidal direction. Since the internal helicities, so the chiralities as well, are opposite so for the left-handed torus α changes from 0 to 2π whereas for the right-handed torus α changes from 2π to 0 i.e. there instead α is $2\pi - \alpha$ or $-\alpha$ i.e. $\Delta\alpha < 0$. This means that for right-handed torus is

$$x(-\alpha, \beta) = (R - r\cos\alpha)\cos\beta,$$

$$y(-\alpha, \beta) = (R - r\cos\alpha)\sin\beta,$$

$$z(-\alpha, \beta) = -r\sin\alpha.$$

The sum of the columns for the left-handed and right-handed tori is

$$x(\beta) = 2R\cos\beta,$$

$$y(\beta) = 2R\sin\beta,$$

$$z(\beta) = 0,$$

i.e. we obtain one circle on xy plane that radius is $2R = 4O/3$, where O is the equatorial/outer radius of the tori. If O defines radius of electron applied in quantum physics then the radius $4O/3$ is the radius of electron obtained in the classical theory of electrically charged particles. The obtained result $2R$ is for two overlapping tori. In reality, such situation is impossible i.e. in reality there is loop that is the binary system of entangled loops. The obtained solution suggests that then the loops have radius 2*O*/3 but it is in physics as well the wrong conclusion. The Es components in a loop have the spin speed equal to the speed of light. In the torus of electron such situation is only on its equator. This means that electron-positron pair arises from a binary system of loops and both have the same equatorial/external radii equal to *O*. Spin of the binary systems is unitary whereas of the components is half-integral. After annihilation of an electron-positron pair there appears the non-gravitational loop in which the Es components rotate but due to the Kasner solution, such loop can expand and at infinity the rotational energies disappear i.e. there is loop composed of the exchanged entanglons. The upper limit for the radius of such loop is the radius of our Cosmos [6]. We can see that information is coded on the surface of our Cosmos – it is the holography [7].

Emphasize that binary system of tori with parallel spins and opposite internal helicities (i.e. the zero-helicity vector object) can transform into spinning loop and vice versa.

3. Kasner solution, generalized Kasner solution and a generalization of the generalized Kasner solution

The Kasner metric [4] is an exact solution to Einstein's Theory of General Relativity (GR). It is for an anisotropic cosmos without matter so it is a vacuum solution i.e. solution for the gravitationally massless Higgs field and fields composed of the exchanged entanglons. The metric in D = 4-dimensional spacetime is

$$ds^2 = -dt^2 + t^{2a}\, dx^2 + t^{2b}\, dy^2 + t^{2c}\, dz^2, \qquad (3)$$

where *a*, *b* and *c* are the Kasner exponents. It describes spatially flat the equal-time slices. In different directions space is contracting or expanding at different rates defined by the Kasner exponents. If commoving coordinate differs, for example, by Δx for a test particle then the physical distance is $t^a\,\Delta x$.

Much more general solutions are obtained by a generalization of an exact particular solution derived by E. Kasner [4] for a field in vacuum, in which the space is homogeneous and has Euclidean metric that depends on time according to the Kasner metric

$$dl^2 = t^{2a}\, dx^2 + t^{2b}\, dy^2 + t^{2c}\, dz^2. \qquad (4)$$

The Kasner metric is an exact solution to Einstein's equations in vacuum if the Kasner exponents satisfy the following Kasner conditions

$$a + b + c = 1, \qquad (5a)$$

$$a^2 + b^2 + c^2 = 1. \qquad (5a)$$

The volume of the spatial slices always goes like *t*. I will show its physical meaning. There is

$$t = t^{a + b + c}. \qquad (6)$$

It suggests that time *t* splits into three factors.

Isotropic expansion or contraction is not allowed due to the lack of matter.

The Kasner solution is (a=0, b=0, c=1). If not, then at least one Kasner exponent must be always negative. If, for example, the time coordinate *t* to increase from zero then because the volume of space is increasing like *t*, at least one direction corresponding to the negative Kasner exponent must contract.

For following solution (0, 0, 1) the Ricci and Riemann tensors vanish so to describe internal structure of such object we need any extension of GR i.e. the Everlasting Theory.

The partially symmetric generalized Kasner solution is (2/3, 2/3, -1/3).

I will explain the physical meaning of partially symmetric both the Kasner solution (0, 0, 1) and the generalized Kasner solution (2/3, 2/3, -1/3). Two Kasner exponents among the three are the same only in these two sets of values.

Gravity is directly associated with the gradients produced in the modified Higgs field by masses [1]. The properties of the modified Higgs field satisfy both the sets of the initial conditions for the Kasner solution and the generalized solution [1], [2]. The gas composed of tachyons/pieces-of-space or the fields composed of the exchanged entanglons are gravitationally massless so they are free from matter. Anisotropy is local but it is enough to produce anisotropic objects. Of course, the global symmetry must be conserved. The pressures of the considered fields are very high (the tachyons and entanglons are the superluminal objects) so they are homogeneous and have Euclidean metrics. Moreover, they are practically flat (but can be curved) even if there is some distribution of masses.

Now I will prove that during the inflation the volume of the spatial slices for the considered fields went like time *t*.

In the General Theory of Relativity (GR) we apply formula for the total energy E of particles in the Einstein spacetime for which is obligatory the Principle of Equivalence i.e. mass M denotes both the inertial mass and gravitational mass.

Assume that the word ‘imaginary’ concerns physical quantities characteristic for objects that have broken contact with the wave function that describes state of the Universe. This means that such objects cannot emit some particles. Assume that the tachyons are the internally structureless objects, i.e. they are the pieces of space, so they cannot emit some objects. From this follows that the tachyons have only the inertial mass m. Substitute ic instead c, iv instead v and im instead M, where i = sqrt(–1). Then the formula for the total energy N of a gas composed of tachyons is:

$$N = -imc^2/\mathrm{sqrt}(1 - v^2/c^2) = mc^2/\mathrm{sqrt}(v^2/c^2 - 1). \quad (7)$$

We can see that the GR leads to the imaginary modified Higgs field composed of the tachyons. For v >> c we obtain

$$N = mc^3/v = mc^3/(s/t) \sim t. \quad (8)$$

We can see that energy of the modified Higgs field had increased during the inflation. It was possible only due to the inflows of energy to the expanding field. It was due to the initial collision of two very big pieces of space initially timeless. During the inflation, the energy density of the created cosmos was conserved

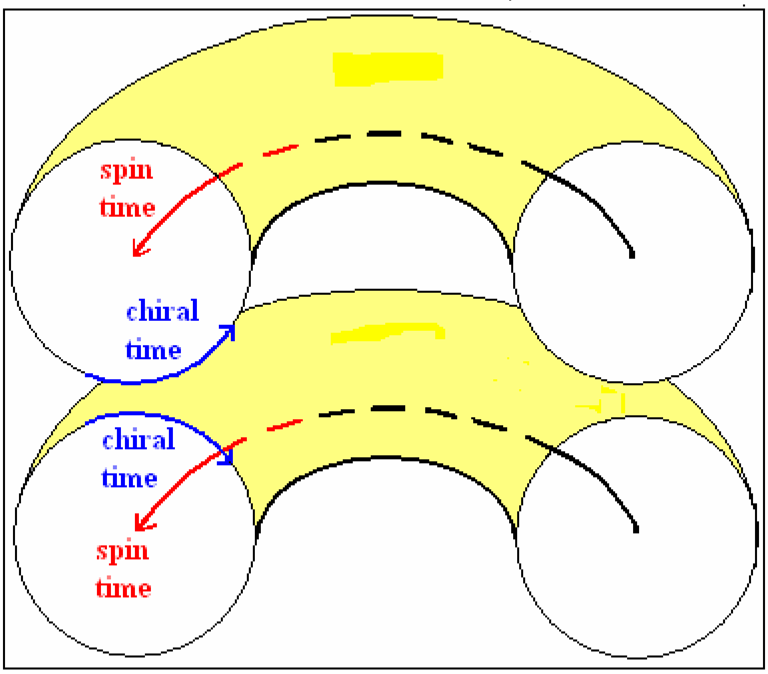
$$N/V = \mathrm{const.}, \quad (9)$$

i.e. energy density of the inertial mass only is independent on time. Since the energy N is directly proportional to time so during the inflation the volume of the spatial slices went like time *t*. It is the last conditions that must be satisfied the generalized Kasner solution could be valid

$$V \sim t. \tag{10}$$

Since for the exchanged entanglons is v >> c so formula (10) concerns the field composed of the exchanged entanglons as well. This means that both Kasner solutions concern some fundamental phase transitions of the modified Higgs field.

The formula (6) suggests that when the modified Higgs field or the field composed of the entanglons expand or contract then time *t* splits into three factors. There appear two symmetrical times. They can be the chiral times. There as well appears the third time which can be the spin time. The binary system on the figure is the zero-helicity vector particle which components have opposite internal helicities and the parallel spins that directions overlap.



The tori are the most stable objects for $R = 2r$. We can see that the poloidal circumferences associated with the chiral speeds is two times shorter than the toroidal circumference associated with the spin speed. Assume that a test particle is moving with the speed of light c and that unit of time is equal to period of spinning. Then, the two chiral units of time are two times shorter than the one spin unit of time i.e. the spin time is going two times slower than the chiral times. If we assume that the outer radii of the tori are unitary $O = R + r = 1$ then $R = 2/3$ whereas $r = 1/3$. This means that the Kasner exponents associated with the two chiral times are equal and are $a = b = 2/3$ whereas the third associated with the spin time is $c = –1/3$. The sign "–" follows from the fact that when a region of the considered field contracts then the unit of the spin time decreases (-) whereas the two units of the chiral times increases (+). It leads to following solution (2/3, 2/3, -1/3) that is the generalized Kasner solution.

Emphasize that when a region of the considered fields contracts then there arise the zero-helicity vector particles. Since the upper limit for speed in GR is the speed of light c so the obtained zero-helicity vector particles/spinors must be the Einstein-spacetime components. The Einstein-spacetime component is the essential component of the lacking part of ultimate theory i.e. the Everlasting Theory [1].

Nature "copies" the gravitationally massless objects using matter and then "copies" the gravitational objects at lager scales so there appear the bigger loops and the cores of baryons, the bare electrons and protoworlds that lead to the new cosmology [1]. Just there appear the phase transitions of the modified Higgs field [1].

Notice also that for expanding torus the poloidal directions disappear so we obtain (0, 0, 1). It is a spin loop.

We can see that there are possible following oscillations: binary-system-of-tori ←→ spin-loop. It is the reason why a loop can transform into electron-positron pair or into quark-antiquark pair and next, a pair into loop, and so on.

From the generalized Kasner solution we can decipher the shape and proportions of the Einstein-spacetime components but we cannot calculate the sizes and other physical quantities – it is possible within the Everlasting Theory. It is beyond the GR.

There some generalization of the generalized Kasner solution is possible.

The internal structure of the zero-helicity vector particles leads to additional two conditions. For the units of the chiral and spin times is

$$\Delta t^a/\Delta t^c = \Delta t^{2/3}/\Delta t^{-1/3} = \Delta t = 1/2, \tag{11a}$$

whereas for the chiral and spin times is

$$t^a/t^c = t^{2/3}/t^{-1/3} = t = 2. \tag{11b}$$

The condition (11a) gives $\Delta t^a = 0.62992$ and $\Delta t^c = 1.2599$.

The condition (11b) gives $t^a = 1.5874$ and $t^c = 0.79370$.

Only one of the four values is independent, for example the $t^c = 0.79370$. If radius of a homogeneous ball is 1 then the t^c is radius of ball that mass is two times smaller. This means that the $\Delta t = 1/2$ represents the symmetrical decays of particles when such decays are possible. Such symmetrical decays appear here [1] and lead to the Titius-Bode law for the strong interactions and, next, to the atom-like structure of baryons. The Titius-Bode law is as well characteristic for typical gravitational black holes [1]. On the other hand, the $t = 2$ represents a splitting/transformation of a loop into two tori – it leads to the bifurcation described within the Chaos Theory, for multi-loops that consist of 2^n loops, where n = 0, 1, 2, 3, …. The $t = 2$ can represents as well the period-doubling as r increases. We can see that the generalization of the generalized Kasner solution leads to the gravitational and quantum chaos.

An entangled non-gravitational loop from "infinity" (it is the edge of our Cosmos [6]) can produce binary system of tori and vice versa – it looks as holography.

Due to the finite maximum density of the pieces of space there do not appear any singularities.

Here [1] you can find many Chapters concerning the General Relativity, Theory of Chaos and Quantum Physics – these areas of knowledge follow from the succeeding phase transitions of the modified Higgs field described within the Everlasting Theory.

4. Summary

The generalized Kasner solution (2/3, 2/3, -1/3) leads via the new interpretation of the Einstein formula $E = mc^2$ to the zero-helicity vector particles applied in quantum physics – they are the Einstein-spacetime components. The Kasner solution (0, 0, 1) leads to a spinning

loop. The period of spinning and chiral period for a test particle moving, for example, with the speed of light c define the units of time associated respectively with the spin time and chiral time. For torus R = 2r, the chiral time associated with the radius r is going two times faster than the spin time associated with the radius R. Such binary system of tori with parallel and overlapping directions of spins and antiparallel internal helicities of the components is the essential component of the lacking part of ultimate theory i.e. the Everlasting Theory described here [1], [2], and the other 17 papers [5]. Nature copies the non-gravitational objects using matter and next copies the gravitational objects in bigger scales as well so there appear the core of baryons, bare electrons and new cosmology.

The lacking part of ultimate theory is based on two fundamental axioms [1]. There are the phase transitions of the fundamental spacetime composed of the superluminal and gravitationally massless pieces of space (tachyons). The phase transitions follow from the saturated interactions of the tachyons and lead to the superluminal binary systems of closed strings (entanglons) responsible for the entanglement, lead to the binary systems of neutrinos i.e. to the Einstein-spacetime components, to the cores of baryons and to the cosmic objects (protoworlds) that appeared after the era of inflation but before the observed expansion of our Universe. The second axiom follows from the symmetrical decays of bosons that appear on the surface of the spinor/core of baryons. It leads to the Titius-Bode law for the strong interactions i.e. to the atom-like structure of baryons. The two first phase transitions are associated with the Higgs mechanism that leads from the modified non-gravitational Higgs field to the Principle of Equivalence and the initial conditions applied in the General Theory of Relativity (GR). The three first phase transitions concern the particle physics whereas the structure and evolution of the most sophisticated spinor, i.e. the cosmic spinor/object, defined by the four phase transitions leads to the new cosmology.

The basic mathematical method applied in Quantum Physics, i.e. the action of some orthogonal group on column vector that leads to the spin representations, is some generalization of action of matrix of rotation of a circle around the z-axis on circle on xy plane, defined parametrically and written as a column – such action leads to the parametric equations for torus.

The generalization of the generalized Kasner solution leads to the Theory of Chaos.

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