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THE A-TEMPORAL COSMIC SPACE AND A GENERALIZATION OF THE DIRAC EQUATION

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Abstract

A model describing an a-temporal space-gravity endowed with a quantum wave structure is proposed. In this model the most fundamental physical quantities are the density of cosmic space (physical quantity which depends on the amount of matter present in the region into consideration), the electric density of space (physical quantity which indicates the amount of charge present in the region into consideration) and a quantum number indicating a sort of "rotation-orientation" of each point of space. A mathematical formalism regarding the wave function of quantum-gravity space is developed, which is based on a generalized Fiscaletti-Dirac equation for the density of cosmic space. A generalized Fiscaletti-Dirac equation for the density of cosmic space coupled with electromagnetic interaction is also introduced.

1. Introduction

At the beginning of the new millennium, a certain conceptual confusion is evident in different physical theories, models and ideas (for example relativity theories, standard model, quantum gravity, nature of space, time and mass and sense of higher space dimensions, to name a few). It is true that quantum mechanics and general relativity, the two fundamental XX century physical theories, have obtained huge success from the predictive point of view but it is also true that they provide a picture of the world which is somewhat incomplete and fragmented. The most important challenge in today's fundamental physics is to find a coherent and satisfactory unification of these theories and thus to incorporate consistently gravity in the quantum mechanical scheme.

As regards the challenge of quantum gravity, in order to complete the revolution opened by general relativity and quantum mechanics, loop quantum gravity predicts that at the most fundamental level physical space has a granular structure, namely is composed by elementary grains, a net of intersecting loops (also defined spin elements or "spin networks" because their quantum numbers and their algebra look like the spin angular momentum numbers of elementary particles) having the Planck size [1,2]. On the ground of the results of loop quantum gravity, nodes of spin networks represent the elementary grains of space, and their volume is given by a quantum number that is associated with the node in units of the elementary Planck volume, $V = \left(\eta G / c^3\right)^{3/2}$, where η is Planck's reduced-constant, G is the universal gravitation constant and c is the speed of light.

In this article, following the philosophy of loop quantum gravity, we want to suggest a new view, a new physical model which starts from the idea that gravity-space is a-temporal (in the sense that time exists only as a stream of material movements and changes) and is characterized by a quantum wave and granular structure. The central idea suggested by this model is that physical universe can be described by introducing a fundamental level of description, which can be called "quantum-gravity space", which is a gravitational space that exhibits wave structure and granular structure. In particular, in this model each region of space can be characterized by a wave function which depends on two fundamental quantities: the density of cosmic space (which is linked to the amount of matter present in the region under consideration) and a quantum number indicating a sort of "rotation-orientation" of each point of space. We will show that this wave function satisfy a fundamental generalization of the Dirac equation for the density of cosmic space and that the standard Dirac equation of quantum theory can be obtained from this generalized Dirac equation in a particular case. We will analyze also the situation in which the density of cosmic space is coupled with an electromagnetic interaction by introducing a generalized Dirac equation for the density of cosmic space with electromagnetic interaction.

2. The density of cosmic space and the gravitational interaction, the electric density of space and the electrostatic interaction

On the basis of elementary perception, the passing of the time cannot be perceived directly as matter and space; we can perceive only the irreversible changes of matter in space. Time cannot be considered a "real" physical entity: it has not an autonomous existence but exists only as a stream of irreversible material changes happening in an a-temporal space. It is permissible to assume, on the ground of our elementary perception, that change does not run in time, but change itself is time. Time means change (movement) and, therefore, when there is no change there is no time. Clocks run in a-temporal space. With clocks we measure the duration and the numerical order of all changes [3].

Phenomena run in space-time only in the mathematical models of reality, which sometimes become more real than reality itself, which instead – on the ground of our elementary perception – turns out to be a-temporal. The stage in which natural phenomena happen is not space-time but is an a-temporal space. This is an alternative, different point of view from that conventionally adopted in physics, but is perhaps more correct and appropriate because is more coherent with experimental facts (i.e. with the fact that there is no evidence that material objects move in time) [4].

Starting from the idea that space is a-temporal, interesting perspectives are opened in theoretical physics. In particular, in a-temporal physical space the fundamental interactions and physical fields can be interpreted as special states of space under certain circumstances, can be seen as entities which derive from real properties of space [5].

If time exists only as a stream of irreversible material changes happening in space, we are presented with the possibility to provide a new, a-temporal interpretation of gravitational interaction. According to this interpretation, gravitational interaction is immediate in the sense that acts instantly through the density of cosmic space. Moreover, gravitational force is a-temporal: no movement of particle-wave is needed for its acting. Gravity is transmitted by the density of cosmic space existing in each point of space.

The density of cosmic space can be considered the fundamental physical property which characterizes universal space. It depends on the amount of matter present in the region into consideration. The density of cosmic space associated with a material object of mass *m* in the points situated at distance *r* from the centre of this object is defined by the relation $D(r) = \frac{Gm}{r^2}$ (1) where *G* is gravitational constant.

While in the Newtonian view the source of the gravitational field is mass, in this model we suggest the idea that the gravitational field in each point of space is a property that depends on the density of cosmic space existing in that point. It is the density of cosmic space (1) that determines the appearance of a gravitational field in each point of space. Introducing the concept of the density of cosmic space associated with a given mass *m* on the basis of relation $D(r)=\frac{Gm}{r^2}$ (1), the gravitational field associated with that density of cosmic space in the points situated at distance *r* from its centre assumes the form $\vec{g}=D(r)\hat{r}$ (2). Equation (2) shows that the gravitational field derives directly from the density of cosmic space characterizing a given point.

The fundamental ideas of the approach here suggested can be also expressed in the following way. We can say that if a region of space is characterized by a density of cosmic space given by (1) in the points situated at distance *r* from a given point P, this means that in the region there is a material object of mass *m* and that the point P is the centre of this material object. It is the density of cosmic space (1) that determines the appearance of a material object in a given region of space. In other words, considering a certain region of space, the mass of a particle can be seen as the “portion” of that region where the density of cosmic space is bigger. This view allows us to interpret mass as a quantity which is not much different from space, as a consequence of a property of cosmic space, namely its density.

Newton’s gravitational attraction between two masses m_1 and m_2 (situated at distance *r*) can be seen as a consequence of a more fundamental attraction of two points of space characterized by a different density of cosmic space. In fact, if $D_1(r_1)=\frac{Gm_1}{r_1^2}$ (3) is the density of cosmic space associated with a material object of mass m_1 in a given point of space situated at distance r_1 from its centre, $D_2(r_2)=\frac{Gm_2}{r_2^2}$ (4) is the density of cosmic space associated with a material object of mass m_2 in a given point of space situated at distance r_2 from its centre, *r* is the distance between these two particular points, we can write: $\vec{F}_g=\frac{D_1(r_1)\cdot D_2(r_2)\cdot r_1^2\cdot r_2^2}{Gr^2}\hat{r}$ (5) which represents the general law of interaction between these two densities of cosmic space (the one associated with the mass m_1, the other associated with the mass m_2). Taking into account relations (3) and (4), equation (5) turns out to be completely compatible with equation $\vec{F}_g=G\frac{m_1\cdot m_2}{r^2}\hat{r}$ (6) which is Newton’s law of gravitational interaction written in the standard form.

We can say that, introducing the density of cosmic space, Newton’s law (6) can be considered as a particular case of a more general equation, the equation (5), which describes the interaction between two densities of cosmic space, the one associated with the mass m_1, the other associated with the mass m_2. The a-temporal model of gravitation interaction here proposed opens therefore this important perspective in theoretical physics: two points of space characterized by a different density of cosmic space attract each other and this concerns all the points of space satisfying this condition. And the following interpretation of masses’ interaction derives: the material objects move in the direction where the density of cosmic space is increasing.

In other words, a-temporal physical space can be seen as an elastic medium which has a tendency to shrink. The more medium is dense, the stronger the force of shrinking. The force of shrinking is the gravitational force[6]. According to the model here proposed, areas of lower density have a tendency to move towards areas of higher density. This is the reason why objects with lower mass have a tendency to move towards objects with bigger mass.

If the density of cosmic space is the most universal physical property of a-temporal space, there is however also another important physical property, which can be considered fundamental, namely the electric density of space. The electric density of space is the physical quantity, which indicates the amount of charge characterizing the region of space into consideration and therefore which indicates the electric properties of a given region of physical space. If we have a charged particle, still in a given point of space, this charge determines a modification in the properties of a-temporal cosmic space, concerning in particular the trajectories of other charged particles situated in that region. In particular, the electric density of space associated to a charge *q* in the points situated at distance *r* from its centre can be defined through the relation $D_e(r) = \frac{Kq}{l_p^3 r^2}$ (7), where $K = \frac{1}{4\pi\varepsilon_0}$ is the constant indicating the strength of the electric force (with ε_0 being the dielectric constant of the vacuum), *r* is the distance from the central quantum of space. If a region of space is characterized by an electric density of space given by relation (7), this means that in this region there is a particle of charge *q*[7]. Taking into consideration its physical dimensions, the electric density of space can be interpreted as a measure of the electric field for unit of volume, namely for Planck volume l_p^3.

Introducing the concept of the electric density of space, we can say that each point of a given region endowed with the electric density of space (7) presents an electrostatic field as a consequence of this electric density of space. In particular, the electrostatic field due to an electric density of space in a given point at distance *r* from the centre of this electric density can be expressed in the following way $\vec{E} = l_p^3 D_e(r)\hat{r}$ (8). Equation (8) shows clearly that the electric field is a property of space depending on the value of the electric density of space characterizing that point. We can say therefore that the source of the electric field is not properly the electric charge but the electric density of space. If mass can be seen as a structure of space deriving from the density of cosmic space, in a similar way charge can be seen as a property of space deriving from the electric density of space. It is the electric density of space (7) that determines the appearance of a charged particle in a given region of space. In other words, considering a certain region of space, a charge can be seen as the "portion" of that region where an opportune electric density of space assumes its maximum value.

In the classical domain the electrostatic force acting between two charges q_1 and q_2 (situated at distance *r*) can be seen as a consequence of a more fundamental interaction between two points of space characterized by a different electric density of space. In fact, if $D_{e1}(r_1) = \frac{Kq_1}{l_p^3 r_1^2}$ is the density of cosmic space associated with a particle of charge q_1 in a given point of space situated at distance r_1 from its centre, $D_{e2}(r_2) = \frac{Kq_2}{l_p^3 r_2^2}$ is the electric density of space associated with a particle of charge q_2 in a given point of space situated at distance r_2 from its centre, *r* is the distance between these two particular points of space, we can write: $\vec{F}_e = \frac{D_{e1}(r_1)\cdot D_{e2}(r_2)\cdot r_1^2 \cdot r_2^2 \cdot l_p^6}{Kr^2}\hat{r}$ (9) which represents the general law of interaction between two electric densities of cosmic space (the one associated with the charge q_1, the other associated with the charge q_2). Equation (9) establishes that electrostatic force acts between regions of space endowed with different electric densities of space.

It is important to observe that, taking into account the definition of the electric density of space (7), Coulomb's law $\vec{F}_e = K\frac{q_1 \cdot q_2}{r^2}\hat{r}$ (10) is perfectly equivalent to equation (9). We can therefore conclude that, introducing the concept of the electric density of space, Coulomb's law (10) can be considered as a particular case of a more general equation, the equation (9), which describes the interaction between two electric densities of space. We are presented therefore with this interesting perspective: two points of space characterized by a different electric density of space interact each other and this concerns all the pairs of points of space satisfying this condition. And the following interpretation of electrostatic interaction derives: as each point of space is characterized by the property of the electric density of space, not only the centres of the charged particles move but also all the other points move according to equation (9).

3. A-temporal gravitodynamics: the wave function of quantum-gravity space and the Fiscaletti-Dirac equation for the density of cosmic space

Several authors have taken into consideration the possibility that space is endowed with gravito/magnetic properties. In particular, in some recent articles[8,9] Turanyanin proposed the idea of a gravity-space phenomenon characterized by a non linear wave dynamics in which the wave function describing the state of space is expressed in terms of two fields, the gravitostatic/electric field $\vec{E}_g = \frac{G}{c^2}\frac{M}{r^2}\hat{r}$ (11) (having physical dimensions of a wave vector, l^{-1}) and the gravitokinetic/magnetic field $\vec{B}_g = \frac{G}{c^2}\frac{\vec{J}}{r^3}$ (12) (having physical dimensions of a frequency, t^{-1}) where $\vec{J} = \vec{L} + \vec{S}$, $\vec{L} = \vec{r} \times M\vec{v}$ is the orbital angular momentum of the source, *M* is the source mass, $\vec{S}$ is the spin angular momentum of the source.

Drawing a starting point from these results, we want to suggest now a new view of a physical space, endowed with a wave structure and in which time exists only as an irreversible motion of matter. According to this interpretation, the most fundamental physical quantities describing space are the density of cosmic space (1) and a quantum vector $\vec{j}$ defined as $\vec{j} = \frac{G\vec{S}}{r^3}$ (13) and therefore having the dimensions of an angular momentum for unit of volume and multiplied with the gravitation universal constant. This quantum vector $\vec{j}$ can be therefore considered as a sort of "rotation-orientation" of each point of space. The quantum number *j* multiplied for r^3/G can assume integer or half-integer multiple values of the Planck reduced constant in order to assure consistency with the results of standard quantum mechanics. We will say thus that each point of space is characterized by a determinate value of the density of cosmic space and is endowed with a particular rotation-orientation linked to a particular value of the quantum number *j* which can assume integer of half integer multiple values of $\frac{\hbar G}{r^3}$.

In analogy with the proposal of Turanyanin, in the theory here suggested space is described in terms of two fields: the gravistostatic/electric field defined on the basis of the relation $\vec{E}_g = \frac{D(r)}{c^2}\hat{r}$ (14) (which is completely compatible with (13)) and the gravitokinetic/magnetic field defined on the basis of the relation $\vec{B}_g = \frac{D(r)\cdot v\cdot sen\vartheta}{c^2}\hat{b} + \frac{\vec{j}}{c^2}$ (15) where ϑ is the angle between $\vec{r}$ and $\vec{v}$, $\hat{b}$ is an unitary vector identifying direction and versus of $\vec{L} = \vec{r}\times m\vec{v}$, *m* being the mass of the particle associated with the density of cosmic space *D*(*r*). The modulus of $\vec{B}_g$ is $B_g = \frac{1}{c^2}\sqrt{(D(r))^2\cdot v^2\cdot sen^2\vartheta + j^2 + 2D(r)\cdot v\cdot sen\vartheta\cdot j\cdot\cos\eta}$ (16) where η is the angle between $\hat{b}$ and $\vec{j}$. It is important to observe that the gravitostatic/electric field and the gravitokinetic/magnetic field here defined have the physical dimensions of a wave vector and a frequency respectively. It appears thus legitimate to introduce the wave function of space $\psi_S = A\exp\left[2\pi i\left(\frac{D(r)}{c^2}\hat{r}\cdot\vec{r}_0 - \frac{1}{c^2}\sqrt{(D(r))^2\cdot v^2\cdot sen^2\vartheta + j^2 + 2D(r)\cdot v\cdot sen\vartheta\cdot j\cdot\cos\eta}\cdot t + \varphi_0\right)\right]$ (17) where the amplitude *A* is a function of the point (*x*,*y*,*z*) of space. Since the density of cosmic space is the universal physical property of space, *A* will depend in general on the density of cosmic space and the speed of the particle determined by this density of cosmic space. The wave function (17) of quantum-gravity space can be considered the starting-point of an a-temporal interpretation of the universe, in which time exists only as motion of matter. In fact, for *v*=0 and *j*=0 (conditions which mean no motion), one can easily see that this wave function assumes the form $\psi_S = A\exp\left[2\pi i\left(\frac{D(r)}{c^2}\hat{r}\cdot\vec{r}_0 + \varphi_0\right)\right]$ (18) namely turns out to be independent from time: this means just that when there is no motion there is no time.

Now we want to analyze the particular case $j = \frac{1}{2}\frac{G}{r^3}$ and develop a mathematical formalism for this. Since $j = \frac{1}{2}\frac{G}{r^3}$ corresponds to the appearance of a particle of spin ½, one can introduce in this case the idea of a general wave function of quantum-gravity space ψ_S satisfying a Dirac-type equation for the density of cosmic space $\left(i\gamma^\mu\partial_\mu - \frac{D(r)}{c^2}\right)\psi_S = 0$ (19) where $x = (x^0, x^1, x^2, x^3) = (t, \vec{x})$ and γ_μ are the well-known relativistic matrices $\gamma^0 = 1\otimes\begin{pmatrix}1 & 0\\ 0 & -1\end{pmatrix}$, $\gamma^i = \sigma_i\otimes\begin{pmatrix}0 & 1\\ -1 & 0\end{pmatrix}$ (and $\vec{\sigma}$ are the Pauli matrices which are linked to $\vec{j}$ through the relation $\vec{j} = \frac{1}{2}G\eta\frac{\vec{\sigma}}{r^3}$)[10]. Equation (19) can be considered the equation which describes a region of space characterized by a density of cosmic space which determines the presence of a particle of spin ½, without electromagnetic interaction (namely in which the density of cosmic space is not coupled with an electromagnetic interaction). The general solution of equation (19) can be expressed as $\psi_S(x) = \psi_S^{(P)}(x) + \psi_S^{(A)}(x)$ (20) where $\psi_S^{(P)}(x)$ represents the wave function of space associated with the appearance of particles of spin ½ and $\psi_S^{(A)}(x)$ represents the wave function of space associated with the appearance of the corresponding antiparticles. These two set of wave functions of space can be expanded as $\psi_S^{(P)}(x) = \sum_k b_k u_k(x)$ (21),

$\psi_S^{(A)}(x)=\sum_k d_k^* v_k(x)$ (22) respectively[11,12,13]. Here u_k are positive-frequency 4-spinors of space while v_k are negative frequency 4-spinors of space; they together form a complete set of orthonormal solutions to (19). The label *k* is an abbreviation for the set $(\vec{k}, j)$ where $\vec{k}$ is the 3-momentum $\vec{k}=(p_1,p_2,p_3)$ and $j=\frac{Gs}{r^3}$ with $s=\frac{1}{2}$, is the label of the rotation-orientation of the generic point of space at distance *r* from the centre of the density of cosmic space $D(r)$ (namely where $D(r)$ assumes its maximum value). As regards the expressions of u_k and v_k, equation (19) leads to the following results: $u=W^z(\vec{k})\exp\left[-\frac{i}{\hbar}p_\mu x^\mu\right]$ (23) with z=1,2 and $v=W^z(\vec{k})\exp\left[\frac{i}{\hbar}p_\mu x^\mu\right]$ (24) with z=3,4, where $p_0=\frac{\hbar D(r)}{c}$ and

$$W^1=\frac{cE+\hbar D(r)}{c}\begin{bmatrix}1\\0\\\frac{p_3c}{cE+\hbar D(r)}\\\frac{(p_1+ip_2)c}{cE+\hbar D(r)}\end{bmatrix} \quad (25),$$

$$W^2=\frac{cE+\hbar D(r)}{c}\begin{bmatrix}0\\1\\\frac{(p_1-ip_2)c}{cE+\hbar D(r)}\\\frac{-p_3c}{cE+\hbar D(r)}\end{bmatrix} \quad (26),$$

$$W^3=\frac{cE+\hbar D(r)}{c}\begin{bmatrix}\frac{p_3c}{cE+\hbar D(r)}\\\frac{(p_1+ip_2)c}{cE+\hbar D(r)}\\1\\0\end{bmatrix} \quad (27),$$

$$W^4=\frac{cE+\hbar D(r)}{c}\begin{bmatrix}\frac{(p_1-ip_2)c}{cE+\hbar D(r)}\\\frac{-p_3c}{cE+\hbar D(r)}\\0\\1\end{bmatrix} \quad (28).$$

where *E* is the energy of the particle associated with the density of cosmic space $D(r)$.

Now, by introducing the quantities $\Omega^{(P)}(x,x^I)=\sum_k u_k(x)u_k^+(x^I)$ (29), $\Omega^{(A)}(x,x^I)=\sum_k v_k(x)v_k^+(x^I)$ (30), one can obtain $\psi_S^{(P)}(x)$ and $\psi_S^{(A)}(x)$ from ψ_S using $\psi_S^{(P)}(x)=\int d^3x^I\Omega^{(P)}(x,x^I)\psi_S(x^I)$ (31) and $\psi_S^{(A)}(x)=\int d^3x^I\Omega^{(A)}(x,x^I)\psi_S(x^I)$ (32) where $t=t^I$. One can also introduce the particle and antiparticle currents associated respectively with the particle wave of space $\psi_S^{(P)}(x)$ and the antiparticle wave of space $\psi_S^{(A)}(x)$ defined as $J_\mu^{(P)} = \overline{\psi}_S^{(P)}\gamma_\mu\psi_S^{(P)}$, $J_\mu^{(A)} = \overline{\psi}_S^{(A)}\gamma_\mu\psi_S^{(A)}$, where $\overline{\psi} = \psi^+\gamma_0$. Since $\psi_S^{(P)}(x)$ and $\psi_S^{(A)}(x)$ separately satisfies the Dirac-type equation (19), the currents $J_\mu^{(P)}$ and $J_\mu^{(A)}$ are separately conserved $\partial^\mu J_\mu^{(P)} = \partial^\mu J_\mu^{(A)} = 0$ (33). Therefore, one can introduce the idea of trajectories of particles and antiparticles which derive from $\psi_S^{(P)}(x)$ and $\psi_S^{(A)}(x)$ on the basis of the equations: $\frac{d\vec{x}^{(P)}}{dt} = \frac{\vec{J}^{(P)}(t,\vec{x}^{(P)})}{J_0^{(P)}(t,\vec{x}^{(P)})}$ (34), $\frac{d\vec{x}^{(A)}}{dt} = \frac{\vec{J}^{(A)}(t,\vec{x}^{(A)})}{J_0^{(A)}(t,\vec{x}^{(A)})}$ (35) respectively, where $\vec{J} = (J^1, J^2, J^3)$.

It is also interesting to observe that the well-known Dirac equation for relativistic particles of spin ½ of standard quantum theory $\left(i\gamma^\mu\partial_\mu - \frac{mc}{\hbar}\right)\psi = 0$ (36) can be seen as a particular case of the equation (19). In fact, equation (36) can be directly obtained from (19) in the condition $\frac{mc}{\hbar} = \frac{D(r)}{c^2}$ namely $D(r) = \frac{mc^3}{\hbar}$ that is $r^2 = l_p^{\,2}$ and, in correspondence, the wave functions (23) and (24) become the standard 4-spinors which are solutions of the standard Dirac equation of the standard quantum theory for particles. This consideration allows us to open the following important perspective: equation (36) can be interpreted as the equation of the density of cosmic space for the particular points of space situated at distance $r = l_p$ from the centre of the density of cosmic space into consideration. In other words, the standard wave functions of Dirac particles can be seen as particular cases of more general wave functions of quantum-gravity space for the particular points situated at distance $r = l_p$ from the centre of the density of cosmic space into consideration. We are therefore presented with the possibility that equation (19) can be considered as a more fundamental equation than the standard Dirac equation (36): we can call equation (19) as the generalized Dirac equation for the wave function of quantum-gravity space without electromagnetic interaction or the Fiscaletti-Dirac equation without electromagnetic interaction.

Finally, let us consider now a region of space characterized by a density of cosmic space which determines the presence of a particle of spin ½ which is subjected to an electromagnetic interaction, namely a region of space in which the density of cosmic space is coupled with electromagnetic interaction. In this case, we can introduce the idea of a wave function of quantum-gravity space ψ_S satisfying a generalized Dirac-type equation for the density of cosmic space with electromagnetic interaction $\left(i\gamma^\mu\partial_\mu - \frac{D_e(r)l_p^{\,3}G}{Kc^4}A_\mu - \frac{D(r)}{c^2}\right)\psi_S = 0$ (37) where $D_e(r)$ is the electric density of space, *K* is the electrostatic constant, A_μ is the electromagnetic potential. The well known Dirac equation for relativistic particles of spin ½ with electromagnetic interaction $\left(i\gamma^\mu\partial_\mu - \frac{q}{c\hbar}A_\mu - \frac{mc}{\hbar}\right)\psi = 0$ (38) can be seen as a particular case of the equation (33). In fact, equation (38) can be directly obtained from (37) in the conditions $\frac{q}{c\hbar} = \frac{D_e(r)l_p^{\,3}G}{Kc^4}$ (namely $D_e(r) = \frac{Kqc^3}{\hbar G l_p^{\,3}}$) and $\frac{mc}{\hbar} = \frac{D(r)}{c^2}$ (namely $D(r) = \frac{mc^3}{\hbar}$) which together correspond to the condition $r^2 = l_p^{\,2}$. This consideration allows us to open the following important perspective: equation (38) can be interpreted as the equation of the density of cosmic space coupled with electric density of space and electromagnetic interaction for the particular points of space situated at distance $r = l_p$ from the centre of the density of cosmic space and the electric density of space into consideration. This implies also that the standard wave functions of Dirac particles with electromagnetic interaction can be seen as particular cases of more general wave functions of quantum-gravity space coupled with electromagnetic interaction for the particular points situated at distance $r = l_p$ from the centre of the density of cosmic space and the electric density of space into consideration. We are therefore presented with the possibility that equation (38) can be considered as a more fundamental equation than the standard Dirac equation (55): we can call equation (38) as the generalized Dirac equation for the wave function of quantum-gravity space with electromagnetic interaction or the Fiscaletti-Dirac equation with electromagnetic interaction. The possibility is opened that the Fiscaletti-Dirac equation with electromagnetic interaction (37) can be resolved, analogously to the corresponding standard Dirac equation of quantum theory, by introducing a Feynman propagator inside a perturbative method with respect to the electric density of space (7). In absence of the electric density of space we have the wave functions of quantum-gravity space without electromagnetic interaction, solutions to the Fiscaletti-Dirac equation (1) (these solutions, on the basis of this perturbative treatment, can be interpreted as approximations at the zeroth order of the solutions to the Fiscaletti-Dirac equation with electromagnetic interaction (37)). When the electric density of space is present and is lead to its physical value, we have the solutions to the Fiscaletti-Dirac equation for the density of cosmic space with electromagnetic interaction (37) at the first order. About the solutions of the Fiscaletti-Dirac equation with electromagnetic interaction (37) and their consequences, further research will give you more information.

4. Conclusions

Starting from the idea that physical space is a-temporal in the sense that time exists only as motion of matter and introducing the concepts of the density of cosmic space, the electric density of space and of the "rotation-orientation" of each point of space, a new view of quantum-gravity space arises. In this view space can be described in terms of two fields, the gravitostatic field and the gravitokinetic field, which are defined in terms of the density of cosmic space and of the rotation-orientation of each point of space. In virtue of the nature of these fields, a wave function of gravity-space and therefore the idea of a wave quantum-gravity space can be introduced. In the particular case $j = \frac{1}{2}\frac{G}{r^3}$ (which corresponds to the appearance of a particle of spin ½) generalized Fiscaletti-Dirac equations for the density of cosmic space both without electromagnetic interaction (and therefore without the coupling with an electric density of space) and with electromagnetic interaction (and thus with the coupling of an electric density of space) have been introduced. The well known Dirac equations without electromagnetic interaction and with electromagnetic interaction for elementary particles of standard quantum theory can be seen as special cases of the generalized Fiscaletti-Dirac equations for the density of cosmic space without electromagnetic interaction and with electromagnetic interaction respectively. The link between the standard Dirac equations without electromagnetic interaction and with electromagnetic interaction for elementary particles and the generalized Fiscaletti-Dirac equations for the density of cosmic space without electromagnetic interaction and with electromagnetic interaction has the important consequence that physical space turns out to be not indefinitely divisible, but to have a minimal size equal to Planck length. In this way, the model here suggested provides an important justification of the fact that, in a certain sense, the idea of a wave structure of space must not be considered incompatible with the idea of a granular structure of space. In sum, the interpretation of quantum-gravity space proposed in this article can be considered the starting-point of a modification in the 20th century field-geometry paradigm towards a real granular-wave-dynamic picture and deeply holistic view of the universe.

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