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The Medium for Motion: A Critical Clue to Understand Spacetime

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Abstract

Spacetime and motion are interconnected concepts. A better understanding of motion leads to a better understanding of spacetime. We use the historical critical analysis of the various theoretic proposals on motion in search of clues ignored. The prediction of the general relativity that the motion occurs in the static gravitational field is not valid because the motion always occurs in a given medium as vacuum, atmosphere, water, etc. The concept of motion and the equations of the special and general relativity, as the theory of Galilee-Newton reduce motion elements to particle and spacetime. In this paper, we present the medium (in special, the quantum vacuum), as the third essential element of motion, inseparable of spacetime since it is its material support of which the spacetime is its structural form, and we analyse its consequences in the theories of spacetime. Our contribution is declare, that the spacetime itself does not exist, or is a relational property of matter, but a structural property of matter.

Keywords

Motion, Medium, Spacetime

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1. Introduction

Natural philosophers have struggled to comprehend the nature of three tightly interconnected concepts: space, time, and motion. A proper understanding of motion, in particular, has been seen to be crucial for deciding questions about the natures of space and time, and their interconnections. (Huggett and Hoefer, 2009) [1].

What is spacetime? Is there spacetime absolutely empty? Is there spacetime filled of a substance and independent of matter-energy? Or is there spacetime as a relational quality of matter-energy?

From ancient times, there are answers given by philosophy, philosophy of science and metaphysics, about the nature of space-time, while no there is an answer given for the science of physics. The most common answer is that spacetime is container of any existing thing and its motion in the Universe, philosophical view of substantivalism. To substantivalism spacetime carries the undulatory motion and is medium where the motion of particles and bodies occur. As monistic substantivalism is a special material substance, called aether, or as the dualistic substantivalism, spacetime and Universe are two different beings with equal reality of existence.

In physics, in the general relativity, the young Einstein, approached incorporate the relationism of Leibniz under the principle of Mach, the other philosophical view of spacetime as category of the thinking, that express the relational property of matter, one only being existent; therefore, spacetime as result of relations of place and moment between material objects. But, Einstein was pressured by the influential scientists Lorentz, Weyl and Eddington, so Einstein had introduce the relativistic ether in order to give reality to gravity, which he changed to field as soon as he

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could. Closed to death, Einstein considered the principle of Mach, abandoned from 1918, a mistake. Therefore, he chose implicitly the dualistic substantivalism, although the spacetime as a structural property of the gravitational field, a geometric field, since it is described for the functions $g_{\mu\nu}$. Therefore, a great ontological problem in the general relativity, since how can it have physics effects?

According to general relativity, the spacetime is a structural quality of gravitational field then the particle or body moves through the static gravitational field, in turn generated by matter-energy. But, according to experience, the particle or body always moves in a given medium: the atmosphere, water, vacuum etc.

In the approach of author, the particle or body moves into a particular compound medium, therefore motion has a third element: medium. This is hypothesis that is developed in this paper with objective of show spacetime as the structural and intrinsic form of the dynamic Matter (matter-energy-quantum vacuum taken as one being), because the particle or body moves through geometrical structure spacetime of a determined medium which is always a manifestation or form of matter-energy.

The difference of our hypothesis with the equivalent of general relativity is that, in our case, medium holds physical reality that transfers directly to spacetime, while in the case of general relativity the medium is the geometric static gravitational field, devoid of material reality, too spacetime as quality structural of it, even after introduced the cosmological constant, understood as the geometric effect of the energy density of the vacuum, component of the tensor energy-momentum, according the current version of this theory. That is, as Einstein equations presents space-time geometry on left side, and the energy and momentum of matter and vacuum on the right (Gupta, 2012) [2], the physical reality of medium would be in the right side and, therefore, it would be external and not intrinsic.

The medium is a composite medium. So, all the material existence (understood like Matter) is the universal medium that, on the scale of the universe, configures the universal spacetime, which is the geometric property structural of dynamic Matter (Guillen, 2010a) [3] and, therefore, of the medium.

2. Elements of Motion

According to the particle physics, to the wave and field physics and to the quantum gravity the concept of motion and its quantitative expression at the equations of motion, the elements are: particle and spacetime.

2.1. In Newtonian Mechanics

In Newton, in an Euclidean spacetime, an equation of motion M takes the general form of a second order ordinary differential equation in the position s (x_1,x_2,x_3) or in the momentum p (p_1,p_2,p_3) in function of time t (x_0):

In kinematic mechanics:

$$M\left[s(t),\frac{ds}{dt}(t),\frac{ds^2}{dt^2}(t),t\right]=0 \ \wedge \ at \ \ t=0 \ \rightarrow s(0),\frac{ds}{dt}(0) \quad (1)$$

In dynamical mechanics the momentum p of the particle or body is using in instead of s:

$$M\left[p(t),\frac{dp}{dt}(t),\frac{dp^2}{dt^2}(t),t\right]=0 \ \wedge at \ \ t=0 \ \rightarrow p(0),\frac{dp}{dt}(0) \quad (2)$$

The solution s (or p) to the equation of motion, combined with the initial values, describes the system for all times after t = 0. Thus, in Newton the elements of motion in the equations are: particle or a rigid body and Euclidean spacetime.

2.2. In the Mechanics of Special Relativity

In the special relativity, in a flat spacetime of Minkowski, an equation of motion M takes the general form of a second order ordinary differential equation in the position s (x1,x2,x3) or in the relativistic momentum p (p1,p2,p3) in function of proper time (τ):

- In kinematic mechanics:

$$M\left[s(\tau),U^{\mu}(\tau),\frac{dU^{\mu}}{d\tau}(\tau),\tau\right]=0 \ \wedge at \ \ \tau=0 \ \rightarrow s(0),U^{\mu}(0) \quad (3)$$

Where $U^{\mu} = dX^{\mu}/d\tau$, $X^{\mu} = (X^0, X^1, X^2, X^3) = (ct, x_1, x_2, x_3)$, $\tau = \int dt/\gamma$, $\gamma = 1/(1-v^2/c^2)^{1/2}$

In dynamical mechanics the relativistic momentum p of the particle or body is using in instead of s:

$$M\left[p(\tau),mU_{\upsilon}(\tau),\frac{dmU_{\upsilon}}{d\tau}(\tau),\tau\right]=0 \ \wedge \ at \ \ \tau=0 \ \rightarrow p(0),mU_{\upsilon}(0) \quad (4)$$

Where $p=\gamma mv$

The solution s (or p) to the equation of motion, combined with the initial values, describes the system for all times after t = 0.

Thus, in special relativity the elements are: particle or a rigid body and Minkowski spacetime.

2.3. In the Mechanics of General Relativity

In the general relativity, in a curved spacetime, the geodesic equation is the equation of motion; a second-order differential equation in the coordinates, the general solution is a family of geodesics:

$$\frac{d^2 x^\mu}{ds^2} = -\Gamma^\mu_{\alpha\beta} \frac{dx^\alpha}{ds} \frac{dx^\beta}{ds} \quad (5)$$

$\Gamma^\mu_{\alpha\beta}$ is a Christoffel symbol of the second kind, which contains the metric (with respect to the coordinate system).

Thus, in general relativity the elements are: particle or a rigid body and a spacetime of Lorentz (semi Riemann spacetime).

2.4. In the Mechanics of Undulatory Motion

According to physics of wave and field (waves can be constructed as physical fields), in relation with the undulatory motion there is a transport of energy-momentum in function of space and time. And there are mechanical and quantum waves. In the mechanical waves, energy-momentum of a local oscillation, of the particles of a medium, is propagated through of phonon, without the transport of particles. In the quantum waves, the energy is transported by the boson of a determined field, in the special case of electromagnetic wave by photon. The equations of waves and fields are always partial differential equations, because the waves or fields are functions of space and time, while in the particles is its movement. The general linear wave equation in 3d is:

$$\frac{1}{v^2} \frac{\partial^2 X}{\partial t^2} = \nabla^2 X \quad (6)$$

Where $X = X(s, t)$ is any mechanical or electromagnetic field amplitude and

$$\nabla = x_1 \frac{\partial}{\partial x_1} + x_2 \frac{\partial}{\partial x_2} + x_3 \frac{\partial}{\partial x_3} \quad (7)$$

2.5. In the Mechanics of Quantum Gravity

In the quantum gravity theories the virtual graviton is included. In the string theory the gravitational field is the sum of two components: brane with metric $g_{\mu\nu}$, quantum field, embedded in bulk, and the background spacetime with metric $g_{\mu\nu}$; of other hand, the equations of motion are an infinite collection of non-linear coupled differential equations $QB\Psi+\Psi^*\Psi=0$. In loop quantum gravity there is not a background spacetime since the gravitational field is the same spacetime (as a physical field without metric) that through of their quantum excitations (loops, in low energy, virtual gravitons), interact with the particles of the standard model (too, fields since only there is fields on fields) directly; result is Holst gravity, which is equivalent to the General Relativity coupled to a pseudo-scalar field and the equations of motion lead to those of the general relativity with torque (Einstein-Cartan).

(Einstein, 1986 [4], wikipedia, 2014a [5] and wikipedia, 2014b [6])

3. Medium

Newton described his physics in the framework of absolute space and absolute time; both are independent of one another. According to Newton, even if world be destroyed, space and time still exist (substantivalism). But, according to Leibniz, space is the order of coexistence phenomena and time is the order of successive phenomena and therefore, both are relative. To Leibniz, if there is no phenomenon, there is no time and no space (relationism). Classical physicists like Maxwell, Heaviside, Morton followed the path of Newton. Einstein followed initially the path of Leibniz until he arrived to dualistic substantivalism. On other hand, the quantum mechanics introduced the quantum vacuum filling the space-time. Thus, on medium there are four responses: three arise of the evolution of the classical physics and fourth arises of the quantum mechanics:

3.1. Medium in Monistic Substantivalism

Medium would be matter in fluid state (atmosphere, water etc) and aether as a mechanical substance that filled spacetime. This response is given by the monistic substantivalism. Between Aristotle and Maxwell was believed that only matter exists (i.e matter composed by fermions). Therefore, reciprocal interaction of fermions was through of a special material substance: aether, which was introduced initially due to the ontological reason of fill the space. Subsequently by the three physical reasons of serve support of the waves of light and gravity, i.e. aether as transmitter of forces by contact action, and provide the special frame in which Maxwell's equations were valid. Author says: too, aether would be medium where the motion of fermions and bodies occur when they move in the space free of matter. The evolution of theories regarding the space filled of aether as mechanical substance, transmitter of forces - from one fermion or body to another – and in the electromagnetic waves as the electromagnetic aether, or in the gravity waves as the gravitational aether. But, every attempt to explain the electromagnetic phenomenon in moving, with help of motion of ether, motion through ether, or both these movements, proved unsuccessful (Einstein and Infeld, 1938) [7].

3.2. Medium in Dualistic Substantivalism

Medium would be aether, matter in fluid state, energy and empty absolute space. This response is given by the dualistic substantivalism. Between Democritus and Newton it was believed that space-time and matter are two beings that exist independently and they are of different nature. Spacetime is an absolute geometric real object; its substantial nature is understood as real presence, existing by itself, with dimensional, topological and metric structure. Spacetime contains matter-energy and aether. Spacetime can exist

absolutely empty. Newton sustained that space exists with equal reality that matter and aether. He did not eliminate aether because he considered ether necessary for explain diffraction and reflection of light and gravity. Space contains aether (in the sense of field) and matter-energy. If ether and matter are eliminated then only there is absolute empty space.

3.3. Medium as the Static Geometric Gravitational Field

Medium would be the static geometric gravitational field. In 1916, Einstein assumed relationism by apply the principle of Mach in general relativity: The geometric field (g_{uv} metric field) is completely determined by the masses of bodies in universe. Since mass and energy are equivalent according to special relativity and energy is formally described by the symmetric energy tensor (T_{uv}), this means that the geometric field is caused and determined by the energy tensor (Einstein, 1918) [8]. But, in 1920, Einstein reintroduced aether as the relativistic gravitational aether. He emphasized on the need for relativistic ether to remove the action to distance, carry the electromagnetic wave in spite of that he had stated previously no necessary and the gravity action. The relativistic ether is another denomination of spacetime that cannot exist without the gravitational field. "Since according to our present conceptions the elementary particles of matter are also, in their essence, nothing else than condensations of the electromagnetic field, our present view of universe presents two realities which are completely separated from each other conceptually, although connected causally, namely, gravitational aether and electromagnetic field, or as they might also be called space and matter" (Einstein, 1920) [9]. However, in 1938, Einstein abandoned the relativistic aether when he said: "this is the moment to forget the aether completely and to try never to mention its name. We shall say: our space has the physical property of transmitting waves, and so omit the use of a word we have decided to avoid" (Einstein and Infeld, 1938) [7]; and he replaced the relativistic aether by the geometric field.

In 1954, proximate to pass away, Einstein formulated that spacetime has not existence independent of the geometric field. It must observe that there are two classes of fields: physical fields as electromagnetic field, gravitational waves etc. and geometric fields as the static gravitational field g_{uv} of general relativity. Einstein specified that the static gravitational field is the functions g_{uv}, as chronogeometric relations between events, therefore the static gravitational field is a geometric field in the sense that is the curvature of spacetime that arises from matter and physical fields. Einstein began declaring that spacetime and matter-physical fields are two different beings. Its relation is: space serves to describe metrical properties of the matter-physical fields, since he declared: "In order to be able to describe at all that which fills up space (i.e, T_{uv}) and is dependent on the coordinates, space-time (i.e g_{uv}) or the inertial system (i.e, T_{uv}) with its metrical properties (must be thought of at once as existing, for otherwise the description of that which fills up space (i.e, T_{uv}) would have no meaning". Immediately, he passed to identify spacetime as property structural of static gravitational field, i.e. if static gravitational field is eliminated then spacetime disappears. Einstein said: "On the basis of the general theory of relativity, on the other hand, space (i.e, g_{uv}) as opposed to what fills space (i.e, T_{uv}), which is dependent on the coordinates, has no separate existence. Thus, a pure gravitational field might have been described in terms of the g_{uv} (as functions of the coordinates), by solution of the gravitational equations. If we imagine the gravitational field, i.e. the functions $g_{uv,}$ to be removed, there does not remain a space of the type (1) (type 1 is Minkowski´s spacetime), but absolutely nothing, even topological space". The functions g_{uv} describe both the static gravitational field and the spacetime, and simultaneously of spacetime, both manifold (dimensions and topology) and metric (chronogeometric relations), also property of manifold, since Einstein said: "For the functions g_{uv} describe not only the field, but at the same time also the topological and metrical structural properties of the manifold"... Einstein clarified that the field to which he is referring is the geometric field and no to the physical fields, furthermore, that a spacetime of Minkowski is a special case of the spacetime of the static gravitational field, for which the functions g_{uv} have values that do not depend on the coordinates, because is a space free of matter-physical fields, but there is no space without geometric field. That is, in this special case the functions g_{uv} are independents than it would occupy spacetime that would be T_{uv}, since the coordinate system used, in itself has no objective significance, because it is a mere convention to describe the dimensions of a spacetime of Minkowski. But, in the general case of the spacetime of Lorentz, the functions g_{uv} are dependents of the coordinates, since if it changes coordinates, the components of the Riemannian curvature tensor change along with the metric tensor components. Thus, Einstein said: "A space of the type (1), judged from the standpoint of the general theory of relativity, is not a space without field, but a special case of the g_{uv} field (when $R_{\mu v}$=0), for which – for the co-ordinate system used, which in itself has no objective significance – the functions g_{uv} have values that do not depend on the co-ordinates. There is no such thing as an empty space, i.e. a space without field"... Space-time does not claim existence on its own, but only as a structural quality of the field... there exists no space "empty of field" (Einstein, 1954) [10]. However, Einstein did not return philosophically to relationism, because he declared previously inconsistent the principle of Mach with the theory

of field (Einstein, 1949) [11], besides that the vacuum solutions lead to the dualistic substantivalism.

3.4. Medium as Vacuum

Notwithstanding, that Einstein declared that spacetime does not exist empty because spacetime is a quality of the geometric field, vacuum is a medium that permeates totally the universe, mainly the called outer space, i.e the space almost totally emptiness between stars, where density is 10^{-24} g/cm^3, and in universe 10^{-30} g/cm^3 (Marquardt, 1999) [12]. Also, atoms are mostly empty space, more than 99,999 percent. This means that universe is mostly vacuum. The vacuum within atom can have local structure negative charged, i.e. polarized, if the electrical field of its atomic nucleus is strong enough (Rafelski and Muller, 1985) [13], indeed such charge is caused by the electrical field of the nucleus. According its functions, the vacuum would be the aether without the problems of the mechanic aether.

The two fundamental theories of physics have different conceptions on vacuum energy:

To quantum theory, vacuum is the carrier of the contact actions of matter through different physical fields and of the physical fields same. Vacuum lacks of structures formed by fermions or real bosons, indeed vacuum lacks of mechanic interactions with matter-radiation. But vacuum interacts quantumly with matter and radiation. Due to the discoveries of radiant energy as electromagnetic wave and the bosons carriers of the electric-magnetic, weak and strong forces arises the hypothesis that when it obtains the mechanic vacuum, i.e, the fermions are eliminated, yet there remain fields of the radiant energy and Higgs. Too, the radiant energy is possible eliminate, but not bosons whether they are virtual particles. Therefore it can obtain a vacuum without matter and radiant energy. So, the vacuum medium is a quantum medium no charge of virtual particles (DeWitt, 1967 [14], Davis and others, 2006 [15] and Oldershaw, 2009 [16]).

To general relativity, in 1917, Einstein introduced in his equations of field the term Λ, in order to reach gravitational balance and secure a static universe (Einstein, 1917b) [17]. Thus in general relativity the vacuum energy density is believed acts as the cosmological constant Λ. This constant has been in and out of Einstein's equations. It knows, at least in four moments: 1) Hubble's discovery of the expanding universe caused that Einstein eliminates the cosmological constant in 1931. 2) In 1927, Lemaıtre incorporated the cosmological constant in his non-static model of universe. During the 1930s similar models were discussed, primarily in connection with the so-called age problem, but more precise measurements of the Hubble constant (which is related to the age of universe) subsequently undermined this motivation for cosmological models with a non-zero Λ. 3) In the late 1960s, Petrosian, Salpeter and Szekeres once again re-introduced the cosmological constant, to explain some peculiar observations of quasars indicating a non-conventional expansion history of universe, but the later data about quasars removed also this motivation. 4) Recently, observations of supernovaes have indicated that a non-zero cosmological constant in the cosmological models is needed because universe is in accelerated expansion (Rugh and Zinkernagely, 2000) [18].

In the quantum theories, the dark energy is alternative to cosmological constant that, unlike, its density maybe no is constant, i.e., energy can softly change of density, in time and/or in space.

Therefore, both, general relativity and quantum theories explain the expansion of universe tend to speed up, effect uncovered at 1998.

The cosmological constant was tried to interpret as vacuum energy, but the cosmological constant is of order many smaller than the estimated vacuum energy. Hence equating the cosmological constant with the vacuum energy is problematic. Furthermore, due to that the field equations, in general relativity, the $\Lambda\, g_{uv}$ term is a geometric term; rather it must understand as geometric effect of the energy density of empty space of matter (fermions) and radiation (real bosons, especially real photons).

To author, spacetime is not other name of the medium because spacetime is essentially the geometric structural property of Matter and medium is always a realization of Matter as an state or mix of states, and structured as super atom, atoms, plasma, radiation or virtual particles or their mix that serves of the material support of motion. Of other hand, there is not absolute empty space. Truly, exists quantum vacuum energy, a super fluid background medium (Wang, 2007) [19].

4. The Medium for Motion

In the current physics, there are two conceptions on the medium for motion: from general relativity and quantum theory.

4.1. In General Relativity

In the general relativity the equations of Einstein are:

$$G_{\mu\nu} + \wedge g_{\mu\nu} = T_{\mu\nu}^{matter-energy} + T_{\mu\nu}^{vacuum} \tag{8}$$

And their solutions are:

4.1.1. Vacuum Solutions

In Vacuum solutions the motion occurs in a geometric field, since:

If $T^{matter\text{-}energy}{}_{\mu\nu} = 0$ and $\Lambda>0$ then $R_{\mu\nu} = \Lambda\, g_{\mu\nu}$. Although, the energy-momentum tensor $T^{matter\text{-}energy}{}_{\mu\nu}$ it vanishes Einstein metric tensor $G_{\mu\nu}$ no vanishes because it vanishes only if the Ricci tensor, $R_{\mu\nu}$, vanishes, and $R_{\mu\nu}$, no vanishes because it is impossible vanish $T^{vacuum}{}_{\mu\nu}$. Result is an Einstein manifold, due to that its Ricci tensor is proportional to metric ($R_{\mu\nu}=k\, g_{\mu\nu}$). Vacuum solutions are lorentzian manifolds with k proportional to Λ. The lorentzian manifolds are: $+R_{\mu\nu}$ when k>0 (sphere), $-R_{\mu\nu}$ when k<0 (hyperbolic space) and $R_{\mu\nu}=0$ when k=0 (Ricci-flat manifolds), but for spaces of 4 dimensions only sphere and Minkowski spaces are diffeomorphic, i.e. that can be admit as metric (Besse, 1987) [20].

In absence of the cosmological constant the Einstein equations take form:

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} = T_{\mu\nu}^{matter-energy} \tag{9}$$

When $R_{\mu\nu}=0$, the Ricci-flat manifold, although curvature vanishes due $T^{matter\text{-}energy}{}_{\mu\nu}=0$, still there is deformation of shape as effect of curvature of the tensor of Weyl, $C_{\mu\nu\lambda\sigma}$, but no of volume. Thus, the Ricci-flat manifold originated from a gravitational field, remains as a geometric field, also for an Einstein manifold with k>0.

4.1.2. Matter-Energy Solutions

In matter-energy solutions also the motion occurs in a geometric field, since:

In the general relativity when there is matter, i.e, $T^{matter\text{-}energy}{}_{\mu\nu}>0$, without cosmological constant ($\Lambda=0$) the static gravitational field is a geometric field, i.e:

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}^{matter-energy} \tag{10}$$

When there is matter and cosmological constant, too the static gravitational field is a geometric field, i.e:

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}^{matter-energy} + T_{\mu\nu}^{vacuum} \tag{11}$$

4.2. In Quantum Theories

Motion occurs in the quantum theories in Euclidean spacetimes, in the relativistic quantum theory in Minkowskian spacetimes and in quantum gravity in lorentzian spacetimes. The notion of empty space has been replaced by a vacuum state, defined to be the ground state of a collection of quantum fields such as electromagnetic static field, Higgs field and other static fields due to that these fields are formed by virtual bosons. A quantum mechanical feature of the quantum fields is that they exhibit zero-point fluctuations everywhere in space, even in regions which are otherwise empty i.e. devoid of matter (fermions) and radiation (real bosons). Therefore the truly special with relation to medium for motion is on quantum vacuum considered as a quantum fluid form of existence of matter-energy. The quantum vacuum is aether, but without mechanical nature, also is the spacetime empty, but no absolutely empty.

5. Consequences of the Medium for Motion in the Spacetime Theories

In the general relativity, without or with the cosmological constant Λ, the solutions of the equations of Einstein: in the vacuum when $T^{matter\text{-}energy}{}_{\mu\nu} = 0$ or in the matter-energy when $T^{matter\text{-}energy}{}_{\mu\nu} > 0$, give to the gravitational static field as a geometric field. As the spacetime is a quality structural of the gravitational static field then the medium for motion is a geometric field, of course in general relativity the medium for motion is the gravitational static field, exactly the motion occurs at the spacetime of the gravitational static field.

Notwithstanding, according to our experience always the motion occurs inside of a material medium, subject to static gravity, i.e, in our perception of the static gravitational phenomenon, the two terms of the equations of Einstein are united in a material body: $G_{\mu\nu} \cup T_{\mu\nu}$, that resolves the ontological need of the material reality of the static gravitational field. But due to that, according to general relativity, both terms possess proper reality: geometrical $G_{\mu\nu}$ and material $T_{\mu\nu}$, as two interdependent beings, and the existence of $G_{\mu\nu}$ dependent of the existence of $T_{\mu\nu}$, therefore, the physical reality of the static gravitational field would be external and no intrinsic. Yet, if it opts by an interpretation closed to the reality: spacetime as quality structural of the gravitational static field and gravitational geometric static field as quality structural of the matter-energy, of course, gravitational static field acquires intrinsic material reality, although, it loses the notion of gravity of the general relativity. So, this no would be an alternative solution.

Truly, according to the physical experience, the motion occurs always in a medium, mainly, in the water, atmosphere and vacuum or between two mediums as solid-atmosphere, or water-atmosphere etc. The essential conditions of the medium are three: be material, have four dimensions, i.e, a geometric structural spacetime intrinsic property, and allow the motion of the particle or body in a given scale, for example, although a solid medium is material and has four dimensions, it does not allow the motion of macro particle or body, but whether in the micro and nano scales of particle as real bosons and sub atomic particles, neutrinos etc. in the

vacuum inter molecular. Therefore, it can generalize that the elements of motion are three: medium, spacetime and particle or body. Thus, spacetime is a quality structural geometric intrinsic of the medium, i.e., matter-energy in any of its forms and states (Guillen, 2010a) [3]. However, the mathematical description of the gravitational motion in any theory only it refers to motion under the gravitational interaction. Of course, the introduction of the medium, as essential component of motion, only is a methodological step with the next objective: the motion occurs in the spacetime of a material medium.

We assume the model of general relativity as: ($G, \rho, E, \Theta, \Phi, ...$) where G is the geometric static gravitational field as chronogeometric spacetime structure; ρ is a fluid density of any kind of matter, done of fermions; E is the dynamic electromagnetic field, as electromagnetic waves, done of real photons; Θ is the dynamic gravitational field, as gravitational waves, done of real gravitons; Φ the static electromagnetic field, done of virtual photons, main component of the quantum vacuum (truly quantum fluctuations, see: Mukhanov [21]); and the suspension points correspond to any other kind of virtual or real particles field. So, the introduction of the medium as the third element of motion reveals the conceptual impossibility of the general relativity of explain, although can describe mathematically (tested empirically), the local gravitational motion, due to that replaces the medium by the static geometric gravitational field and understand erroneously spacetime as structural property of the static gravitational field (can the Matter exist without spacetime?). Furthermore, the concepts of general relativity on spacetime and static gravitational field are circulars, since, according Einstein, spacetime is the structural quality of the static gravitational field and, according followers of Einstein, this is the curvature of the spacetime.

If it understands that the motion happening in a medium (in general, the Matter at $\leq 10^{-27}$cm is quantum fluctuations - this theory was proved in the Planck mission - (Mukhanov, 2015) [21]), as a material state, then spacetime is a structural property of the matter-energy-vacuum, whose geometry provides (Guillen, 2010b) [22]. The medium as the third element of motion leads to: particle or body move within a given compound fluid. Therefore, the most general equations of motion are the equations of Euler in fluids, since they apply to the motion on a compound medium, for example, the motion of a particle or body into ocean under terrestrial gravitation.

"Leonhardt and Piwnicki have shown that a nonuniformly moving medium appears to light as an effective gravitational field for which the curvature scalar is nonzero. They also show how light propagation at large distances around a vortex core shows Aharonov-Bohm (AB) effect and at shorter distances resemble propagation around what are termed as optical black holes. Berry demonstrated the AB effect with water waves and Roux observed it for acoustical waves in classical media. The curved space analogy has been predicted for fluids and superfluids". "Novello and Salim have shown that the propagation of photons in a nonlinear dielectric medium can also be described as a motion in an effective spacetime geometry" (Nandi, Zhang, Alsing, Evans and Bhadra, 2002) [23]. In the exact reverse direction, Nandi, Zhang, Alsing, Evans and Bhadra "proceed from the gravity field and arrive at an effective optical refractive medium". "The motion of this medium is caused by the relative motion between the observer and the gravitating source". They saw the "dispersion effects, both for massless and massive particles, appear naturally as a consequence of the systematic development of an effective medium approach to gravitational field" (Nandi, Zhang, Alsing, Evans and Bhadra, 2002) [23].

Recently, it has been established also that the equation of motion of a particle or body rigid immersed at an incomprehensible fluid is equals to the geodesic equation of a curved space. This suggests that the motion in a physical medium is determined by the geometric structure of the medium. "The motion of a rigid body immersed in an incompressible perfect dimensional bounded domain have been recently studied which have set a Cauchy theory for classical solutions, under its partial differential equation (PDE) formulation. In particular classical solutions have been shown to exist locally in time". It been rigorously tested "that the classical solutions can be equivalently thought as geodesics of a Riemannian manifold of infinite dimension, in the sense that they are the critical points of an action, which is the integral over time of the total kinetic energy of the fluid-rigid body system". "It was pointed out in a famous paper by Arnold that both the Euler equations for a rigid body as well as the Euler equations for a perfect motion of a rigid body in a frame attached to its center of mass can be considered as a geodesic on the special orthogonal group SO(3). On the other hand the motion of a perfect fluid filling a container Ω (without any immersed rigid body in it) can be considered as a geodesic equation on the space $Sdiff^{+}(\Omega)$ of the volume and orientation preserving diffeormorphisms of Ω". "One can see the motion of a rigid body in a fluid governed by the incompressible Euler equations, as a geodesic flow, in the presence of a regular distributed vorticity, as well" (Glass and Sueur, 2011) [24].

On other hand, in "quantum mechanics, the gravitational force is attributed to the exchange of virtual gravitons between the particles of the bodies" (Hawking, 1988) [25], therefore, the static gravitational field is a quantum material

phenomenon and undoubtedly it possesses physical reality. Thus, let me propose the ideal representation of the Matter (matter-energy-vacuum) by my model: ($G, \rho, E, \Theta, \Phi, g', \ldots$) where G is the chronogeometric spacetime structure of the Matter; ρ is the fluid density of any kind of matter, done of fermions; E is the dynamic electromagnetic field, as electromagnetic waves, done of real photons; Θ is the dynamic gravitational field, as gravitational waves, done of real gravitons; Φ the static electromagnetic field, done of virtual photons, component of the vacuum; g' the static gravitational field, done of virtual gravitons, component of the vacuum; and the suspension points correspond to any other kind of virtual or real particles field. Under the next relations: $G_{\mu\nu} \subseteq T_{\mu\nu}$ ontologically one being. Where $T_{\mu\nu}$ is ($\rho, E, \Theta, \Phi, g', \ldots$).

So, the form, $G_{\mu\nu}$, gives the structure to content, $T_{\mu\nu}$, and this to through of its interactive forces, although according to the gravitational quantum approach, surely, g', the static gravitational force, determines $G_{\mu\nu}$: $G_{\mu\nu}=T_{\mu\nu}$ (Einstein´s equations). Of course, the static gravitational phenomenon can be described by equations of Einstein as phenomenon of the curvature of spacetime, notwithstanding, that this phenomenon truly is a quantum phenomenon, as effect of the fluid density of the gravitational static energy (see: Glass and Sueur, 2011 [24]). As the equations of Einstein were heuristically constructed, they work very well adjusted to the curvature of spacetime, caused by, g', the static gravitational force.

6. Conclusions

Universe is vacuum, matter and radiation. They are material forms of existence, by have physical reality, in last instance, they are Matter. Spacetime is a geometric intrinsic property of the dynamic Matter, whose forces determine the geometry of spacetime and, reciprocally, the spacetime determines as Matter moves.

The differences of our proposal with general relativity are: spacetime is the structural form of the dynamic Matter and the static physical gravitational field causes the curvature of Matter and, of course, of spacetime as its structural form, while in the general relativity spacetime is the quality structural of the static geometric gravitational field and the Matter causes the curvature of spacetime. The outcome of this work allocates medium as third element of motion and in summary is:

- The motion occurs in the dimensions of spacetime of a given compound medium, that it can be formed by fermions and its associated fields: static fields (virtual particles) and dynamic fields (real particles) or it can be formed by free fields of its sources (quantum vacuum).
- The bodies move in spacetime of a medium or mix as: atmosphere, water, vacuum, solid-water, etc.
- The mechanical waves propagate in spacetime of a mechanical medium and the other waves as electromagnetic waves; gravitational waves etc. propagate in spacetime of the quantum vacuum.
- The virtual particles and real particles move in spacetime of quantum vacuum.
- Spacetime does not have a beginning and an end, since Matter is eternal.
- Spacetime has a discrete structure caused by the discrete structure of the Matter.

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