What is spacetime?

By Alfonso León Guillén Gómez

aguillen@gmx.net

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Abstract

Based on the Russian school of Logunov and others, with the contribution of Tom van Flandern, and his previous works on space-time, gravitational waves and speed of the gravity, the author discusses the theory of the time-space fluid that results from the supposed gravitational waves that would have detected LIGO, and reaffirms the space-time as a structural geometric property of the dynamic matter (radiation, matter and quantum vacuum), now with the strong argument that without escape, in an unnatural way, the physicists and philosophers of science confer the conception of the author to that ridiculous material space-time, while depriving Matter, of the intrinsic space-time. In addition, he warns about the conceptual contradiction existing between NASA and Caltech over gravitational waves, being absurd the concept of Caltech, operator of LIGO, since gravitational waves would propagate in five non-detectable dimensions. NASA valiant and validly recognizes that they would be waves of space; therefore, there are no space-time waves that correspond to gravitational waves that, according to the great current of relativistic physicists, would exist. Finally, the author reaffirms that the quadrupole waves detected by LIGO are waves of the quantum vacuum.

1. Introduction

The science of physics that studies energy, matter and spacetime, as well as their mutual interactions, arose with Nicolas Copernico (1543), remarkable antecedent, with his treatise on astronomy, and Galileo Galilei (early 1600), properly founder, in special, with his principle of relativity, foundation of the mechanics and, for the first time, the use of the scientific method, causing this science was detached from the so-called “natural philosophy” that came from the world of antiquity, in which, among many philosophers, excelled Aristotle, Thales of Miletus and Democritus.

Paradoxically, until very recently, physics only defined mathematically-geometrically, space-time. Therefore, lacking a conceptual definition, this was provided by philosophy, through the ontological interpretation of its formalisms, mainly by the schools of Substantialism (also called Sustantivalism) and Relationism. Until a few years ago "Space-time is still an enigma to science and philosophy" [1] because “We really do not know what spacetime” [2]. And “the proponents of General Relativity believe space is non-physical and describe the dynamic activity of space by employing the term geometro-dynamics, thereby underscoring the fact that Einstein’s space is a mathematical construct —a 4-dimensional geometrized space-time. The foundation of general relativity is a four coordinate mathematical space” [3].

The topic of spacetime is so current that between 14-17 May 2018, the "International Society for the Advanced Study of Spacetime", since "the question "what is the nature of spacetime?" remains open" [4] and the "Institute for Foundational Studies Hermann Minkowski" from Montreal realized the "Fifth International Conference on the Nature and Ontology of Spacetime" in Varna, Bulgaria [5]. Also, in May, in Nature, it was written: “People have always taken space for granted. It is just emptiness, after all—a backdrop to everything else. Time, likewise, simply ticks on incessantly. But if physicists have learned anything from the long slog to unify their theories, it is that space and time form a system of such staggering complexity that it may defy our most ardent efforts to understand” [6].

Since 2007, the author has been working on a third theory on spacetime that breaks with the General Relativity unlike the theories of Substantialism and Relationism that complement it. He presented “Spacetime structural property of the matter in movement” in Petrov 2010 Anniversary Symposium on General Relativity and Gravitation, Russian Federation (Kazan), 1-6 November 2010 [7]. Matter is defined in the sense of universal and philosophical category, therefore, as the union of matter, energy and quantum vacuum in physical terms. And the spacetime is defined not as the geometrical condition of the existence of dynamic matter but as the structural geometrical property of material existence; of course, the matter exists self-contained and in movement and transformation.

However, the german professor of physics at the University of Maryland, College Park, Dieter Rudolf Brill, Ph.D of Princeton University, discoverer with James Hartle, in 1964 of the Brill-Hartle geon and chairperson of Parallel Session ES2 - Theoretical Issues in GR who accepted my work "The medium for motion: a critical clue to understand spacetime" [8] as contribution to Fourteenth Marcel Grossmann Meeting MG14, University of Rome "La Sapienza" - Rome, July 12-18, 2015, told me “spacetime is no longer problem”. Of course, he was referring to physics at some scientific institutions as the best universities in the United States.

The author believes that the professor Brill was referring to that physics was finally able to conceptually define spacetime giving it a material character, from the internal gravitomagnetism. This would be the supposed frame-dragging effect caused by the distortion in the spacetime due to the mass of the Earth and its rotation. It is obtained from the equations of General Relativity and it was supposedly established experimentally in the Gravity Probe B, performed by the Stanford and NASA teams. In April 20, 2004 it was realized the launch of GP-B satellite from Vandenberg, USA, that was inserted into polar orbit. After collecting a large amount of data and analyzing them, the results were delivered in May 2011. The measured frame-dragging was 37.2 ± 7.2 milliarcseconds, the predicted of 39.2 milliarcseconds; the error were unusually high. “The original goal of GP-B was to measure the frame-dragging precession with an accuracy of 1%, but the problems discovered over the course of the mission dashed the initial optimism that this was possible.” [9]. Paul Worden of Stanford University [10] and V. G. Turishev of NASA [11] wrote in independently articles: according "frame-dragging effect: Rotating matter drags space-time ("space-time as a viscous fluid")". The verification of the existence of the gravitomagnetism was a great incentive for the project of detection of gravitational waves.

From the previous physical conception of space-time as material and viscous fluid, the "California Institute of Technology", that with the Massachusetts Institute of Technology (Caltech) operate LIGO, defines “Gravitational waves are 'ripples' in the fabric of spacetime caused by some of the most violent and energetic processes in the Universe” [12]. And the NASA: “A gravitational wave is an invisible (yet incredibly fast) ripple in space” [13]. Of course, for them spacetime and gravitational waves are material phenomena. Not so for the "International Society for the Advanced Study of Spacetime" since the nature of spacetime is still an enigma.

On the 11 February 2016, LIGO announced the first detection of gravitational waves on 14 September 2015.

The surprise for the author was very great since he did not expect such an event to happen. For this reason, on the 31 March 2016, he wrote: “General Relativity mathematically defines, through a dynamic geometric differential tensor model, a static gravitational field as the metric tensor of a Lorentz manifold, which represents the curvature of a four-dimensional geometric entity called space-time, dependent on the four-tensor of impulse and energy. On the other hand, Einstein conceptually formulated space-time as the structural quality of the gravitational field, that is, a circular definition between gravity and space-time.

Also, Einstein denoted "Space and time are ways in which we think, not the conditions in which we live" and "We denote everything except the gravitational field as matter", therefore, space-time is nothing and Gravitational field is not a material field, but in the first approximation is a coordinate effect, and definitely a geometric field, that is, nothing.

The mathematical model generates quantitative predictions coincident with observations in a high degree of accuracy without physical meaning.

The philosophy of science complements the General Relativity from two schools: in Substantialism, space-time exist itself, storing all events, according to the order of coexistence and the order of succession, while in Relationalism the space-time are the metric relations of coexistence and succession between events. But, "Space-time remains an enigma for science and philosophy" (Lorente, 2006) because "We really do not know what space-time" (Odenwald, 2015).

In this way, the results of the black box, which is the mathematical model of space-time, within the context of the dominant scientific positivism, have supported for a century the validity of General Relativity, which in the absence of intrinsic physical meaning, results are interpreted arbitrarily.

Due to its mathematical dynamic model, Einstein formulated, from sources of quadrupole energy, the formation of waves in that geometric entity designated as space-time, that propagate as gravitational waves, traveling in space, which Einstein abandoned in 1938 when he wrote that gravitational waves do not really exist.

On February 11, 2016, the LIGO Scientific Collaboration announced that they had the first detection, on September 14, 2015, of gravitational waves from a couple of black holes that were merged. They say that they are waves of the fabric of space-time, therefore, interpreting them according to the Substantialism, a conventional philosophical conception in dispute with the Relationalism. Those waves detected by LIGO are actually mechanical transverse quadru-polar quantum waves of the quantum vacuum that is in a physical medium; these waves carry energy but not gravitons” [14], [15].

The author correctly understood that the science of physics in the United States has opted for Substantialism.

PhDs, philosophers of the science and physicists, on March 4, 2017, Mario Bunge, “a former relationist' to the Leibniz” [16], and, on August 15, 2017, Gustavo Romero protocolized Substantialism as the only possible conception of space-time from the detection of the supposed gravitational waves.

In this article, the author presents the works of Bunge and Romero and formulates his critique on the Substantialism of space-time and the supposed gravitational waves.

2. Space-time in Bunge and Romero

Of the philosophical consequences of the supposed detection of gravitational waves, Mario Bunge and Gustavo Romero agree that this implies the realism of space-time and, in addition, its materiality, that is, they are materialist substantialist.

Bunge based on the results of the LIGO experiment, that according to the assumptions of LIGO: “The gravitational signal was traveling through the intergalactic space during $\sim$ 1200 Myr. Once the wave arrived to the earth it produced physical changes in the detectors of two independent instruments at Hanford, WA, and Livingston, LA (USA)” [17]. The Bunge's line of reasoning is: Gravitational waves activated detectors. Detectors react only to specific material stimuli. LIGO has detected gravitational waves [16]. Therefore, Bunge's arguments are: Gravitational waves are material. Gravitational waves are ripples in spacetime. Spacetime is material [16]. “The view that gravitation is a manifestation of the curvature of spacetime is discussed, and the reality of gravitational waves is regarded as the coup de grâce to that view" [16]. "For Bunge, an entity is material if it can change. Material objects, contrary to mere concepts, are changeable and can trigger changes in other objects" [16].

However, as Romero correctly wrote "Notice that there is no gravitational (static) field in this interpretation. There is just spacetime and matter. Bunge's argument shows that spacetime is as material as matter". "The theory, of course, can account for the phenomena we dub gravitational through curvature of space-time" [16].

For his part, Romero shares with Bunge the realism and materiality of spacetime with the arguments: "Although Einstein originally was inspired by Maxwell's and Lorentz's concepts of field, the final theory that resulted from his endeavors was not completely akin to Maxwell's. Einstein himself realized this after his famous debate with Willem de Sitter about dynamical empty universes (see Smeenk 2014). Spacetime has a unique ontological status in general relativity: it is an entity, which can exist by itself and, as LIGO detectors have shown, act upon matter. But spacetime can also exist in the absence of any other material entity. Einstein recognized the ontological status of spacetime in his address delivered on May 5th, 1920 in the University of Leyden (Einstein 1920): Recapitulating, we may say that according to general relativity space is endowed with physical qualities" [16].

But Romero rejects Bunge's additional identification of space-time with the static gravitational field since for Romero there is only space-time, therefore, consistent with Substantivalism. "Bunge argues that a different, equally valid interpretation of the field equations is possible, in terms of a gravitational field. This interpretation is suggested by the Newtonian limit of the theory and the comparison with the Poisson equation $\nabla^2 \Phi = 4\pi G\sigma$, where Φ is the potential of the gravitational field, and σ is the mass density. According to Bunge, this limit implies that the coefficients of the metric can be interpreted as the potential of the gravitational field (a view already expressed in Bunge 1967). So, Einstein's equations can be read alternatively as referring to a gravitational field or to spacetime. Since reality is unique, Bunge infers the identity of spacetime and gravitational field" [16]. Romero's argument against Bunge is: "The coincidence of both theories in the Newtonian limit does not imply a transfer of referent from the less to the more comprehensive theory. It just implies that general relativity incorporates in its domain many results also obtained by Newton's theory, to good approximation. There is a semantical shift when we go from one theory to the other (see Bunge 1974a, b). The reference class changes, although some aspects of the formalism are recovered in the limit. In general relativity, what we call "gravitational effects" are due to spacetime when its curvature is different from zero" [16].

When Bunge resorts to the hollow sphere argument of General Relativity to argue that the null matter within the hole causes the disappearance of the static gravitational field and therefore the space-time also disappears, Romero remembers and criticizes Bunge that "is not taking seriously enough his own conclusion enunciated above: spacetime is material. And as a material entity, spacetime can exist in absence of matter – just as gravitational waves show us it is the case" [16].

3 Static gravitational field

In General Relativity according to its tensorial equations:

$$G_{\mu\nu} = k\, T_{\mu\nu} \qquad \text{(Eq. 1)}$$

There is only space-time defined by $G_{\mu\nu}$ and Matter (matter, energy) defined by $kT_{\mu\nu}$

Spacetime is a purely geometric entity, i.e. nothing. Einstein in the equations of the theory of Entwurf materialized space-time for him to include $t_{\mu\nu}$ the tensor of impulse and energy generator of the gravitational field, but because the equations did not give the anomalous orbit of Mercury and, neither in the limit of Newton, the law of gravity of Newton had to discard them. Remember, in Entwurf's theory, "the gravitational equations are of the form":

$$\Delta_{\mu\nu}(\varphi) = k\,(T_{\mu\nu} + t_{\mu\nu}) \qquad \text{(Eq. 2)}$$

However, since 1916, through the supposed non-localized energy obtained from a pseudotensor, the materiality of the static gravitational field is claimed, which, paradoxically, makes it impossible to obtain a quantified gravity. Even in the context of the static gravitational field the non-localized energy is a problem. "The central problem of geometrical description of gravity is the problem of"non-localizability" of the energy of the gravitational field or uncertainty of its value" [18]. "In relativity a non-localizable form of energy is inadmissible, because any form of energy contributes to gravitation and so its location can in principle be found." [19]. "The nature of lack of locality in the theory of gravity is the imperfection of the Einstein equation" [20] causing different authors such as Brans-Dicke, Rosen, Yilmaz and Grishchuk to formulate new alternative equations to those of Einstein, some in the context of very structured theories as remarkable as "The Relativistic Theory of Gravitation" by Anatoly Logunov and his group of scientists. Even, the equations used by the scientist Sergei Kopeikin that allowed him to calculate the supposed speed of gravity; for which he wrote "the stress-energy tensor $T_{\mu\nu}$ is defined locally as a special relativistic object and can not physically depend on the speed of gravity in a direct way because gravitational field is not localized. Nonetheless, $T_{\mu\nu}$ can depend on the speed of gravity indirectly through the metric tensor $g_{\mu\nu}$. This dependence may be important in higher orders of the post-Newtonian approximation scheme. Thus, we have to keep in mind that the fundamental speed c entering the (special relativistic) definition of $T_{\mu\nu}$ is the speed of light. Confusion in the interpretation of physical effects can arise, however, if one keeps the same notation for the speed of gravity and the speed of light. In order to avoid it, one will denote the speed of gravity as c_g and the speed of light as c in accordance with convention adopted in section 1.1. Then, the Einstein equations (1) $G_{\mu\nu}[c_g]=k\,T_{\mu\nu}[c]$" [21]. If static gravitational field (originally a geometric field) has speed then it is material. Contradictorily he recognizes that "According to Einstein, the notions of geodesic, parallel transport (affine connection), and curvature of space-time manifold have a pure geometric origin and do not correlate with any electromagnetic concepts. At the same time, curvature is generated by matter which is not affiliated with the spacetime geometric concepts." [21].

In General Relativity, $G_{\mu\nu}$ is equivalent to the matrix 4x4 of the $g_{\mu\nu}$ coefficients of curvature that can be of zero curvature, that describe the static gravitational field (in general, a metric quantifier referred to the geometry of a manifold) multiplied by the 4x4 matrix of space-time coordinates of a given manifold (an abstract mathematical space), resulting in ten different differential equations. If it fulfilled that when μ=v then $g_{\mu v}$ = 1 and when μ≠v then $g_{\mu v}$ = 0 it has an manifold of Minkowski; on the contrary, there is a manifold of semi Riemann (a manifold of Lorentz) that, depending on the values of $g_{\mu v}$ will be of a certain geometry, for example, from the solutions of Schwarzschild, De-Sitter, Anti De-Sitter, etc. There are much possible geometries.

As a consequence of Einstein's equivalence principle, "Einstein identified the existence of gravity with the inertial motion of accelerating bodies (i.e. bodies in free-fall) whereas contemporary physicists identify the existence of gravity with space-time curvature (i.e. tidal forces). The interpretation of gravity as a curvature in space-time is an interpretation Einstein did not agree with" [22]. For Einstein in the space-time of Minkowski, in homogeneous gravity, the free fall is explained and in the space-time of Lorentz the free fall and the convergent movement of the bodies in interaction (their attraction) is explained, that is, the two main effects of gravity.

In the philosophical interpretation of spacetime, in Substantialism properties of the metric are intrinsic properties of the manifold, while, in Relationalism space-time geometry is a manifestation of a particular field, the gravitational field. I.e., in the Substantialism the gravitational field is nothing, but a local distortion of space-time geometry, while in the Relationalism the space-time geometry is nothing since is a simple manifestation of the gravitational field [23].

Of course, the choice of NASA, Caltech and some prestigious universities in the United States of Substantialism reduce the static gravitational field to the geometrodynamics of a material spacetime which, in the case of homogeneous gravity, is absurd.

Bunge identifying spacetime with the static gravitational field coincides with Einstein when he defined that "Space-time does not claim existence on its own, but only as a structural quality of the (static gravitational) field" [24]. But Bunge and Romero erroneously conclude that in the hole of the sphere in the absence of a static gravitational field, i.e, since there is not curvature, there is no spacetime. Both ignore that, in the terms of Einstein, in the hole there is a homogeneous gravity, therefore, a space-time Minkowski. Note that, in 1954, Einstein wrote: "In order to be able to describe at all that which fills up space and is dependent on the co-ordinates, space-time or the inertial system with its metrical properties must be thought of at once as existing, for otherwise the description of "that which fills up space" would have no meaning. On the basis of the general theory of relativity, on the other hand, space as opposed to "what fills space", which is dependent on the co-ordinates, has no separate existence. Thus a pure gravitational field might have been described in terms of the g_{uv} (as functions of the co-ordinates), 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 space-time), but absolutely nothing, and also no "topological space". 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... 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, 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" [24]. However, Romero is right that by giving materiality to spacetime, it necessarily implies that spacetime exists in the hole. On the other hand, Bunge's error is to discard the zero curvature of spacetime in the hole, corresponding to homogeneous gravity. But in General Relativity, Einstein's real problem is to reduce the static gravitational field to a metric field.

4. Space-time in Substantialism

For Substantialism, space-time is the container of Matter, its mechanical movements of absolute translation and rotation, as well as its processes of evolution and transformation. Space-time does not owe its existence to the presence of Matter; therefore, it can exist in the absence of it.

"Substantivalists understand the existence of spacetime in terms of the existence of its pointlike parts, and gloss spatiotemporal relations between material contents in terms of the spatiotemporal relations between points at which they occur" [25]. "One regards space-time as something that exists in its own right and which literally has the geometric structure that the affine connection, amongst other things, encodes. In terms of such ontology, one can provide a metaphysical account of the distinction between absolute and relative motion in a way that respects the physical equivalence of inertial frames" [26]. "Space-time as an entity existing separate from the objects contained within it." [27]. "A modern-day substantivalist thinks that spacetime is a kind of thing which can, in consistency with the laws of nature, exist independently of material things (ordinary matter, light, and so on) and which is properly described as having its own properties, over and above the properties of any material things that may occupy parts of it" [28].

In General Relativity, Substantialism has two versions. In the primitive version, space-time is the manifold and in its events the material fields are distributed. In the updated version, called Sophisticated Substantialism, to overcome the indeterminism generated by the hole argument, reopened by Earman and Norton (1987), Leibnitz's principle of the identity of the indiscernible was admitted, causing space-time corresponds to manifold and metric, that is, (M , g), therefore, in the events of this structure the material fields are distributed. In the hole argument, a space-time (M) that contains a material field (T), it submits to an active diffeomorphism, that displaces totally to the spacetime, even through of the hole, empty of matter (H, with T=0). Within of the Hole the transformation of the coordinates of M occurs together with the deformation of the geometric tensor (G) causing, for example that the event x_7, in M to the entry to the hole, corresponds in M to the event x_{20}, in its exit, generating indeterminism.

"In the literature on General Relativity, we find two main types of substantivalism, "manifold substantivalism" and "metric field substantivalism", depending on whether spacetime is identified with the differentiable manifold or with the metric field (plus the manifold)" [29].

In Philosophy, Substantialism has two conceptions of space-time: an idealist and a materialist one. The first is Newton's dualism, in which the two categories of existence are matter and space-time as a non-material substance. The second is that of monism, in which there is only one category of existence subdivided into Matter and material space-time.

The science of physics chose spacetime as a material substance, hence the conception of monistic materialist Substantialism.

"What is the relation between material objects and spacetime regions? Supposing that spacetime regions are one sort of substance, there remains the question of whether or not material objects are a second sort of substance. This is the question of dualistic versus monistic substantivalism. I will defend the monistic view. In particular, I will maintain that material objects should be identified with spacetime regions. There is the spacetime manifold, and the fundamental properties are pinned directly to it......What I am presupposing is that spacetime regions are one sort of substance, where a substance is a fundamental entity. A fundamental entity is basic, ultimate, and irreducible. It is not dependent on, grounded in, or derivative from anything else. Call this view of spacetime substantivalism" [30].

According to materialist substantialism, space-time is a material entity external to Matter of which it is its continent; it is the preferred reference frame existing in nature, with respect to which any movement of material bodies or particles can refer. Thus, the substantialism of space-time breaks with Einstein's principle of relativity because it implies an absolute movement. In addition, it breaks with the principle of equivalence which, based on the equivalence between the inertial and gravitational masses, relativizes the whole movement through the Einstein's principle of equivalence, which makes any type of movement an effect of changing coordinates [31].

On the other hand, the materialist monist substantialism leads to the following crucial questions:

- If spacetime is the container of Matter and spacetime is matter, then what is the container of spacetime?

- If spacetime would be self-contained, then why is not Matter self-contained?

- If spacetime and Matter are of a dynamic nature, then what is the time of spacetime? Why is time an intrinsic property of the material space-time while externally it is a property of Matter and is not time an intrinsic property of Matter?

- If the material space-time has space and Matter would not have space, then why is space an intrinsic property of material space-time while externally it is a property of Matter and space is not an intrinsic property of Matter?

- If all material existence has form and form is its geometry given by its space-time structure then, why is space-time external and not an intrinsic property of Matter?

- If the dynamic space-time is external to the dynamic Matter, then why space-time of the Matter requires externally of the material space-time?

Materialist substantialism recognizes space-time as an intrinsic property of material space-time, but absurdly deprives to the Matter of space-time. Of course, it is much more natural that space-time is the structural property of dynamic matter that, since 2007, the author affirms [7].

5 Space-time and gravitational field to Einstein are nothing

Between August 1912 and March 1914, Einstein, physicist, and Grossman, mathematician, Jewish descendants, met again in Zurich. They making their studies of pre-grade between 1896 and 1900, in the section VI A, specialized in mathematics, physics, and astronomy of the department VI, the School for Mathematics and Science Teachers, of the Swiss Polytechnic School in Zurich. They were classmates during the two first basic years, being colleagues from the same university department in the next two years. They also continued being colleagues during the postgraduate years at the University of Zurich, obtaining the Ph.D Grossmann in 1902 with a thesis. “On the Metric Properties of Collinear Structures", while Einstein in 1905 with the thesis “A New Determination of Molecular Dimensions” dedicated to his friend Grossmann [32]. The three years of delay of Einstein were magnificently compensated since in 1905 also he formulated the "Special Relativity".

In 1907, Albert Einstein sought found a new physical theory based in “physical laws are independent of the state of motion” through of the Einstein principle of equivalence [33], using as frame the Special Relativity and the principle of equivalence between inertial and gravitational masses. However, until 1912, while velocity is relative, the acceleration was absolute due he had wrote that the principle of relativity no holds for accelerated systems [34]. As Poincare and Minkowski, Einstein could not obtain the Relativistic theory of gravity, RTG, from the Special Relativity, despite the great efforts that he made, to formulate the Galilean law of inertia to all arbitrary frame of reference in absence of the strong equivalence principle, SEP. RTG was rejected during its formation due to impossibility of describing the gravity potential by a 4-vector since it was necessary a covariant, second-order, symmetric tensor on a Minkowski´s spacetime in Entwurf theory and on a Lorentzian manifold in General Relativity [31]. In addition, over the years, Einstein established that the principle of equivalence was in total contradiction with Special Relativity, and there did not seem to be a generalization that would save the principles of the latter, therefore, the theory could not be invariant under the transformations of Lorentz, which led him in 1911 and 1912 to develop a scalar theory of the static gravitational field, in which the speed of light plays the role of gravitational potential [34].

Two mathematical events of progressive geometric character propelled Einstein's work transcendently. With time according to the philosophers of science, General Relativity is their equations [35], [36]. These were: in 1908-1909, when Hermann Minkowski introduced "geometric methods and thinking into in Relativity” [34] inspired by the work of Felix Klein on the new non-Euclidean geometries in his Erlangen program. And the second was in 1912-1913 when Grossmann led Einstein to introduce the Absolute Differential Calculus in Relativity.

Thus, the meet again of Einstein and Grossmann in Zurich radically changed the mathematical work of Einstein that went from scalars and vectors to tensors. The Absolute Differential Calculus permit the representation of quantities as geometrical objects, and further permit the statement of relations between such quantities in such a way that they hold in every frame of reference if they held in any [34].

As a mathematician, Grossman presented Einstein with two types of tensors:

(a) Those whose components are transformed as a tensor under arbitrary coordinate transformations (general covariance), therefore, into a spacetime of Riemann´s geometry;

(b) Those whose components are transformed as a tensor under a limited set of coordinate transformations (limited covariance), therefore, into a space-time of Minkowski's geometry.

If Einstein chose the first type, he would achieve what in the past was his goal of making a general relativistic physical theory obtained as an mathematical intrinsic property of the general covariance of the Riemann´s tensors; however as a physicist, Einstein chose the tensors of the second type, to preserve the law of conservation of the impulse-energy of the material process and the static gravitational field as a whole, therefore, giving it, also, material character, formulating the Entwurf´s theory, in June 1913, the best work done by him in collaboration with Grossmann; but the equations failed, in the Newtonian limit, to obtain the law of newton's gravity and, also, to give the anomalous orbit of Mercury. Entwurf´s theory …"the $t_{\mu\nu}$ characterize the stress-energy components of the gravitational field in a manner analogous to the way in which the quantities $T_{\mu\nu}$ characterize those of the material process" [37] (See Eq. 2) … "the gravitational field… is thus a physical state of space that simultaneously determines gravitation, inertia, and the metric" [38]. To justify the limited covariance, Einstein built the hole´s argument.

Between 1911 and 1913, Einstein was abandoning Einstein Equivalence Principle, recognizing the static gravitational field as a physical field and not a simple coordinate effect, more exactly as an energetic phenomenon until in the Entwurf´s theory to determine it through the tensor $t_{\mu\nu}$ as a material field, thus integrally conserving the law of energy, only possible in a space-time of Minkowski.

Within the framework of the Entwurf´s theory, since the static gravitational field is considered a material field, "in 1913, at the eighty-fifth congress of the German Natural Scientists and Physicists in Vienna, Einstein started to think about gravitational waves" [39] and in the after discussion, to this talk, "Max Born asked Einstein about the speed of propagation of gravitation, whether the speed would be that of the velocity of light. Einstein replied that it is extremely simple to write down the equations for the case in which the disturbance in the field is extremely small. In that case the metric tensor components differ only infinitesimally from the metric without a disturbance, and the disturbance would propagate with the velocity of light. Einstein also told Born that this is a mathematically complicated problem, because in general it is difficult to find solutions to the field equations which are non-linear" [39].

Previously to Einstein, in 1893, Oliver Heaviside, in 1905, Henry Poincare and, in 1912, Max Abraham formulated the existence of gravitational waves propagating with finite speed and originated with the changes of a gravitational field due to the movement of the attracting masses, for Abraham by an accelerated mass. They consider the gravitational field analog to the electromagnetic field, for Abraham as the gravitational potential energy of the field itself [40].

At the end of 1913, Einstein “is offered the membership in the Prussian Academy of Sciences as well as a professorship at the University of Berlin without the need to teach and the management of the still to be founded Kaiser Wilhelm Institute for Physics. On November 12 Einstein’s membership in the Academy is approved of by Wilhelm II, German Emperor and King of Prussia, and Einstein accepts the offer of the “Berliners” on December 7” [41]. At the beginning of April of 1914, Einstein arrived to Berlin ending with the collaboration of Grossmann.

General Relativity did not arise from the further development of Entwurf's theory; about seventy years later Logunov achieved it with "The Relativistic Theory of Gravitation", but from a deep personal crisis of Einstein in the face of stiff competition, begun in July 1915, with the best german mathematician of the time, David Hilbert, who worked similar equations, threatening to overcome him. Einstein's competition with Hilbert became critical in the end they exchanged letters almost daily.

On November 18, 1915, Einstein, aware that Hilbert was working the tensors in Riemann's space-time and supported by the previous collaboration of his Jewish-Italian friend Michele Besso, achieved success by matching his general covariant equations with the correct calculations of the anomalous orbit of Mercury. Therefore, the premise of limited covariance, imperative to save the gravitational field with stress-energy was abandoned. Einstein declared the last three years lost due to "an error of judgment". “My efforts in recent years were directed toward basing a general theory of relativity, also for non-uniform motion, upon the supposition of relativity. I believed indeed to have found the only law of gravitation that complies with a reasonably formulated postulate of general relativity; and I tried to demonstrate the truth of precisely this solution in a paper that appeared last year. Renewed criticism showed to me that this truth is absolutely impossible to show in the manner suggested." [42].

In this desperate scenario, Einstein went on to use the equations of the first type of tensors that Grossmann had offered him, definitively adopting the general covariance in a space-time of semi Riemann (Lorentz). Einstein, with the help of his friend, the philosopher Moritz Schlick, elaborated "the point argument coincidence" to nullify his hole´s argument. Thus, Einstein had to choose the general covariance, ending the gravitational field with stress-energy. “The most important feature of the Einstein’s equations is that the right part of equations (Eq. 1) does not include the energy-momentum of the gravity field itself, and this corresponds the fact that in General Relativity the gravity is not a material field” [43]. In 1913, in Entwurf's theory, Einstein and Grossmann emphasized that the gravitational field should have an energy- impulse tensor like any physical field and they had warned that otherwise “there would be untenable consequences” [44]. To Einstein, from that moment it was not more importance although “requirement of general covariance.., takes away from space and time the last remnant of physical objectivity...” [35]. “How could physicists talk about gravitational energy in the framework of general relativity? There is no gravitational field and no gravitational force; the gravitational field is at best a geometric not a physical field, and as such it does not possess any energy. Moreover, the mathematical formalism of general relativity itself refuses to yield a proper (tensorial) expression for gravitational energy and momentum." [45].

In General Relativity, Einstein, returning to a point passed in time, in the line of development of his works on gravitation, adhered to the Riemannian geometry where the differences in mass concentration within a cosmic distribution cause a non-homogeneous curvature in space-time geometric, with greater curvature where the concentration of mass is greater. The Riemann tensor, also called tidal force tensor, provides the curvature of geometric spacetime.

In 1918, Emmy Noether showed that the symmetry of Minkowski space tensor is the cause of conservation of energy-impulse of a physical field and Schrodinger proved that the mathematical object suggested by Einstein in his General Relativity for describing the energy-momentum of the gravity field, it can disappear by means of a coordinate transformation for the Schwarzschild solution if that solution is transformed into Cartesian coordinates. In addition, Bauer noted that Einstein's energy-impulse object, when calculated for a flat space-time but in a curvilinear system of coordinates, leads to a nonzero result. In other words, it can be zero when it should not be, and it can be non-zero when it should. Einstein replied that he had withdrawn his claim of 1913, of Entwurf's theory, since "There may be gravitational fields without stress and energy density" [43]. "As it was noted 90 years ago by Hilbert (1917), Einstein (1918), Schrodinger (1918) and Bauer (1918) within geometrical gravity approach (General Relativity) there is no tensor characteristics of the energy-momentum for the gravity field" [43]. The same thing happened to Einstein as to Newton that, without knowing what gravity is, their equations work. "When in 1687 Isaac Newton introduced his law of gravity, it described in a single equation the gravitational attraction between any two objects. The striking thing was, whereas most previously known forces arose when two objects pushed or pulled each other via physical contact, Newton's gravitational force evidently operated across great voids of empty space. Such "action at a distance" disturbed fellow philosophers, who demanded to know how gravity was transmitted from the Earth to the Moon. Newton's celebrated reply was "Hypotheses non fingo," which loosely translates as, "Guys, I haven't the faintest idea, but the equation works." [40].

The philosophical theories supported by the mathematical model, $G_{\mu\nu} = kT_{\mu\nu}$ of the General Relativity are strictly restricted to:

- For dualistic idealist Substantialism, space-time is a fundamental metaphysical entity, i.e., an immaterial entity whose curvature is the static gravitational field, i.e., a geometrical property of space-time; therefore they are nothing.

- For idealistic Relationalism, space-time is a category of the thought that expresses metric relations encoded in the static gravitational field, which is a geometric field; therefore they are nothing.

The other alternatives theories that grant materiality to space-time or to gravitational field require of a mathematical model of the form $G_{\mu\nu} = k(T_{\mu\nu} + t_{\mu\nu})$ typical of the Entwurf´s theory. Remember that the Einstein´s equations of General Relativity are without the term $t_{\mu\nu}$:

- For monistic materialist Substantialism, the space-time is a special substance that belongs to the material substances whose geometry is the static gravitational field, i.e., a geometrical property of the material space-time; therefore static gravitational field is nothing like in Schaffer, 2009; Turishev, 2011; Worden, 2012 and Delplace, 2014. Thus, the gravitational field is no longer a physical field that exists in spacetime; it is now part of the geometry of space-time, degrading the state of the gravitational field from physics to geometry.

- For materialist Relationalism, space-time is a category of the thought that expresses metric relationships encoded in the gravitational field, which is a dynamic material field; therefore space-time is nothing, as indirectly in Lorentz, 1916; Weyl, 1918; Eddington, 1920 because they considered $g_{\mu\nu}$ generated by the relativistic aether and directly in Cala, 2006; Bain, 2014, etc., because they do not differentiate between the static gravitational field of the metric tensor and the dynamic gravitational field that would be of the energy-impulse tensor. Thus, the metric field is physically real and is the gravitational field, raising the metric field from geometry to physics.

Of the other hand, for the author the space-time is the structural geometric form of dynamic Matter [7], therefore space-time are not conditions of existence of Matter but geometrical properties of Matter, because any real thing, in the Universe, has dynamic existence, with spatial properties and as a process with temporary duration.

As it was exposed, in the numbers 1, 2, 3 and 4, the conception on the space-time of the science of the physics of Caltech-NASA and the philosophy of Bunge-Romero like a material entity corresponds to the monist materialism Substantialism that it is not compatible with the equations of General Relativity.

6 The static gravitational field as relativistic ether

Hendrik Antoon Lorentz studied at the University of Leiden, where he was later a professor of theoretical physics between 1878 and 1883, he was author between 1892 and 1895 of the ether theory (LET) based on a completely motionless ether, Nobel Prize in Physics of the year 1902, died in 1928.

In 1895, Lorentz formulated the "corresponding states theorem" for the terms of order v/c, which states that observers in inertial motion and rest in relation to the ether make the same observations. But when changing the inertial frames, it is necessary to change the space-time variables. Because both the contraction of physical length, to explain the Michelson-Morley experiment, and the dilation of time, to explain the aberration of light and the Fizeau experiment occur. The dilatation is of coordinate time, which is a mathematical local time, respect to the time indicated by clocks in rest in the ether, which is the proper time or the "true" time. Those changes led to the transformation of Lorentz that replaces that of Galilei.

In 1900, Lorentz explained gravity using the Maxwell equations and the Le Sage model on gravity. His idea was that there is a field of universal electromagnetic radiation, very penetrating, that exerts a uniform pressure on all bodies. If that incident energy is completely absorbed by the bodies, Lorentz showed that an attractive force would arise between them, but as it must lead to a huge heating of the bodies, which is not observed, Lorentz abandoned his hypothesis.

In 1904, Lorentz presented his theory of the electron-ether, in which the electrons (matter) reside in completely immobile ether, without interaction with them. This ether is an electromagnetic field, which acts as a mediator between electrons and changes in this field, propagating at speed c.

In 1905, Albert Einstein formulated Special Relativity, using the Galilei principle of relative motion in the inertial frames, ending with the privileged frame of universal reference and, therefore, with the luminiferous ether. Based on the Michelson-Morley experiment that did not detect the translation movement of the Earth around the Sun through the drag of the supposed ether, Einstein wrote: “The introduction of a “luminiferous ether” will prove to be superfluous inasmuch as the view here to be developed will not require an “absolutely stationary space” provided with special properties, nor assign a velocity-vector to a point of the empty space in which electromagnetic processes take place” [46]. In addition, in the same month of 1905, in his work on the photoelectric effect, with which he won the Nobel Prize in 1921 that he received in 1922, Einstein demonstrated that light are photons that have a "wave nature" [47]. Light as photons does not need a means to travel.

In 1911, Lorentz in his lectures, who had not accepted the disappearance of the ether, declared that "the theory of relativity has to say ... can be carried out independently of what one thinks of the aether and the time". "whether there is an aether or not, electromagnetic fields certainly exist, and so also does the energy of the electrical oscillations" [48]. Today we know that electromagnetic waves propagate not in absolutely empty space, as Einstein believed, but in the quantum vacuum, mainly compound of electromagnetic static fields, in which the universe is immersed.

In 1916, Einstein published the final version of General Relativity, which according to the general covariance, space-time, is a relational ideal geometric object, obviously without material properties, but in June of that year, after an exchange of letters with Lorentz, he identified spacetime with the relativistic ether, which of course, implies physical attributes, totally alien to the electromagnetic ether that he had rejected in Special Relativity. This hypothesis was formally presented in 1918. “Einstein identified the gravitational aether with the static gravitational field and this field with the spacetime that he called the metric field.. of who arises physical properties” [49].

Lorentz was who led to Einstein to formulate the relativistic ether through of successive letters until that Einstein accepted. “On June 6th, 1916, Lorentz wrote a long, article-like letter, in which he tried to convince Einstein that the General Relativity Theory allows the hypothesis of immobile stationary ether. In his reply, Einstein proposed a definition of new relativistic ether that can be expressed in the following short form:

field $g_{\mu\nu}$ = ether

In his letter to Lorentz of June 17th, 1916 we read:

I agree with you that the general theory of relativity is closer to the ether hypothesis than the special theory. This new ether theory, however, would not violate the principle of relativity, because the state of this $g_{\mu\nu}$ = ether would not be that of rigid body in an independent state of motion, but every state of motion would be a function of position determined by material processes." [50].

Lorentz exerted a great influence in the scientific community obtained as Nobel Prize. Probably Lorentz realized the impossible geometric explanation about the gravity of General Relativity, so he pressed Einstein until he had to introduce the relativistic ether contrary to his equations that absolutely exclude it.

Lorentz's vision of General Relativity was gradually adopted by Einstein's scientific friends who made the pressure on him stronger. In 1918, Weyl said: the metric field described by the coefficients g_{uv} is more aether that gravitational field and, in 1920, before of the conference of Einstein in Leyden, Eddington declared similarly to Weyl.

In 1918, Einstein said: while according to the special theory of relativity a part of space without matter and without electromagnetic field seems to be characterized as absolutely empty, e. g. not characterized by any physical quantities, empty space in this sense has according to the general theory of relativity physical qualities which are mathematically characterized by the components of the gravitational potential, that determine the metrical behavior of this part of space as well as its gravitational field. One can quite well construe this circumstance in such a way that one speaks of an aether, whose state of being is different from point to point. Only one must take care not to attribute to this aether properties similar to properties of matter (for example every point a certain velocity) [51].

In 1920, Einstein presented his theory on the relativistic gravitational ether in a lecture at the University of Leyden, former cloister of Lorentz. From this lecture Romero supports his thesis on Einstein's materialist view of spacetime, but Romero ignores that it was due to the pressure exerted on Einstein in contradiction with the equations of General Relativity. Einstein emphasized on the need for relativistic ether to remove action to distance and he left the relationist model of space-time and adopted the substantialist model of spacetime, i.e the spacetime is a geometric object with a real existence although is a contingent existence. He said: "How does it come about that alongside of the idea of ponderable matter, which is derived by abstraction from everyday life, the physicists set the idea of the existence of another kind of matter, the aether? The explanation is probably to be sought in those phenomena which have given rise to the theory of action at a distance.. assuming that the Newtonian action at a distance is only apparently immediate action at a distance, but in truth is conveyed by a medium permeating space, whether by movements or by elastic deformation of this medium. Thus the endeavor toward a unified view of the nature of forces leads to the hypothesis of an aether... inertial resistance opposed to relative acceleration of distant masses presupposes action at a distance; and as the modern physicist does not believe that he may accept this action at a distance, he comes back once more, if he follows Mach, to the aether, which has to serve as medium for the effects of inertia. But this conception of the aether to which we are led by Mach's way of thinking differs essentially from the ether as conceived by

Newton, by Fresnel, and by Lorentz. Mach's ether not only conditions the behavior of inert masses, but is also conditioned in its state by them... Mach's idea finds its full development in the ether of the general of relativity. According to this theory the metric qualities of the continuum of spacetime differ in the environment of different points of spacetime, and are partly conditioned by the matter existing outside of the territory under consideration. This space-time variability of the reciprocal relations of the standards of space and time, or, perhaps, the recognition of the fact that "empty space" in its physical relation is neither homogeneous nor isotropic, compelling us to describe its state by ten functions (the gravitation potentials), has, I think, finally disposed of the view that space is physically empty. But there with the conception of the aether has again acquired an intelligible content, although this content differs widely from that of the aether of the mechanical undulatory theory of light. The aether of the general theory of relativity is a medium which is itself devoid of all mechanical and kinemassic qualities, but helps to determine mechanical (and electromagnetic) events... What is fundamentally new in the aether of the general theory of relativity as opposed to the aether of Lorentz consists in this, that the state of the former is at every place determined by connections with the matter and the state of the aether in neighbouring places, which are amenable to law in the form of differential equations; whereas the state of the Lorentzian aether in the absence of electromagnetic fields is conditioned by nothing outside itself, and is everywhere the same... I think, that the ether of the general theory of relativity is the outcome of the Lorentzian ether, through 'relativation'... If we consider the gravitational field and the electromagnetic field from the standpoint of the ether hypothesis, we find a remarkable difference between the two. There can be no space nor any part of space without gravitational potentials; for these confer upon space its metrical qualities, without which it cannot be imagined at all. The existence of the gravitational field is inseparably bound up with the existence of space. On the other hand a part of space may very well be imagined without an electromagnetic field; thus in contrast with the gravitational field, the electromagnetic field seems to be only secondarily linked to the aether, the formal nature of the electromagnetic field being as yet in no way determined by that of gravitational aether... 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 the universe presents two realities which are completely separated from each other conceptually, although connected causally, namely, gravitational ether and electromagnetic field, or as they might also be called space and matter [52].

Lorentz and other scientists as Michelson and Heaviside continued defending the ether until their last days, to end of decade 1920. During the next decade of 1930, the word ether fell into disuse. The scientists changed the concept of ether by the concept of field, used currently [49].

With the death of Lorentz his influence in the scientific community was extinguishing. In addition, in 1933, Einstein immigrated to the United States although there he would live new confrontations. Thus, Einstein separated from the relativist ether. In 1934, Einstein stated that for physical reasons, gravity, spacetime is the static gravitational field which in turn is determined by physical factors. Of course, there is a symmetrical relationship between geometry and physics, since for physical reasons arises geometry and of this arises physical properties. Regarding the relationship, in the sense from physics to geometry Einstein said: “On physical grounds it was assumed that the metrical field was at the same time the gravitational field... Since the gravitational field is determined by the configuration of masses and changes with it, the geometric structure of this space is also dependent on physical factors. Thus, according to this theory space is exactly as Riemann guessed no longer absolute; its structure depends on physical influences. (Physical) geometry is no longer an isolated self-contained science like the geometry of Euclid" [53].

In 1938, the final rupture of Einstein and the relativist ether occurred when he wrote: "Our only way out seems to be to take for granted the fact that space has the physical property of transmitting electromagnetic waves, and not to bother too much about the meaning of this statement. We may still use the word ether, but only to express some physical property of space." … "At the moment it no longer stands for a medium built up of particles." "The electromagnetic field carries energy which, once emitted from its source, leads an independent existence." "If the Galilean relativity principle is valid, then motion through ether makes no sense at all. It is impossible to reconcile these two ideas." "After such bad experiences, this is the moment to forget the ether 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." [54].

In effect, the ether was replaced by the field, disappearing from normal science. In 1954, close to death, Einstein returned to his thesis of General Relativity, final version of 1916. He wrote "space-time has no independent existence of the field" and "the gravitational field are the g_{uv} functions", that is, the geometric and causal relationships between events (such as distance, volume, curvature, angle, present, past and future) that lead us to think that space -time is a structural property of a geometric field [24].

7 Gravitational waves to Einstein

Of course, if as a consequence of the Lorentz pressure, Einstein accepted that the static gravitational field is ether, then, as a material field, its variations will propagate, like gravitational waves with a finite speed. Thus, Einstein had to resume the line of research, interrupted in 1913, on gravitational waves to answer what is its nature? And, particularly to Born, what is your speed?

Obviously, Einstein had to face a very difficult challenge with which he could not be intimately in agreement since his equations did not support the static gravitational field as material but geometric. "After completing his General theory of Relativity in 1916, he initially dismissed the idea of gravitational waves, and his first paper dedicated to the subject got the description very wrong. Einstein soon hit on the correct formulation, but two decades later he rejected the physical reality of gravitational waves, and he remained skeptical about them for the rest of his life." [40].

On 22 June 1916, from the mathematical model, Einstein formulated the existence of gravitational wave caused by perturbations at values of g_{uv} that it should propagate through space. "Einstein presented to the Prussian Academy of Sciences a paper on gravitational waves, published later under the title, "Approximate Integration of the Field Equations of Gravitation". In this paper he considered the weak field linearized approximation" [39].

Due to the complexity of the original equations of General Relativity, Einstein worked with an infinitely weak gravitational field in frames with low v/c, mathematically expressed in the linearized version:

$$g_{\mu\nu} = -\eta_{\mu\nu} + h_{\mu\nu} \quad \text{(Eq. 3)}$$

”It was de Sitter who gave Einstein the idea to follow this route by sending him the values of the metric previous in a letter” [55]. The $\eta_{\mu\nu}$ are the metric coefficients in the flat space-time of Minkowski. The $h_{\mu\nu}$ are metric perturbations. However, Einstein calculated $h_{\mu\nu}$ in a manner analogous to the retarded potentials of Liénard-Wiechert in electrodynamics. Being that both are not metric expressions of a perturbation that occurs in a material phenomenon, since this is true in electrodynamics, but false in the static geometric gravitational field. “From this follow next that gravitational fields propagate at speed of the light” [39], conclusion based in a spurious similarity. Actually, according to Einstein, gravity lacks speed, because even if the energy-impulse tensor changes its configuration, the speed will be the propagation of that change, i.e., a wave of matter not of the metric tensor. “General relativity explains …. by suggesting that gravitation (unlike electromagnetic forces) is a pure geometric effect of curved space-time, not a force of nature that propagates” [56].

From this exploratory mathematical exercise, the result was the equations of six possible gravitational waves grouped into two types of longitudinal and transverse waves that were apparent waves because they do not transport energy while the third of a new type of wave, because it transports energy, Einstein considered it real. However, the mathematical results obtained by Nordström, 1917, and Schrödinger, 1918, contradicted Einstein [39], who in his new article: "Graber Gravitationswallen" [57], published in February 1918, corrected his error.

In his paper of 1918, “Einstein discovered that a source emitting gravitational waves will slowly lose energy transported away by these waves“. “Einstein wrote the quadrupole formula that describes the rate of energy loss due to emission of gravitational waves from a binary mechanical system” [39]. The new result only gave the two standard types of longitudinal and transverse waves of physics. As the longitudinal waves do not transport energy, they were discarded. Therefore, Einstein deduced that, like the electromagnetic wave, the gravitational wave is a transverse wave, but it is a quadrupole wave, while the electromagnetic wave is a dipole wave. The quadrupole wave would shrink and stretch matter simultaneously in two perpendicular directions.

In 1936, Einstein and Rosen sent the document: "Do Gravitational Waves Exist?" to "The Physical Review". They argued that gravitational waves do not exist. Einstein had already told Max Born, after two years of reflection on this subject. The work was rejected by the referee Harvey Robertson, professor of Princeton, citizen of EE. UU, while Einstein was a distinguished immigrant. Due to the departure of Rosen for Russia, Einstein had as an assistant Leopold Infeld, who agreed with Robertson, his secret interlocutor, that Einstein and Rosen were wrong. Infeld presented, to Einstein, Robertson's solution of the cylindrical gravitational wave instead of the flat wave, valid locally. Einstein said he had also found an error that he corrected with Infeld but Einstein thanked ironically to Robertson, causing him annoying surprise. Pressed again, Einstein reintroduced the existence of the gravitational wave, and changed the name of his article and of Rosen as "On gravitational waves" that was published, in 1937, by the "Journal of the Franklin Institute" [58]. Einstein never again sent his new papers to "The Physical Review".

In 1938, leaving aside any tactical engagement with Robertson, “Einstein proposed a new method of approximation for determining the gravitational field of a moving particle – choose a weak field approximation and consider very low accelerations”. “Einstein with his assistants, Infeld and Hoffmann, calculated the first two stages of this approximation and found that in the first stage the equations of motion take the Newtonian form. In this approximation, if we consider very low accelerations then the exact equations of motion indeed take the Newtonian form and we obtain a material particle that cannot radiate. In this state of affairs, we have revived the good old assumption that there could be no gravitational waves” [58]. Einstein, Leopold Infeld and Banesh Hoffmann published, in 1938, "The gravitational equations and the problem of motion" in “Annals of Mathematics”, remember that, also in that year, Einstein definitely broke with the relativist ether. Thus, Einstein achieved his full autonomy; Einstein itself and to itself. But the mathematical physicists follow adhered to the mathematical model and intuitively devotees of the Substantivalism although to their backs.

“Like most scientific concepts, that of gravitational waves emerged over many years, through the work of numerous architects. Those architects were neither naïfs nor plagiarists. They were merely scientists working in sometimes friendly and sometimes not-so-friendly competition, seeking to solve a long-recognized problem. In those efforts, they may well have believed they were being less revolutionary than evolutionary” [40].

Without the consent of Einstein, behind his back, according to his equations, a majority group of recognized physicists supports the radiation of gravitational waves that, in the lowest order, would be proportional to the quadrupole moment of the distribution of the mass of energy, from a local region. This radiation would originate in the loss of mechanical energy, i.e, kinetic and/or potential, during the non-uniform accelerations produced in the large cosmic structures within the region. Therefore, from the interacting masses there is no radiation of gravitons but from the orbital energy there is electromagnetic radiation, although they declare that is gravitational radiation.

However, its mechanical origin, the lost energy would appear in the undulations of the curvature of space-time, of course, absurdly assuming it as material, from the naive interpretation of a current of primitive thought that conceived the interstellar medium as if it were space in itself, that is, naked, absolutely devoid of matter, absolutely empty, serving as the container of matter, nowadays, updated as a material container, in every rule.

“The gravitational field is not a physical field possessing an energy-momentum density. Consequently, Einstein´s formula for gravitational waves does not follow from General Relativity. The gravitational wave flux can always be destroyed by the proper selection of the reference frame and, hence, the quadrupole formula for gravitational wave is not a corollary of General Relativity. Basically it does not follow from General Relativity that a binary system loses energy in the form of gravitational waves” [59].

“If substantivalism hypothesis were true then the bare spacetime would exist, i.e. the absolute empty would exist therefore, the spacetime could be observed directly. Furthermore, as said

Aristotle, the vacuum is something because whether vacuum was nothing it not would exist. Of course, without vacuum all matter it would rush upon itself to form an unstable Universe that would implode". "Universe is quantum vacuum, matter and radiation. They are material forms of existence, by being objectives and, have physical reality, in last instance, they are the Matter. Quantum vacuum is a medium that permeates totally the Universe, mainly the called outer space, i.e the space almost totally emptiness between stars, where the density is 10^{-24} g/cm^3, and in the Universe 10^{-30} g/cm^3 and empty regions in space 10^{-33} g/cm^3 [60]. Also, atoms are mostly empty space, more than 99,999 percent. This means that Matter is mainly quantum vacuum" [61].

In 1998, Tom Van Flandern wrote "it seems fairly certain that, if gravitational radiation exists, its waves will propagate at the speed of light. In what way this type of disturbance of space-time may differ from very-long-wavelength electromagnetic disturbances of space-time, if indeed it does differ, remains to be seen". In addiction based on his exercises on "predicted period changes that would result if gravity propagated at the speed of light in a manner analogous to electromagnetic forces are orders of magnitude larger than the observed period changes" [56] of the binary pulsars PSR1913 + 16, and PSR1534 + 12, Tom Van Flandern wrote that the waves radiated by binary pulsars are not gravity waves, but are a form of electromagnetism, "we can set a lower limit to the speed of gravity as an electromagnetic-type propagating force"[56]. The radiation attributable to gravitational waves of those referred binary pulsars is the unexplained remainder, which results once all the known electromagnetic-mechanical effects that cause the loss of energy that can reappear in the form of radiation are included.

The radiation of the binary pulsar Hulse-Taylor, PSR B1913 + 16, is in agreement with the rate of orbital decay predicted by the Einstein equations of quadrupole radiation, although the value is higher, approximately 0.3%. According to Einstein's equations, the real graviton is of mass 0, that is, gravitational waves would lack gravitons. However, when the orbital decay rates of the binary pulsars PSR B1913 + 16 and PSR B1534 + 12 are combined, it is obtained that the mass of the real graviton is not zero but maximum lower than 1.35342×10^{-52} grams, with 90% confidence. This upper limit for the mass of the actual graviton was calculated, in 2002, by Lee Samuel Finn and Patrick J. Sutton, from the Center for Gravitational Wave Physics, Pennsylvania State University, USA [62] and it is very close to the value of the upper limit of the mass of the real photon of 1.2×10^{-51} grams, according to the calculi of 2003, that Jun Luo and colleagues realized [63], at the Huazhong University of Science and Technology in Wuhan, China. And very far from the upper limit value of the mass of the real graviton less than 4.5×10^{-66} grams, that, in 1997, SS Gershtein, AA Logunov and MA Mestvirishvili calculated, with base on the observed parameters of the expansion of the Universe [64], which is consistent with the value less than 0.5×10^{-65} grams that, in 1968, K Staniukovich and M Vasiliev estimated [65]. Therefore, the radiation of binary pulsars maybe some type of electromagnetic radiation, as Tom Van Flandern wrote.

On the other hand, Caltech and NASA do not agree with what LIGO detected. While for Caltech "Gravitational waves are 'ripples' in the fabric of spacetime caused by some of the most violent and energetic processes in the Universe" [12], for NASA "A gravitational wave is an invisible (yet incredibly fast) ripple in space" [13]. Of course, Caltech operator of LIGO affirms that LIGO detected waves that it would propagate in five dimensions, since In General Relativity, “The concept of gravitational wave in this theory is in contradiction with its equations. Gravitational waves consist on propagation of oscillations of spacetime itself, all dimensions must be taken into account. But, according to the equations, they consist on the propagation of the oscillations of X and Y dimensions of spacetime in the Z direction. This way, gravitational waves are really waves in space, exactly, quadrupole waves. This is actually the universally known and accepted definition. There is a big difference between both definitions. According to a mathematical law for N dimensional spaces, a variation in an N dimension space generates an N+1 dimension space. If spacetime has 4 dimensions, its oscillations must propagate in 5 dimensions” [66]. I do not agree with Caltech. Obviously, from our 4-dimensional World it is not possible to access 5 dimensions therefore, what was it that LIGO detected?

NASA correctly understands that the equations of Einstein's gravitational waves are waves of space. “Gravitational waves cannot be experimentally discovered and measured, since it is physically impossible to reach the five dimensions, starting from four dimensions. However, the partial reconfigurations of spacetime will propagate in 4D, for example, when the dimension of the time, according to an observer, does not intervene. These partial spacetime waves it can detect” [66]. So, can we say gravitational waves?

In 2006, the author from the formal, non-ontological point of view, supervised Einstein's equations of gravitational waves and the author found that they are spatial waves. The spatiotemporal equations would be of type Eq. 4, built by the author [66]:

$$(\nabla^2 - \frac{\partial^2}{c^2 \partial t^2}) h_{\mu\nu} = 0 \; where \; \mu = (1,5) \nu = (1,5) \quad \text{(Eq. 4)}$$

While Einstein´s equation are [67]:

$$(\nabla^2 - \frac{\partial^2}{c^2 \partial t^2}) h_{\mu\nu} = 0 \; where \; \mu = (1,4) \nu = (1,4) \quad \text{(Eq. 5)}$$

Therefore, I agree with NASA. Even so, formally, Einstein's equations are not gravitational waves, since they only refer to spatial waves.

Now, from the ontological point of view, according to the hypothesis of the author, the quadrupole waves would originate in the process of transformation of the mechanical energy of a stellar asymmetric event to some type of complex electromagnetic energy since it is caused by a double dipole that gathers the energy relation of four non-symmetrical angular moments, of two cosmic masses, or equivalent cosmic phenomenon, that through a new transformation of such complex electromagnetic energy to the quantum mechanical energy of the quadrupole waves, into the structure of the quantum vacuum, it would propagates as perturbations of this material medium, similar to any other physical wave, because “quantum vacuum satisfies the functions that were attributed to the ether, specially, in the close approximation of Lorentz, theoretical support of his proved electrodynamics of moving bodies [33], without the inconvenient of its mechanical fermionic structure, because the quantum vacuum is a bosonic medium, elastic, gifted of inertia, subject to the superposition principle of Bose-Einstein, and viscous fluid nature that in the Gravity Probe-B, NASA [10], [11], [68] attributes mistakenly to the spacetime deduced of General Relativity. Therefore, vacuum supports the transport of transverse waves” [61].

The ”vacuum is not really empty. It is filled with virtual particles, which are in a continuous state of fluctuation. Virtual particle-antiparticle pair can be created from vacuum and annihilated back to vacuum. These virtual particles are created in quantum vacuum fluctuations, which are the temporary change in the amount of energy in a point in space, as explained by Heisenberg uncertainty: $\Delta E.\Delta T \geq \hbar/4\pi$. Virtual photons are the dominant virtual particles, but other particles produced as well. As vacuum is as a superposition of many different states of electromagnetic field, the creation and subsequent absorption of a photon by the vacuum implies the vacuum fluctuates [69]” [61].

“From the cosmology, near thirty three years later, starting in 1980, when worked in the two first years with Gennady Chibisov in the Lebedev Physical Institute, Viatcheslav Mukhanov, established that in the present the structure of the Universe in the scale ≤ 10^{-27} cm [70] are quantum fluctuations, that produced originally the spectrum of inhomogeneities, as the galaxies and their clusters, in the early Universe [71]. Thus, they are authors of the theory of Quantum Origin of the Universe Structure. The numerous experiments, during the era of the high precision cosmology, characterized by the use of the satellites COBE, in 1992, WMAP, in 2003, and completed by mission Planck, in 2013, in which there were measured the temperature fluctuations of the Cosmic Microwave Background Radiation, CMB, discovery by Penzias and Wilson in 1965, are in highly agree with their predictions confirmed definitely that assures us that everything in our Universe was originated from quantum fluctuations. CMB measurements have robustly proved quantum origin of the Universe structure irrespective of any alternative theories to inflation” [61].

8. Conclusions

After centuries, the science of physics has taken a big step by having today a definition of space-time as a substantial entity with material properties of viscous and elastic fluid, a material medium for the generation and propagation of quadrupole, transverse gravitational waves, with velocity c, which they would originate , in the cosmic events of immense energy radiation as occurs in the coalescence of a binary pair of black hole (perhaps dark stars), which although this concept not yet reaches unanimity in the scientific community as such, is a starting point, for the process of criticism and conceptual change, which is proper in the context of fallible science.

On the other hand, in the inevitable adjustment of correspondence between the science of physics and the philosophy of science, it has put an end to the long dispute of more than a century between the Sustantivalism and the Relationalism in favor of the first, from the science and by mandate of it. Today, only the sustantivalist interpretation of spacetime is possible.

There were four combined elements that, from one moment to another, produced an unexpected qualitative leap in thought, in the philosophy of science and in the science of physics. These were: the equations, of 1918, of Einstein on the gravitational waves; the stream of physicists who believe in the existence of those waves, according to those equations, which Einstein abandoned, in 1938; the fabulous engineers of the LIGO project and the economic interest in the industrial development of the complex technology, of high precision laser interferometry to detect effects of quadrupole waves like the Tianqin satellite project. Nowadays, through of international cooperation, medium-term objective is build a gravitational wave detection network that covers the entire gravitational spectrum (source: MG15, University of Rome "La Sapienza" - Rome, from June 1 to 7, 2018), similar to the one existing for the electromagnetic spectrum. In any case, this constitutes an advance in the understanding of the physics of the universe, although these waves are not true gravitational waves, since the nature of the gravitational phenomenon has not yet been understood.

Under the pressure of Lorentz, Einstein had to adopt the apparent materiality of the static gravitational field, which he called relativistic ether and respond: What is the speed of gravity? Therefore, necessarily, Einstein had to formulate the existence of gravitational waves, which he abandoned as soon as he could. But, relativistic physicists did not.

As a result of the Gravity Probe B, which was confirmed in the supposed gravitational waves detected by LIGO, spacetime is a material entity. The theory of fluid time-space confers intrinsically space-time to that surprising material substance that would be externally the space-time of Matter intrinsically without space-time. Therefore, space-time as a structural geometric property of dynamic matter (radiation, matter and quantum vacuum) is a much more natural hypothesis.

The conceptual contradiction, existent between NASA and Caltech about gravitational waves, stablishes that from Einstein´s equations of gravity (1915), in particular, from Einstein´s equation of gravitational waves (1918), there is not gravitational waves in the sense of waves of perturbations of space-time because those are perturbations of only space according NASA. If Einstein´s equations of gravitational waves are modified for include perturbations of space-time according Caltech, paradoxically operator of LIGO, they would propagate in five dimensions and they do not would detect.

The stellar asymmetric events originate, through the process of transformation of mechanical energy, to some complex electromagnetic energy, since it is caused by a double dipole that gathers the energy relation of four non-symmetrical angular moments, of two stellar masses or equivalent cosmic phenomenon. By means of a new transformation of such complex electromagnetic energy to quantum mechanical energy, into the structure of the quantum vacuum, it would propagate as perturbations of this material medium, producing quadrupole waves, of the quantum vacuum similar to any other physical wave.

9 References

[1] Lorente, M. (2007). El espacio-tiempo sigue siendo un enigma para la ciencia y la filosofía: Tendencias 21

[2] Odenwald, S. (2015). What happens to the fabric of space-time when an object moves through it near the speed of light?: Gravity Probe B

[3] Ranzan, Conrad. (2005 rev 2009-10). Relativity of Time in the Aether Medium of the DSSU – Absolute Motion and Intrinsic Time: Published on the Cellular Universe

[4] International Society for the Advanced Study of Space-time. (2018). Question of the nature of space-time: http://www.spacetimesociety.org/

[5] Institute for Foundational Studies Hermann Minkowski. (2018). Fifth International Conference on the Nature and Ontology of Space-time: http://www.minkowskiinstitute.org/conference

[6] Musser, George. (2018). What is spacetime?: Nature 557, S3-S6

[7] Guillen, A. L. (2010). Spacetime structural property of the matter in movement: Relativity, Gravity and Geometry Petrov 2010 Anniversary Symposium on General Relativity and Gravitation 1-6 November 2010, Kazan Contributed papers, pages 101-109

[8] Guillen Gomez, Alfonso Leon. (2015). The Medium for Motion: A Critical Clue to Understand Spacetime: International Journal of Modern Physics and Applications Vol. 1, No. 5, 2015, pp. 210-218 http://www.aiscience.org/journal/ijmpa ISSN: 2381-6945 (Print); ISSN: 2381-6953 (Online)

[9] Clifford M. Will. (2011). Viewpoint: Finally, results from Gravity Probe B: Physics 4,43

[10] Worden, P. (2012). Gravity Probe B and other Fundamental Physics Experiments In Space: CERN,

[11] Turishev, V. G. Gravity Probe-B History, Mission Performance and Current Status: Jetpropulsion Laboratory, California Institute of Technology, USA, (2011)

[12] California Institute of Technology. (2018). What are Gravitational Waves? | LIGO Lab | Caltech: https://www.ligo.caltech.edu/page/what-are-gw

[13] NASA. (2018). What is a gravitational wave? :: NASA Space Place: https://spaceplace.nasa.gov/grav

[14] Segal, Michael. (2016). The Gravity Wave Hunter: Nautilus http://nautil.us/issue/34/adaptation/the-gravity-wave-hunter

[15] Sweatman, Will. (2016). About Those Gravitational Waves: Hackaday https://hackaday.com/2016/02/17/about-those-gravitational-waves/

[16] Romero, Gustavo Esteban. (2017). Mario Bunge on gravitational waves and the reality of space-time:

[17] Bunge, M. (2017). Gravitational waves and space-time: Springer Netherlands

[18] Baryshev, Yurij. (1999). Field Theory of Gravitation: Desire and Reality: Astronomical Institute of the St.-Petersburg State University, St.-Petersburg, Russia

[19] Bondi, H. (1990). Proc. R. Soc. London A427, 249

[20] Morozov, Valery Borisovich. (2018). Is the non locality of the gravitational energy a serious problem for General Relativity (GRT)?: ResearchGate. Question

[21] Kopeikin, Sergei M. (2004). The Speed of Gravity in General Relativity and Theoretical Interpretation of the Jovian Deflection Experiment: arXiv:gr-qc/0310059

[22] Brown, Peter M. (2002). Einstein´s gravitational field: arXiv:physics/0204044v2

[23] Rovelli, C. (1997). Half way through the woods, in The Cosmos of Science. University of Pittsburgh Press and University.

[24] Einstein, A. (1954). Relativity and the Problem of Space: Relativitybook.com

[25] Belot, Gordon and Earman, Jhon. (2001). Pre-Socratic Quantum Gravity: Physics Meets Philosophy at the Planck Scale. Cambridge University Press. pp. 213--55

[26] Pooley, Oliver. (2012). Substantivalist and Relationalist Approaches to Space-time: PhilSci-Archive

[27] Baker, David J. (2005). Spacetime Substantivalism and Einstein's Cosmological Constant: PhilSci-Archive

[28] Hoefer, Carl. (1996).The metaphysics of space-time Substantivalism: Journal of Philosophy, 93, pp. 5-27

[29] Dorato, Mauro. (2007). Is Structural Spacetime Realism Relationism in Disguise? The supererogatory nature of the substantivalism/relationism debate: PhilSci-Archive

[30] Schaffer, Jonathan. (2009). Spacetime the one substance: Philpapers Stud 145:131–148

[31] Guillen Gomez, Alfonso Guillen. (2017). In General Relativity, gravity is effect of coordinates with change of geometry of space-time: PhilArchive

[32] Sauer, Tilman. (2014). Marcel Grossmann and his contribution to the general theory of relativity: arXiv:1312.4068v2 [physics.hist-ph]

[33] Einstein, Albert. (1907). On the relativity principle and the conclusions drawn from it: Jahrbuch der Radioaktivität und Elektronik 4, pages 411-462

[34] Earman, John and Glymour, Clark. (1978). Lost in the tensors: Einstein's struggles with covariance principles 1912-1916: Stud. Hist. Phil. Sci., Vol. 9, No. 4. pages 251 –278

[35] Norton, John D. (1993). General covariance and the foundations of general relativity: eight decades of dispute, Department of History and Philosophy of Science, University of Pittsburgh.

[36] Guillen Gomez, Alfonso Leon. (2015). Einstein's gravitation is Einstein-Grossmann's equations: Journal of Advances in Physics, Vol. 11, No. 3

[37] Einstein, Albert. (1914). Physical Foundations of a Theory on Gravitation: Naturforschende Gesellschaft in Zürich. Vierteljahrsschrift 58, 284-290

[38] Einstein, Albert. (1925). Theory of Relativity, Kultur der Gegenwart. Ihre Entwicklung und ihre Ziele. Paul Hinneberg, ed. Part 3, sec. 3, vol. 1, Physik. Emil Warburg, ed. Leipzig: Teubner, 1915, pp. 703-713 (the first section of the paper), and in Die Kultur der Gegenwart. Ihre Entwicklung und ihre Ziele. Paul Hinneberg, ed. Part 3, sec. 3, vol. 1, Physik. 2d rev. ed. Ernst Lecher, ed. Leipzig and Berlin: Teubner, 1925, pp. 794-79 (the second section of the paper), reprinted in revised form in Die Kultur der Gegenwart. Ihre Entwick- lung und ihre Ziele. Paul Hinneberg, ed. Part 3, sec. 3, vol. 1, Physik. 2d rev. ed. Ernst Lecher, ed. Leipzig: Teubner, 1925, pp. 783-797

[39] Weinstein, Galina. (2016). Einstein's Discovery of Gravitational Waves 1916-1918

[40] Rothman, Tony. (2018). The Secret History of Gravitational Waves: American Scientist, volume 6, number 2

[41] Küpper, Hans-Josef. (2018). Chronology of Einstein's life: www.einstein-website.de

[42] Einstein, Albert. (1915). On the General Theory of the Relativity: Königlich Preußische Akademie der Wissenschaften (Berlin). Sitzungsberichte, 778-786

[43] Baryshev, Yurij. (2008). Energy-Momentum of the Gravitational Field: Crucial Point for Gravitation Physics and Cosmology: Astronomical Institute of the St.-Petersburg State University, St.-Petersburg, Russia

[44] Einstein, Albert and Grossmann, Marcel. (1913). Outline of a generalized theory of the Relativity and of a theory of gravitation.

[45] Petkov, Vesselin. (2012). Hermann Minkowski, Space and time: Minkowski's Papers on Relativity, Minkowski Institute Press

[46]Einstein, Albert. (1905). On the electrodynamics of moving bodies.

[47] Einstein, Albert. (1905). On a heuristic point of view concerning the production and transformation of light

[48] Wikipedia. (2018). Luminiferous aether

[49] Cassini, A and Levinas, M. (2009). El éter relativista: un cambio conceptual inconcluso:Crítica, revista Hispanoamericana de filosofía. Vol 41, No 123

[50] Kostro, L. (2004). Albert Einstein's new ether and his General Relativity

[51] Einstein, A. (1918). Dialog about Objections against the Theory of Relativity:wikisource

[52] Einstein, A. (1920). Aether and the Theory of Relativity: University of Leyden, Germany

[53] Einstein, A. (1934). The problem of space, ether, and the field in physics: Mountain Man Graphics

[54] Einstein, Albert and Infield, Leopold. (1938). The evolution of physics: The Cambridge Library of Modern Science

[55] Einstein, Albert. (1916). Näherungsweise Integration der Feldgleichungen der: Annalen der Physik, pages 688-696

[56] Van Flandern, Tom. (1998). The Speed of Gravity – What the Experiments Say: Physics Letters A 250:1-1

[57] Einstein, Albert. (1918). Ûber Gravitationswallen: Annalen der Physik, pages 154-167

[58] Weinstein, Galina. (2016). Einstein and Gravitational Waves 1936-1938

[59] Logunov, A. and Mestvirishvili, M. The Relativistic Theory of Gravitation. Moscow, (1989)

[60] Marquardt, N. (1999). Introduction to the principles of vacuum physics, CERN-99-0

[61] Guillen Gomez, Alfonso Leon. (2016). Wave detected by LIGO is not gravitational wave

[62] Bangert Patrick. On the Underlying Principles of the Main Theories of the World: General Relativity and Quantum Theory. - Genova (Italia). 1995. En Internet //p.banger@ucl.ac.uk

[63] Luo, Jun; Tu Liang-Cheng, Hu, Zhong-Kun; and Luan, En-Jie. (2003). Experimental tests of Coulomb's Law and the photon rest mass: Physical Review Letters, Vol 91, Number 14

[64] Gershtein S S, Logunov A A, and Mestvirishvili M A. Upper limit on graviton mass. Rusia. 1997

[65] Staniukovich, K and Vasiliev, Mijail. (1968). El cosmos y sus siete estados: MIR, Moscú

[66] Guillen Gomez, Alfonso Leon. (2006). Gravitational wave in 5D

[67] Barish Barry. (1999). Detection of Gravitational waves with LIGO. USA: arXiv:gr-qc/9905026

[68] Delplace, F. (2014). Liquid spacetime (aether) viscosity, a way to unify physics: GSJ

[69] Nguyen, T. (2003). Casimir Effect and Vacuum Fluctuation: Spring

[70] Mukhanov, V. Quantum Universe: Conference, MG14, Rome, (2015)

[70] Chibisov, G. and Mukhanov, V. Quantum fluctuations and a nonsingular Universe: P. N. Lebedev Physics Institute, Academy of sciences of the USSR, Pis’ma Zh. Eksp. Theor. Fiz. 33, No.10, (1981), Pages 549-553