SPACETIME STRUCTURAL PROPERTY OF THE MATTER IN MOVEMENT

A.L. Guillen

Abstract

The theoretical contradiction between General Relativity and Quantum Gravity about gravity was ended, since spacetime is not structural property of the gravitational field like Einstein said. Exactly spacetime is the structural geometric property of the matter and energy that it gives their geometric dimensions. Thus, spacetime is not continent of the matter (Substantialism), since it is contained. Neither is the category of the relations between material bodies or between their events (Relationalism) since is not relational property; spacetime is structural property. The particle-wave, of matter and field, has intrinsically three spatial dimensions and one temporal dimension. The spacetime is intrinsically the structural quality of particle-wave. The spacetime is the geometric dimensions of the particle-wave itself and for others. Therefore, the matter and its movements are containing itself. Now only Quantum Gravity is possible.

Key words: classic General Relativity.

---

1. Introduction

Space and time are linked to the shape (geometry) and to the movement (physics) of the material objects. Updates to the geometry and physics are connected, also with the evolution of concepts of space and time. Originally the geometry was united with the material form, but when it become a formal science, space and time were separated from the material form and they were happened to be governed by laws of reason. Space and time acquire an independent and abstract existence for many centuries, disconnected from material existence. At General Relativity again the space-time were connected with material existence, where space-time is conditioned by the matter and in turn matter condition it, but space-time maintaining their own ontological entity like a substance or as a relational category.

General Relativity is a geometric dynamic theory (Wheeler, 1963) of spacetime, which maintains that it is not vacuum and is bent due to its content of matter and energy, whose particles are obligated to move freely within causal geodesics, timelike to particles with nonzero mass and lightlike to electromagnetic field particles, which causes gravity; therefore, gravity is not a force but an aspect of the geometry of spacetime. "The space-time has no claims for himself an independent existence, but claims the category of structural quality of gravitational field" (Einstein, 1954).

It has tried to unify General Relativity with Quantum Physics, which explains gravity as the effect of the gravitational material field. "In quantum mechanics, the gravitational force is attributed to exchange of gravitons between

the particles of bodies ... " "From a mechanical point of view, considering the quantum-gravitational field, the force between two particles is transmitted by a particle of spin 2 called the graviton" (Hawking, 1988).

The strategies of unification are: explain the gravitational field as material since General Relativity or explain all fields as geometric fields since Quantum Physics. But, unification continues in litigation since according with conclusion of the group II Society Space-time, space-time is an enigma (Lorente, 2006).

The contradiction between the gravitational field as geometric field and the gravitational field as material field is examined in this work, since perspective of General Relativity, for to overcome it.

2. Substantialism and relationalism

The issue of space and time emerged of the questions of the presocratics: What contain the Universe and its evolution? Is space their continent?. To which were added questions about the intelligibility of local movement that led: Are space and time relations?.

Plato and Aristotle argued that space and time are the fixed background which contains the universe and its evolution while Heraclitus and Democritus that space and time are relations that register the movement between the objects which compose the Universe.

In the seventeenth century, the discussion came to Newton and Leibniz: is real the space or results from the relations between material objects?. This dilemma led to that space-time relations are seen as relations between points at which events occur (substancialism) or as the relations between the events themselves (relationalism). Matter provides the dynamic on a fixed background (substantialism of Newton). In the intrinsic dynamics (relationalism of Leibniz) is deleted that background.

Leibniz refuted to Newton, he denied persistence of spatial points in the time, saying that if the world was somewhere else, inverted or moving it would have ontological redundancy, while the spatial relationships among its components not would be altered. But Leibniz cannot explain the inertial structure and, therefore, the inertial motion. For this reason the substantialism of Newton endures because of the inertial structure of the movement, which exists and would be independent of matter, but, stripped of absolute motion with respect to the absolute space and formulated in the context of the space-time manifold (General Relativity) in exchange for space.

The space-time has an affine structure that makes possible to establish the existence of absolute motion with respect to this, which would be independent of the presence of matter or field. Thus, the existence of this inertial structure is taken as an inherent structural property of space-time (Sophisticated substantialism).

In sophisticated substantialism the transformations Galilei's should be interpreted as different representations of one same physical reality. These changes do not create worlds displaced in space. Although the identity of the points in

space is suppressed is replaced by redundancy of possible representations. So Leibniz's ontological redundancy become possible representations of the same physical reality.

But, as in General Relativity, space-time is identified with the gravitational field, Rovelli says (1997), the debate continues between substancialism and relationalism, since it has not been resolved which is real or property of another. Space-time is real or is the gravitational field?.

Relationalism and substantialism are identified in that space-time is a geometric object and differ in that in the relationalism is an geometric ideal object refereed to the material existence, while for the substantialism is a geometric real object, its substantial nature is understood as presence, existing by itself, although, is not material presence.

3. Space and time continents of the matter and its movement

According to Newton space-time is the container of the matter and their movements. Space, time and matter are absolutes and independents.

Matter is defined as aggregations of particles arranged in the elements or substances. Each particle is capable of acting instantaneously at distance, in vacuum, and exerts forces (fields) that are transmitted in vacuum, directly, to other particles. Substance is for all state o form of matter and field is for electromagnetic and gravitational forces. Space and time are non-material substances.

Space and time can to exist completely vacuums and are independents of the system of coordinates that is chosen. With investigations of Faraday and Maxwell was assumed that the space contains the ether, medium to transport electromagnetic waves. Due to the lack of interaction between ether and matter, in the Newtonian neo review, the ether is defined as structural property of space-time. However, today, the ether remains in dispute, preferring the relationalism extended object while the substantialism property of the space.

Space y time is defined in Euclid's geometry, according to the configuration space (R^3, t), metric (η_{ij}, t). The configuration space (R^3, t) are points and topology, while the metric (η_{ij}, t), consists of Euclidean geometry, inertial structure and absolute causality. Euclidean geometry allows infinite speeds.

Space and time in Euclid's coordinates is an inertial system in which the objects in movement, free of forces, will maintain their relative state of rest or rectilinear movement uniform with respect to other systems. This inertial character of the movement arises directly from Euclidean geometry. Also it serves for to establish the other structures of the accelerated and gravitational movements.

Between reference systems the coordinates are transformed according to Galilei's group which does not apply when the reference system, contains the electromagnetic field, it is outside the scope of Newtonian mechanics.

4. Spacetime fixed background

The scientific theory of space-time is Einstein's relativity, which has the Special Relativity of flat space-time, and General Relativity of curved space-time.

The relativistic space-time is an absolute continuum of four dimensions (interrelated by c speed and interchangeable according to different moving observers), which exists independently of matter and field to which contains. It is merely a frame for the physical events without affecting space-time. Space-time tells matter how to move 'but matter does not affect the space-time. The event is the true element of the space-time continuum. The physical reality of space-time is truly material, as resident in the material event. But Einstein did not end with the existence of abstract point of Newton.

Space-time may be devoid of matter but not of field. Electromagnetic and gravitational fields have energy. But, the space-time as inertial structure is a not material field. The space-time empty of matter, electromagnetism and gravity, in itself constitutes the substratum of the inertial structure, ie, plane geometry is a field that cannot be made up of events and it returns to Newton's points.

The physical problems of the movement are treated as geometric problems in the continuum of Minkowski $(R^4, \eta_{uv} metric)$ that, therefore, are determined geometrically. In the spacetime of Special Relativity applies the principle that all laws of physics (except gravity) are the same for all inertial observers. Gravity has no geometric character and it is a force, with no instant action and their problems have no solution. The relativism of the components of space-time is the result of Einstein's interpretation of the Lorentz transformation, which implies that the length it contracts and time it dilates in proportion to $\alpha = (1 - v^2/c^2)$ between reference systems in relative movement.

Special Relativity is in contradiction with Leibniz's relationism because it is based on universal time, which implies absolute simultaneity of Newtonian mechanics, while relativism of space and time in Special Relativity, is based in the relative simultaneity, because the connectivity between the events is constrained to the speed c. Minkowski's space-time like in Newton is a substance no material, in fact, it is the fixed substrate which serves of continent of matter-field.

5. Spacetime property of the gravity field

In General Relativity the distribution of mass-energy of the universe determines the geometry of spacetime (Lorentz' manifold M^4, g_{uv} metric), which is intrinsically curved because of the tension that exerts mass and energy (T_{uv}) on each event.

Spacetime takes relative character determined by the physical conditions in it. g_{uv} is only the metric of the manifold M (spacetime bare) that describes the curvature (gravitational field) of the manifold. The author believes that Einstein erred when he defines spacetime as the structural property of the gravitational field, since, according to the existing logic in General Relativity, the curvature

is the property and not the entity that supports the manifold, therefore, the right thing in terms of General Relativity is that the gravitational field is the structural property of spacetime.

The gravitational force is fictitious, since only is the effect of the curvature of spacetime in itself, in the trajectory of particles in movement when do not follow geodesic lines, so force is replaced by the metric of spacetime. Also it twists due to bodies' movements, phenomenon called gravitomagnetism. Problems of gravity are resolved geometrically.

The movement is always relative and the laws of physics are covariant in all reference systems: inertial, accelerated and gravitational. Moreover, Schwarzchild (1916) introduced the assumption that the g_{uv} metric must tend at infinity to the Minkowski metric η_{uv}, which restored the property complete inertial structure of spacetime, beyond the limit at which the matter ceases to act on it. The same is true on the infinitesimal limit and, in general, all solutions for a vacuum spacetime ($T_{uv} \equiv 0$). Besides, of the principle of equivalence between inertial and gravitational mass is apparent that gravity is the inertia movement in curved spacetime. In addition, the background independence of General Relativity is not that of relationism, which denies the existence of a background, but refers to the independence of the geometry of spacetime with respect of an only geometry, what is certain is that it is not static but dynamic, since that, due to its interaction with matter, it changes its intrinsic geodesics, which determines the change in the bodies movement.

The laws of the gravitational field of General Relativity suggest that the Minkowski space-time is the simplest case of the laws of nature, as in, $ds^2 = dx_u dx_v$ the g_{uv} are in function of the coordinates, which are determined by the transformation chosen arbitrarily, but these are not arbitrary functions of the new coordinates, since such functions must be recovered by $ds^2 = \eta_{uv} dx_u dx_v$, through a continuous transformation of four coordinates, so the g_{uv} functions must satisfy the condition of Riemann. Also suggests that the spacetime of Einstein is not essentially different from Minkowski space-time, ie that there is a primitive identity between them.

The best interpretation of General Relativity spacetime is of the substantialism but due to the Leibniz equivalence principle it produces indeterminism in front of hole argument (Earman,1986 y Norton, 1988,2003) direct consequence of the general covariance. The solution is to link the metric field with the manifold M (thesis of sophisticated substantialism). However, despite the sophisticated substantialism, persists the dilemma raised by Rovelli each other 'the gravitational field is nothing but a local distortion of the geometry of spacetime (substantialism) or the geometry of spacetime is nothing but a manifestation of the gravitational field (Relationism).

6. Space-time a state of the matter

In the theory 'space-time-mass' it says that because there is no empty space, therefore, space and mass (mass-energy) are the same thing, since the mass is

space, but mass and space are different. How can the mass-space, be same and different thing?. The theory space-time-mass is background-dependent. The response is based on another contradiction: empty space as topological space, is container.

The geometric curve of spacetime is made of geometric particles that serve as the continent of the particles of energy, forces and matter. Thus, the geometric particles are the lowest state of existence of particles with mass or energy and the mass-energy is transformed into geometric particles and vice versa. Therefore, the space-time is a phase of matter.

7. Spacetime and quantum gravity

With the goal of unifying General Relativity with Quantum Field theory has been formulated Quantum Gravity, which seeks to describe everything in the universe in terms of the quantum field.

The Quantum Gravity is associated with the Planck scale since their explicit quantum-mechanical effects are confined to it and similar to General Relativity, has a space-time description but replaces causality (determinism total) by uncertainty relations. Quantum theory does not deny the principle of real determination, by laws and causes, but whether the deterministic description of the space-time.

The Quantum Gravity explains the gravitational interaction of matter-energy from virtual graviton and assumes quantum spacetime. The event as a point on the manifold M becomes an extended object without structure (field). The characteristics and properties of spacetime at the quantum level are closely linked to the physics of the quantum vacuum states that are associated to the residual energy of the overlapping of the fields, in averaged of energy zero, known as zero-point energy (ZPE), composed of virtual particles without real particles.

In addition, there another vacuum that is of negative energy, generated by eliminating the electromagnetic waves that appear inside the uniformly accelerated reference system. Since, in the quantum vacuum worth the principle of relativity of motion, but not the equivalence between an inertial system and a uniformly accelerated system. An observer cannot determine its speed through the quantum vacuum fluctuations, ie cannot set the absolute motion, but can determine accelerated system. Therefore the gravity cannot be the curvature of spacetime, as General Relativity says due to the general covariance of the same. In consequence, there can be no privileged observers so the total tensor energy-momentum, T_{uv} (including the contribution of the gravitational field g) must be identically zero that ensures to the observers the energetic balance between the flow associated to matter $\phi(T_{uv}content)$ and the associated to gravitational field g (contained in $-(c^4/8\pi G)\ g_{uv}$) in a way that both flows are canceled.

The two main theories of quantum gravity are: Superstring M (favoring substancialism) and Loop quantum gravity (LQG) (favoring the relationism). In M theory, the dynamic spacetime (M^4, g_{uv}) is the brane, which is a geometric object continuous. The brane would be incrusted in the bulk in Planck scale,

which is an extra space of 6 or 7 dimensions. In M there may be several branes and the particles are open and closed strings of the brane. The strings are under tension and vibrate in a number infinite ways.

Gravitational interaction is caused by the vibration modes of the closed strings that correspond to the graviton virtual. The Standard Model particles are excitations of open strings confined to the surface of branes while the graviton would be the only one that would exist also in the bulk that would be the cause of the weakness of gravity.

In LQG exists only the manifold (M). Therefore, quantum spacetime is bare, composed of a network of elements called spin. The connections between vertices and edges of the spins generate graphs that evolve to new structures. The particles are entangled braids differently in spacetime. Because the network changes in every place at every moment, it requires of a structure-mechanism of quantum superposition that gives persistence to particles. This would be analogous to the qubit, which at each moment can be in two states. Calculations show that the resistance of the quantum qubit preserve braids in spacetime, and explains how the particles can have a very long lifetime in the midst of quantum turbulence.

8. Geometric structure of the particle-wave

The Universe is field-matter contained in the vacuum that is the background. Field-matter-vacuum always exists in the wave-particle structure subject to motion. The vacuum is energy of the point zero subject to quantum fluctuations.

The field-matter-vacuum has the geometric property of volume. Its geometric structure has the three dimensions of latitude, wide and length. These dimensions are the geometric property associated to the mere condition of static existence of the field-matter-vacuum that has the potentiality to serve as continent of other structures. The vacuum is by excellence the continent of all the other structures of the field-matter. Due to this potentiality of continent that has the volume, the three dimensions are the geometric spatial property of the field-matter-vacuum. Space means continent.

The movement of translation and/or rotation of the matter, the variations of the field and the fluctuations of the vacuum from the geometric point of view cause that field-matter-vacuum leaves its three-dimensional continuous and one fourth dimension is generated. This is a mathematical law of dimensional geometric spaces N: if N leaves its continuous N, in a direction k contained in the (N+1) continuous then the geometric space of (N+1) dimensions is generated. Thus, the field-matter-vacuum in motion has four dimensions. The fourth dimension corresponds to the dynamic reality of the existence of the field-matter. The fourth dimension is the temporary geometric property of the field-matter-vacuum. Time means becoming of the existing.

The wave-particle of vacuum is compound of virtual particles. Also the wave-particle of field although can additionally be compound of real particles. The particles of vacuum and field are without mass according to four vector

moment subject to superposition principle. The wave-particle of matter is compound of real particles with mass according to four vector moment subject to exclusion principle. Therefore, the wave-particle exists in four dimensions that are intrinsic geometric property.

9. Conclusions

The spacetime is objective, that is, exists independent of consciousness and is intrinsically connected to the material existence, which is the necessary condition of its existence. The separation between spacetime and material existence at the thought occurs during transit from the philosophical of the ancient to scientist knowledge. They understood the opposite of what it is, that is, space-time as the condition of material existence and movement.

Such inversion, in the connection between material existence and spacetime, was inferred of the geometry of Euclid, constituted as a formal science before of the physics, and is a fact that the science of the geometry was walking ahead of the science of physics, up with General Relativity, physics become geometry.

The root of the separation between spacetime and material existence is not physics but epistemological. Inside of Euclids conceptual framework was underlying the physical science of Galileo and Newton; they established absolute space and time, acting on the mechanical motion of matter in determining the inertial structure of the uniform rectilinear motion.

The geometry of Minkowski and the Michelson-Morleys experiments on the speed of light made conceptually possible, that in Special Relativity, it established the link between the mechanical motion of matter and spacetime, putting the speed limit c.

Einstein looked a physical theory of general covariance, according to the geometry of Riemann. He, with base in the equivalence between inertial and gravitational mass, formulated the equivalence between all mechanical movements of material existence, and the mutual dependence between the spacetime and the material existence. Although, ontologically as separate entities. Also define spacetime as the structural property of the gravitational field. Question in dispute because can be it opposites. The consequence is that the rest of the material existence lacks of spacetime in contradiction with all our experience.

In the theory mass-spacetime it would be a geometric state of the material existence and equal that Einstein it ignores that all material form has spacetime.

M and LQG are geometric theories about of quantum gravity and all material existence. Spacetime generates totally the material existence. Therefore, all material existence originally is geometry. The replace of the material content by its form is consequence of the General Relativity. Ortega and Gasset had said, in Einstein's visit to Spain in 1923: You geometrize physics.

Substantialism and relationism coincide in considering the gravitational field like being-in-itself. However, substantialism and relationism differ with respect to the space-time that, while for the substantialism is the structural geometric property of the gravitational field, for relationism the spacetime is simply a

category of thought, which express the being-in-relation-to (Hegel). The error of the relationism is to define space in relation to the movement without respond which is the container of the universe. While the error of substantialism is not respond what it's made spacetime.

These problems are resolve with spacetime structural geometric property of the material existence (thesis of this work). Since the vacuum is the universal container of material existence and the vacuum it self-contained. But, What is the gravitational field?. Is the curvature of spacetime? Is a force of interaction that curves the spacetime?. The spacetime, as the geometric dimensional property of the material existence, as the very matter, must exist according to the characteristic of the wave-particle. Therefore, the spacetime must have various structures differenced according to: virtual and real particles, massless and with mass particles, the superposition and exclusion principles, the determinism and uncertainty principles.

Literature

Baez John. La Relatividad General. USA. 2004.

Baker David J. Spacetime Substantivalism and Einstein's Cosmological Constant. USA. 2004.

Brown Peter M. Einstein's gravitational field. USA. 2002.

Cala Vitery Favio Ernesto. De la relatividad de la inercia a la geometrodinamica intrinseca: Una interpretacion relacional del Espacio-tiempo. Spain. 2006.

Daywitt William C. The Source of the Quantum Vacuum. USA. 2008.

Diaz Pazos Patricio. El concepto de espacio en la RG. 2003.

Einstein Albert. El significado de la Relatividad. Colombia. 1986.

Enciso Fernndez Santiago. Contribucion al Conocimiento de los espacios n-dimensionales.

Felder Gary. Bumps and Wiggles: An Introduction to General Relativity. USA. 2003.

Hawking Stephen. El Espacio y el Tiempo se Curvan. Spain.

Hedrich Reiner. Quantum Gravity: Has Spacetime Quantum Properties?. Germany. 2009.

Herdeiro Carlos. M-theory, the theory formerly known as Strings. USA, 1996.

Hooft Gerard't. The conceptual basis of quantum field theory. Netherlands. 2005.

Jones Andrew Zimmerman. Wave Particle Duality. USA. 2006.

Konstantinov F. El espacio y el tiempo. Cuba. 1986.

Kuhne Rainer W. General Relativity Requires Absolute Space and Time. Germany. 2002.

Lorente M. El espaciotiempo sigue siendo un enigma para la ciencia y la filosofia. Spain. 2007.

Meschini Diego, Lehto Markku. Is empty spacetime a physical thing?. Finland. 2005.

Murphy John. Quantum Theory and Wave/Particle Duality. New Zealand. 2000.

Norton John. Standford Encyclopedia of Philosophy. The Hole Argument. USA. 2008.

Odenwald Sten. Why is the gravitational field another name for space-time?. USA. 1997.

Perez Alejandro. Introduction to loop quantum gravity and spin foams. Brazil. 2004.

Reyna Lizandro, Ghassemi Frank and Sparrow Julian. Space-time-mass USA. 1998.

Rovelli Carlo. Loop Quantum Gravity. USA. 1998.

Tegmark Max. On the dimensionality of spacetime. USA. 1997.

Thiemann Thomas. The fabric of space: spin networks. Germany. 2006.

Waite David. Modern Relativity. USA. 2000.

Wesson Paul. Zero-point fields, gravitation and new physics. Canada.

Weinert Friedel. Relationism and Relativity. Germany. 2006.

Zinkernagel Henrik. The Philosophy behind Quantum Gravity. Spain. 2006.