GRAVITY AS A RESULT OF QUANTUM-TYPE INTERACTIONS

Author: SANTIAGO LOPEZ UGARTE
E-mail: ugarteslu@gmail.com

GRAVITY AS A RESULT OF QUANTUM-TYPE INTERACTIONS

(HYPOTHESIS ON THE ROLE OF ENERGY AND QUANTUM-TYPE INTERACTIONS THAT WOULD AFFECT THE DEFORMATION AND MOVEMENT OF BODIES IN A SPACE-TIME CONFIGURATION OF FOUR SPATIAL DIMENSIONS PLUS THE DIMENSION OF TIME).

ABSTRACT:

A quantum-type process is proposed in a four dimensional space plus the time dimension (5d space-time dimensional framework), which would be responsible for gravitational phenomena, producing the curved space-time due to Gravity and the relativistics effects corresponding to any energy-momentum applied to the physical system. The proposal does not exhibit discrepancies with respect to the Theory of Relativity when considering Special Relativity scenarios, but do arise with respect to General Relativity when gravitational scenarios are included, being greater the stronger and negligible considering gravitational systems like Earth´s, requiring very strong ones to obtain significant discrepancies. It allows a physical interpretation of the Einstein Field Equations within Quantum Mechanics area of study. Taking into account the proposal, the EFE would be a mathematical model that partially collects the effects produced by the proposed process, this being the physical phenomenon responsible for producing the geometry that has been mathematically expressed by the EFE. However, if it actually occurs as defined here, additional restrictions are required. One such additional effect would be a quantum type one due to the extension of the uncertainty principle to frameworks with an extra spatial dimension.

INTRODUCTION

So far, Einstein´s General Relativity is the theory that best explains the phenomena related to Gravity, it has been tested many times obtaining always positive results, and it has allowed us to make very accurate calculations and predictions, with practical applications such as GPS technology. Nonetheless, there are many scientists who still consider that it is not a fundamental theory of Nature, that is to say, Einstein´s Field Equations would be a very good approximation to the physical reality descibed, just as Maxwell´s equations are a good approximation to the phenomena of electromagnetism, which were relegated by the modern conception of Quantum Mechanics.

A fundamental feature of Quantum Theory is the association of probabilities with events, for instance, we cannot predict with certainty the location of an electron, what we know is the probability that the electron will be located in a specific region of spacetime. Based on QT mathematical models have been developed for electromagnetism, strong and weak nuclear forces. On the other hand Gravity, as defined by General Relativity, would not be a conventional force, but the effect corresponding to the alteration of the space-time framework. Furthermore, GR would be a classical theory in the sense that it has not been formulated in terms of probabilities, although we could say that it affects them at least indirectly, since it curves the space-time framework, which is the fundamental background where quantum states take place.

There have been many attemps to develop a new theory for Gravity, some of them do introduce corrections to the curvature, resulting in bigger discrepancies the greater the curvature, for example increasing the closer to the event horizon of a black hole, where extreme gravitational effects are taking place.

One of the most notorius alternative theories is String Theory, with its diverse variants, which have been endorsed by many renowned scientists. A very remarkable feature of this theory is that it introduces additional dimensions. Another alternative theory that proposes additional dimensions is the Kaluza-Klein theory, which adds a fourth spatial dimension to Relativity´s space-time framework. Initially proposed by Kaluza as a possible way to combine Gravity and electromagnetism, this theory was dismissed by Einstein at first glance, but later, after more careful analysis, he concluded that it was an interesting approach. The fourth dimension, as defined in the theory of Kaluza-Klein would be compactified, being the reason for us to be unaware of it. The concept of compactification was later assumed by the String Theory extending it to a greater number of dimensions. In recent decades there have been new versions of the Kaluza-Klein theory without the limitation of compactification, being Paul S. Wesson one of the most relevant supporters of this approach. He repeatedly expressed the view that physics needs a fourth spatial dimension, based on mathematical arguments from models with four spatial dimensions plus time, which would naturally explain some physical behaviors. Although there are various versions of the Kaluza-Klein theory, mainly the ones exposed by Paul S. Wesson and his colleagues basically consist of adding a new spatial dimension to the space-time configuration defined in GR, extending this way relativity to five dimensions, but the open question is how we should extend the value of energies corresponding to the stress-energy tensor assuming an additional spatial dimension, because the values are mathematically defined in Einstein´s model of GR using a space-time framework in a four manifold configuration, but considering an additional dimension it is not clear how to determine the components of the tensor. It can be defined in such a particular way that there are no discrepancies with respect to GR, but in general the extension to five dimensions introduces discrepancies, producing the effect of what has been named the “fifth force”. These effects should be experimentally detected, therefore, we have to rely on experimental observations to find out and narrow down the values corresponding to the components that would be responsible for the so-called fifth force. These deviations, if they really exist, must be detected in the proximity of black holes events. The progressive development of technology is allowing closer observations to black holes, thus testing GR in contrast to Kaluza-Klein´s models or other alternative theories.

This article will conjecture about the existence of an extra spatial dimension. Kaluza and most modern versions of the Kaluza-Klein Theory extend Relativity via adding a fourth spatial dimension to the space-time configuration defined in GR, here it is taken a different approach, proposing the existence of a quantum-type process that conditions the movement and deformation of bodies in a space-time dimensional framework of four spatial dimensions plus time, which would be responsible for the phenomena of Gravity. Assuming the proposed hypothesis, there are no discrepancies with respect to Einstein´s Special Relativity, and discrepancies with respect to GR, including gravitational scenarios, increase the stronger the effect of Gravity.

Paraphrasing Paul S. Wesson, one of the conclusions of this article is that the Universe we live in, either has a configuration of at least four spatial dimensions plus time, or it behaves in such a peculiar way that it seems so, because it has some outstanding features in accordance with what would be expected in a Universe with an extra spatial dimension. In this way, here it will be defined a hypothetical quantum-type process that takes place in a 4s+t space-time configuration (space-time framework of four space dimensions plus the dimension of time).

The Encyclopedia Britannica defines deformation in physics as "the alteration in shape or size of a body under the influence of mechanical forces". Meanwhile Wikipedia defines deformation in Continuum Mechanics as follows: "Is the transformation of a body from a reference configuration to a current configuration. A configuration is a set containing the positions of all particles of the body." If we look for the definition in a classical book such as the Schaums Outlines Series dealing with Continuum Mechanics, George E. Mase already assumed a similar definition half a century ago, considering the deformation as the change in the shape of the continuum from an initial to a final configuration. Depending on the behavior of the body undergoing deformation, this can be classified into different types, such as elastic or plastic.

The theory of the continuum mechanics, initially formulated by Augustin-Louis Cauchy in the 19th century, defines a mathematical model that allows us to perform calculations on practical problems of our daily lives, obtaining results close to the real ones. Using this model an engineer can calculate the expected behavior of a given material. Even knowing that the defined model does not truly correspond to the reality of the physical object with which he is working, that assumption is useful from a practical point of view. If we had lived centuries ago or do not know too much about physics, based on these results and relying on our intuitive perception, we might believe that objects such as billiard balls or stainless steel spoons are solid objects with a continuous configuration, but current scientific knowledge shows that these objects have a discrete composition of matter and if we delve deeper into the underlying nature of the material, then we face the fundamental forces of nature defined in physics: electromagnetism, gravity, strong and weak nuclear forces. They condition the configuration of the material, whether it is in solid, liquid, plasma or gas physical state, the particles that constitute the material interact with each other, and the fundamental forces are the consequence of the interactions occurring.

In this regard, it should be taken into account the following considerations on issues that will be subject to disscusion in this article. First of all, here it has not yet been specified the space-time framework where the material is based (in particular, whether it is 3s+t or 4s+t space-time), it seems to be unnecessary because we all take for granted that it is 3s+t (three space plus time dimensional framework), although below it will be argued that this assumption is not so obvious, which carries out far-reaching implications. Secondly, the model established by General Relativity, developed by Einstein, defines Gravity not as a conventional force, but as the effect produced by a curved space-time, that is to say, the hypothetical gravitational interactions do alter the space-time framework, which will determine the trajectory of a body or a particle. This model confers capital importance to space-time, which is not the classical euclidean space-time, but a Riemann´s type one. So certainly, space-time is a key issue to keep in mind, that must be analyzed in depth if we want to get a better comprehension of the physical phenomena taking place.

For example, Schwarzschild´s metric is the solution of Einstein´s Field Equations when it comes to gravitational systems generated by a uniform spherically symmetric distribution of matter, uncharged non rotating.

$$ds^2 = c^2 d\tau^2 = (1 - r_s/r)\ c^2 dt^2 - (1 - r_s/r)^{-1} dr^2 - r^2 (d\theta^2 + \sin^2\theta\ d\varphi^2) \quad (1)$$

τ: proper time **t: time coordinate**

r: Schwarzschild radial coordinate

θ: colatitude **φ: longitude**

$r_s = 2GM/c^2$ G gravitational constant; M mass of the sphere; c speed of light

This metric represents the space-time configuration locally in an elementary region outside of the sphere close to its surface, and it will condition the trajectory that a particle will follow in that region of space-time. Or if we consider an object composed by the sphere plus the particle, we could also affirm that it will condition the deformation of the object. The gravitational effect and its associated space-time curvature will be weaker the less massive the sphere of material that is the source of Gravity. So that this effect is extremely small when considering objects such as a billiard ball, a car, a steel beam or any other object in our daily life. The curvature produced by these objects is negligible and we can perform calculations with very little error assuming a non curved space-time configuration. On the other hand, massive objects like planet Earth produce significant space-time curvature, and although it does not strictly conform to the requirements of the Schwarzschild metric (for example its shape is more similar to an ellipsoid of revolution rather than to a sphere), this metric can be used in practical calculations as a good approximation to physical reality.

The theory of General Relativity establishes that a free fall body follows the geodesic that is being defined by the metric, the body is not being accelerated by the force of Gravity in the way it was assumed by the Newtonian model, the matter situated on the surface is what is being accelerated to the outside, due to the internal forces, so that when the body hits the surface, the accelerated impact is caused by the matter of the surface not by the body.

If we consider a star such as our sun, the nuclear reactions taking place do offset the effect of Gravity, avoiding the progression of the star deformation via compresion, but when the fusion reactions of hydrogen atoms to helium is done due to the waste of hydrogen, then there is compresion and if the star has mass above a value called the Chandrasekhar limit (1.44 the mass of the sun), then it will collapse developing a neutron star or a black hole.

The fundamental forces of Nature condition the space-time trajectory that a particle will follow, and in doing so, it will also condition the deformation experienced by an object. So that there is an interrelation between all the particles that make up the physical system, which will depend on its composition and space-time arrangement. If Gravity is the field of study of General Relativity, forces such as electromagnetism, strong and weak nuclear are the scope of Quantum Theory.

Based on Quantum Theory, scientists have developed mathematical models that very accurately predict the behavior of particles and the interactions corresponding to all fundamental forces but Gravity. In this way, the wave function collects the physical features of a particle, and assuming that accurately describes the intrinsic nature of the particle, then we are unable to know forehand with absolute certainty the behavior of the particle, what we know is the probability of a particular event occurring. For example, we do not know for sure if a particle such an electron, will be located in a specific region of space-time, what we know is the probability of being there.

So linked to particles, there are wave functions $\Psi(r, t)$, which assign probabilities to events. The wave nature concurring with particles has many important implications and its behavior has been modeled by Quantum Mechanics, a theory developed since the early 1900s. A very remarkable feature of QM was defined by Heisenberg in 1927, when he enunciated the uncertainty principle, which states that it is not possible to measure simultaneously both position and momentum (this one comprises mass and velocity) of a particle like an electron with absolute certainty ("The more precisely the position is determined, the less precisely the momentum is known in this instant, and vice versa").

$$\Delta r \Delta p \;\geq\; \frac{\hbar}{2} \qquad \text{with } \hbar = \frac{h}{2\pi} \qquad (2)$$

Representing r position, p momentum and $\hbar$ the reduced Planck´s constant

This principle also applies to physical properties such as energy and time

$$\Delta E \Delta t \;\geq\; \frac{\hbar}{2} \qquad (3)$$

This restriction implies that energy is required in order to confine a particle within a region of space-time, and the energy required increases the smaller the region, reaching an infinite value for a hypothetical null size.

It has been experimentally proven that particles exhibit these very peculiar characteristics, and the development of Quantum Mechanics has progressed as it has been detecting, predicting and assimilating the physical behavior of particles and their interactions.

As previously stated, the wave function collects the physical features of a particle, If it is not isolated, then the interactions ocurring do alter its physical state, for example when the photoelectric effect is generated.

Based on Quantum Theory, mathematical models have been developed that match with an extraordinary degree of reliability (up to what currently is being possible to test in laboratories) the effects produced by electromagnetism, strong and weak nuclear forces.

So, QM allows us to mathematically describe and predict what happens when a particle approaches a hypothetical empty region of space (such as the example of the sphere), or the effects corresponding to electromagnetism, strong and weak nuclear forces due to interactions between particles, for example when there are particles inside the sphere inducing these effects. But when it comes to gravitational effects, such as the one corresponding to the presence of a considerable amount of matter within the sphere, then the theory of General Relativity is the one that best describes this physical reality. Gravity and any kind of Energy-momentum applied alters the space-time configuration and Einstein´s Field Equations mathematically represent this physical phenomenon.

Then, considering a particle with its associated wave function, located close to the surface of a hypothetical empty sphere:

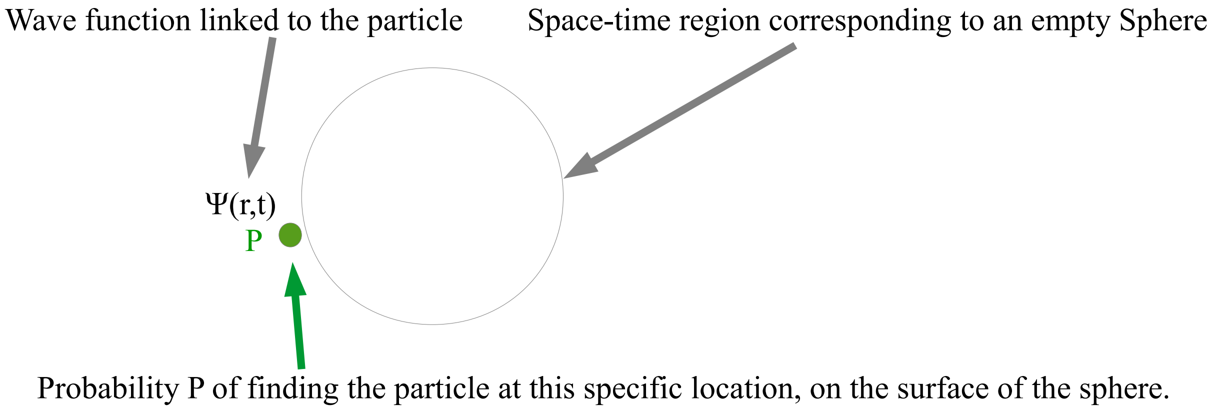


Fig.1
Scheme showing the wave function of a particle and its corresponding probability of being in the specified position on the surface of the sphere.

And we have to take into account a curved space-time when there is matter within the sphere, as defined by General Relativity:

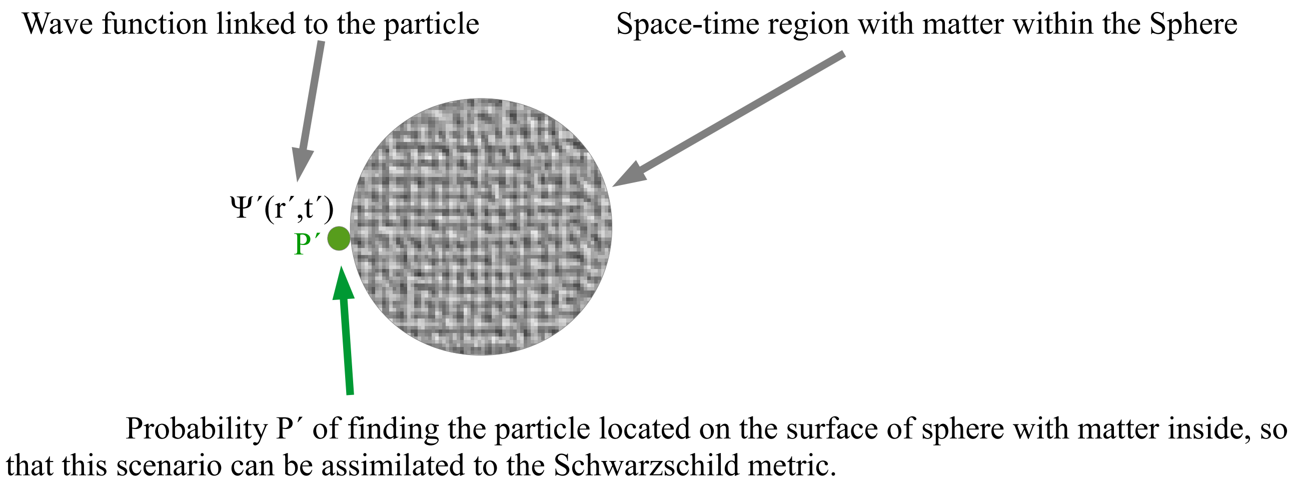


Fig.2
Scheme showing the wave function of a particle and its corresponding probability of being in a given position corresponding in this case to the surface of the sphere.

Prime letters represent that the particle is now immerse in a gravitational system, where we have to take into account the reference of the observer as established by GR In this way, r´ and t´ schematically represent the altered spacetime configuration that in the Schwarzschild metric scenario is mathematically expressed by equation (1).

Noting that the deformation of a body consists on the displacement of its components, which is conditioned by the curved space-time. The Einstein Field Equations allow us to obtain the metric, which defines the elementary displacement that the particle will follow due to the space-time curvature produced by the sphere with material inside. As mentioned above and using the established definitions of deformation, it also conditions the deformation of the hypothetical system configured by the sphere plus the particle or it will condition as well the deformation of a body situated on the surface.

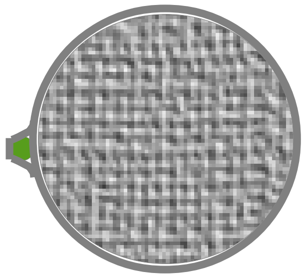


Fig.3
We can consider the elementary displacement of the particle as deformation of a system configured by the sphere of material plus the particle or the case of a body situated on the surface.

There are physical systems where quantum-type effects are predominant and gravitational effects are negligible, for example, an electron in an atom. On the other hand, planets orbiting the sun are mainly driven by gravitational effects. Current theories of physics do not fully reconcile General Relativity with Quantum Theory, mathematical models developed for each one are very reliable in their own environment, but unifying both has been an elusive quest for science. QT is characterized by the uncertainty and the probabilistic nature of the events that occur within quantum rules, and they have energy related effects corresponding to a force which are included in relativistic equations. Meanwhile, the effect of Gravity, as defined by GR, curves the space-time, where planets, living creatures like us and everything that is part of the Universe rest, including elementary particles. So there seems to be a physical interrelationship between Quantum and Gravity effects, and we might wonder whether the apparent dichotomy between QT And GR is a fundamental feature of our Universe, or if there is indeed a connection between both, the quantum states defined in Quantum theory and the effects associated to Gravity.

PROPOSAL

In this article it is proposed that Gravity is actually a physical phenomenon that alters quantum states, producing deformation of bodies in a four space plus time dimensional framework, where a correspondence relationship can be established between the space-time curvature and the effects produced by a hypothetical process that alters the state of the particles. If everything that constitutes or is part of a region of space-time is altered via deformation, then the configuration of this region of space-time will also be altered by replicating the physical alteration.

The warping of the space-time framework would be a consequence of these alterations, so that knowing the metric we can deduce the corresponding alteration that is taking place. In this way, the proposal implies that gravitational interactions alter the state of the particles and of everything that forms part or constitutes the space-time framework, producing deformation of the bodies in five dimensions (four space plus time).

Summarizing, there would be interactions due to electromagnetism, strong and weak nuclear forces, which currently are the subject of Quantum Theory, which is characterized by quantum states and the probabilistic nature of events, and gravitational interactions would alter these quantum states with their linked probabilities, by means of a proposed process that operates in a 4s+t dimensional space-time. Setting this way a direct connection between QM and Gravity.

Certainly as described above, depending on the composition and arrangement of the physical system, there are scenarios where the effects corresponding to gravitational interactions are very strong, and physical systems like an electron in an atom, where they are negligible compared to the other type of interactions.

The proposal implies the existence of discrepancies with respect to the theory of General Relativity when considering gravitational effects, the discrepancies are greater the stronger the effects of Gravity.

General Relativity:

Absence of gravitational effects

Ψ(r,t)

p

Presence of gravitational effects

Ψ′(r′,t′)

p′ (We have to take into account the reference of the observer, due to the gravitational effects on the location of the particle with respect to the corresponding G.E. on any reference)

Proposal:

Absence of gravitational effects

Ψ(r, t)

p

Presence of gravitational effects

Ψ′(r′, t′)

p′ (We have to take into account the reference of the observer)

plus

*Ψ′(r′, t′) (also requires to take into account the reference of the observer)

q′

Scheme representing the wave function and the probability associated with an event when considering the proposal in contrast to the theory of General Relativity. It is proposed that Gravity produces alteration of quantum states and the corresponding wave function, resulting in Ψ′(r′, t′) and *Ψ′(r′, t′). Ψ′ will be designated α-state in this article, while *Ψ′ will be associated to β-state. The stronger the effect of Gravity in a local region of space-time where it is expected to be located a particle such an electron, the stronger the alteration and the greater the value corresponding to β-state. So, there is a correspondence between the alteration, which assigns quantities corresponding to each state and the space-time configuration. In this way the hypothesis would allow to quantisize Gravity in a kind of quantum-type interpretation of the EFE which would collect effects associated to the proposed process

A by-product of the proposed alteration is the generation of additional matter. Einstein defined an interrelation between energy and matter, so that the second term can be obtained at the expense of the first one and vice versa, for example the energy released by atomic bombs.

$$E = mc^2 \qquad (4)$$

The additional matter linked to the wave function $^*\Psi'(r', t')$ is obtained at the expense of velocity. This demand of energy reduces the value of velocity with respect to the expected value established by the standard theory. The effect is greater the stronger is Gravity and it is extremely small when considering scenarios like Earth´s, in this case the additional matter and the effect producing reduction of the expected velocity are negligible.

The proposed process that would be responsible for the gravitational phenomena is explained in more detail below.

First of all, it is assumed that the space-time framework is in fact a four space dimensional framework. It should be noted that General Relativity deals with time dimension by means of an artificial transformation, introducing the term cdt, as we can check for example in eq.(1). That is to say, the space-time framework is an entity where time is embedded and treated in the same way as it does with the spatial dimensions. Using a generic notation, the space-time framework is configured by three spatial dimensions denoted x_1, x_2, x_3 and the term ct which is linked to the time dimension. In this way the proposal assumes that ct is a truly physical spatial dimension, a fourth dimension, denoting them x_1, x_2, x_3 and x_4. The idea of assimilating space-time with four spatial dimensions has already been suggested, for example in: "The Biggest Misunderstanding of 20th Century Science is that Time is the 4th Dimension of Space", 2011 Amrit Srecko Sorli.

Now assuming that what General Relativity defines as the space-time framework is a genuine physical framework of four spatial dimensions, it is proposed a quantum-type process that would be responsible for shaping this physical entity. The interactions that take place produce alterations of the quantum state. Denoting here two types of states: Alpha and Beta, where α-state is linked to x_1, x_2, x_3 dimensions, while β-state would be linked to the fourth dimension x_4. and remarkably, the β-state is generated at the expense of the α-state and this is what produces the alteration of space (roughly speaking, the body is undergoing deformation in a 4d space framework, where the deformation into the fourth spatial dimension takes place at the expense of the other three spatial dimensions), noting that this would be the reason for the alteration of the fourth dimension (what the Standard theory of

Relativity considers as the time dimension) at the expense of the three conventional space dimensions (assuming four spatial dimensions, the fourth dimension is generated at the expense of the other three ones), and regarding scenarios of Special Relativity, it would be responsible for producing time dilation in the same proportion as length contraction.

Considering additionally an alteration of time dimension inversely to the three conventional spatial dimensions, then the value corresponding to the probability α-state is restored, so that it is obtained the same quantity of mass in α-state, but now there is an additional value of mass in β-state. And being the metric the result of the alteration due to the proposed process, then knowing the metric we can deduce the corresponding alteration. The system of non-linear partial differential equations that set the Einstein Field Equations and its resulting metric, collect the alteration taking place in any given coordinate. This statement that the metric collects the alterations produced by the proposed process has some nuances that will be later described, because there are discrepancies in the expected results, so the EFE do not fully reflect the effects produced, requiring additional restrictions.

It should be noted that the proposal establishes a five dimensional framework composed of four spatial dimensions plus the one linked to time, resulting the same dimensions than those defined in Kaluza-Klein common models, but these ones are obtained adding a new spatial dimension to the space-time framework defined in the theory of GR, which is 3s+t, meanwhile current proposal assumes that what is considered as the space-time framework is actually a four spatial dimensions and time is the fifth dimension.

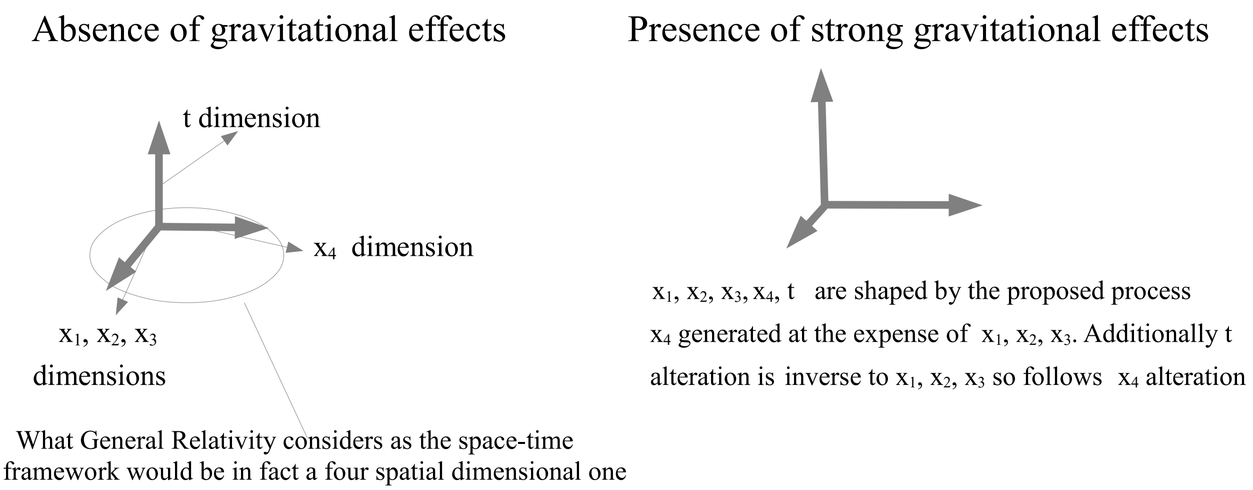


Fig.4

Figure 4 schematically showing the alteration of five dimensions produced by the proposed process. Noting that when considering the Riemannian space with coordinates such as dx_1dx_2, dx_1dx_4 … the process will be responsible of the metric with the corresponding combined effect on those coordinates, fulfilling globally that the fourth dimension is generated at the expense of the other three spatial ones.

Since the alteration of the fourth spatial dimension is the same as the corresponding to the dimension of time, this would be the reason to mislead us, so that mainstream considers that General Relativity is based on an entity called the space-time framework, made up of three spatial dimensions plus time, when actually this entity would be a truly four spatial dimensional framework, and additionally there would be dimension of time. Taking into account the proposed hypothesis, we could say that GR is suppressing a dimension taking a partial image, in order to see the full picture it is required a five dimensional framework (4d space plus the dimension of time).

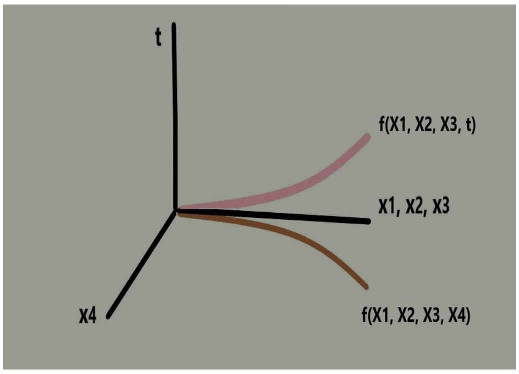


Fig. 5

Figure 5 schematically showing a trajectory (pink line) in a hypothetical space-time framework $f(x_1, x_2, x_3, t)$ in contrast to the trajectory (brown line) in a four spatial dimensional framework $f(x_1, x_2, x_3, x_4)$

Noting that the figure schematically represents the metric, a Riemannian space would be required to be rigorously represented.

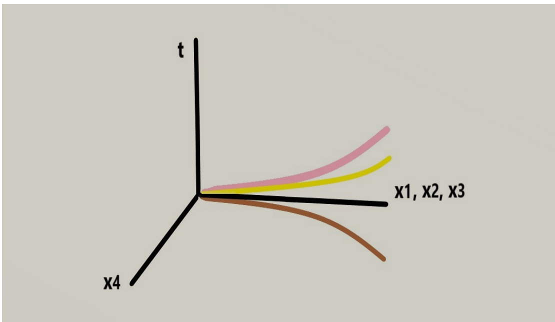


Fig. 6

Fig. 6 yellow line schematically represents the evolution of the particle in a 4d+t space-time framework with alteration of time dimension replicating the alteration of the fourth spatial dimension (**Christoffel symbols values linked to coordinates of metrics such as dx_1^2, dx_1dt... are replicating the corresponding to dx_1^2, dx_1dx_4...**) where the christoffel symbols are the consequence of the physical alteration produced by the proposed process.

In this way, the proposed process takes place in a five dimensional framework x_1, x_2, x_3, x_4, t, with a dependent relationship between the fourth spatial dimension and the dimension of time, where for instance considering a Minkowski space:

$$c^2dt^2 - dx_1^2 - dx_2^2 - dx_3^2 = dx_4^2 - dx_1^2 - dx_2^2 - dx_3^2 \quad (5)$$

And the Schwarzschild metric scenario defined in eq (1) would correspond to:

$$ds^2 = \mathbf{(1 - r_s/r)}\ dx_4^2\ -\mathbf{(1 - r_s/r)}^{-1}\ dr^2\ -\ r^2\,(d\theta^2 + \sin^2\theta\ d\varphi^2) \qquad (6)$$

Which would be the physical result of the proposed process, so the metric is the consequence of the proposed alteration. If the same amount of mass (source of Gravity) is uniformely distributed in a sphere with smaller radius or the same radius but increasing the quantity of matter inside, then the alteration produced on the surface is stronger, generating its corresponding metric.

So, regarding the proposed process, Gravity is producing deformation in a 4s+t dimensional framework, a body affected by the gravitational effects will increase its alteration the closer to the source and consequently increasing its deformation into the 4s+t framework. In the same way, the particles that constitute the source of Gravity are affected according to its location, being altered and deformed in 4s+t.

In the previous example, the smaller the radius or the greater the amount of matter within the sphere, the greater the alteration suffered by a body located on the surface of the sphere, increasing the amount of mass in β-state. And this value can be obtained knowing the alteration of the space-time framework:

Amount of mass in β-state will be: **(dt/dτ) m - m**
being **τ: proper time and t: coordinate time**

And the energy linked to this mass, considering eq.(4), is:

$$\mathbf{E = (dt/d\tau)\ mc^2 - mc^2}$$

The value of the factor **(dt/dτ)**, as defined by General Relativity on the surface of the sphere with its corresponding proper time. Then the value increases the smaller the radius or the greater the amount of matter inside the sphere.

Noting that **m** corresponds to the mass of the body when it was located far away from the source of Gravity, where time is assimilated to coordinate time **t**, with linked energy **E= mc²**.

It should be noted that since the alteration of time dimension is the same as the corresponding to the fourth spatial dimension, then the factor **(dt/dτ),** which defines the alteration of time, is replicating the alteration corresponding to the fourth spatial dimension, so that this factor is the result of a deformation produced in a 4s+t configuration.

Due to the alteration produced by the proposed process, the body progressively increases its mass from m, when it was located far away from the source of the gravitational effects, to the value **$(dt/d\tau)m$** (including α and β mass), when it is on the surface of the sphere. So, the proposal implies some discrepancies with respect to General Relativity, raising as well many reasonable questions about it. To begin with, where does this increase in the value β-state of matter and its bound energy come from? And why don´t we directly detect this increment? or why don´t we perceive directly the additional spatial dimension? The last two questions have an explanation which is related to the concept of Relativity and will be discussed later in this article. First of all, it will be analyzed the increased value of matter caused by Gravity and the energy involved in the described process **$(dt/d\tau)\ mc^2 - mc^2$**

In order to explain the increased value of matter and where it comes from when considering the proposed process due to the presence of Gravity, it will be first evaluated the Special Relativity scenario, analyzing what happens in the absence of gravitational effects when the proposal is taken into account.

Regarding the Special Relativity scenarios in the absence of Gravity, the proposal does not introduce discrepancies, from a practical point of view the expected results do not change, what is modified is the physical interpretation of the phenomena that occur.

The absence of Gravity would correspond to a null value of matter β-state linked to the body (due to gravitational effects). For that to happen, the particle or any body considered would be required to be at an infinite distance from the source or located in a local region where the effects are offset and consequently vanished. Thereby, the Special Relativity scenario is assimilated here with a more common one where the effects associated to Gravity, in terms of curvature, are extremely small, so they represent a negligible value although not null. If we apply kinetic energy to this physical system, it will increase the amount of matter β-state. So we would have a value due to the gravitational effect, which would be enhanced with kinetic energy.

Now it is considered a particle far away from any significant source of Gravity, which is located in a space-time region where gravitational effects are extremely small, so it can be aproximated to the Special Relativity scenario. Applying the very same criterion that the space-time configuration of a given region is in accordance with the alteration of what constitutes that region of space-time, that is, there is a correspondence between the alteration of particles and bodies and the alteration of space-time. Then, we can conclude that kinetic energy applied to the body produces a physical alteration and consequently also it is produced alteration of the space-time framework with respect to the previous frame of reference. So that there is an interrelationship between the kinetic energy applied, the alteration of the body and the alteration of the space-time framework, noting that this is a 4s+t dimensional one.

The hypothesis assumes alteration of matter, with energy linked to mass as established in eq (4), but this alteration takes place in a 4s+t space-time dimensional configuration as a consequence of the proposed process:

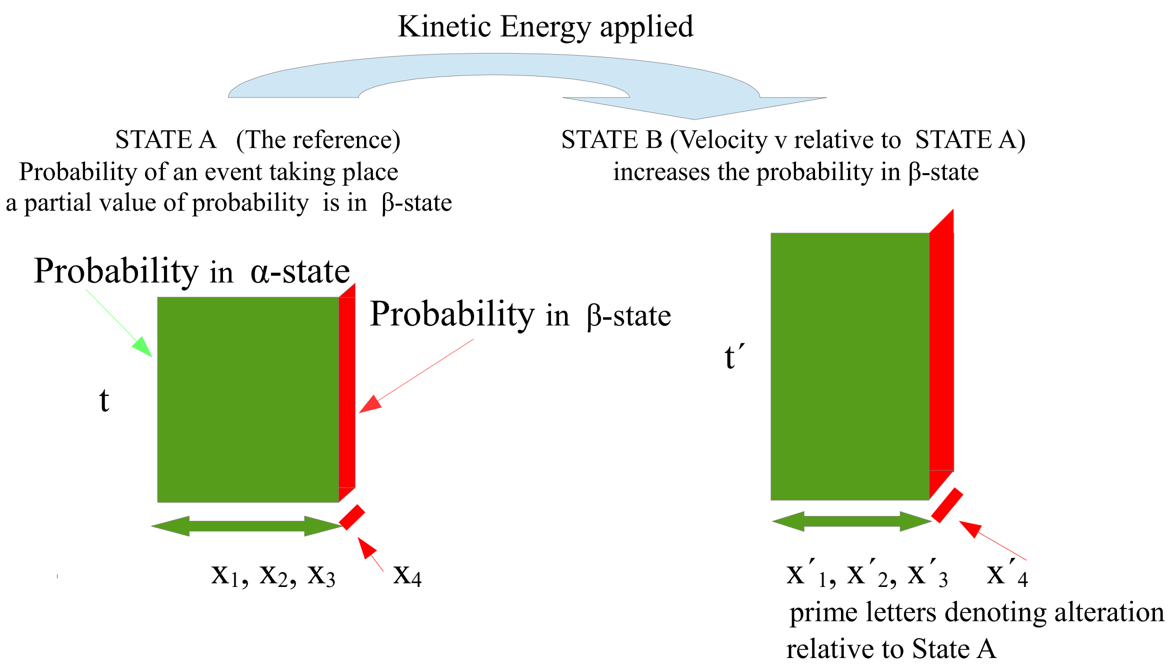


Fig. 7

Scheme representing 5 dimensions with a correspondence relationship between Probability in α-state and x_1, x_2, x_3 dimensions, while Probability in β-state is linked to x_4. The alteration of the quantum state when changes to STATE B (velocity v relative to STATE A) produces a reduction of Probability in α-state, being transformed into β-state, which implies a corresponding alteration of dimension x_4 (represented now by x'_4) at the expense of x_1, x_2, x_3 dimensions (x'_1, x'_2, x'_3 representing the alteration of these spatial dimensions), and the alteration of t in the same proportion as what has been altered x_4 restores the value of the probability in α-state.

Previous scheme is showing an interrelationship between the alteration of the quantum state and the space-time configuration, again pointing out that it would be composed of three conventional spatial dimensions plus a truly fourth spatial dimension, in addition there is the dimension of time.

State A would correspond to particles or bodies which do not generate a significant gravitational effect and are located far away from any significant gravitational source, so there is extremely low gravitational effects and consequently extremely small amount of matter in β-state due to Gravity.

Meanwhile, State B which is also located in a region far away from significant gravitational effects, but with velocity relative to State A, has greater quantity of matter in β-state relative to the reference, State A. So that State B has increased the probability of matter in β-state at the expense of α-state, which corresponds to the alteration of the fourth spatial dimension at the expense of the other three ones, and the alteration of the time dimension in the same proportion but inversely to what has been altered the three conventional spatial dimensions (which implies that time dimension is altered in the same proportion as the fourth spatial dimension), restores the quantity of matter in α-state. Shaping this way the Minkowski space as defined in eq(5) (neglecting matter in β-state due to Gravity with its corresponding effects).

Assuming the proposed hypothesis:

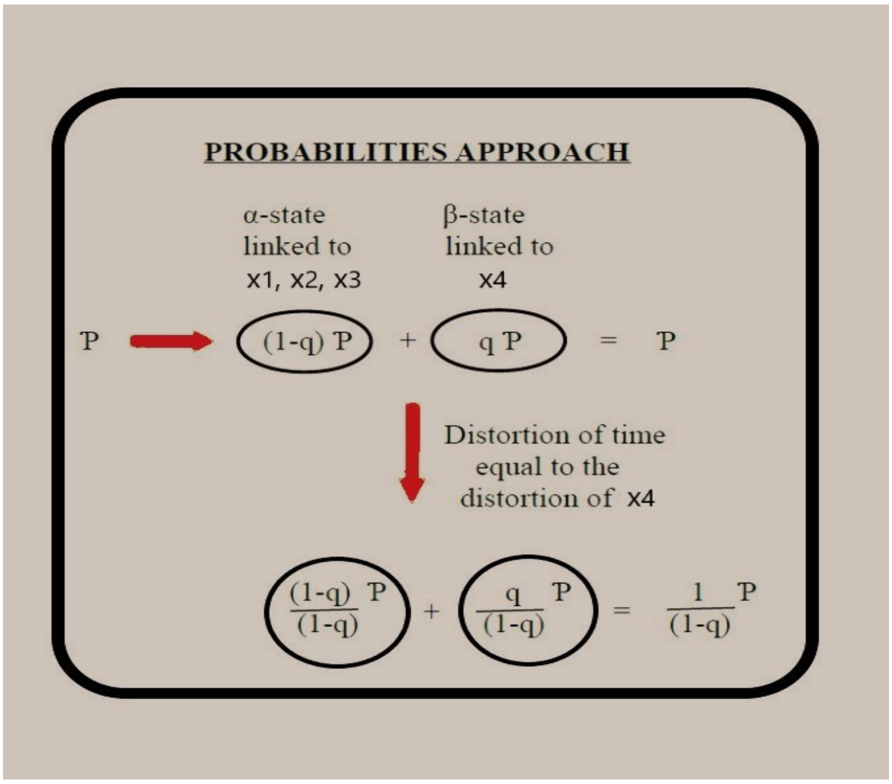


Fig. 8
Fig.8 shows the alteration of probabilities linked to quantum states

Being P the probability that a certain event occurs (linked to any type of quantum state, for instance the probability of a particle being located in a specific region of space-time), and p factor conditions the amount of that probability in α-state, obtaining this way pP, meanwhile q is the factor corresponding to β-state, qP

The alteration into β-state takes place at the expense of α-state, so that p=1-q with $0<p<1$ and $0<q<1$

STATE A (reference)	STATE B (velocity v relative to STATE A)
$p\approx 1$ $q\approx 0$	q increases with velocity at the expense of p
x_1, x_2, x_3	x'_1, x'_2, x'_3
x_4	x'_4 prime letters denoting alteration

Where there is a correspondence between quantum alteration and the space-time alteration

$$x_4 = x'_4 \, (1-q) \quad (7)$$

And the alteration of time dimension in the same proportion as what has been altered the fourth spatial dimension, restores the value of probability in α-state

Probability in α-state has been reduced by the factor (1-q) due to the alteration into β-state, with the corresponding alteration of x_1, x_2, x_3 and x_4 Now the alteration of time dimension in the same proportion as the fourth spatial dimension, corresponds to an increased factor 1/(1-q) so that all in all it is obtained the same quantity of probability in α-state, but additionally results q/(1-q) probability in β-state

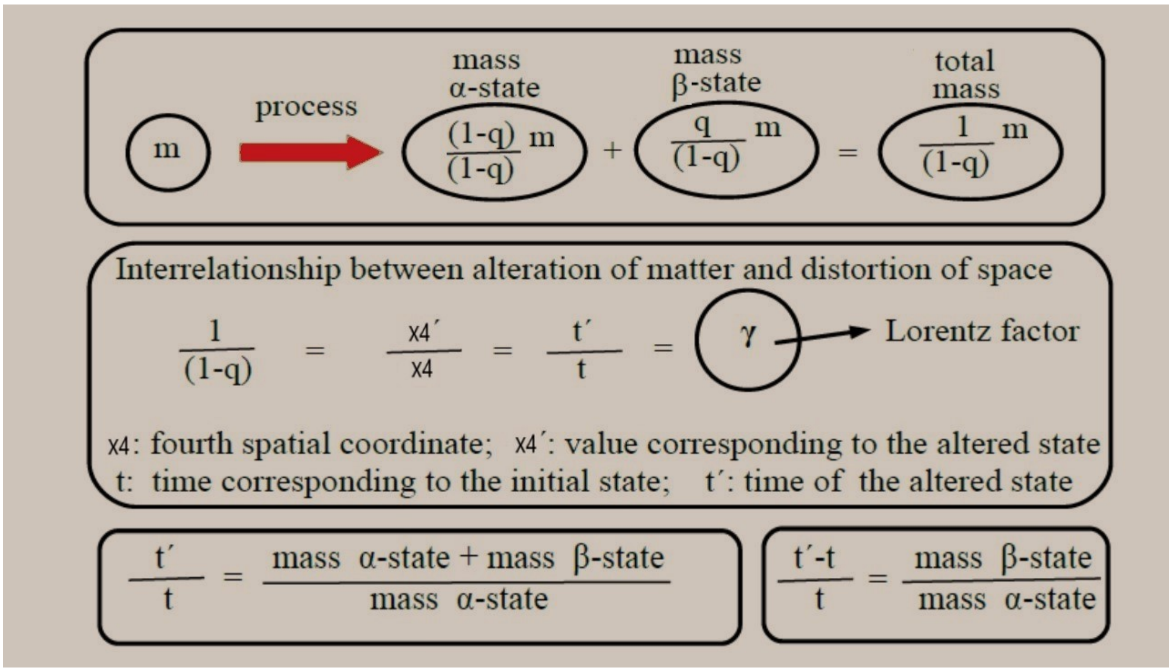


Fig. 9

Fig.9 shows a correspondence between the space-time alteration and the physical alteration produced by the proposed process, allowing us to quantisize the effects of Gravity.

Noting that what has been said about probabilities can be extrapolated to the mass of objects, so that additionally to mass m in α-state, there is mq/(1-q) mass in β-state, so adding one to another the total amount of mass is m/(1-q)

As previously stated the alteration of time dimension is the same as the fourth spatial dimension $\quad x'_4 / x_4 = t' / t$

Based on the proposed hypothesis $\quad x'_4 / x_4 = 1/(1-q)$

As we know from Relativity $\quad t' / t = \gamma \quad$ being γ the Lorentz factor

Then the total amount of mass α-state plus β-state: m/(1-q) corresponds to the value of the relativistic mass defined by Einstein γm

$$m/(1-q) = \gamma m \qquad (8)$$

The proposal implies that the Lorentz factor is the consequence of the alteration produced by the process previously defined.

Where mass in β-state: $mq/(1-q) = m(\gamma-1)$

And its linked energy as established in eq (4) is:

$$mc^2 q/(1-q) = m c^2 (\gamma-1) \qquad (9)$$

As we know mc^2 (γ-1) is the kinetic energy defined in relativity, so that when we apply kinetic energy to a body, this energy is transformed into energy linked to mass β-state in relation or relative to the previous physical state.

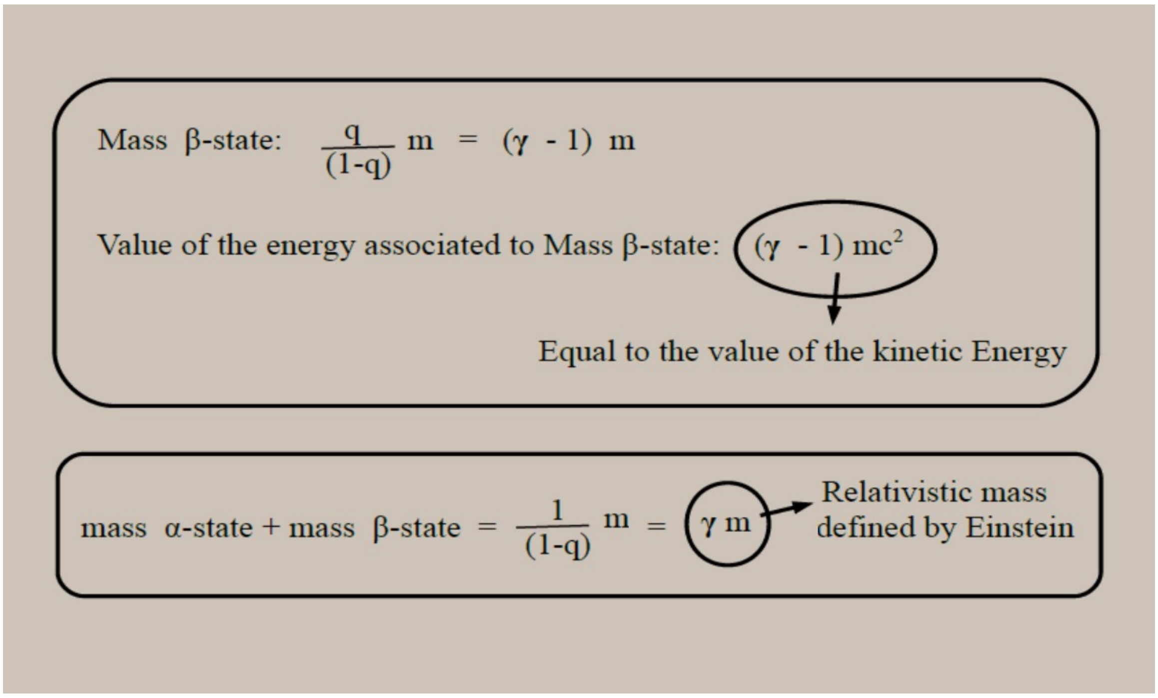


Fig. 10
Quantum interpretation of the kinetic energy and the relativistic mass.

So, considering Special Relativity scenarios, the proposal is basically just a different physical interpretation of the phenomenon that is ocurring.

If we apply kinetic energy to a body, then its quantum state will be altered, increasing the amount of matter in β-state with respect to the previous state and correspondingly it will be modified as well its space-time configuration. Increasing the kinetic energy applied, then further creation of mass in β-state will be obtained. On the other hand reducing the value of the kinetic energy produces the effect of annihilation of matter in β-state with respect to the previous state.

Now taking a hypothetical target as reference and considering a body with its corresponding physical states, with kinetic energy values and velocities related to the target.

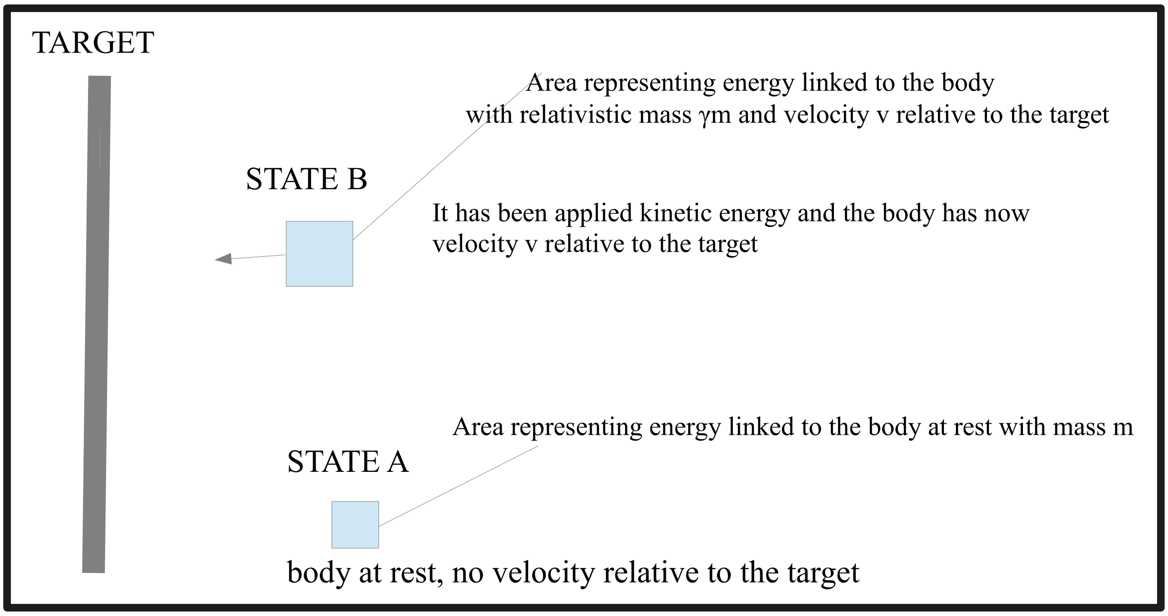


Fig. 11

The total amount of energy corresponding to the impact of the body on the target will depend on the kinetic energy applied to the body

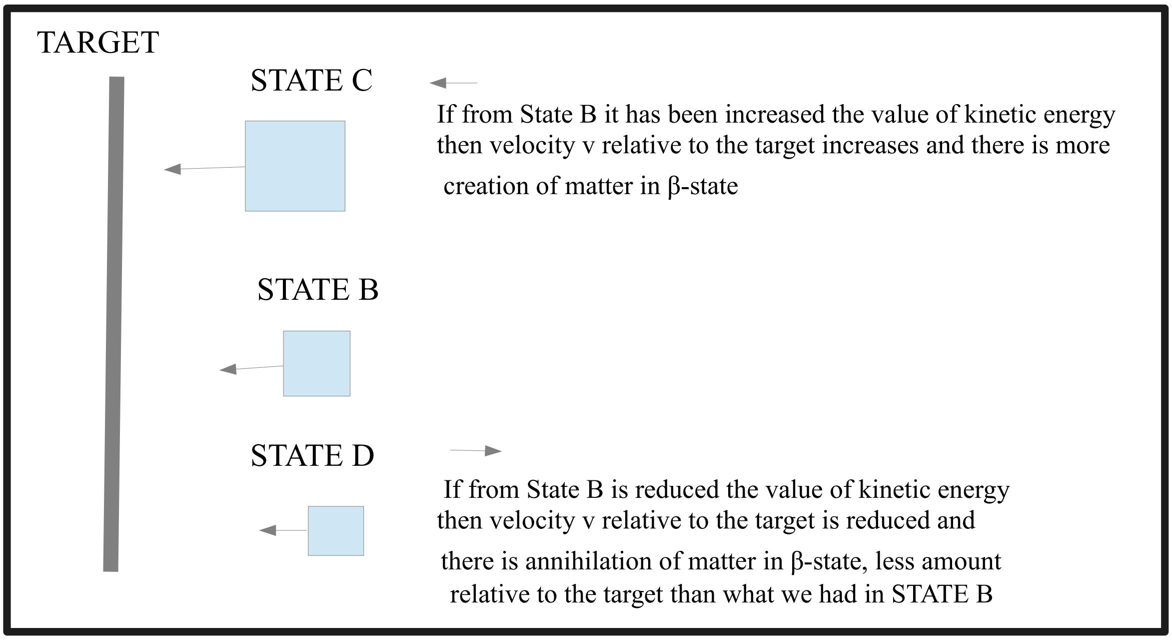


Fig. 12

Taking as reference the target, positive kinetic energy applied to the body will produce the effect of creation of matter β-state in the body relative to the target, increasing the energy on the impact, meanwhile negative kinetic energy will produce the effect of annihilation of matter in β-state, reducing the energy on the impact.

Now returning to the gravitational phenomenon and taking into account the proposed hypothesis, it has been established a relationship between a hypothetical quantum-type process that produces alteration of quantum states and a corresponding alteration of the space-time framework, where the evolution of time dimension is replicating the fourth spatial dimension. If energy is applied, for example kinetic energy, then the alteration of the physical state is enhanced. Similarly to how the coordinates are affected by a factor due to the proposed process in the scenario of Special Relativity, when considering General Relativity scenarios with presence of Gravity, coordinates will also be affected depending on the effect according to each coordinate. The alteration that occurs in a body as it follows each coordinate due to the presence of gravitational effects or when energy is applied, has its corresponding reflection in the Einstein Field Equations, which are collecting the alteration produced by the proposed process. The Christoffel symbols defining the metric are the consequence of the physical alteration, curving the space-time framework with alteration of coordinates linked to the three conventional dimensions at the expense of the fourth dimension, and with its corresponding contribution to the total mass of the body, which will be defined by the curvature, having the same physical value regardless of the system of coordinates chosen.

For example, the effect corresponding to the Schwarzschild metric will affect the Schwarzschild radial coordinate to a greater extent the more massive is the source of Gravity, increasing the amount of matter in β-state, consequently increasing the total amount of matter by the factor **$(dt/d\tau)$,** the greater the factor between coordinate time and proper time, the higher the total amount of matter. When considering the Special Relativity scenario, the greater the factor $\gamma=t'/t$, which relates times of different frameworks, the greater the total amount of matter. And denoting p_v probabilistic factor linked to velocities and p_c the one corresponding to curvatures of space due to Gravity, then $p_v=1/\gamma$ Meanwhile $p_c=1/$**$(dt/d\tau)$**

Special Relativity scenario

v=0 Body at rest relative to reference $p_v=1$ $q_v=0$

v=c Body hypothetically velocity c relative to reference $p_v=0$ $q_v=1$

Black hole scenario with reference the body

t time coordinate, Body far away from the source of Gravity $p_c=1$ $q_c=0$

Body hypothetically at the event horizon of a Black hole $p_c=0$ $q_c=1$

As previously analyzed, the increased amount of matter, in the Special Relativity scenario, is generated by the kinetic energy applied, and the question is, where does the energy related to the gravitational effect come from? So what happens when we consider for example a free fall body immerse in a gravitational well?. The Theory of General Relativity concludes that the body is not being accelerated by the effect of a force, instead it follows the geodesic corresponding to a curved space-time. Besides, the relativistic effect relative to any reference will be affected by the combination of the effects due to the curved space-time and the relativistic velocity with respect to the reference.

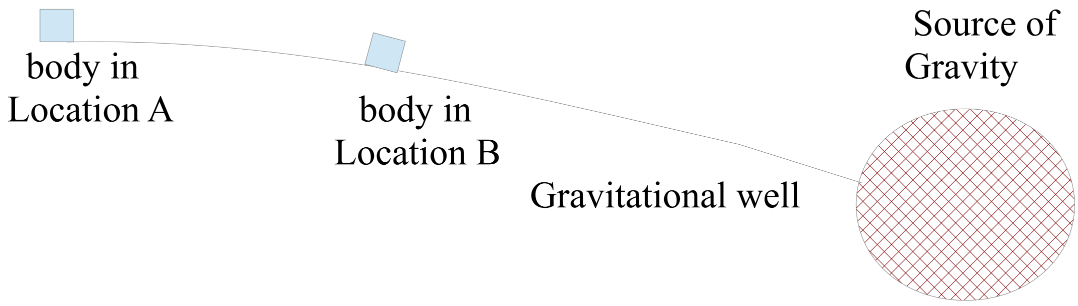


Fig. 13

Schematically representing a body following the geodesic linked to the curved space-time

Meanwhile, considering the proposal, Gravity now has a new role where the body is being affected by a process that alters its physical state

In this way, if we analyze the relativistic effects experienced by a free fall body taking into account the proposal, then the body is affected by two types of alterations, corresponding to the curved space-time by Gravity and the relativistic velocitiy. The second is producing annihilation of matter in the β-state. In fact when the body is in STATE B we would have to apply energy opposite to the gravitational effect. if we want to get the same effect on the target as when the body was in STATE A, or if we want to return the body to STATE A. That is to say, it has been reduced the energy linked to the physical state, with respect to the previous state, which resembles what happened in Figure 12 of the Special Relativity scenario when comparing STATE D and B after subtracting kinetic energy. But now, considering the free fall body, we have not subtracted negative energy from the body to the outside.

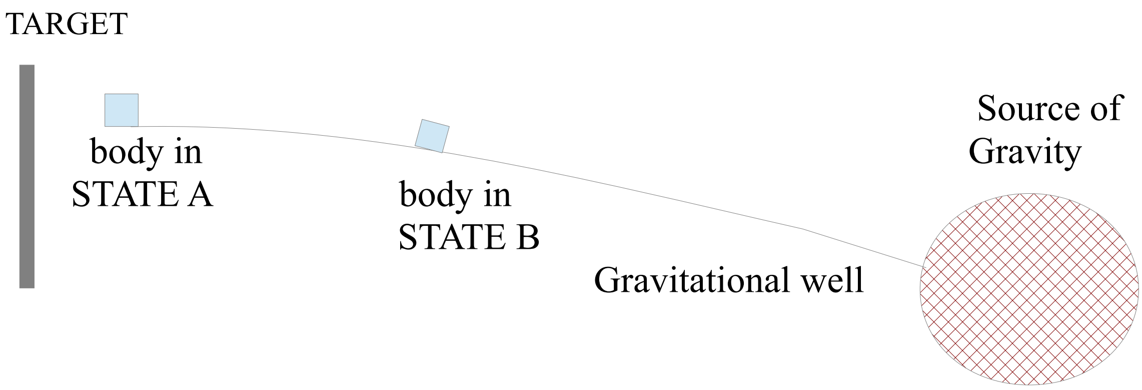


Fig. 14

Figure 14 emphasizes the relativistic velocity effect produced by gravity with energetic implications on the hypothetical target (the wall), reducing energy linked to State A with respect to the corresponding to State A

On the other hand the curved space, taking into account the proposal, would have associated positive energy producing creation of matter.

There is annihilation of matter due to relativistic velocity with negative energy associated **$-(\gamma mc^2 - mc^2)$**,

being $\gamma = \dfrac{1}{\sqrt{1-\dfrac{v^2}{c^2}}}$ with v velocity value from the point of view of the free fall body

and creation of matter with positive energy associated **$(dt/d\tau)mc^2 - mc^2$** (value also taking as reference the free fall body) corresponding to the curvature of space produced by Gravity. As we know from The Theory of General Relativity, $\gamma = (dt/d\tau)$

Therefore, here it is proposed that Gravity is actually a quantum-type process that produces creation-annhilation of matter, where the positive energy accountable for the creation of matter linked to the curvature of space-time is generated at the expense of the negative energy linked to the relativistic velocity. Or reciprocally we could say that the negative energy linked to the relativistic velocity effect produced as it falls into the gravitational well is offset by the positive energy linked to the curvature, because both are bound and one requires the other, driven this way the evolution of the body in free fall. Energy producing curvature of space-time (curving any coordinate dx^2_1, dx_1dx_2, dx_1dx_3, dx_1dx_4...) is obtained from the negative energy corresponding to relativistic velocity as the body follows those coordinates, or we could say that the negative energy linked to relativistic velocity is due to the falling of the body into the gravitational well.

It is worth emphasizing that considering the proposal, any space-time alteration, whether linked to the space-time curvature produced by Gravity or linked to relativistic velocities, is associated with a corresponding energy component that is responsible for producing the alteration. That is to say, any spacetime alteration has a correspondence alteration of physical states with their corresponding energy component. So that for example, relativistic velocity relative to the reference implies a differential value of energy that can be positive or negative relative to it, due to the proposed process of creation or annihilation of matter in the β-state.

Newton established a mathematical model for Gravity based on the paradigm of forces, where time has an absolute value, so we could say that the theory is defined using a 3s+t euclidean framework, although that was certainly assumed to be obvious based on experimental data available at the time, in other words, the theory developed could be considered as the most credible at that time using logical and reasonable deductions applied to the available experimental observations. So, Newton developed a theory based on physics where time has an absolute value, with forces producing a cause-effect action (we might consider as well the effects of forces as being induced by energies), A kind of physics which assumes as a basic principle the idea that any effect produced by a force must have a counterpart, any action has a reaction, considering the energies approach, this implies that there should be energy conservation. This principle of conservation was expressed mathematically in the early 20th century using a more universal conception with the Noether´s theorem.

At the end of the 19th century, experimental observations were made which did not agree with the established model of physics, in particular it was observed that the speed of light had a constant value, no matter what the velocity of the framework corresponding to the source of light is with respect to the observer, the speed of light has a constant value. This was an unexpected result and Einstein proposed at the beginning of the 20th century an explanation that changed the established paradigm in physics, he concluded that if the speed of light was constant it would imply that space and time are altered relative to the frame of reference considered. Now there is no absolute value of time and there is a new paradigm regarding Special Relativity scenarios. Then Einstein pondered on how would affect the new paradigm to the established gravitational model. He concluded that bodies are not being accelerated by a kind of gravitational force, instead a curved space-time is driving the evolution of the body. A free fall body is not being accelerated, it is following the geodesic defined by a curved space-time produced by the gravitational effect. He endeavoured a decade of his life to establish the constraints that should be taken into account, the conditions in physics that would obey the laws of Nature, developing a mathematical framework that would represent this physical reality. Thereby he formulated the equations of what is known as the General Theory of Relativity, because upgrades Special Relativity to more generic scenarios which include the presence of gravitational effects. If Newton´s theory of Gravity was based on a euclidean model, GR is a 4d manifold (three spatial ones plus time) but not a euclidean space-time, but a Riemannian´s one where the space-time is curved by the presence of matter.

So, Einstein determined the physical constraints that should govern the effects of Gravity, resulting in Einstein´s Field Equations. What gives more credibility to these equations is the fact that the experimental observations agree with the expected results. We could choose different constraints, add more or less supposing a different behavior of Nature, but in the end, the expected results must better match the experimental observations in order to validate these assumptions.

Einstein set a new paradigm in physics and defined a mathematical model for Gravity based on this paradigm, the new model transformed our comprehension of the Universe and changed some basic principles established by the previous postulates in physics. In particular the Noether´s theorem had to be adapted to the rules defined by the theory of GR. If we define a different model, for example, the hypothesis described here about the proposed existence of a process that produces alteration of physical states in 5d frameworks (4d spatial plus the dimension of time), then Nature and its fundamental laws would correspond to a different configuration. The aim of the present article is not to demonstrate the validity of the proposal, what validates this or any other hypothesis are the experimental results. Here, the main features of the proposal are described, contrasting them with those corresponding to GR, but certainly without prejudging that it is a better approach.

Newton´s model

Special Relativity Scenario

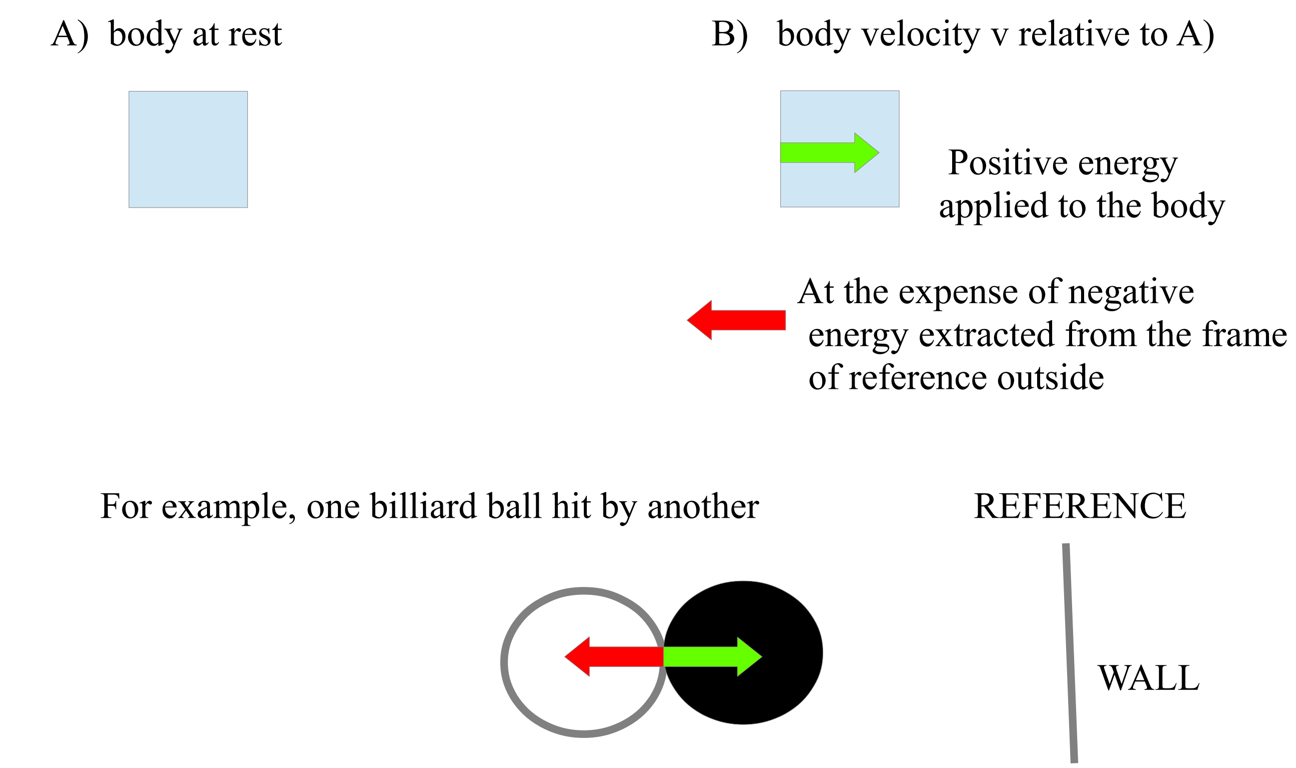


Fig. 15
Scheme representing Newton´s model

The black ball was at rest with respect to the wall, but after the hit of the cue ball, there is transfer of energy from the white to the black ball. Discounting wasted energy, the black ball now moves with velocity v_B relative to the reference, meanwhile the white ball which initially was moving with velocity v_W relative to the reference has stopped after the hit. So, the force applied to the body, in this case the black ball, produces alteration of its physical state, changing velocity with its corresponding kinetic energy with respect to the physical state at rest. Noting that from the point of view of the proposal the hit reduces the amount of energy in Beta state (linked to the cue ball) relative to the reference, increasing that value (discounting wasted energy) in the black ball

Newton extrapolated this force scenario to the gravitational phenomenon, with the assumption that bodies are attracted by a gravitational force that pushes them towards the source. From Newton´s point of view, bodies increase velocity as they get closer to Earth due to gravitational force. But unlike balls that collide with each other, the effect linked to Gravity ocurrs without a direct contact between the source and the affected body, in this case the body that suffers the attraction effect of the planet. Having said that, it is true that there are forces that produce effect at a distance, for instance electromagnetism. So, it might be possible that Gravity behaves in a similar way, they would be comparable forces. and the effect would be a force driven like one ball hitting another, where the black ball accelerates due to the energy transfered by the cue ball, in the gravitational case, the body would undergo the attractive force from the planet increasing the closer to it. But, as it has been experimentally demonstrated, neither Gravity is comparable to electromagnetism, nor can it be assimilated to the case of a ball accelerated by the cue ball.

When considering electromagnetism, there is energy transfer, so actually there is the action of a force, but regarding Gravity there is not such energy transfer. The hypothetical gravitons are not energy carriers, or at least not enough to produce the corresponding effect, consequently the body is not being accelerated. In this way, Newton´s theory is not consistent with experimental observations, supporting Einstein´s approach. Hoewer there is still an issue that deserves a more detailed analysis. As noted above, GR assumes that Gravity is not a force that produces acceleration in bodies, instead there is an alteration of the space-time framework, so that a body follows the resulting geodesic, experimental observations do support this reasoning. But the alteration of the space-time framework defined by the model of GR has energy implications without a counterpart. As the body falls into the gravitational well, if we want to return it to a space-time location away from the source (which would correspond to less altered physical states considering the hypothesis proposed in this article), we need to apply energy. Certainly, it is assumed by GR that Gravity alters the fabric of space-time (schematically represented in Figure 14), and if that is the case, as experimental observations bear out, then the alteration has energy related implications and a direct consequence is that we have to apply energy if we want the body to undo its evolution of fall into the well. But shouldn´t the energy implications include an energy counterpart for that result?, that is to say, even including globally the alteration of the fabric of space-time and the fall of the body, shouldn´t there be an energy counterpart for that physical result? Or in other words, it is obvious that if Gravity alters the fabric of space-time, we have to apply energy to overcome the curvature, but it is worth considering as a plausible scenario, that the alteration is the effect corresponding to a component of energy that has a counterpart.

The first approach to this idea could lead us to conclude that the existence of a component of energy and its counterpart necessarily refers us back to Newton´s paradigm of forces, with reactions corresponding to any action and acceleration of the body. Having to choose between two alternative options, GR model (which does not include the constraint of a counterpart to a component of energy) and an alternative model with actions, reactions an accelerated bodies, certainly GR gets all the credit, as mentioned above, the forces paradigm with accelerated bodies is not backed by experimental observations, and the issue related to counterpart for energies effects raised here is just conjecture. It is credible that the type of Universe in which we live follows rules where Gravity just produces alteration of the fabric of space-time without a component of energy and its corresponding counterpart, furthermore, there is no evidence to the contrary (although as described below, the proposal implies the existence of discrepancies that should be detected experimentally).

That said, the proposed hypothesis researches a third way. In the Special Relativity scenario, there is energy transfer, as described above in the example of one ball hitting another, but regarding Gravity, here it is proposed that the alteration of the space-time framework is also promoted by energy but in a different way, where there is a component of energy producing the relativistic effect corresponding to velocitiy, and there is a counterpart of energy for that effect to take place, with the peculiarity that the counterpart is not being implemented outside the particle with respect to another frame, but inside.

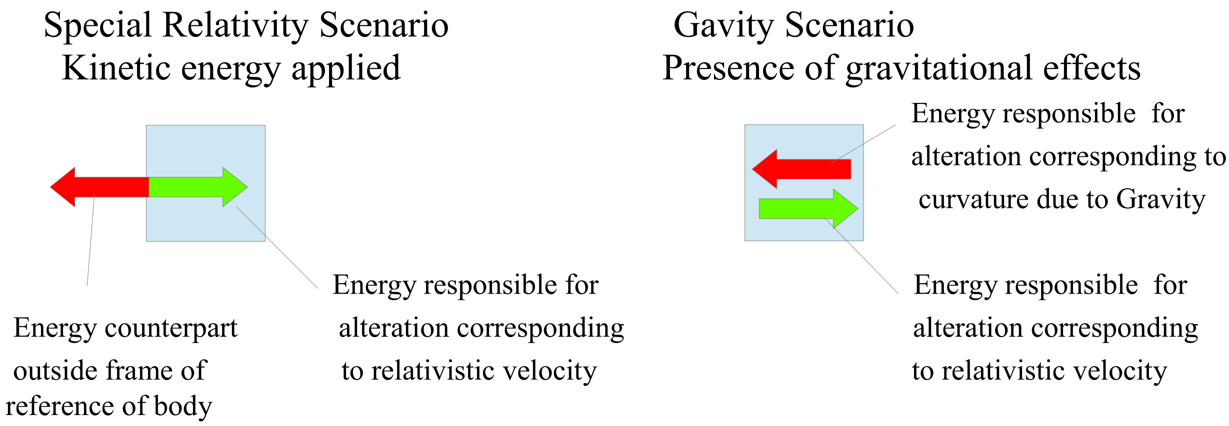


Fig. 16
Regarding the proposal, Gravity produces a double alteration (with energy components that are not being taken into account by G.R) in the particle or body considered, where one energy component is offset by the other within the particle, so that there is not the effect of an accelerated movement.

Now considering a body affected by gravitational effects, if we apply energy that offsets the component of energy linked to relativistic velocity, the body still will have the component related to the curved space, which would change as the body moves to another location with different gravitational effects.

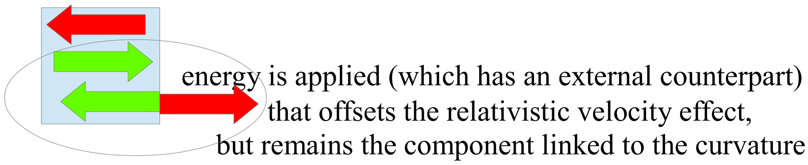


Fig. 17
Simplified scheme showing a body being altered by Gravity and the additional effect corresponding to energy applied to the body.

If the body is located in a space-time region where gravitational effects are very weak, then this scenario can be approximated to the Special Relativity one.

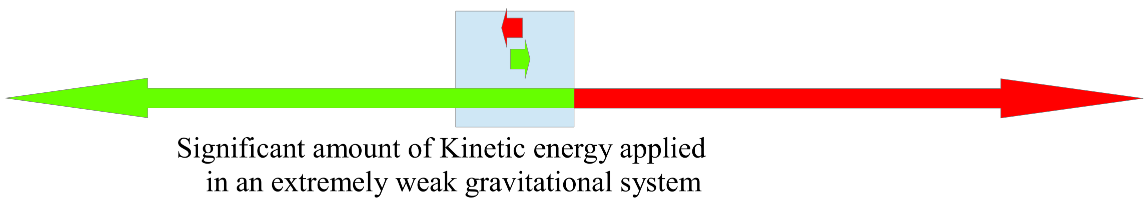


Fig. 18
scheme representing energy applied to a body located in a weak gravitational system.

From a practical point of view, the main discrepancy between the proposed hypothesis and GR is the existence of matter in the β-state produced by gravitational effects and the linked energetic effects due to this matter in the β-state. If the proposal is correct, then a model like GR which is not including these constraints would underestimate the amount of matter and energy that exists in the Universe. So, the presence of dark matter and dark energy which have been added to explain effects that are not attributable to ordinary matter and energy might be related to the proposed process. Considering planets like Earth, the factor **(dt/dτ)** is extremely small, so the amount of matter in the β-state linked to Earth´s gravitational system is negligible, but increases the stronger the gravitational system is. One must also distinguish between galaxies with centrally located supermassive black holes and those without them, where the amount of matter in the β-state linked to the latter is negligible compared to those with black holes.

The hypothetical existence of the proposed process and the resulting matter in the β-state has another important implication. Concerning Special Relativity scenarios, there is the corresponding relativistic velocity alteration, but when including the presence of Gravity, there is a double alteration as previously described.

Special Relativity Scenario

STATE A	STATE B (Velocity v relative to State A)
m	$(\gamma mc^2 - mc^2)$
Rest mass	Kinetic Energy linked to velocity *v*

Gravity Scenario
(Presence of gravitational effects)

STATE A	STATE B
m	$(\gamma(dt/d\tau)mc^2 - (dt/d\tau)mc^2)$
Body far away from Gravitational source	Body located close to the surface of the sphere

Fig. 19
scheme contrasting SR And GR in the latter has to be taken into account **(dt/dτ)m**

It has been proposed that gravitational effects produce alteration of the body, so that on the surface of the sphere (which is the source of the GE) the body will have mass **(dt/dτ)m**, then if the body follows the geodesic defined by the theory of GR (which corresponds to free fall velocity v) it would imply that the energy linked to the relativistic velocity would be $(\gamma(dt/d\tau)mc^2 - (dt/d\tau)mc^2)$ because the body with velocity v has mass **(dt/dτ)m** when located close to the surface of the sphere.

But what has been previously deduced is that the value of the energy responsible for the alteration due to the curvature resulting in **(dt/dτ)m** is $(dt/d\tau)mc^2 - mc^2$ and this energy is offset by $(\gamma mc^2 - mc^2)$, so that this should be the value of the energy corresponding to velocity of the body in free fall. But:

$$(\gamma mc^2 - mc^2) < (\gamma(dt/d\tau)mc^2 - (dt/d\tau)mc^2) \qquad (10)$$

Because $(dt/d\tau) > 1$

Then if $(\gamma mc^2 - mc^2)$ is the energy available and really do take place the proposed process producing the alteration as defined here resulting in $(dt/d\tau)m$, the only way to resolve the inequality (10) is that the body would not follow the geodesic obtained by GR, which implies:

$$(\gamma mc^2 - mc^2) = (\gamma_{mod}(dt/d\tau)mc^2 - (dt/d\tau)mc^2) \quad (11)$$

In this way we could obtain γ_{mod} and correspondingly the trajectory that the body would follow.

being $\gamma_{mod} = \dfrac{1}{\sqrt{1-\dfrac{v_{mod}^2}{c^2}}}$ with v_{mod} velocity corresponding to the trajectory due to the proposed process

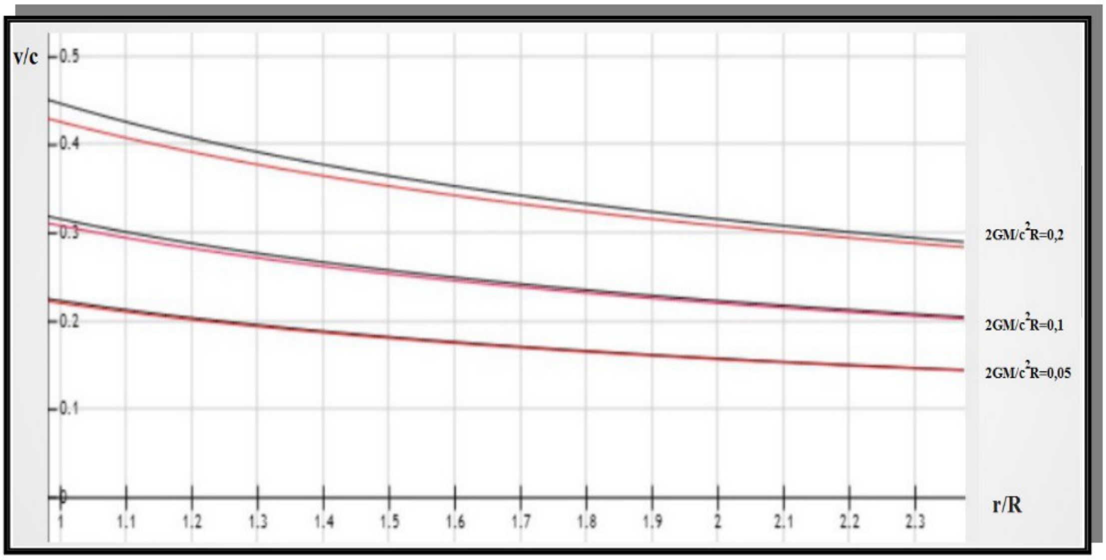


Fig. 20

Graph showing deviations. Black lines represent the free fall velocity divided by the speed of light (considering the Standard Theory of Relativity). Red lines correspond to values of the proposal. Representing values for three different gravitational systems, the higher the value of the factor $2GM/c^2R$ the stronger the source, value 1 would correspond with black holes events. The graph shows how the discrepancies decrease the weaker the source and the longer the distance from it.

It is reasonable to assume that a body that occupies 4s+t, undergoing deformation into an additional spatial dimension and moving not in 3s+t but 4s+t, the trajectory that follows will differ from the geodesic established by GR, that is to say, the projection of the trajectory from four to three spatial dimensions will differ from the geodesic corresponding to the model of GR defined in 3s+t

Therefore, the behavior and evolution of a body in 4s+t would differ from what should be expected in 3s+t frameworks. But what is causing this supposed deviation?

Initially we might consider that the deviation is due to the effect of the so-called fifth force. In this way, based on the above, we would be able to determine the values assigned to this fifth force, the energetic components that would be responsible for the previously defined deviations. Nonetheless, here it is proposed a different approach, the deviation instead of being the effect of the fifth force, would be due to the extension of quantum-like properties into an extra dimension:

The additional mass, due to the proposed alteration, that is arranged in an extra dimension would increase the uncertainty. Eq (2) is defined in 3s+t, extending it to an extra dimension would imply an additional factor increasing the uncertainty, that would affect any coordinate depending on the alteration corresponding to the coordinate. In this way the uncertainty affecting the Schwarzschild radial coordinate will increase the greater its alteration.

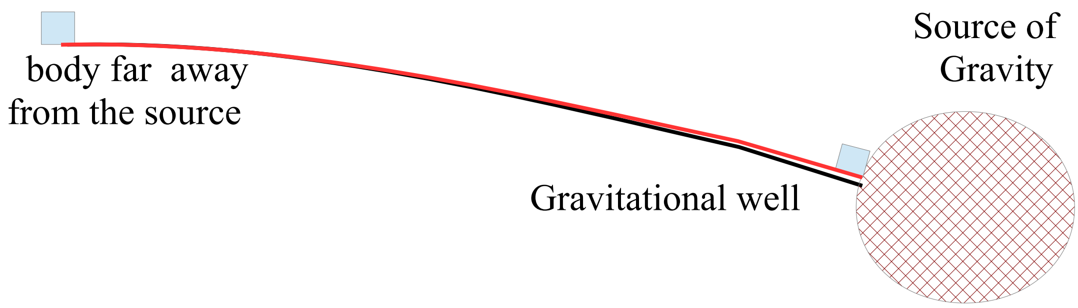


Fig. 21
Black line schematically represents the geodesic defined by the model of G.R. meanwhile red line represents the deviation due to the proposed process

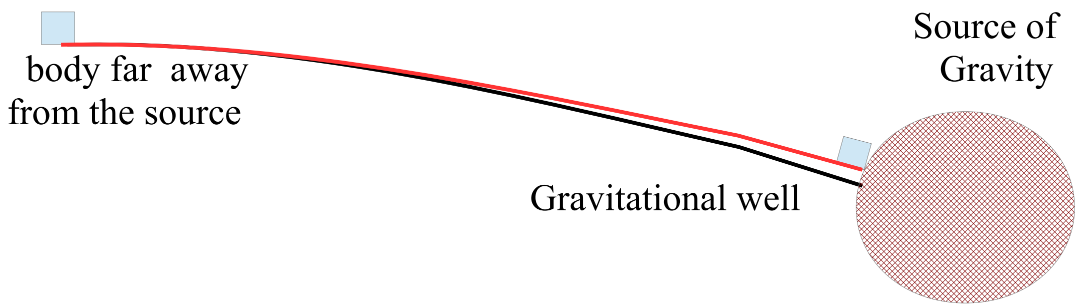


Fig. 22
Deviation increases the higher the amount of matter within the sphere

If we want a particle or body to follow the geodesic defined by the model of GR it would be required to apply kinetic energy continuously as the body falls into the gravitational well. At each location of the trajectory should be applied the increment between the value corresponding to GR and the one due to the proposed process. The increment on the surface of the sphere is:

$$(\gamma(dt/d\tau)mc^2 - (dt/d\tau)mc^2) - (\gamma mc^2 - mc^2) = ((dt/d\tau)-1)(\gamma mc^2 - mc^2) \qquad (12)$$

The greater the amount of matter within the sphere, the greater the value $2GM/c^2R$ and consequently the higher the value $((dt/d\tau)-1)$

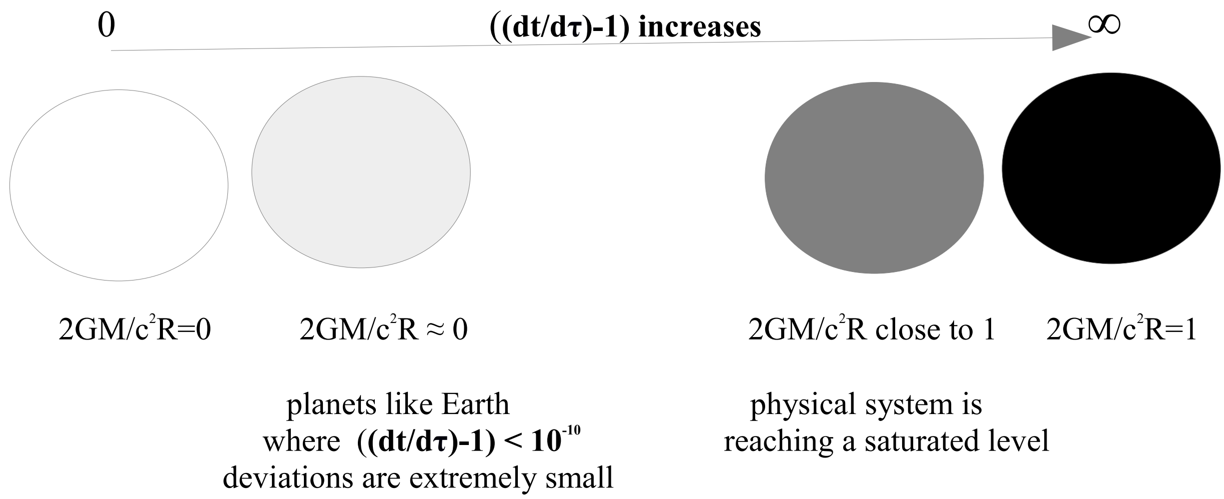


Fig. 23
The factor $((dt/d\tau)-1)$ is greater as the amount of matter within the sphere increases.

The energy that we have to apply to force a body to follow the geodesic defined by GR increases the greater the amount of matter within the sphere, hypothetically reaching an infinite value at the event horizon of a black hole, where $2GM/c^2R=1$ and consequently: $((dt/d\tau)-1) = \infty$

Let´s recall that Eq(3) implies that we have to apply energy if we want to confine a particle within a region of space-time and here it is concluded that considering the proposed process taking place in 4s+t frameworks, Eq(3) should be extended to incorporate the extra dimension, adding a factor that increases the energy required. If we want to confine a particle following a specified coordinate for an elementary displacement, the factor corresponding to this coordinate will increase the greater the alteration due to the proposed process for the specified coordinate and there will be a component of energy for that coordinate ($E_{x_{ij}}$) linked to the mentioned factor. That is to say, if we consider for example a particle close to the surface of a sphere, the energy required to confine the particle following the Schwarzschild radial coordinate towards the sphere, will increase with respect to Eq(3) when there is matter within the sphere, and the energy required will be greater the more matter is located inside the sphere, hypothetically reaching now an infinite value at the event horizon of a black hole event.

Therefore the increased energy expressed in Eq(12) corresponds to the effect of the additional factor that should be incorporated into the uncertainty principle if we extend it to an extra dimension, assuming the proposal. The factor will have a component for each coordinate corresponding to its alteration and consequently there will be a component of energy for this, that will increase the value of energy required to confine the particle following the coordinate.

Here it is assumed that Gravity alters fundamental properties of particles and, in doing so, it also alters the uncertainty factor. Another way to get to the same conclusion is the following reasoning, being assumed here that energy enhances gravitational interactions, then as energy alters uncertainty by a factor corresponding to the affected coordinates, then there should be also factors applied to coordinates due to Gravity effects.

Below it will be argued questions such as:
Why don´t we detect directly matter in the β-state? Or why don´t we perceive directly the fourth dimension or the alteration of the space-time?

First of all, it is reiterated that what General Relativity considers as the space-time framework configured by three spatial dimensions plus time, it would be actually a four spatial dimensional framework. Then elementary displacements or any trajectory that GR considers as the movement of the bodies in frameworks of three spatial dimensions plus time, would correspond to movement in four space ones. What we consider as curved space-time, in fact would be the result of deformation into an extra dimension and additionally there is the corresponding time, which is undergoing the same alteration as the fourth dimension.

Another important issue to take into account is that when an extra dimension is added we have to change our framework of reference. It is required to shift our mental approach, because the system will behave oddly if we assume only three spatial dimensions.

If indeed there is an extra spatial dimension, represented the physical system schematically by (x_1, x_2, x_3, x_4, t), then it would not be well defined using just (x_1, x_2, x_3, t). We have to specify the alteration of the body into the 5d framework and its consequent effects. An extra dimension introduces a new degree of freedom, a body with mass m in 3s+t will have multiple values in 4s+t, it is required to introduce an additional parameter. For example, a person located in a space-time region with weak gravitational effects, the mass of an object relative to him is not well defined if it is not specified the velocity relative to him, mass of the object will be m (rest mass) in case of no velocity, and will increase the greater the velocity relative to him, resulting **γm**. If we assume that $\gamma = t'/t$ is replicating the alteration of a fourth spatial dimension $t'/t = x_4'/x_4$ then we can conclude that γ is playing the role of the parameter that specifies a particular value of the multiple possible values corresponding to the additional dimension. Similarly, concerning for instance the Schwarzschild metric, **($dt/d\tau$)** is the parameter that specifies a particular value of the extra dimension caused by the gravitational effects.

Assuming that an object with mass **m** when located far away from significant gravitational sources, has now mass **($dt/d\tau$) m** when it is on the surface of a sphere with matter inside. If we are situated in the same region undergoing the same gravitational effects, we would measure value **m** as mass of the object, because when there is an additional dimension there are multiple values and the specified value of the object will depend on the alteration suffered by the object with respect to the one corresponding to the reference. In the previous example as we are undergoing the same alteration than the object, then the value is **m**, from our point of view (relative to us). This is the mass of the object considering the same reference than the object, but taking as referene a region far away from the source of gravity where time can be assimilated to coordinate time t, the mass of the object would be **($dt/d\tau$) m.** Similarly concerning Special Relativity scenarios, if an object is not moving relative to us, will have rest mass **m**, as it is undergoing the same alteration than us, but when it moves with velocity **v** towards us will have mass **γm** relative to us. So, we have to specify physical properties like mass of the object relative to a reference, being due to the multipe values corresponding to an extra dimension and the specified value will depend on the alteration suffered by the object with respect to the alteration that is undergoing the reference. That is to say, Relativity is the kind of property that should be expected in a Universe with an extra dimension with bodies undergoing alterations such as the ones proposed here. Concerning Special Relativity scenarios, results expected by the proposal are the same than the standard theory of Relativity, but when gravitational effects are included there are discrepancies, deviation in the trajectory described above and the effects corresponding to multiple values due to the extra dimension.

If we evolve to a new framework, which is undergoing a different alteration in relation to the previous one, it will be modified values like space, time and mass with respect to the initial framework (if we consider this one as the reference), but from our point of view, taking as reference ourselves, in our own frame of reference nothing changes, what is modified is the previous framework, which is now undergoing a different alteration in relation to the ours. In our own we do not perceive the alteration directly, because everything corresponding to our framework is altered, including any kind of elementary pattern we use to measure. For example if we use an atomic clock, as it is exposed to the same alteration than us, we do not perceive directly that the passage of time has changed, similarly concerning space dimensions or the mass of objects, we do not perceive directly the alteration in our own frame of reference. It is only when we compare our framework with another one exposed to different alterations, that we realize the existence of discrepancies with respect to us and is the other the one that changes, ours remains unchanged from our point of view. Similarly a particle moving in curved spacetime will keep the fundamental values unchanged in its own framework, but will change in relation to the others.

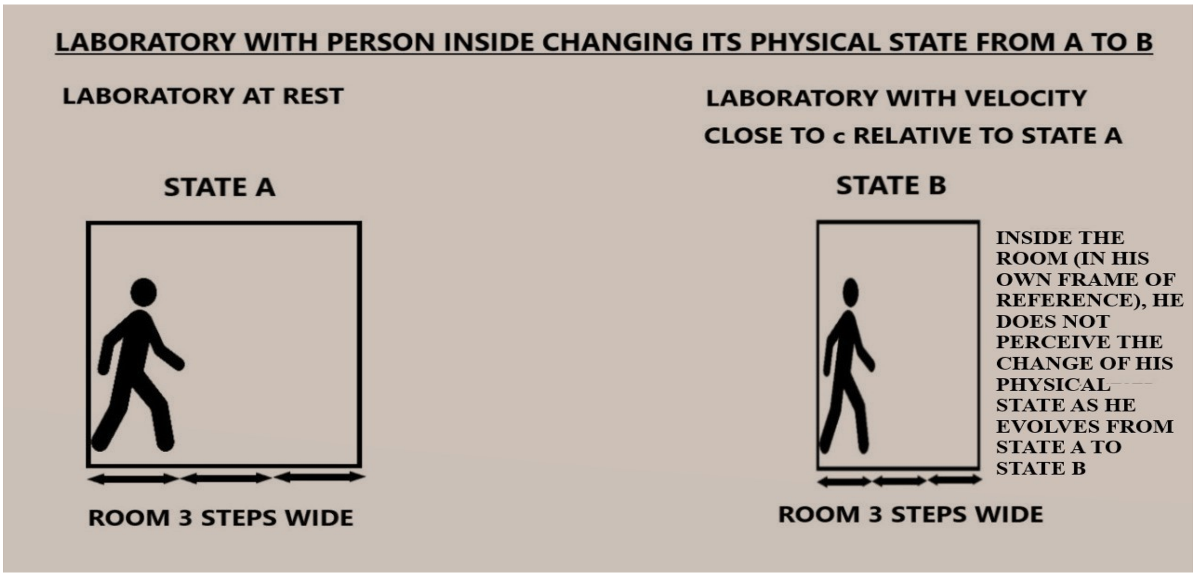


Fig. 24

From our point of view, if we evolve from State A to State B, nothing has changed in our own framework, is the one in State A what has changed in relation to us. But from the point of view of someone that remained in State A, we are the ones changing physical properties.

Therefore, considering very strong gravitational systems such as galaxies with supermassive black holes at the center, the gravitational effects will be greater in a star located far away from the center than one closer, as increases the alteration corresponding to the source in relation to the alteration affecting the goal.

Concerning weak gravitational systems, these discrepancies discerning the effects depending on the alteration of the source in relation to the goal are negligible even for the corresponding to Earth´s.

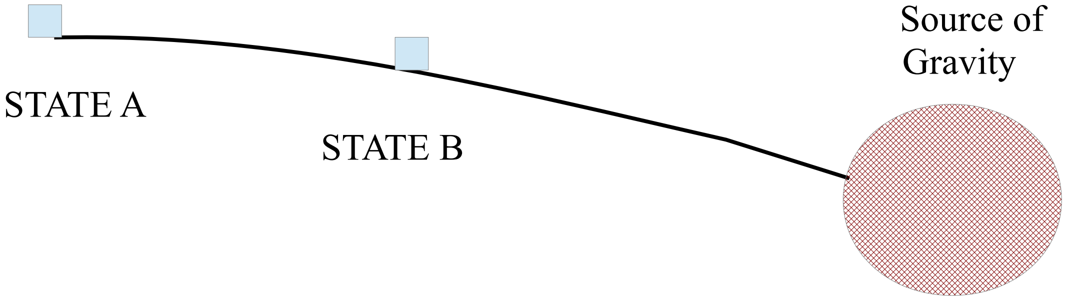


Fig. 25

The mass of the source in relation to the body, will be higher for a body that is further away in a space-time region with less alteration.

But also particles of the source undergoing different alterations will have different values. For example particles on the surface in relation to the body in STATE B of Figure 25, will have a different value than particles located at the center in relation to the same body. These values are affecting the mass of particles and simultaneously depend on them, where each particle affect and is affected by the others. So, it is required to know which is the equilibrium state of the physical system, that might be mathematically calculated by numerical methods such as iteration, to which would be applied the restriction that produces deviations due to the increased uncertainty previously described.

In this way, due to the additional dimension, the gravitational effects will depend on the alteration affecting each particle of the source in relation to the goal. Nonetheless, discrepancies with respect to General Relativity are extremely small ones unless the physical system is affected by very strong gravitational effects.

Considering hypothetically a three spatial plus time dimensional framework, a body or particle in two different locations affected by similar relativistic effects, for instance a case where threre is negligible gravitational interactions and energy-momentum do not differ in both locations, then there is no alteration of the frame of reference and fundamental values such as m_p, l_p and t_p would not change in one location in relation to the other one.

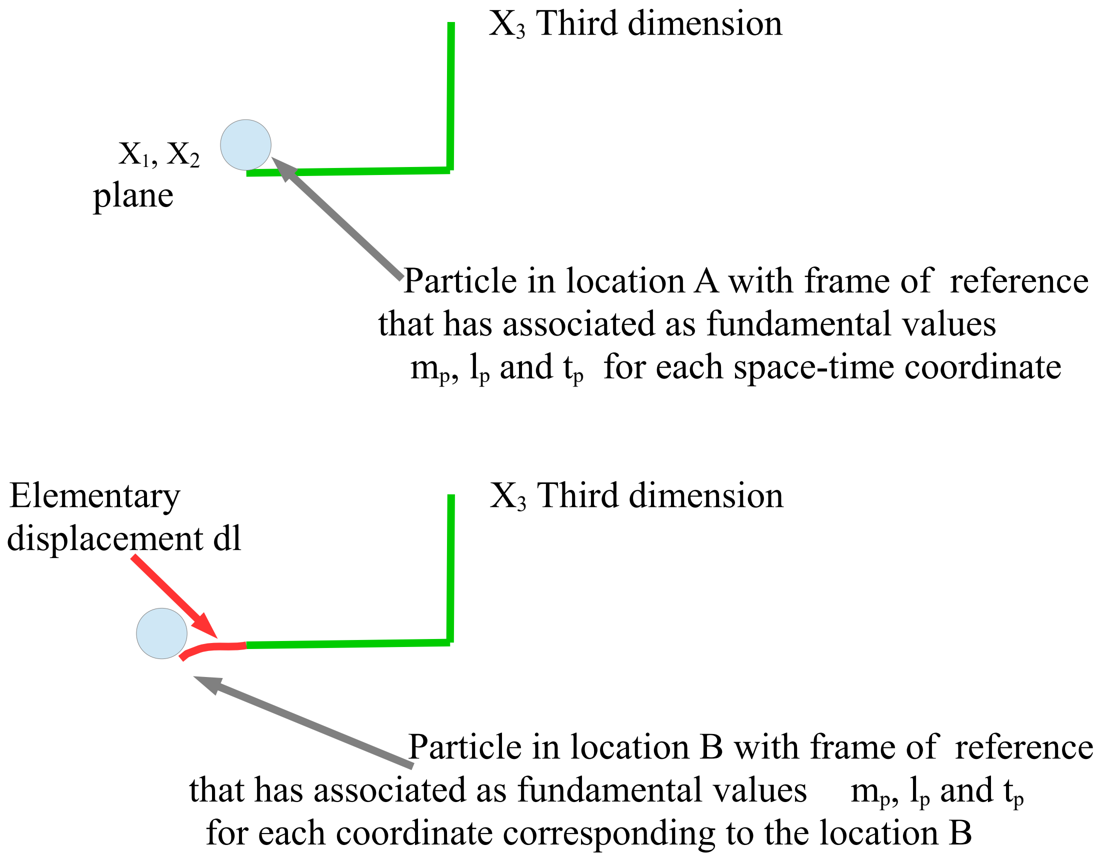


Fig. 26
Scheme where the particle undergoes an elemental displacement dl, which takes place with respect to the frame of reference (which has not been altered)

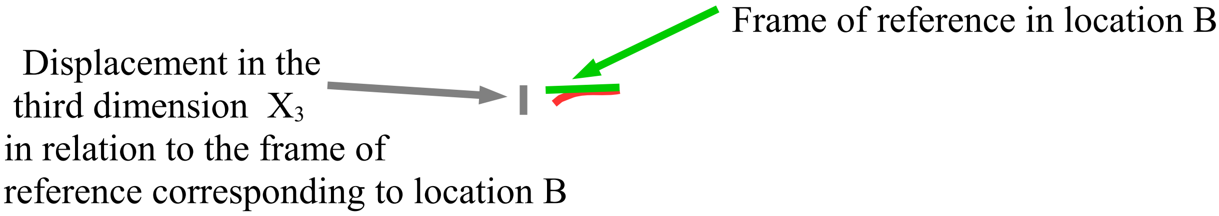
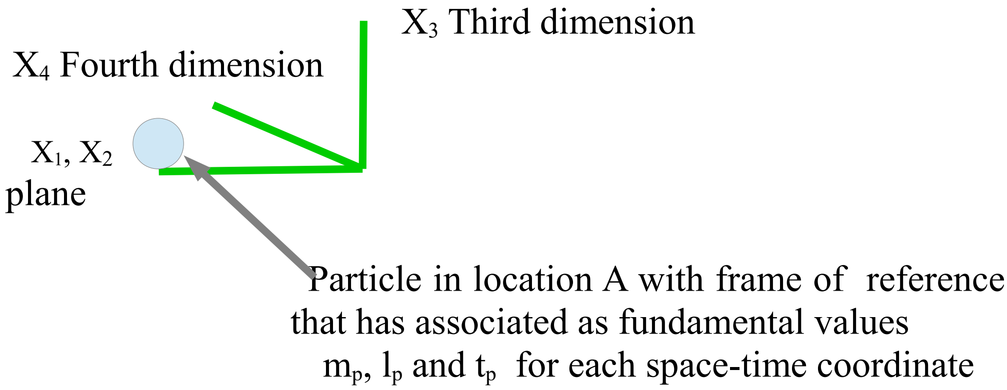
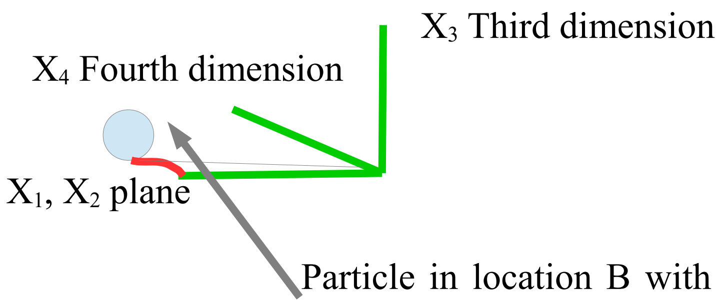


Fig. 27
Displacement in the third dimension takes place with respect to the frame of reference which is the same in location B than the corresponding in location A

If we now consider an additional spatial dimension, so there is a 4s+t space-time configuration where it is taking place the proposed process, then there is alteration of the particle or bodies and of the corresponding space-time frameworks, with the peculiarity that the deformation and the movement into the additional fourth dimension is not due to the displacement with respect to the framework of reference, but to the alteration of the framework itself.





Particle in location B with frame of reference that has associated as fundamental values m_p, l_p and t_p for each space-time coordinate. There has been an alteration so that the fundamental values are the same in relation to itself (the Particle in location B) but have changed in relation to location A.

Fig. 28
Scheme representing a four spatial dimensional configuration where it is taking place the proposed process

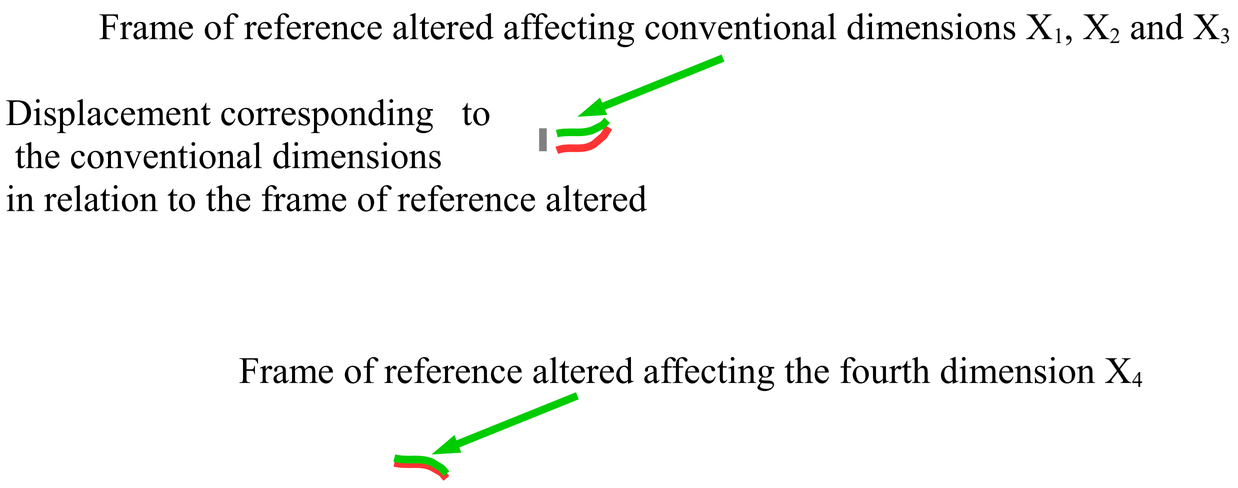


Fig. 29
In contrast to the conventional dimensions X_1, X_2 and X_3 there is no displacement in the fourth dimension in relation to the altered frame of reference.

While concerning conventional dimensions X_1, X_2 and X_3 there is a double contribution due to the displacement in relation to the altered reference frame that affects these dimensions and the alteration of the framework involving the corresponding coordinates (in this way we would perceive directly the first contribution but not the second one, because it has also changed the patterns of reference). On the other hand, when considering the fourth dimension, as all the deformation and movement would be due to the proposed process, then there is no displacement in the fourth dimension in relation to the own frame of reference, locally all the deformation and movement in the fourth dimension is fully due to the alteration of the framework affecting the coordinates involving this fourth dimension. Therefore, we would not directly perceive (in our own frame of reference) the alteration corresponding to the three conventional dimensions, nor the complementary alteration of the fourth dimension, but when we consider the physical system as a whole, then we realize that we are evolving in a curved four space dimensional framework, where even different parts of our body are being affected by different alterations.

In this way, we have to distinguish between the deformation of the body with respect to the frame of reference and the deformation or alteration of the frame of reference and the corresponding to the body located there. We perceive directy the first one, but not the second.

CONCLUSIONS

It is proposed a quantum-type process in a four spatial plus time dimension configuration that would be responsible for gravitational phenomenon, where the effects linked to Gravity would be the result of interactions producing alteration of quantum states, establishing a correspondence relationship between these alterations and the curvature of the space-time framework. Concerning Special Relativity scenarios, it is shown that the proposal does not imply discrepancies with respect to the standard theory of Relativity, it is just a different interpretation of the physical phenomenon that is ocurring. Discrepancies do arise when there is presence of gravitational systems, requiring very strong ones to obtain significant discrepancies. Gravitational interactions would be responsible for producing a double alteration in a quantum-like process of creation-annhilation of matter. The main features and consequences of this hypothetical process have been described. Finally it has been discussed the properties that should exhibit a physical system undergoing alterations such as the ones described here, concluding that the peculiar characteristics of Relativity, defined in Special Relativity, are the kind of properties that should be expected in a Universe with an extra dimension where alterations such as those corresponding to the proposed process are taking place.

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