PROPOSED HYPOTHESIS OF A PROCESS LINKED TO GRAVITY AFFECTING MASS-ENERGY

SEP, 19
2018

AUTHOR:

SANTIAGO UGARTE

ABSTRACT

The proposal assumes that the distortion of space-time due to relative velocity (Special Relativity) and the distortion of space-time produced by gravitational fields (General Relativity), are linked to changes of state that affect to the physical properties of bodies, particularly space-time and mass-energy (The expression mass-energy refers to Einstein´s mass and energy equation $E=mc^2$).

The hypothesis proposes the existence of a process linked to gravity, this phenomenon would affect mass-energy. Requires adding an additional condition (being a more restrictive scenario). There is a relationship between Einstein´s Field Equations and the proposed process. The additional condition changes the trajectory that a body would follow in the curved space-time, with respect to the established by the Standard Model of Relativity (the curvature is modified, so the geodesic is modified as well). The effect is negligible if the distortion of space-time caused by a gravitational field does not have a significant value. The proposed hypothesis allows to mathematically calculate the discrepancy with respect to the Standard model. In case of being correct, would have important implications in various areas of science and its effect would be decisive in the study of black holes or issues related to Cosmology.

.

BACKGROUND, PROBLEMS JUSTIFYING NEW CONTRIBUTIONS

The mathematical model of General Relativity has made accurate predictions and calculations, however there are certain issues about gravity that have not been satisfactorily resolved and lead to the conclusion that something is wrong or that is not being interpreted properly, or requires something else like additional conditions that are not being taken into account. Below are briefly described some of the problems concerning gravity:

- Theoretically, General Relativity predicts or gives rise to singularities under certain circumstances. The rules established by quantum mechanics require an increasing energy demand in order to increase the degree of confinement of a particle. However, the model defined by relativity, there is not such an impediment to that circumstance, quite the contrary, what the theory seems to indicate is that under certain conditions bodies would inexorably follow a path to singularity. Other forces such as electromagnetism where initially there were divergences at certain conditions, have been renormalized thus avoiding such divergences, which has not yet been possible with gravity. These have been some of the reasons for defining alternative models such as String Theory.

- Stephen Hawking's contributions to black-holes radiation that lead to the paradox of information loss for a body that crosses the horizon of events, was a problem without a clear resolution until the middle of the 1990s, when the Holographic Principle was proposed, which currently has the consensus and majority support of the scientific community.

- In 2012 arose a new conflict, presented by Ahmed Almheiri, Donald Marolf, Joseph Polchinski and James Sully. Taking into account the officially accepted model, including the Holographic Principle, a particle would have at the same time two quantum entanglements, while being entangle with a particle that crosses the event horizon and at the same time with the duplicate information linked to that event horizon. The fact of a double quantum entanglement contravenes the quantum rules, this has generated a new conflict that has in some way divided the scientific community and still does not have a clear resolution. The proposal or solution presented by Ahmed Almheiri, Donald Marolf, Joseph Polchinski and James Sully included the existence of a Firewall at the event horizon of a black hole, whereby an observer on reaching the event horizon or in the vicinity of it would encounter quantum energy that would prevent the passage through the event horizon. However that proposal is still controversial, critics argumenting that energy firewall seems an "Ad Hoc" solution and that firewall seems to come from nothing because only Would appear in the vicinity of the black hole.

If the proposed hypothesis presented in this paper is correct, it would have important implications and should be taken into account in relation to the phenomena described above.

INTRODUCTION

There are four fundamental forces in Nature, weak and strong nuclear forces, electromagnetic and Gravity. The first three of them have a physical model based on Quantum Mechanics. The best model for Gravity is General Relativity (it is the known model that fits better the experimental observations), where gravity is not a conventional force, but the effect linked to the curvature of space-time. One of the proofs to support that gravity is not a force (or at least not a conventional force), is that an accelerometer for a body in free fall should not measure any acceleration. That fact can be proven at the earth´s gravitational field with a high degree of accuracy.

The Stress-energy tensor for the Einstein Field Equations of the Standard Model of General Relativity does not incorporate any element linking the gravitational field with a force, so that the result obtained does not show any effect of force. In the past, there were some attempts to incorporate a term in the Stress-energy tensor corresponding to a force effect due to gravity, but it was not found. From the very beginning was assumed that the effect of the gravitational fields is the curvature of space-time as defined in Einstein´s Field Equations, nothing more and nothing less. The Standard model of Relativity has allowed to make predictions and calculations that have been tested with high level of accuracy.

This is briefly a simplified description corresponding to the Standard Model of Relativity, in contrast to it:

When an additional condition like the proposed hypothesis is added to the Standard Model of Relativity, then the modified model adquires some interesting properties, which resemble those of Quantum Mechanics. The hypothesis implies that there is indeed a force linked to gravity and should be taken into account by the Einstein Field Equations. That force is an extremely small one and negligible insofar distortion of space-time does not reach a significant value, but the effect of that force is relevant considering strong gravitational fields like the corresponding to black-hole events. For instance analizing the Schwarzschild metric, the force is opposed to the free fall and produces distortion of the coordinates, so that the value of v obtained from the field equations (considering the Standard Model of Relativity), is modified to v_{mod} where the Schwarzschild radial coordinate and time coordinates suffer the additional distortion due to the proposed effect opposed to the free fall. Knowing the space-time distortion corresponding to the Standard Model of Relativity, it can be calculated the proposed effect.

Features of the proposed hypothesis:

- **The hypothesis allows to use the Relativity framework to make calculations and predictions (for instance, in this paper it is calculated discrepancies with respect to the Standard Model for the Schwarzschild metric scenario).**

- **Discrepancies with respect to the Standard Model of Relativity are negligible if the gravitational field does not have a significant value, those discrepancies are smaller ones the weaker the gravitational field.**

- **The effect of the proposed process corresponds to the effect of a force opposite to the free fall, that effect will produce an additional distortion of the space-time, so that for an object in free fall, in order to follow the geodesic established by the Standard Model of Relativity, it would be neccesary to apply energy to compensate for the proposed effect. The energy required would have an infinite value at the event horizon of a black hole.**

- **Quantification. The hypothesis proposes that there is an interrelation between space-time distortion and the alteration of mass-energy, mc^2 value corresponds to the quantity of mass in (α-state). The higher the amount of mass-energy in (β-state), the higher the space-time distortion. Knowing the Einstein Field Equations, it is possible to obtain the quantity of mass-energy in (β-state). The counterpart of that value is the energy that will produce an additional space-time distortion, producing a discrepancy with respect to the Standard Model of Relativity.**

- **Probabilistic approach. The proposed process where mass-energy changes from (α-state) to (β-state) is linked to a probabilistic phenomenon, where the interaction between graviational waves with mass will alter the state of that mass. The stronger the gravitational field, the higher the amount of mass-energy in (β-state). If energy-momentum is applied, then that process will be boosted.**

- **Considering expansive scenarios, the reverse process takes place, so that instead of taking energy from the physical system, it will provide energy, this way expansive scenarios (for example the expansion of the Universe) will show velocities higher than the expected by the Standard Model of Relativity.**

The expression: "State of a body", alludes to the physical properties of the body.

Physical properties:

- Mass-energy value **$E=mc^2$.** The interaction between spin-2 particles ("gravitons") and mass-energy, will alter the state of mass-Energy from **(α-state)** to **(β-state).** The stronger the gravitational field in a region of space-time, the higher the quantity of mass-energy in (β-state). **The hypothesis establishes a relationship between the amount of mass-energy in (β-state) and the distortion of space-time.**

- Space } The proposal considers space-time as intrinsec properties of the body.

  Time } Space-time distortion corresponds to alterations of the state of the body

The distortion of Space-time is a consequence of the alteration of mass-energy (this conclusion is based upon the premise of establishing a relationship between the alteration of mass-energy and the distortion of space-time proposed by the hypothesis). The cause or agent responsible of the alteration of a state, are the gravitational fields, if energy-momentum is applied, then that alteration is boosted (for instance, when kinetic energy is applied).

So that, Mass-energy and space-time are affected by:

Gravitational Fields }

Energy-Momentum }

In this way, the physical state of a body changes when its position varies in a gravitational field or when energy-momentum is applied to the body.

The Standard Model of Relativity defines the curvature of space-time and its interrelation with the Stress-energy tensor (including the effects of Gravitational Fields) applying the Einstein Field Equations.

$$R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\Pi G}{c^4}T_{\mu\nu}$$

The hypothesis proposes that when relativity is identified with changes in the state of a body, the physical properties, previously defined, follow rules of relativity (the Special Relativity scenario and the General Relativity scenario will be analyzed below). This approach allows to define a process which shows some interesting properties, it is an extensive model, the weaker the gravitational field, the closer the results to the Standard Model (discrepancies are extremely small ones unless the gravitational field is a siginificant one).

Special Relativity Scenario

Considering a hypothetical pure Special Relativity scenario, if a body has no velocity relative to the reference, we might say that the body is in "State A", if it is applied kinetic energy (Υmc^2 $-mc^2$) to the body, then changes the state of the body (physical properties mass-energy and space-time do change) the body is now in "State B" with mass-energy Υmc^2 relative to the "State A" (the previous frame of reference) and with space-time distortion relative to the "State A".

Minkowski space $ds^2= c^2dt^2-dx^2-dy^2-dz^2$

Kinetic energy (Υmc^2 $-mc^2$)

"STATE A"

Physical properties of an object in "State A":

- $E=mc^2$
- Space-time { L, t }

"STATE B" (velocity v relative to A)

Physical properties, relative to A, of an object in "State B":

$E' = \Upsilon mc^2$ **Υ the Lorentz factor**

$$\Upsilon = 1/\sqrt{(1- v^2/c^2)}$$

Space-time { $L' = L/\Upsilon$, $t' = t * \Upsilon$ }

Considering a hypothetical pure Special Relativity scenario (with negligible gravitational fields), now taking into account the proposed hypothesis, the result would be the same: we would say that mass-energy (mc^2) of the body would be affected by the Kinetic energy (Υmc^2 $-mc^2$), as result would be obtained: Mass-Energy **(α-state)**(quantity mc^2) plus Mass-Energy **(β-state)** (quantity Υmc^2 $-mc^2$) with total quantity of mass-energy (Υ mc^2) and space-time distortion as defined by relativity ($L' = L/\Upsilon$ and $t' = t*\Upsilon$).

Taking as reference State A, the process between A and B: "State A"→"State B"
Mass-Energy mc^2 **(α-state) + Energy (**Υmc^2-mc^2**)**→Mass-Energy (**α-state)+**Mass-Energy (**β-state) =** Υmc^2 Being Υ The Lorentz factor.

There is an interrelation between the physical properties: mass-energy and space-time

(1) $E' = \Upsilon mc^2$ $\longleftrightarrow$ Space-time

Mass-energy is affected, being altered in accordance with what is modified the space-time, or inversely we could say as well that space-time distortion is in accordance with the alteration of mass-energy.

Knowing that $L' = L/\Upsilon$ and using the defined concepts:

(L-L´)*(total mass-energy) = (L-L´)*(mass-energy(α-state)+mass-energy(β-state)) = $(L - L/\Upsilon) * (\Upsilon mc^2) = L(\Upsilon mc^2 - mc^2)$ =L*(mass-energy (β-state))

then the proportion: (L-L´)/L = (mass-energy(β-state))/(total mass-energy)

While (L´)*(total mass-energy)= $L(mc^2)$ =L (mass-energy (α-state))

with $\Upsilon = L/L'$=(total mass-energy)/(mass-energy (α-state))

That is $E' = \Upsilon mc^2$ = (L/ L´) * (mass-energy (α-state))

From a practical point of view, considering a hypothetical pure Special Relativity scenario, the result is the same, either by assuming the proposed process or the model corresponding to the Standard Model of Relativity. But when the gravitational fields effects are not negligible, then the proposed process establishes discrepancies with respect to the Standard Model of Relativity, that discrepancy is negligible if the graviational field is a weak one, but the discrepancy increases the stronger the graviational field.

General Relativity Scenario

Standard Model of Relativity , without taking into account the proposed process:

$$R_{\mu\nu} - \frac{1}{2}R g_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\Pi G}{c^4} T_{\mu\nu}$$

Einstein Field Equations corresponding to the Standard Model of Relativity.

Considering the Schwarzschild metric for the vacuum solution of a homogeneous sphere, uncharged, non rotating.

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

τ: proper time

t: time coordinate

r: Schwarzschild radial coordinate

θ: colatitude

φ: longitude

$r_s = 2GM/c^2$

Energy

“STATE A”

Physical properties of Object in “State A” region of space-time where time is coordinate time t

“STATE B”

Physical properties of Object in “State B” region of space-time where time is proper time **τ**

- $E=mc^2$

$E' = (dt/d\tau) mc^2$

- Space-time **(dt, dr, dθ, dφ)**

(E.F.E. With negligible Gravitational Field)

Space-time E.F. E.

(No negligible G.F.)

Modified E.F. E.

Previous Scheme, without including the terms in red (Energy; $E' = (dt/d\tau)mc^2$; Modified E.F. E.) would correspond to the Standard Model of General Relativity.

Modified Einstein Field Equations means that the Stress Energy Tensor of the E.F.E. Should include the effect of the energy required by the process to take place, so it might be denoted as well modified Stress Energy tensor of the E.F.E.

The hypothesis proposes that the physical properties of an object will change according to the region of the gravitational field that it occupies, and there would be an interrelation between mass-energy and the curvature of space-time defined by the E.F.E. (that is how it is calculated the expression $(dt/d\tau)mc^2 - mc^2$) of a static situation), in a similar manner as it was defined when considering the Special Relativity scenario where:

(1) $E' = \Upsilon mc^2$ ⟷ Space-time.

Considering a gravitational field scenario, mass-energy of the object would depend on the E.F.E. Being $E' = (dt/d\tau)mc^2$ That process requires Energy to take place and the counterpart effect of that energy will be the corresponding of energy opposed to the free fall of the object, which has to be included in the E.F.E. So that instead of the E.F.E. Corresponding to the Standard Model of Relativity it is defined the Modified E.F. E. which are the E.F.E. taking into account that effect.

Gravitational waves will interact with mass-energy, that process requires energy (it is an endothermic process), will be at the expense of reducing the velocity term so that instead of v will be v_{mod}. That effect is the corresponding to energy opposed to the free fall so that the factors $(1 - r_s/r)c^2$ and $(1 - r_s/r)^{-1}$ linked to dt^2 and dr^2 will be modified giving as result vmod instead of v.

Mass-Energy mc^2 (**α-state) interaction with G.W.** + **Energy**→

Mass-Energy (**α-state**)(quantity mc^2) +Mass-Energy (**β-state**) (quantity $(dt/d\tau)mc^2 - mc^2$) = **total mass-energy** (quantity $(dt/d\tau)mc^2$).

Taking as reference "State A" **Energy: (**$(dt/d\tau)\mathbf{mc^2} - \mathbf{mc^2}$**)**

The energy required implies that the process is an endothermic one, it takes place at the expense of taking energy from the physical system. We have:

\+ **(**$(dt/d\tau)\mathbf{mc^2} - \mathbf{mc^2}$**) energy required by the process and**

\- **(**$(dt/d\tau)\mathbf{mc^2} - \mathbf{mc^2}$**) the counterpart of the energy required by the process**

The counterpart of the energy required by the process, has a negative value and produces the effect corresponding to energy opposed to the free fall, so that coordinates dr and dτ (values corresponding to the Standard Model of Relativity) will be modified due to the effect of the energy required by the process. Considering a free fall scenario:

Note: that is to say, the factors $(1 - r_S/r)c^2$ and $(1 - r_S/r)^{-1}$ linked to dt^2 and dr^2 used to obtain v, are affected by the energy linked to the proposed process, giving as result v_{mod} instead of v.

If the proposed process has an effect such that there is conservation of energy, then:

$(\Upsilon_{mod}(dt/d\tau)mc^2 - (dt/d\tau)mc^2) = (\Upsilon mc^2 - mc^2)$

Result: $\Upsilon_{mod} = 1 + \Upsilon * d\tau/dt - d\tau/dt$ being $\Upsilon_{mod} = 1/\sqrt{(1 - v^2_{mod}/c^2)}$

Considering the Special Relativity scenario, there is a contribution of energy (kinetic energy) between the states, an interrelation between space-time distortion and the alteration of mass-energy, and the value of mass-energy depends on the reference taken.

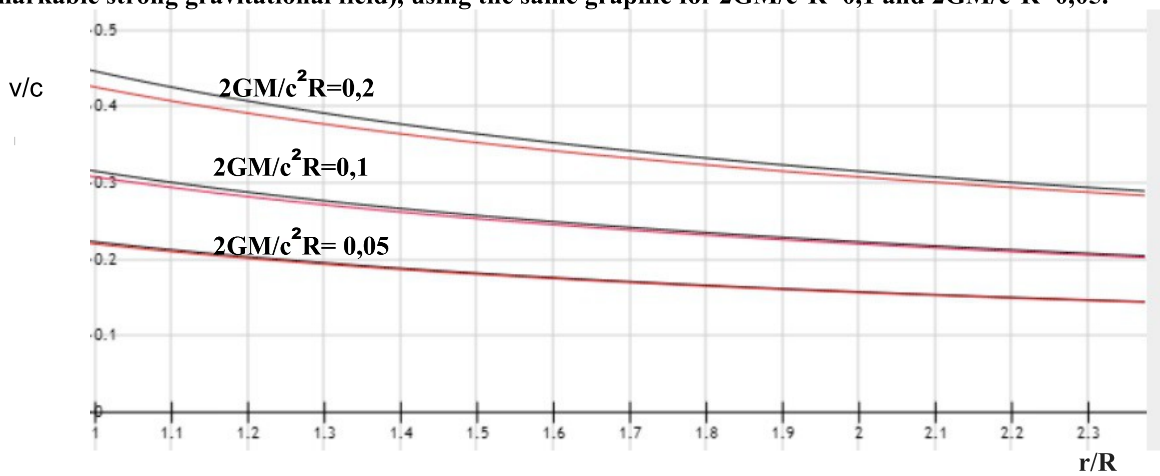
Considering the presence of gravitational fields, it is proposed a process that takes place at the expense of energy taken from the physical system, there is as well an interrelation between space-time distortion and the alteration of mass-energy, and the value of mass-energy depends on the reference taken.

$$E^A_C - E^A_B = \int_{dt/d\tau_B}^{dt/d\tau_C} mc^2 d\phi$$ **Energy linked to the proposed process (static situation)**

p= 1/ϕ Being ϕ= dt/dτ (t coordinate time; τ proper time)

τ_B proper time at B; τ_C proper time at C. When the states B and C correspond to A and B respectively, and denoting generically $\tau_B = \tau$, then: $E^A_B - E^A_A = (dt/d\tau)mc^2 - mc^2$

Below, it is represented the effect at the vicinity of a sphere (Schwarzschild metric) when $2GM/c^2R=0,2$ (a remarkable strong gravitational field), using the same graphic for $2GM/c^2R=0,1$ and $2GM/c^2R=0,05$.



Black lines represent the value of v/c of free fall body. considering the Standard Model of Relativity, meanwhile the red ones do represent the modified value v_{mod}/c taking into account the proposed hypothesis.

DISCUSSION

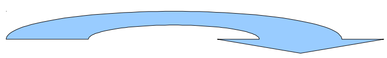
The proposal assumes that the distortion of space-time due to relative velocity (Special Relativity), and the distortion of space-time that is produced by gravitational fields (General Relativity) are linked to changes of state that affect to mass-enegy. Mass-energy would be affected, changing its state, generically denoted "State A" and "State B". The present paper establishes as reference "State A" while "State B" is taken as referenced to A (This will be the criterion followed at the paper if it is not said otherwise). Concerning relative velocity, these states correspond to relative velocities between bodies. Taking as reference "State A", if a body moves at velocity v relative to another body, we would say that the reference body is in "State A", while the other body that moves at velocity v relative to A, is in "State B". Considering General Relativity, the distortion of spacetime generated by the gravitational field will also be associated with different states, if we take as reference the state for which the gravitational field effect is zero, then "State A" would be associated with time dt, while the "State B" would be in a generic way, characterized by the proper time dτ, which would depend on the space-time distortion. That is to say, concerning relative velocity, “State B” would be generically characterized by v, meanwhile concerning gravitational fields “State B” would be generically characterized by proper time τ.

Note: Concerning General Relativity the proposed hypothesis adds an additional condition to the system of ten non-linear partial differencial equations corresponding to the Standard Model of Relativity. As example (at this paper) of General Relativity scenario with the presence of a gravitational field, will be considered the Schwarzschild metric for the vacuum solution of the field outside the homogeneous sphere, uncharged, non rotating.

Quantum mechanics is characterized by processes where particles interact, passing from an “α state” to a “β state”, with a probability associated to those processes. The proposal introduces a process linked to gravity, where mass-energy would be affected changing its physical state. A body would change its state from A to B, where “State B” has a greater amount of altered mass-energy (denoted in Beta State).

The hypothesis proposed at this paper assumes that there is a contribution of energy between both states. That would be already taken into account by the Standard Model of Relativity for Special Relativity ($E_T=E_K$), but not for General Relativity with the presence of a gravitational field.

E_T

State A E_A  State B E_B with $E_B = E_A + E_T$

$E_A= mc^2$ $E_T= (1/p)mc^2-mc^2$ $E_B= (1/p)mc^2$

Where p is a factor that relates the referenced state (State B) to the reference state (State A).

- Concerning Special Relativity: $p= 1/ϒ$ **Being ϒ The Lorentz factor**

Then $E_T= ϒmc^2-mc^2$ kinetic energy.

$E_B= ϒmc^2$ This value includes the factor $p= 1/ϒ$, So that a relation between the reference (State A) and the state referenced to it (State B) is established, so that the value $E_B= ϒmc^2$ implies that “State A” is the reference, if we take as reference “State B” and we consider it as reference to itself (for example an observer situated at “State B” observing something which is at “State B” as well) then velocity 0, $ϒ=1$ and the factor p=1, so $E_B= mc^2$ because the observer is at reference (State B) and the object observed is in “State B” as well and E_T between them has a null value.

From a practical point of view, considering the Special Relativity scenario, there would be no changes with respect to the Standard Model. The energy required to pass from one state to another would be the kinetic energy, and mass-energy in "State B" would have a value increased by the factor ϒ with respect to "State A", we would say that "State B" has reference at A or is relative to A. Thus this approach would be compatible with the Standard Model of Special Relativity.

- Concerning General Relativity: "State A" is linked to dt and "State B" linked to dτ, hypothetically with no relative velocity between both states, the relation between times is given by: p=dτ/dt denoting **p= 1/ϕ ; Being ϕ= dt/dτ**

If the reference is "State B" and the referenced state is also "State B": p= dτ/dτ =1

If the reference is "State B", and "State A" is referenced to it, then p= dt/ dτ

(Both observers, one of them situated at "State A" the other at "State B" would agree on time linked to A is t, while time linked to the "State B" would be τ. Concerning relativistic velocity, both observers would take as value p for the other state as p= **1/ϒ**)

If the reference is a state associated with $d\tau_1$; and another state, with $d\tau_2$ is referenced to it, then p= $d\tau_2$ **/** $d\tau_1$

Considering "State A" as reference and B with reference at A:

E_A= mc² E_T= (dt/dτ)mc²-mc² E_B= (dt/dτ)mc²

Considering an observer in "State A", and an object in State A as well, with associated energy E_A=mc². If that object passes to "State B", while the observer is sit in "State A", the value of the energy associated to that object relative to the observer fixed in "State A", changes to E_B= (dt/dτ)mc², and the value of the energy required for that proccess to take place is E_T= (dt/dτ)mc²-mc²

The value of the energy E_B is the value at B with reference the "State A", indicating that energy at B is with respect to A, already implies that relation, although for this concept to be explicitly represented would be required a notation of the type:

E^A_A= mc² **E^A_B= (dt/dτ)mc²**

Upper index A indicates that the reference is "State A", so the value of the energy at A with reference A has value mc² while the value at B with reference A would have value: (dt/dτ)mc²

If we consider the value at B with reference B then E^B_B= mc²

and the value at A with reference B would be E^B_A= (dτ/dt)mc²

The energy between two states B and C taking as reference A (with time t, coordinate time):

$$E^A_C - E^A_B = \int_{dt/d\tau_B}^{dt/d\tau_C} mc^2 d\phi$$ **Energy linked to the proposed process**

τ_B proper time at B; τ_C proper time at C

When the states B and C correspond to A and B respectively, and denoting generically τ_B=τ, then: **E^A_B - E^A_A = (dt/dτ)mc²-mc²**

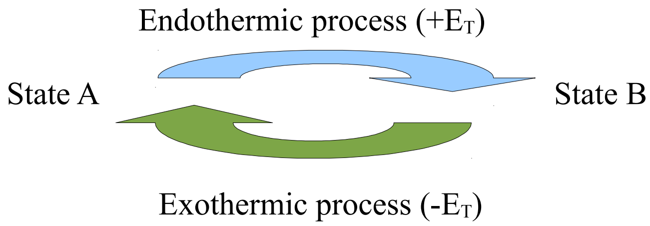
The value at B for an observer in State A E^A_B= (mc²)+((dt/dτ)mc²-mc²) = dt/dτ mc²

The value at A for an observer in State B E^B_A= (mc²)+((dτ/dt)mc²-mc²) = dτ/dt mc²

Because concerning General Relativity, both observers do agree on the values of dτ and dt, so that the parameters dτ and dt have inverse position for an observer at B.

If the observer is fixed at "State B", then the object at "State A" has associated energy E^B_A= (dτ/dt)mc² (meanwhile, for the observer fixed at "State A" the associated energy of the object is E^A_A= mc²). now for the observer fixed at "State B", when the object changes from "State A" to "State B", its associated energy would change to E^B_B= mc² being E^B_T= mc²-(dτ/dt)mc² the energy required (taking as reference B) for that process to take place. Considering the reverse proccess, if the object with associated energy E^B_B= mc² changes to "State A" (E^B_A= (dτ/dt)mc²), then instead of requiring energy, would be an exothermic process, having ((dτ/dt)mc²-mc²) a negative value.

Concerning the process linked to General Relativity:



If the object changes its state from "State A" to "State B" (greater amount of mass-energy in Beta State"), the process is an endothermic one (requiring energy), the reverse proccess, changing from "State B" to "State A" is an exothermic one, releasing energy

The proposed process, as defined, implies an additional effect to the currently accepted model, caused by the gravitational waves. The endothermic process from A to B would be at the expense of velocity corresponding to the Kinetic Energy, while the exothermic process from B to A would increase velocities of bodies for an expansive scenario.

Elements involved in the proposed process:

- Gravitational waves, which will interact with mass-energy.

- Mass-energy with a starting reference value mc^2. (value of mass-energy at "State A" with reference the state linked to dt, $E^A_A= mc^2$).

- Potential Energy, part of it will be absorbed by the process and the rest would be transformed into the velocity term of the kinetic energy. Or equivalently, without the potential energy concept, the process from "State A" to "State B" requires energy (it is an endothermic process), that energy will be at the expense of the velocity term.

Result (state B):

- Space-time distortion at the space-time position linked to the "State B" (as defined by Einstein field equations, plus the additional effect of the energy required by the process).

- Mass-energy with value $E^A_B= (dt/d\tau)mc^2$

- Kinetic energy that will have the altered mass-energy in the new state. Noticing that mass-energy of the body will depend on the reference taken, and the velocity term of that kinetic energy is modified, because the process will take place at the expense of the velocity, being $\Upsilon_{mod} =1/\sqrt{(1-v^2_{mod}/c^2)}$ and $\Upsilon = 1/\sqrt{(1- v^2/c^2)}$ would be the value corresponding to the theoretical Kinetic energy without taking into account the proposed process.

In order to calculate Υ_{mod}, it is neccesary to take into account the combination of the energy required by the process and the gravitational field as defined by the E.F.E.

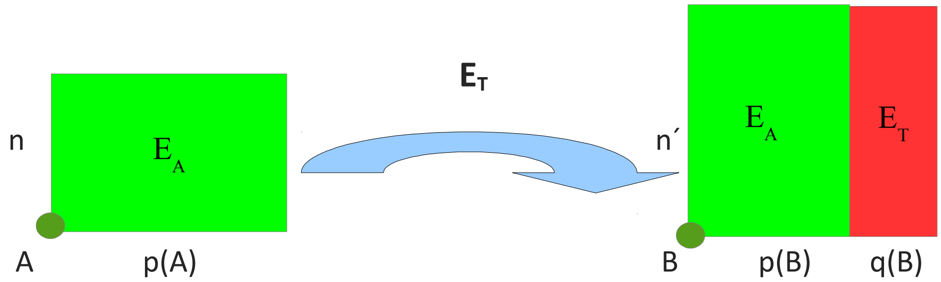
It is noteworthy that the process as described is similar to the phenomenon corresponding to the photoelectric effect (each with its own characteristics):

Photons interact with electrons, part of the energy is absorbed by the process and the rest goes to kinetic energy.

Hypothesis: Gravitational waves would interact with mass-energy, part of the energy is absorbed by the process, the rest goes to the velocity term of the kinetic energy.

Gravitational Field scenario, Static situation:

"State A" "State B"



$p(B)=p(A)(d\tau/dt)$; $q(B)=p(A)-p(B)$

$dt/d\tau=n'/n$

$p(A)=1$, then $p(B)= d\tau/dt$ and $q(B)= 1- d\tau/dt$

$E^A{}_T = q(B)\,E^A{}_B = (1- d\tau/dt)(dt/d\tau)mc^2 = (dt/d\tau)mc^2-mc^2$

$E^A{}_A = p(B)E^A{}_B = (d\tau/dt)\,(dt/d\tau)mc^2 = mc^2$

$E^A{}_B= E^A{}_T + E^A{}_A = (dt/d\tau)mc^2$

Taking as reference the "State A":

$E^A{}_A= mc^2$ $E^A{}_B= (dt/d\tau)mc^2$ $E^A{}_T= (dt/d\tau)mc^2-mc^2$

Taking as reference the "State B":

$E^B{}_A= (d\tau/dt)mc^2$ $E^B{}_B= mc^2$ $E^B{}_T= mc^2-(d\tau/dt)mc^2$

E_T is the energy required by the process to pass from "State A" to "State B", if $dt/d\tau=10$ (considering quite an extreme distorted spacetime scenario) then $E^A{}_T=9\ mc^2$ it would be 9 times the reference A, $E^B{}_T= (9/10)\ mc^2$ it would be (9/10) times the reference B, because the value of energy at B is 10 times the value at A.

The hypothesis implies that not all the potential energy would transformed into the velocity term of the kinetic energy. Considering a free fall body, if v is the velocity when all the potential energy transforms into kinetic energy, $\mathbf{v_{mod}}$ would be the velocity taking into account the process as defined. Discrepancy would be an extremely small one, insofar the space-time curvature has not a siginificant value.

Noticing that v depends on the reference as well (as it is well Known the Kinetic Energy is not invariant, as it includes velocity), so that a strong gravitational field, for example a black hole, v would show diferent values depending on the reference, for example an observer fixed at position far away from the black hole, $\mathbf{v=(1-r_s/r)c\sqrt{(r_s/r)}}$ being $\mathbf{r_s}$ the Schwarzschild radius, meanwhile an observer in free fall, would observe the free fall velocity.

The proposed process produces the alteration of mass-energy (the physical state of a body will be altered). Below is summarized the values of mass-energy corresponding to different states for the following scenarios: 1) Pure Special Relativity scenario (velocity between bodies hypothetically in absence of Gravitational fields); 2) Gravitational field outside a homogeneous sphere, uncharged, non rotating, static situation (no velocities between bodies situated in different regions of a gravitational field); 3) a "free fall" body for the previous gravitational field (noticing that what the Standard Model considers as "free fall" would be affected by the proposed process reducing the velocity term), Scwarzschild metric, different states will correspond with the evolution of the body in that gravitational field.

.

(all values of energy are units divided by mc^2).

Proposed Hypothesis	Reference	"STATE B"	Mass-Energy (**β-state**)
1) Pure Special Relativity scenario	**1**	**ϒ**	**(ϒ-1)**
2) G.F. Static scenario	**1**	**(dt/dτ)**	**(dt/dτ) -1**
3) G.F. Free fall body scenario	**1**	**ϒ**	**($ϒ_{mod}$ -1)**
			(ϒ-$ϒ_{mod}$)

Table 1

Considering scenario 3 (a body in free fall), the total quantity of Mass-Energy (**β-state**) is (**ϒ-1**), a portion of that is (**$ϒ_{mod}$ -1**), which is due to the velocity term and the rest is (**ϒ-$ϒ_{mod}$**), which is due to the proposed Gravitational Field effect.

With (**ϒ-$ϒ_{mod}$**) = (**1-dτ/dt**) * (**ϒ-1**) 3.1)

And (**$ϒ_{mod}$ -1**) = (**dτ/dt**) * (**ϒ-1**) 3.2)

3.2) obtained from the equality: (**$ϒ_{mod}$-1**) * **(dt/dτ) mc^2** = (**ϒ-1**) **mc^2**

and 3.1) is as well obtained from (**$ϒ_{mod}$-1**) = (**dτ/dt**) * (**ϒ-1**),

then **$ϒ_{mod}$** = **1** + (**dτ/dt**) * (**ϒ-1**) so (**ϒ-$ϒ_{mod}$**) = **ϒ** - (**1** + (**dτ/dt**) * (**ϒ-1**)) = (**1-dτ/dt**) * (**ϒ-1**)

If the gravitational field is not a very strong one, then (**dτ/dt**) ≈ **1** and the value (**ϒ-$ϒ_{mod}$**) corresponding to 3.1) is very close to 0, while the value (**$ϒ_{mod}$-1**) ≈ (**ϒ-1**), then scenarios 2) and 3) are reduced to the values established by the Standard Model shown below on table 2.

On the other hand, strong gravitational fields, for example the collapse of a star into a black-hole event, as the physical system evolves towards a black-hole event the value of (**dτ/dt**) gets closer to the value 0, reaching that value at the event horizon of the hypothetical black-hole. During the evolution of that physical system, as the value (**dτ/dt**) gets closer to zero, then the term 3.1) corresponding to mass-energy in beta-state linked to velocity gets closer to zero, reducing the velocity with respect to the established by the Standard Model, meanwhile, the term 3.1) is assuming almost all of the mass-energy in beta-state.

The energy required by the process, due to the Gravitational Field, produces an additional distortion of space-time equivalent to the subtraction (**1-dτ/dt**)mc^2 of Kinetic energy. As the mass-energy increases by the factor **(dt/dτ)**, affected by the proposed process linked to the gravitational field, the kinetic energy linked to velocity decreases with the factor (**dτ/dt**). The free fall body hitting a static region of the gravitational field, has energy (Υ_{mod} mc^2) instead of (Υ mc^2), the scenario of the body in free fall with energy (Υ_{mod} mc^2) would be equivalent to the effect of apply kinetic energy (Υ_{mod} mc^2- mc^2) to the body. This way the energy required to get the static situation is (Υ_{mod} mc^2), but it has to be noted that from the point of view of the reference situated far away from the gravitational field, the total mass-energy of the body in free fall is (Υ mc^2), a component of that value is the corresponding to the velocity (Υ_{mod} mc^2), plus the mass-energy due to the gravitational field (Υ-Υ_{mod}) mc^2 . If we apply energy in order to reduce the velocity of the body in free fall, then the value of the Mass-Energy (**β-state)** linked to velocity will be reduced and will be increased the quantity of Mass-Energy (**β-state)** linked to the effect of the gravitational field, until reaching the value **(dt/dτ)-1** when we have the static scenario.

The table below shows the values corresponding to the Standard Model (noticing that it is assimilated the concept of Mass-Energy (**β-state)**). The pure Special Relativity scenario shows no practical discrepancies, but there are important ones when considering the other scenarios.

Standard Model	Reference	"STATE B"	Mass-Energy (**β-state)**
1) Pure Special Relativity scenario	**1**	**Υ**	**(Υ-1)**
2) G.F. Static scenario	**1**	**1**	**0**
3) G.F. Free fall body scenario	**1**	**Υ**	**(Υ-1)**
			0

Table 2

Schemes contrasting Standard Model to the proposed hypothesis:

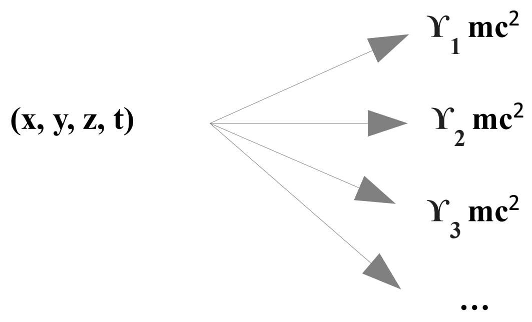
Standard Model, free fall body: Proposed hypothesis, "free fall" body:

What the Standard Model, considers as a free fall body scenario, the hypothesis introduces the proposed effect.

Equivalence principle:

Standard Model: Proposed hypothesis:

Concerning Relativity, it is not enough the assignation of four space-time coordinates to define the properties of the physical system. For instance, considering the Special Relativity scenario:



Mass-energy of a body located in (x, y, z, t) depends on the reference taken.
ϒ relates the "State B" (referenced state) of the body situated at (x, y, z, t) with the "State A" (the reference).

In order to establish the physical properties of a body, it is required to define x, y, z, t and ϒ.

The present paper suggests that there is not just three space-like dimensions and one time-like dimension, but four spatial dimensions and one time dimension x, y, z, w, t where the space-time framework fulfills:

$$ds^2=c^2d\tau^2=c^2dt^2-dx^2-dy^2-dz^2=dw^2-dx^2-dy^2-dz^2$$

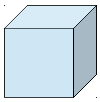
- There is a dependent relation between them as established by the expression $c^2d\tau^2=dw^2-dx^2-dy^2-dz^2$ linking the time-like coordinate to the space-like coordinates.

- The distortion of the space-like coordinate w is the same than the distortion of the time-like coordinate t. That is what is representing $c^2dt^2-dx^2-dy^2-dz^2=dw^2-dx^2-dy^2-dz^2$

- There is an interrelation between mass-energy and space-time.

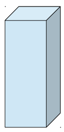
In order to explain those concepts it is used the following simplified schemes:

A) Supposing a three dimension euclidean space.



Isotropic properties, with a uniform distribution of mass-energy within a region of that euclidean 3d space.

B) Now supposing another scenario where there is distortion of space.



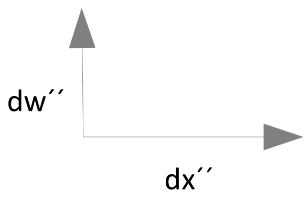
Contraction of one of the coordinates at the expense of dilation of another coordinate.

The value of the mass-energy distributed on scenario A) and B) is the same, but changes the configuration, it is further distributed configuring the dilated dimension at the expense of the contracted dimension.

Now considering the Minkowski space-time $\mathbf{ds^2=c^2d\tau^2=c^2dt^2-dx^2-dy^2-dz^2}$ for the Special Relativity scenario and the Riemannian geometry corresponding to a curved space-time framework due to the presence of mass-energy, for instance the Schwarzschild metric for the vacuum solution of a homogeneus sphere, uncharged, non rotating.

The proposal implies that the distortion of the time coordinate is the same than the distortion of w coordinate.
Representing just the space-like distorted coordinate and the coordinate w:
Special Relativity scenario, Minkowski space-time, velocity on x direction $\mathbf{dw^2-dx^2-dy^2-dz^2}$

(1) "State A" (2) "State B"

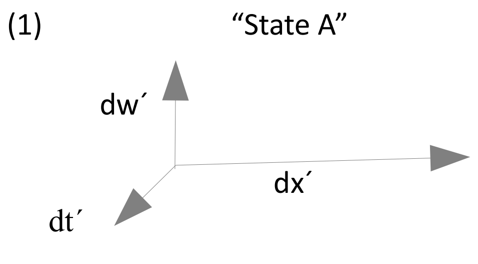


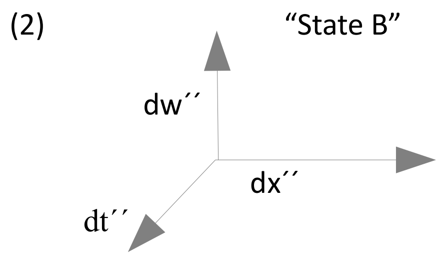
The scheme represents that there is space distortion producing contraction on the space-like distorted coordinate and dilation of the w coordinate. Considering those four space-like dimensions (without taking into account the time coordinate) the value of mass-energy is the same at (1) and (2), just changes the distribution of mass-energy.

The value of mass-energy (considering those four space-like dimensions) is mc^2 in both cases (1) and (2), but changes the distribution of that energy, increasing the quantity of energy linked to the w coordinate in case (2), that situation would correspond with the quantity of mass-energy (β-state) in "State B".

The proposal implies that there is an interrelation between the quantity of mass-energy that changes to mass-energy (β-state) and the distortion of space-time.

Time has to be taken into account, with distortion of time coordinate the same than distortion of w.





Taking into account now the effect due to the distortion of the time coordinate, the amount of mass-energy will be:

mc^2 value of mass-energy corresponding to "State A"
Υmc^2 value of mass-energy corresponding to "State B" relative to "State A"

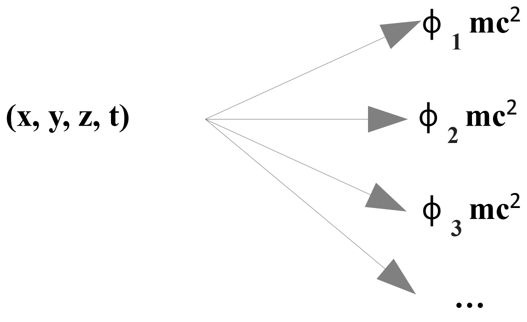
Similarly to the Special Relativity Scenario, will be the General Relativity Scenario with the presence of gravitational fields.

mc^2 value of mass-energy corresponding to "State A" being space-time region with negligible gravitational field effect where time is coordinate time t.
$(dt/d\tau)mc^2$ value of mass-energy corresponding to "State B" being **τ** proper time in "State B"

The energy required to change from one physical state to another is **$(dt/d\tau)mc^2-mc^2$**

Denoting $\phi=(dt/d\tau)$

The hypothesis proposed implies that considering gravitational fields scenarios, it is not enough the coordinates (x, y, z, t) to define the properties of the physical system.



The value of mass-energy will depend on the reference taken.

It is needed to define (x, y, z, t) plus ϕ, required to characterized a value with the coordinates (w, x, y, z, t). That is the reason for the notation of the type $\mathbf{E}^{A}_{B}$ where it is defined the referenced and reference taken.

Probabilistic approach

It is defined the following Physical System: Special Relativity Scenario.

A radioactive element that has a hypothetical uniform distribution of mass, dm/(dxdydz) homogeneous density throught a region of space-time between (0, 0, 0) and (x, y, z).

The decay of that radioactive element over a period of time t (0 starting point of the expeeriment and t moment of the measurement, with dt time element for the time coordinate), follows the Poisson´s distribution: Ƥ(λ,x) where λ represents the frequency of occurrence of a given event (this case, the decay of the radioactive element) and x would represent the amount or number of events in an interval.

The Poisson distribution is related to another discrete probability distribution, the binomial distribution. Considering n Bernoulli statistical trials, each of them with probability p · P that a certain event takes place, fulfilling the following conditions:

$0<p\cdot P<<1$ very small probability of success.

n↑↑ very high number of statistical trials.

$n\cdot p\cdot P = \lambda$ The product of the number of statistical events multiplied by the probability associated with each of the trials is equal to the frequency of occurrence λ

If these three conditions are met, both distributions give very similar values, at the limit when $n\to\infty$ are equivalent ones.

This leads to the proposal that at the Physical System is taking place the occurrence of statistical events each one with probability p · P of being successful. That is to say, during the period of time dt, it takes place n statistical events, P representing the probability of an event taking place at a particular trial (the example corresponds to the decay of the radioactive element), meanwhile p is a factor (which depends on distortion of space-time) that modifies the value of P. The value of p will be linked to the alteration of mass-energy, if all the mass-energy corresponds to mass-energy **(α-state)** then the value of p is 1 (that is the case for a reference frame with no velocity), when there is velocity, the kinetic energy do alter the state of mass-energy. The higher the quantity of mass-energy that is affected changing to **(β-state),** the lower the value of p. The value of mass-energy corresponding to mass-energy **(α-state)** is p · P, while the corresponding to mass-energy **(β-state)** is q · P= (1-p)· P. Each of the n statistical events will have associated a value for mass-energy **(α-state)** and mass-energy **(β-state),** the quantity of mass-energy **(β-state)** is linked to the dilation of the w coordinate and the contraction of the coordinate corresponding to the direction of velocity (considering the Special Relativity scenario).

p and n are dimensionless factors that depend on distortion of space-time, the product of both is a constant value. "State A" (1, n) "State B" (p, n´) with $1\cdot n= p\cdot n'$ then $p=n/n'=t/t'$

The value of p for the "State A" (no velocity) is 1, the value of p for the "State B" is linked to the quantity of mass-energy **(α-state)**, but increasing the number of statistical events to n´ instead of n, the physical system reaches the same total amount of mass-energy **(α-state)**

where $n\cdot 1\cdot P = \lambda = n'\cdot p\cdot P$

"State A" "State B"

The kinetic energy alters the amount of mass-energy (α-state), and that value is linked to the distortion of space-time. Considering scenarios with presence of gravitational fields, it is proposed that the curvature of space-time is linked to the alteration of mass-energy, so knowing the E.F.E. might be calculated the alteration of mass-energ and in turn the energy required for that alteration to take place, which is responsible of an additional distortion of space-time.

This way it is linked the curvature of space-time with the probability of events taking place.

METHODS TO TEST THE HYPOTHESIS

The proposed hypothesis shows discrepancies with respect to the Standard Model of Relativity.

Considering the Schwarzschild metric for the vacuum solution outside the sphere of a homogeneous sphere (radius R), uncharged, non rotating. Spherical coordinates, being r the Schwarzschild radial coordinate.

Discrepancy corresponding to free fall velocities:

$$\Upsilon_{mod} = 1 + \Upsilon * d\tau/dt - d\tau/dt$$

being $$\Upsilon_{mod} = 1/\sqrt{(1 - v^2_{mod}/c^2)}$$

Below, Fig.1 represents the effect at the vicinity of a sphere when $2GM/c^2R=0,2$ (a remarkable strong gravitational field), using the same graphic for $2GM/c^2R=0,1$ and $2GM/c^2R=0,05$.

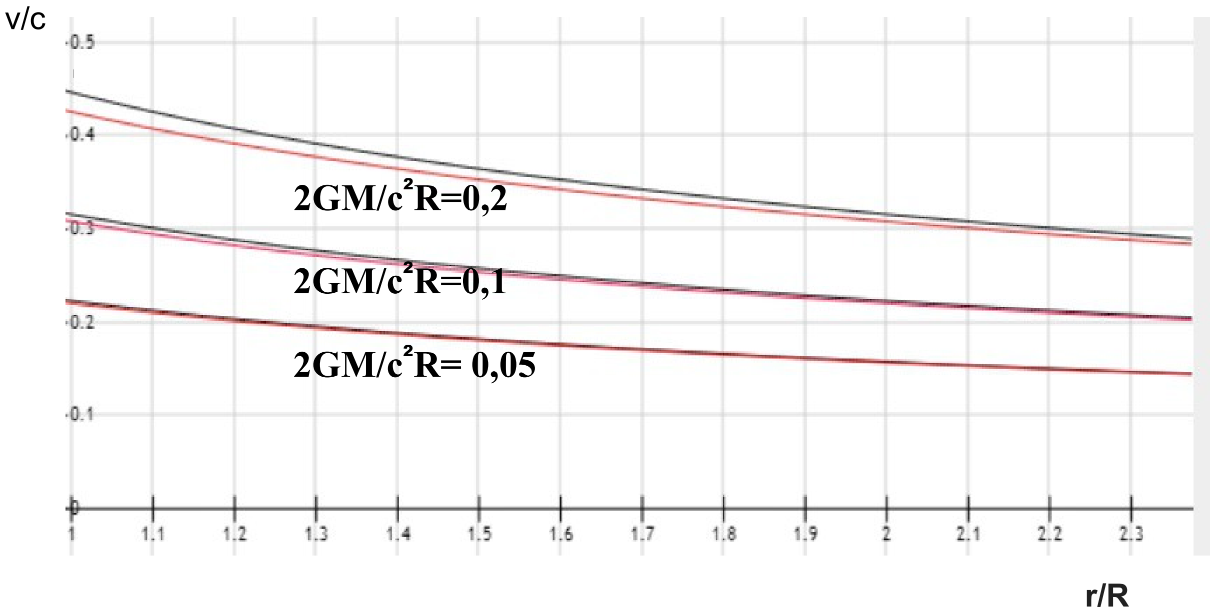


Fig.1

Black lines represent the value of v/c considering the Standard Model of Relativity, meanwhile the red ones do represent the modified value v_{mod} /c taking into account the proposed hypothesis. Fig.1 shows that the hypothesis is an extension of the Standard Model of Relativity, being closer to that Standard Model, the weaker the effects of the gravitational field.

The discrepancy increases the higher the value of the factor $2GM/c^2R$ and the closer to the source of the gravitational field.

For instance, considering the Earth´s Gravitational field, the discrepancy between the black and red lines, at the distance from the Earth corresponding to the moon´s orbit, is of the order 2,8 10^{-17} (order 10^{-12} when it is calculated per unit $(v-v_{mod})/v$). Discrepancy, at the distance from the earth corresponding to the International Space Station´s orbit is of the order 1,3 10^{-14} and the discrepancy at the surface of the Earth is 1,2 10^{-14}.

Considering the Sun´s Gravitational field, the discrepancy between the black and red lines, at the distance from the Sun corresponding to the Earth´s orbit is of the order 6,9 10^{-13}. Discrepancy, at the distance from the Sun corresponding to Mercury´s orbit is of the order 2,9 10^{-12} and the discrepancy at the surface of the Sun is 2,2 10^{-9}.

Those discrepancies of velocities do have associated discrepancies of space-time curvature with respect to the Standard Model. Considering the Earth´s Gravitational field, the discrepancy of time at the distance from the Earth corresponding to the moon´s orbit is of the order 1,3 10^{-22}. Discrepancy, at the distance from the earth corresponding to the International Space Station´s orbit is of the order 4,3 10^{-19} and the discrepancy at the surface of the Earth is 4,8 10^{-19}. Considering the Sun´s Gravitational field, the discrepancy at the distance from the Sun corresponding to the Earth´s orbit is of the order 9,7 10^{-17}. Discrepancy, at the distance from the Sun corresponding to Mercury´s orbit is of the order 6,5 10^{-16} and the discrepancy at the surface of the Sun is 4,5 10^{-12}.

The clocks of the GPS satelllites do have an accuracy of about 10^{-09}. In recent years, technological advances have allowed the development of atomic clocks with an accuracy of up to 10^{-18}. In 2013 the record was established with a precision of one second every 300 million years, in 2017 the record was established with an atomic clock that would not lose or gain a second in 15 billion years.

Increasing accuracy of atomic clocks makes it a possible method to test Relativity.

Discrepancies of free fall velocities or the corresponding distortion of time with respect to the Standard Model of Relativity, would increase the closer to the source of the gravitational field and that effect could not be explained by any known phenomenon within the Standard Model.

Fig. 1 showed discrepancies between values defined by the Standard Model of Relativity and the ones obtained taking into account the proposed hypothesis, nonetheless, if it is realized a measurement in a specific space-time position (for example how the gravitational field of the sun affects the orbit of the earth) if that measurement is a very accurate one, then we should obtain a value corresponding to the red line (with values modified by the proposed hypothesis), but if we assume that the value is due to the effect of the Standard Model, then that curvature of space-time would be linked to a estimated mass of the source M´ instead of M with M´<M, so that the value will be the same in that specific position, but would differ with other values of r/R.

Fig.2 represents the issue previously described, black and red lines are the same than on Fig.1, meanwhile the blue line corresponds to the expected values by the Standard Model with an understimated value of the mass corresponding to the source of the gravitational field, crossing the red curve at r/R equal to 1,6 (hypothetically it has been realized an accuracy measurement at that space-time position) for the **$2GM/c^2R=0,4$** and with r/R equal to 1 (this case the initial measurement is done at the surface of the sphere) for the **$2GM/c^2R=0,2$**

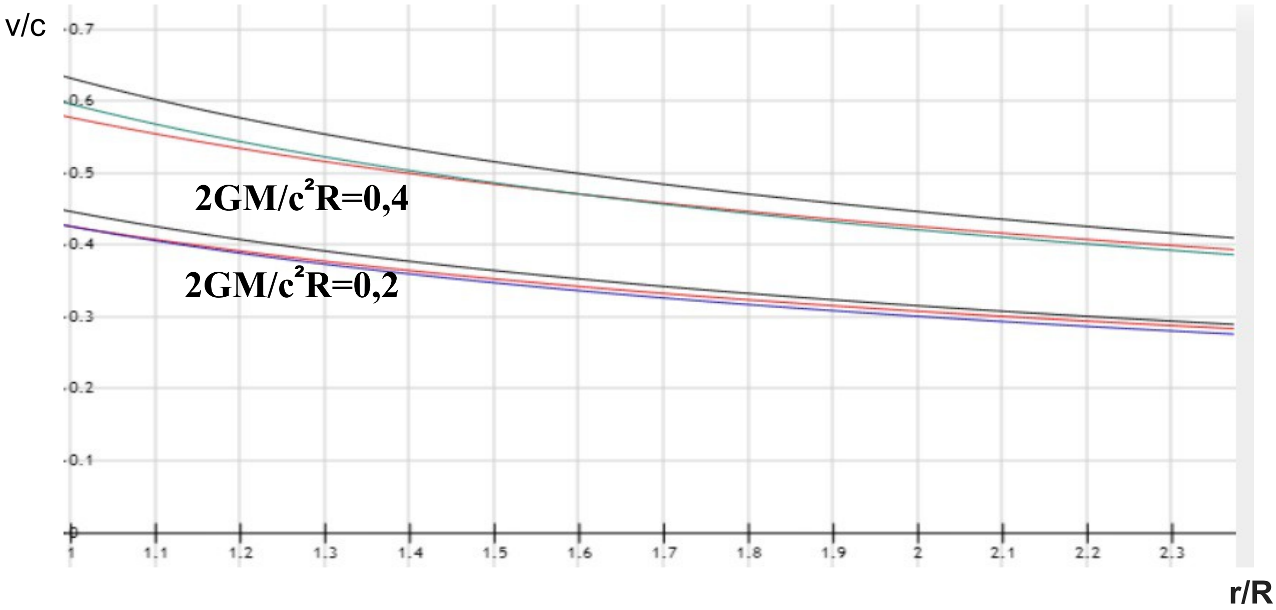


Fig.2

A test within the solar system or the earth´s gravitational field might be the following one:

If E is the energy associated with quantity of mass m in free fall, so that E_1, E_2 and E_3 are the energies corresponding to space-time positions with free fall velocities v_1, v_2 and v_3 (getting closer to the source of the gravitational field) The hypothesis establishes that the value instead of $E_i=\Upsilon_i mc^2$ it would be measured $E_i=\Upsilon_{imod} mc^2$ (If we have a sensor in position i=1, 2, 3...) being the kinetic energy reduced by the factor: **($d\tau_i/dt$)** Discrepancy (1- **($d\tau_i/dt$))** would be higher the closer to the source of the gravitational field, if those deviations do follow what is predicted by the hypothesis, it would be a relevant test. Note: the value of m might be any chosen for us, so that the discrepancy might be measured.

(Expression for t and τ with reference in the region with time dτ):

$\Upsilon_{mod} m_p c^2 - m_p c^2 = (d\tau/dt)\Upsilon m_p c^2 - (d\tau/dt) m_p c^2$ then, $E_p = \Upsilon_{mod} m_p c^2 - m_p c^2 + (d\tau/dt)\, m_p c^2 = (d\tau/dt)\Upsilon m_p c^2$ being m_p mass of the particle.

Other ways to detect the discrepancies would be via astronomical observation, some projects are looking for deviations with respect to the Standard Model http://www.dailymail.co.uk/sciencetech/article-4554492/Researchers-suggest-FIFTH-force-nature.html or analyzing data from strong gravitational fields phenomena: https://futurism.com/a-new-discovery-is-challenging-einsteins-theory-of-relativity/

Another discrepancy with respect to the Standard Model of Relativity is due to the alteration of mass-energy value depending on the reference taken.

$$E^{A}_{B} = (dt/d\tau)mc^2$$

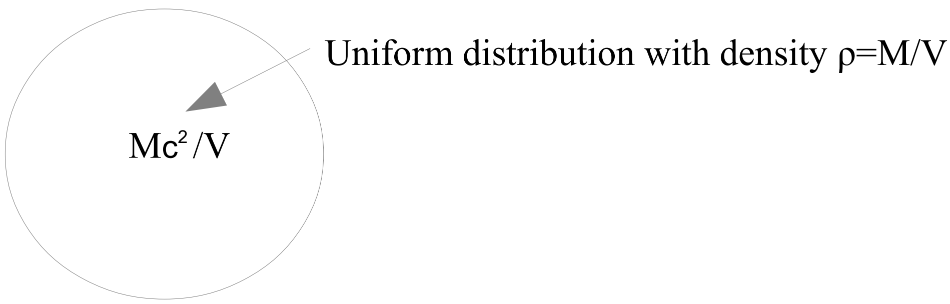
The value in "State B" with reference or with respect to the "State A" is $(dt/d\tau)mc^2$

This way, considering the homogeneous sphere (with uniform distribution of mass M), uncharged, non rotating. τ_e generically denoting proper time outside the sphere and τ_i generically denoting proper time inside the sphere.

i takes values between the center and the surface of the sphere.

e changes with the radial coordinate outside the sphere.

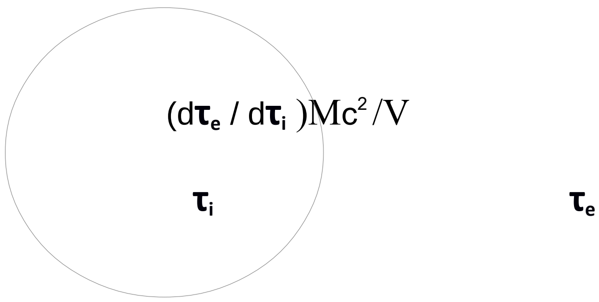
The concept of homogeneous and uniform distribution of energy is distorted by the proposed effect. Instead of the uniform distribution of the mass M



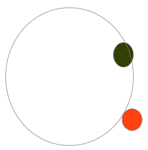
Note: it is used the expression M/V but has to be taken into account that the space-time is curved.

The value of mass-energy will depend on the reference proper time (τ_e) and the referenced proper time taken (τ_i)

The value of mass-energy will be affected by the factor $(d\tau_e / d\tau_i)$



For instance, if we consider a test particle situated at the surface of the sphere, then the mass-energy corresponding to the source of the gravitational field situated on the surface of the sphere has value relative to the test particle:

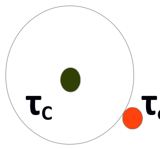


τ_i $(d\tau_e / d\tau_i) Mc^2/V = Mc^2/V$ due to $\tau_i = \tau_e = \tau_R$

τ_e

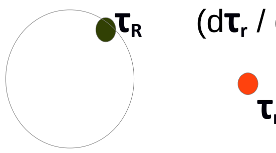
If we consider a test particle situated at the surface of the sphere, then the mass-energy corresponding to the center of the gravitational field has value relative to the test particle:

$(d\tau_e / d\tau_C) Mc^2/V$



τ_C τ_e being τ_c proper time corresponding to the center

When test particle is situated at distance r, then the mass-energy corresponding to the surface of the gravitational field has value relative to the test particle:

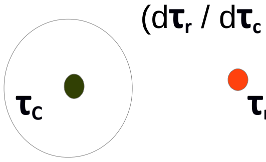


τ_R $(d\tau_r / d\tau_R) Mc^2/V$

τ_r being τ_r proper time of test particle situated distance r

If we consider a test particle situated at distance r, then the mass-energy corresponding to the center of the gravitational field has value relative to the test particle:

$(d\tau_r / d\tau_c) Mc^2/V$



τ_C τ_r being τ_r proper time of test particle situated distance r

The consequence is that there is no the Schwarzschild metric scenario produced by a homogeneous and uniform distribution of mass in a sphere, the value of mass-energy is different depending on the proper time at each radial coordinate inside the sphere, and the effect will depend as well on the proper time of the radial coordinate outside the sphere. Although that discrepancies will be extremely small ones with respect to the Standard Model of Relativity insofar the gravitational field does not have very significant values. In this way, there is another discrepancy with respect to the established by the Standard Model of Relativity. Noticing that it should be taken into account non-linear effects.

The weak equivalence principle

The trajectory of a point mass in a gravitational field depends only on its initial position and velocity, and is independent of its composition and *structure*

Space-time position A	Space-time position B
body with mass-energy m1	body with mass-energy m1 and velocity v
body with mass-energy m2	body with mass-energy m2 and velocity v

In order to keep that equality, as the value of mass-enegy at space-time position B has changed, v has to change as well. So taking into account the process:

"State A"	"State B"
body with mass-energy m	body with mass-energy $(dt/d\tau)m$ and velocity $\mathbf{v}_{mod}$ Relative to "State A"

Energy conservation would allow us to know the value of $\mathbf{v}_{mod}$

Below is calculated the value of $\mathbf{v}_{mod}$ considering different references, using conservation of energy and obtaining a result which would be a function of v. For all the references the expression is the same $\Upsilon_{mod} = 1+ \Upsilon\, d\tau/dt - d\tau/dt$, taking into account just the proposed effect, the expression would be invariant, but the value of v and consequently $\mathbf{v}_{mod}$ would depend on the reference. In fact what the expression tries to formulate is that in order to preserve the Noether Theorem, the velocity has to be modified. The kinetic energy available for the velocity term would be reduced depending on the factor $(dt/d\tau)$:
$(\Upsilon_{mod}\, mc^2 - mc^2) = (1/(dt/d\tau))(\Upsilon\, mc^2 - mc^2)$ that would be the same for all the references, because they agree on those values, but the value of v and consequently $\mathbf{v}_{mod}$ would depend on the reference.

The trajectory of a free fall object would be modified considering $\mathbf{v}_{mod}$ instead of v, that modified trajectory can be defined knowing $\mathbf{v}_{mod}$ at each space-time position, that would be the effect corresponding to the proposed process, added to that we must take into account that the trajectory whether modified or not, would depend as well on the reference of the observer, so the modified trajectory should be transformed to the reference of the observer.

Taking as reference "State A"

Mass-Energy at States A and B with reference A would be

$E^A_A = mc^2 \qquad E^A_B = (dt/d\tau)mc^2$

The kinetic Energy of the body, now with energy $E^A_B = (dt/d\tau)mc^2$ when it reaches the "State B" has to be the same than the kinetic energy of the body if all the Potential Energy would transform into Kinetic Energy corresponding to velocity v.

$$\Upsilon_{mod}\,(dt/d\tau)mc^2 - (dt/d\tau)mc^2 = \Upsilon\, mc^2 - mc^2$$
$$(\Upsilon_{mod} - 1)\,(dt/d\tau)mc^2 = (\Upsilon - 1)\, mc^2$$

$$\Upsilon_{mod} = 1+ \Upsilon\, d\tau/dt - d\tau/dt$$

This expression does not depend on mass, so bodies with different mass will still have the same velocity, but v_{mod} instead of v

Taking as reference "State B"

Energies at States A and B with reference B would be

$E^B{}_A = (d\tau/dt)mc^2$ $\qquad E^B{}_B = mc^2$

Now for the observer fixed at "State B" the value of the mass-enegy linked to the body when it was at the "State A" is $E^B{}_A = (d\tau/dt)mc^2$ so if all the Potential Energy transforms into Kinetic Energy, it would obtain $\Upsilon(d\tau/dt)mc^2 - (d\tau/dt)mc^2$

But the value of the energy at "State B" would be $E^B{}_B = mc^2$ which is higher than the corresponding to $E^B{}_A = (d\tau/dt)mc^2$ as consequence of the process $\Upsilon_{mod}\, mc^2 - mc^2$

The equality between them:

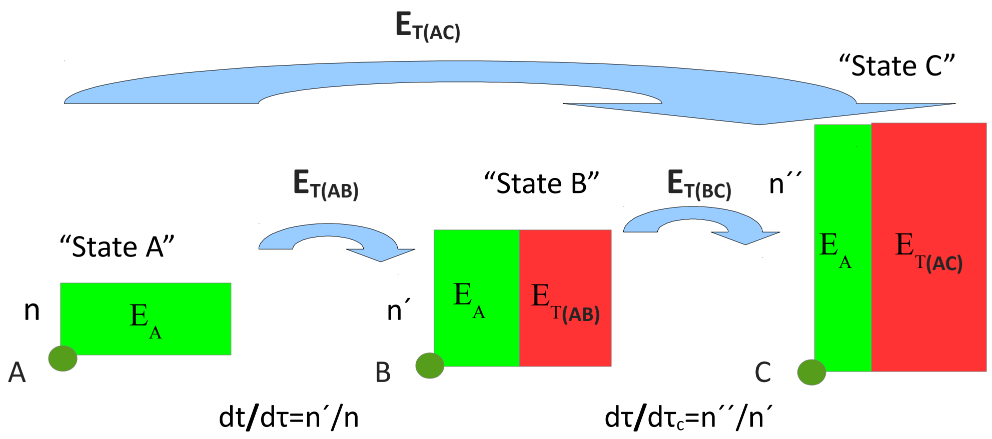
$$\Upsilon_{mod}\, mc^2 - mc^2 = (\Upsilon(d\tau/dt)mc^2 - (d\tau/dt)mc^2)$$

Changing the reference, changes $(d\tau/dt)$ to $(dt/d\tau)$ at the second term (for the obsever at B), so the result is the same: $\Upsilon_{mod} = 1 + \Upsilon\, d\tau/dt - d\tau/dt$

Discrepancy between Υ_{mod} and Υ is negligible insofar distortion of time does not change siginificantly. **It should be notice, that this discrepancy is the one accumulated during the whole of the trajectory from A to B**, it would lose kinetic energy with respect to the expected value at each space-time position, the accumulated of the whole trajectory results in the discrepancy corresponding to Υ_{mod}.

The reverse process (from B to A) has a negative value for E_T; mass-enegy value decreases at "State A" relative to the "State B" that effect is offset by increasing velocity.

Similarly, it might be calculated the value of Υ_{mod} from any other point of reference



<u>Considering the relation between A and C:</u>

Taking as reference the "State A":

$E^A{}_A = mc^2$ $\qquad E^A{}_C = (dt/d\tau_c)mc^2$ $\qquad E^A{}_{T(AC)} = (dt/d\tau_c)mc^2 - mc^2$

$E^A{}_{T(AC)}$ is the value of E_T between A and C with reference A. $E^A{}_{T(AC)} = -E^A{}_{T(CA)}$

Taking as reference the "State C":

$E^C{}_A = (d\tau_c/dt)mc^2$ $\qquad E^C{}_C = mc^2$ $\qquad E^C{}_{T(AC)} = mc^2 - (d\tau_c/dt)mc^2$

<u>Considering the relation between B and C:</u>

proper time at B: $d\tau$ $\qquad$ proper time at C: $d\tau_c$

Taking as reference the "State B":

$E^B{}_B = mc^2$ $\qquad E^B{}_C = (d\tau/d\tau_c)mc^2$ $\qquad E^B{}_{T(BC)} = (d\tau/d\tau_c)mc^2 - mc^2$

Taking as reference the "State C":

$E^C{}_B = (d\tau_c/d\tau)mc^2$ $\qquad E^C{}_C = mc^2$ $\qquad E^C{}_{T(BC)} = mc^2 - (d\tau_c/d\tau)mc^2$

To Calculate the value Υ_{mod} (corresponding to "State B" corresponding to the trajectory from A to B), with reference C:

Υ_{mod} $(d\tau_c/d\tau)mc^2 - (d\tau_c/d\tau)mc^2 = (\Upsilon(d\tau_c/dt)mc^2 - (d\tau_c/dt)mc^2)$

Obtaining the same result: $\Upsilon_{mod} = 1 + \Upsilon\, d\tau/dt - d\tau/dt$

That would be the value at B, for a free fall body, passing from "State A" linked to dt, to "State B" linked to dτ $\Upsilon_{mod}(AB)$ that value would be the same whatever the reference we take. The value corresponding to $\Upsilon_{mod}(AC)$ between A and C: $\Upsilon_{mod}(AC) = 1 + \Upsilon\, d\tau_c/dt - d\tau_c/dt$

Considering as reference an observer at free fall with the body:

If the observer fixed at A, observed that the free fall body passes to states with lower potential energy (the proposal implies that not all of that potential energy is transformed into Kinetic Energy due to increased mass-energy of the body relative to A, so instead of v we obtain the value $\mathbf{v}_{mod}$). Now the observer linked to the free fall body observes that "State A" passes to higher potential states relative to itself, that increment has now a negative sign, during its transition reaching the negative value $E_p(B)-E_p(A)$ at the "State B", (when the observer was fixed at A the variation of potential energies was $E_p(A)-E_p(B)$). Considering the free fall observer, a portion of the value $E_p(B)-E_p(A)$ would be used to reduce the value of mass-enegy from $E^A{}_A = mc^2$ to $E^B{}_A = (d\tau/dt)mc^2$ to offset that value, the Kinetic Energy available is reduced, so that:

$\Upsilon_{mod}\, mc^2 - mc^2 = (\Upsilon(d\tau/dt)mc^2 - (d\tau/dt)mc^2)$

- Considering the proposed process for the observer in free fall from A to B

The observer in free fall would have associated energy with reference to itself mc^2 because the reference and the referenced states are the same.

The observer would experience a negative acceleration, would measure a negative acceleration linked or due to the proposed process (although that value would be negligible insofar distortion of time due to the gravitational field does not change siginificantly).

The energy associated with the previous reference would change, if an object is fixed at A while the observer passes form "State A" to "State B" the energy associated to the object changes from mc^2 , when the observer was at "State A" to $(d\tau/dt)mc^2$, when the observer reaches the "State B".

- Considering the proposed process for the observer passing from B to A

The observer would have associated energy with reference to itself mc^2 because the reference and the referenced states are the same.

The observer would experience a positive acceleration, the observer would measure a positive acceleration linked or due to the proposed process (altough that value would be negligible insofar distortion of time does not change siginificantly).

The energy associated with the previous reference would change, if an object is fixed at B while the observer passes from "State B" to "State A" the energy associated to the object changes from mc^2 , when the observer was at "State B" to $(dt/d\tau)mc^2$, when the observer reaches the "State A".

- Considering an hypothetically "pure Special Relativity scenario" for the observer passing from "State A" to "State B".

The observer in transition from a "State A" to a "State B" with relative velocity v with repect of A, would have associated energy with reference to itself mc^2 because the reference and the referenced states are the same.

The observer would experience a positive acceleration.

The energy associated with the previous reference would change, if an object is fixed at A while the observer passes form "State A" to "State B" the energy associated to the object changes from mc^2 , when the observer was at "State A" to Υmc^2 , when the observer reaches the "State B".

The equations proposed represent an additional condition.
The equation of motion (if there is no external force):

$$m(d^2x^\mu/d\tau^2) = f^\mu - m\,\Gamma^\mu_{\nu\lambda}\,(dx^\nu/d\tau)(dx^\lambda/d\tau)$$

That is the equation for the geodesic in the curved space-time

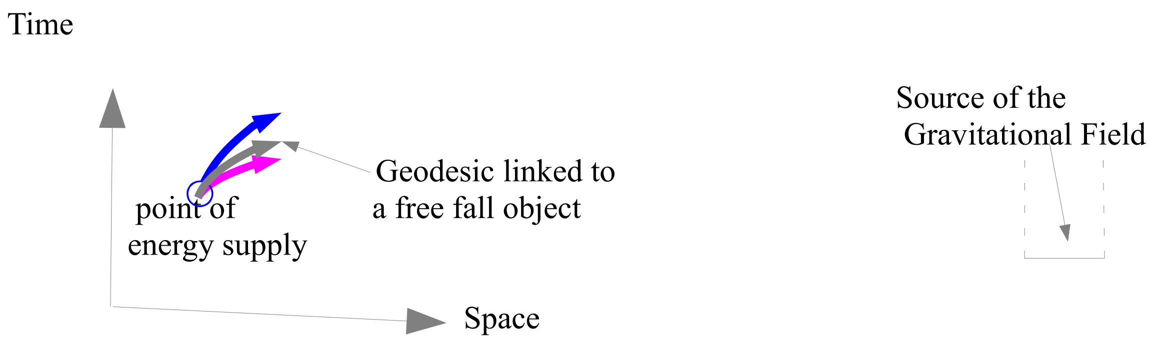
If we add the additional condition proposed, then the system would not correspond to the equation of motion with no external force.

We know the geodesic that the particle or the body would follow if there is no external force, to know the trajectory of the particle adding the additional condition, we have to add the force corresponding to each space-time position of the trajectory (the equations proposed allow us to know that force corresponding to each space-time position) So it has to be applied the Energy term (opposed to the free fall) that takes place between the initial State A and all the space-time positions in its trajectory until reaching the final State B. Knowing the energy required by the proposed process.

The proposal implies that a free fall object would not follow the geodesic that results after apply the Euler-Lagrange equations to the Einstein field equations. The discrepancy would be an extremely small one, insofar the distortion $dt/d\tau$ does not reach a significant value. The process would require energy and that would be at the expense of Kinetic energy. In other words, what in the officially accepted model corresponds to a scenario of free fall, would not exist as such since that body would have its trajectory in space-time forced by the proposed effect.

Scenario 1

Space-time curvature that affects the three spatial coordinates and the temporal coordinate

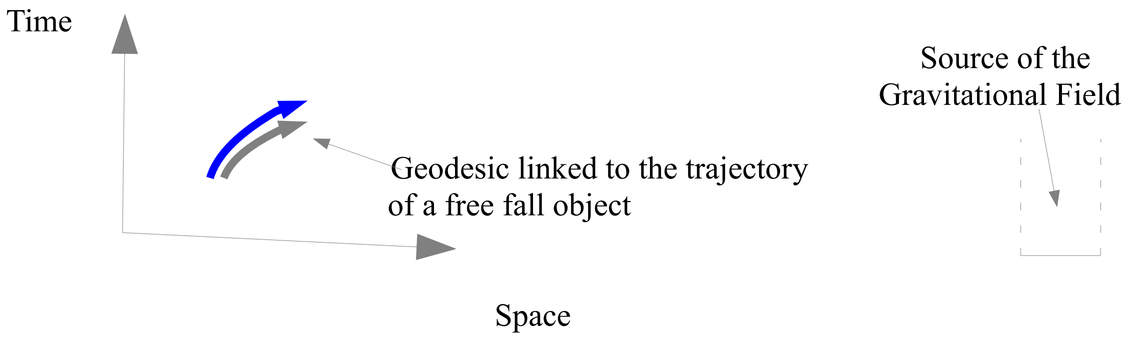


Using a simplified scheme (to contrast it against the second scenario), the path that would follow a body affected by a gravitational well is represented schematically.

Gray color represents the trajectory that would follow a body in free fall, that would be linked to the geodesic of the space-time curved by effect of the gravity. The blue and magenta lines correspond to states in which energy has been supplied (in the scheme it has been done at a certain point, from which it diverges from the path of the body in free fall) for or against the gravitational effect (Although according to the scheme does not get to overcome the gravitational effect) what forces the body to leave the initial trajectory of the geodesic linked to the body in free fall.

If the source of the gravitational well corresponds to a sphere not charged electrically and not rotating, with uniform mass distribution, considering the case of a black hole, the body in free fall, when arriving at the event horizon, at that moment all the future trajectories of that body point towards the interior of the black hole, and would inexorably be directed theoretically to the inside of the black hole ending in a singularity.

Scenario 2



Considering scenario 2, the evolution of a free-fall body would not be the same as in scenario 1, but would follow the trajectory represented by the blue line rather than the gray line (this gray line represents the path that in theory would have the body in free fall). Since now the body does not behave properly as a body in free fall, as its evolution would be forced by the effect corresponding to the process that is associated with the distortion of space-time linked to gravity. That is to say, the phenomenon that is understood as free fall would be affected by this effect and the body instead of following the gray trajectory, would follow a trajectory like the one corresponding to a case of forced fall.

We could know the evolution of the body, if we calculate the effect of the proposed process at each point of the trajectory. We could also make the body follow the path corresponding to the body in free fall (as defined by the officially accepted model, the gray line), if at each point of the path is compensated the energy corresponding to that effect.

Both paths converge at a distance from the source of the gravitational field to which there is no gravitational effect (theoretically at infinite distance from the source). Under usual conditions, weak gravitational fields, the discrepancy between the two is negligible and increases as the distortion produced by the gravitational field increases. For the case of the black hole described in scenario 1, as the body approaches the event horizon, the energy needed to bring the body to the evolution of the geodetic path for the body in Free fall (the corresponding to the gray line) increases until reaching an infinite value at the black hole event horizon.

So, in summary, while scenario 1, the free-fall body evolves following the path marked by the geodesic, at scenario 2, by adding a condition to the equations, the body supposedly in free fall, does not behave as such, as the added effect causes its trajectory to be altered.

The proposed process Schematically:

- General Relativity (Gravitational field)

(1) State A $p \cdot E$ → Gravitational waves → State B $p' \cdot E'$

Notation: E' energy at State B related to A; $E' = E_B = E_A + E_T = E^A{}_B = (dt/d\tau)mc^2$

The change of mass-energy from "State A" to "State B" will be caused by gravitational waves, its effect will depend on the location of mass-energy relative to the source of the gravitational field.

$E=mc^2$ being "State A" the reference, then p=1, if we take as reference the place where the gravitational field has no effect (theoretically at infinite distance with respect to the source) its temporal coordinate will correspond to dt. Taking as generic value for state B, the proper time $d\tau$, values:

$p' = d\tau/dt$ and $E' = (dt/d\tau)\, mc^2$

"State A" related to A; $p \cdot E = mc^2$

"State B" related to A $p' \cdot E'$ would be mc^2 as well, with the distinction that there would be a different distortion of space-time at B comparing to A, as established by the field equations.

This result would correspond to the one obtained by the officially accepted model. The hypothesis proposed nevertheless leads to the result set out at (2) which is discussed below.

(2) State A $p \cdot E$ → Gravitational waves + E_T → State B $p' \cdot E' + q' \cdot E'$

Considering this scenario, changing the state from "A" to "B", in addition to gravitational waves, will require the energy input with value E_T and at the final state, we would have, besides the initial value of the mass-energy, the value corresponding to the energy added.

q' would be $1 - d\tau/dt$ and $E_T = E'_q = q' \cdot E' = (dt/d\tau)\, mc^2 - mc^2$

$E'_p = p' \cdot E' = mc^2$

$E' = p' \cdot E' + q' \cdot E' = (dt/d\tau)\, mc^2$ with reference A (That is to say $E^A{}_B = (dt/d\tau)mc^2$)

And with the distortion of space-time as established by the field equations, but needing to add the additional condition corresponding to the proposed process.

It is wellworth noticing that the process as described is similar to the phenomenon corresponding to the photoelectric effect, where we have:

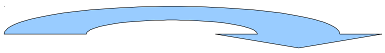
Photons interact with electrons, part of the energy is absorbed by the process and the rest would go to kinetic energy.

Hypothesis: Gravitational waves would interact with mass-energy, part of the energy would be absorbed by the process ($E_T = E'_q$) and the rest would go to kinetic energy.

But there is another analogy or coincidence, since the energies linked to the relative velocity, would follow the same pattern as the one proposed by the hypothesis.

- Special Relativity (relativistic velocity v at “State B” with refeence A, hypothetically in absence of gravitational fields)

State A → State B

(3) $p \cdot E$  $p' \cdot E' + q' \cdot E'$

E_T

This case E_T would correspond to the Kinetic energy (energy corresponds to the Kinetic energy and is already taken into account in the Relativity model)

$E = mc^2$

$E' = \Upsilon mc^2$

$p = 1$ $p' = \mathbf{1/\Upsilon}$ $\mathbf{q' = 1 - 1/\Upsilon}$

$\mathbf{p' \cdot E' + q' \cdot E'} = \Upsilon mc^2$ with reference A

As it is known, by considering expression (3) if the relativistic velocity v at "State B" relative to "State A" is equal to the speed of light c, then an infinite amount of energy is required to pass the mass-energy from "State A" to "State B".

If we now analyze at expression (2), if "State B" corresponds to the event horizon of a black hole, then an infinite amount of energy would be required to pass the mass-energy from "State A" to "State B ".

Special Relativity

$v = x\,(l_p/t_p)$

$x<1$

$x=1$ that state corresponds to a “saturated Physical System” requires an infinite amount of energy.

General Relativity

Considering the Schwarzschild metric for the vacuum solution of the field outside the homogeneus sphere, uncharged, non rotating.

$2GM/c^2 r = (2M/m_p)/(r/l_p)$

with $m_p = \sqrt{(hc/2\Pi G)}$; $l_p = \sqrt{(hG/2\Pi c^2)}$ then $l_p / m_p = G/c^2$

$(2M/m_p) < (r/l_p)$ or $(2M/r) < (m_p/l_p)$

$(2M/r) = (m_p/l_p)$ that state corresponds to a “saturated Physical System” requires an infinite amount of energy for a body to reach the event horizon of a black hole event, because the value of the energy required by the proposed process ($(dt/d\tau)\ mc^2$) to reach that state (corresponding to the event horizon) has an infinite value.

PROBABILISTIC APPROACH

If E represents mass-energy, now P represents the probability that a given event will take place. As example, a particular phenomenon, the decay of a radioactive material, is analyzed. This phenomenon is probabilistically characterized by the Poisson distribution. $\mathcal{P}(\lambda,x)$ where λ Represents the frequency of occurrence of a given radioactive material decaying and x would represent the amount of radioactive material that decays. this way $\mathcal{P}(\lambda,x_1)$ Would give us the probability that a certain amount of material x_1 will decay after a given period of time.

The Poisson distribution is related to another discrete probability distribution, the binomial distribution. So if we have n statistical tests, each of them with a linked probability $p \cdot P$ that a certain event takes place (taking into account the example, the event would correspond to the decay of the radioactive material), fulfilling the following conditions:

$0<p \cdot P <<1$ very small probability of success.

$n\uparrow\uparrow$ very high number of statistical tests.

$n \cdot p \cdot P = \lambda$ The product of the number of statistical trials multiplied by the probability associated with each of the trials is equal to the frequency of occurrence λ

If these three conditions are met, both distributions give very similar values, in fact at the limit when $n \rightarrow \infty$ are equivalent ones.

This leads to the proposal that this phenomenon might be linked to the occurrence of statistical tests each of them with probability $p \cdot P$ to be successful.

Analyzing the components of the expression $n \cdot p \cdot P = \lambda$ (at the end we would have a value or final result set, but would be the result of combining several effects).

P would be linked to the probability of this event taking place, if we were able to vary the value of P to P´ but keeping $n \cdot p$ as a constant value, then λ value would change to $\lambda' = n \cdot p \cdot P'$.

On the other hand, p and n would be interrelated, where p would act as a distribution factor of the probability P at each trial. Thus if we keep P constant and what varies is p to p' (this value being less than p), then the value of $p' \cdot P$ at each of the trials is smaller, than that we had with $p \cdot P$ but If we increase the number of trials so that $n' \cdot p' \cdot P = n \cdot p \cdot P$ then λ would remain a constant value.

The third possible scenario is to change P and change p and n as well (the variation of p and n would always go together, what decreases one, increases the other).

All this leads to the proposal that gravitational waves interact with mass-energy by altering the value of the factor p and consequently the value of n. The alteration of p would be linked to the distortion of the space, whereas the variation of n would be linked to the distortion of the time.

Modern science confers to all the fundamental forces except for gravity a probabilistic approach; gravity causes space-time to be distorted and it is done in such a way that what is contracted space, at the same proportion time expands. The approach presented here, confers a probabilistic approach to the gravitational force, where the distortion of space-time is a direct consequence and there is also an inverse proportion between the distortion of space and the distortion of time.

The factor p, called here a distribution factor, is the one that would affect the energies, in the section related to energies, it is the factor that relates the reference state (State A) to the referenced state (State B)

As shown for the particular phenomenon of decay of radioactive material, there would be an imbalance between the number of tests n and the time elapsed

If we consider the same value of n at A and at B, while dt is time elapsed at A, then at B with reference A it will have elapsed dτ. The variation of the p factor would depend on the ratio dt/dτ.

The above analysis corresponds to a particular phenomenon, to extrapolate it to the general behavior of nature, it would be necessary to extend it to all phenomena that take place at Quantum Mechanics.

Should be fulfilled: $n'\cdot p'\cdot P' = n\cdot p\cdot P'$

Where the variation of $n\cdot p$ to $n'\cdot p'$ should be linked to spacetime distortion.

Noticing that the example analyzed is a very particular case where the probability P in each of the tests remains constant.

On the other hand, the p factor, which is related to time distortion, should vary with the coordinate axes as established by the field equations while maintaining that the distortion of the space is inversely proportional to the distortion of time. Thus, for the Schwarzschild solution external to the sphere, considering the spherical coordinates, p would vary with the Schwarzschild radial coordinate and would remain constant for the other two spatial-type coordinates. The value of p, taking as reference A (taking as reference a state where it is not affected by the gravitational field which would have associated dt) changes with the radial coordinate, taking as value dτ/dt, reaching a value Null at the event horizon of a black hole.

Taking into account the proposed approach, there would be an alternative variant. The imbalance between the number of tests and the time elapsed in addition to the fact that the distribution factor decreases the value of the probability assigned to each test, would correspond to the physical phenomenon of gravitational waves altering the mass-energy, and the value of the p factor. However, something more may happen. The hypothesis proposed raises a scenario where gravitational waves interact with mass-energy and energy $q'\cdot P'$ is required, as a result instead of having p'P' we would have $p'\cdot P'+q'\cdot P'$

Now, instead of diluting the probability at each of those n´ tests (as the factor p' decreases its value), being q`=1-p`, this way the total value of the probability remains a constant value after adding the term $q'\cdot P'$(P´ the generic value of the probability linked to the altered state), that is to say the value changes from P to P´.

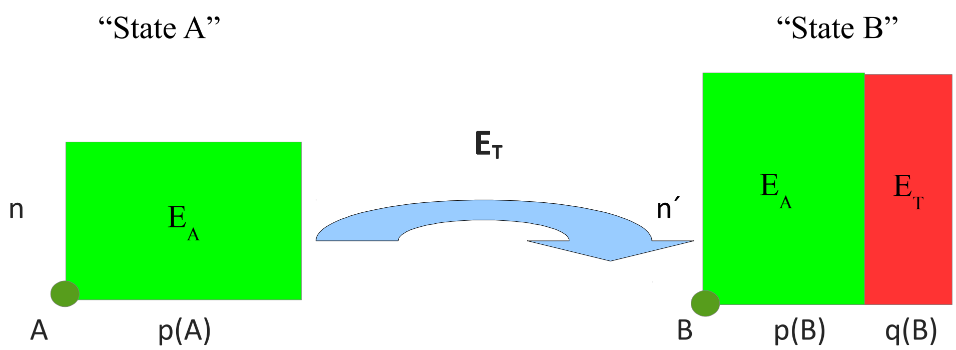
It should be noticed that considering the probabilistic approach, P´ represents a variation of the probability, meanwhile when dealing with energies, E´ represents the value $E_B = E_A + E_T$

However, adding the term $q' \cdot P'$ implies or requires an input of energy, which corresponds to the value E_T

This would correspond to a scenario where occur phenomena of the type

Gravitational waves interact with mass-energy, part of the energy would be consumed in the process (E_T) and the rest of the energy would be used as Kinetic.

Considering energies it was used the following scheme:



the probabilistic approach we have at "State B" $p'\cdot P'+q'\cdot P'$

where $q'\cdot P'$ would correspond to the probability associated with the **"β state" of mass-energy** while $p'\cdot P'$ would correspond to the probability associated with the **"α state".**

Mass-energy passing from **"α state" to "β state"** requires the contribution of E_T

What has been generically defined as "State A" and "State B" correspond to different values for those **"α state" and "β state" (the amount of energy at "β state" increases as the distortion of time increases which generically is characterized by the proper time** dτ and generically has been used the notation "State B")

Considering Special Relativity, the different states would correspond to the relativistic velocities, the relation between times corresponds to the inverse of the Lorentz factor **ϒ** and the $\mathbf{E_T}$ value coincides with the kinetic energy.

If the proposed process depends on the interaction between gravitational waves and mass-energy. That interaction is affected by the velocity of mass-energy, so that, bodies with different velocities would have associated different states, those different states depend on the inverse of the Lorentz factor **ϒ** (the hypothetically pure Special Relativity from a practical point of view would not change), if we have the presence of a gravitational field and a relative velocity, there is a combination of both,

METHODOLOGY

Note: this methodology section would not be part of the paper. The proposal is presented as a hypothesis, adding a new condition, giving different results comparing to the officially accepted model, the hypothesis can not be deduced from the established model, requires to add the additional condition, so this methodology section has not the goal to deduce the hypothesis, but to define a criteria (which differs from the established one) that drives to the proposal.

The proposal adds a new condition to the established model. It will be considered two approaches, an energy related approach and a probabilistic approach, analyzing the consequences of the additional condition on both perspectives. Considering the probabilistic approach, following will be defined an example to better understand the proposal and its implications.

Considering the Schwarzschild metric and two space-time positions corresponding to that metric, one linked to a space-time position where the gravitational field is negligible, linking it to time dt, and the other one with proper time dτ, denoting them "State A" and "State B" respectively. Time runs at more slowly rate at "State B" (closer to the source of gravity) than at "State A" and the metric might be used in order to obtain the ratio between both $dt/d\tau$.

(1) "State A" "State B"

dt dτ

Representing quite an extreme curved space-time scenario (to see the different values at the scheme (1)) Note: red text would not be included at the paper, is just to clarify some topics better. where $dt/d\tau=3$, time runs three times more slowly at B than at A.

Considering now the Poisson distribution $\mathcal{P}(\lambda,x)$ where λ represents the frequency of occurrence of a given event and x would represent the amount or number of events in an interval.

The Poisson distribution is related to another discrete probability distribution, the binomial distribution. Considering n statistical trials, each of them with probability $p \cdot P$ that a certain event takes place, fulfilling the following conditions:

$0<p\cdot P<<1$ very small probability of success.

$n\uparrow\uparrow$ very high number of statistical trials.

$n\cdot p\cdot P = \lambda$ The product of the number of statistical trials multiplied by the probability associated with each of the trials is equal to the frequency of occurrence λ

If these three conditions are met, both distributions give very similar values, at the limit when $n\to\infty$ are equivalent ones.

This leads to a proposal relating both so that at the Physical System is taking place the occurrence of statistical trials or tests each one with probability $p \cdot P$ of being successful.

P representing the probability of an event taking place at a particular trial

p is a factor (which depends on distortion of time) that modifies the value of P

p and n are dimensionless factors that depend on distortion of time, the product of both is a constant value. At "State A" (p, n) At "State B" (p´, n´) with $p\cdot n= p'\cdot n'$

The value of n is linked to distortion of time, so that the higher the distortion of time, the higher the value of n.

The Physical System will comply $dt\cdot n= d\tau\cdot n'$

That is an invariant value for all the corresponding states whatever the distortion of time.

Considering the number of statistical trials, it is obtained the inverse relation:

(2) "State A" "State B"

n n´

(Now the lines represent a different feature, not the distortion of time but the ratio of the number of trials), keeping the metric where time runs more slowly at B. Those two features: number of statistical trials and time distortion, have an inverse relation.

"State B" is linked to three times the number of statistical trials in relation to "State A"
So that if clock runs three seconds at "State A" while one at B, each second at "State B" is configured by three times the number of trials corresponding to one second for the "State A"

Combining (1) and (2) results the invariant value: $dt \cdot n = d\tau \cdot n'$

"State A" "State B"

$dt \cdot n$ $d\tau \cdot n'$

The number of trials corresponding to the interval dt at "State A" is equal to the number of trials corresponding to dτ at "State B".

Considering the Physical System, it would take place the same number of trials, but while that number of trials corresponds to dt time at A, it will correspond to dτ at B. For example, if n is the number of trials corresponding to one second at "State A", after 3n trials the clock has run three seconds at A, while one at B. These features hint that the Physical System might behave taking the number of trials as an invariant value.

Two space-time positions denoted as States A1 and A2 where the gravitational field is negligible (with no relative velocity) clock will run at the same rate.

"State A1" "State A2"

n n After n statistical trials, time elapsed at A1 and A2 is the same.

Adding to the scheme "State B" with proper time dτ

"State A1" "State A2" "State B"

n´ n´ n´

n n n

After n´ statistical trials, time corresponding to A1 and A2 is dt while at B is dτ

(After n statistical trials clock will run one second at A1 and A2 but 1/3 of a second at B, after n´ trials with n´=3n time will run three seconds at A1 and A2 while one second at B).

Previously has been stated that the number of trials taking place at the Physical System might behave as an invariant value. But that behaviour would have some problems.

I) Considering the same number of trials on both states:
mass-energy at "State B" = (p´/p) * mass-energy at "State A"

The value of the probability and consequently the mass-energy corresponding to the same number of trials would be reduced at "State B". Because p·n= p´·n´

II) If "State B" corresponds to the event horizon, then then number of trials would reach an infinite value. Because n´/n= dt/dτ time elapsed at "State A" is infinite comparing to B

Those two problems might be solved by taking into account a process linked to gravity as it will be defined. The introduction of the process is the hypothesis proposed at this paper, which implies an additional condition to the oficially accepted model.

Taking as reference "State A", the process between A and B: "State A"→"State B"
Mass-Energy mc^2 (**α-state) interaction with GW + Energy** (($(dt/d\tau)mc^2-mc^2$))→Mass-Energy (**α-state)**+Mass-Energy (**β-state)** = $(dt/d\tau)mc^2$

Mass-energy interacts with Gravitational Waves, obtaining as result Mass-Energy (**α-state)** +Mass-Energy (**β-state). That process requires energy** (($(dt/d\tau)mc^2-mc^2$)) **to take place.**

Mass-Energy **at β-state depends on the factor q´=(1-p´). where p´=** dτ/dt.

considering the probabilistic approach:
α-state corresponds to p´P´ being P´ the probability of a given event taking place. The interaction with gravitational waves generates the β-state (q´P´), that process requires energy (($(dt/d\tau)mc^2-mc^2$))**, depending on the factor q´ the probability at β-state would increase and consequently the amount of mass-energy at the β-state would increase, that is what is called generically "State B" which is characterized by the quantity of mass-energy at β-state**

Relative velocities will affect the process as well, so that bodies situated at the same space-time position of the gravitational field but with different relative velocities would correspond to different states, the energy differenciating those states corresponds to the Kinetic energy (note: taking into account that velocity is not invariant, as it depends on the reference).

Concerning Special Relativity

Taking as reference State A, the process between A and B: "State A"→"State B"

Mass-Energy mc^2 **(α-state) + Energy** (Υmc^2-mc^2)→Mass-Energy (**α-state**)+Mass-Energy (**β-state**) = Υmc^2 Being ϒ The Lorentz factor

Concerning Special Relativity (hypothetically in the absence of GF, this expression is an idealistic scenario because bodies are immersed on gravitational fields and would be required an infinite distance from the source to avoid being affected, so the process is taking place even if it is a weak interaction, different velocities would alter that interaction with the kinetic energy being associated to those different states, so the meaning of hypothetically in the absence of gravitational fields means that the focus is now on analizing how the relative velocity produces a change of the State):

"State A" reference

"State B" relative velocity (repect to A)=0 then p´=1; q´=0

Note: although it is used the same notation (p´,q´) now they are referred to the phenomenon corresponding to relative velocity, now those factors will define the distinction between states corresponding to relative velocity.

"State B" relative velocity (repect to A)=v then p´=1/ϒ; q´=1- 1/ϒ

Energy between both states (energy required to pass from "State A" to "State B")= Υmc^2-mc^2

values of p´ between 0 and 1 ; p´=1 when relative velocity=0 and p´=0 when relative velocity=c

values of q´ between 0 and 1 ; q´=0 when relative velocity=0 and q´=1 when relative velocity=c

Concerning General Relativity (hypothetically with no relative velocities between states):

"State A" as reference, with associated time dt

"State B" proper time dτ (repect to A) if State A and B are the same then p´=1; q´=0

"State B" proper time dτ (repect to A) p´=dτ/dt; q´=1- dτ/dt

Energy between both states (energy required to pass from State A to State B)= $(dt/d\tau)mc^2-mc^2$

values of p´ between 0 and 1 ; p´=1 when State A and B are the same and p´=0 when state B corresponds to the event horizon

values of q´ between 0 and 1 ; q´=0 when State A and B are the same and q´=1 when state B corresponds to the event horizon

Considering a combination of both GR and SR

"State A" reference time dt

"State B" with proper time dτ and velocity v relative to State A

Note: taking into account that Kinetic energy is not invariant, as it depends on the reference.

If we consider:

"State A" as reference, with associated time dt

"State B1" with proper time dτ and velocity v1 relative to State A

We would have distortion of time between both states due to GR and SR with velocity v1

If we consider:

"State A" as reference, with associated time dt

"State B2" with proper time dτ and velocity v2 (<v1) relative to State A

We would have distortion of time between both states due to GR and SR with velocity v2

The distinction between both B1 and B2 is the energy required to decelerate the object from v1 to v2

The proposal implies that the value of $(dt/d\tau)mc^2-mc^2$ **corresponds to a negative acceleration in the trajectory from A to B, so instead of velocity v1 would be v2**

That is why it is taken this approach, in order to get a better understanding of the phenomenon. This approach is useful to obtain certain data, for expample we can calculate the velocity at State B or time distortions. We could force the object to follow the geodesic if we apply the energy required by the process, between the initial position and each space-time position.

The proposed process follows a pattern similar to the phenomenon corresponding to the kinetic energy.

Concerning SR:

Reference "State A" and "State B" with velocity v relative to "State A".

Mass-energy of a body passing from A to B increases by the factor **ϒ** (relative to an observer at State A), that increase is at the expense of kinetic energy.

Concerning the proposed process:

Reference "State A" (dt) and "State B" with proper time dτ.

Mass-energy of a body passing from A to B increases by the factor **(dt/dτ)** (relative to an observer at State A), that increase is at the expense of the velocity term of the kinetic energy.

Taking up problems I) and II)

I) $p\cdot P' = p'\cdot P' + q'\cdot P' = (dt/d\tau)mc^2$ The hypothesis adds the term $q'\cdot P'$

The value of the probability and consequently the mass-energy corresponding to the same number of trials is the same in both States A and B.

If the Physical System behaves as proposed would satisfy two demands

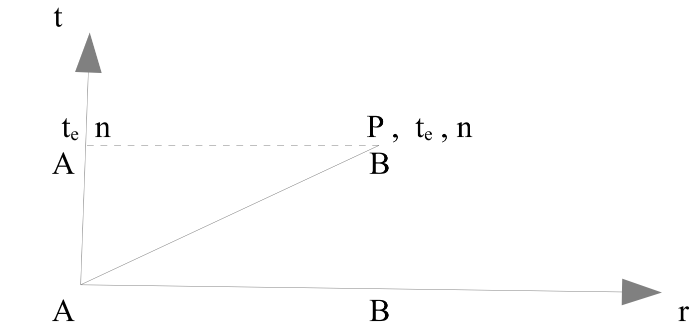
The corresponding to Time, preserving the Noether Theorem, conservation of energy with time. The counterpart of the energy $((dt/d\tau)mc^2-mc^2)$ would account for that.

The corresponding to number of trials as an invariant reference. Mass-Energy (**β-state)** would account for that.

II) If "State B" corresponds to the event horizon, then the energy required to reach that state would be infinite, $((dt/d\tau)mc^2-mc^2)$ where $(dt/d\tau)$ representing the ratio between time elapsed at A and B takes an infinite value.

ψ (r, t)

Absence of GF and no relative velocity between A and B

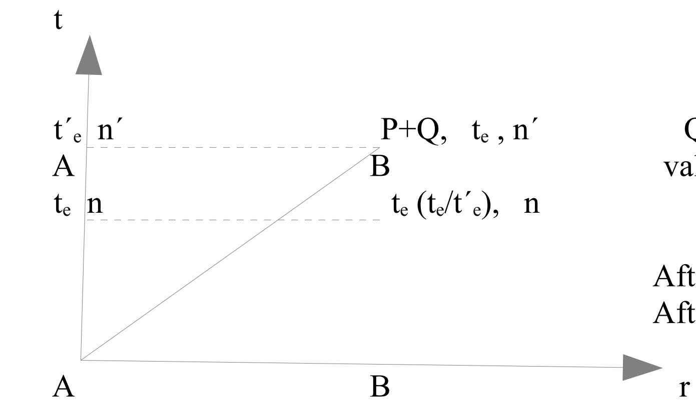


r representing (x, y, z)

Observer at reference A

GF and no relative velocity between A and B

just taking into account space-time distortion effect and not the effect on values of the wave function.



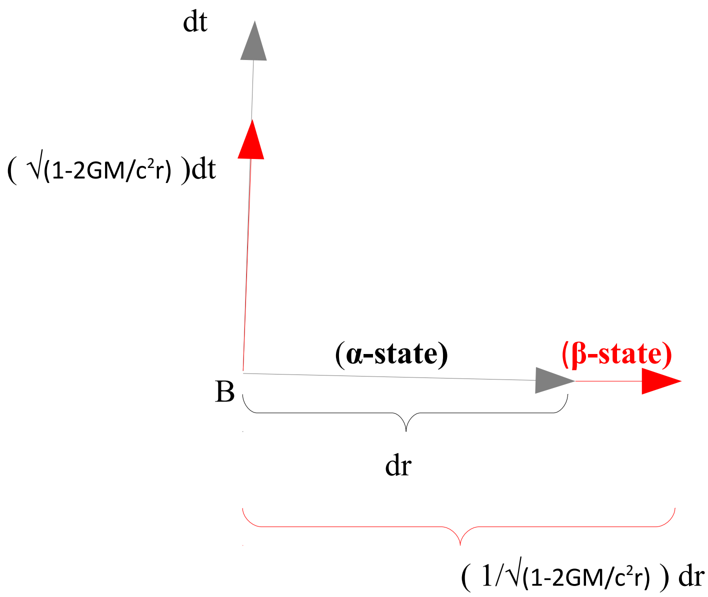
Q= (t'_e / t_e)P-P in order to keep the same value of probability per number of trials n

After n′ Clock has run t'_e at A but t_e at B

After n Clock has run t_e at A but t_e (t_e/t'_e) at B

The effect produced by the gravitational field affects space-time position B and locally to its space-time surroundings, as defined by the Einstein Field Equations.

Considering the Schwarzschild metric



r representing now the radial coordinate, distortion of time coordinate corresponding to clock running more slowly at B and space contraction on radial direction

Scheme represents the proportion between **α-state** and **β-state**, meaning that interaction of gravitational waves and mass-energy on the radial space direction produces as result **β-state** of mass-energy on that proportion, which corresponds to the distortion of space on that direction. Inversely to the distortion of space, is the distortion of time. So knowing the value of the distortion of time is possible to know the value of mass-energy at **β-state** linked to the space-time position B (or "State B").

Locally, for the radial coordinate on the surroundings of B, the chances of a quantum of energy to transform into **β-state** will increase, the higher the value of $2GM/c^2R$. On the other hand, time-like coordinate is distortioned as previously defined. Similarly, this process will take place on a general expression of space-time curvature considering gravitational fields and energies corresponding to General Relativity. **The Schwarzschild metric does not include space-time like coordinates, metrics with space-time distortion including them, have to be taken into account to obtain the value of the energy linked to the process, which ultimately will depend on the corresponding distortion of space.**

The probabilistic approach as defined, establishes a discrete quantity for space-time distortion, if the interaction between gravitational waves and mass-energy giving as result **β-state** of mass-energy is quantized and the distortion of space corresponds to that proportion.

Another quantum like property to take into account is the Heisenberg´s uncertainty principle, because now the energy required to confine the particle on a region of space-time increases with the value of the energy linked to the proposed process.

If we consider a sphere, and uniformely fill that sphere with mass, the energy required to confine the particle up to the surface of the sphere increases reaching an infinite value when the mass of the sphere corresponds to Schwarzschild value and the surface corresponds to the event horizon of a black-hole.

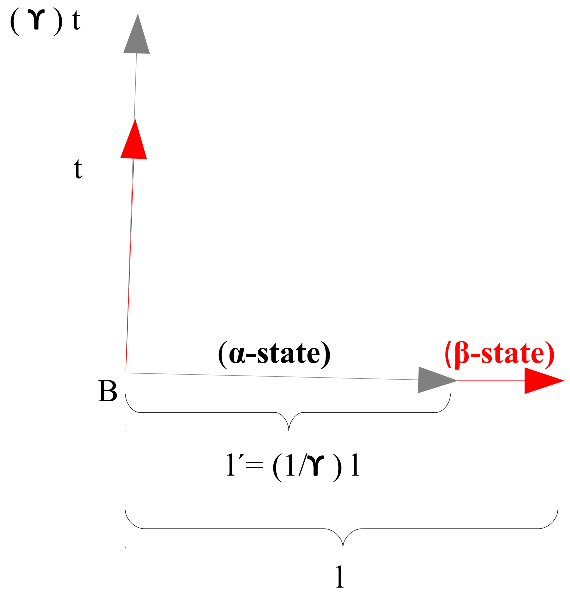
So the Einstein Field Equations give us quantum like information about the interactions taking place locally on the surroundings of any given space-time position and the energy required for that process to take place and consequently the energy linked to that space-time position.

The process, in order to take place as defined, requires energy, and it has to be taken into account the conundrum of General Relativity and Special Relativity.

Special Relativity

Considering the same interval of time, and the same space-time position B (same "State B" of the Gravitational Field), bodies with different relative velocities would suffer a different interaction process between gravitational waves and mass-energy, corresponding to different states. Note: the pure idealistic "Special Relativity" scenario in absence of gravitational fields is not a realistic scenario, bodies are immersed in gravitational fields, even in an area of extremely low effect produced by gravitational fields, the proposed process would take place, bodies with different relative velocities would affect the interactions and correspond to different states.

Considering the same interval of time, or a particular instant of time, interactions will differ depending on the velocity of the body.



Velocity on x direction.

A case of negligible distortion of space-time corresponding to General Relativity, the energy linked to the proposed process is the Kinetic Energy, so that energy is already taken into account as a body passes from "State A" to "State B".

$Q= E_K= \Upsilon mc^2-mc^2$

Q energy linked to the proposed process concerning Special Relativity

When General Relativity has a siginificant effect and it is needed to take into account both effects, for example a free fall body at space-time position B relative to another position A, between them there is different space-time curvature due to General Relativity and Special Relativity in this case the energy required for the process corresponding to General Relativity will be at the expense of the velocity, so that the energy available will satisfy the process corresponding to General and Special Relativity.

CONCLUSIONS

Quantum mechanics is characterized by processes where particles interact, passing from an "α state" to a "β state".

Considering the phenomenon corresponding to the photoelectric effect :

Photons interact with electrons, part of the energy is absorbed by the process and the rest goes to kinetic energy.

The hypothesis at this paper proposes that the interaction between Gravitational waves and mass-energy requires a contribution of energy,

The proposal defines a process linked to gravity where mass-energy would be affected changing its state from A to B. Gravitational waves would interact with mass-energy, part of the energy is absorbed by the process and the rest goes to the velocity term of the kinetic energy.

Factor p (which depends on time distortion) relates "State B" to "State A"

The energies linked to Special Relativiy and General Relativity would follow a similar pattern: $E_B = E_A + E_T$

$E_A = mc^2$ $E_T = (1/p)mc^2 - mc^2$ $E_B = (1/p)mc^2$

Considering the process linked to gravitational fields, both observers do agree on the values of dt and dτ corresponding to "State A" and "State B" respectively.

The value of the energy at B with reference A: $E^A{}_B = (dt/d\tau)mc^2$

The value of the energy at A with reference B: $E^B{}_A = (d\tau/dt)mc^2$

The process linked to gravitational fields is endothermic from A to B and exothermic from B to A. the endothermic process would be at the expense of reducing velocity of the kinetic energy, meanwhile the reverse process would be an exothermic one, increasing the velocity of the body that passes from "State B" to "State A". Expansive scenarios would show velocities higher than expected.

A free fall body follows a trajectory in a curved space-time framework towards the source of the gravitational field. The trajectory is defined by applying the Euler-Lagrange equations to Einstein field equations. The effect proposed implies that the body would not follow the geodesic of a "free fall body" what we consider as a "free fall body" in fact would be forced by the effect proposed. The effect is negligible insofar the distortion of time does not reach a siginificant value. Considering the officially accepted model, nothing prevents from a free fall body reaching the horizon event and inevitably ending in a Singularity. The proposal forces the body out of that geodesic, the energy required to follow that geodesic at the event horizon would be infinite.

The proposal allows to mathematically calculate the discrepancy between both scenarios.

REFERENCES:

Larmor, J.

"A Dynamical Theory of the Electric and Luminiferous Medium. Part III. Relations with Material Media".Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 190: 205. (1897).

Poincaré, H.

“The Principles of Mathematical Physics” The Monist, Vol. XV. (1905).

Einstein, A.

"Zur Elektrodynamik bewegter Körper". ("On the Electrodynamics of Moving Bodies"). Annalen der Physik Vol. 322 Issue 10 pages 891-921 (1905).

“Concerning an Heuristic Point of View Toward the Emission and Transformation of Light” (1905) Translation into English American Journal of Physics, v. 33, n. 5, May 1965

"On a Heuristic Viewpoint Concerning the Production and Transformation of Light". (1905).

“Die Feldgleichungen der Gravitation” Sitzungsberichte der Preussischen Akademie der Wissenschaften zu Berlin: 844–847. Retrieved 2006-09-12. (1915).

"The Foundation of the General Theory of Relativity” Annalen der Physik 354 (7): 769. (1916).

"Does the Inertia of a Body Depend Upon Its Energy Content?" Translation by George Barker Jeffery and Wilfrid Perrett in The Principle of Relativity. London: Methuen and Company, Ltd., 35-65. (1923).

“Quantentheorie des einatomigen idealen Gases. 2. Abhandlung.” Sitzber. Ber. Preuss. Ak. Wiss. : 3–14. (1925).

Planck, M.

“Eight Lectures on Theoretical Physics.Wills, A. P. (transl.). Dover Publications. ISBN 0-486-69730-4.(1915).

Noether, E.

"Invariante Variationsprobleme". *Nachr. D. König. Gesellsch. D. Wiss. Zu Göttingen, Math-phys. Klasse 1918*: 235–257. (1918).

Heisenberg, w.

"Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik". *Z. Phys.* 43 (3–4): 172–198. (1927).

Kennard, E.

"Zur Quantenmechanik einfacher Bewegungstypen". *Zeitschrift für Physik* 44 (4–5): 326. (1927).

Bohr, N.

"Discussions with Einstein on Epistemological Problems in Atomic Physics". In P. Schilpp. Albert Einstein: Philosopher-Scientist. Open Court. (1949).

Macfarlane, A.

"On the Restricted Lorentz Group and Groups Homomorphically Related to It". Journal of Mathematical Physics 3 (6): 1116–1129. (1962).

Hawking, S.

"Particle Creation by Black Holes" Commun. Math Phys. 43(3): 199–220. (1975)

Hooft, G.

"Dimensional Reduction in Quantum Gravity". ArXiv:gr-qc/9310026 (1993).

Susskind L.

"The World as a Hologram".*Journal of Mathematical Physics 36* (11): 6377–6396.(1995).

Hamza, K.

"The smallest uniform upper bound on the distance between the mean and the median of the binomial and Poisson distributions" Statist. Probab. Lett. 23 21–25. (1995).

Saunders, S.

"Complementarity and Scientific Rationality".*Foundations of Physics* 35 (3): 417–447. doi:10.1007/s10701-004-1982-x. (2005).

Sorli, A.

"The Biggest Misunderstanding of 20th Century Science is that Time is the 4th Dimension of Space." *general science journal.* (2011)

Secular, P.

"Exploring the Statistics of Radioactive Decay." *Imperial College London*. (2013)

Ahmed Almheiri, Donald Marolf, Joseph Polchinski, and James Sully

"Black Holes:Complementarity or Firewalls?" doi: 10.1007/JHP02(2013)062