HYPOTHESIS

PROCESS LINKED TO GRAVITY AFFECTING MASS-ENERGY

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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 mass-energy.**
- The hypothesis proposes the existence of a process linked to gravity
  - This phenomenon would affect mass-energy
  - Requires an additional condition (being a more restrictive scenario) to the field equations that define space-time curvature,
  - Adding the condition linked to the proposed phenomenon, the trajectory that follows mass-energy in that curved space-time, changes with respect to the established by the Standard Model of Relativity.
  - 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 those discrepancies.
- It is described a method to test the hypothesis.
- The proposal would have important implications in diverse areas of science and its effect would be determinant in the study of black holes or questions related to Cosmology.

BACKGROUND, PROBLEMS JUSTIFYING NEW CONTRIBUTIONS

The mathematical model of General Relativity has allowed to carry out accurate predictions and calculations.

However there are certain issues about gravity that have not been satisfactorily resolved. Below are briefly described some of the problems concerning gravity:

- Theoretically the mathematical model of relativity predicts singularities at certain circumstances, an observer reaching the event horizon of a black hole, inexorably ends in a singularity.
- Paradox of information loss 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.
- At 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 the Horizon of events, contravening the quantum rules

INTRODUCTION

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 the state of the body changes (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 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 $\begin{cases} L \\ t \end{cases}$

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

Space-time $\begin{cases} L' = L/\Upsilon \\ t' = t^* \Upsilon \end{cases}$

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

INTRODUCTION

General Relativity scenario

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

Einstein Field Equations corresponding to the Standard Model of Relativity.

Considering the Schwarzschild metric for the vacuum solution of a homogeneus 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

$E=mc^2$

Space-time **(dt, dr, dθ, dφ)**
(E.F.E. With negligible Gravitational Field)

"STATE B"

Physical properties of

Object in "State B"

region of space-time where

time is proper time **τ**

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

Space-time E.F. E.
(No negligible G.F.)

Modified E.F. E.

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

Note:

Scheme, without including the terms in red (Energy; $E' = \mathbf{(dt/d\tau)}mc^2$; Modified E.F. E.)

would correspond to the Standard Model of General Relativity.

INTRODUCTION

The hypothesis proposes the existence of a process (not taken into account by the S. M. of Relativity), where gravitational waves alter the physical properties of mass-energy.

(Taking as reference the “State A”) “State A”→“State B” Body passes from a space-time position in “State A” (with coordinate time t) to another space-time position in “State B” (with proper time τ).

(1) 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 $(dt/d\tau)mc^2$). The stronger the gravitational field in a region of space-time, the higher the quantity of Mass-Energy (**β-state)**

Besides, the energy required by the process to take place will be at the expense of producing space-time distortion similarly to the effect of energy opposed to the free-fall of the body (opposed to each space-like coordinate distortion if there is more than one coordinate distorted, see slides 14, 15). The term $((dt/d\tau)mc^2 - mc^2$ increases the value of mass-energy, the counterpart effect $-(dt/d\tau)mc^2 + mc^2$ produces space-time distortion).

If it is applied momentum and energy, then the process will be altered, further changing the state of mass-energy.

The proposed process is the fundamental base where all those interactions take place, but insofar gravitational fields are not strong enough, the effects of (1) are negligible, so the result is very similar to the Standard Model (EFE without taking into account the proposed process). For example considering Special Relativity scenario (with a very small curvature produced by gravitational fields):

Without taking into account the proposed process: **(2) Mass-Energy** mc^2 **+ Kinetic Energy (**$\Upsilon mc^2 - mc^2$**)** → Υmc^2 Body in “State B” has velocity v

Taking into account the proposed process, (the combination of **(1)** and **(2)**) gives as result: **(3) Mass-Energy (α-state)** mc^2 **+ Kinetic Energy (**$\Upsilon mc^2 - mc^2$**)** → $\Upsilon_{mod}(dt/d\tau)mc^2 - (dt/d\tau)mc^2 + mc^2$ = Mass-Energy (**α-state)** mc^2 + Mass-Energy (**β-state)** $(\Upsilon mc^2 - mc^2) = \Upsilon mc^2$ (this is the total value of energy, there is conservation of energy, but Body in “State B” has velocity $v_{mod} < v$, so that physical properties has changed, corresponding to the expression $\Upsilon_{mod}(dt/d\tau)mc^2 - (dt/d\tau)mc^2 + mc^2$

Scenario corresponding to body in free-fall (Schwarzschild metric for the vacuum solution of a homogeneus sphere, uncharged, non rotating), from space-time position with time t to space-time position with time τ. Showing the interrelation between the value of mass-energy and space-time distortion. Now “State B” corresponding to free fall scenario, is different from the one defined at (1) which corresponds to a forced scenario, preventing the body from further falling (for example a body on the surface of a planet, theoretically non rotating), could be used a different notation, nonetheles here generically it is used the notation “State B” to characterized the state that has changed properties with respect of “State A”. There is conservation of energy, knowing the value of ϒ, it can be calculated the value of Υ_{mod}, but the velocity is the corresponding to Υ_{mod} and not the linkef to ϒ, if $(dt/d\tau) \approx 1$ then $\Upsilon_{mod} \approx \Upsilon$ (with $\Upsilon_{mod} = 1 + \Upsilon\, d\tau/dt - d\tau/dt$). values $\Upsilon_{mod} = 1/\sqrt{(1 - v^2_{mod}/c^2)}$ where $v_{mod} = dr_{mod}/d\tau_{mod}$ and $\Upsilon = 1/\sqrt{(1 - v^2/c^2)}$ with $v = dr/d\tau$

Note: expression (3) should take into account the reference, so that if the reference is “state B” then mass-energy **(α-state)** is $(d\tau/dt)\, mc^2$ and total energy at the end is $(d\tau/dt)\Upsilon mc^2$ If the reference is “State A” then value of mass-energy **(α-state)** is mc^2 but we have to take into account the considerations about kinetic energy depending on the reference as well.

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Considering an observer in "State A" (Space-time position where time is dt or where distortion is so insignificant that dt value is considered), and an object in State A as well, with associated energy $E_A = mc^2$. 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 **$E_B = (dt/d\tau)mc^2$,** and the value of the energy required for that proccess to take place is **$E_T = (dt/d\tau)mc^2 - mc^2$**

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:

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

Upper index A indicates that the reference is "State A", so the value of the energy at A with reference A has value mc^2 while the value at B with reference A would have value: $(dt/d\tau)mc^2$ If we consider the value at B with reference B then $E^B_B = mc^2$ and the value at A with reference B would be $E^B_A = (d\tau/dt)mc^2$

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

$$E^A_C - E^A_B = \int_{dt/d\tau_B}^{dt/d\tau_C} mc^2 d\phi$$

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 $\tau_B = \tau$, then: $E^A_B - E^A_A = (dt/d\tau)mc^2 - mc^2$

EXAMPLE

Discrepancy (increment per unit) between Υ (**$\Upsilon = 1/\sqrt{(1- v^2/c^2)}$**) and Υ_{mod} (**$\Upsilon_{mod} = 1/\sqrt{(1- v^2_{mod}/c^2)}$**)

Considering the GF corresponding to the Sun, the Schwarzschild metric outside the sphere

Taking as value $2GM/c^2r$= 0,00000424607412878786

corresponding to a trajectoy between State A (far away from the gravitational source so that its effect is negligible) State B (the surface of the sun)

That discrepancy has a value of 0,0000000000045072738

That would be the discrepancy for a body in free fall for the whole trajectory between State A and State B. If “State B” corresponds to a distance r to the surface of the sun, the discrepancy is substancially lower, because most of the discrepancy is produced at the vicinity of the sphere.

If the body evolves in space-time without increasing time distortion, then the discrepancy is null, evolution at the surface of a planet or in an orbit around a planet or a star with little change of time distortion, the effect of the proposed process is negligible. That might be the reason for this effect to go unnoticed.

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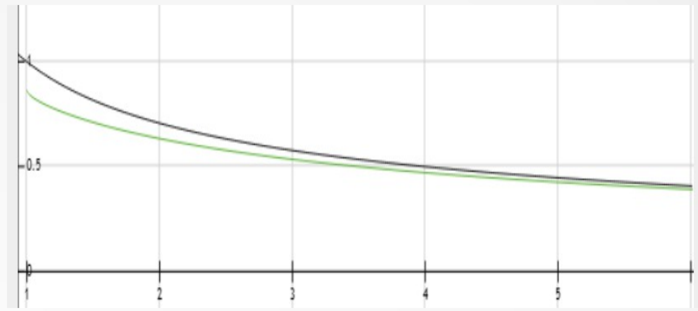
The biggest discrepancies will be at the vicinity of a black-hole event: velocities, taking as reference a free fall observer.

y: ratio of velocities   v/c $\in$ (0,1) being 1 the speed of light.

x: r/r_S being r the Schwarzschild radial coordinate, starting at r/r_S equal to 1.

Black: v/c velocity in free fall without taking into account the proposed process.

Green: v_{mod}/c velocity in free fall taking into account the process.



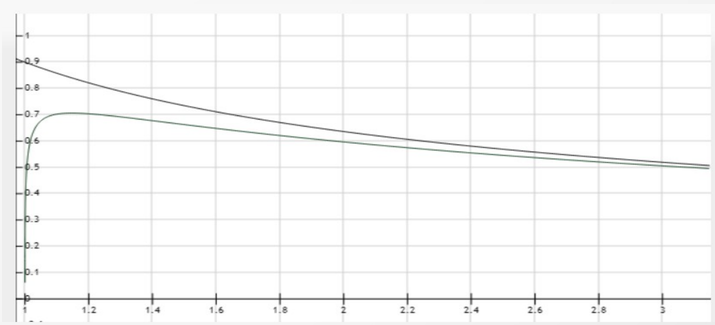
Note: The graph represents the value v/c and its corresponding value v_{mod}/c this theorical case v/c is equal to 1 at the event horizon, but if that value is not exactly 1 (for example body that has not been in free fall, and when reaches the event horizon is in free fall but with v<c)

Then the value of v_{mod}/c at the event horizon (r_s=1) will be 0

Graph on the right represents

v/c and v_{mod}/c

whith v/c =0,9 at the event horizon



METHOD TO TEST THE HYPOTHESIS

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

It is defined a method to test those discrepancies:

Considering the Schwarzschild metric for the vacuum solution of a homogeneus sphere, uncharged, non rotating, where two space-time regions of a gravitational field have associated proper time τ_1 and τ_2 (time runs more slowly at τ_2 region). A particle or a body in free fall between the space-time region with time τ_1 (starting point) and τ_2 (final point of the trajectory analyzed). If initial velocity is v_1 and final velocity v_2 (taking into account the Standard Model of Relativity), now considering the proposed hypothesis initial velocity will be v_1 but final velocity will be v_3 ($v_3<v_2$). The energy of a particle (it is not specified which would be the best type of energy to test), will be lower than expected when reaching the region with time τ_2, If we consider instead of one particle a source of energy located at region with time τ_1, that energy with value mc^2 (that value with reference the region with time τ_1, then with reference τ_2 the value is $(\tau_2/\tau_1)mc^2$), if we measure the energy that will be received at the goal region with time τ_2, will be lower than expected depending on the ratio τ_2/τ_1 , obtaining $(\tau_2/\tau_1)\Upsilon mc^2$ energy instead of Υmc^2,

(Expression for t and τ with reference in the region with time dτ): $\Upsilon_{mod} m_p c^2 - m_p c^2 = \Upsilon(d\tau/dt) m_p c^2 - (d\tau/dt) m_p c^2$ **then,** $E_p = \Upsilon_{mod} m_p c^2 - m_p c^2 + (d\tau/dt)\, m_p c^2 = \Upsilon(d\tau/dt) m_p c^2$

This way, the higher the energy at the source, the higher the discrepancy. Then to detect the discrepancy has to be taken into account three factors, the sensibility of the receiver to measure the energy received at the goal, the ratio (τ_2/τ_1) and the amount of energy at the source. So increasing the energy at the source, we might detect those discrepancies even if the ratio (τ_2/τ_1) is a very small one. If the experiment is realized with the source located at region with time τ_2, and the receiver is at region with time τ_1, then the reverse process will take place and would be measured higher energy than expected, with velocities higher than the predicted by the Standard Model of Relativity.

Other ways to detect the discrepancies would be via astronomical observation, some projects are looking for deviations with respect to the current 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/