

Conflict between the Gravitational Field Energy and the Experiments

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Abstract

From the equivalence principle and true gravitational (G) time dilation experiments it is concluded that “matter is not invariable after a change of relative position with respect to other bodies”. As a general principle (GP), such variations cannot be locally detected because the basic parameters of all of the ‘well-defined parts’ of the instruments change, lineally, in the same proportion with respect to their original values”. Only observers that don’t change of position can detect them. Thus, to relate quantities measured by observers in different G potentials they must be previously transformed after Lorenz and G transformations derived from experiments. They are account for all of the “G tests”. However “they are not consistent with the presumed energy exchange between the field and the bodies”. The lack of energy of the G field is justified from the GP, according to which particles models made up of photons in stationary state obey same inertial and G laws as particle. Such model has been previously tested with relativistic quantum-mechanics and all of the G tests.

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1. INTRODUCTION

The main purpose of the present work is to find, after using “strictly homogeneous relationships”, whether or not the current hypotheses normally used in gravitation are simultaneously consistent with all of the experimental facts. Obviously, this must be done independently on any conventional or non-conventional hypothesis.

In current physics, from long time ago, it has been normally assumed that *the gravitational (G) field exchanges energy with the bodies*¹. Such hypothesis is a consequence of another more basic one on *the absolute invariability of matter* after a change of G potential with respect to the observer, which corresponds to one alternative of interpretation of the Einsteinium’s Equivalence Principle (EP).

However such principle has two rather opposed alternatives of interpretation

- I) The bodies are really invariable, which is the conventional hypothesis, and
- II) All of the bodies of a local system change in the same proportion after identical changes of G potential. Thus an observer moving altogether with his instrument cannot detect such changes because his standard has changed in just the same proportion as any other part of the instrument. Only in this way every ratio in his local system can remain constant.

Notice that in the case II), “any observer that has not changed of potential can observe the real changes that have occurred to the bodies after a change of potential”.

On the other hand, *the experiments on G time dilation (GTD)*, as shown below, prove, definitively, that the standard clocks located in different G potentials run with different frequencies with respect to the clock of an observer in a well-defined potential.

Then the positive results of the GTD experiments can only be consistent with the alternative II).

Since the observers located at rest in different G potentials have standard clocks running with different frequencies with respect to each other, then their unit systems are different to

each other. Then the current relationships between the quantities measured by observers in different G potentials are inhomogeneous and without a well-defined physical meaning. To relate them, homogeneously, they must be previously corrected for the differences of frequencies of their clocks. Then the corrected quantities must be position dependant quantities.

Thus, the new formalisms that must be used, to describe the real physical changes of a body, after a change of its position in a G field, is a plain generalization of the one used in special relativity, after using position and velocity dependant quantities.

As a matter of fact, the present work is based almost exclusively on the G Time Dilation (GTD) experiments and the Equivalence Principle (EP). The full consistency with all the other experiments can be verified later on

2. THE EXPERIMENTAL FACTS

For the purposes of the present work, the experiments in G fields have been divided into two main categories whose general results have some fundamental differences with respect to each other.

- I. *Local experiments* in which the differences of G potential between the object and the observer are small enough so that special relativity can be applied locally.
- II. *Nonlocal (NL) experiments* in which the objects and the observers are located in different G potentials.

1. The global result of local experiments

The EP is already a general result from the most exact local experiments. According to it, *the special relativistic forms of the local physical laws do not change after any well-defined change of velocity and G potential of the observer and his measuring system³*. Thus, “*the “ratios” between the local parameters of the atoms and particles are constant values that do not depend on the velocity and on the G potential of the local system*”. For this reason, and

for strictly “local purposes”, every local observer arbitrarily “*assigns*” the same numerical value to the frequency of his local (standard) clock. According to the EP, such assigned frequency also fixes the rest values of the other the parameters of the local system. Then, such constant number can only be legally used for strictly ”local” relationships in which the differences of G potential between the object and the observer, can be neglected¹.

2. The global results of the non-local experiments

The results of the most exact experiments used for testing gravitational theories, currently known as “gravitational tests”, show most clearly, that some real “physical changes” do occur to the bodies and to the space after a change of position in a G field. For example, the deviation of light in a G field gradient proves, definitively, that the G field has a variable refraction index with respect to any well-defined observer.

The physical changes occurring to the bodies are most evident in the experiments on G Time Dilation (GTD) made up with clocks. They have important differences with the experiments on G Redshift (GRS) of photons because the observed time intervals between two pulses of light do not depend either on the frequency of photons or on their times of flight between the clock and the observer. A time interval is a difference of times in which such time of flight is cancelled out. The frequency of such photons is not measured at all. Then the GTD experiment is entirely independent the mechanisms of propagation of light signals between the clock and the observer.

This experimental facts are most clear when the readings of atomic clocks travelling in airplanes or satellites have are compared. For example the Cesium clock of the Global Position System (GPS) NTS-2, during a period of 20 days of June of 1977, accumulated a difference of time of the order of 760,000 nanosecond. The average frequency of the NL clock

¹The local case is similar to that of a small country. The number “1” assigned for the local moneys cannot be legally used for buying in other countries.

measured during that interval was +442.5 parts in 10^{12} faster than clocks on the ground, which is in good agreement with the GTD predicted by general relativity.

Then the GTD experiments prove, definitively, that *the clocks located in different G potentials do run with different rates with respect to each other, i.e., that the objects are not absolutely invariable after a change of G potential.*

On the other hand, from the change of sign observed after exchanging the position of the object with the observer it is concluded that: the differences of frequencies are *absolute* ones.

Since the eigen-frequency of any clock depends on the general physical properties of its atoms, then a general conclusion derived from GTD experiments is that: *“the standard atoms of observers located in different G potentials are physically different with respect to each other, respectively”.*

Then, from the positive results of the GTD experiments it is inferred that, *the current comparisons of frequencies measured with clocks located in different potentials are inhomogeneous and without well-defined physical meaning. They are referred to reference clocks that run with different rates with respect to each other.* Such illegal kind of relationship is bounded to be a current source of fundamental errors similar to the classical ones that existed before Einstein. Since this is a current practice, then it is reasonable to find some fundamental errors in current literature.

Consequently, to fairly relate the quantities measured by observers at rest in different G potentials, after strictly homogeneous relationships, all of the quantities must be previously transformed to some strictly invariable unit system based on a clock or reference standard located at rest in some well-defined potential. This is because only such kind observer can be strictly invariable. For the present purposes, such transformations must be found from the experimental facts, independently on any of the conventional hypotheses.

3. Global Results from Local and Nonlocal Experiments

According to the EP, *the constants relating the frequencies, the masses and the lengths, of any well-defined part of a local system, are values that do not depend on the velocity and G potential of such system.* Thus if any of these parameters change, after a change of potential with respect to a fixed observer, then the other parameters must also change in just the same proportion. Only in this way every local ratio within the instrument can remain unchanged.

Then the GTD experiments can be consistent with the EP only if:

The basic parameters of any well-defined part of any measuring system change linearly, in just the same way and in the same proportion, after any common change of G potential².

Then according to the EP and to the positive results of the GTD experiments, an observer travelling altogether with his local instruments cannot detect any change of the local ratios, after a change of G potential, because all its parts change in the same way and in the same proportion, after identical changes of G potential”. The reason is obvious: “All of the well-defined parts of the instrument obey the same inertial and gravitational laws and, therefore, they must change in just the same way and in the same proportion after identical circumstances”. This may be called *the Nonlocal form of the EP* (NL EP).

Since a similar fact is observed in special relativity, after velocity changes, then the common point for the two cases is that:

All of the well-defined parts of the measuring system, without any exception, obey the same general inertial and gravitational laws³. This is a *more general principle (GP)* because

²Only in this way every ratio within the measuring system can remain unchanged after any circumstance. Notice that if this were not so, the differences could be detected from local measurements thus violating the EP.

³*If the inertial or gravitational laws of some particle were different from another particle, such differences could be detected after local measurements made up after changes of velocity and G potentials of the measuring system. Such positive results would violate the EP.*

it is a general condition that the bodies must meet to account for all of them: the EP, special relativity and the G experiments.

It is important to observe that the same principle must also hold for any photon in stationary state between two well-defined parts of the same system. This is because its frequency and its wavelength have well defined values fixed by the local speed of light. Its mass-energy is fixed by its frequency, according to $m = E = h\nu$. Thus, an idealized clock can be emulated by a photon in stationary state between two well-defined parts of the same system.

3. The new formalism for an homogeneous description of the gravitational phenomena

From the changes of frequencies of the clocks revealed by the GTD experiments it may be concluded that:

- *The constant numerical values assigned to the rates of the local clocks are well defined (legal) only for strictly local relationships in which the GTD phenomenon can be neglected.*
- *In principle the relative changes occurring to the objects, after changes of G potential can only be measured (or described) by observers that have not changed of G potential.*
- *For a complete description of all of the phenomena occurring in G fields it is essential that the reference standard has not had any of the changes that have occurred to the objects. This one fixes a strictly flat theoretical reference frame.*
- *To relate quantities measured by observers in different G potentials, they must be previously transformed to some common reference standard (Lorenz frame) in some well-defined state of velocity and G potential. This is equivalent to use a strictly invariable (flat) reference framework that has not changed in the same way as the objects.*

Here, the basic relationships for transforming the data of observers at rest in different positions of a G field, to some common observer at rest in some well-defined position, are

called “*G transformations*”.

Below, *the transformation factors are derived from the Equivalence Principle and the data of GTD experiments after using strictly homogeneous relationships*. Those factors correct each quantity for the real physical changes that have occurred to the nonlocal bodies and clocks after changes of G potential with respect to the observer’s ones.

In more general cases, when the NL bodies are moving with respect to the observers the “*Lorenz Transformations*” can be as important as the Gravitational Transformations. In such cases *the two kinds of transformations factors must be applied*. Using can do this

a), *Lorenz Transformations factors* for the description of the relative changes that the bodies have had after changes of velocity, and

b), *Gravitational Transformations*, for the description of the absolute changes occurring to the bodies after changes of G potential..

In this way the relative and absolute differences between the NL bodies and the local ones, due to differences of G potential and velocity, have been taken into account.

The last transformations extend the application range of special relativity for nonlocal cases in G fields. Thus a reasonable name for this formalism is *nonlocal relativity*.

For the present purposes it is obvious that it not necessary to use the geometry of space-time. However the present formalism gives a direct and complete (non-distorted) description of the net changes occurring both in matter and in the space, after changes of position and velocity with respect to some fixed (invariable) reference frame.

4. Conventions

To prevent ambiguities, it is necessary to make clear the differences between the *local* and the *nonlocal* conditions of the object with respect to the observer, depending on whether or not the objects are in the same G potential of the observer. Thus the terms “*NL objects*” and “*NL observers*” are used here for the nonlocal conditions. For the same reason, the transformed quantities, after correction for differences of velocity and G potential, have

been named “*NL quantities*”. They correspond to a plain generalization of the “*relativistic quantities*”, used in special relativity.

Here, for simplicity, a static central field has been used. In this way the G potentials are plain (point) functions of just the radius. The observer’s standard is located at rest in some fixed radius of some central field, which is assumed to be strictly static. However, due to its high importance, most of the times *the fixed position of the observer has been explicitly stated in each quantity by means of a “subscript”*.

For example, it is assumed that some observer A and his standard clock are located in some NL radius a_a of a central body of nearly infinite NL mass M_a compared with the test mass. Another standard clock is located in some NL radius r_a . Notice that the common subscripts ($_a$) puts into relief that these radii are expressed in terms of the common unit system fixed by the standard of the observer A .

The GTD experiments put on relief that the frequency of a clock “at rest” with respect to the observer is a well-defined (point) function of the NL radius of the NL clock (r_a) and of the observer’s clock A (a_a).

On the other hand, according to special relativity, if the NL clock were moving with respect to the observer, its NL frequency would also be a function of its velocity (V_a) with respect to the observer A . Thus the general symbol used here for the NL frequency of such clock, with respect to the observer A , is $\nu_a(V, r)$. The same symbol is used for the average NL frequency of any well-defined standing wave of the NL system. Notice that, for simplicity, the subscripts of the variables in parenthesis are omitted. However, by convention, it is assumed that the tacit subscripts are the same for all of the variables of the same quantity.

For an object “at rest” with respect to the observer, the value of the velocity ($V = 0$) is “not” omitted. Thus the symbols $\nu_a(0, a)$ and $\nu_a(0, r)$ are used for the frequencies of a local clock and a NL one, respectively. They are at rest with respect to the observer A .

According to current conventions, the numerical values of assigned to the rates of the “local” clocks are universal values that do not change when the observer changes of G potential. For this reason in the current literature most of the times the positions and velocities of the

observer are not explicitly stated. However, according to the GTD experiments, such rate has really changed after a change of G potential. Then, as shown in the discussion (below), such practice applied to relations between quantities measured in different G potential has been source of fundamental errors, as shown below. For this reason, the observer and the object positions must also be explicitly stated.

Due to the different frequencies of the clocks located in different positions in the field, the NL speed of light is also position dependent. This is consistent with the refraction phenomena observed in G fields. Thus the in the case of *a free photon in a NL position r* , its basic NL parameters with respect to the observer have the symbols $\nu_a(r)$, $\lambda_a(r)$. The NL speed of light, with respect to the observer A , $c_a(r)$, can depend only on the NL positions of the photon and of the observer. This is not in conflict with the constant value of the “local” speed of light because the differences between the NL values and local values tend to zero when the differences of G potential between the object and the observer tend to zero. Thus when $r_a \rightarrow a_a$, $c_a(r) \rightarrow c$.

For a photon in stationary state, in a NL system at rest with respect to the observer, its NL speed of light, is obviously equal to:

$$c_a(r) = \nu_a(0, r)\lambda_a(0, r) \tag{1}$$

In which $\nu_a(0, r)$ and $\lambda_a(0, r)$ are the average values of the NL frequency and NL wavelength of the radiation in stationary state with respect to the observer.

4. GRAVITATIONAL TRANSFORMATIONS FROM EXPERIMENTS

Here the G transformations are derived from just experimental facts. Using the EP, which is already a global result of the local experiments, and the results of GTD experiments, can do this. In this way the simultaneous fit of the G transformations with the rest of the gravity tests can be used as experimental “tests” for such transformations.

Assume a GTD experiment in which a standard clock is raised from the NL radius r_a of the observer A up to a NL radius $r'_a = r_a + dr_a$. If $\nu_a(0, r)$ is the initial frequency with respect

to the observer A , the experiments show that the proportional change of the frequency of the NL clock, compared with the original frequency has the form:

$$\frac{\nu_a(0, r + dr) - \nu_a(0, r)}{\nu_a(0, r)} = d\phi(r) \cong \frac{gdr}{c^2} \cong \frac{GM_a}{r_a} \frac{dr_a}{r_a} = \frac{dE_a}{m_a(0, r)} \quad (2)$$

In which the last members are the experimental values in which, for simplicity $M[\text{joule}] = M^{\text{newt}}c^2$, and $G = G^{\text{newt}}c^{-4}$. In this way the mass and the energy can be expressed in terms of a common mass-energy unit (joule).

On the other hand, *according to the EP*, the local values of the frequencies, mass-energies, wavelengths and lengths of any well-defined part of a local system ARE related to each other after some relation like:

$$k^\nu \nu_a(0, r) = k^m m_a(0, r) = k^\lambda \lambda_a(0, r) = k^L L_a(0, r) \quad (3)$$

In which the constants k^ν , k^m , k^λ , and k^L do not change after changes of velocity and G potentials. Thus *if any of these parameters change, after a change of G potential with respect to the fixed observer, the other ones must also change in just the same proportions, compared with their original values.*

Then, from equations 2 and 3, the common NL changes occurring in any part of a system, after a change of G potential, can be represented by the single expression :

$$\frac{d\nu_a(0, r)}{\nu_a(0, r)} = \frac{dm_a(0, r)}{m_a(0, r)} = \frac{d\lambda_a(0, r)}{\lambda_a(0, r)} = \frac{dL_a(0, r)}{L_a(0, r)} = d\phi_a(r) = \frac{dE_a}{m_a(0, r)} \quad (4)$$

This means that such NL parameters of the bodies are no longer the constant (universal) values. All of them are well-defined point functions of the NL positions of the object and of the observer with respect to the source of G field

In particular, from the NL EP, this relation must hold for the frequency and the wavelength of any standing wave in the NL system at rest with respect to the observer. In this case , from 1 and 4

$$\frac{d\nu_a(0, r)}{\nu_a(0, r)} = \frac{d\lambda_a(0, r)}{\lambda_a(0, r)} = \frac{1}{2} \frac{dc_a(r)}{c_a(r)} \quad (5)$$

In a more general case, when a local instrument is changed from the position of the observer A up to a NL radius r_a , the common G transformation factor can be derived integration of 4 and 5:

$$f_a(r) = \frac{\nu_a(0, r)}{\nu_a(0, a)} = \frac{m_a(0, r)}{m_a(0, a)} = \frac{\lambda_a(0, r)}{\lambda_a(0, a)} = \sqrt{\frac{c_a(r)}{c_a(a)}} = e^{\Delta\phi_a(r)} \cong 1 + \Delta\phi_a(r) \quad (6)$$

The first four members of equation 6 define *the G transformation factor* between the NL and the local parameters of each well-defined part of the same system at rest in the two places. From the EP, the same ratio must hold for any clock, atom, particle, or any well-defined radiation in stationary state that may exist at rest in the local and NL systems. Thus the phenomenon of G redshift (GRS) of a photon coming from a NL atom is a consequence of the GTD that existed in the atom before emitted it .

The fifth member gives the explicit values of the transformation factors in terms of the NL speed of light. This member puts on relief that *the G field is a gradient of the NL refraction index of the space*.

The last member of equation 6 is the experimental value found for the 2nd member, according to single GTD experiment.

The sixth member is the NL transformation factor obtained by integration of the values obtained from GTD experiments.

From equation 6 it is verified that the parameters of a NL object at rest with respect to the observer are point functions that depend on the NL positions of the object and of the reference standard. Something similar occurs for the NL speed of light.

Notice that, in general, *in regions of lower NL speed of light there is a general contraction of the rest-values of all of them: the frequencies, the mass-energies, the wavelengths and the lengths*. This holds for every well-defined particle or radiation in stationary state.

A. Gravitational tests

The equation 6 is obviously consistent with the EP because in any local limit $\phi_a(a) = 1$. This value is independent on velocity and G potentials of the local system. This means a full agreement with the most exact experiments.

In previous works the equation 6 has been derived in an entirely different way, from the theoretical properties of a particle model made up of radiation in stationary state. In them it has been proved that *the different members of this equation are consistent with all of the experiments used for testing gravitational theories*⁴⁻⁶.

For example, the same transformation factor has been found from the GRS experiments⁷. In them, the frequency of light coming from a NL luminous source, located in a different G potential, has been measured. In them, the NL form of the EP is clearly verified because *“the frequencies of the clocks and of all of the spectrum lines of the atoms turn out to be redshifted in just the same proportion”*.

It is simple to verify that the gradient of the NL speed of light fixed by the 5th member accounts for the results of the experiments on *the time delay of radar waves traveling close to the Sun*⁸. *This member also accounts for the deviation of light travelling close to the Sun*⁹.

In such literature it is proved that the theoretical orbit of a particle model, derived from equation 6, is also consistent with the observed perihelion shift of Mercury¹⁰. In this case the perihelion shift depends on a second order approximation of the 6th member this equation.

Then it may be said that *“equation 6 is simultaneously consistent with all of the local and NL experiments made up in G fields”*. Since this one does not depend on any particular G theory, then it may be used to test the current hypotheses normally used in G theories.

5. CONFLICTS OF SOME CURRENT HYPOTHESES WITH THE EXPERIMENTS

Some of the most basic questions are:

A. Can a photon exchange real energy with G fields?

Assume that several experiments on G redshift are made up by different observers located consecutively along the trajectory of a light beam going away from a central body. Such observers would find “decreasing frequencies values”. This fact currently makes believe in that light is redshifted during its way out and, therefore, that there is a real exchange of energy between the photons and the field. Thus it is often assumed that the photons Is doing a work, which is the *tired light hypothesis*.

However, such reasonings are inhomogeneous because, from GTD experiments, such frequencies are referred to clocks that are running with different frequencies. Then such differences of frequencies have no well-defined physical meanings.

Then the single way to compare such frequencies is after transforming the frequencies, previously, to some well defined clock located in some well-defined G potential. This can be done, by using the equation 6 obtained above from GTD experiments or any other gravitational test. According to it the photons emitted by the NL oscillators at r_a should have an initial NL frequency, with respect to the observer A, given by:

$$\nu_a(r) = \nu_a(0, a) [1 + \Delta\phi_a(r)] \quad (7)$$

If the field had given up some energy ΔE to the photon, the final frequency of the photon, after travelling up to the observer’s potential, would be somewhat higher, like :

$$\nu_a(a) = \nu_a(0, a) [1 + \Delta\phi_a(r)] + \Delta E/h \quad (8)$$

On the other hand, according to the results of the experiments on G redshift, the value of the frequency at the observer potential is given by

$$\nu_a(a) = \nu_a(0, a) [1 + \Delta\phi_a(r)] \quad (9)$$

Then, after comparing 7, 8 and 9, it is concluded that

$$\Delta E = 0 \quad ; \quad \nu_a(r) = \nu_a(a) \quad (10)$$

This means that, within the experimental errors,

- The G field does not exchange energy with photons. This rules out the tired light hypothesis.
- The NL frequency of photons, with respect to a clock in a fixed G potential, remains constant during its trip through the ordinary gradients of G fields (NL frequency conservation of free photons).
- The presumed energy exchange between the photons and the G field is not simultaneously consistent with the GTD and GRS experiments.

1. *Verification from ordinary properties of light*

According to ordinary experiments, a gradient of the refraction index does not change the frequency or color of the radiation, i.e., photons do not exchange energy with the dielectric. According to equation 6, light is deviated in a G field according to normal refraction laws. Consequently, “*photons do not exchange energy with static G fields*”.

2. *Verification from wave properties of light*

From current experiments made up with of single photons it is inferred that even *single photons have wave properties*. Then *each photon* must be the result of constructive interference of a large number of “*wavelets*”. Thence the “*wave-continuity*” of a light beam must be a direct consequence of the “*wavelet continuity*”. According to such “*continuity*”, a change of the NL refraction index of the space would not change the net number of waves of a wavelet-train. It would produce just a change of its NL wavelength *without a net change of its NL frequency*. It is important to observe that the different observers along the trajectory of a wave train should observe *the same number of waves*. However they would observe different rates because their clocks run with different frequencies.

This may be even more clear if pulses of light and *bullets* are sent after well defined number of waves of electromagnetic radiation. Since the number of pulses or bullets cannot change, regardless of the current work (tired light) hypothesis, then single alternative for explaining the different number of bullets per second detected by observers located in different potentials is that their clocks run with different rates.

Then it is concluded, either from experiments or from general properties of radiation, that:

- *Photons do not exchange energy with strictly static G fields*⁴ (The no exchange law for G fields.)
- *The differences of frequencies observed in the GRS experiments are due to differences of the eigen-frequencies of the atoms and clocks located in different G potentials. The G redshift phenomenon has occurred in the bodies, “before” the emission of light. It does not occur during the light trip.*

B. Does a G field exchange energy with the bodies?

Let us find, after using strictly homogeneous relationships, whether or not such hypothesis can be “simultaneously” consistent with the Equivalence Principle and with the gravitational experiments.

A direct answer comes from the 2nd and the last member of Eq. 4, from which $dE_a = dm_a(0, r)$. Thus the energy used up to raise the body is not stored in the field but in the body, as an extra mass-energy. The same result can be derived from other ways, as follows:

⁴Curiously, the NL frequency conservation law can be demonstrated with the aid of the results of GRS experiments, which are often interpreted in the opposite sense.

1. *The no exchange law for bodies derived from free fall experiments*

Assume that an observer A is located at rest in a fixed radius a_a of a central field. He observes, locally, the free fall of a test body which was initially at rest at B in some NL radius $r_a = a_a + h_a$.

For a real mass-energy balance during the free fall, the initial and final values of the NL rest masses, both referred the unit system of the observer A , must be known with high exactitude.

Strictly, the observer at A does not know the exact initial (NL) rest mass of the body at B , compared with its final rest mass at A . However he can find it either from GTD experiments done before the free fall, i.e., after using the transformations given in equation 6. According to it, the initial (NL) mass of the test body at B , with respect to the observer A , is:

$$m_a(0, r) = m_a(0, a) \left[1 + \frac{GM_a h_a}{r_a r_a} \right] \quad (11)$$

On the other hand, according to special relativity and the current results of free fall experiments, the final (local) mass of the body at A , just “before the stop”, is:

$$m_a(V, a) = \gamma m_a(0, a) = m_a(0, a) \left[1 + \frac{GM_a h_a}{r_a r_a} \right] \quad (12)$$

Notice that this is a strictly local (legal) relationship. Then, from 11 and 12, the single strictly homogeneous relationship between the initial and final mass-energies during the free fall is:

$$m_a(0, r) = m_a(V, a) \quad (13)$$

On the other hand, the net energy released during the stop is:

$$\begin{aligned} \Delta E_a &= m_a(V, a) - m_a(0, a) = m_a(0, r) - m_a(0, a) \\ &\cong \frac{GM_a m_a(0, a)}{r_a^2} h_a \end{aligned} \quad (14)$$

From equations 13 and 14 it may be concluded that

- *During a free fall, the mass-energy of a body, with respect to some well-defined observer, remains constant (NL mass-energy conservation during a free fall.).*
- *The net energy released from G work comes not from the G field. It is just a small fraction of the rest mass-energy of the test body, which is liberated during the G work.*
- *There is not a true exchange of energy between the field and the test body (The no energy-exchange law for G fields.).*

2. *The no energy-exchange law derived from gedanken-experiments*

Experiment 1. Matter and anti-matter annihilation occurring during a free fall.

Assume an observer at rest far away from a neutron star and an electron pair falling vertically into a neutron star. Statistically the annihilation may occur in any radius. Assume, for simplicity, that the pair decays into two gamma photons travelling in symmetrical trajectories with respect to the annihilation radius, so that the two photons have the same energy with respect to the observer.

According to global mass-energy conservation made up by the observer at infinity, *the net energy going far away from the system cannot depend on the specific radius in which annihilation occurs.* Then the “NL annihilation”, occurring during the fall must produce the same net energy with respect to the observer, regardless on the radius in which it has occurred.

$$m_{\infty}(V, r) = 2h\nu_{\infty}(r) = 2h\nu_{\infty}(\infty) = m_{\infty}(0, \infty) \quad (15)$$

The NL annihilation, stated in 1st and 2nd member of equation 15, must be equal to the local one occurring far away from the system, stated in the 3rd and 4th member. The conservation of the NL frequency of the photons travelling between r_{∞} and ∞ is obvious

from the 2nd and 3rd members, and the one for the NL mass of the particles is obvious from the first and last members.

Then it may be concluded that *during the free fall of the particle-pair its NL mass-energy remains constant. The same holds for the NL energy of the photons.*

Experiment 2. Radioactive decay occurring during a free-fall.

A similar gedanken-experiment can be done by assuming the free fall of a radioactive atom that may decay producing a gamma photon in any arbitrary radius of a central field.

According to the EP, *the energy of a photon is a constant fraction of the mass of an atom.* This fraction is independent on the radial position in which the atom decays. Thus, for an observer at ∞ , this fraction should be the same both for the local position (∞) and for any other NL position (r_∞) during the fall. This means that:

$$\frac{\Delta E}{m} = \frac{h\nu_\infty(\infty)}{m_\infty(0.\infty)} = \frac{h\nu_\infty(r)}{m_\infty(V.r)} = Constant \quad (16)$$

According to NL frequency conservation, given in 10, the numerators of the equation 16 must be the same. Consequently, the denominators of such equation must also be the same values. This means that *“during the free fall of the atom, its NL (relativistic) mass-energy with respect to some well-defined the observer, is conserved”.*

6. THEORETICAL DISCUSSION OF THE EXPERIMENTAL RESULTS

To understand the nature of the G phenomena we must understand first the nature of matter. Some help can be found, directly from the NL EP.

A. Help from the minimum well-defined “part” of a system.

According to the NL form of the EP, found above from all of the experimental facts, *all of the well-defined parts of a local system must obey the same inertial and gravitational laws.* Then the same should hold for “the minimum well-defined part of a local system”. Thus the general properties of uncharged particles can be understood in terms of the minimum well-

defined part of a system, which is “*a single quantum of radiation in stationary state*”. This quantum may be confined between any other well-defined parts of a systems, like a wave cavity. The last one fixes well-defined values of the wavelength, frequency and mass-energy of the quantum in stationary state⁵.

Then it may be concluded that, according to the EP, *the general properties of uncharged particles and their fields can be derived from the general properties of particle models made up of a photon in stationary states.*

Notice that, the net number of parameters of the particle model at rest with respect to the observer is minimum⁶. For a model in a potential different from the observer’s one, they are its NL frequency with respect to the observer A , called $\nu_a(0, r)$, and its NL wavelength, $\lambda_a(0, r)$. The product of such variables fixes the value of the NL speed of light, according to equation 1, or vice versa. Its NL mass-energy with respect to the observer A is, by definition, the energy confined in it:

$$m_a(0, r) = h\nu_a(0, r) \tag{17}$$

Thus the mathematics involved in this approach turns out to be extremely simple⁷.

⁵This kind of “particle model” can also be found after consecutive simplification of the Michelson-Morely experiments and of Kennedy’s ones¹¹ made up with arms of different lengths. From the negative results of both kinds of experiments it may be inferred that the number of wavelengths on each arm must remain unchanged after changes of velocity and G potential. Thus the length of the rod and the wavelengths of the radiation must change in the same proportion after identical circumstances.

⁶For the present purposes, the values of spins or other internal details of the model can be ignored.

⁷In previous works^{4-6,12-15}, it has been found that the particle model provides a direct way to account for the transformations given by equation 6. It has also been used to find self-consistent explanations for basic relations in special relativity, quantum mechanics and gravitation. Thus the

Consequently, *the particle model can be used to find more fundamental reasons for the above results.*

For example, it may be easily verified that *such particle model cannot change of velocity unless that a gradient of the NL refraction index exists in the space, i.e., without the G field gradient shown in Eq. (4).*

B. Why G fields do not exchange energy with the particles?

The physical reasons for the above results can be understood from several different viewpoints.

a) Explanation according to the nature of the particle model

According to Eq. (6) the main phenomenon producing the G acceleration is just “*refraction*”. For a transversal model, for example, the increase of momentum comes from the net deviation of the trajectories of light occurring during a round trip of the wave propagation inside it. It is well a well-proved fact that the phenomenon of refraction “*does not change the frequency of the photons*”, i.e., it does not exchange energy with the dielectrics.

Then the particle model does not exchange energy with the field because it is made up of photons that do not exchange energy with strictly conservative fields.

A more detailed explanation on the mechanism of acceleration of the particle model in a static G field is given in the references^{5,6}

b) Explanations according to the nature of the G field.

The G field of a particle model can only depend on long-range properties of a single photon in stationary state.

consistency of the properties of the particle model and those of any other uncharged particle seem to be fairly well tested.

Such properties can be learned from the results of optical experiments made up with single photons. From them it is simple to conclude that:

- The wave properties of a single photon should come from the wave properties of more elemental kinds of “*wavelets*”. They must be interfering constructively in the photon and destructively far away from it.
- The wavelets are not destroyed during destructive interference with other wavelets. Thus, in other places, they interfere with other wavelets independently on their previous interference’s with other wavelets⁸.
- A photon in stationary state between dielectric mirrors must be the result of interference of wavelets travelling in opposite directions. They must interfere constructively only within its reflection zones⁹. Outside of such zones, they must interfere destructively.
- The wavelets going away from a particle model must propagate themselves rather indefinitely the space with random phases.
- The NL properties of G field can only depend on the gradient of the NL perturbation rate of the space produced by “*wavelets with random phases*” that are actually crossing it.
- “*The G field has no energy*” because the net amplitude of wavelets with random phases is zero”. Thus, statistically, the probability for the existence of energy in such space must be zero.

⁸The wavelets associated to single photons have also been used, in the works cited above describe other physical properties of uncharged particles.

⁹In optics, the existence of such reflection zone, outside of the dielectric, is obvious from the experiments on “frustrated reflections”

C. Where the current errors may come from?

When Einstein conceived his theory on General Relativity he postulated a field equation by assuming, as a basic hypothesis, that “*the G field transfers energy and momentum to the matter in that it exerts forces upon it and give it give it energy*”¹. To support such hypothesis, he used arguments based on the properties of electric fields. He ignored the fact that the geometrical and physical properties of electric fields are radically different to the G ones.

Notice that in the above statement, due to the lack of more convincing arguments, Einstein tacitly postulated twice the same hypothesis, in different words. Because to exert a force, or to give up momentum, it is not necessarily associated to an energy transference. He tacitly ignored the alternative of the self-propelled bodies that use up their own internal energies to accelerate themselves after the momentum given up by some static external force.

Such hypothesis of Einstein has also been supported by the classical-like hypothesis in that matter is absolutely invariable after a change of G potential with respect to the observer’s one”. According to such hypothesis the standard clocks of all the observers in different potentials are physically identical with respect to each other. For this reason, the position of the observer is not usually stated in the equations of the current literature.

However such hypothesis is not consistent with the GTD experiments that prove, as shown here, that some fundamental changes have occurred to the clocks after change of G potential. Then such experiments can be consistent with the EP only if all of the parts of a measuring system have ”changed” in just the same proportion after identical changes of potential. Only in this way every ratio within the measuring system can remain constant. Only in this way any local observer moving altogether with the system cannot detect such changes. In principle, only the observers that have not changed of potential can observe the real changes that have occurred to the bodies after a change of G potential. This accounts for the experiments on GTD and the other G tests.

The errors in current literature can be easily found when the position of the observer is

stated by a subscript. For example: assume that a body falls freely between the radii b_a and a_a . Assume that the final mass relativistic mass at a_a , before the stop, is called $m(V)_{final}$, and that the initial mass at b_a is called $m(0)_{initial}$. Then a current mass-energy balance for a “free fall” would have the form:

$$m(V)_{final} = m(0)_{initial} + \Delta E \quad (18)$$

This form of equation makes believe in that ΔE is some energy that the field gives up to the body. This one may look perfect, but the lack of homogeneity of this equation stands out when the positions of the initial object and the observer are explicitly stated according to the above conventions:

$$m_a(V, a)_{final} = m_b(0, b)_{initial} + \Delta E_a \quad (19)$$

The different subscripts of the different terms of this equation put on evidence that this equation is an inhomogeneous mixture of quantities measured by observers in different G potentials. Then *this equation has not well-defined physical meaning because the reference standards of the observers at b and at a are physically different with respect to each other.*

It may be argued that in equation 19 the value of $m_b(0, b)_{initial}$ can be replaced by $m_a(0, a)_{after\ stop}$ because they have the same numerical values. Effectively, such replacement gives:

$$m_a(V, a)_{final} = m_a(0, a)_{after\ stop} + \Delta E \quad (20)$$

But now this relation has a radically different meaning. It is just a mass-energy balance occurring “during the local-stop period”, which *is independent on where the free fall energy comes from.* Then it is not possible to find, from just Eq. 20, where the G energy comes from.

7. CONCLUSIONS

From the EP and the positive results of the GTD experiments it is concluded that:

- Some absolute changes do occur to every well-defined part of any local system after a common change of G potential. Such changes cannot be detected from local measurements because the changes of frequencies, masses and lengths of each part of any local system, occur in just the same proportion. *Such changes can only be detected, and described, by observers that have not changed in the same way as the objects.*
- The reference standards of observers located in different G potentials are physically different with respect to each other, regardless of the identical numbers normally assigned to them. Thus most of the current relations between quantities measured in different potentials are inhomogeneous and meaningless.
- The single way for a complete description of all of the changes that have occurred to the NL objects, after a change of G potential, is after using some well-defined (flat) reference frame that has not changed in the same way as the objects.
- To relate quantities measured in different G potentials they must be previously transformed to some common Lorenz frame in some fixed and well-defined G potential.
- In principle, and in fact, the G transformations derived from the EP and GTD experiments are simultaneously consistent with the results of all of the local and NL experiments used for testing gravitational theories. According to them:
 1. The G field is a space with a gradient of the NL speed of light.
 2. The basic NL parameters of the bodies at rest in different positions of a static G field are well-defined functions of their NL positions in the field. They are proportional to the square root of the NL speed of light.
 3. *During a free fall in a static field, the NL mass-energy of a body, with respect to any well-defined observer in a fixed potential, remains constant (NL mass-energy conservation during a free fall.).*
 4. *A static G field does not exchange energy either with radiation or with the test bodies.*

5. *It is the body, not the field, the one that puts on the energy for the G work.*

The G energy is a fraction of the mass-energy of the particles which is released by the effect of the lower NL speed of light that exists in lower G potentials. In different words, gravity is more related to matter annihilation than to the energy given up by some external force.

These conclusions are in clear discrepancy with the Einstein hypothesis on the energy exchange between the G field and the bodies.

The above results have also been explained from a non-conventional approach based on a more general form of the EP. According to it, *all of the well-defined parts of a local system must obey the same general physical laws. Thus any quantum of radiation in stationary state must have the same inertial and gravitational properties as ordinary matter.*

Consequently, the general properties of matter can also be derived from the theoretical properties of a particle model made up of radiation in stationary state. Thus the acceleration of gravity comes from a refraction phenomenon that does not change the average frequency of the photons. This accounts, globally, for the no-exchange law derived from the experiments.

According to the nature of particle model, its G field turns out to be the result of interference of wavelets with “random phases”. Then *the long-range G field itself has no energy because the net wave amplitude is zero.* Thus the probability for the existence of energy in a G field is also zero.

Then the experimental facts *rule out the possibility of existence of some appreciable G field energy that can be exchanged with the bodies or particles*’. This would question the possibility for the existence of gravitons of properties similar to those of photons. However, the most exact experiments are not exact enough to discard the possibility for the existence of some much weaker kind of energy exchange between photons, or bodies, and G fields.

The above errors have prevailed for about a century because they are tacitly supported by the classical-like hypothesis in that matter does not change after a change of G potential with respect to an observer. Then most people do not realize that the relations between quantities

referred to standards located in different potentials, are inhomogeneous and without well-defined physical meaning. In the current literature such inhomogeneity errors are not obvious because most of the times the positions of the reference standards are not explicitly stated in each quantity.

Due to the lack of energy of the G field, new kind of black hole and new universe must have some radical differences with the conventional ones^{4-6,12,13,15}.

. More details are given in <http://sites.netscape.net/rafaelveram/index.htm> and <http://educar.org/cecc/rvera/fotonu.00.htm>.

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