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FUNDAMENTAL PROBLEMS IN GRAVITATION AND COSMOLOGY FIXED FROM EXPERIMENTAL FACTS

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Starting all over from just experimental facts and the equivalence principle, it is found that all of the particles and standing waves of a system do change, linearly, in identical proportion, after a position change of the system with respect to other bodies. To detect and describe such changes, the observer must use a Lorenz frame that does not change of position or velocity. New linear relationships are derived either from experiments or from theoretical properties of a particle model consistent with them. The new scenario is different from the conventional one. The gravitational energy comes not from the field. It comes from bodies. The "linear" black holes, after absorbing radiation, explode generating hydrogen. A universe expansion would produce an increase of G potential that expands particles in identical proportion. Relative distances cannot increase with time. The universe age is infinite. Celestial bodies must evolve in cycles between luminous and dark states. Most of the universe mass must be as dark galaxies, absorbing energy. They should account for the missing mass in the intergalactic space and the radiation coming from it, including cosmic and low temperature radiation. The average mass-energy and entropy would not change with time.

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1. A Classical Problem in Actual Physics

The Einstein's theory on general relativity (GR) is based on direct relations of quantities measured by observers at rest in different positions of a gravitational (G) field. This is equivalent to use a classical hypothesis after which the relative properties of the atoms and standard bodies are invariable after a change of rest position with respect to the observer or to other bodies. It is simple to verify that the Einstein's hypothesis on the G field energy is a direct consequence of the classical one.

However the classical hypothesis is clearly inconsistent the "positive" results of G time dilation (GTD) experiments made up with clocks^{1, 2}. According to them, in static conditions, the relative frequency of some "non local" (NL) clock B , compared

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with the frequency of a "local clock" A , depends on the relative distances r and a , of the clocks B and A , respectively, with respect to the earth center. Thus such clocks are not identical with respect to the other one some fundamental physical differences exist between standard clocks (bodies) located in different G potentials. This means that, the reference standards of observers located in different distances from the earth are not strictly the same with respect to each other, respectively. Consequently the current comparisons of quantities measured by them are not homogeneous, without a well-defined physical meaning. Thus the classical hypothesis should have been a source of fundamental errors in physics.

Thus, to fairly describe NL phenomena in G fields, after strictly homogeneous relationships, a formalism that depends on positions and velocities with respect to the field sources must be used. The quantities must be corrected (transformed) to a common reference standard that does not change of position and velocity.

1.1. Discussion

This classical error has remained untested for long time due to the fact that the current G tests have been traditionally interpreted according to the same formalism used in GR. Consequently, such traditional "interpretations" are also contaminated with the same kind of classical error.

Since the GTD experiments made up with clocks cannot be easily interpreted according to GR, what it is often done is to arbitrarily substitute them by G red shift (GRS) experiments made up with photons. The last ones, in turn, have been traditionally interpreted according to GR.

For example some referee has said that, "the results of GTD experiments have been "negative" because, (according to GR), "photons must do some work in moving around and their frequency changes"

This kind of argument is wrong for several reasons:

A) It is just a gravitational hypothesis that must be fairly tested, first, for the classical hypothesis. Therefore, regardless of its common acceptance, it cannot be legally used to change the results of GTD experiments, from "positive" to "negative", just to fit with some theory.

B) The results of the true GTD experiments have been clearly "positive". Thus the presumed explanations are necessarily wrong.

C) A GTD experiment made up with clocks cannot be arbitrarily replaced by GRS experiments with photons because the results of the first ones don't depend on the frequency of any photon travelling between the clocks^a.

^aThis fact is obvious in the Hafele-Keating experiments¹ in which the readings of the two clocks were directly compared to each other, before and after the experiments, at the earth surface. The differences of readings, after correction for velocity differences, were certainly positive. They did not depend on the frequency of any photon travelling between the clocks. The same holds for experiments using electromagnetic signals². They measured "time intervals" that are independent on the photon's frequency. This would be more obvious in experiments with long time intervals

Then the presumed frequency shifts of the photons have nothing to do with the results of the GTD experiments.

D) From the common frequency shift (Z) observed in the GTD and G Redshift experiments it is inferred that during the photon's trip, its relative frequency, with respect to the observer A , is constant. Its "initial value" at B , found from GTD experiments is identical to the "final value" at A , found from GRS experiments.

E) From wave continuity of electromagnetic waves, the number of waves of a wave train is conserved during its trip throughout static conservative fields. Consequently, the theoretical number of waves that cross any static plane between B and A , in unity time interval of a clock of constant frequency, must be the same. In other terms, the relative frequency of a photon, with respect to any observer in a well-defined position of the field, must remain constant^{3, 4}.

Either from G experiments or from wave properties of radiation it is concluded the above argument is wrong. The relative frequency of a photon, with respect to a well-defined observer, is conserved during its trip in a G field (Relative frequency conservation with respect to a strictly invariable observer). Then the GRS is not due to a real frequency change occurring during the photon's trip. It is a consequence of GTD, i.e., to relative differences of the eigen-frequencies of bodies at rest in different G potentials^{3, 4}.

Thus, to fairly describe the phenomena occurring in different positions of a G field, some strictly invariable observer, that does not change of velocity and position with respect to the G field sources is required. This is a kind of "strictly invariable" (SI) observer whose clock rate does not change with the time. His local Lorenz reference frame can be extended for non-local cases, i.e., for bodies in different G potentials, previous corrections for the differences of positions and velocity of the NL bodies with respect to the G field sources. This turns out to be a plain extension of special relativity for the non-local cases in which the objects may be anywhere.

Here, to use the minimum number of variables, the observer A is at rest in a fixed distance from the center of a static (non rotating) central mass M . For simplicity, its position is stated by a subscript. For example, if a NL clock B travels with the velocity V with respect to the observer A , the symbol for its relative frequency with respect to the observer A is: $\nu_a(V, r)$.

To get strictly homogeneous relationships between quantities measured by observers at rest in different positions of a central field, all of the quantities must be transformed to some common reference clock located at some well-defined (invariable) distance (a) from the field source.

2. A more general form of the equivalence principle

From the Equivalence Principle⁵ (EP) it is inferred that all of them: the frequencies (ν), the masses-energies (m) and the lengths (λ), of any well-defined part of a

and just two signals marking the initial and the final reading of the clock B .

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measuring system, are related to each other by constants (k, k^0). Such constants don't change after any simultaneous change of position (r) of the bodies and of the observer (a) with respect to other bodies. This means that, in static conditions ($V = 0$),

$$\text{Lim}_{r=a} \nu_a(0, r) = k \text{Lim}_{r=a} m_a(0, r) = k^0 \text{Lim}_{r=a} \lambda_a(0, r). \quad (1)$$

After a small change of r , from partial derivative of (1) and GTD experiments,

$$\frac{d\nu_a(0, r)}{\nu_a(0, a)} = \frac{dm_a(0, r)}{m_a(0, a)} = \frac{d\lambda_a(0, r)}{\lambda_a(0, a)} = d\phi(r) \neq 0. \quad (2)$$

The relative values of all of them, the frequencies, the mass-energies and the lengths, of any well-defined part of the non local (NL) system (B), change in just the same proportion, compared with the ones of the local clock (A).

This NL form of the EP is more general because it is valid for NL cases in which bodies are in a G potential different from the observer's one. Notice that any photon in stationary state (standing wave) within any parts (or mirrors) of such system is also a well-defined part of it. Then it must have the same inertial and gravitational properties as any other particle of the system. If this were not so, the Michelson-Morley experiment would give positive results thus violating the EP. Then, for inertial and gravitational purposes, particle models made up of photons in stationary state can emulate uncharged particles and clocks.

In previous works ^{4, 7}, this particle model was called "light-box" model. In them it is proved that the theoretical properties of the model and its G field are consistent with special relativity, quantum mechanics and with all of the G tests.

Let $\nu_a(0, r)$ and $\lambda_a(0, r)$ be the relative frequency and wavelength of a particle model at rest at B with respect to the observer A . Let its relative mass-energy be $m_a(0, r) = h\nu_a(0, r)$. Thus the relative speed of light at B with respect to the observer A is:

$$c_a(r) = \nu_a(0, r) \cdot \lambda_a(0, r). \quad (3)$$

Thus, for any particle model at rest at B , from (2) and (3),

$$d\phi(r) = \frac{d\nu_a(0, r)}{\nu_a(0, a)} = \frac{dm_a(0, r)}{m_a(0, a)} = \frac{d\lambda_a(0, r)}{\lambda_a(0, a)} = \frac{1}{2} \frac{\Phi c_a(r)}{c_a(a)}. \quad (4)$$

Eq. (4) gives proportional changes of the relative properties of the NL bodies and of the NL space after a change of distance of just the clock with respect to the field source.

2.1. Gravitational transformations from experiments

For example, assume that the observer A throws upward a clock with some energy $\Phi E_a(r)$. Such clock would stop at some radius $r = a + \Phi r$ that can be derived from general results of free fall experiments, according to the three first members of (5)^b

^bHere the common unit of mass and energy is 1 joule.

Now, with the clock B in its new rest position, the observer A can make a GTD experiment whose result is given by the 3rd and 4th member of (5). The relation between the 4th member and the last members are fixed by the NL EP, i.e., by (4)

$$\Phi\phi(r) = \frac{\Phi E_a(r)}{m_a(0, a)} = \frac{GM}{a} \frac{\Phi r}{a} = \frac{\Phi \nu_a(0, r)}{\nu_a(0, a)} = \frac{\Phi m_a(0, r)}{m_a(0, a)} = \frac{\Phi \lambda_a(0, r)}{\lambda_a(0, a)} = \frac{\Phi c_a(r)}{2c_a(a)}. \quad (5)$$

This equation is identical to the one derived theoretically from a particle model made up of photons in stationary state³. In such occasion it was proved that (5) accounts for all of the conventional G tests.

2.1.1. Discussion

The description of the phenomena done by the non-classical observer A are Radically different from the ones of the classical observer that moves altogether with the objects.

For the non-classical observer A , when a body is raised from A to B , there is a change of the G potential of the body with respect to the observer A . This one is associated to several real changes that have occurred to the body and to the space, compared with the ones that existed in A previous such change.

In the space, there is an increase of the NL speed of light at B with respect to the observer A . This one accounts for the phenomena of G refraction and time delay of electromagnetic radiation travelling close to the sun.

In the body, there is an increase of the NL frequencies and lengths of all of its parts and of any standing wave that may exist between them. The last effect may be called G expansion of matter.

Observe that both the EP and the GTD experiments do not depend on the nature of the local forces between and within atoms. Therefore such forces do not prevent the G expansion of the bodies after an increase of G potential with respect to the observer.

The classical observer B , whose standards change in the same proportion as the bodies, cannot detect such G expansion. This fact makes him believe that the bodies are absolutely invariable. Only for them, the local forces and the local units defined in terms of them are invariable. Consequently such units, according to the EP and the GTD experiments, are only well defined in regions of constant G potentials. They are like the coin defined within the space of each country. They cannot be used in other country unless some exchange rate is previously established. The classical error is to pretend to use such units, defined locally, in other regions with different G potentials.

2.2. Inconsistency of the gravitational field energy

From the 2nd and 5th member of Eq. (5),

$$m_a(0, r) = m_a(0, a) + \Phi E_a(r). \quad (6)$$

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Then “all of the energy $\Phi E_A(r)$ given up to the clock remains in the clock as an extra mass of the same clock”. No energy at all is given up to the G ...eld. Vice versa, during a free fall from B , the “initial” rest mass-energy of the clock at B , with respect to A , is $m_a(0, r)$. From local relativity, and Eq. (6), the local mass-energy of the clock arriving at A , is:

$$m_a(V, r) = m_a(0, a) + \Phi E_a(r) = m_a(0, r). \quad (7)$$

Thus the initial and the ...nal mass-energy of the body, with respect to the observer A , is the same. This means that during the free fall in a G ...eld, the relative mass-energy of the body, with respect to an observer in a ...xed position of the ...eld, remains constant (Conservation of the relative mass-energy of bodies).

From (5) and (6), bodies do not exchange energy with the G ...eld. From the points D) and E), above, the same holds for photons, because they don't change of frequency. Then, in general, the relative mass-energy of bodies and photons, with respect some strictly invariable observer, are constant. During the trips they do not exchange energy with the ...eld. They can only exchange momentum.

More exact and general properties of bodies and G ...elds were derived before from particle models.^{3,4}

2.2.1. The new kind of linear black hole

The strict linearity of the ...eld equation ...xed by the EP also ...xes more exact properties of the new kind of linear black hole (LBH). This one would be just a neutron star in which the ordinary physical laws are valid. From (5) it has been proved that the high gradient of the NL refraction index around the neutron star would prevent the escape of photons and neutrons⁴. Thus a LBH would absorb all kind of radiation and emits almost nothing. The average NL mass-energy of its neutrons must increase with the time. According to nuclear physics, when the average mass of the nucleons becomes equal or higher than the one in free state, the LBH can explode. The adiabatic explosion would generate a rather spherical cloud of neutrons decaying into clean H.

3. The new universe ...xed by general experimental facts

From the NL EP, the theoretical properties of particles and their G ...elds can be derived from general properties of photons. This has been done before, step after step, in previous works^{3,6,7}. Here a short cut is given as follows:

When particle models emulate all of the uncharged particles of the universe it is found that their positions are ...xed by constructive interference of wavelets. Since the wavelets are not destroyed after that, then the properties of the empty space can depend only on the net perturbation frequency produced by all of the wavelets with “random phases” crossing it. (This accounts for the lack of real energy of the vacuum). Each contribution must be proportional to the product of its frequency and of its amplitude.

After taking into account the Hubble red shifts, after which $\Phi\nu/\nu$ is proportional to Φr , the net perturbation frequency of the space, in some position r^i , turns out to be proportional to:

$$w(r^i) \propto \prod_{j=1}^3 \frac{\nu^j}{r^{ij}} \exp \left(i \frac{r^{ij}}{R} \right) = \prod_{j=1}^3 \frac{m^j}{r^{ij}} \exp \left(i \frac{r^{ij}}{R} \right) \cong 4\pi\rho R^2. \quad (8)$$

The average density of the universe, in joules/m³, is ρ . The Hubble radius is R . The best fit between (5) and (8) occurs when particles are in equilibrium with the rest of the universe so that $w_a(r)\nu_a(r) = \text{Constant}$. So that:

$$\Phi\phi(r) = \frac{\Phi\nu(r)}{\nu(r)} = i \frac{\Phi w(r)}{w(r)} = G \prod_{j=1}^3 \frac{m^j}{r^{ij}} \exp \left(i \frac{r^{ij}}{R} \right). \quad (9)$$

In which

$$G = \frac{1}{w(r^i)} \frac{1}{4\pi\rho R^2}. \quad (10)$$

From (10), the universe density is about 30 times the average density of luminous matter of the universe. This is consistent with proportion of dark matter estimated in some clusters.

3.1. Matter Expansion versus Universe Expansion

In the current models of universe expansion, it is normally assumed that the standard rods do not expand in the same proportion as the other parts of the universe. Let us test this hypothesis by assuming that that such standard rod can exist. In such case we could say that that the distances between generic galaxies i and k increase a common proportion, compared with the standard rod.

$$\frac{dr^{ik}}{r^{ik}} = \frac{dR}{R} = Hdt. \quad (11)$$

From (8), (9) and (11), the general increase of G potential would be:

$$d\phi(r^i) = i \frac{dw(r^i)}{w(r^i)} = \frac{1}{w(r^i)} \prod_{j=1}^3 \frac{m^j}{r^{ij}} \exp \left(i \frac{r^{ij}}{R} \right) \frac{dr^{ik}}{r^{ik}} = \frac{1}{w(r^i)} w(r^i) \frac{dR}{R} = Hdt. \quad (12)$$

From (5) and (12), the G expansion of any standard rod would be given by:

$$\frac{d\lambda}{\lambda} = Hdt. \quad (13)$$

From this equation it is concluded that, during universe expansion, every particle would expand in the same proportion as the other parts of the universe. This means that there is not a single standard rod in the universe that does not expand in just the same proportion as any other distance of the universe. Then the relative proportions of the universe, with respect to real standard rods, cannot change with the time.

In other terms only an absolutely homogeneous expansion of the universe can exist, but this one would not produce any local change with the time. Paradoxically, such expansion cannot possibly be detected from local measurements, i.e., by observers expanding in the same way as everything else. This is because such expansion cannot change all of them: the relative distances, the relative velocities and the cosmological red shifts.

Notice that the above results come from just experiments whose results are entirely independent on the local forces or other interactions in matter. Thus the last ones are not excuses for invalidating the equations (5) and (13), and the conclusions derived from them.

3.2. The new cosmological scenario^c

From (13), the universe age must be infinite. Then the actual state of the universe can only be the result of evolution cycles that conserve the entropy. Thus matter must be evolving, indefinitely, in closed between states of gas and LBH, and vice versa. The LBH explosions must provide the new H gas that would be captured by older bodies thus regenerating new luminous star clusters and galaxies. Then the galaxies must also be running, indefinitely, in pseudo closed cycles between luminous and black states, and vice versa.

When a luminous galaxy runs out of plasmas, it must end as a more compact and stable black galaxy (BG) made up of a set of non-luminous bodies such as LBH, neutron stars, dead stars, planets and planetesimals.

For a period of order of magnitude higher than the presumed age of the universe, a LBH should absorb radiation until it can explode thus generating a rather spherical shell of gas with the highest proportions of H and randomly oriented angular momentum. Old bodies like dead stars, planets would capture such gas relatively fast thus becoming new stars. They would form a somewhat elliptical galaxy. After cancellation of most of the randomly oriented angular momentum, and running away of available energies, most of their stars would become dark ones.

The last luminosity of a galaxy would occur in a small region in its center. This one is consistent with the properties of the kind of radio-noisy quasar of high (G) red shift and relatively variable luminosity. Statistically, all of the evolution stages of the galaxies must be present in the sky in the proportion mixed by their corresponding evolution periods.

Since the energy-recovering period of a black galaxy must be of a higher order of magnitude than its luminous period, then most of the galaxies must be in the black state. Their G fields should account for the high velocities of galaxies in clusters. Since their LBHs would absorb all kinds of radiation, they should have very low temperatures. Thus the blackbody radiation emitted by them, red shifted after the Hubble law, must account for the low temperature microwave background (CMB)

^cA more detailed work is in <http://www.cecc.cl/vera/index.html>

of the universe. The eventual collisions between their components should account for gamma bursts and some cosmic radiation. The higher proportions of heavy elements in a BG should account for higher proportion of Fe spectrum lines of the radiation coming from the intergalactic space.

The evolution of H gas up to LBH state generates G energy of order of magnitude higher than that of nuclear fusion of H. Most of such energy should be released very close to neutron stars or LBHs. i.e., inside of some stars-like objects, either after periodical micro-collapses or by star explosions.

Notice that the G binding energy in a neutron star is higher than the nuclear binding energy of neutrons in the atomic nuclei. Thus the mechanism of neutron stripping should generate recycled protons or cosmic rays^{4,8}.

4. Conclusions

The classical hypothesis on the invariability of the bodies after a change of G potential has caused fundamental errors in physics. Such hypothesis is inconsistent either with the wave properties of radiation or with GTD experiments. What happens is that "the relative properties of all of the well-defined bodies and standing waves of the measuring systems do change, linearly, in just the same proportion with respect to the other bodies that have not changed of position. This fact normally makes believe in that nothing has changed, which is not strictly true.

Such errors have not been detected by the conventional G tests because the last ones have been normally interpreted according to the same classical hypothesis. Here, to correct such errors, the Lorenz transformations were generalized for NL cases in G field. Thus the product of the two transformations has been used to describe all of the relative changes that occur in bodies after velocity and positions in fields.

There is a chain of errors coming from the classical hypothesis. The most important one seems to be the presumed energy of the G field.

In cosmology, after fixing this error, it is inferred that only relatively small explosions can produce local effects because the space properties are mainly fixed by the long-range distribution of matter in the universe. Thus a global expansion of the universe cannot produce relative changes anywhere because the global increase of G potential should produce a G expansion of every particle, in just the same proportion, i.e., every ratio would remain invariable. Thus, in one way or another, the universe must look the same after the time. The average relative parameters of the universe should be conserved throughout the time.

Entropy conservation in the universe can occur thanks to the linear properties of the LBH. This one would absorb radiation that would increase the average energy of its neutrons, which decreases its average entropy, until they can escape, collectively, from the G field. Such gas, captured by older bodies, would form new stars. During star evolution the average entropy of its nucleons would increase until a new LBH is formed and so on.

The LBH explosions would account for almost clean H and the high density of angular momentum with random orientations that exist in some globular clusters and some elliptical galaxies. They are not old galaxies but clear testimonies that their gases come from relatively recent explosions of LBHs.

Galaxies should evolve in nearly closed cycles between luminous and black states. The explosions of their most massive LBHs should provide gas for really new stars. The last ones should be formed from condensation of gas, free of metals, over older bodies in cool states like planets and dead stars.

Most of the universe mass must be as black galaxies resulting from evolution of the luminous ones. They should account for the properties of the intergalactic space, including cosmic radiation and the CMB.

More exact relationships and a better understanding of the physical phenomena result by emulating particles by particle models made up of photons in stationary state. The universe turns out to be a sea of "wavelets" that are interfering constructively at the sites of particles and destructively between them. Thus wavelet continuity accounts for the homogeneous expansion of the universe And of its particles and for the lack of energy of the G ...elds.

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