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Full Length Research Paper

Wave-like interaction, occurring at superluminal speeds, or the same, de Broglie relationship, as imposed by the law of energy conservation: Gravitationally bound particles (Part II)

Tolga Yarman

Okan University, Akfirat, Istanbul, Turkey. E-mail: tyarman@gmail.com.

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Previously, merely based on the law of energy conservation, we have demonstrated that, the gravitational motion depicts a "rest mass variation", throughout. The same applies to a motion driven by electrical charges; this constituted the topic of the preceding article (Part I of this work). One way to conceive the rest mass variation phenomenon in question is to consider a "jet effect". Accordingly, an object moving with the velocity v_0 on a given orbit, must eject mass to accelerate, or must pile up mass, to decelerate, through its journey. The speed U to be associated with the jet (which we will in short call "jet speed"), strikingly points to the de Broglie wavelength. This makes that, the jet speed U becomes a superluminal speed, $U = c_0^2 \sqrt{1 - v_0^2/c_0^2} \big/ v_0$; c_0 is the speed of light in empty space. As seen, U is made of the product of the speed $V = c_0 \sqrt{1 - v_0^2/c_0^2}$, which is the luminal speed of the ejected rest mass, by the coefficient $\gamma = c_0/v_0$, the Lorentz coefficient coming into play based on the luminal speed V. The thing is that, the superluminal speed U eventually works as a whole and holds, even if there is no rest mass variation, such as the case of an object moving on a circular orbit; thus U appears to be an interactional velocity, yet based on no energy exchange. This result is important in many ways. Amongst other things, it means that, both gravitationally interacting macroscopic bodies, and electrically interacting microscopic objects, in fact any objects interacting with each other in any given way, such as for instance, an object plugged in a "centrifugal field" created by the rotation of another, sense each other, with a speed much greater than that of light, and in exactly the same way. We have to emphasize that, the interaction coming into play, excludes any energy exchange; for this reason, we would like to call it, "wave-like interaction". This implies that interactions without energy exchange can take place at speeds faster than light. Interestingly, the approach proposed here, constitutes not only the essence of quantum mechanics, but also, it induces immediately that both the "gravitational field" and the "electric field", in fact any field, such as a centrifugal field, are quantized in exactly the same manner.

Key words: Special theory of relativity, electric interaction, tachyons, superluminal or wave-like interaction, general theory of relativity, gravitation, centrifugal field.

INTRODUCTION

In the first part of this work, along our approach, we have elaborated on the motion of two electric charges vis-à-vis each other. More specifically, we have considered the closed system of an electron rotating around a proton (Yarman, 2010 b). Assuming that the proton is much more massive than the electron, it remains untouched as the two unite to form the hydrogen atom. Hence, the electron's internal dynamics weakens (besides the slowing down of it that will come into play due to the electron's motion around the nucleus), as much as the static binding energy coming into play. The bound electron should then weigh less than the free electron, and the difference should be as much as the static binding energy of concern, already before the electron is further brought to its orbital motion. Recall that this consideration led us to a "new equation of motion", followed by a “new relativistic quantum mechanical” set up (Yarman and Rozanov, 2006 a, b). Note that our approach is in full compatibility with all existing quantum electro dynamical data (Kholmetskii et al., 2010).

The weakening of the internal energy of the electron would be hard to check; nonetheless one can well verify that the bound muon decay rate retards, as compared to the free muon decay rate, and this (besides the usual relativistic retardation, due to motion, further), as much as the static binding energy coming into play (Lederman and Weinrich, 1956; Barrett et al., 1959; Glinsky and Mathews, 1960; Yovanovitch, 1960; Huff, 1961; Herzog and Adler, 1980). Our prediction about this occurrence, in effect, remains better than any other available predictions (Yarman, 2001, 2005, Yarman et al, 2011).

In Part I, based on the framework we have set up regarding the electric interaction, we derived the de Broglie relationship, through essentially the law of energy conservation. The tools we used on the way, points to the striking result that, the electric interaction can take place with speeds much higher than the speed of light (without however any exchange of energy, between interacting charges). For static charges, the interaction seems to be spontaneous.

In this paper, which will be Part II, we study the gravitational interactions within the framework we developed in Part I.

In fact, our approach was initially developed to describe the gravitational motion, more specifically, to describe the end results to the General Theory of Relativity (GTR) (Yarman, 2004, 2006b, 2010a). This allowed us not only to derive the de Broglie relationship, vis-à-vis the electric interaction, taking place within the frame of an atom, but as unusual as this may be, also allowed us to derive the de Broglie relationship already within the frame of the gravitational interaction.

In a way though, this outcome should be considered quite natural, owing to the exact similarity between Coulomb’s law (written for electric charges), and Newton’s law (written for masses); then again, recall that, we consider these fundamental laws for static objects, exclusively.

Physics community has long been seeking for a whole complete package of conception for the unique nature existing out there, whether it is question of micro aspects, or macro aspects; amazingly our approach seems to provide a framework for this search, as it appears to restore the broken or non-existing links, or annoying incompatibilities, between different disciplines of atomic physics, quantum mechanics, relativity, and celestial mechanics.

Thus, our approach seems to reinstate the broken link between the end results of the GTR, and Newton Mechanics. Though, it indicates that Newton’s law of gravitational attraction is valid for static masses strictly, just like the Coulomb’s law is only valid for static charges. In other terms, the gravitational mass entering Newton’s law of gravitational attraction, is not the inertial mass, entering the Newton’s description of force, more precisely, (force) = (inertial mass) x (acceleration), that is, the Newton’s second law of motion. These two masses turn out to be different (Yarman, 2006 a, b); it is that

(Gravitational Mass) = (Inertial Mass) / (Lorentz Dilation Factor)^2.

This result is evidently, against the phrasing of the principle of equivalence (PE) of Einstein (which states that the two masses of concern should be equal). Before we present our stand point, we feel the need of elaborating a little, on this latter point.

Thus, in this paper, we discuss further, the novelty of our approach in comparison with the existing main theory, and summarize our previous work, (Yarman, 2010b).

A SHORT DISCUSSION ABOUT WHY WE ABANDON THE CLASSICAL APPROACH

At this stage it is inevitable to present a discussion shedding light on why we abandon the classical gravitational approach, that is, the GTR, given that we introduce a totally new approach, though well yielding the end results of the GTR, and bridging, excitingly, the micro and the macro worlds.

Experiment achieved at the general physics institute in Moscow, supporting the decrease of the gravitational mass with velocity

At any rate, the above relationship suggests that a moving particle in a gravitational field would weigh less than the same particle at rest, in the same location in that field. V. Andreev effectively reported at the PIRT Conference held in July 2005 in Moscow, that, a pendant load irradiated at the General Physics Institute of the Russian Academy of Sciences, by high energy electrons, comes to weigh less than its untouched twin counterpart (Tsipenyuk et al., 2005).

We have immediately suggested that, the effect must be due to energizing the valence electrons of the atoms of the load in consideration (which happened to be duraliminium); these electrons (based on our finding vis-à-vis the gravitational mass and the inertial mass), become lighter. A quick calculation indeed proves this point of view, which shall be presented, in a subsequent article. The conclusion is that, heated electrons weigh less than normally bound electrons, and this, points to a clear violation of the common interpretation of the PE.

Note that, at a first strike, heat, being energy, and energy bearing a mass equivalent, heated electrons would weigh more than cold electrons, and this is perfectly compatible with the Special Theory of Relativity (STR).

Yet, as we will recall further, (Yarman, 2004, 2006b), the strength of the attraction force exerted on particles moving in a gravitational field, is decreased as compared to what is classically expected, and this, by the inverse of the usual Lorentz coefficient coming into play.

Essentially, it is not that we question, or we do not accept the principle of equivalence (PE), it is that we are in no need to utilize it!

It will become clear in the following discussions that our approach does not use the PE. Thus, we neither question nor reject it, we just do not utilize it, to derive and establish the proposed framework. We do not really bother whether PE is valid or not. After all, to us, it represents a prodigious and useful analogy, but this is not really the point.

Being able to develop a unifying framework without using the PE, seems to be very controversial, as there is a belief and claim in the physics community that, one must need the PE and that, one cannot question whether the PE is right or wrong. According to this belief, PE is surely "right" and no doubt we "need" it. However, as we will see herein, we really do not need the PE to develop our framework.

The fact that we do not use it, does not, on the other hand, constitute any contradiction with the theory of relativity, more precisely with the STR, which constitutes our main framework. Quite on the contrary, our approach, as will be elaborated further, remedies the inconsistencies, otherwise coming into play.

Few words about the ambiguity of the PE, as defined by various articles in the literature: Tuning of the definition of the PE, for the present purpose

As we have just stated; according to Newton, the "gravitational mass", is the mass to be plugged in the expression of "Newton's law of gravitational attraction", whereas the "inertial mass" is the mass to be plugged in the expression of "Newton's Second Law of Motion" (Newton, 1686).

Newton himself, before anyone else, doubted the equality of these two masses (and we find indeed that they are not equal). However, many researchers, following the grand master (Einstein, 1953), openly state, that the PE sets these two masses equal to each other.

The GTR, on the other hand, rejects (in favor of geometry, more precisely curvature), the concept of "force" which, in Newton's description, made of "mass" and "acceleration", involves the "inertial mass"; the GTR also generally rejects the concept of "Newton's law of gravitational attraction", which involves the "gravitational mass". Thus, within the frame of the GTR, the original ground considered by Newton to appraise the two masses in question, is in fact, totally wiped out.

Here is another point we would like to make, against the classical comparison about the inertial mass and gravitational mass. "Inertia", by definition, is a characteristic; an object develops as a resistance to any variation, in its motion. Thus the concept of inertia is associated with the change, the object undergoes, through a given motion. Regarding the PE, the "motion" of concern is that of the accelerated elevator, as assessed by an outside observer, fixed, in regards to distant stars.

Thus, Einstein considers the rest mass of an object, lying on the floor of the elevator, accelerating (as assessed by the outside fixed observer) "upward" (here, meaning, along the direction drawn from the floor to the ceiling of it). And this is what constitutes the basis of the PE. Then, the "effect of acceleration" on the object of concern, is considered to be equivalent to the "effect of gravitation" (yeld by the acceleration, in question). This indeed seems to be a striking, but as we show elsewhere, constitutes unfortunately, a non-conform, thus inaccurate analogy (Yarman, 2006a, 2007; Kündig, 1963; Kholmetskii et al., 2008). Anyway, by the analogy in consideration, so far, we describe a "rest mass sitting in a gravitational field". In other words, at this stage, we do not describe, say, a "mass in motion, in a gravitational field" (such as a planet around the Sun, as originally visualized by Newton, in regards to the equivalence of inertial mass and gravitational mass). In order to describe properly, a mass in motion in a gravitational field, according to Einstein's analogy, we have to go inside of the accelerated elevator, and see what happens to the object originally at rest on the floor, for instance, if it is thrown, in a given direction.

Then, consider the rest mass of the object originally lying on the floor of the elevator. Then consider the twin of this mass, but now thrown out, in the elevator, thus drawing a "relativistic mass", in regards to a given observer, say, sitting on the floor. Now, only the comparison of these two masses (the first one, sitting at rest on the floor, and the other one flying in the elevator, with regards to the observer situated at rest on the floor of the elevator), can, within the framework of the analogy set by Einstein, between acceleration and gravitation, bring an answer to the question introduced by Newton, regarding the equality or non-equality of the "gravitational mass", and the "inertial mass".

It is obvious that, the two masses (that is, the mass sitting on the floor of the accelerated elevator, and the same mass, but thrown away in the accelerated accelerator frame, with respect to the observer at rest situated on the floor), are not equal, even within the frame of the GTR.

Thus, anyone caring about the PE should not really be frustrated right away, when we say that the "gravitational mass" and the "inertial mass" are not really equal. It is that they are not equal in the way Newton first questioned. Unfortunately, there are quite a number of books, which are inevitably misleading when they introduce the PE, through Newton's original question, and they aim to provide an answer to it in a domain where Newton's original tools are essentially demolished by Einstein.

A succinct comment, from our stand point, about the acclaimed highly accurate measurements about the PE

One may criticize our approach as, by not resorting to the PE, we bypass the reported highly trustable measurements. We think that such criticism stems from the belief that the PE is required for unifying theories. However, we think that the PE is not crucial for developing a unified theory, although it is of course, monumental, and it served a lot for the development of modern physics. Our standpoint, here is that, we do not need the PE for developing our framework. What we need is just the relativistic law of conservation of energy. We do believe that as useful as it may be, the PE is of course well thought of, but still remains just like electronic tubes, bound to be forgotten, when replaced by transistors.

While our findings puts indeed, at stake the PE; it should also be recalled that, this principle is anyway, scrupulously, questioned (Lobov, 1990; Logunov, 1990). The equality of the gravitational mass and the inertial mass, based on the approach presented herein, is an approximation which is acceptable, only if the velocity of the object in motion is small, as compared to the velocity of light in empty space. It is interesting to note that, all the highly precise measurements regarding the relative divergence of these two masses (how ever they are defined), are performed on Earth (where the observer is moving with Earth), so that the precision they produce, no matter how fine this may be, according to our approach, should be considered, as misleading. In effect, since along our finding, (gravitational mass) = (inertial mass) / (Lorentz dilation factor)^2 (cf. the above relationship), it seems that one should rely on the experiments in question, no more then he should count on the null result of the Michelson Morley experiment (Michelson and Morley, 1887) (which, being performed on Earth, fails to detect the motion of Earth around the Sun). In other terms, the Galilean Principle of Relativity (Yaglom, 1979), which is the main ingredient of the STR, forbids that we can, on Earth, detect any such difference, based on the velocity of motion in question (since otherwise we should be able to tell, how fast we are cruising in space, and we really cannot).

Not knowing that, the equality of gravitational mass and inertial mass, is only approximate, one may still insist (just the way it is done regarding the experiments in question) that, such an equality can well be established on Earth. But the rotational velocity V_0 of Earth around itself is 1667 km/h. Hence, one should attain a precision of v_0^2/c_0^2, that is, better than 2.6×10^{-12}, whereas, the highest precision reached so far, is barely this much.

We can yet well rely, as Newton himself predicted, on measurements based on a possible polarization of Earth and the Moon, through their motion around the Sun. The polarization according to our approach must result from the fact that, the speed of the Moon with respect to the Sun, as the Moon rotates around Earth, varies a little. The speed of Earth around the Sun is about 30 km/s. The speed of the Moon around Earth is about 0.6 km/s. Thus, the speed of the Moon with respect to the Sun is about 30 km $\pm$ 0.6 km. The detection of a difference in the falls of Earth and that of the Moon toward the Sun thus requires a measurement of the distance between the Earth and the Moon, with a precision better than (0.6^2 km^2/s^2)/ c_0^2 , that is, ~ 4x10^{-12} whereas, the precision actually reached seems still to remain below this (Braginsky and Panov, 1971; Nordtvedt, 1996).

Note further that, even through the fastest observable celestial motions, such as that of binary stars, around each other (where the objects move with speeds around 1000 km/s), the difference between the gravitational mass and the inertial mass, remains still undetectable.

The classical approach, developed on the basis of the PE, is somewhat equivalent to the present approach, where we consider the mass decrease due to static binding, in describing an object sitting in a gravitational field

The next major point we would like to bring to the attention of the reader, at this stage, is the following: The classical approach developed on the basis of the PE, is somewhat equivalent to the present approach, in describing, the changes, an object sitting (at rest) in a gravitational field, would display. Indeed, following our approach, as will be summarized below, an object brought quasistatically into a gravitational field, suffers a rest mass deficiency, and this, as much as the gravitational binding energy coming into play.

The concept of binding energy is worked out in Part I, of this work (Yarman, 2010b), with regards to the closed system chiefly made of the pair of proton and electron. The idea we will follow here, is exactly the same, with regards to the closed system made of the pair of a celestial body and an object bound to it.

Such a decrease of rest mass is - owing to the law of conservation of energy, broadened to embody the equivalence of mass and energy drawn by the STR - nothing else, but a decrease of the overall, internal, rest relativistic energy of the object at hand. This yields, a quantum mechanical weakening of the internal energy of the object, at hand; thus, the classical gravitational red shift, which is substantially the same result held by the GTR (Yarman, 2010a). More generally, along with our approach, we consider the stationary quantum mechanical description of the object in consideration.

Now, if we inject in this description an arbitrary decrease of all different masses, and this, by the same amount, to represent the mass decrease the object would display in the gravitational field, then quantum mechanically, we find that, the total energy of the object, or the same, the eigenvalue of the quantum mechanical description of it, does decrease just as much. Thus, we land at the general relativistic red shift. Concomitantly, the size of the object stretches, as much.

What we would like to stress here is that, in fact, such a procedure, virtually achieves what the PE does, with regards to the object sitting on the floor of the accelerated elevator, assumed to represent the gravitational field.

This is exactly why we affirm that, we do not need the PE, since we are well able to get the end results of the GTR (up to a precision, actual measurements delineate), via essentially, the law of conservation of energy. There are though characteristic differences between our approach and the GTR (although, as mentioned, the measurable end results, are very similar, in fact practically the same).

The major difference is that the PE can be applied to an object, subject to a gravitational attraction, exclusively, whereas our approach can be applied to any object, subject to any force field.

This makes that, whereas the stick meter contracts in a gravitational field, only if it is lied, parallel to the attraction direction, in our approach, it is stretched just as much, and this uniformly, in all directions. (Recall that in the GTR, originally, only if the stick meter is lied along a direction perpendicular to the gravitational attraction, as assessed by a distant observer, it remains untouched.)

Furthermore, the rest mass of the object in the GTR increases in the gravitational field, whereas in our approach, it decreases. (Note that mass and energy vary in opposite directions in the GTR.)

But then, all that, with regards to the GTR, yields not only incompatibilities, and eventually a violation of the laws of energy conservation and momentum conservation, but also blocks the association of the gravitational attraction, with any other force field, for one, is unable to conceive a PE with regards to forces, other than the gravitational attraction (since, there is no such thing as electric mass, or nuclear mass, that can be visualized like the “gravitational mass”).

It is furthermore important to recall that the GTR does not allow the quantization of the gravitational effect. It is to be noted once more here that, while there are differences between the GTR and our approach, the two theories devilishly end up with practically the same measurable results.

Clue to the question of how come that our results are the same as the end results of the GTR, but still display characteristic differences

To make things easy, let us consider a rotating disc. The PE tells us that a clock fixed at the edge of the disc and rotating with it, is equivalent to its twin, sitting on a gravitational ground, supposing that the centrifugal acceleration of the disc and the gravitational acceleration, affecting both clocks respectively, are equal. The centrifugal acceleration of the disc and the gravitational acceleration, delineate respectively the “accelerational world” which we call AW, and the “gravitational world” which we call GW.

Earlier (Yarman, 2006a; Yarman et al., 2007), we have proven that the classical PE is based on a non-conform analogy, that is, it does not embody a one to one correspondence between the AW and the GW. Although it furnishes good results, it appears to be totally erroneous. For one thing, the PE overlooks the rest mass deficiency the object brought to the force field should undergo, and this constitutes a clear violation of the law of energy conservation. Let us elaborate on this a little bit. Thus recall that, Kündig, almost half a century ago, measured the time dilation of an object in rotation, and published data that were claimed to be firmly in agreement with the classical prediction (Kündig, 1963). However, decidedly, he has badly misprocessed the data (Kholmetskii et al., 2008), and the measured time dilation effect, turns out to be much greater than that predicted, by the classical theory; thence the start point of the GTR is (as correction brought to the data by Kündig, claiming it, proves), erroneous. Recent measurements, clearly back up our stand point (Kholmetskii et al., 2009a, b, 2011).

The remedial of the classical PE, leaves it unnecessary. We do not need the PE. On the contrary, we can straightly derive it in the correct way, based on our approach, in which, we treat gravitation in the same way we treat any other field. Thus, gravitation is not a privileged field at all. Any field, even that caused by a centripetal force due to a rotational motion (as we will elaborate further), yields the same change. Accordingly, we state the following:

- Both gravitation and acceleration alters the rest mass in the same manner; the rest mass decreases as much as the energy necessary to furnish to the object in order to remove it from the force field.

Thence, the gravitational theory we have developed well covers the end results of the GTR. Moreover, it turns out to be valid (not only for gravitation but) for all fields. It excludes any singularity and treats the photon like any ordinary object, or vice versa, just like quantum mechanics does. The decrease of the mass of the bound particle, via our quantum mechanical theorem (Yarman, 2010 a), applied to the internal dynamics of the particle in hand, changes both the period of time, and the size of space to be associated with the internal dynamics in question, in exactly the same manner, at either an atomistic scale, or a celestial scale. Our approach yet, leads to a different metric than that of the GTR.

Thus, briefly:

i) The rest mass (and not the "energy") of an object embedded in a gravitational field (in fact, any field, it can interact with), is decreased as much as the static binding energy coming into play. (Here note again that "rest mass" and the corresponding "rest energy" vary in opposite direction in the GTR). In contrast, GTR, owing to the analogy it draws between acceleration and gravitation, predicts an increase of rest mass, in the gravitational field.

ii) According to our approach, the length of the mass uniformly stretches just as much. However, according to the GTR, it contracts as much, and this is only along the direction of attraction.

iii) The period of time associated with the object, dilates along our approach. In the GTR, it dilates just as much, but also delineates a singularity.

An important conclusion of our approach is that, our approach remedies the splitting between Newton's approach and Einstein's approach, restoring the incompatibilities arising between the STR and the GTR, such as the breaking of the fundamental relativistic result, (energy) = (mass) x (speed of light)^2. Along the same line, it does not allow the law of energy conservation, nor the law of momentum conservation, to break down (contrary to, as pointed out, what happens within the frame of the GTR).

Our approach, furthermore, because it leaves unnecessary the usage of the PE, that is, the basis of the GTR, provides us with a whole different horizon. We come to be able to establish a natural link between our approach and quantum mechanics, otherwise badly hindered by the GTR.

In effect, the frame we draw, describes in an extreme simplicity, both the atomic scale, and the celestial scale, on the basis of, Coulomb force (written for static electric charges only), and Newton's force (written for static masses only) respectively. Thus, the frame we draw yields exactly the same metric change and quantization, at both atomic and celestial scales.

In particular, gravitationally bound clocks shall, according to our approach, retard as implied by the amount of the gravitational static binding energy coming into play; thus, not only this, but, "clocks anyway bound to any field", they interact with, should also retard. For instance, an electrically charged clock, bound to an electric field, must come to slow down, just like clocks bound to gravitational field, slow down. More specifically, the decay rate of a muon, when this is bound to an atomic nucleus, as pointed out earlier, retards as much as the static binding energy, coming into play. This shows that, the metric change induced by protons nearby a nucleus vis-à-vis negative charges, is exactly the same as the metric change induced by the mass nearby a celestial body, vis-à-vis masses.

Most important of all, our approach (based on just the law energy conservation, broadened to embody the mass and energy equivalence of the STR), allows, as we will elaborate throughout, the derivation of de Broglie relationship, just based on the law of energy conservation, with regards to the gravitational field (just like we did it, with regards to the electric field), thus indeed, the quantization of the gravitational field (not any different than the quantization of the electric field).

About the de Broglie relationship

In the previous work (Yarman, 2010b) we have formulated the de Broglie relationship as

$$\lambda_B = \lambda_0 \frac{c_0}{v_0}\sqrt{1-\frac{v_0^2}{c_0^2}} \quad \text{(Equation 6, Yarman, 2010b)} \qquad (1)$$

λ_B is the de Broglie wavelength; λ_0 is given by

$$h\nu_0 = m_0 c_0^2 \quad ; \qquad (2)$$

m_0 is the rest mass of the object in consideration; c_0 is the speed of light in empty space; ν_0 is the frequency of the electromagnetic radiation, were the object in hand (totally) annihilated.

By definition, we have

$$c_0 = \frac{\lambda_0}{T_0} = \lambda_0 \nu_0 \, ; \qquad (3)$$

thus, T_0 is the period of time of the wave coming into play.

Equations 2 and 3 lead to

$$\lambda_0 = \frac{h}{m_0 c_0} \quad . \qquad (4)$$

Dividing the two sides of Equation 1 by T_0, yields

$$\frac{\lambda_B}{T_0} = \frac{\lambda_0}{T_0}\frac{c_0}{v_0}\sqrt{1-\frac{v_0^2}{c_0^2}} = \frac{c_0^2}{v_0}\sqrt{1-\frac{v_0^2}{c_0^2}} \quad \text{(Equation 7a, Yarman, 2010b)} \qquad (5)$$

Let us define for convenience, the LHS, as U_B :

$$U_B = \frac{\lambda_B}{T_0} \quad . \tag{6}$$

Thus, U_B , via Equation 2, becomes

$$U_B = \frac{c_0^2}{v_0}\sqrt{1-\frac{v_0^2}{c_0^2}} \text{ (Equation 7c Yarman, 2010b)} \tag{7}$$

Equations 5 and 6, tell us that, through a motion, such as the Bohr rotational motion, of say, the electron around the proton, in the hydrogen atom, each time the inherent periodic phenomenon of the electron (assumed by de Broglie, and) described by λ_0 , beats; something else also beats all the way through the stationary orbit of perimeter λ_B.

In other words, the de Broglie wavelength, becomes the wavelength of the pulse of frequency $\nu = \nu_0 / \sqrt{1 - v_0^2 / c_0^2}$, propagating with the speed c_0^2 / v_0 * (cf. Eq.(6-b) of Part I), where ν_0 is the inverse of T_0. Note that this comes as well, to state that, the Broglie wavelength, becomes the wavelength of the pulse of frequency ν_0 , propagating with the speed $(c_0^2 / v_0)\sqrt{1 - v_0^2 / c_0^2}$.

PREVIOUS WORK: A NOVEL APPROACH TO THE EQUATION OF GRAVITATIONAL MOTION

In a previous work (Yarman and Rozanov, 2006a, b; Yarman, 2004, 2006b), a whole new approach to the derivation of the Celestial Equation of Motion was achieved; this, well led to all crucial end results of the GTR (and this, in a few lines only, and already in an integral form).

Thus, we had started with the following postulate, essentially, in perfect match with the relativistic law of conservation of energy, thus, embodying in the broader sense the concept of "mass", though we will have to precise, accordingly, the notion of field.

Postulate

The rest mass of an object bound to a celestial body amounts to less than its rest mass measured in empty space, the difference being, as much as the mass, equivalent, to the static binding energy coming into play.

A mass deficiency conversely, via quantum mechanics, yields the stretching of the size of the object at hand, as well as the weakening of its internal energy, via quantum mechanical theorems proven elsewhere (Yarman, 1999, 2010a), still in full conformity with the STR. An easy way to grasp this is to consider Equation 2, if the mass is decreased due to binding, so will be the frequency. Thus, we land at the gravitational red shift. Equation 4 makes that the size is accordingly stretched.

In order to calculate the binding energy of concern, we make use of the classical Newtonian gravitational attraction law, yet with the restriction that, it can only be considered for static masses. Luckily we are able to derive the 1/distance^2 dependency of the gravitational force between two static masses, still just based on the STR (Yarman, 2008). Thus, the framework in consideration fundamentally lies on the STR. Henceforth; one does not require the PE assumed by the GTR, as a precept, in order to predict the end results of this theory.

Let then m_0 be the mass of the object in consideration, at infinity. When this object is bound at rest, to a celestial body of mass $\mathcal{M}_{00}$, assumed for simplicity, infinitely more massive as compared to m_0 , this latter mass will be diminished as much as the static binding energy coming into play, to become m(r) (cf. Appendix A), so that (Yarman, 2004)

$$m(r) = m_0 e^{-\alpha(r)} \, , \tag{8}$$

(mass of the bound object at rest)
where $\alpha(r)$ (or in short α) is

$$\alpha(r) = \frac{G_{00}\mathcal{M}_{00}}{r c_0^2} \; ; \tag{9}$$

G_{00} is the universal gravitational constant; r is the distance of m(r) to the center of $\mathcal{M}_{00}$, as assessed by the distant observer; recall that, after all, G_{00} is not as universal as one may think it is (Yarman, 2006b); one can show that, it depends on the location; what is meant over here by G_{00} is the proper gravitational constant (Appendix A),which would as well be that measured by a distant observer, based on a Cavendish (Standish, 1995) type experiment, but achieved in a rather free space.

At this stage it is important to draw a parallelism between what we did in the first part of this work, with regards to the electric charges getting electrically bound to each other, and what we undertake herein, with regards to masses getting gravitationally bound to each

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* $\dfrac{c_0^2}{v_0} = \lambda_B \nu = \lambda_B \dfrac{\nu_0}{\sqrt{1-\dfrac{v_0^2}{c_0^2}}}$ (Equation 6b Yarman, 2010b)

other. Thus note that in Part I of this work, we assumed Coulomb force to be valid, not only exceptionally for statically interacting electron and proton, but also, in the frame of reference of the electron. (The proton being too heavy as compared to the electron was then supposed unaltered through the binding process.) Therefore, on the basis of the fascinating similarity between Coulomb Force and Newton Force, we are of course, very much inclined to pay attention that what we do for gravitation, is harmonious with what we did for electrically bound charges.

Accordingly, we would like to undertake a brief analysis about the subject in Appendix A. Luckily, the related discussion is not primordial for the present approach, for as we will show in Appendix B, one is able to derive the de Broglie relationship - the way we have presented in the previous part and that we will present herein - not only for electric and gravitational forces, but in fact with regards to any force existing in nature, including, the centrifugal force, This appears evidently, as a great and unique basis regarding the alliance of different fields of concern.

In any case, note that, as Equation 8 delineates, the present theory excludes singularities, thus black holes.

Now, suppose that the object of concern is in a given motion around $\mathcal{M}_{00}$; the motion in question can be conceived as made of two steps:

1. Bring the object quasistatically, from infinity to a given location r, on its orbit, but keep it still, at rest.
2. Deliver to the object at the given location, its motion on the given orbit.

The first step yields a decrease in the mass of m_0 as delineated by Equation 8. The second step yields the Lorentz dilation of the rest mass m(r) at r, so that the overall mass $m_\gamma(r)$, or the same, the total relativistic energy of the object in orbit becomes

$$m_\gamma(r)c_0^2 = \frac{m(r)c_0^2}{\sqrt{1-\frac{v_0^2}{c_0^2}}} = m_0 c_0^2 \frac{e^{-\alpha(r)}}{\sqrt{1-\frac{v_0^2}{c_0^2}}} ; \qquad (10)$$

(overall mass, or the same, total energy of the bound object, on the given orbit)

v_0 is the local tangential velocity of the object at r.

Here, we refer to the distance r, as measured by the distant observer (Yarman, 2006b), and the related details are discussed in Appendix A.

The total energy of the object in orbit (that is, $m_\gamma(r)c_0^2$) must remain constant, so that for the motion of the object in a given orbit, one finally has,

$$m_\gamma(r)c_0^2 = m_0 c_0^2 \frac{e^{-\alpha}}{\sqrt{1-\frac{v_0^2}{c_0^2}}} = \text{Constant} = m_\gamma \quad . \qquad (11)$$

(total energy written by the author, for the object in motion around the Sun)

This is in fact, the integral form of the general differential equation of motion, we will furnish right below; it is interesting to note that we have arrived at it, in just a few lines (that is, Equations 8, 10 and 11).

The differentiation of Equation 11 leads to

$$-\frac{G_{00}\mathcal{M}_{00}}{r^2}\left(1-\frac{v_0^2}{c_0^2}\right)dr = v_0 dv_0 \ . \qquad (12a)$$

(differential form of Equation 11, leading to the equation of motion)

This equation can be put into the form

$$-\frac{G_{00}\mathcal{M}_{00}}{r^2} m_0 e^{-\alpha_0}\sqrt{1-\frac{v_0^2}{c_0^2}}\frac{\underline{r}_0}{r_0} = m_\gamma \frac{d\underline{r}_0^2(t_0)}{dt_0^2} , \qquad (12b)$$

or into the form

$$-\frac{G_{00}\mathcal{M}_{00}}{r_0^2}\left(\frac{e^{-\alpha_0}}{1+\alpha_0}\right)\left(1-\frac{v_0^2}{c_0^2}\right)\frac{\underline{r}_0}{r_0} = \frac{d\underline{r}_0^2(t_0)}{dt_0^2} , \qquad (12c)$$

(vectorial equation written based on Equation 12a, or the same, equation of motion written by the author, via the law of energy conservation, extended to cover the relativistic "mass and energy equivalence")

written in terms of the proper quantities only, via the relationship (Appendix A)

$$r = r_0 e^{\alpha} \cong r_0 e^{\alpha_0} , \qquad (12d)$$

(length stretched in the gravitational field)

As induced by Equation 8, and a theorem proven elsewhere (Yarman, 1999, 2010a) (which can be quickly crosschecked via Equation 4); $\underline{r}_0$ is the vector bearing the magnitude r_0, and directed outward. It should be noted that, the gravitational constant can be measured locally without receiving any information from the outside, and from this angle, is in fact, altitude dependent, as assessed by the distant observer. Yet it is interesting to discover that, when G_{00} measured in practically empty space by the distant observer, is used along the proper distance r_0 of the bound object, but measured locally, Equation 12c becomes the equation of motion, valid, for the distant observer (cf. Appendix A).

Though consisting in a totally different set up, than that of the GTR, Equation 11, thus Equations 12a and 12c, amazingly yields all measurable end results intercepted by this latter theory, up to a third order Taylor expansions (Yarman, 2004, 2006b), yet in an incomparably easier manner.

Note that our approach, just like the classical Newtonian approach, leads to the “law of linear momentum conservation”, as well as the “law of angular momentum conservation” (contrary to what is drawn within the frame of the GTR, where these classical laws are broken).

It may be somewhat tiring to show how our approach leads in general to the “law of linear momentum conservation”. Nonetheless, it does not take long to show how it leads to the “law of angular momentum conservation”. One can see this readily, by multiplying the vector Equation 12c, by the vector $\underline{r}_0$. Thus the related cross product becomes:

$$m_\gamma(r_0)\underline{r}_0 \times \frac{d\,\underline{v}_0(t_0)}{dt_0} = 0 \qquad (12e)$$

(the cross product of Equation 12b by $\underline{r}_0$)

The integration of this equation yields

$$\underline{r}_0 \times \underline{v}_0(t_0) = \text{Constant} \qquad (12f)$$

(Angular Momentum Conservation law derived from the author’s set up)

This result is important, since it tells us that, our approach is well compatible with Kepler’s laws (Pauli, 1955; Holton, 1956).

Furthermore, it may be considered remarkable that within the frame of our approach, we are able to treat a light photon just like an ordinary particle. Thus, Equations 11, 12a, b and c are perfectly valid for a photon, just like any object affected by the gravitational field. Note that, the sameness in the treatment of an ordinary particle, and a light photon constitutes the basis of quantum mechanics. Indeed, as we will soon realize, our approach yields the derivation of the de Broglie relationship, thus the possibility of quantization.

Thus, based on just the relativistic law of energy conservation, we already came to meet straight, with the sameness of a light photon and an ordinary particle. But this is somewhat the essence of quantum mechanics. On the other hand, the inverse square spatial dependency of Newton’s law of gravitational attraction, turned out to be a requirement imposed by the STR. The laws of linear and angular momentum conservation, too, are obtained directly from the present approach. Henceforth, different disciplines and tools, classified as such, up to now, came to be united, with each other, within the frame of our approach.

Furthermore, the fact that, we can treat a light photon just like an ordinary particle, induces the fact that, light photon, most likely, bears a kernel; already de Broglie speculated on this point, in his doctorate thesis, and calculated the “rest mass of the photon” to be 10^{-44} g, if an electromagnetic wave of wavelength of 1 km, moves with an extra speed, only 10^{-2} times larger than that of an electromagnetic wave of wavelength of 30 km (de Broglie, 1925).

Recall that we have no problem whatsoever with the STR. Quite on the contrary, we base on our approach on it, more precisely on the relativistic law of energy conservation. Thus, no matter what we anticipate that light behaves just like any ordinary object, and accordingly the photon may possess a kernel, as tiny as this may be, and light propagation speed may depend on the energy of the photons making it; we still conjecture that the difference this may cause, in photon speed, is minimal with respect to photon energy.

At any rate the “classical Lorentz invariant velocity of light” c_0, assumed by the STR, is an unsurmounted speed, for any object (Sobczyk and Yarman, 2008). In fact, in our approach, only a photon of infinite energy could reach it.

At this stage, it seems useful to draw the following table, displaying the differences between our approach and the standard approach.

The raw before the last raw of Table 1 requires a discussion regarding the discrepancy (as small as this may be), between our result and the corresponding result yield by the GTR (Laundau and Lifshitz, 1999), that is,

$$m_\gamma(r)c_0^2 = m_0c_0^2\frac{\sqrt{1-2\alpha}}{\sqrt{1-\frac{v_0^2}{c_0^2}}} = \textit{Constant}, \text{versus}\; m_\gamma(r_0)c_0^2 = m_0c_0^2\frac{e^{-\alpha}}{\sqrt{1-\frac{v_0^2}{c_0^2}}} = \textit{Constant} \qquad (12k)$$

(total relativistic energy of a given object, predicted by the GTR, versus that predicted by our approach)

Our result coincides up to a third order of the corresponding Taylor expansion, with the result furnished by the GTR (that is, the first relationship, written above).

There is an easy way to interpret the singularity arising in the numerator of the Einsteinian equation appearing above, though it is the well known Schwarzchild solution, of Einstein Equations. Whereas, not only that it is possible to ascertain what the numerator of our expression is all about, but also, the set up of it is almost evident. We would like to recall that, in fact, the

Table 1. Differences between the “standard approach” and the “present approach”, based on the pair of sun and planet.

	Standard approach	**Present approach**
Force between the sun and the planet, altogether at rest	$G_{00}\dfrac{\mathcal{M}_{00}\,m_0}{r^2}$	$G_{00}\dfrac{\mathcal{M}_{00}\,m_0 e^{-\alpha}}{r^2}$ (as assessed, by the local observer) (see Appendix A)
Total energy of the statically bound planet	$m(r_0)c_0^2 = m_0c_0^2 - \dfrac{G_{00}\mathcal{M}_{00}}{r}$ (Newtonian approach) $m(r_0)c_0^2 = m_0c_0^2\sqrt{1-2\alpha}$ (Einsteinian Approach)	$m(r_0)c_0^2 = m_0c_0^2e^{-\alpha}$
Total dynamic energy	Rest energy + Potential energy + Kinetic energy (Newtonian approach)	The concept of potential energy, as considered classically, is misleading.
Total dynamic energy of the sun and the planet in motion	$m_\gamma(r_0)c_0^2 = m_0c_0^2\dfrac{\sqrt{1-2\alpha}}{\sqrt{1-\dfrac{v_0^2}{c_0^2}}}$ (The Einsteinian total energy)	$m_\gamma(r_0)c_0^2 = m_0c_0^2\dfrac{e^{-\alpha}}{\sqrt{1-\dfrac{v_0^2}{c_0^2}}}$
Force between the sun and the moving planet	$G_{00}\dfrac{\mathcal{M}_{00}\,m_0}{r^2}$ (Newtonian approach)	$\dfrac{G_{00}\mathcal{M}_{00}}{r^2}m_0e^{-\alpha_0}\sqrt{1-\dfrac{v_0^2}{c_0^2}}$ (as assessed, by the local observer)

Einsteinian singularity arises because of the non-conformal analogy between the accelerational world and the gravitational world, leading to the set up of the GTR (Yarman, 2006a; Yarman et al., 2007).

Thus, we are not a bit disappointed not to have obtained identical results in comparison with the GTR. The two approaches are based on completely different setups. And as pointed out, although the GTR furnishes results well covering measurement results, it seems to be erroneous. For one thing, it overlooks the rest mass deficiency the object brought to the force field, should undergo, and this is a clear violation of the law of energy conservation. Strikingly, it catches up with this, through a number of mistakes, devilishly compensating each other (Yarman, 2006a; Yarman et al., 2007). Thence the discrepancy coming into play does not disfavor our approach a bit, up against the GTR.

It is interesting to note here that, there is no singularity underlined by our approach in contrast to the existence of singularities in many works in the literature which yield the “black hole” concept.

Recall that our result is yet consistent with what Yilmaz would have written (Yılmaz, 1979, 1992), in the same way as that presented by Landau and Lifshitz leading to the GTR’s relationship, then with the exponential correction, Yilmaz proposed to Einstein’s metric, which is,

$$m_\gamma(r)c_0^2 = m_0c_0^2\frac{e^{-\alpha}}{\sqrt{1-\dfrac{v_0^2}{c_0^2}}} = Constant \quad , \tag{12l}$$

(relationship that would have been written by Yilmaz, had he followed the same way as that presented by Landau and Lifshitz (1999), with regards to the GTR, thus along with the correction he proposed to Einstein’s metric)

Though the set up would still be very different. Further, we would like to mention that, likewise, Logunov landed at a similar result, with no singularity, whatsoever (Logunov, 1998).

MASS SUBLIMES INTO KINETIC ENERGY, AND KINETIC ENERGY CONDENSES INTO MASS, THROUGHOUT THE MOTION: A JET MODEL

According to our approach, $c_0^2\ m_{0\gamma}(r_0)$ of Equation 11 (that is, the total relativistic energy of the planet) ought to be constant, all along the planet's journey around the Sun. As the planet speeds up nearby the Sun, it is that, an infinitesimal part of its rest mass somehow sublimes into extra kinetic energy (the planet acquires, as it accelerates).

In other words, the extra kinetic energy coming into play is fueled by an equivalent rest mass. As the planet slows down away from the Sun, through its orbital motion, it is that, a portion of its kinetic energy somehow condenses into extra rest mass, on the orbit. In other words, the rest mass spent previously to fuel the extra kinetic energy, is now brought back.

One way of conceiving this phenomenon, is to think in terms of a "jet effect". Thus, within the frame of such a modeling, in order to accelerate, the planet would throw out an infinitesimal net mass from the back, just like an accelerating rocket. Conversely, in order to decelerate, it would absorb an infinitesimal net mass, from the front.

Whether in reality, the whole thing works out this way or not, we do not know. For the present purpose, we do not need to know it, either. Though, we came to be able to refer to a mechanism which can provide us, with the end result we have disclosed; this is basically the rest mass change throughout; we require such a change, in order to take care of the variation of the kinetic energy, in relation to the variation of the static gravitational binding energy. In other words, the change in the static binding energy, together with the law of energy conservation broadened to embody the mass and energy equivalence of the STR, must lead to a mass decrease throughout, which ought to manifest as an extra kinetic energy. The jet model we developed, in effect, well takes care of all that.

Referring to Equation 12a, we suppose that, around the location r, the planet of rest mass m(r), and velocity v_0, accelerates as much as dv_0, through an infinitely small period of time dt_0, around the time t_0. This occurrence, according to our approach, is insured by an amount of jet of mass -dm(r) thrown by the planet, through the period of time dt_0, with a tangential jet velocity U, with respect to the fixed sun. The law of momentum conservation requires that (cf. the derivation provided in Part I, regarding an electric motion, whose frame turns out to be strictly identical to that of the gravitational motion),

$$m_\gamma(r)dv_0 = -U dm(r) \ . \tag{13a}$$

(kick received by the planet due to the jet effect, on a rectilinear motion) note that the quantity dm(r) (which is, by definition, m(r + dr) - m(r)), is negative (so that –dm(r) is a positive quantity)

Recall that above, we happened to have associated the jet speed U with the rest mass variation $|dm(r_0)|$, the planet displays on the way. We did it, on purpose, just the way we did on the level of Equation 16a of Part I. The reason is that, as we will see, it is the rest mass $|dm\ (r_0)|$ that can be determined directly, here, from the related static gravitational binding energy; moreover, $dm\ (r_0)$ may well be zero, while U still remains defined.

At any rate, here again, not to yield misinterpretations, the "jet momentum" $U|dm\ (r_0)|$, should better be written, as

$$|dm(r_0)|U = \frac{|dm(r_0)|}{\sqrt{1-\frac{V^2}{c_0^2}}}V = \gamma_V|dm(r_0)|V = \left(\gamma_V|dm(r_0)|\right)V = |dm(r_0)|\left(\gamma_V V\right) \tag{13b}$$

(momentum of the jet expressed in different terms)

where γ_V is

$$\gamma_V = \frac{1}{\sqrt{1-\frac{V^2}{c_0^2}}} \ , \tag{13c}$$

and V is the jet speed of the "relativistic mass" $\gamma_V|dm(r_0)|$, so that

$$\gamma_V V = U \ . \tag{13d}$$

Equation 13b is remarkable, given that the RHS of it, that is, $\gamma_V|dm(r_0)|V$ can be read either as $\left(\gamma_V|dm(r_0)|\right)V$, or as $\left(\gamma_V V\right)|dm(r_0)|$. In the former case, the relativistic mass $\left(\gamma_V|dm(r_0)|\right)$ multiplies the speed V to yield the relativistic momentum of the jet in consideration. The latter case becomes interesting, as we will see, for the case where $dm(r_0)$ is zero, pointing to an interaction with "no net mass variation"; in this case, the product $\gamma_V V = U$, is to be considered as a whole; in any case, the product $\gamma_V V$, is to be considered in its entirety, since it turns out that we will end up with U, as just one specific quantity, and not separately γ_V and V.

This outcome is noteworthy, because, as simple as it may look, along with our approach, it underlines the particle-wave duality (not only for the atomistic world, as discussed in the previous Part I, but) for the celestial world, as well: The relativistic momentum $(\gamma_V |dm(r_0)|)V$ evidently points to a particle character of the electron, whereas $\gamma_V V = U$ as a whole, taking place in the product $|dm(r_0)|(\gamma_V V)$ (as we will soon discover) indeed works as the key of the wave-like character of the object in hand; this becomes particularly evident when $dm(r_0)$ vanishes.

For the gravitational interaction too, we will discover that $U = (c_0^2 / v_0)\sqrt{1 - v_0^2 / c_0^2}$, and $V = c_0\sqrt{1 - v_0^2 / c_0^2}$; for this reason, we propose to call U the "wave-like jet speed", or the "superluminal jet speed", and V the "relativistic jet speed"; wherever we write just "jet speed", we will mean the tangential wave-like speed U.

Based on our jet model, henceforth, there seems reason to believe that, even when the "jet mass" is null, which happens to be, in effect, the case for a circular motion (cf. Equations 16, 17 and 22 of Part I), whatever is the information we would expect to be carried by the jet speed, this information is still transferred.

It is that, when there is no change in the speed of the moving object, the "jet mass" is accordingly zero. But as we will once again derive (here, vis-à-vis the gravitational motion), U ultimately depends only on the velocity v_0 of the moving object. Thus even if the jet mass is null, U is finite. In other words, whatever is the information carried by the jet speed U, this information can still be transferred, along with "no mass", thus "no energy" transfer, whatsoever. This is very interesting since, based on our approach, and the discussion we have provided all along, we came to say that:

- *The gravitational information, just like the electric information, can well be transferred with no need of energy exchange.*

DERIVATION OF THE DE BROGLIE RELATIONSHIP, AND SUPERLUMINAL SPEEDS

Let us now multiply Equation 13a by c_0^2:

$$c_0^2 m_\gamma(r) dv_0 = -c_0^2 U dm(r) . \tag{14}$$

The relativistic law of energy conservation requires that, the quantity $-c_0^2 dm(r)$, appearing at the RHS of this equation, must come to be equal, to the change in the corresponding kinetic energy, which in return, must be equal to the change in the corresponding gravitational static binding energy (cf. Equation 8).

Thus,

$$c_0^2 dm(r) = G_{00} \frac{\mathcal{M}_{00}\, m(r)}{r^2} dr \tag{15}$$

(variation of the rest mass, in terms of the static, gravitational binding energy)

Note, on the other hand that, when the planet accelerates, it gets closer to the sun; in this case dr (just like, dm(r)), turns out to be a negative quantity. We would further like to note that, we do not even have to precise the static binding energy appearing in the RHS of Equation 15 (here, as a static gravitational binding energy); as we will indeed see, in Appendix B, we could just leave it as a general binding energy developed in any given field, and our derivation, would still hold.

Anyway, equating the LHS of Equation 14, with the product of the RHS of Eq.(15) and U (via Equation 10), leads to

$$c_0^2 m_0 \frac{e^{-\alpha}}{\sqrt{1 - \frac{v_0^2}{c_0^2}}} dv_0 = -UG_{00} \frac{\mathcal{M}_{00}\, m_0 e^{-\alpha}}{r^2} dr \quad . \tag{16}$$

Here, we can replace dv_0, by the same quantity, furnished by Equation 12a.

Thence, the jet velocity U, as assessed by the distant observer, turns out to be

$$U = \frac{c_0^2}{v_0}\sqrt{1 - \frac{v_0^2}{c_0^2}} \quad . \tag{17}$$

(the jet speed as referred to the outside fixed observer)

This equation is amazingly the same as Equation 7, if the jet velocity U is taken to be same as U_B, of this latter equation. It only depends on the velocity of the object of concern.

We can, anyway, write Equation 17 as

$$U = \frac{\lambda_0}{T_0}\frac{c_0}{v_0}\sqrt{1 - \frac{v_0^2}{c_0^2}} \ , \tag{18}$$

via the usual definition of the velocity of light, that is, Equation 3.

Now, if we propose to write the jet velocity U, in question, in terms of the period of time T_0, of the electromagnetic wave, we associate with the mass m_0, along Equation 2; we come to the expression of a wavelength λ, in terms of λ_0, that is,

$$\frac{\lambda}{T_0} = \frac{\lambda_0}{T_0}\frac{c_0}{v_0}\sqrt{1-\frac{v_0^2}{c_0^2}} \quad , \tag{19}$$

which is nothing else, but the de Broglie wavelength (cf. Equation 1):

$$\lambda = \lambda_B = \lambda_0 \frac{c_0}{v_0}\sqrt{1-\frac{v_0^2}{c_0^2}} \quad ; \tag{20}$$

(de Broglie wavelength obtained from the wave-like jet speed, derived in here)

recall that we did not have to allow any restriction, while landing at this relationship.

Though, it remains interesting to tackle with it, primarily for a constant velocity, thus for a circular motion.

For such a motion, for the nth level, one can write (cf. the concluding footnote in the Introduction of Part I):

$$\lambda_{Bn} = n\lambda_0 \frac{c_0}{v_{0n}}\sqrt{1-\frac{v_{0n}^2}{c_0^2}} = \frac{nh}{m_0 v_{0n}} = 2\pi r_n \quad , \tag{21}$$

(de Broglie wavelength on the n^{th} orbit)

r_n, being the radius of concern.

This relationship, numerically would serve, to calculate n, if other quantities are given:

$$n = \frac{2\pi r_n m_0 v_{0n}}{h} \quad ; \tag{22a}$$

n, for earth rotating around the sun, for instance, approximately becomes

$$n \approx 122x10^{72} \quad . \tag{22b}$$

This number appears to be very large; yet this affects in no way the validity of the foregoing approach. The fact that a relationship similar to Equation 20, can be obtained, on the basis of an electric interaction (the way it was achieved in Part I), already constitutes a direct derivation of the usual de Broglie relationship.

We can, on the other hand, calculate the velocity u of the jet velocity, with respect to the planet. As a rough approximation, one can write,

$$u \approx U + v_0 \quad , \tag{23}$$

where v_0 is the speed of the planet, with respect to the sun (assumed at rest); we will call u the superluminal jet speed, since, as clarified right below, it is always greater than the speed of light. Note that in our approach, the ceiling c_0 cannot be reached, unless the photon bears an infinite amount of energy.

Obviously, we do not know the rule regarding the addition of superluminal velocities, with velocities taking place under the speed of light. Nonetheless, the examination of Equation 17 makes our task, easy. The two interesting cases indeed occur for $v_0 = 0$ and $v_0 = c_0$. For $v_0 = 0$, $U = \infty$; thus, one can right away guess that, in this case, u must be infinite. For $v_0 = c_0$, $U = 0$; thus one can guess that, in this case u must be c_0.

Hence, in conformity with the usual conception regarding the tachyon postulation (Bilaniuk et al., 1962; Feinberg, 1970) we can well establish that, the speed u (with respect to the object in question) of the superluminal interaction, which we like to call wave-like interaction, varies between ∞ (for the object of concern, at rest), and c_0 (for the object moving with the speed of light). As tautological as it may seem, this yields the fact that, light cannot interact with anything, via a speed above the speed of light (since its superluminal jet speed is, at best, c_0).

Note that, rigorously speaking, Equation 14 should be written in vector form as

$$m_\gamma d\underline{v}_0 = dm(r_0)\underline{U} \quad . \tag{24}$$

(the general jet equation in vector form)

$\underline{U}$, is the wave-like jet velocity vector. It always lies in the same direction as $d\underline{v}_0$. Thus, $\underline{U}$ lies in the radial direction, in the case, say of an elliptic motion. U, that we tackled with so far, becomes the tangential component of the velocity vector $\underline{U}$.

Once again, one has to be careful, with regards to a stationary circular motion, since, through such motion, both (the scalar) dv and dm, are null. Thus $\underline{U}$ must become infinite to secure a finite LHS in the above equation, and we have here, perhaps an expression of the Mach Principle (Mach, 1906; Einstein, 1923) .

More specifically, the tangential component of $\underline{U}$, is $U = |\cos\theta \underline{U}|$, θ being the angle $\underline{U}$ makes with the tangent, that is, $\pi/2$. Accordingly, $\cos\theta$ is null. The magnitude of $\underline{U}$, as stated, is infinity. This, as we had derived above (cf. Equation 18), indeed makes that, $U = |\cos\theta \underline{U}| = \infty x\, 0$, a finite quantity, thus well matching Equation 14. Thence, in any case U, is finite.

One final remark should consist in the following: Our approach seems to bring an answer to the quest of "gravitational interaction achieved with a speed much faster than the speed of light". Such an interaction does not of course embody any exchange of energy, and for this reason, we would like to call it wave-like interaction.

The fact that the Sun and the planets must interact with each other, with a speed at least a 109 times larger than the speed of light, is to be known, since long (Laplace, 1966). The French scientist, Laplace, more than two centuries ago, had discovered that if the gravitational field propagates with the mere speed of light, then the sun and the planets would get torn apart.

This would yield the doubling of earth's distance from the sun, in a period of about 1200 years. Amazingly this discovery by Laplace, no doubt, because it is considered to contrary the theory of relativity, does not take place in very many text books. It is unfortunate that many physicists are accordingly unaware of Laplace's findings. Via the same considerations, one with recent data, can conclude that the speed of propagation of gravity comes to amount even to much greater velocities (Flandern, 1998; Flandern and Vigier, 2002).

GENERAL CONCLUSION

Herein, based on just energy conservation, we figured out that, the gravitational motion, just like the electric motion, depicts some sort of rest mass exchange, throughout. One way to conceive this phenomenon is to consider a jet effect. Accordingly, an object on a given orbit, through its journey, must eject mass to accelerate, or must pile up mass, to decelerate.

The velocity U of the jet (as referred, not to the object, but to the fixed outside observer), strikingly delineates the de Broglie wavelength, coupled with the period of time T_0, displayed by the corresponding electromagnetic energy content of the object (as required by Equation 2).
This result seems to be important, in many ways:

i. We were able to derive the de Broglie wavelength, in regards to both the electric motion (Part I) and to the gravitational motion (Part II). This leads to our conclusion that, the objects interacting via gravitational charges, do behave in exactly the same way, as that displayed by quantum mechanical objects, interacting via electric charges. It is interesting to note that our approach can be generalized, to any force field existing in nature (cf. Appendix B).

ii. Our approach appears to be able to remove, at least partly, the assumption about the unpredictability, or indeterminism to be made, to cover the quantum weirdness, such as that displayed by the EPR experiment (Einstein et al., 1935). The immediate action at a distance induced by the feature we disclosed, vis-à-vis de Broglie wavelength, indeed seems to take care of it. It is that, Einstein seemingly rejected to believe in quantum mechanics, because the gedanken (then verified) EPR experiment, pointed to an "action at a distance", occurring with a speed much faster than the speed of light.

iii. However, we have disclosed throughout that, such an action is possible. Note that recent measurements seem to back up our arresting deduction (Kholmetskii et al., 2007, 2010).

iv. Furthermore, a team led by A. Kholmetskii at Belarusian State University, performed a Mössbauer experiment to see how a nuclear clock mounted at the edge of a rotor is affected by rotational motion. They were able to verify, with a high degree of precision, the prediction made by Yarman et al. (2007). Kholmetskii et al. (2009 a, b) found, contrary to the prediction made by Einstein (1953), that the clock is not only affected by its tangential velocity, but also by its binding to the acceleration field. Thus the overall time dilation becomes practically twice as much as that predicted classically. This result, not only challenges the validity of the Principle of Equivalence in General Relativity, but also favors the predictions framed by the approach proposed throughout.

v. Regarding an EPR type of experiment, the question of "How the subsequent quantum collapse occurs?" remains to be elaborated on. Nonetheless we feel we have discovered a clue to dig with, in it. It is that the superluminal wave-like jet velocity $U = \gamma_V V$ is made of the relativistic jet speed $V = c_0\sqrt{1 - v_0^2 / c_0^2}$, and the Lorentz dilation factor $\gamma_V = c_0 / v_0$. U, appears though, to operate as an independent single quantity. Yet, this seems to assume no interference from the outside, with the interacting objects. Any interference seemingly would destroy the entirety of U, and induce its components γ_V and V to get decoupled from each other. This may be a clue for the mysterious quantum mechanical duality. Recall that, the uncertainty, is a mathematical implication of quantum mechanics, whereas the unpredictability, still remains as an assumption, to take care of the quantum collapse, followed by the measurement coming into play. Thus, at this stage, we come to understand that an immediate action at a distance is possible, and it seems to be connected to the wave-particle duality. The quantum collapse phenomenon could perhaps be elaborated on, based on the latter point.

vi. There appears reason to believe that, even when the jet mass is null, which is the case for an object at rest, or in a circular rotation around an attraction center, whatever is the information (we would expect to be) carried by the jet of speed, this information still transferred instantaneously. In other words, the information in question can be transferred, along with no mass exchange in between interacting bodies, whatsoever. One can accordingly conjecture that, were the conditions favorable,

information can be transferred with no need of energy, at all.
vii. At any rate, the wave-like jet speed U, we have introduced, appears to be quite physical, though it varies between infinity (when the velocity v_0 of the object is zero), and null (when the velocity v_0 of the object is c_0, the speed of light).
viii. On the other hand, the jet speed u with respect to (in our latter example) the planet, in a rotational motion around the sun, in conformity with the definition of tachyons, varies between ∞ (were the object in consideration at rest), and c_0 (if the object in hand, moved with the speed of light).
ix. Thus, our approach seems to bring an answer to the quest of “gravitational interaction achieved with a speed much faster than the speed of light”, disclosed more than two centuries ago, by the French Scientist, Pierre-Simon Laplace.
x. Our approach can be equally applied to a macro system or a micro system. For the latter case, it induces yet, the fact that, the mass of the electrically bound electron (contrary to the general wisdom) must decrease, just like the mass of the gravitationally bound celestial object decreases (or vice versa).
xi. But then, the metric must change a nucleus nearby, just like it is altered nearby a celestial body.
xii. The de Broglie wavelength, for a rectilinear motion or, along the ground state of an elliptic orbit, that may come into play, within the frame of a bound system, happens to be equal to ((c_0 / v_0) x (the wavelength λ_0) x $\sqrt{1 - v_0^2 / c_0^2}$ (that is, the Lorentz contraction factor, due to the motion)). It is infinitely long, if there is no motion.
xiii. Every beat delineated by Equation 4, on the basis of the mass m_0, thus coming into play through the intrinsic period of time T_0, covers, not only a space of size λ_0, but concurrently, a space of size λ_B (that is, the de Broglie wavelength).
xiv. This, somehow seems to draw, a “factual tachyonic” type of interaction.
xv. This means that, either gravitationally interacting macroscopic bodies, or electrically interacting microscopic objects, moving with relatively low velocities, interact through an almost immediate action at a distance, and this, in essentially the same way.
xvi. Thus, practically everything in the universe, must affect each other, from very far distances, and this, at speeds much greater than the speed of light, and without any exchange of energy.
xvii. Our conjecture is in full compatibility, with the established theory of Quantum Mechanics, and the Special Theory Relativity. It also seems to concretize the Mach Principle.

It may be checked, with isolated electric charges, sufficiently far away from each other; they should interact with each other, immediately, were the isolation in question, is removed. Screening and unscreening, at will (just like Morse coding), then, may constitute a “communication mean”, seemingly faster than the speed of light. At any rate, it would still be wise to consider such a statement with care.

In effect, it seems legitimate to consider the interaction as a process through which the two objects of concern, somehow, sense each other. Thus, a *“given information”* should insure the sensing mechanism coming into play. According to our approach, whatever this information is, it is supposed to flow with a speed much greater than the speed of light, and with an infinite speed, if the two objects are at rest.

It is to be noted here that all the above discussion and conclusions are valid in a “closed system”.

Hence the following question arises:

- Can we extend the concept of “interaction” to the usual engineering concept of “communication”?

In fact, to communicate, that is, to exchange information at will, one has to have a control on the encoding (embedding the information) and decoding (extracting the information) of the information, one wishes to transfer. Whether this whole process, based on the findings we have presented throughout, can be achieved with speeds faster than the speed of light, should still be elaborated on. In other words, it seems real that two particles at rest can interact at an infinite superluminal speed. But once we attempt to extract the information from a closed system, we need a control over it, and we cannot avoid altering it. Therefore, whether our finding can be used, as the basis of a communication faster than light, should be considered with caution. Although this problem lies beyond the scope of this article; we can still anticipate that, our finding can be used as the basis of a communication faster than the speed of light.

Obviously, the strength of the force of concern, decreases with the square of the distance; thus even if our prediction turns out to be valid, the range of application of it, seems relatively restricted. It seems nonetheless plausible to implement it, to computation faster than the speed of light. We can on the other hand, conjecture the following: Although the energy is conserved, say on an orbit, in the atom, or in the solar system, or elsewhere in a celestial closed system, because energy by nature aims to get minimized, the electron or the planet on a level other than the ground level, tends to get closer to the attraction center (here assumed for simplicity infinitely more massive than the companion in question). We then have a situation exactly in accordance with Bohr's postulate, which is, the electron (or the same the planet) radiates only if it jumps to a lower state!.. And, all other things being equal, it should (most likely, following a determined rotation on the given orbit), keep on jumping to lower states, until it reaches the ground state, as induced by the minimum energy requirement. Here may be the cause for the gravitational radiation.

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APPENDIX A

SOME PROPERTIES OF THE GRAVITATIONAL ATTRACTION LAW ALONG THOSE OF COULOMB FORCE LAW

In Part I (Yarman, 2010b) we have considered Coulomb Force F_{C0} reigning between two static electric charges Ze and e, say a nucleus bearing Z protons and an electron (both, at this stage, assumed at rest), separated by a distance r_0, thus written, in CGS unit system, as

$$F_{C0} = \frac{Ze^2}{r_0^2} \ . \tag{A1}$$

It is important to recall that; i) the electric charges are not altered through the interaction; ii) furthermore Equation A1 is written, as we will soon detail, as referred to an observer, attached to the static electron. We had anyway shown that the 1/distance^2 dependency of Equation A1 happens to be a requirement imposed by the Special Theory of Relativity (STR). It is that, we were able to derive the 1/distance^2 dependency in question, just based on the STR (Yarman, 2008). The underlying reason is merely that, the quantity (force) × (mass) × (distance)^3 (bearing the dimension of the square of the Planck Constant), is Lorentz invariant. Thus, suppose we take an electric dipole, such as a water molecule, at first, entirely at rest, into a uniform translational motion. Consider for simplicity, the case, where the uniform translational motion takes place, along the direction of the line joining the two electric poles of concern. Let the mass coming into play, in the above product, be the mass of the dipole in question. Then, the quantity (mass) × (distance), is Lorentz invariant (given that as mass dilates the length contracts); for this case, accordingly (in view of the Lorentz invariance of the quantity (force) × (mass) × (distance)^3), the quantity (force) × (distance)^2, becomes Lorentz invariant. The electric charges, on the other hand, are - following observations - Lorentz invariant. (In effect, if they were not, in chemical reactions through which the speed of electrons around nuclei, change, the intensity of the charges would consequently change, and no such thing occurs, more essentially if the electric charges were not Lorentz invariant, the Galilean Principle of Relativity would be broken, and accordingly electric charges, just like the speed of light, must remain Lorentz invariant.)

Previously, regarding the pair of statically bound proton and electron, we had disclosed that, we better work in the frame of reference of the (static) electron (Yarman, 2010b), rather than in the frame of reference of the distant observer (for the former, in a world made of the two particles of concern, engaged with each other, constitute, not a special, but a general basis, embodying further, the reference frame of the distant observer, for which the interaction vanishes, as a limit case). Thus, in Equation A1, r_0 is the distance an observer attached to the frame of reference of the (static) electron would measure, in the way we will summarize, right below. (The proton, being too heavy as compared to the electron, was, without any loss of generality, supposed unaltered through the binding process.)

Note that, in our approach the lengths and the periods of time, being affected in just the same way, by the field of concern, the speed of light, is anyway untouched. This facilitates our task of factual measurements.

Thus for instance, r_0 is measured as follows. An observer attached to the static electron, sends a light pulse to the static proton, and records the time his signal takes to go forth and to come back. Considering the speed of light unity; half of the time he records, becomes, his distance to the proton.† His clock though (which is in fact nothing, but the statically bound electron's internal dynamics), works slower than a twin clock situated out there, next to a distant observer.

Therefore, the distance of the electron to the proton, in the frame of the distant observer, is little longer than r_0 (for again, the clock of the distant observer, say a free electron's internal dynamics, works a bit faster than that of the statically bound electron).

On the basis of the similarity between Coulomb force and Newton Force, we are much inclined to pay attention to the fact that, what we do for gravitation, happens indeed to be harmonious, with what we did for electrically bound charges.

Thus, consider the Newton attractional force F_{G0} written for the static masses M_{00}, and m_0, say the sun and earth, here assumed, say instantaneously, at rest with respect to each other, and separated by a distance r_0, as assessed by a local observer on earth. F_{G0} as a first approach would be

$$F_{G0} = \frac{G_{00}\,\mathcal{M}_{00}\,m_0}{r_0^2} \ ; \tag{A2}$$

G_{00} is the proper gravitational constant.

All quantities used herein, are in fact, local quantities, and below, we will review how they are fixed, also how accordingly they should be modified, if assessed by the distant observer. Thereby, the force F_{G0} is a quantity measured locally, by an observer attached to earth. We used the double subscript "$_{00}$" for the gravitational constant G_{00}, and for the mass M_{00} of the Sun, assessed by the local observer, to avoid possible notational confusions. We do the same, in the corps of the text. Equations A1 and A2 constitute a strict parallelism. The product $G_{00}\,\mathcal{M}_{00}\,m_0$ then, must then remain unchanged, as the statically bound mass go closer to the gravitating body, just like Ze^2 is, regardless the observer is the local

† Let us emphasize that in our approach, the speed of light remains untouched, i.e. it is the same for both the distant observer and the local observer, given that, in the field, lenghts and periods of time are altered in just the same way; due to binding, and based on quantum mechanics, they both get stretched by the same amount.

observer, or the distant observer, and we will soon show indeed that such a property holds.

But there are basic characteristic differences, between the frames drawn by Equations A1 and A2, and we should take them carefully into consideration. The essential difference is that, in the first case one works with electric charges and in the second case he works with masses. Along this line, the measurement of the distance r_0 by the local observer with regards to Equation A1 does not constitute any information about any possible change of e; on the contrary, the local observer attached to the electron in this case, firmly deduces that the electron charge is not affected, in anyway. He also knows that the distant observer too, agrees with him that electron charge is left unaltered if he went closer to Ze.

The same is of course true for Ze: Both observers agree that Ze remains the same, no matter what the distance of e to Ze is. For simplicity, but without any loss of generality, we assume that the mass of Ze is infinitely heavier than that of e, so that as e approaches Ze, this latter charge well stays in place. Even if not and we had a third observer attached to Ze, he too would agree with the two other observers that neither Ze nor e, would get changed throughout.

Things are not so, at all, with regards to the local and distant observers making measurements, on the basis of Equation A2. Once the local observer in this latter case, measures his distance to the gravitating body, he can deduce right away that the mass he is attached to, is decreased as much as the static gravitational binding energy coming into play. Thus, contrary to what we affirmed within the framework of Equation A1, in the case of gravitational attraction, both the local observer and the distant observers, will agree that the bound gravitational charge, does not remain unchanged, but is decreased. Henceforth the local observer will reconsider his law of gravitational attraction, that is, Equation A2. He is to plug in, the local gravitational charge, instead of m_0. This has, following his measurement of his distance r_0 to the gravitating body, become $m(r_0)$. But as we will see below, $m(r_0)$ assessed by the local observer, and m(r) assessed by the distant observer, are practically the same quantities.

More essentially (as we will determine below), the local observer will also be aware about how distances are transformed, between the two frames. Thus, once he plugs m(r) in his Equation A2 instead of m_0, he will at the same time consider to plug in r, instead of r_0. None-theless, as we will soon disclose, the local observer, can measure his gravitation constant, being strictly enclosed in his frame (not receiving any information from the outside). Under these circumstances, we would end up, by the law of force $F_{G0} = G_{00}\mathcal{M}_{00}\, m(r)/r^2$ to be proposed by the local observer, following his deduction about the decrease of the rest mass, he is attached to, through his measurement of his distance to the gravitating body.

Note however that, once we convert this latter relationship into that (which we denote by F_G), to be written in the frame of reference of the distant observer; G_{00} will get transformed into a new quantity G, so that the distant observer's gravitational law of attraction will become $F_G = G\mathcal{M}_{00}\, m(r)/r^2$ or $F_G = G_{00}\mathcal{M}_{00}\, m(r)/r_0^2$, for as we will soon derive, $G/G_{00} = r^2/r_0^2$, or the same $G/r^2 = G_{00}/r_0^2$.

One can naturally question why in the expression of F_{G0}, we do not as well change G_{00} (measured by the local observer) into G (measured by the distant observer). The reason is, just the way we are going to show below, that the gravitational constant G, that the distant observer is to plug in his gravitational law, $F_G = G\mathcal{M}_{00}\, m(r)/r^2$, does not remain a constant throughout; in our approach it varies with the altitude, just like mass, unit length, and period of time do, as we will soon, demonstrate it, mathematically.

Note anyway that unlike the electric charges, the gravitational constant is not even a Lorentz invariant constant, and the reason is simply the following. The quantity Ze^2 of Equation A1 and the product Gravitational Constant × First Mass × Second Mass of Equation A2, do have the same dimensions; Ze^2 is Lorentz invariant, but masses are not; this means that the gravitational constant is just not Lorentz invariant. Therefore, it is not really a universal constant the way the electric charges, or the Planck Constant, are. Thus, it is not surprising, if it varies with the altitude, in a gravitational field.

Fortunately, as one writes $F_G = G\mathcal{M}_{00}\, m(r)/r^2$ (expressed by the distant observer), in terms of r_0 (measured by the local observer), as $F_G = G_{00}\mathcal{M}_{00}\, m(r)/r_0^2$ (see right above); then, we do not have to worry about the change in the gravitational constant through the field (for $G_{00,}$ which we can call "proper gravitational constant", measured by the distant observer, in a space free of any gravitational field, between two small balls, asymtothically speaking, can well be considered as a given constant of nature, which do not vary, either, for a local observer measuring it, being strictly imprisoned in his frame, lowered into a gravitational field). This is the reason for which, we will write the gravitational force as assessed by the local observer as, $F_{G0} = G_{00}\mathcal{M}_{00}\, m(r)/r^2$, where we consider ultimately, r and m(r) as measured assessed by the distant observer, but the gravitational constant as assessed locally.

Let us now derive all that.

MEASUREMENT OF LOCAL QUANTITIES

In any case, to insure the similarity between Equations

A1 and A2, as we proposed, to begin with; the quantities G_{00}, $\mathcal{M}_{00}$ and m_0, the product $G_{00}\mathcal{M}_{00}m_0$ embodies, must be determined by an observer attached to the statically bound mass, i.e. in the example we have picked, above, earth. We say statically, for, in our approach, as Newton himself had originally suspected (Newton, 1686), the equality of the masses of the object entering in Newton's gravitational force attraction law, and in Newton's second law of motion, that is, force = mass × acceleration, is accordingly established to be only valid for small velocities of the object revolving around the gravitating body, that is, in our example, earth revolving around the sun (Yarman, 2004, 2006b). More precisely, in our approach, we start out with two, strictly, static (either gravitational or electric) charges, to prove that the 1/distance^2 of the force reigning in between these charges, is a requirement imposed by the STR, and what we assume next, is no more than the law of energy conservation, embodying the mass and energy equivalence of the STR.

Measurement of the proper time $\boldsymbol{\tau_0}$, and the proper distance r_0, as compared to the same quantities, but measured by the distant observer

An observer attached to earth, can measure the distance r_0 of earth to the sun, just the same way summarized above for an observer attached to the electron bound to a proton, and proposing to measure the distance of the electron to the proton (via sending a light signal to the proton and recording the time this takes to go forth and to come back). Thus, an observer attached to earth, can send a signal to the sun, and record how much time his signal takes to go to the Sun, and to come back. Note once again that, the speed of light in our approach remains unaltered. (In effect, in our approach, periods of time and lengths are touched, in exactly the same way).

Thus, considering the speed of light unity; half of the time, the signal, an observer on earth, would send to the sun, takes for a round trip, becomes the distance r_0 of earth to the sun (as measured by the observer on earth). Since the clock of the observer on earth, works slower than that of a distant observer; r_0 measured by the observer on earth, is shorter than the same distance, but assessed by a distant observer. Let us call the latter distance r. Then, we have (Yarman, 2004, 2006b)

$$r = \frac{r_0}{\kappa}, \quad \kappa < 1 \ . \tag{A3}$$

The scaling factor κ, is a quantity we do not yet know, within the framework of this Appendix. It is nevertheless smaller than unity, so that r_0 (assessed by the observer on earth) is shorter than r (assessed by the distant observer). Given that r_0 is measured by the local observer, the "scaling factor" κ, should also be determined in the local frame of reference, but here we will not bother with this detail.

The scaling factor κ determined by the distant observer is anyway, very close to that assessed by the local observer, and for the purpose of the present dissertation, we can well overlook the difference between the two.

Let us further call the unit proper period of time τ_0. This will appear to the distant observer as τ, that is, a bit stretched (Yarman, 2004, 2006b, 2010a):

$$\tau = \frac{\tau_0}{\kappa}, \quad \kappa < 1 \ . \tag{A4}$$

The unit period of time τ as assessed by the distant observer, being stretched, as compared to the unit period of time τ_0 of the distant observer; thereby, the time of the local observer, will run slower than the time of the distant observer.

Note that the unit proper length R_0 is affected just the same way, that is,

$$\mathcal{R} = \frac{\mathcal{R}_0}{\kappa}, \quad \kappa < 1 \ . \tag{A-5}$$

If then R_0 is a stick meter's length measured by the local observer; this length, will become R, as assessed by the distant observer. Note that in our approach, a length is stretched in all directions, by the same given amount $1/\kappa$ (Yarman, 2004, 2006b).

Measurement of the decrease of the proper mass m_0

Suppose now an engine is approaching quasistatically the sun. At a given altitude, not receiving any information from the outside, an observer in the engine will have no way to detect any change on his mass, or the engine's mass. But, via constantly determining his distance to the sun (based on the technique, we have just elaborated on), he will well be able to tell that, due to increasing gravitational binding of his engine to the sun, his engine's rest mass is getting more and more decreased (due to the law of energy conservation embodying the mass and energy equivalence of the STR). Accordingly, he could end up with a relationship, such as Equation 8 of the text, but at this stage, he might not precisely know, how to operate based on the force law, that is, Equation A2 (he will be inclined to alter it, the way we summarized above, and we will detail, such a task, below).

Nevertheless, he can anyway very well tell that, the proper (rest) mass m_0 of the engine, measured at infinity, is decreased by κ, to become $m(r_0)$, at r_0, so that

$$m(r_0) = m_0\kappa, \quad \kappa < 1 \ . \tag{A6}$$

This is, as well, the mass of the engine, determined by the distant observer, were evidently, the distance of the engine to the Sun assessed by the distant observer to be r (and not r_0).

Thus, the observer attached to the engine, measuring his distance r_0 to the sun, is surely capable to predict, what the distant observer, will say about the mass m(r) of the engine (m(r) and $m(r_0)$ being, not rigorously, but practically, the same quantity).

At this stage, it will be useful to further precise the following points:

The observer attached to the engine at rest, at a given altitude, would in effect, not be able to determine that the mass m_0 is decreased, if he did not receive any information from the outside. Thus, for him, enclosed in his engine, the mass of the engine is m_0, originally weighed at infinity. Yet, as soon as he measures his distance r_0 to the Sun, he can right away deduce that m_0 has decreased to become $m(r_0)$.

He should then propose to modify Equation A2, accordingly. He will further consider how to determine his gravitational constant G_{00}, also the mass of the sun M_{00}.

The same of course, occurs, with an observer attached to earth (here assumed at rest, as referred to the sun), when referred to, what, a distant observer would assess. Without the prescription we will draw little below, he would not know, what the distant observer would read about the proper gravitational constant G_{00} he locally measures.

As we will now see, it is important to note that, the gravitational constant G_{00}, can be measured by internal means only (without receiving any information from the outside). In any case, the gravitational constant for the distant observer, if measured out there, in his own frame of reference, is still G_{00}.

Measurement of the gravitational constant by an observer strictly imprisoned in his frame (not receiving any information from the outside)

The observer attached to earth, can measure the proper gravitational constant G_{00}, just like Cavendish did (Standish, 1995). Thus one should, in the proper frame of reference (to earth), measure the gravitational force F_0 acting between two, relatively small, say, equal balls, each weighing m_0, situated at a relatively close distance R_0 to each other, so that

$$G_{00} = \frac{F_0 R_0^2}{m_0^2}. \tag{A7}$$

(Note that m_0 used above, is the mass of Earth, and m_0 used right up here, is the mass of either ball, we use in order to measure the gravitational constant.) The force F_0 manifests as a local torsion force; it bears the dimension $M_0 L_0 T_0^{-2}$.

It is interesting to derive how the local force F_0 will, in return, be assessed by the distant observer, thus, as F:

$$F = MLT^{-2} = \frac{\kappa M_0 \; L_0/\kappa}{\kappa^2 T_0^2} = \frac{F_0}{\kappa^2}. \tag{A8}$$

This means that, when measured locally, the force F_0 is less intense, as compared to the same force F, thus assessed by the distant observer. The decrease factor in question, is κ^2. We can use this result, below, to transform the locally measured gravitational attraction force, to that assessed by the distant observer.

According to the above disclosures, G, as assessed by distant observer - if we considered the quantities, just in terms of their dimensions - will then, turn out to be:

$$G = \frac{MLT^{-2} R^2}{m^2} = \frac{\kappa M_0 \; L_0/\kappa \quad R_0^2/\kappa^2}{\kappa^2 m_0^2 T_0^2/\kappa^2} = \frac{G_{00}}{\kappa^2}; \tag{A9}$$

the quantities without subscripts are, those assessed by the distant observer.

The conclusion is that, the “universal gravitational constant” is not as universal, as one may think, it is. The local gravitational constant G_{00}, if assessed by the distant observer, thus as G, is greater than the one the distant observer would measure in his frame, as much as $1/\kappa^2$.

Note that the proper gravitational constant G_{00} is, as well, the gravitational constant the distant observer would measure, if he performed the Cavendish experiment in practically free space, say, in a freely floating spaceship, out there.

Measurement of the mass of the sun

One way an observer on earth can, in principle, measure the mass of the sun, is the following. We say, “in principle”, for we basically wish to see just how, different quantities considered in terms of their dimensions are modified, in conformity, with the transformation relationships, we stated above.

Thus, via a Newton’s elementary approach, applied to earth, rotating around the sun bearing the mass M_{00}, referred to an observer attached to earth, we propose to measure M_{00} locally on earth. This planet completes one revolution around the sun, in a period of time T_0, still measured locally on earth. We suppose for simplicity (though without any loss of generality), that, earth moves in a circular orbit, of radius r_0, which is still locally measured. Therefore, via Newton’s second law of motion and Newton’s law of gravitational attraction, we can right away write

$$\mathcal{M}_{00} = \frac{4\pi^2 r_0^3}{G_{00} T_0^2}. \tag{A10}$$

Therefore, as assessed by the distant observer, this mass, will become

$$\mathcal{M} = \frac{4\pi^3 r^3}{GT^2} = \frac{4\pi^3 r_0^3/\kappa^3}{G_{00}/\kappa^2\, T_0^2/\kappa^2} = \kappa\frac{4\pi^3 r_0^3}{G_{00} T_0^2} = \kappa\mathcal{M}_{00} \;; \qquad \text{(A11)}$$

here again, the quantities without subscripts are, those assessed by the distant observer.

The conclusion is, thereby, the following. The mass M of the sun as assessed by the distant observer becomes κ M_{00}, where M_{00} is the mass measured by the local observer on earth (the coefficient κ, once again, being smaller than unity). It is obvious however that, M and M_{00} are practically the same, were m_0 infinitely very small as compared to M_{00} , no matter how small κ may be; it is that, infinity x anything (different than zero), is still infinity

CHECKING, THE INVARIANCE OF THE QUANTITY $G_0M_{00}m_0$, AT A FIXED ALTITUDE, STRICTLY CLOSED TO THE OUTSIDE WORLD

One important corner stone about the similarity between Equations A1 and A2, must be the invariance of the quantity $G_{00}M_{00}m_0$, considered, when embedded in the "gravitational field", created by M_{00}, versus the invariance of the product of electric charges Ze^2, considered when embedded in an electric field created by Ze, essentially based on the invariance of the speed of light.

Let us now see whether $G_{00}M_{00}m_0$ stays, in effect, invariant:

$$G_{00}\mathcal{M}_{00}m_0 = \frac{\kappa^2 G\mathcal{M}m(r_0)}{\kappa\kappa} = G\mathcal{M}m(r_0) = \frac{G_{00}}{\kappa^2}\kappa\mathcal{M}_{00}\kappa m_0 = G_{00}\mathcal{M}_{00}m_0 \;. \qquad \text{(A12)}$$

This is cute indeed, for we have come to demonstrate that the product $G_{00}M_{00}m_0$, stays invariant in the "gavitational field" created by M_{00}, just like the product of electric charges (Ze)e, does in the "electric field" created by Ze.

This was one thing we wanted to prove in this Appendix. But the fundamental problem, with respect to the law of gravitational attraction, is still left to be elucidated.

THE FUNDAMENTAL PROBLEM: THE LAW OF GRAVITATIONAL ATTRACTION WITH RESPECT TO THE LOCAL OBSERVER, AND WITH RESPECT TO THE DISTANT OBSERVER

Whereas Equation A2 remains valid for the observer at rest, at a fixed altitude, entirely closed to the outside world, he must still send a light signal to the gravitating body, in order to determine r_0. By doing that, he can though determine immediately that, the mass m_0 measured at infinity, must have been decreased.

Then, what is really the law of gravitational attraction force, the local observer is to adopt? In other words, somehow, he better incorporates with Equation A2, the decreased mass $m(r_0)$, and not really m_0.

Furthermore, ultimately, we should visualize to jump to the stage of the distant observer, in order to frame the law of gravitational attraction force, the way this latter observer, will assess.

Thereby (our proof with regards to the validity of the local constancy of $G_{00}M_{00}m_0$ being, "gravitationally" speaking, still valid, for frames strictly "closed" to the outside world); in the perspective of the foregoing discussion, instead of Equation A2, at this stage, it seems more legitimate to write for the local observer, quasistatically approaching the gravitating body of mass M_{00} (and measuring gradually how close he gets to it, the way we explained above); the gravitational attraction force, as:

$$F_{G0} = \frac{G_{00}\mathcal{M}_{00}m(r)}{r^2} \;. \qquad \text{(A13)}$$

(written for the local observer, along with the locally measured gravitational constant, although the distance r, is that measured by the distant observer, but deduced locally)

Why is this expression valid for the local observer, in spite of the fact that, at a first glance, all of the parameters incorporated with it, except G_{00}, are those of the distant observer? For one thing, the local observer can deduce that the distant observer would guess the following. The local observer would indeed measure the proper gravitational constant as G_{00}, the mass of the gravitating body as M_{00}, the mass of the object he is at, as m(r), and his distance to M_{00} (via Equation A3) as r. Notice anyway that, G_{00} is the gravitational constant measured locally, and via just local means, that is, not needing any outside information (see above, Equation A7). The other quantities appearing in Equation A13 are all deduced locally, but receiving information from the outside.

Equation A13 points evidently, to a slightly different law, than that expressed by Equation A2. However, as soon as the local observer determines his distance r_0 (locally, as explained above), to the gravitating source of mass M_{00}, he will come out immediately with the following related information: i) $r = r_0/\kappa$, ii) $m(r_0) = m_0\kappa$, and iii) M_{00} remains unchanged given that, it is anyway infinitely more massive than m_0.

Henceforth, via following the special relativistic steps we summarized at the beginning of this appendix, with regards to framing the 1/distance^2 dependency of the force law, he would finally come out with Equation A13, thus well valid locally. Note that the act modifying masses via receiving information from the outside, evidently kills the invariance of $G_{00}\mathcal{M}_{00}m_0$, that comes into play, through just local measurements, that can be converted by the distant observer, through rules we have established above, with respect to the transformations of masses, lengths and periods of time.

In view of Equation A8, we can anticipate that the same force, but as assessed by the distant observer, will be written as

$$F_G = \frac{F_{G0}}{\kappa^2} = \frac{G_{00}\,\mathcal{M}_{00}\,m(r)}{r^2\,\kappa^2} = \frac{G\,\mathcal{M}_{00}\,m(r)}{r^2} = \frac{G_{00}\,\mathcal{M}_{00}\,m(r_0)}{r_0^2} \qquad \text{(A14)}$$

(written for the distant observer, along with the locally measured gravitational constant)

And this coins, the framework, we had adopted previously (Yarman, 2004, 2006b).

One could, as well obtain this result, first writing the gravitation attraction force as referred to the distant observer:

$$F_G = \frac{G\,\mathcal{M}_{00}\,m(r)}{r^2} , \qquad \text{(A15)}$$

and then via plugging here, instead of r, the RHS of Equation (A-3), and finally using Equation (A9):

$$F_G = \frac{G\,\mathcal{M}_{00}\,m(r)}{r^2} = \frac{G\,\mathcal{M}_{00}\,m(r)}{r_0^2/\kappa^2} = \frac{G_{00}\,\mathcal{M}_{00}\,m(r_0)}{r_0^2} . \qquad \text{(A16)}$$

This, having bypassed Equation A8 (or having justified it), evidently constitutes, a comforting cross check.

Here, it is interesting to see that, for the distant observer, G_{00}, measured by the local observer, is transformed according to Equation A9, derived above, to become $G = G_{00}/\kappa^2$. An alternative way to express the issuing law, is to keep the proper gravitational constant G_{00}, as it is, or the same, the way it would have been determined out there, in a space, free of any surrounding gravitational field, but then modify instead r, as $r = r_0/\kappa$, which then finally leads to the last part of the RHS of Equation A14.

The gauche picture, related to the fact that the gravitational law, we coined for the local observer embodies r (and not r_0), and that we coined for the distant observer, embodies r_0 (and not r); particularly comes from the fact that, having G together with r, as assessed by the distant observer in the expression of the attraction law, comes to be equivalent to having G_{00} together with r_0, in the same law (still as assessed by the distant observer). In other words the gravitational law of attraction force F_G, as assessed by the distant observer in our approach, is $F_G = G\,\mathcal{M}_{00}\,m(r)/r^2$. But this is the same as $F_G = G_{00}\,\mathcal{M}_{00}\,m(r)/r_0^2$, for (via Equations A3 and A9) one can write, $G/G_{00} = r^2/r_0^2$, or the same $G/r^2 = G_{00}/r_0^2$. Let us emphasize that:

i) the mass M_{00}, being infinitely more massive than m_0, should anyway stay unaffected throughout;
ii) along the same line, the observer attached to earth, will further know that, as he (the way we have assumed), quasistatically approaches, toward the sun, this latter does not practically move, meaning that the total rest mass deficit, delineated by the process in question, must be accounted for, by the rest mass decrease delineated by earth, alone (Garret and Yarman, 2008);
iii) furthermore, m(r) and $m(r_0)$ are practically equal, to each other.

DERIVATION OF THE SCALING FACTOR

Equation A14 allows us to finally determine κ:

$$\frac{G_{00}\,\mathcal{M}_{00}\,m(r)}{r^2}dr = c_0^2 dm(r) \quad . \qquad \text{(A17)}$$

This leads to Equation 8 of the text:

$$m(r) = m_0 e^{-\alpha(r)} , \qquad \text{(A18)}$$

(mass of the bound object at rest)

where $\alpha(r)$ is $G_{00}\,\mathcal{M}_{00}/(rc_0^2)$ (cf. Equation 9 of the text). Therefore the coefficient κ becomes:

$$\kappa = e^{-\alpha(r)} . \qquad \text{(A19)}$$

Note further that one way or the other, one still ends up with the derivation of de Broglie relationship, provided in the text, as we will show in the subsequent appendix. Nevertheless, the specific derivation of de Broglie relationship, we provided in this article, particularly shows that the gravitational field, just like the electric field, is quantized, and this in exactly the same manner the electric field is.

The fact that our derivation in fact applies to any force field, furthermore, offers a symbiosis with no equal, of all fields, as well as that of disciplines such as STR and Quantum Mechanics, so far classified separately from each other, despite the current amalgamic usage of these latter two disciplines. We show this, in the next appendix. Here we find it interesting to note the following: As seen from Table A1, the fact that the force as assessed by the distant observer, increases in parallel to the increase of the gravitational constant, evokes a clue toward the understanding of "dark energy". Indeed, as the universe expands, an observer on Earth, will take more and more the place of a distant observer, and the gravitational force he would assess between two-far-out layers of the universe, would keep on going more and more intense. The inner layer would then appear to get accelerated outward. Before we close this appendix, we would like to summarize different findings presented in the Table A1.

Table A1. Different quantities in the local frame and distant observer's frame.

Quantity	Measured in the local frame of the bound object	Measured in the distant frame	Related properties
Scaling factor	$\kappa_0 < 1$	$\kappa < 1$	$\kappa \cong \kappa_0$
Mass of the Gravitating Body	M_{00}	M	$\mathcal{M} = \kappa \mathcal{M}_0$
Mass of the bound object	m_0	m	$m = \kappa m_0$
Unit length	R_0	R	$\mathcal{R} = \mathcal{R}_0 / \kappa$
Unit period of time	τ_0	τ	$\tau = \tau_0 / \kappa$
Distance of the bound object to the gravitating body	r_0	r	$r = r_0/\kappa$
Mass of the Cavendish balls used to measure the local gravitational constant*	m_0	m	$m = \kappa m_0$
Distance between the Cavendish balls	R_0	R	$R = R_0/\kappa$
Gravitational force between the (two Equal) Cavendish balls	F_0	F	$F = F_0 / \kappa^2$
Gravitational constant measured through Cavendish experiment	G_{00}		$G = G_{00}/\kappa^2$
Gravitational force between the static gravitating body and the static bound object	$F_{G0} = \dfrac{G_{00} \mathcal{M}_{00} m(r)}{r^2}$	$F_G = \dfrac{G \mathcal{M}_{00} m(r)}{r^2} = \dfrac{G_{00} \mathcal{M}_{00} m(r)}{r_0^2}$	$F_G = F_{G0}/\kappa^2$, $G/G_{00} = r^2/r_0^2$, or the same $G/r^2 = G_{00}/r_0^2$
The scaling factor derived from the established law	$\kappa_0 = e^{-\alpha(r_0)}$, $\alpha(r_0) = \dfrac{\mathcal{M}_{00}}{r_0 c_0^2}$	$\kappa = e^{-\alpha(r)}$, $\alpha(r) = \dfrac{\mathcal{M}_{00}}{r c_0^2}$	$\alpha(r) \cong \alpha(r_0)$ $(\kappa \cong \kappa_0)$

* this quantity is measured without receiving any information from the outside, thus strictly locally.

APPENDIX B

THE DERIVATION FO THE DE BROGLIE RELATIONSHIP WE PRESENTED FOR ELECTRICALLY AND GRAVITATIONALLY BOUND PARTICLES, HOLDS IN FACT GENERALLY FOR ALL KINDS OF INTERACTIONS: THENCE THEY ALL ARE QUANTIZED

The dumping of a minimal rest mass in any attractive force field, owing to the law of energy conservation, embodying the mass and energy equivalence of the Special Theory of Relativity (STR) well leads to the de Broglie relationship, via a superluminal speed that arises throughout (Yarman, 2009, 2010b).

We can thus write, the overall relativistic energy $m_\gamma(r) c_0^2$, in such a force field, along with the familiar notation, as;

Table B1. Static binding energy.

	Electric field	Gravitational field
Static binding Energy B(r)/(rest energy free of field)	$\frac{Ze^2}{r\,m_0c^2}$	$1-\exp\left[-G_{00}M_{00}/(rc_0^2)\right]$

$$m_\gamma(r)\,c_0^2 = m_0c_0^2\frac{1-B(r)/m_0c_0^2}{\sqrt{1-v^2/c_0^2}} = \text{Constant} \quad , \qquad \text{(B1)}$$

where B(r) is the static binding energy of the object at hand, to the field in consideration (herein we will overlook the nuance between an assessment made in the local frame and that made in the distant frame, for it becomes fortunately unessential with respect to the derivation we will provide).

We will denominate the overall relativistic energy as just $m_\gamma c^2$, given that it remains constant, in a closed system. The constancy here, is evidently nothing else, but the expression of the relativistic energy conservation. In Table B1, we sketch expressions for static binding energy (divided by the rest energy of the object, in a location free of any field), with regards to the cases pertaining to an electric field, and a gravitational field. Recall that the derivation we present herein is in fact, valid for any field. The static binding energy regarding, say an electron of charge e, in the electric field of a nucleus of charge Ze, is calculated likewise, as the energy to be furnished to the electron, to carry it quasistatically from a distance r, to the center of the nucleus to infinity.

Note that the constant in the case, say of an object placed at the edge of a rotating disc, is just the original rest energy $m_0c_0^2$, of the object. In other words, according to our approach, bringing an object to a rotational motion, evidently, does not only consist in bringing it, into the instantaneous tangential motion it will delineate, but at the same time, it consists in bringing it, into the accelerational field that would come into play. This latter act means, via delivering to the object its rotational motion, we come to pump a minimal rest mass out of it, causing its rotational kinetic energy. The rest mass decrease of concern could be observed by an observer situated near the center of rotation of the disc, and rotating with the object with the same angular velocity (Yarman et al., 2007).

In any case, the differentiation of the above relationship leads to

$$dB(r)\sqrt{1-v_0^2/c_0^2} = m_\gamma v dv\,. \qquad \text{(B2)}$$

The change in the binding energy with respect to the field in consideration (whichever it may be), means a mass deficit (with opposite sign):

$$dB(r) = -c_0^2 dm(r)\,. \qquad \text{(B-3)}$$

The infinitely small rest mass change $|dm(r)|$ well corresponds to a factual infinitesimal rest mass. We have discussed in the text how such a rest mass is dumped or piled throughout a given gravitational motion. The case of an electric field was considered in Part I, of the present article (Yarman, 2010 b).

For a change, let us now consider our object, at the location r, from the center of a disc; we suppose both at rest, at the beginning. Though next, we bring them to a rotation altogether, while they are still at rest with respect to each other. Thus the object is situated at the same place, but it is brought gradually, into a rotation together with the disc. As the rotational velocity increases, as explained briefly little above, the object gets bound more and more strongly to the growing centrifugal field, and according, to our approach, a rest mass is dumped, out of it, and this, as much as the centrifugal binding energy coming into play.

In order to account for the rest mass deficit in question coupled with the increase in the rotational kinetic energy coming into play, we associate a momentum kick with the infinitesimal rest mass –dm(r), dumped out, to secure the overall tangential momentum conservation:

$$m_\gamma dv = -dm(r)\,U \quad , \qquad \text{(B4)}$$

where U is a tangential velocity, to the itinerary, being the basis of this equality.

Note that the overall relativistic energy m_γ of the object, in our approach, is constant throughout. We made it so that, in order to speed up along the direction of motion, as much as dv, the object has thrown from its back the rest mass –dm(r), at the location r. We will discover once again that U becomes even independent of the mass –dm(r). Accordingly, Equation B4 becomes an artifact we introduce, to concretize the rest mass decrease, in the field the object is bound to, along with the law of relativistic conservation of momentum.

In any case, the rest mass decrease is a must imposed by the relativistic law of energy conservation.

Rigorously speaking, Equation B4 should be written in vector form, as (cf. the text)

$$m_\gamma d\,\underline{v} = dm(r)\underline{U} \quad . \tag{B5}$$

Here U lies in the same direction as the radial vector $d\,\underline{v}$. U becomes the tangential component of U, but one has to be careful, with regards to a stationary circular motion, since, through such motion, both (the scalar) dv and dm are null.

Thus, U must become infinite to secure a finite LHS in the above equation, and as explained in the text, we have here, perhaps a concretization of the Mach Principle (Mach, 1906). Anyway, the tangential component of U, that is, $U = \left|\cos\theta\,\underline{U}\right|$ (θ being the angle U makes with the tangent) is still (as a result of, zero (for the cosine) × infinity (for the magnitude of U)), finite, thus well matching Equation B4. Thence, in any case, U is finite. Equations 9, 10 and 11 lead to;

$$U = \frac{c_0^2}{v}\sqrt{1 - v^2/c_0^2} \quad . \tag{B6}$$

Right here, we arrived to it, via not having to assume any specific field. In effect, the purpose of this Appendix, was to show that the derivation we have provided, for an electric field, in Part I for electrically bound particles, and in here (Part II), for gravitationally bound particles, is in fact general, and can be extended to any field; we do not even have to precise what field we exactly deal with. Thence, while we could provide a general derivation, the way we sketched in this appendix, we had anyway to discuss various peculiarities our derivation draws with regards to the classical concepts used through electric and gravitational existing theories, given that we alter considerably the established understanding, but at the same time luckily unify the micro and the macro worlds, in an unequal way, and this based on just the relativistic law of energy conservation.