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GENERALIZED LORENTZ GROUP OF SPACE-TIME TRNSFORMATIONS

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ABSTRACT

Gravitational interaction between particles must break Lorentz Symmetry (LS), as well as per Yarman's Approach that forms the basis of YARK (Yarman-Arik-Kholmetskii) theory of gravity. This approach, being general, just as at the atomistic level, so too in gravitation will LS always break down under Yarman's Approach. All the while, General Theory of Relativity (GTR) is known to already break LS; still, its violation in gravitation according to YARK points to a different mechanism than it does under GTR. Said mechanism can be right away extended to all other interactional fields. The core finding herein is that the customary Lorentz transformations, and the proper Minkowskian metric resulting from them, should be replaced by general equalities involving a novel interactional coupling parameter emerging out of Yarman's Approach.

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1. INTRODUCTION

"Symmetry" is principally correlated with conservation laws in physics, and especially with laws such as energy, momentum, angular momentum, and charge conservation. There are of course other kinds of fundamental symmetries in nature as well. One such symmetry is "Lorentz Symmetry" (LS). In the recent past, it was suggested that Lorentz Invariance should anyway be an "approximate symmetry" of nature.[1,2,3]

Case in point, it is well known that General Theory of Relativity (GTR) breaks LS. It is simple to understand how this happens. If, for the sake of demonstration, "Captain Kirk" is parked in gravitation, and "Captain Picard" watches him from some remote distance, with both being at rest with respect to each other, then, based on GTR, they would both agree that Captain Kirk's watch runs slower, and his stick meter (along the direction of the gravity pull) is contracted; or the same, they would both agree that Captain Picard's watch runs faster, and his stick meter (along the same direction, still according to GTR) is elongated.

Whereas, if either were in a state of uniform translational motion in free space with respect to the other, a faultless symmetry would reign between them. In other words, in such a state, both would measure the other's time as dilated, and both would measure the other's stick meter as contracted (e.g., along the direction of motion).

In case they came to rest, there would be just one time and one stick meter for both.

This is yet not the case when Captain Kirk is parked in gravity and Captain Pickard is parked at a remote distance away from any gravity (or vice versa); or the same, when they are both embedded in gravity, still at rest, but at different altitudes.

Were they to move, with each being at different altitudes, no LS would hold up; for such a symmetry is, for one thing, already broken when they were initially at rest at different altitudes to begin with.

On the other hand, based on YARK, the violation of Lorentz symmetry in gravitation takes place differently than it does in GTR; for YARK operates straightly through “integral forms” – i.e. not differential forms – of “time” and “space”, whereas GTR foundationally starts up with and operates through “differential forms” of “time” and “space” before eventually landing at their integral forms (though only whenever viable).

As we shall see further below, YARK theory, built on Yarman’s approach, also betokens the violation of LS in gravitation, and its core principles can right away be extended to all other fields of interaction.

Let us briefly recall that, Lorentz transformations were mathematically framed by Poincaré to account for the anomalous result of the Michelson-Morley experiment.[4] These transformations, in modern notation, and with regards to boosting a particle in a given direction, were in effect furnished by Poincaré in 1905.[5] Historically, Poincaré named them “Lorentz transformations” because of the respect he held for his mentor.

Lorentz Symmetry was then first used in physics by Einstein to construct his special theory of relativity (STR).[6] Einstein worked out the consequences of the LS and he concluded that length and time must be altered, yet *symmetrically*, when two observers move relative to each other. Lorentz transformations thusly describe how measurements of space and time obtained by two different observers are related to the velocity of the uniform translational motion of one of them as gauged by the other.

All the same, Lorentz transformations, the way they had originally been forged, do not tell anything about space and time variations when the observers interact with each other. Concomitantly, it has been proven that *CPT (Charge-Parity-Time) violation* implies that the theory breaks LS.[7,8]

Recall further that, CPT symmetry is what holds unchanged under the inversion of *charge*, *parity* and *time* simultaneously.

One good example of CPT violation is the one we can pick from the lepton sector; it is defined by the difference between the form factors of the electron and the positron:[9,10]

$$(g_{e+} - g_e) / < g_e > = (-0.5 \pm 2.1) \times 10^{-12} \, .$$

Nowadays, new experimental techniques are used to search for clues in the violation of Lorentz invariance at low energies, and they may well corroborate the expectation that Lorentz invariance should indeed be violated as such.[11,12]

Bound muon decay rate retardation is one interesting area to check the violation of Lorentz invariance in the atomistic world, via Yarman’s Approach. When a muon interacts with and is caught by a nucleus, the muon’s decay rate gets retarded; in other words its decay half-life is prolonged in contrast to its unbound siblings.[13,14,15,16]

This is one example where the electric field of the nucleus appears to affect space and time in just the same way as gravitation does.[17] As we shall soon see below, under the framework of Yarman’s Approach extended to gravitation in YARK theory, this is indeed what transpires. The common feature in either the atomistic or the celestial scale, and effectively, in all interactional cases, is that *binding through interaction* must, according to Yarman’s Approach, alter space and time inasmuch as invalidating Lorentz symmetry. The same occurs in the case of alpha particles richocheting from the “repulsive field” of gold atoms, where the "repulsive energy" is stored inside the alpha particle, again, as per Yarman's Approach.[18]

As Yarman had shown at the outset (see below), what happens throughout binding is that the "rest mass" *(or the same, "rest energy" were the velocity of light taken as unity)* of the bound object is decreased owing to the law of energy conservation embodying the mass and energy equivalence of the Special Theory of Relativity (STR) as much as the static binding energy the client object cedes.

When such "rest mass decrease" coming into play is inserted into the quantum mechanical description of the client object, the related "total energy eigenvalue" is decreased as much, hence pointing to a "stretching of the period of time" of the internal dynamics the object at hand delineates, and conjointly to a "stretching of its size" just as much.[19,20] Recall that Yarman's approach is just as well applicable to a repulsive field (in which case, the rest mass of the ricocheted alpha particle would conversely increase).

Notice that, none of the available explanations given for bound muon decay rate retadation in the cited references [13-16] were satisfactory enough to explain the phenomenon.

Concurrently, Yarman, already having predicted it theoretically, has been the first who provided a simple explanation through his anticipation that any bound particle must undergo a "rest mass" (or the same – *taking the speed of light in vacuum as unity* – a "rest energy") decrease commensurate with the "static binding energy" the object transactions. With this in mind, a number of discrepancies between theory and experiment were easily overcome in quantum mechanics as such.[21,22,23,24,25]

This already points to the fact that a free clock (e.g., an unbound muon) and its twin bound to an electric field (e.g., a bound muon) sitting in an isolated chamber, where an electric field reigns, ought to run at different paces as per Yarman's approach. In other words, the bound clock runs slower while a free clock runs faster.

Suppose we attach observers to these clocks / muons at hand when they are at rest with respect to each other. It is not that Lorentz Symmetry really breaks thereafter as they are put in motion; it is essentially that Lorentz Symmetry was never there to begin with.

Thence, the question we pose here is this: "How can we write Lorentz transformations related to two interacting objects?" We will provide an answer to this question within the framework of YARK, starting with gravitational interaction first, with yet no loss of generality.

Before we proceed, it would be useful to present a brief summary of YARK theory.

2. YARK GRAVITATION THEORY: BASIC CONCEPTS

In our previous papers,[26,27,28,29,30] we have gone over how YARK theory is based on the original "Universal Matter Architecture" and the subsequent "Yarman's Approach" framework developed by Yarman,[31,32,33,34,35,36,37,38] and then advanced together with his colleagues.[39,40,41,42,43,44,45,46,47,48] For the sake of convenience, we reproduce below some important points of this theory in order to stress its physical meaning.

The root postulate of YARK theory states that the overall energy of the object with the proper mass *m* initially measured at an infinitely far away distance from all other masses in the presence of gravity acquires the form [29, 30]

$$E = \gamma mc^2 \left(1 - E_B / mc^2\right), \tag{1}$$

where ¥ is the Lorentz factor associated with the motion of the test object, and E_B represents the "static binding energy" defined as the work one has to carry out in order to bring the object quasi-statically from infinity to the given location.

In fact, eq. (1) states that the rest mass *m* of the object is not a constant, but is rather altered within the gravitational environment of concern by the value E_B/mc^2 owing to the law of energy conservation as assessed by the remote observer. Such a postulate also implies that the gravitational energy is localized inside interacting particles rather than getting distributed in the surrounding space.

Further, due to Yarman's intrinsic quantum mechanical relationships between the quantities "mass", "energy", "frequency", "time", and "size", the variation of the rest mass of a test particle by the static binding energy (1) affects the time rate for the particle, and furnishes a corresponding transformation of spatial intervals in the presence of gravity [29, 30, 34, 35].

Hence, the variation of the rest mass of a test particle by the static binding energy does, in effect, alter – just like in metric theories of gravity – the metric of space-time in YARK theory. In particular, in the radially-symmetric case, we have [29, 30]

$$t = t_0 e^{\alpha} \,,\; r = r_0 e^{\alpha} \,, \qquad (2)$$

where t_0, r_0 stand for the corresponding quantities in the absence of gravity. By the same token, they are proper quantities measured by the observer attached to the test mass *m*. Let us recall here that $\alpha = GM/rc^2$.

Note that the usual *squared space-time interval* $s_0^{\;2}$ in *empty space* is

$$s_0^{\;2} = c^2 t_0^{\;2} - r_0^{\;2} \,. \qquad (3a)$$

Based on eq. (2), YARK's squared space-time interval s^2 in the presence of gravity thusly becomes

$$s^2 = s_0^{\;2} e^{2\alpha} \,. \qquad (3b)$$

We will particularly elaborate on this *precious result* in order to achieve the goal of the current paper.

Further differentiation of eq. (3b) defines the *post hoc* geometry of space-time in YARK theory.

At the same time, we emphasize that, unlike GTR, YARK's metric properties of space-time do not play a decisive role in the determination of the motion of objects in the gravitational environment. This statement can already be demonstrated by the fact that, for a test particle *m* moving in a gravitational field created by a considerably heavy host mass $M \gg m$ (i.e., the one-body problem), the motional equation of the test particle can be derived straightforwardly via the differentiation of eq. (1) – *as had been originally done by Yarman in refs.* [29, 30] – independently from the metric properties of space-time. Indeed, due to the energy conservation law for the isolated system of interacting objects *m* and *M* at $M \gg m$, the time derivative of the right hand side of eq. (1) should be equated to zero, which directly yields the motional equation of the test particle *m* without necessitating an *ad hoc* determination of the metric of space-time. This indicates, in particular, that YARK, unlike GTR, is not a purely metric theory, but rather subsumes the properties of dynamic and metric theories (see, e.g., [29, 30, 38]).

The derivation of the motional equation of the particle *m* in the presence of gravity (which can be straightforwardly extended to the interaction of many bodies) can be based on the minimization of the action as usual, but only after the YARK outcome of Eq.(1) is known. For those who are accustomed to follow that line of reasoning, we have produced it in Ref. 28, so much so that we would like to skip it over here.

In any case, as we had previously shown,[49] under the framework of YARK theory, the same conclusion (*i.e.*, the independence of the motional equation of the particle from its rest mass in the presence of gravity) remains in force in the general case of the many-body problem, too. This means that the weak equivalence principle (WEP) is perfectly fulfilled in YARK theory [29, 30, 38, 24]. In addition, it is important to emphasize that YARK theory is fully compatible with the foundational premises of STR [29, 30] to the extent that it satisfies both local Lorentz invariance and local position invariance. Therefore, YARK theory is wholly compatible with the Einstein equivalence principle (EEP), too.

At the same time, the physical meaning of the EEP in YARK theory – which combines the properties of dynamic and metric theories – is different as referred to purely metric theories of gravity such as GTR. In particular, the dynamical side of YARK signifies that, in the case where the gravitational force experienced by a particle in a chosen frame of observation is not equal to zero, then, it does not disappear in any other frame, including the frame of free fall of the particle,[50] In the latter case, the gravitational force is "sensed" by the particle through the variation of its rest mass even if it is exactly counterbalanced by a *fictitious force* existing in an accelerated frame of this particle. This means, in essence, that gravitational energy, contrary to what GTR delineates, can indeed be localized. Therefore, we see that the EEP does not, in general, make it requisite that only purely metric theories of gravity should be adopted; compliance to it in YARK theory is, as we have seen, assured by the existence of such a reference frame wherein, at each four-point, the force of gravity can be exactly counterbalanced by a fictitious force as experienced by the particle in this frame.

To elucidate what we mean by the localization of gravitational energy, we first compare eq. (17) with the known expression of GTR for the energy of the test particle in a gravitational field,[51] *i.e.*,

$$E_{GTR} = ¥mc^2\sqrt{1-2\alpha}\,, \tag{4}$$

and find that the terms describing the effect of gravity in these equations coincide with each other up to the accuracy of c^{-3} ($me^{-\alpha} \cong m\sqrt{1-2\alpha} \cong m(1-\alpha)$). Thus, with respect to many implementations, GTR and YARK do converge in the limit of a weak gravitational field, and, in particular, both provide successful explanations for gravitational redshift, gravitational lensing, Shapiro delay and precession of the perihelion of Mercury (see, e.g., [30-31, 33-34, [52]). One should also mention that YARK theory also achieved considerable successes in the explanation of modern observations where the weak relativistic limit is abandoned (e.g., derivation of the alternating sign for the accelerated expansion of the Universe without the need to involve a notion of "dark energy" [39]; presentation of the Hubble constant in an analytical form [39]; elimination of the information paradox for black holes of the YARK type [[53]]; and the abnormal redshift of the star S0-2 as it orbits the central supermassive blackhole of our Milkyway galaxy[54]). What is more, YARK theory remains the only alternative to GTR which provides an adequate account of the GW150914 and GW151226 signals of LIGO beyond the hypothesis about gravitational waves.[55]

Besides these, we wish to spotlight two very recent experimental facts – the extra-energy shift between emission and absorption resonant lines in a rotating system,[56,57,58] and the practically null bending of high-energy ¥-quanta under Earth's gravity[59] – both of which have found a successful explanation under YARK theory,[60] while they still remain as puzzles within the framework of GTR.[61,62]

Finally, we stress that YARK theory of gravity is in natural symbiosis with quantum mechanics[63]; this fact definitely reflects advantages in combining metric and dynamical approaches in comparison with the purely metric approach of extended theories of gravity.

3. LORENTZ TRANSFORMATIONS: DERIVATION OF THE YARK RELATIONSHIP $s=s_0exp(\alpha)$ THAT ENTAILS THE *INVALIDATION* OF LORENTZ SYMMETRY (LS) IN ALL KINDS OF INTERACTIONS

One well-known example of the violation of Lorentz invariance is the familiar expression for the total energy of an Hydrogen (H) atom. In this atom of mass m_H, according to the simplest visualization, there is one proton of mass m_p, and one electron of mass m_e which may be thought to rotate around the proton at a distance r to it. So the total energy of the system can be written, *in the CGS unit system*, as

$$m_pc^2 + \gamma_e m_e c^2 - e^2/r = m_H c^2\,, \tag{5}$$

with γ_e being the Lorentz coefficient that we associated with the tangential velocity delineated by the electron around the proton, and c being the velocity of light in vacuum.

This equality, when the atom is delivered a uniform translational motion, indeed breaks down, since the masses of concern will be multiplied by the Lorentz coefficient γ corresponding to that motion, whereas the radius r is contracted by the inverse of γ – yet only along the direction of motion.

The derivation of the violation of LS, as we will soon provide below, is not restricted to gravitation, and can be applied to any field the object at hand is embedded into. All the same, it would be helpful to specify the field we are dealing with; accordingly, we shall hereby pursue calculations in a gravitational field.

As per YARK, at a given location in gravity, lengths and periods of time are altered in just the same way [cf. eq. (2)]; both are stretched as much as, in effect, the static binding enery coming into play. This precisely takes place due to the rest mass decrease in gravity owing to the law of energy conservation embodying the mass and energy equivalence of the STR as framed by YARK (which is very unfortunately given up in GTR). And when, for the location of concern, the "rest mass decrease" in, say, an H atom is inputted into its quantum mechanical description, then its total energy (eigenvalue), as well as the spatial dimensions it is structured in, are stretched by exactly the same amount.

In YARK, size stretching, unlike what the foundations of GTR delineates, is uniform; that is, in YARK, spatial dimensions stretch the same in all directions.

Before defining the related transformations under gravity, let us state the usual plain Lorentz transformations:

$$x_L = \gamma(x_0 + vt_0), \tag{6}$$

$$t_L = \gamma\left(t_0 + \frac{vx_0}{c^2}\right). \tag{7}$$

Here, x_0 and t_0 represent the *proper space and time coordinates* of the moving object, while x_L and t_L represent the space and time coordinates of the moving object as assessed by a *fixed local observer* in gravity.

The conjoint reverse transformations are:

$$\begin{aligned} x_0 &= \gamma(x_L - vt_L), \\ t_0 &= \gamma\left(t_L - \frac{vx_L}{c^2}\right). \end{aligned} \tag{8, 9}$$

As is known, the familiar relationship $s_L{}^2 = s_0{}^2$, i.e.

$$x_L{}^2 - c^2 t_L{}^2 = x_0{}^2 - c^2 t_0{}^2 \;, \tag{10}$$

is thereby fulfilled.

Note further that these Lorentz transformations provide us with the following usual differential equations:

$$dx_L = \gamma(dx_0 + vdt_0), \tag{11}$$

$$dt_L = \gamma\left(dt_0 + \frac{vdx_0}{c^2} \right). \tag{12}$$

Their conjoint reverse transformations are:

$$\begin{aligned} dx_0 &= \gamma(dx_L - vdt_L), \\ dt_0 &= \gamma\left(dt_L - \frac{vdx_L}{c^2} \right). \end{aligned} \tag{13, 14}$$

Here, one lands at the customary equality of squared differentials $ds_L{}^2 = ds_0{}^2$, i.e.

$$dx_L{}^2 - c^2 dt_L{}^2 = dx_0{}^2 - c^2 dt_0{}^2 \ . \tag{15}$$

We will soon see that not only is the equality $s_L{}^2 = s_0{}^2$ [cf. Eq.(10)] broken in interaction – with yet the possibility remaining to redeem this *cast* later on in the manner of YARK; the equality of squared differentials $ds_L{}^2 = ds_0{}^2$ [cf. Eq.(15)] is also broken in interaction, with *still* the possibility remaining to redeem this *cast* later on in the manner of YARK, which all the same, totally invalidates the classical metric cast developed and exercised, in the past century.

Extraordinarily enough, this fact alone dismantles a whole century of mathematical progress in formulating "curved spacetime" with corresponding metric operations based on relationships involving the squares of differentials.

Now, we are going to insert the gravitational interaction terms into the aforementioned Lorentz transformations.

We expect hence, in gravity and in motion, that periods of time, when assessed by the distant observer, will dilate for two reasons:

1. Quantum mechanical stretching due to the effect of gravity by the factor $e^{-\alpha}$*,*

2. Stretching due to uniform translational motion as much as the Lorentz coefficient γ*.*

Let us once more recall that $\alpha = GM/rc^2$, where *M* is the mass of the host body, *G* is the gravitational constant, *r* is the distance from the location of concern to the center of *M*, and *c* is the speed of light in vacuum.

As for the lengths – as assessed by the distant observer – within the framework of YARK, they too are stretched in gravity; and this, in all directions, by the factor e^{α}. But, at the same time, they must get contracted by $e^{-\alpha}$ along the direction of motion – again when assessed by the distant observer. So, the factor γ and the factor $e^{-\alpha}$ should, in that case, work against each other.

Thusly we have:

$$\begin{aligned} x &= ¥(e^{\sim} x_0 + e^{\sim} vt_0), \\ t &= \gamma\left(e^{\sim} t_0 + e^{\sim} \frac{vx_0}{c^2} \right). \end{aligned} \tag{17, 18}$$

This, revolutionarily, is the standard writing pinned down of late by the first co-author where both time and space are stretched in gravity by the same e^{α} factor as seen from the reference frame of the distant observer.

Indeed, if v were 0, then we would be able to write,

$$x = e^{\alpha} x_0 \,,$$
$$t = e^{\sim} t_0 \,. \qquad (19, 20)$$

Thence,

$$x^2 - c^2 t^2 = e^{2\alpha}\left(x_0{}^2 - c^2 t_0{}^2\right); \qquad (21)$$

or the same,

$$x_0{}^2 - c^2 t_0{}^2 = e^{-2\alpha}\left(x^2 - c^2 t^2\right). \qquad (22)$$

So, we no longer have the proper Minkowskian mold $x_0{}^2 - c^2 t_0{}^2 = x^2 - c^2 t^2$ [cf. eq. (6)] that one can anymore define in the absence of gravity.

In what follows, let us prescribe

$$s_0{}^2 = x_0{}^2 - c^2 t_0{}^2 \,, \qquad (23a)$$

and

$$s^2 = x^2 - c^2 t^2 \,. \qquad (23b)$$

Therefore, instead of the accustomed $s_0{}^2 = s^2$ found throughout the literature, we now assert our novel "proper Minkowskian-Yarman" to "non-proper Minkowkian-Yarman" transformation:

$$s_0{}^2 = s^2 e^{-2\sim} \,. \qquad (23c)$$

This ultimately means that, as per YARK, gravitational interaction always breaks Lorentz Symmetry. It is crucial to note that, via the present approach, one could – in contradistinction to the manner in which it was exercised throughout the past century – obtain a relationship between s_0 and s straightforwardly in an *integral form* at the outset instead of in terms of the squares of differentials, whereby an integral result is recovered only after much extensive labor.

What is more, the differential equation that comes out of Eqs. (23a) and (23b) would too have no correspondence with the original Minkowskian $dx_L{}^2 - c^2 dt_L{}^2 = dx_0{}^2 - c^2 dt_0{}^2$ resulting from "authentic Lorentz transformations".

To show this we reconsider Eqs. (19) and (20), to write first [32],

$$dx = \frac{e^{\sim}}{1+\sim} dx_0 \,, \qquad (24a)$$

and concurrently,

$$dt = \frac{e^{\sim}}{1+\sim} dt_0 . \tag{24b}$$

Therefore, from Eq.(23c), for a fixed proper observer,

$$ds_0{}^2 = e^{-2\sim}\left(1+\sim\right)dx^2 - c^2 e^{-2\sim}\left(1+\sim\right)dt^2 . \tag{25a}$$

Or, for a fixed local observer:

$$dt_0{}^2 = e^{-2\sim}\left(1+\sim\right)^2\left[dx^2 - c^2 dt^2\right]. \tag{25b}$$

This allows us, at the same time to write obviously,

$$ds_0{}^2 = e^{-2\sim}\left(1+\sim\right)^2 ds^2 . \tag{25c}$$

via positing,

$$ds_0{}^2 = dx_0{}^2 - c^2 dt_0{}^2 , \tag{26a}$$

and

$$ds^2 = dx^2 - c^2 dt^2 . \tag{26b}$$

It is important to notice that YARK is not a purely metric theory, and Eq.(25c) should be considered along with the YARK root integral equation, i.e. Eq.(1). And, Eq.(25c) does not in fact bear any role really, other than a role for comparison of YARK with classical metric theories' root differential equations, for we do not even have to integrate Eq.(25c), via say, using it, in an action minimization operation, etc; we already have its integral form, as the set of quantum mechanical Eqs. (19) and (20), which we had in effect used beforehand, to finally write Eq.(26a).

It is easy to notice that the foregoing derivation is valid for any interaction, insofar as yielding

$$x_0{}^2 - c^2 t_0{}^2 = \left(1 - E_B / m_{0\infty} c^2\right)\left(x^2 - c^2 t^2\right) , \tag{27}$$

where E_B is the binding energy between the client object and the host body.

CONCLUSION

We have shown in the present paper how interaction between particles always breaks down Lorentz Symmetry (LS) as per Yarman's Approach, and more generally, in gravitation according to YARK (Yarman-Arik-Kholmetskii) theory of gravity.

An interesting case, other than an object moving in gravitation, where LS is violated – *but where existing quantum electrodynamical explanations in the literature are not satisfactory* – is that of the bound muon (when it is substituted in place of an electron around a given atomic nucleus); whose decay rate retardation can be explained under Yarman's Approach in a much more suitable and elegant way.

While it is known that General Theory of Relativity (GTR) already breaks LS, we demonstrate that the violation of LS in gravitation under the framework of YARK takes place differently than it does in GTR. Fundamentally, and for all kinds of interactions, it is not that LS breaks when bodies interact; it is that LS was never there to begin with.

This is so much so that, in the present approach, one readily obtains a simple relationship between the local Minkowskian squared line element s_0^2 and the non-proper Minkowskian squared line element s^2 in a straightforward integral form to land at $s_0^{\ 2} = s^2 e^{-2\sim}$ *;* whereas, GTR embarks on a similar enterprise by starting with the squares of the differentials of the space time quantitites under consideration only to arrive at an integral form after much cumbersome mathematical labor.

It is worth recalling that the present approach leads to $ds_0^{\ 2} = e^{-2\sim}\left(1+\sim\right)^2 ds^2$, with regards to the squared differentials.

It should be emphasized that YARK is not a purely metric theory, and Eq.(25c) should be considered along with the YARK root integral equation, i.e. Eq.(1). And, Eq.(25c) does not in fact bear any role really, other than a role for comparison of YARK with classical metric theories' root differential equations.

One can easily see that the derivation $s_0^{\ 2} = s^2 e^{-2\sim}$ we framed remains valid for any kind of interaction, insofar as leading to the general form

$$s_0^{\ 2} = x_0^{\ 2} - c^2 t_0^{\ 2} = \left(1 - E_B / m_{0\infty} c^2\right)\left(x^2 - c^2 t^2\right) \quad , \tag{27}$$

where E_B is the binding energy of the system comprised of a client object and a host body.

The above expression, remaining in full symbiosis with quantum mechanics and being fundamentally valid for all kinds of interactions, is moreover directly applicable to the many-body problem – just as well as being extensible to gravitation through YARK theory, and in an incomparably simpler manner compared to what is available in metric theories of gravity.

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