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Incompleteness of General Relativity, Einstein's Errors, and Related Experiments-- American Physical Society March meeting, Z23 5, 2015 --

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ABSTRACT

General relativity is incomplete since it does not include the gravitational radiation reaction force and the interaction of gravitation with charged particles. General relativity is confusing because Einstein's covariance principle is invalid in physics. Moreover, there is no bounded dynamic solution for the Einstein equation. Thus, Gullstrand is right and the 1993 Nobel Prize for Physics press release is incorrect. Moreover, awards to Christodoulou reflect the blind faith toward Einstein and accumulated errors in mathematics. Note that the Einstein equation with an electromagnetic wave source has no valid solution unless a photonic energy-stress tensor with an anti-gravitational coupling is added. Thus, the photonic energy includes gravitational energy. The existence of anti-gravity coupling implies that the energy conditions in space-time singularity theorems of Hawking and Penrose cannot be satisfied, and thus are irrelevant. Also, the positive mass theorem of Yau and Schoen is misleading, though considered as an achievement by the Fields Medal. $E = mc^2$ is invalid for the electromagnetic energy alone. The discovery of the charge-mass interaction establishes the need for unification of electromagnetism and gravitation and would explain many puzzles. Experimental investigations for further results are important.

KEYWORDS

anti-gravity coupling; gravitational radiation; repulsive gravitation; principle of causality.

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1. INTRODUCTION

Einstein is commonly recognized as a genius because he created new theories and led us with accurate predictions to new areas of physics, namely, special relativity, quantum mechanics and general relativity [1-3]. Thus, a faith in Einstein was developed. In particular, many believed that the Einstein equation is always correct.

However, as time has gone by the shortcomings of his theories are gradually shown and even include mistakes [4, 5]. We admire Einstein not because he was perfect as we previously believed, but rather for his ingenuity in starting new chapters of physics. In what follows in this paper, we shall point out the current problems. This leads to the necessary rectification of his theories, in particular, the Einstein equation. Then, at the end of this paper, it also becomes clear that his conjecture of unification between gravitation and electromagnetism is established.

However, currently many theorists believed that Einstein's conjecture was invalid because they fail to show his unification although they follow Einstein's steps. This is understandable and it will be shown that what stops us from arriving at the conclusion of his unification is precisely Einstein own inadequacy in his previous theories.

A major error of Einstein is that he considered his theory complete. This is obviously wrong because general relativity does not include the gravitational radiation reaction force [6] and it follows that general relativity is not a theory of geometry. Moreover, Einstein and his followers [7] neglected the interaction of gravitation toward a charged particle because of Einstein's speculation of $E = mc^2$. [1)]

2. INVALIDITY OF THE COVARINCE PRINCIPLE

Moreover, general relativity is very difficult to understand. This is due to, as Zhou [8] pointed out, the confusion created by Einstein's covariance principle. Einstein incorrectly reduces the problem of measurement to a determination of space-time coincidences. As he admitted this takes away from space and time the last remnant of physical objectivity [1]. This reflects Einstein's inability to distinguish the difference between mathematics and physics. We shall show that this principle is invalid through an explicit example.

In the bending of light, the relation of two physical quantities is gauge dependent [9]. The impact parameter b and the shortest distance from the sun r_0 are related in the Schwarzschild gauge and the harmonic gauge respectively as

$$b \approx m + r_0, \quad \text{where} \quad m = GM/c^2 \tag{1a}$$

or

$$b \approx 2m + r_0 \tag{1b}$$

where M is the mass of the sun and G is the Newtonian coupling constant. However, since the relation between two physical quantities must be unique, the covariance principle is invalid. [2)]

Then, an immediate question would be what the physically valid gauge is. Unfortunately, we still do not have an exact answer for this. However, for the case of weak gravitation, the Maxwell-Newton Approximation, which uses the linearized harmonic gauge has been proven valid [10]. Thus, we may use the harmonic gauge until we have a better theory.

3. THE NON-EXISTANCE OF DYNAMIC SOLUTION FOR THE EINSTEIN EQUATION

Historically, Einstein's confidence on his theory was based on that he obtained the remaining of the perihelion of Mercury from his equation [11]. However, since the calculation of perihelion of Mercury is based on a perturbation approach to get the influence of other planets, Einstein must show that the perturbation approach is valid, i.e.,

$$G_{\mu\nu} \equiv R_{\mu\nu} - (1/2)g_{\mu\nu}R = -KT_{\mu\nu}, \tag{2}$$

where $g_{\mu\nu}$ is the space-time metric, $R_{\mu\nu}$ is the Ricci curvature tensor, $T_{\mu\nu}$ is the sum of the energy-stress tensor of matter, and K is the coupling constant, having a bounded solution for a many-body problem.

Nevertheless, Gullstrand [12] suspected that the Einstein equation does not have such a solution. Thus, Einstein was awarded a Nobel Prize for his photo-electric effects instead of general relativity as many theorists expected.

In 1938, Einstein, Infeld, and Hoffmann [13] incorrectly assumed the existence of a bounded dynamic solution and deduced the geodesic equation from the 1915 equation. A problem in their proof is that Einstein et al. have not been able to show the existence of a dynamic solution. They merely assumed the existence of a dynamic solution.

In 1993, Princeton Professors Christodoulou and Klainerman [14] claimed they have constructed dynamic solutions for the Einstein equation. Then the 1993 Nobel Committee for Physics believed them and claimed the Einstein equation has bounded dynamic solutions. Consequently, Hulse and Taylor were awarded a Nobel Prize for gravitational radiation of the binary pulsars [15]. [3)] Thus, it seems that Einstein had won and his equation did have bounded dynamic solutions.

However, in 1995 it is found that Gullstrand is correct and the Einstein equation actually does not have any dynamic solution [16]. This paper was published in Astrophys. J. with the Editor-in-Chief S. Chandrasekhar, a Nobel Laureate, and an expert on general relativity. Thus, it is necessary to examine the book of Christodoulou and Klainerman [14] carefully. Upon a close examination, it is found that they actually have not completed their construction [17]. Their so-called “dynamic” solutions are merely constructed from their presumed strong asymptotically flat (S.A.F.) “initial data sets” without showing the physical relevance. In fact, they have not shown the existence of a case other than the static solutions. Thus, their claim of the existence of dynamic solution is invalid because simply it has not been proven.[4] Moreover, a S.A.F. initial data set is incompatible with Maxwell-Newton approximation, the linear field equation for weak gravity. It is concluded that the only physically valid S.A.F. initial data sets are the static solutions [17, 6].

Perlik [18], who wrote a review that appeared in ZFM in 1996 and republished in the journal of GRG in 2000 [19] complained, "What makes the proof involved and difficult to follow is that the authors introduce many special mathematical constructions, involving long calculations, without giving a clear idea of how these building-blocks will go together to eventually prove the theorem. The introduction, almost 30 pages long, is of little help in this respect. Whereas giving a good idea of the problems to be faced and of the basic tools necessary to overcome each problem, the introduction sheds no light on the line of thought along which the proof will proceed for mathematical details without seeing the thread of the story. This is exactly what happened to the reviewer."

Moreover, he pointed out "Before this book appeared in 1993 its content was already circulating in the relativity community in the form of a preprint that gained some notoriety for being extremely voluminous and extremely hard to read. Unfortunately, any hope that the final version would be easier to digest is now disappointing. Nonetheless, it is to be emphasized that the result presented in this book is very important. Therefore, any one interested in relativity and/or in nonlinear partial differential equations is recommended to read at least the introduction."

The review actually suggests that problems would be identified in the introduction with non-linear mathematics. Although their claim on "dynamic" solutions was met with wide spread skepticism [18], many did not openly question this book probably because they had blind faith on Princeton. Nevertheless, a modified Einstein equation with an additional gravitational energy-stress tensor with an anti-gravitational coupling, does have a bounded dynamic solution [20, 21].

Misner et al. [22] claimed that they have a bounded solution for a metric of the following form,

$$ds^2 = c^2dt^2 - dx^2 - L^2\left(e^{2\beta}dy^2 + e^{-2\beta}dz^2\right) \quad (3)$$

where $L = L(u)$, $\beta = \beta(u)$, $u = ct - x$, and c is the light speed. Then, the Einstein equation $G_{\mu\nu} = 0$ becomes

$$\frac{d^2L}{du^2} + L\left(\frac{d\beta}{du}\right)^2 = 0 . \quad (4)$$

However, it has been shown with undergraduate mathematics [23] that they are incorrect and Eq. (4) does not have a physical solution that satisfies Einstein's requirement on weak gravity. In fact, $L(u)$ is unbounded even for a very small $\beta(u)$.

On the other hand, from the Maxwell-Newton approximation, Einstein [24] obtained a solution as follows:

$$ds^2 = c^2dt^2 - dx^2 - (1+2\phi)dy^2 - (1-2\phi)dz^2 \quad (5)$$

where ϕ is a bounded function of u (= $ct - x$). Note that metric (5) is the linearization of metric (3) if $\phi = \beta(u)$. Thus, the waves illustrate that the linearization is not valid for the dynamic case when gravitational waves are involved.[5]

Another clear evidence that eq. (2) has no bounded dynamic solution is, as shown by Hu, Zhang, & Ding [25], that the calculated gravitational radiation depends on the perturbation approach used. To have a dynamic solution, it is necessary to add an additional gravitational energy-stress tensor with an anti-gravitational coupling [21], i.e.,

$$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2} g_{\mu\nu}R = - K[T_{\mu\nu} - t(g)_{\mu\nu}], \quad (6)$$

where $t(g)_{\mu\nu}$ is the gravitational energy-stress tensor.

While eq. (6), but not eq. (2) is consistent with the linearized equation for the massive case[6] and can do an approximate calculation for the gravitational radiation, one might object that it is still not clearly the exact equation. For this, our position is that this is the best we can get so far. Further verification can be done only after the exact form of $t(g)_{ab}$ is known.

Historically, eq. (6) was first proposed by Lorentz [26] and one year later it was also proposed by Levi-Civita [27] as $Kt(g)_{ab} = G_{ab} + KT_{ab}$. Then, the gravitational energy-stress tensor takes a covariant form. However, Einstein [28] objected to eq. (6) on the grounds that his equation (2) implies $t(g)_{\mu\nu} = 0$. Now, Einstein is clearly wrong since his equation is proven invalid for the dynamic case. Thus, eq. (6) should be called the Lorentz-Levi-Einstein equation.

4. THE FORMULA E = MC^2 IS AN INVALID SPECULATION OF EINSTEIN

The existence of the anti-gravity coupling implies that the formula $E = mc^2$ may not be generally valid. Moreover, this formula is actually only a speculation, because Einstein had failed [3] to prove it after many years of efforts (1905-1909). This error is a main reason why general relativity was so difficult to understand [4, 5].

A basic problem is that Einstein failed to see that there is an intrinsic conflict between his formula and his field equation in general relativity. The Einstein equation [1, 2] is,

$$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = - K T_{\mu\nu} , \quad (2)$$

where $T_{\mu\nu}$ is the sum of energy-stress tensors and K is the coupling constant. According to (2), an electromagnetic energy-stress tensor cannot affect the curvature $R = Kg^{\mu\nu}T_{\mu\nu}$, but a massive energy-stress tensor does. Thus, the mass and an electromagnetic energy cannot be equivalent. Clearly, Einstein did not understand his own theory adequately.

Based on $E = mc^2$, Einstein [29] claimed that a piece of metal will have increased weight after it is heated up. However, experiments [30] show that six kinds of metal have reduced weight after being heated up. Moreover, it is known [31] that a charged capacitor has reduced weight, and this is also against $E = mc^2$. Unfortunately, many theorists and journals such as the Physical Review failed in recognize these important experiments because of their blind faith toward Einstein.

5. THE EINSTEIN EQUATION WITH THE SOURCE OF AN ELECTROMAGNETIC WAVE

It has been shown that $E = mc^2$ is not generally valid, and the anti-gravity coupling is necessary for the dynamic case of massive matter. Naturally, one may ask if the anti-gravity coupling is generally necessary for any dynamic case. To answer this, let us consider the case of an electromagnetic wave as the source. Einstein [32] believed that there is no anti-gravity coupling as usual. However, Einstein is proven wrong again [33, 34].

It has been found [33, 34] that for such a case with an electromagnetic wave as the source, there is no valid solution unless a photonic energy-stress tensor with an anti-gravitational coupling is added. i.e.,

$$G_{ab} = K[T(E)_{ab} - T(p)_{ab}], \quad \text{and} \quad T_{ab} = - T(g)_{ab} = T(E)_{ab} - T(P)_{ab} , \quad (7)$$

where $T(E)_{ab}$ and $T(P)_{ab}$ are the energy-stress tensors for the electromagnetic wave and the related photons. Thus, we have that the photonic energy includes the energy for its gravitational wave component. This also solves the puzzle that the photonic energy can be equivalent to mass, but the electromagnetic energy-stress tensor is traceless. Moreover, now we have a good reason why in the calculation of QED, a renormalization is necessary. [7)] Thus, general relativity can potentially start another revolution in physics.

6. THE SPACE-TIME SINGULARITY THEOREMS OF HAWKING AND PENROSE

The space-time singularity theorems brought fame to Hawking and Penrose because they can serve as the justification for the theory of black holes and the expanding universe. Many even regarded Hawking as another Einstein. However, a problem is that their theory has no experimental verification.

Now, the necessary existence of the anti-gravity coupling implies that the energy conditions in the space-time singularity theorems of Hawking and Penrose cannot be satisfied (Appendix A) and thus their theorems are irrelevant to physics. Moreover, their claim that general relativity is inapplicable to microscopic phenomena is clearly nonsense since general relativity provides a justification for the existence of photons. In physics, traditionally when a result is strangely unusual, a physicist would go back to examine the assumptions. However, the singularity theorems are treated as an exception because physicists had found nothing wrong in the assumption of the theorems.

This error of Hawking and Penrose has three sources namely: 1) the acceptance of Einstein's speculation of general validity of $E = mc^2$; 2) the inadequate understanding of the non-linear mathematics; 3) inadequate understanding on the principle of causality (Appendix B). The explosion of the atomic bomb leaves little doubt on the validity of $E = mc^2$. Inadequate understanding of non-linear mathematics leads to the false belief [35] that the linearization is a valid approximation for the non-linear Einstein equation. [8)] As a mathematician, Penrose [23, 36] does not understand the principle of causality, and thus accepts unbounded solution physically valid. [9)]

In fact, the principle of causality was not well understood although Einstein [1, 2] uses this principle implicitly. In short, the problem of Hawking and Penrose is that they do not understand physics adequately.

7. THE MISLEADING POSITIVE MASS THEOREM OF YAU AND SCHOEN

Since many physicists do not understand mathematics adequately, one might expect that professional mathematician can help. A problem is that most of the mathematicians, such as Hawking and Penrose, do not understand physics. Moreover, some mathematicians such a Christodoulou, are just as incompetent in mathematics.

Mathematicians, who do not understand physics, can provide misleading information, instead of help. Another example is the positive mass theorem of Yau and Schoen [37], who use the formulas for energy and momentum given by Arnowitt, Deser, and Misner (ADM). A problem is that ADM does not understand that the Einstein equation has no dynamic solution, and thus their formula is not applicable to the dynamic case. The theorem of Yau and Schoen is misleading because their theorem also implicitly uses the invalid physical assumption, the unique sign for all the couplings.

Since Yau does not understand physics, his help actually created more problems. Since Witten [38] adapted his view, Witten also misunderstood general relativity [39]. This may give some insight why there is little progress in string theory. Nevertheless, their theorems [37, 38] were cited as an achievement by Fields Medal because mathematicians such as Michael Atiyah do not understand general relativity [39]. [10)]

8. THE QUESTION OF THE CHARGE-MASS INTERACTION

A major problem of $E = mc^2$ is that gravity is mistakenly considered as the effect of mass only. Therefore, the gravitational effects of the other types of energy are neglected. The Reissner-Nordstrom metric was ignored since 1916. Due to the existence of many intrinsic errors, essentially nothing has been done until 1997 [40]. Now, let us reexamine again the Reissner-Nordstrom metric [22] (with c =1) as follows:

$$ds^2 = \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)dt^2 - \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)^{-1} dr^2 - r^2 d\Omega^2, \qquad (8)$$

where q and M are the charge and mass of a particle, and r is the radial distance from the particle center. In metric (8), the gravitational components generated by electricity have not only a very different radial coordinate dependence but also a different sign that makes it a new repulsive gravity in general relativity [7].

However, theorists such as Herrera, Santos, & Skea [41] argued that M in (8) involves the electric energy. Then they obtained a metric that would imply a charged ball would increase its weight as the charge Q increased. However, this is in disagreement with experiments [42].

Nevertheless, they are not alone. For instance, Nobel Laureate 't Hooft even claimed, in disagreement with special relativity, that the electric energy of an electron contributed to the inertial mass of an electron [43]. In the Nobel Speech of Wilczek [44], he also has been mistaken that $m = E/c^2$ was universally true. [11)]

On the other hand, if the mass M is the inertial mass of the particle, the weight of a charged metal ball can be reduced [45]. Thus, as Lo expected [40], experiments of Tsipenyuk and Andreev on two metal balls [42] supports that the charged ball has a reduced weight. This is an experimental direct proof that the electric energy is not equivalent to mass. According to metric (8), a particle with charge q, the repulsive force to a particle of mass m at a distance r is approximately mq^2/r^3.

The discovery of the repulsive gravitation is important because it would solve a puzzle as to why we have never seen a black hole. If gravity is always attractive to mass, simulation convinces Wheeler that a black hole must be formed [46]. However, now we know that gravity is not always attractive to mass.

9. THE QUESTION OF CURRENT-MASS INTERACTION

While the electric energy leads to a repulsive force from a charge to a mass, the magnetic energy would lead to an attractive force from a current toward a mass [46]. Also, due to the fact that a charged capacitor has reduced weight, it is necessary to have the current-mass interaction to cancel out the charge-mass interaction.

In other words, the existence of the current-mass attractive force would solve a puzzle, i.e., why a charged capacitor exhibits the charge-mass repulsive force since a charged capacitor has no additional electric charges? In a normal situation, the charge-mass repulsive force would be cancelled by other forms of the current-mass force as Galileo, Newton and Einstein implicitly assumed. This general force is related to the static charge-mass repulsive force in a way similar to the Lorentz force is related to the Coulomb force.

The existence of such a current-mass attractive force has been verified by Martin Tajmar and Clovis de Matos [47]. It is found that a spinning ring of superconducting material increases its weight much more than expected. However, according to quantum theory, spinning super-conductors should produce a weak magnetic field. Thus, they are measuring also the interaction between an electric current and the earth. The current-mass interaction would generate a force which is perpendicular to the current. Moreover, the charge-current interaction could be identified as the cause for the anomaly of flybys.

One may ask what the formula for the current-mass force is. However, unlike the static charge-mass repulsive force, this general force would be beyond general relativity since a current-mass interaction would involve the acceleration of a charge that would generate electromagnetic radiation. Then, the electromagnetic radiation reaction force and the variable of the fifth dimension must be considered [48]. Thus, we are not yet ready to derive this force.

Nevertheless, we may assume that, for a charged capacitor, the resulting force is the interaction of net macroscopic charges with the mass. The irradiated ball has the extra electrons compared to a normal ball [42]. A spinning ring of superconducting material has the electric currents that are attractive to the earth [47]. This also explains a predicted phenomenon, which is also reported by Liu [31] that it takes time for a capacitor to recover its weight after being discharged [30]. This was observed by Liu because his rolled-up capacitors keep heat better. A discharged capacitor needs time to dissipate the heat generated by discharging, and the motion of its charges would accordingly recover to normal.

Thus, there are three factors that determine the weight of matter. They are; 1) the mass of the matter; 2) the charge-mass repulsive force; and 3) the attractive current-mass force. For a piece of a heated-up metal, the current-mass attractive force is reduced, but the charge-mass repulsive force would increase. Therefore, a net result is a reduction of weight [30] instead of increased weight as Einstein predicted [29]. Thus, the weighing of metals in room temperature and after it is heated-up or melted verifies the intrinsic difference between mass and electromagnetic energy.

10. THE CHARGE-MASS REPULSIVE FORCE AND EINSTEIN'S UNIFICATION

To show the static repulsive effect, one needs to consider only g_{tt} in metric (8). According to Einstein [1, 2],

$$\frac{d^2x^\mu}{ds^2}+\Gamma^\mu{}_{\alpha\beta}\frac{dx^\mu}{ds}\frac{dx^\nu}{ds}=0, \quad \text{where} \quad \Gamma^\mu{}_{\alpha\beta}=(\partial_\alpha g_{\nu\beta}+\partial_\beta g_{\nu\alpha}-\partial_\nu g_{\alpha\beta})g^{\mu\nu}/2 \tag{9}$$

and $ds^2=g_{\mu\nu}dx^\mu dx^\nu$. Note that the gauge affects only the second order approximation of g_{tt} [49].

Let us consider only the static case. For a particle *P* with mass m at **r**, the force on *P* is

$$-m\frac{M}{r^2}+m\frac{q^2}{r^3} \tag{10}$$

in the first order approximation because $g^{rr} \cong -1$. Thus, the second term is a repulsive force.

If the particles are at rest, then the force acting on the charged particle *Q* has the same magnitude

$$(m\frac{M}{r^2}-m\frac{q^2}{r^3})\,\hat{r}\ \text{,where} \quad \hat{r} \quad \text{is a unit vector} \tag{11}$$

because the action and reaction forces are equal and in the opposite directions. However, for the motion of the charged particle with mass M, if one calculates the metric according to the particle *P* of mass m, only the first term is obtained.

Then, it is necessary to have a repulsive force with the coupling q^2 to the charged particle *Q* in a gravitational field generated by masses. Thus, force (11) to particle *Q* is beyond current theoretical framework of gravitation + electromagnetism. As predicted by Lo, Goldstein, & Napier [48], general relativity leads to a realization of its inadequacy.

The charge-mass repulsive force for two point-like particles of respectively mass m and charge q with a distance r is mq^2/r^3. Thus such a repulsive force would become weak faster than gravity at long distance. Hence a capacitor lifter would hover on earth only in a limited height [50]. Moreover, this force is independent of the charge sign. Such characteristics would make the repulsive effects verifiable [31, 51] because a concentration of electrons would increase such repulsion.

The repulsive force in metric (8) comes from the electric energy [7]. An immediate question would be whether such a charge-mass repulsive force mq^2/r^3 is subjected to electromagnetic screening. It is conjectured that this force, being independent of a charge sign, would not be subjected to such a screening although it should be according to general relativity. Physically, this force can be considered as a result of q^2 interacting with a field created by the mass m. Thus such a field is independent of electromagnetism and is beyond general relativity, and the need of unification is established.

11. EXTENSION OF EINSTEIN'S THEORY AND THE FIVE-DIMENSIONAL RELATIVITY

The coupling with q^2 leads to a five-dimensional space of Lo et al. [48] because such a coupling does not exist in a four-dimensional theory. Kaluza [52] started a five-dimensional relativity. However, his cylindrical condition reduces the five variables to four, and his theory reproduces the Einstein equation and the Maxwell equation. Thus, his five-dimensional relativity does not have the coupling with the square of a charge since the "extra" metric elements are neglected. Otherwise, the radiation reaction force would also be accounted for [48].

Now let us give a brief introduction of the five-dimensional relativity. The five dimensional geodesic of a particle is

$$\frac{d}{ds}\left(g_{ik}\frac{dx^k}{ds}\right)=\frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{ds}\frac{dx^l}{ds}+\left(\frac{\partial g_{5k}}{\partial x^i}-\frac{\partial g_{5i}}{\partial x^k}\right)\frac{dx^5}{ds}\frac{dx^k}{ds}-\Gamma_{i,55}\frac{dx^5}{ds}\frac{dx^5}{ds}-g_{i5}\frac{d^2x^5}{ds^2}\ , \tag{12a}$$

$$\frac{d}{ds}\left(g_{5k}\frac{dx^k}{ds}+\frac{1}{2}g_{55}\frac{dx^5}{ds}\right)=\Gamma_{k,55}\frac{dx^5}{ds}\frac{dx^k}{ds}-\frac{1}{2}g_{55}\frac{d^2x^5}{ds^2}+\frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{ds}\frac{dx^k}{ds}, \tag{12b}$$

where $ds^2=g_{\mu\nu}dx^\mu dx^\nu$, μ, ν = 0, 1, 2, 3, 5 ($d\tau^2=g_{kl}dx^k dx^l$; *k, l* = 0, 1, 2, 3) .

If instead of *ds*, $d\tau$ is used in (12), for a particle with charge q and mass M, the Lorentz force suggests

$$\frac{q}{Mc^2}\left(\frac{\partial A_i}{\partial x^k}-\frac{\partial A_k}{\partial x^i}\right)=\left(\frac{\partial g_{i5}}{\partial x^k}-\frac{\partial g_{k5}}{\partial x^i}\right)\frac{dx^5}{d\tau}\ . \tag{13a}$$

Thus,

$$\frac{dx^5}{d\tau} = \frac{q}{Mc^2}\frac{1}{K}, \qquad K\left(\frac{\partial A_i}{\partial x^k} - \frac{\partial A_k}{\partial x^i}\right) = \left(\frac{\partial g_{i5}}{\partial x^k} - \frac{\partial g_{k5}}{\partial x^i}\right) \qquad \text{and} \qquad \frac{d^2x^5}{d\tau^2} = 0 \tag{13b}$$

where K is a constant. It thus follows that (12) is reduced to

$$\frac{d}{d\tau}\left(g_{ik}\frac{dx^k}{d\tau}\right) = \frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{d\tau}\frac{dx^l}{d\tau} + \left(\frac{\partial A_k}{\partial x^i} - \frac{\partial A_i}{\partial x^k}\right)\frac{q}{Mc^2}\frac{dx^k}{d\tau} - \Gamma_{i,55}\left(\frac{q}{Mc^2}\right)^2\frac{1}{K^2}, \tag{14a}$$

$$\frac{d}{d\tau}\left(g_{5k}\frac{dx^k}{d\tau} + \frac{1}{2}g_{55}\frac{q}{KMc^2}\right) = \Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau} + \frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{d\tau}\frac{dx^k}{d\tau}. \tag{14b}$$

One may ask what the physical meaning of the fifth dimension is. Our position is that the physical meaning of the fifth dimension is not yet very clear [48], except some physical meaning is given in the equation, $dx^5/d\tau = q/Mc^2K$ where M and q are respectively the mass and charge of a test particle, and K is a constant. This equation relates the fifth variable x^5 to τ.

The fifth dimension is assumed [48] as part of the physical reality, and the metric signature is (+, –, –, –, –). We shall denote the fifth axis as the w-axis (w stands for “wunderbar”, in memorial of Kaluza), and thus the coordinates are (t, w, x, y, z). Our approach is to find out the full physical meaning of the w-axis as our understanding gets deeper.

For a static case, we have the forces on the charged particle Q in the ρ -direction

$$-\frac{mM}{\rho^2} \approx \frac{Mc^2}{2}\frac{\partial g_{tt}}{\partial\rho}\frac{dct}{d\tau}\frac{dct}{d\tau}g^{\rho\rho}, \qquad \text{and} \qquad \frac{mq^2}{\rho^3} \approx -\Gamma_{\rho,55}\frac{1}{K^2}\frac{q^2}{Mc^2}g^{\rho\rho} \tag{15a}$$

and

$$\Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau} = 0, \qquad \text{where} \qquad \Gamma_{k,55} \equiv \frac{\partial g_{k5}}{\partial x^5} - \frac{1}{2}\frac{\partial g_{55}}{\partial x^k} = -\frac{1}{2}\frac{\partial g_{55}}{\partial x^k} \tag{15b}$$

in the (-*r*)-direction. The meaning of (15b) is the energy momentum conservation. Thus,

$$g_{tt} = 1 - \frac{2m}{\rho c^2}, \qquad \text{and} \qquad g_{55} = \frac{mMc^2}{\rho^2}K^2 + \text{constant。} \tag{16}$$

In other words, g_{55} is a repulsive potential. Because g_{55} depends on M, it is a function of local property, and thus is difficult to calculate. This is different from the metric element g_{tt} that depends on a distant source of mass m.

On the other hand, because g_{55} is independent of q, this force would penetrate electromagnetic screening. From the above, it is also possible that a charge-mass repulsive potential would exist for a metric based on the mass M of the charged particle Q. However, because P is neutral, there is no charge-mass repulsion force (from $\Gamma_{k,55}$) on P.

Thus, general relativity must be extended to accommodate the charge-mass interaction, and five-dimensional relativity is a natural candidate. According Lo et al. [48], the charge-mass interaction would penetrate a charged capacitor. On the other hand, we would not get a repulsive force acting on a test particle outside a capacitor from current four-dimensional theory. Since the electromagnetic field outside a capacitor would cancel out, there would be no charge-mass interaction outside the capacitor. To verify the five-dimensional theory, one can simply test the repulsive force on a charged capacitor. This has been experimentally confirmed [31, 50, 53].

12. CONCLUSIONS AND DISCUSSIONS

Clearly, a major error of Einstein was that he failed to recognize that the Einstein equation does not have any dynamic solution. [12)] Einstein's failure is due to that he must have a dynamic solution to justify his calculation on the remaining perihelion of Mercury from his equation. However, as Hu, Zhang, & Ding [25] show, that the calculated gravitational radiation depends on the perturbation approach used. This is clear evidence that the Einstein equation has no bounded dynamic solution. As pointed out by Gullstrand [12] such a solution may not be obtainable as a limit of a dynamic solution.

This error leads to the wrong conclusions by Hawking and Penrose that general relativity is inapplicable to microscopic phenomena and inconsistent with quantum theory [54]. Moreover, general relativity itself is not yet complete because of the absence of the gravitational radiation reaction force [6]. It is also interesting to note that Einstein and Rosen [55] are the first who discovered there is no gravitational wave solution for the Einstein equation. Then, an interesting question would be did Einstein know that a dynamic solution must be accompanied with a gravitational wave.

The Hulse and Taylor binary pulsar experiments are indispensable for verifying the necessity of the anti-gravity coupling experimentally [16, 21]. In addition to experimental supports, the Maxwell-Newton Approximation can be derived from physical principles [20]. A perturbation approach cannot be established for the Einstein equation simply because there are no bounded dynamic solutions.

Einstein's "covariance principle" was a mistake due to his inadequate ability to distinguish the difference between mathematics and physics [1].[2)] Moreover, it was not recognized that boundedness of a wave is crucial for its association with a dynamic source. These inadequacies allowed incorrect acceptance of unphysical "time-dependent" solutions as physical waves [56].[9)] However, Hawking is supported by mathematicians such a S. T. Yau. and E. Witten. This is due to that Yau also used the same wrong assumption to prove his misleading positive mass theorem [37, 38].

In general relativity, many famous institutes such as Harvard, Princeton Advanced Studies, and the Royal Society, actually are the sources of errors [6]. The fact that so many theorists believed in and awarded the errors of Christodoulou testified that many theorists still do not understand the non-linear mathematics and general relativity [6].

Einstein's error started from his failure to recognize that the mass and electromagnetic energy are intrinsically different. Thus, he failed to see that his field equation is in conflict with $E = mc^2$ because the electromagnetic energy-stress tensor has a zero trace. Since he had proposed inadequately that the photons would consist of only electromagnetic energy, Einstein had mistaken that the equivalence of mass and photonic energy is a proof for the equivalence of mass and electromagnetic energy. Thus, he overlooked that the photons actually include the gravitational wave energy. In addition, he also missed the need of the anti-gravity coupling in general relativity. It thus follows that the existence of photons is a necessary consequence of general relativity. Moreover, gravity is the connection between relativity and quantum mechanics.

This error leads to the spacetime singularity theorems of Hawking and Penrose which are actually irrelevant to physics. These theorems are the starting points for the notion of black holes and the assumption of an expanding universe. Now, one must find new justifications for these theories.

The invalid formula $E = mc^2$ also leads to negligence of the gravity generated by non-massive energy-stress tensor. [1)] This is why the 1916 Reissner-Nordstrom metric was not investigated for a long time. The existence of the charge-mass repulsive force would be a deciding evidence for the non-equivalence between mass and electromagnetic energy [7]. Moreover, this force is crucial for the unification between electromagnetism and gravitation since it shows that the theoretical framework of general relativity is inadequate. An experimental consequence is that a charged capacitor would fall slower. And an electron would fall slower than a proton falling toward the earth [57].

Within the framework of general relativity, the gravitational field of a radiating asymptotically Minkowskian system is given by the Maxwell-Newton Approximation [10]. Note that, for the dynamic case, the Maxwell-Newton Approximation is actually a linearization of the up-dated modified Einstein equation (3). With the rectification of the Einstein equation established, the exact form of $t(g)_{\mu\nu}$ is an important problem.

However, the Wheeler School still has strong influence; and even the MIT open course Phys, 8,033 and Phys, 8.962 are currently filled with their errors [23]. Due to their ignorance in non-linear mathematics, general relativity was incorrectly believed as effective only for large scale problems. Thus, the study for the applications of general relativity on earth and understanding material structure is neglected or ignored. For example, there are numerous experiments on the weight reduction of a charged capacitor [50, 53]. However, these experiments are unfairly regarded as due to errors or simply ignored by editors of journals such as the Physical Review. These experiments are important because they support the charge-mass interaction that is crucial for the unification of electromagnetism and gravitation [31].

In current theory, the charge-mass repulsive force would be subjected to electromagnetic screening. Physically, it is unnatural that a neutral force could be screened. From the viewpoint of the five-dimensional theory, however, the charge-mass repulsive force would be understood as that the charge interacts with a new field created by a mass. Therefore, the repulsive force would not be subjected to such screening. It thus follows that such a force is a perfect test for the existence of a five-dimensional space. Moreover, this can be verified by simply weighing a capacitor before and after charged.

Einstein believed that the increment of energy would increase the gravitational attraction [29]. However, in a five-dimensional theory, the charge-mass repulsive force is not subjected to screening, and thus would make the charged capacitor lighter. In a charged capacitor, both the positive and the negative charges are concentrated, and thus an effect of the repulsive force would be observed as a lighter weight for the charged capacitor [31, 51]. Thus, in addition to the cases of heated-up metals, this is a second example that can show experimentally the invalidity of Einstein's prediction.

Gravitation was considered as producing only attractive force, and all the coupling constants were assumed to have the same sign. Recently, it is proven that for the gravitational radiation of binary pulsars the coupling constants must have different signs [16, 21]. Since the electromagnetic energy is not equivalent to mass, the physical picture provided by Newton is just too simple for a phenomenon as complicated as gravity that relates to everything.

Since the existence of the charge-mass repulsive force is established, the unification of gravitation and electromagnetism is necessary. From the weight reductions of charged capacitors we conclude: 1) The electromagnetic energy is not equivalent to mass. 2) However, Einstein's conjecture of unification is established. Moreover, the Einstein equation remains to be rectified and completed in at least two aspects: a) The exact form of the gravitational energy-stress tensor; and b) The radiation reaction force. Due to the radiation reaction force, general relativity is not just a theory of geometry.

The weight reductions of a piece of heated-up metal and a charged capacitor confirm the existence of a charge-mass interaction. The experimental confirmation of such an interaction means that the unification between electromagnetism and gravitation is proven valid [30, 31]. Einstein failed to show such unification because of his three shortcomings: 1) He failed to see that unification is necessary to create new interactions. 2) He has mistaken that $E = mc^2$ was unconditional. 3) He rejected repulsive gravitation because of 2). Hence, Einstein is the biggest winner from the rectification of his theories. [13)]

Einstein failed because of his over confidence on himself, but ignored experiments. Thus, there are at least ten major Errors in relativity. A major problem is that Einstein's followers advocate their own errors,[14)] but does not read papers that do not fully agree them. Einstein failed unification because he did not accept any required new interaction. Einstein spend much time advocating against the blind faith toward authorities, but ironically he forgot to question and fight himself as an authority.

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APPENDIX A: The Space-Time Singularity Theorems and the Unique Sign of Couplings

Let us examine the energy conditions in the singularity theorems [54], listed as the following:

Theorem 1. Let (M, g_{ab}) be a globally hyperbolic spacetime with $R_{ab}\xi^a\xi^b \geq 0$ for all timelike ξ^a, which will be the case if the Einstein equation is satisfied with the strong energy condition holding for matter. Suppose there exists a smooth (or at least C^2) spacelike Cauchy surface Σ for which the trace of the extrinsic curvature (for the past directed normal geodesic congruence) satisfies $K \leq C < 0$ everywhere C is a constant. Then no past directed timelike curve from Σ can have length greater than $3/|C|$. In particular, all past directed timelike geodesics are incomplete.

Theorem 2. Let (M, g_{ab}) be a strongly causal spacetime with $R_{ab}\xi^a\xi^b \geq 0$ for all timelike ξ^a, as will be the case if the Einstein equation is satisfied with the strong energy condition holding for matter. Suppose there exists a compact, edgeless, achronal smooth spacelike hypersurface S such that for the past directed normal geodesic congruence form S we have $K < 0$ everywhere on S. Let C denote the maximum value for K, so $K \leq C < 0$ everywhere on S. Then at least one inextendible past directed timelike geodesic from S has length no greater that $3/|C|$.

Theorem 3. Let (M, g_{ab}) be a connected, globally hyperbolic spacetime with a noncompact Cauchy surface Σ. Suppose $R_{ab}k^ak^b \geq 0$ for all null k^a, as will be the case if (M, g_{ab}) is a solution of Einstein's equation with matter satisfying the weak or strong energy condition. Suppose, further, that M contains a trapped surface T. Let $\theta_0 < 0$ denote the maximum value of θ for both sets of orthogonal geodesic on T. Then at least one inextendible future directed orthogonal null geodesic from T has affine length no greater than $2/|\theta_0|$.

Theorem 4. Suppose a spacetime (M, g_{ab}) satisfies the following four conditions. (1) $R_{ab}v^av^b \geq 0$ for all timelike and null v^a, as will be the case if Einstein's equation is satisfied with the strong energy condition holding for matter. (2) The timelike and null generic conditions are satisfied. (3) No closed timelike curve exists. (4) At least one of the three properties holds: (a) (M, g_{ab}) posses a compact achronal set without edge [i.e., (M, g_{ab}) is a closed universe], (b) (M, g_{ab}) possesses a trapped surface, or (c) there exists a point $p \in M$ such that the expansion of the future (or past) directed null geodesics emanating from p becomes negative along each geodesic in this congruence. Then (M, g_{ab}) must contain at least one incomplete timelike or null geodesic.

Originally, the energy condition is related to the energy-momentum tensor T_{ab}. According to the Einstein equation [1]

$$G_{ab} \equiv R_{ab} - (1/2)\, g_{ab} R = 8\pi T_{ab}, \qquad \text{(A1)}$$

one would have

$$R_{ab} = 8\pi\, [T_{ab} - (1/2) g_{ab} T] \qquad \text{where} \qquad T = g^{ab}T_{ab} \qquad \text{(A2)}$$

Then,

$$R_{ab}\,\xi^a\xi^b = 8\pi\, [T_{ab} - (1/2)g_{ab}\, T]\, \xi^a\xi^b = 8\pi\, [T_{ab}\xi^a\xi^b + (1/2)T], \text{ for a unit timelike } \xi^a \qquad \text{(A3)}$$

It is believed that for all physically reasonable classical matter the energy condition is non-negative, i.e.,

$$T_{ab}\, \xi^a\xi^b \geq 0 \qquad \text{(A4)}$$

for all timelike ξ^a. This is known as the weak energy condition. However, it also seems physically reasonable that the stress of matter will not become so large and negative as to make the right-hand side of eq. (A3) negative. This assumption,

$$T_{ab}\, \xi^a\xi^b \geq -(1/2)T \qquad \text{(A5)}$$

for all unit timelike unit vector ξ^a, is known as the strong energy condition. An implicit assumption of these energy-conditions (A3)-(A5) is that all the coupling constants have the same sign. However, as has been shown such an assumption of unique coupling sign leads to the non-existence of dynamic solutions [16, 21].

To illustrate this, consider the Bondi, Pirani, & Robinson metric [56] as follows:

$$ds^2 = e^{2\varphi}\left(d\tau^2 - d\xi^2\right) - u^2\begin{bmatrix}\cosh 2\beta\left(d\eta^2 + d\varsigma^2\right)\\ +\sinh 2\beta\cos 2\theta\left(d\eta^2 - d\varsigma^2\right)\\ -2\sinh 2\beta\sin 2\theta\, d\eta\, d\varsigma\end{bmatrix} \quad \text{(A6a)}$$

where φ, β and θ are functions of u (τ - ξ). It satisfies the differential equation (i.e., their Eq. [2.8]),

$$2\phi' = u\left(\beta'^2 + \theta'^2\sinh^2 2\beta\right) \quad \text{(A6b)}$$

which is a special cases of $G_{\mu\nu} = 0$. They claimed this is a wave from a distant source and weak gravity invalid. The metric is irreducibly unbounded because of the factor u^2. And linearization of (A6b) does not make sense since u is not bounded.

Moreover, when gravity is absent, it is necessary to have ϕ = sinh 2β = sin 2θ = 0. These would reduce (6a) to

$$ds^2 = (d\tau^2 - d\xi^2) - u^2(d\eta^2 + d\zeta^2) \quad \text{(A6c)}$$

However, this metric is not equivalent to the flat metric. Thus, metric (A6c) violates the principle of causality.

This challenges the view that both Einstein's notion of weak gravity and his covariance principle are valid. These conflicting views are supported respectively by the editors of the "Royal Society Proceedings A" and the "Physical Review D"; thus there is no general consensus.

Appendix B: The Principle of Causality and the Physics of Plane-Waves

There are two aspects in causality: its relevance and its time ordering. In time ordering, a cause event must happen before its effects. This is further restricted by relativistic causality that no cause event can propagate faster than the light speed in vacuum. The time-tested assumption that phenomena can be explained in terms of identifiable causes will be called the principle of causality. This is the basis of relevance for all scientific investigations.

Thus, the principle of causality implies that any parameter in a solution for physics must be related to some physical causes. Moreover, Einstein's notion of weak gravity is also based on the principle of causality that implies a weak source would produce a weak gravity. Here this principle will be elucidated first in connection with symmetries of a field, the boundedness of a field solution, and consequently in the validity of a field equation in physics.

In practice, when the considered field is absent, physical properties are ascribed to the space-time as in a "normal" state. For example, the electromagnetic field is zero in a normal state. Then, any deviation from the normal state must have physically identifiable causes. Thus, the principle of causality implies that the symmetry must be preserved if no cause breaks it. The implication of causality to symmetry has been used in deriving the inverse square law from Gauss's law.

The normal state of a space-time metric is the flat metric in special relativity. Thus, if a metric does not possess a symmetry, then there must be physical cause(s) which has broken such a symmetry. For a spherically symmetric mass, causality requires that the metric is spherically symmetric and asymptotically flat. Also, a weak cause can lead to only weak gravity. Therefore, Einstein's notion of weak gravity is a consequence of the principle of causality.

However, the physical cause(s) should not be confused with the mathematical source term in the field equation. In general relativity, the cause of gravity is the physical matter itself, but not its energy tensors in the source term of Einstein's field equation. The energy-stress tensors (for example the perfect fluid model) may explicitly depend on the metric. Since nothing should be a cause of itself, such a source tensor does not represent the cause of a metric. For the accompanying gravitational wave of an electromagnetic wave, the physical cause is the electromagnetic wave. Thus, one should not infer the symmetries of the metric based on the source term (instead of its causes) although their symmetries are not unrelated.

Moreover, inferences based on the source term can be misleading. The source term may have higher symmetries than those of the cause and the metric. For instance, a transverse electromagnetic plane-wave (1) is not rotationally invariant with respect to the z-direction of propagation. But the related electromagnetic energy-stress tensor component $T(E)_{tt}$ for a circularly polarized wave is rotationally invariant. This assumption violates causality and results in theoretical difficulties.

Classical electrodynamics implies that the flat metric is an accurate approximation, caused by the presence of weak electromagnetic waves. This physical requirement is supported by the principle of causality which implies such a metric to be a bounded periodic function. However, this required boundedness is not satisfied by solutions in the literature [58-60]. These solutions also violate causality directly since they involve parameters without any physical cause [59]. They also do not satisfy the equivalence principle [61, 62] although they are Lorentz manifolds.

A necessary and sufficient condition for satisfying the equivalence principle is that a time-like geodesic represents a physical free falling; but the mathematical existence of local Minkowski spaces is necessary. A major problem in general relativity is that many theorists and journals do not understand physics, in particular, the principle of causality adequately.

ENDNOTES:

1) Many major journals such as the Physical Review and Proceeding of the Royal Society (London) A still do not understand that $E = mc^2$ is not generally valid. A serious problem is that they did not even attempt to understand the related experiments because of their blind faith on Einstein. Thus, they become obstacles, instead of helping, for the progress of physics. The weight reduction of charged capacitor experiments cannot be explained with current four-dimensional theory [31]. The weight reduction of heated-up metals [30] shows directly that Einstein's prediction [29] is not valid.

2) Zhou [8] is the first who pointed out from physics, the invalidity of Einstein's covariance principle. However, C. N. Yang believed Einstein's covariance principle is valid. Explicit examples [9] show that C. N. Yang was wrong on this.

3) P. Morrison of MIT had gone to Princeton University to question J. A. Taylor on their justification in calculating the gravitational radiation of the binary pulsars. As expected, Taylor was unable to give a valid justification [63] .

4) The Ph. D. degree advisor of D. Christodoulou was J. A. Wheeler, whose mathematics has been known from ***Gravitation*** [23] as having crucial errors at the undergraduate level [24]. In fact, Perlick [19] pointed out the book of Christodoulou and Klainerman is incomprehensible, and Lo [17, 6] pointed out it is wrong. Accordingly, the honors awarded to Christodoulou actually reflected the blind faith toward Einstein and accumulated errors in mathematics and general relativity [6]. For instance, Yum-Tong Siu who does not understand non-linear mathematics, approved to award him a 2011 Shaw Prize. In short, the contributions of Christodoulou to general relativity are essentially just errors [6].

5) Wald [54] claimed to have a dynamic solution for the second order, but never provided such an impossible one.

6) Bertschinger [64] does not know that, for the dynamic case, linearization does not provide a valid approximation. This is a major error of his book.

7) Einstein's unification may provide an insight for renormalization since the charge-mass interaction is not currently included. The need of renormalization is an unsolved puzzle although it has been established as the only way.

8) Some were unable to see that, for the dynamic case, linearization of the Einstein equation is not a valid approximation [36]. Thus, theorists such as Hod [65] incorrectly claimed that general relativity had a solution for a two-body problem.

9) Journals such as the Physical Review D, in disagreement with Einstein, accepted unbounded solutions as valid. However, it is still necessary to have a bounded solution to calculate the gravitational radiation. Nevertheless, they failed to see that the 1915 Einstein equation does not provide a bounded dynamic solution.

10) Michael Francis Atiyah has been president of the Royal Society (1990-1995), and President of the Royal Society of Edinburgh (2005-2008). Since 1997, he has been an honorary professor at the University of Edinburgh (Wikipedia).

11) Almost all Noble Prize winners make the same mistake. Apparently, nobody checks this formula adequately.

12) Theorists such a Misner et al. [22], Wald [54], Christodoulou & Klainerman [14], 't Hooft [66], and etc. claimed to have explicit dynamic solutions. It turns out that all are due to various errors in mathematics [6, 23, 67]. Note that journals such a the Physical Review, Proceeding of the Royal Society A, Classical and Quantum Gravity, Gravitation and General Relativity, etc. all are against Gullstrand [12] and believed incorrectly that there are bounded dynamic solutions for the Einstein equation [16, 21] because they failed to understand nonlinear mathematics. Moreover, another problem is that many would not read papers that disagree with them.

13) Apparently, Einstein did not know that his unification was that close to confirmation. If he had known this, he may not be that willing to go by rejecting the modern medicine to prolong his life [68].

14) This explains that why papers appear in different journals often agree with each other. However, a common problem is that there is no experimental evidence to support their claims.

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