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The Development of Relativity and Einstein

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ABSTRACT

There are errors in general relativity that must be rectified. As Zhou pointed out, Einstein's covariance principle is proven to be invalid by explicit examples. Linearization is conditionally valid. Pauli's version of the equivalence principle is impossible in mathematics. Einstein's adaptation of the distance in Riemannian geometry is invalid in physics as pointed out by Whitehead. Moreover, it is inconsistent with the calculation on the bending of light, for which a Euclidean-like framework is necessary. Thus, the interpretation of the Hubble redshifts as due to receding velocities of stars is invalid. The Einstein equation has no dynamic solutions just as Gullstrand suspected. All claims on the existence of dynamic solutions for the Einstein equation are due to mistakes in non-linear mathematics. For the existence of a dynamic solution, the Einstein equation must be modified to the Lorentz-Levy-Einstein equation that have additionally a gravitational energy-stress tensor with an anti-gravity coupling. The existence of photons is a consequence of general relativity. Thus, the space-time singularity theorems of Hawking and Penrose are actually irrelevant to physics because their energy conditions cannot be satisfied. The positive mass theorem of Schoen and Yau is misleading because invalid implicit assumptions are used as Hawking and Penrose did. There are three experiments that show formula $E = mc^2$ is invalid, and a piece of heated-up metal has reduced weight just as a charged capacitor. Thus, the weight is temperature dependent. It is found, due to the repulsive charge-mass interaction, gravity is not always attractive to mass. Since the assumption that gravity is always attractive to mass is not valid, the existence of black holes are questionable. Because of the repulsive charge-mass interaction, the theoretical framework of general relativity must be extended to a five-dimensional relativity of Lo, Goldstein & Napier. Thus Einstein's conjecture of unification is valid. Moreover, the repulsive gravitational force from a charged capacitor is incompatible with the notion of a four-dimensional space. In Quantum theory, currently the charge-mass interaction is neglected. Thus, quantum theory is not a final theory as Einstein claims.

KEYWORDS

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

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"Science sets itself apart from other paths to truth by recognizing that even its greatest practitioners sometimes err. … " -- S. Weinberg, Physics Today, November 2005.

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1. INTRODUCTION

Since Einstein's prediction on the bending of light ray was verified, general relativity is dominating the theories of astrophysics [1]. Subsequently, predictions based on the linearization of the Einstein equation were verified [1, 2]. However, Einstein's covariance principle was pointed out by Zhou Pei-Yuan [3] as invalid 1) and this was subsequently verified by Lo [4] with explicit examples. This also means that Wald's approach is invalid 2) although it was adapted by the 1933 Nobel Prize Committee [5]. Moreover, any prediction related to the dynamic case of the non-linear Einstein equation has not been confirmed [6]. 3) In particular, the space-time singularity theorems are actually irrelevant to physics because their energy conditions cannot be satisfied [6, 7]. It was believed that general relativity has superseded Newtonian gravity, but this belief was found as due to careless mathematical errors because the Einstein equation has no bounded two-body solution [8-10].

The inadequate understanding of non-linear mathematics is the cause of errors for solutions of the Einstein equation. Einstein failed to see that his field equation has no bounded dynamic solution [8-10] as suspected by Gullstrand [11], Chairman (1922-1929) of the Nobel Prize for Physics. Also, Pauli [12] misinterpreted Einstein's equivalence principle as at any point there is always existence of a neighborhood of local Minkowski space, an impossibility in mathematics. 4)

The adaptation of Riemannian geometry, as Whitehead [13] pointed out, is invalid in physics. Moreover, the notion of distance in Riemannian space is inconsistent with calculations of the bending of light [14], for which a Euclidean-like theoretical framework is necessary. Thus, regarding the Hubble's redshifts as due to the receding velocities of the stars is invalid [15], and the expanding universe is questionable. Also, the notion of gravitation is a manifestation of Riemannian geometry is inconsistent with the fact that there is a need to add the gravitational radiation reaction force in general relativity [16].

Physically, another major cause of errors is due to Einstein's unverified speculation of $E = mc^2$ [17]. Recently, it is found that there are three experiments that show its invalidity [18, 19]. 5) For instance, Einstein [20] predicted that a piece of heated-up metal would have increased weight. However, experiments show that it has reduced weight instead [18, 19]. Investigation of errors of Einstein naturally leads to rectifications [21, 22]. Unexpectedly, these in turn lead to the verification of Einstein's conjecture of unification between electromagnetism and gravitation [23, 24].

Because of the repulsive charge-mass interaction, the theoretical framework of general relativity must be extended to a five-dimensional space theory of Lo, Goldstein & Napier [25]. Since gravitation is no longer always attractive as Galileo, Newton, and Einstein saw, the notion of back holes is clearly questionable. Moreover, the repulsive gravitation from a charged capacitor is incompatible with the current notion of a four-dimensional space [23]. In short, there are mathematical and physical errors in general relativity that must be corrected.

2. ERRORS RELATED TO FORMULA $E = MC^2$

The speculation $E = mc^2$ is related to many errors in general relativity. They are:

1) There is an intrinsic conflict between Einstein's formula $E = mc^2$ and his field equation.

The Einstein equation [26, 27] for the space-time metric $g_{\mu\nu}$ is,

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

where $T_{\mu\nu}$ is the sum of energy-stress tensors and K is the coupling constant. According to (1), 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.

2) Based on $E = mc^2$, theorists accepted that all the coupling constant of the Einstein equation has the same sign.

However, this unique sign assumption leads to the non-existence of dynamic solution for the Einstein equation as Lo [8] pointed out. Lo's paper was approved by S. Chandrasekhar, a Nobel Laureate and an expert in general relativity, after the 1993 Nobel Prize for Hulse and Taylor [5]. Thus, Chandrasekhar objected to the errors of 1993 Nobel Committee.

3) P. Morrison of MIT had questioned J. A. Taylor on their justification in calculating the gravitational radiation.

As expected, Taylor was unable to give a valid justification [28].

4) Hu, Zhang, & Ding [29] show, that the calculated gravitational radiation depends on the perturbation approach used.

This implies also that there is no bounded dynamic solution for the Einstein equation.

3) For the existence of a dynamic solution, the Einstein equation must be modified to the following equation,

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

where $t(g)_{\mu\nu}$ is the gravitational energy-stress tensor with an anti-gravity coupling. Historically, eq. (2) was first proposed by Lorentz [30] and later by Levi-Civita [31]. Thus, eq. (2) should be called the Lorentz-Levi-Einstein equation.

4) The photonic energy-stress tensor also has an anti-gravity coupling.

Let us consider the case of an electromagnetic wave as the source. Einstein [32] believed that there is no antigravity coupling as usual.[6)] However, for the case with an electromagnetic wave as the source [33, 34], there is no valid solution unless a photonic energy-stress tensor with an anti-gravitational coupling is added. i.e.,

$$G_{ab} = K[T(E)_{ab} - T(p)_{ab}], \quad \text{and} \quad T_{ab} = - T(g)_{ab} = T(E)_{ab} - T(P)_{ab}, \qquad (3)$$

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. Moreover, the claim that general relativity is not valid for microscopic phenomena is clearly false [7].

5) The equivalence of the photons and mass [28] was mistaken as the equivalence of mass and electromagnetic energy.

However, this actually means only that the photons have non-electromagnetic energy.

6) Based on the unique sign of coupling constant, Hawking and Penrose prove the space-time singularity theorems [7].

However, since the anti-gravity coupling is necessary for the dynamic case, these theorems are actually irrelevant to physics since their energy conditions cannot be satisfied. Thus, Hawking is not really a physicist.

7) The gravity due to non-massive matter is incorrectly ignored and the crucial charge-mass interaction is over-looked.

Since energy were considered as always equivalent to mass, one should study only the gravity generated by mass. Thus, the Reissner-Nordstrom metric [1] for a particle with charge q and mass M was ignored until 1997 [21]. For a test particle with mass m, the repulsive force is approximately mq^2/r^3. However, this crucial force is over-looked [24].

3. ERRORS IN NON-LINEAR MATHEMATICS AND THE PRINCIPLE OF CAUSALITY

The errors in general relativity often has its origin from errors in non-linear mathematics. This is due to that many theorists incorrectly use linear mathematics to deal with the nonlinear problems.

1) Conditional Validity of Linearization

For the static case, it has been proven that the linearized euation gives an approximate solution. For instance, the harmonic solution for the Einstein equation is

$$ds^2 = \left(\frac{1-MG/r}{1+MG/r}\right)dt^2 - \left(1+\frac{MG}{r}\right)^2(dx^2+dy^2+dz^2) - \left(\frac{1+MG/r}{1-MG/r}\right)\frac{M^2G^2}{r^4}(xdx+ydy+zdz)^2 \qquad (4)$$

The linearized Einstein equation with the linearized harmonic gauge $\partial^\mu \bar{\gamma}_{\mu\nu} = 0$ is

$$\frac{1}{2}\partial^\alpha\partial_\alpha\bar{\gamma}_{\mu\nu} = \kappa T_{\mu\nu} \quad \text{where} \quad \bar{\gamma}_{\mu\nu} = \gamma_{\mu\nu} - \frac{1}{2}\eta_{\mu\nu}\gamma \quad \text{and} \quad \gamma = \eta^{\alpha\beta}\gamma_{\alpha\beta}. \qquad (5)$$

Note that we have a solution

$$ds^2 = \left(1-\frac{2MG}{r}\right)dt^2 - \left(1+\frac{2MG}{r}\right)(dx^2+dy^2+dz^2). \qquad (6)$$

since (6) is a linearized approximation of (4), the linearization to obtain a approximation is valid for the static case.

Now, the dynamic situation is different. Misner, Thorne, & Wheeler [1] considered a “wave” form as follows:

$$ds^2 = c^2dt^2 - dx^2 - L^2\left(e^{2\beta}dy^2 + e^{-2\beta}dz^2\right) \qquad (7)$$

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

$$\frac{d^2L}{du^2} + L\left(\frac{d\beta}{du}\right)^2 = 0 \qquad (8)$$

which was claimed to have a bounded solution [1]. However, $L(u)$ is unbounded even for a very small $\beta(u)$ [35].

On the other hand, from the Maxwell-Newton approximation in vacuum, Einstein [36] obtained a solution as follows:

$$ds^2 = c^2dt^2 - dx^2 - (1+2\phi)dy^2 - (1-2\phi)dz^2 \qquad (9)$$

where ϕ is a bounded function of u (= $ct - x$). Note that metric (9) is the linearization of metric (7) if $\phi = \beta(u)$. Thus, this illustrates that the linearization is not valid when gravitational waves are involved.[7)] Note that Misner et al. [1] also make other serious errors such as the local time in their eq. (40.14) and disagree with Wald [2] and Weinberg [37].

Misner et al. incorrectly [8-10] assumed that a linearization of a non-linear equation would always produce a valid approximation. However, linearization of (8) yields $L'' = 0$, and in turn this leads to $\beta'(u) = 0$. Moreover, $\beta'(u) = 0$. implies no wave. Thus, one cannot get a weak wave solution through linearization of Eq. (8).

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Many regard a violation of the Lorentz symmetry also as a violation of general relativity. However, this notion actually comes from the distortion of Einstein's equivalence principle by Misner et al. [1] because they do not understand the related mathematics [38]. Clearly they [1] failed to understand Einstein's equivalence principle [39].

2) An Example of no Bounded Dynamic Solutions and the Principle of Causality

We shall illustrate also that for the case of gravitational waves, there is no bounded dynamic solution. Now, consider the metric obtained by Bondi, Pirani, & Robinson [40] as follows:

$$ds^2 = e^{2\varphi}\left(d\tau^2 - d\xi^2\right) - u^2\left[\begin{array}{l}\cosh 2\beta\left(d\eta^2 + d\varsigma^2\right)\\ +\sinh 2\beta\cos 2\theta\left(d\eta^2 - d\varsigma^2\right)\\ -2\sinh 2\beta\sin 2\theta\, d\eta\, d\varsigma\end{array}\right] \quad (10a)$$

where ϕ, β and θ are functions of *u* ($= \tau - \xi$). It satisfies the differential equation (i.e., their Eq. [2.8]),

$$2\phi' = u\left(\beta'^2 + \theta'^2 \sinh^2 2\beta\right) \quad (10b)$$

which is also a special cases of $G_{\mu\nu} = 0$. They claimed (10a) is a wave from a distant source. However, (10b) implies ϕ *cannot be a periodic function.* The metric is irreducibly unbounded because of the factor u^2. Moreover, linearization of (10b) does not make sense since variable *u* is not bounded.

Moreover, when gravity is absent, it is necessary to have $\phi = \sinh 2\beta = \sin 2\theta = 0$. These would reduce (10a) to

$$ds^2 = (d\tau^2 - d\xi^2) - u^2(d\eta^2 + d\zeta^2) \quad (10c)$$

However, this metric is not equivalent to the flat metric. Thus, metric (11c) violates the principle of causality. [8)]

There are other theorists who also ignore the principle of causality. Consider another "plane wave", which is intrinsically non-physical, is the metric accepted by Penrose [41] as follows:

$$ds^2 = du\, dv + Hdu^2 - dx_i dx_i, \text{ where } H = h_{ij}(u)x_i x_j \quad (11)$$

where $u = ct - z$, $v = ct + z$. However, there are non-physical parameters (the choice of origin) that are unrelated to physical causes. Thus, Penrose [41] over-looked the principle of causality. Also, linearization of metric (11) does not make sense.

The linearized equation for a dynamic case has been illustrated as incompatible with the non-linear Einstein equation. Thus, Eq. (8), Eq, (10b), and Eq. (11) serve as good examples for such errors. Also, metric (11) suggests that the cause of having no physical solution would be due to inadequate source terms.

3) The Errors of Christodoulou and his Invalid Claims

The fact that Christodoulou received honors for his errors related to the Einstein equation testified, "Unthinking respect for authority is the greatest enemy of truth" as Einstein asserted. Christodoulou & Klainerman [42] claimed that they have constructed dynamic solutions. However, one should note that Christodoulou obtained his Ph. D. under Wheeler, who also made crucial errors in mathematics.

Because their global smallness assumption has no dynamic requirements in their proofs [42], the existence of a bounded dynamic initial set is assumed only, and their proof is at least incomplete. Essentially, they assume the existence of a bounded initial set to prove the existence of a bounded dynamic solution.

Moreover, the authors seem to try to create enough confusion, as Misner et al. [1] did on their plane-wave solution for eq. (9), to gain the acceptance from the readers. However, careful calculation with undergraduate mathematics shows that, just as Misner et al. [1] are wrong [35], Christodoulou is also incorrect [43].

Christodoulou and many theorists incorrectly assume a physical requirement would be unconditionally satisfied by the Einstein equation. According to the principle of causality, a bounded dynamic solution should exist, but this is true only for a valid equation in physics. Therefore, it does not necessarily mean that the Einstein equation has such a solution [44].

Gullstrand was not the only theorist who questioned the existence of the bounded dynamic solution for the Einstein equation. As shown by Fock [45], any attempt to extend the Maxwell-Newton approximation to higher approximations leads to divergent terms. In 1995, it has been proven [8-10] that for a dynamic case the linearized equation as a first order approximation, is incompatible with the nonlinear Einstein field equation.

Their book [42] was accepted because it supports and is consistent with other existing errors. In physics, a dynamic solution must be related to dynamic sources, but a "time-dependent" solution may not necessarily be a physical solution [46-48]. For instance, their "initial data sets" can be incompatible with the field equation for weak gravity. Second, the only known cases are static solutions. Third, they have not been able to relate any of their constructed solutions to a dynamic source. In pure mathematics, if no example can be given, such abstract mathematics is likely wrong [49]. Moreover, in 1995 it is proven impossible to have a bounded dynamic solution.

The 1993 Nobel Committee led to awards and honors for the errors of D. Christodoulou as follows:

MacArthur Fellows Award (1993);
Bôcher Memorial Prize (1999);
Member of American Academy of Arts and Sciences (2001);
Tomalla Foundation Prize (2008);
Shaw Prize (2011);
Member of U.S. National Academy of Sciences (2012).

Note that there are many explicit examples that show the claims of Christodoulou are incorrect [16, 29, 40]. [9)] However, many theorists just ignored them. Clearly, Christodoulou's contributions to general relativity are essentially just errors.

Note that their book [42] has been criticized by Volker Perlick [50] as “incomprehensible”. Moreover, S. T. Yau has politely lost his earlier interests on their claims [42]. The awards and honors to Christodoulou manifested that most of the physicists do not understand pure mathematics adequately and many mathematicians do not understand physics

4) Errors of the Mathematicians, such as Atiyah, Penrose, Witten, and Yau

One may expect that mathematicians would help improving the mathematics situation in physics. However, this expectation may not always be fulfilled. The reason is that a mathematician may not understand the physics involved and thus could make the situation worse. For instance, most mathematicians were not aware of the need of a term with anti-gravity coupling such that a bounded dynamic solution would be obtained.

An example is the mathematician Roger Penrose. He was misled by the formula that $E = mc^2$ as always valid and thus he believed that all the coupling of energy-momentum tensors must have the same sign. Then his talent comes up with the space-time singularity theorems without realizing such an assumption is invalid in physics.

A dynamic solution which is asymptotically flat would be the most normal physical solution. This leads to acceptance of the positive mass theorem of Schoen and Yau [51]. However, this is in conflict with the implicit assumption of unique sign of couplings. From the Wikipedia, the contributions of Prof. Yau were naively summarized as follows:

> ”Yau's contributions have had a significant impact on both physics and mathematics. Calabi–Yau manifolds are among the ‘standard tool kit’ for string theorists today. He has been active at the interface between geometry and theoretical physics. His proof of the positive energy theorem in general relativity demonstrated—sixty years after its discovery—that Einstein's theory is consistent and stable. His proof of the Calabi conjecture allowed physicists—using Calabi-Yau compactification—to show that string theory is a viable candidate for a unified theory of nature.”

Based on his proof, it was claimed that Einstein’s theory is consistent and stable. A crucial assumption in the theorem of Schoen and Yau is that the solution is asymptotically flat. However, since the Einstein equation has no dynamic solution, which is bounded, the assumption of asymptotically flat implies that the solution is a stable solution such as the Schwarzschild solution, the harmonic solution, the Kerr solution, etc. Therefore, Schoen and Yau actually prove a trivial result that the total mass of a stable solution is positive. This is, of course, misleading [52].

The non-existence of dynamic solutions for the Einstein equation was not recognized by physicists. So, Yau could only invalidly assume the existence of a bounded dynamic solution. Thus, the positive mass theorem of Schoen and Yau also continues such an error. Yau failed to see this problem of misleading since he has not attempted to find explicit examples to illustrate their theorem. Apparently, Atiyah also failed to understand this issue [52].

In fact, Yau [51], Witten [53],[10)] and Christodoulou [42] make essentially the same error of defining a set of solutions that actually includes no dynamic solutions. Their fatal error is that they neglected to find explicit examples to support their claims. Thus, Yau has implicitly used the invalid assumption of unique sign in his positive mass theorem of 1981.

Note that Einstein & Rosen [54] are the first who recognized the non-existence of wave solution for the Einstein equation. The facts that Atiyah [16], Hilbert [55], Witten [53], and Yau [51] were unable to identify their errors, would have misleadingly created a false impression that Einstein and the Wheeler School did not make errors in mathematics. On the other hand, since the famous actually also make errors, this shows clearly that humans are rarely perfect.

4. THE REPULSIVE GRAVITATION AND UNIFICATION

Currently no prediction of general relativity has been verified in any laboratory on earth, and there was no prediction made on non-massive sources [1, 2]. Einstein and many theorists failed to understand gravity repulsive to mass can be generated [23, 24]. It is on these findings that Einstein's conjecture of unification between gravitation and electromagnetism can be established [23]. Einstein & Pauli [56] failed because they did not understand unification as well as Maxwell.

Now, let us examine the Reissner-Nordstrom metric [1] (with c =1) as follows:

$$ds^2 = \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)dt^2 - \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)^{-1} dr^2 - r^2 d\Omega^2, \quad (12)$$

where q and M are the charge and mass of the particle, and r is the radial distance (in terms of the Euclidean-like structure [14]) from the particle center. In metric (12), 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. Unfortunately, many, including journals such as the **General. Relativity & Gravitation** [57], failed to see this important interaction.

Herrera, Santos, & Skea [57] argued that M in (12) involves the electric energy. Then, a ball with charge Q would increase its weight as Q increases [6]. However, this is in disagreement with experiments of Tsipenyuk and Andreev [58]. Nevertheless, Nobel Laureate 't Hooft [59] claimed that the electric energy of an electron contributed to the inertial mass of an electron. [11)] Nobel Laureate Wilczek [60] also has mistaken that $m = E/c^2$ was universally true.

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 [24]. Thus, as Lo and Wong [61] predicted, experiments [58] support that a charged ball has a reduced weight. According to metric (12), the repulsive force to a particle of mass m at a distance r is approximately mq^2/r^3. For a charged ball, the formula becomes Q^2/R^3, where Q is the charge of the ball and R is the distance from the ball center [61].

The discovery of the repulsive gravitation is important because it would solve a puzzle as to why we have never seen a black hole as Wheeler simulated. However, now we know that gravity is not always attractive to mass.

5. THE CHARGE-MASS INTERACTION AND THE EXTENSION OF GENERAL RELATIVITY

To show the static repulsive effect, one needs to consider only g_{tt} in metric (12). According to

$$\frac{d^2x^\mu}{ds^2} + \Gamma^\mu{}_{\alpha\beta}\frac{dx^\mu}{ds}\frac{dx^\nu}{ds} = 0, \quad \text{where} \quad \Gamma^\mu{}_{\alpha\beta} = (\partial_\alpha g_{\nu\beta} + \partial_\beta g_{\nu\alpha} - \partial_\nu g_{\alpha\beta})g^{\mu\nu}/2 \qquad (13)$$

and $ds^2 = g_{\mu\nu}dx^\mu dx^\nu$, we only need to consider g_{tt}. For a particle *P* with mass m at **r**, the static force on *P* is

$$-m\frac{M}{r^2} + m\frac{q^2}{r^3} \qquad (14)$$

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

$$\left(m\frac{M}{r^2} - m\frac{q^2}{r^3}\right)\hat{r}, \text{where } \hat{r} \text{ is a unit vector} \qquad (15)$$

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.

Thus, force (15) to particle *Q* is beyond current theoretical framework of gravitation + electro-magnetism. As predicted by Lo, Goldstein, & Napier [62], general relativity leads to a realization of its inadequacy.

6. EXTENSION TO FIVE-DIMENSIONAL RELATIVITY AND THE CHARGED CAPACITOR

The coupling with q^2 leads to a five-dimensional space of Lo et al. [62] because such a coupling does not exist in a four-dimensional theory nor in the five-dimensional theory of Kaluza [63] as well as the theory of Pauli and Einstein [56].

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

$$\frac{d}{ds}\left(g_{ik}\frac{dx^k}{ds}\right) = \frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{ds}\frac{dx^l}{ds} + \left(\frac{\partial g_{5k}}{\partial x^i} - \frac{\partial g_{5i}}{\partial x^k}\right)\frac{dx^5}{ds}\frac{dx^k}{ds} - \Gamma_{i,55}\frac{dx^5}{ds}\frac{dx^5}{ds} - g_{i5}\frac{d^2x^5}{ds^2}, \qquad (16a)$$

$$\frac{d}{ds}\left(g_{5k}\frac{dx^k}{ds} + \frac{1}{2}g_{55}\frac{dx^5}{ds}\right) = \Gamma_{k,55}\frac{dx^5}{ds}\frac{dx^k}{ds} - \frac{1}{2}g_{55}\frac{d^2x^5}{ds^2} + \frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{ds}\frac{dx^k}{ds}, \qquad (16b)$$

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

If instead of *ds*, $d\tau$ is used in (16), for a particle with charge q and mass M, the Lorentz force suggests

$$\frac{q}{Mc^2}\left(\frac{\partial A_i}{\partial x^k} - \frac{\partial A_k}{\partial x^i}\right) = \left(\frac{\partial g_{i5}}{\partial x^k} - \frac{\partial g_{k5}}{\partial x^i}\right)\frac{dx^5}{d\tau}. \qquad (17a)$$

Thus,

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$$\frac{dx^5}{d\tau} = \frac{q}{Mc^2}\frac{1}{K}, \qquad K\left(\frac{\partial A_i}{\partial x^k} - \frac{\partial A_k}{\partial x^i}\right) = \left(\frac{\partial g_{i5}}{\partial x^k} - \frac{\partial g_{k5}}{\partial x^i}\right) \qquad \text{and} \qquad \frac{d^2x^5}{d\tau^2} = 0 \tag{17b}$$

where K is a constant. It thus follows that (16) is reduced to

$$\frac{d}{d\tau}\left(g_{ik}\frac{dx^k}{d\tau}\right) = \frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{d\tau}\frac{dx^l}{d\tau} + \left(\frac{\partial A_k}{\partial x^i} - \frac{\partial A_i}{\partial x^k}\right)\frac{q}{Mc^2}\frac{dx^k}{d\tau} - \Gamma_{i,55}\left(\frac{q}{Mc^2}\right)^2\frac{1}{K^2}, \tag{18a}$$

$$\frac{d}{d\tau}\left(g_{5k}\frac{dx^k}{d\tau} + \frac{1}{2}g_{55}\frac{q}{KMc^2}\right) = \Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau} + \frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{d\tau}\frac{dx^k}{d\tau}. \tag{18b}$$

The fifth dimension is assumed [62] 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

$$-\frac{mM}{\rho^2} \approx \frac{Mc^2}{2}\frac{\partial g_{tt}}{\partial \rho}\frac{dct}{d\tau}\frac{dct}{d\tau}g^{\rho\rho}, \qquad \text{and} \qquad \frac{mq^2}{\rho^3} \approx -\Gamma_{\rho,55}\frac{1}{K^2}\frac{q^2}{Mc^2}g^{\rho\rho} \tag{19a}$$

and

$$\Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau} = 0, \qquad \text{where} \qquad \Gamma_{k,55} \equiv \frac{\partial g_{k5}}{\partial x^5} - \frac{1}{2}\frac{\partial g_{55}}{\partial x^k} = -\frac{1}{2}\frac{\partial g_{55}}{\partial x^k} \tag{19b}$$

in the (-*r*)-direction. The meaning of (19b) is the energy momentum conservation. Thus,

$$g_{tt} = 1 - \frac{2m}{\rho c^2}, \qquad \text{and} \qquad g_{55} = \frac{mMc^2}{\rho^2}K^2 + \text{constant。} \tag{20}$$

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.

Thus, general relativity must be extended to accommodate the charge-mass interaction, and a five-dimensional relativity is a natural candidate. According to Lo et al. [62], the charge-mass interaction would penetrate a charged capacitor. However, from current four-dimensional theory we would not get the repulsive force acting on a test particle outside a capacitor. Thus, to verify the five-dimensional theory, one can test the repulsive force from a charged capacitor.

Experimentally, it is known that a charged capacitor reduces its weight. In a charged capacitor, the only change is the state of motion of some electrons that have become statically concentrated instead of moving in orbits. Then, a repulsive force appears. Since such a force did not appear before, it is clear that such a force was cancelled out by the force created by the motion of the electrons. In other words, the repulsive force generated by the charges of protons and the electrons was cancelled by the force generated by the motion of the initially moving charges of the electrons.

However, this repulsive force cannot be proportional to the charge density. The equal numbers of negative and positive charges would lead to the cancellation of the forces generated by particles. However, if such a force is proportional to the charge density square, then these two kinds of forces would be added up, instead of cancelled out. Moreover, since the lifter has a limited height [64], one should expect that this repulsive gravitational force would diminish from distance faster than the attractive gravitational force. Thus, if we assume that the force is proportional to mass as usual, the static charge-mass interaction [65] would be a repulsive force between charge density D_q and a particle of mass m. This force would be

$$F_r \approx K_c\, mD_q^2/r^n \quad \text{where } n > 2, \tag{21}$$

r is the distance between the charge and the particle, and K_c is the coupling constant. In formula (21), the coupling constant K_c and n the power of r can be determined by experiments. The simplest case is n = 3. Formula (21) is derived with physical common sense. This approach is different from the derivations with very imaginative assumptions [23, 63].

Moreover, experimental data show a beautiful parabola curve for the repulsive force against the potential difference V of the capacitor [23]. (Note that the charge Q = CV, where C is the capacitance.) However, before the repulsive force is understood in terms of the five-dimensional theory, because of the lack of a valid physical explanation [23] such experiments were rejected by many physicists. In fact, such experiments are confirmed as relating to repulsive gravitation only after Liu measured the weight reduction of charged rolled-up commercial capacitors [23].

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7. WEIGHT REDUCTION OF HEATED-UP METALS & THE CURRENT-MASS INERACTION

To explain $E = mc^2$, Einstein [20] claimed, "an increase of E in the amount of energy must be accompanied by an increase of E/c^2 in the mass." However, experiments show, a piece of heated-up metal actually reduces its weight [18, 19]. Nevertheless, in the April 2015 APS meetings many still did not know this inconsistence with experiments.

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 [38]. Also, it is necessary to have the current-mass interaction to cancel out the charge-mass interaction in a not charged capacitor. Thus, this explains why a charged capacitor exhibits the charge-mass repulsive force since a charged capacitor has no additional electric charges? 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 current-mass attractive force has been verified by Martin Tajmar and Clovis de Matos [66]. It is found that a spinning ring of superconducting material increases its weight much more than expected. 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 [62]. 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.

This current-mass interaction would explain a predicted phenomenon, which is also reported by Liu [23] that it takes time for a discharged capacitor to recover its weight. This is because his rolled-up capacitors keep heat better. A discharged capacitor needs time to dissipate the heat and then the motion of its charges would accordingly recover to normal. In other words, the heat in the capacitor reduces its weight. Thus, one may expect that the weight of a piece of heated-up metal would be reduced although Einstein [20] predicted an increment.

For a piece of a heated-up metal, due to increased heat, the orbital electrons are reduced and the random electrons are increased; and thus the charge-mass repulsive force would increase [18, 19]. Therefore, a net result is a reduction of weight instead of slightly increased weight. Experimentally [67], for a temperature increment from 100^0 C to 600^0 C, the weight reductions of six kinds of metal is from 0.5% to 0.8%. This confirms that mass and electromagnetic energy are different. Nevertheless, some still believed in $E = mc^2$, because they did not know that this has been proven incorrect. [12)]

In conclusion, 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. Experiments support the charge-mass interaction and thus the five-dimensional space. However, details of this temperature dependence of weight is not yet known.

8. MEASUREMENTS OF NEWTONIAN GRAVITATIONAL COUPLING CONSTANT

Currently, many experimentalists [68] are not aware that the weight of matter depends on the temperature. Thus to obtain the Newtonian constant, they use metal as testing material. Although they discovered that the resulting coupling constant are slightly different from using metal and glass as testing material, they incorrectly regarded these as normal experimental errors [66]. However, they were not aware that the weight is actually the result of combined forces.

Nevertheless, Faller [69] is aware of error budgets to be fundamentally flawed because one cannot make allowances for error sources that have not been thought of. Because the American Physical Society (APS) did not know the weight reduction experiments of heated-up metal, Faller also considered that temperature could not significantly affect the weight. Thus, the most accurate Newtonian coupling constant obtained by J. Luo is actually questionable.

However, to obtain the most accurate Newtonian coupling constant, one must understand the influence of temperature. The weight reduction depends not only the temperature but also the kind of metal used. Thus, an accurate Newtonian coupling constant remains, in principle, not yet possible. Nevertheless, for the case of gravity related to the moon, temperature effects does not seem to matter.

9. CONCLUSIONS AND DISCUSSIONS

The Prediction of the bending of light marks the success of general relativity. However, it is also due to such calculations that problems are found in general relativity. First, in such calculations, the gravitational effects of an electromagnetic wave is assumed to be negligible. However, Einstein's theory is proven inadequate since there is no bounded solution for such a gravitational effect. Thus, it is necessary to modify the Einstein equation by adding the photonic energy-stress tensor with an anti-gravity coupling [33, 34]. (Thus, the notion of photons is actually a consequence of general relativity.) In other words, the assumption of unique sign for all the coupling constants is invalid.

Since the unique sign was thought to be implied by $E = mc^2$, this formula of Einstein [17] is now questionable. In fact, there are three types of experiments that shows $E = mc^2$ is not valid [18, 19]. In particular the electromagnetic energy is not equivalent to mass [23, 24]; otherwise it leads to inconsistency with the static Einstein equation. Thus, the gravity generated by the electromagnetic energy should be different.

Moreover, the charge-mass interaction is discovered, and such an interaction implies that the theoretical framework of general relativity must be extended to a five-dimensional relativity of Lo, Goldstein and Napier [25]. Then, the repulsive force from a charged capacitor can be understood because such a force cannot be explained in terms of the current four-dimensional theory. Hence, Einstein's conjecture of unification of electromagnetism and gravitation is proven valid.

However, Einstein himself failed this because of his shortcomings as follows: 1) Einstein believed incorrectly that $E = mc^2$ is unconditional; 2) Einstein failed to see the repulsive charge-mass interaction, which is crucial for his conjecture of unification; 3) Einstein failed to see the need of new interactions in a unification as Maxwell did. Nevertheless, Einstein is the biggest winner of the rectification of his theories.

It was a puzzle that a successful theory such as general relativity with so many correct predictions are so difficult to understand. Now, we know that a successful theory may still have some errors. A problem is Einstein's adaptation of the length measurement in Riemannian geometry. As Whitehead [13] pointed out, “By identifying the potential mass impetus of a kinematics element with a spatio-temporal measurement Einstein, in my opinion, leaves the whole antecedent theory of measurement in confusion, when it is confronted with the actual conditions of our perceptual knowledge.“

In fact, the notion of distance in Riemannian is inconsistent with calculations of the bending of light [14], for which an Euclidean-like theoretical framework is necessary. Thus, regarding the Hubble's redshifts as due to the receding velocities of the stars is invalid [15], and thus, there is no evidence for the expanding universe. Second, there is a need to add the gravitational radiation reaction force in general relativity [16], and thus gravity is clearly not Riemannian geometry.

The existence the repulsive gravitation implies that the picture provided by Galileo, Newton and Einstein is too simple for the complicated gravitation. Since gravitation is not always attractive to mass, the basic assumption for the simulation of Wheeler [70] that leads to the theory of black holes is not valid. Moreover, Einstein's covariance principle is invalid as Zhou [3] pointed out. In fact, such a principle is due to Einstein's confusion between mathematics and physics [26].

Due to inadequacy in mathematics, Einstein failed to see that his equation does not has any dynamic solution [8-10] as Gullstrand, the Chairman (1922-1929) of the Nobel Prize Committee suspected. Einstein also did not see that linearization is valid for the static case, but invalid for the dynamic case [71]. Because of the general inadequacy of mathematics, physicists not only follow Einstein's errors, but also physicists such as Pauli, the Wheeler School, and Eric J. Weinberg, [13)] editor of Physical Review D, misinterpreted Einstein's equivalence principle to become mathematically impossible [39].

If many physicists are incompetent in pure mathematics, one may expect that mathematicians would help improving the mathematics situation in physics. However, a mathematician may not understand the physics involved and thus could make the situation worse. For instance, most mathematicians were not aware of the need of a term with anti-gravity coupling such that a bounded dynamic solution would be obtained [8-10].

An example is the mathematician Roger Penrose. His inadequacy in physics misled him to believe that all the coupling of energy-momentum tensors must have the same sign. Then his talent comes up with the space-time singularity theorems without realizing such an assumption is invalid in physics [7]. Moreover, he also did not know that there is no dynamic solution for the Einstein equation [8-10] since he has never looked for one. Nevertheless, he believed that there are dynamic solutions because of Einstein's mistakes in non-linear mathematics.

Thus, Yau's assumption of asymptotically flat implies that the solution is a stable solution such as the Schwarzschild solution, and the Kerr solution, etc. Therefore, Schoen and Yau actually prove a trivial result that the total mass of a stable solution is positive. However, they regarded this valid for all situations, and thus is misleading. In fact, Yau [51], Witten [55], and Einstein make the same error of defining a set of solutions that actually includes no dynamic solutions.

Thus, physicists must improve their pure mathematics and non-linear mathematics; and mathematicians must understand the related physics before they try to help the physicists.

It should be noted that from the April Meetings 2015 of the American Physical Society, most of the members are not aware the three experiments that show Einstein's speculation $E = mc^2$ is not valid. It seems there are two main reasons that lead to such a situation. 1) Many members of the APS concentrate on their own work, and thus they have little time for the work of others. 2) The APS is dominated by the erroneous theories of the Wheeler School, they simply ignore the progress in physics which are inconsistent with their errors. Because Princeton [39, 42] and Harvard [51] are the main sources of errors [43, 50, 53], the mistakes are not discovered for a long time. [14)] However, in sciences errors cannot be covered up for ever.

Gravitation was considered as producing only attractive force. This physical picture provided by Galileo, Newton and Einstein is just too simple for the complicated gravitation. The present investigation will promote a deeper understanding of gravitational phenomena, and in particular Einstein's unification, will find useful applications in various parts of physics, astrophysics in particular. An immediate problem is to derive the temperature dependence of weight reduction.

Obviously, it is desirable to have a thorough review on general relativity to find out precisely what are valid, what are questionable, and what are needed to be completed. Note that theorists often support errors by referring to the erroneous opinions of the others, although they do not have solid supporting evidence. Moreover, currently in quantum mechanics, the charge-mass interaction is neglected. Thus, quantum theory is not a final theory as Einstein claims. Finally, I would like to apologize for exposing the errors of the experts. However, to be true to sciences, I don't have other choices.

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ENDNOTES

1) C. N. Yang believed that Einstein's covariance principle is valid because he misinterpreted the gauge invariance.

2) Wald rejected the equivalence principle, but adopted the invalid covariance principle. Thus, his 'modern' view is invalid.

3) Einstein's calculation of the perihelion of Mercury is not valid since it cannot be derived from a many-body problem.

4) This is a popular mistake of physicists because of inadequate background in pure mathematics.

5) Dmitriev, Nikushchenko, & Snegov [19] are well-known although Fan, Feng, & Liu [67] are not as well known.

6) Now, it is clear that Einstein's understanding of general relativity needs improvement.

7) Due to poor background in mathematics, Einstein and his followers did not know that linearization is not always valid.

8) The time-tested assumption that phenomena can be explained in terms of identifiable causes is called the principle of causality. This is the basis of relevance for all scientific investigations. This principle of implies that any parameter in a physical solution must be related to some physical causes. In the case of general relativity, the metric is the flat metric when any cause of gravitation is absent.

9) Members of the awarding committee often act on their faith of previous awards, but may not know the subject at all.

10) From the theorem of Witten [53], it is clear that he also does not understand general relativity.

11) This manifests that 't Hooft does not understand special relativity and Newtonian mechanics adequately.

12) Some theorists read papers only if authors are well-known. Some read papers only if the conclusion pleases them.

13) Eric J. Weinberg, editor of Physical Review D, still does not accept the weight reduction of heat-up metal. Apparently, he is unaware of the 2003 work of Dmitriev et al. [19]. Moreover, in agreement with the Wheeler School, he incorrectly considered Einstein's equivalence principle and Pauli's version are the same. (Einstein [26] illustrated this misinterpretation with an explicit example.) Weinberg also makes a crucial error on non-linear mathematics [71] that, for the dynamic case, the linearization would still produce an approximate solution for the Einstein equation. Thus, he also has mistaken that the Einstein equation has dynamic solutions. Weinberg is also unable to understand the charge-mass interaction because he believes $E = mc^2$ unconditionally, and thus is a main reason that the American Physical Society has been lacking behind for the existence of repulsive gravitation. He also accepts the unbounded solution because of inadequate understanding the principle of causality [10]. However, a problem is that, because of inadequacy in mathematics and physics, many make the same errors as Weinberg [39, 71]. Thus, they form a strong obstacle to the progress of physics.

14) Prof. S. Weinberg taught us that general relativity must be understood in terms of physics. This MIT tradition has a long history, starting from Rosen and Einstein’s paper of 1937, followed by Yilmaz, advocated by Weisskopf and Morrison, and so on. It is a pleasure to be able to contribute to such an outstanding tradition. However, to repair such a tradition is urgently needed since it has recently been broken by the Wheeler School [39] after Prof. Morrison passed away. It is hoped that MIT will soon be able to recover the tradition based on physics instead of opinions of the famous. However, this would not be an easy task for MIT.

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