© Mehtapress 2014

Print - ISSN : 2319–9814
Online - ISSN : 2319–9822

Journal of
Space Exploration

WWW.MEHTAPRESS.COM

Full Paper

C.Y.Lo

Applied and Pure Research Institute, 7 Taggart Drive, Unit E, Nashua, NH 03060, (USA)
E-mail: c_y_lo@yahoo.com

Received : December 08, 2013
Accepted : March 18, 2014
Published : May 25, 2014

*Corresponding author's Name & Add.

C.Y.Lo
Applied and Pure Research Institute, 7 Taggart Drive, Unit E, Nashua, NH 03060, (USA)
E-mail: c_y_lo@yahoo.com

The unification of gravitation and electromagnetism and the cause of the pioneer anomaly discovered by NASA

Abstract

It is found that general relativity is incomplete because it involves the charge-mass interaction. The Reissner-Nordstrom metric enables to show that, due to the electromagnetic energy, there is a repulsive effect in gravity. Analysis of this effect shows that the geodesic equation as the equation of motion is inadequate. To include the force of charge-mass repulsion, it is shown that the unification within the theoretical framework of a five-dimensional theory would resolve this problem because of the additional metric elements. In the five-dimensional theory of Einstein and Pauli, those elements were incorrectly disregarded as having no physical meaning. The string theorists led by Witten also failed because they do not understand the Einstein equation adequately. Concurrently, the formula $E = mc^2$ is proven as only conditionally valid and experimental verifications of the new force are discussed. Thus, the full meaning of relativity is still emerging after 100 years of Einstein's creation. The physical meaning and applications of the new charge-mass interaction are discussed.

Keywords

Mass-charge interaction; Geodesic equation; Einstein's equivalence principle; Euclid ean-like structure; Five-dimensional theory; Repulsive effect; 04.20.-q; 04.20.Cv.

INTRODUCTION

Einstein initiated the unification of electromagnetism and gravity, but the need of unification has not yet been clarified[1]. In general relativity, a major error of Einstein was the existence of bounded dynamic solutions[2]. Such an error was the root for the failure in recognizing the unification of electromagnetism and gravitation[2]. Moreover, since Einstein incorrectly considered general relativity as logically complete[3], in the five-dimensional theory of Einstein and Pauli[4], all the "extra" metric elements are regarded as having no physical meaning. On the other hand, however Maxwell showed that unification is a remedy to remove the shortcomings of the theories to be unified[1]. Accordingly, Einstein's unification scheme would fail.

Nevertheless, the rise of non-abelian gauge theories results in a great advance of unifying the weak, the strong, and the electromagnetic[5]. Then, the unification with gravity is the next goal. Many speculated that the string theory would give this final unification. However, string theorists tried for more than a quarter of a century without any visible success. Instead, they misleadingly misinterpreted general relativity[74]. Recently, critics started to openly question the validity of string theory, and even the relevance of unification[5,6].

In this paper, it will be shown that apart from the difficulty in mathematics, a hidden problem is that theorists do not understand general relativity and related theories yet. The real problem is that general relativity is not yet ready for the stage of unification. For instance, the editor of the Royal Society still rejects Einstein's requirement on weak gravity[7,8] since the "covariance principle" is proven invalid only recently[9]. Moreover, there are unphysical metrics that can give the correct light bending[10].

Most of those who work on the issue of unification are particle physicists or mathematicians. Naturally, they rely on experts of relativity. Unfortunately, those perceived "experts" actually do not understand general relativity well[11-13], and Feynman[14] was aware of their inadequacy. For instance, except in Einstein's original works, there are no textbooks or reference books (including the British Encyclopedia [2006]) that stated and explained Einstein's equivalence principle correctly although this principle is stated in page 57 of "The Meaning of Relativity"'[15]. Also, some theorists criticized Einstein without getting the facts straight first[12].

About 25 year ago, we[16] conjectured that, as in the case of electromagnetism, the unification is also due to internal inadequacy of such theories. However, it was very difficult to identify inadequacy in general relativity because things are not clearly defined. For instance, Einstein's equivalence principle[15,17] was very difficult to apply. It took a long time to recognize that Einstein's theory was not even self-consistent because of two reasons. First, Einstein's theory of measurement is actually inconsistent with his equivalence principle[18]. Moreover, he over-looked that his measuring instruments are in a free fall state and his measurement may not be executable for the length of an extended object[13]. Second, the so-called "covariance principle" is not generally valid in physics[9]. In fact, Einstein's argument for the justification of the "covariance principle" was actually not valid[19].

However, problems seem to be rectifiable within the theoretical framework of general relativity[9,12,13,18,20]. A major problem remains to be fixed is that Einstein's equation must be modified to have a dynamic solution[21,22]. However, an equation of first order approximation, which was derived independent of the Einstein equation, would give dynamic solutions for massive sources[23]. It is interesting to note that Einstein and Rosen[22,24] were the first who discovered the non-existence of wave solutions. However, Einstein did not explain his equivalence principle sufficiently although Pauli's version is a misinterpretation of his principle[25].

The famous formula $E = mc^2$[75], was "derived" in 1905[17], but Einstein[26] did not know it is only conditionally valid. For instance, the electromagnetic energy is not equivalent to mass[27]. Moreover, Einstein did not see that his formula is inconsistent with the notion that light consists of just electromagnetic waves[28]. This error led Einstein and his peers to over-look the charge-mass interaction (see Section 2), which is crucial for unification of electromagnetism and gravitation.

Now, any attempt to have a unification including gravity must study general relativity and the issue of $E = mc^2$ first. And the lack of progress in unification should not be blamed on string theorists alone. However, there are indications that such a problem can be resolved in the theoretical framework of a five-dimensional theory. In any case, the conjecture of Lo et al[1,16] that unification is due to internal inadequacy is verified. This means that the current popular approaches to unification need to review thoroughly and restart all over again.

THE INVALID SPECULATION OF $m = E/c^2$

The formula $E = mc^2$ can be traced back to special relativity, which suggested a rest mass m_0 has the rest energy of m_0c^2. This is supported by the nuclear fissions with $\Delta E = \Delta mc^2$, where Δm is the mass difference after the fission and ΔE the total energy created and is usually a combination of different types of energy. After the case of photons, Einstein had tried very hard for years (1905-1909) to prove this formula to be generally valid, but failed[29]. Thus, the relation $m = E/c^2$ is only an unverified speculation[76]. Ironically, the famous formula $E = mc^2$ is also a formula that many physicists do not understand properly[30]. This formula means that there is energy related to a mass, but it does not mean that, for any type of energy, there is a related mass[30,31]. A root of misunderstanding $E = mc^2$ is related to the fact that, for the case of photons, its derivation[17] has not been completed. A crucial step is Einstein's implicit assumption of treating light as a bundle of massless particles. However, Einstein did not consider gravity in 1905 owing to the limitation of Newtonian gravity. Consequently, it was not aware that an electromagnetic energy-stress tensor is very different from the energy-stress tensor of massless particles[28].

Many believed that the equivalence of electromagnetic energy and mass was verified[32]. However, this is in conflict with electromagnetism because the trace of an electromagnetic tensor is zero, but the trace of an energy-stress tensor of massive matter is non-zero. On the other hand, it is observed that a π_0 meson would decay into two γ rays. However, this only means that the photons must include non-electromagnetic energy, which has been identified later as the gravitational energy[28]. If the photons have only electromagnetic energy, the sum is also electromagnetic energy, but the photons, being massless particles, can create a massive energy-stress tensor. Thus, Einstein's proposal of a photon being a quantum of electromagnetic energy[17] is actually inadequate. However, Einstein was limited by the fact that his general relativity had not been created then.

According to general relativity, the electromagnetic energy is not equivalent to mass. Consider the static case,

$$G_{\mu\nu} \equiv R_{\mu\nu} \frac{1}{2} g_{\mu\nu} R = -8\pi \, T_{\mu\nu},$$

$$\text{where} \quad R = g^{\alpha\beta} R_{\alpha\beta}, \qquad (1)$$

and $T_{\mu\nu}$ is the total energy-stress tensors. $R (= 8\pi g^{\alpha\beta} T_{\alpha\beta})$ is independent of the electromagnetic energy-stress tensor $T(E)_{\mu\nu}$ since $T(E)_{\mu\nu}$ is traceless. Thus, the electric energy cannot be equivalent to a mass. (For a dynamic case, the equation would be[2,21] $R_{\mu\nu} - (1/2)g_{\mu\nu} R = - 8\pi [T_{\mu\nu} - t(g)_{\mu\nu}]$, where $t(g)_{\mu\nu}$ is the gravitational energy-stress tensor.)

The unverified speculation E = mc^2, being unconditionally valid, would imply that all the coupling constants would have the same sign. In turn, this would imply that there are no bounded dynamic solutions for the case of massive source[2], and thus general relativity is invalid for the dynamic case. The general validity of E = mc^2 was questioned since the binary pulsars experiment that the coupling constants necessarily have different signs[21].

The unconditional equivalence between mass and energy would imply that gravity would always increase as the energy of sources increase. This will be proven to be unequivocally invalid by the Riessner-Nordstrom metric[33], with the help of experiments[34,35]. However, to save such a situation, misinterpretations[36,37] were created and the charge-mass interaction was overlooked. It will be shown first that such misinterpretations are actually in conflict with the derivation of the Riessner-Nordstrom metric. Experimental verification of this new repulsive force leads to a new chapter in physics (see sections 4-7).

Moreover, the skeptics demand for additional experimental verification on the limitation of $E = mc^2$. Then such an investigation leads to focusing attention to the Riessner-Nordstrom metric. This metric turns out to be a key to find shortcomings of the theoretical framework of general relativity. It will be shown that the geodesic equation is inadequate and this cannot be fixed within the theoretical framework of general relativity + electromagnetism.

THE REISSNER-NORDSTROM METRIC AND THE REPULSIVE EFFECT

General relativity makes it explicit that the gravity generated by mass and that by the electromagnetic energy are different, as shown by the existence of repulsive effect in the Riessner-Nordstrom metric[33],

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

where q and M are the charge and mass of a particle and r is the radial distance, in terms of the Euclidean-like structure[20,23,77] from the particle center. In metric (2), the gravitational components generated by electricity have not only a very different radial coordinate dependence but a different sign that makes it a new repulsive gravity.

In fact, it is probably that the publication of this metric in 1916 and 1918 that ended Einstein's misconception starting from 1905[38] that any energy related to a mass $m = E/c^2$. However, such a misinterpretation[11,13] is crucial to the unconditional universal coupling assumption for the singularity theorems of Hawking and Penrose[39]. Thus, some theorists would even ignore that the Hulse-Taylor experiment has proven the extended universal coupling is incorrect[11,21]. Moreover, Will[40] continues to use his misinterpretations $m = E/c^2$ eight years after it has been proven incorrect[30]. From his book, it is clear that such a misinterpretation was still prevailing[78].

Some argued that the effective mass in metric (2) is M - q^2/2r (in the units, the light speed $c = 1$) since the total electric energy outside a sphere of radius r is $q^2/2r$[79]. However, from metric (2), the gravitational force is different from the force created by the "effective mass" $M - q^2/2r$ because

$$-\frac{1}{2}\frac{\partial}{\partial r}\left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right) = -\left(\frac{M}{r^2} - \frac{q^2}{r^3}\right) > -\frac{1}{r^2}\left(M - \frac{q^2}{2r}\right). \quad (3)$$

They achieved only exposing further an inadequate understanding in the theory of relativity[31,33,41,80]. Some theorists claimed that M should include the electric energy, and this exposes a even deeper error.

DERIVATION THE REISSNER-NORDSTROM METRIC AND ITS MISINTERPRETATIONS

It seems that mass M in (2) as a "total mass" that includes the electric energy, would be allowed if you are careless. However, a close examination shows that this is invalid.

According to Einstein, for the Reissner-Nordstrom metric, the static field equation includes at least the massive energy-stress tensor and the electromagnetic energy-stress tensor. They differ by that the electromagnetic energy-stress tensor is traceless whereas the massive energy-stress tensor is not.

If one assumes that the metric has the following form,

$$ds^2 = f dt^2 - h dr^2 - r^2(d\theta^2 + \sin\theta^2 d\phi^2), \quad (4)$$

then, as shown by Wald[39], at the region outside the particle ($r > r_0$) we have

$$-R_{00} = \frac{1}{2}(fh)^{-1/2}\frac{d}{dr}\left[(fh)^{-1/2}f'\right] + (fhr)^{-1}f', \quad (5a)$$

$$-R_{11} = -\frac{1}{2}(fh)^{-1/2}\frac{d}{dr}\left[(fh)^{-1/2}f'\right] + (h^2 r)^{-1}h', \quad (5b)$$

$$-R_{22} = -\frac{1}{2}(rh)^{-1}f' + \frac{1}{2}(h^2 r)^{-1}h' + r^{-2}(1 - h^{-1}) \quad (5c)$$

Moreover, outside the particle we have

$$T(m)_{\mu\nu} = 0 \qquad \text{for} \qquad r > r_0. \quad (6a)$$

But

$$T(m)_{00} = \rho(r),\ T(m)_{11} = T(m)_{22} = T(m)_{33} = P(r),\ \text{when } r < r_0 \quad (6b)$$

where P(r) is the pressure of the perfect fluid model.

Because the electric energy-stress tensor $T(E)_{\mu\nu}$ is traceless, we also have, for $r > r_0$,

$$R_{00} = -R_{11} = R_{22} = -E^2, \text{ where } \vec{E} = \frac{q}{r^3}\vec{r} \quad (7)$$

is the electric field, according to Misner et al.[33]. If $h = 1/f$ in metric (4), then (5) is reduced to

$$-R_{00} = R_{11} = \frac{1}{2}f'' + r^{-1}f' = E^2 \qquad (8a)$$

And

$$-R22 = -r^{-1}f' + r^{-2}(1-f) = E^2 \qquad (8b)$$

Moreover, if $f = \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)$ as in metric (2), then we have, in consistent with (7),

$$\frac{q^2}{r^2} = r^2E^2 \qquad (9)$$

Thus, from the above derivation, it seems there is no restriction on the mass M of metric (4). However, from (7), it is clear that M in metric (4) cannot include the electric energy (outside the particle) since it has been represented in (7).

Nevertheless, Herrera, Santos, & Skea, argued that M in (2) involves the electric energy[37]. They follow the error of Whittaker[42] and Tolman[43] who believed the equivalence of mass and electric energy. They defined the active gravitational mass density μ with the electromagnetic energy tensor E^{α}_{β} as $\mu = E^0_0 - E^i_i$ and the active mass in a volume V_a is given by

$$m_a(r) = \int_{V_a} \mu(-g)^{1/2} dx^1 dx^2 dx^3, \qquad (10)$$

where g is the determinant of the metric $g_{\mu\nu}$. It thus follows that, for a particle with charge Q, one has

$$m_a(\infty) - m_a(r) = \int_r^{\infty} \frac{Q^2}{r^2} dr, \text{ and } m_a(r) = M - \frac{Q^2}{r},$$

$$\text{where } m_a(\infty) = M \qquad (11)$$

Thus $m_a(r)$ would be in agreement with that the total force is proportion to

$$\frac{1}{2}\frac{\partial}{\partial r}\left(1 - \frac{2M}{r} + \frac{Q^2}{r^2}\right) = (M - \frac{Q^2}{r})\frac{1}{r^2}$$

$$= \left(m_a(r_0) + Q^2(\frac{1}{r_0} - \frac{1}{r})\right)\frac{1}{r^2} \qquad (12a)$$

$$\text{since } M = m_a(r) + Q^2/r = \left(m_a(r_0) + Q^2/r_0\right), \qquad (12b)$$

where r_0 is the radius of the particle. However, (11) does not agree with (3) since

$$-2(M - \frac{Q^2}{r})\frac{1}{r} \neq \left(-\frac{2M}{r} + \frac{Q^2}{r^2}\right) \qquad (12c)$$

Eq. (12a) implies that the weight of a charged metal ball would increase when the charge Q is increased, According to eq. (10), $m_a(r_0)$ would increase as the charge Q increases. Thus, no repulsive effects can be detected. However, as shown in (12b), M includes energy outside the particle, in conflict with (7).

If the mass M is the inertial mass of the particle, the weight of a charged metal ball can be reduced[34] (see Appendix). Thus, as expected[30], experiments of two metal balls[45] reject eq. (11). The repulsive force on a charged ball is an important experiment to be completed for the details since it is also a test of general relativity[44].

The inertial mass of the particle should be smaller than M defined in (12b) since an acceleration of the charged particle would not immediately affect the electric energy at long distances. However, 't Hooft also claimed in his Nobel Lecture[46] that M in (12c) is the inertial mass subjected to Newton's second law. Thus, it is clear that 't Hooft is not a competent physicist. Understandably, 't Hooft as an applied mathematician does not understand the principle of causality adequately[47]. Note that the radius r_e of an electron *e* is about a half of its classical radius e^2/m_0c^2[48], where m_0 is its inertial mass. Thus, the electric energy e^2/r_e would be larger than m_0.

The problem started from the assumption of equivalence between mass and electric energy. Moreover, if electric energy is assumed as equivalent to mass, should it be considered as part of the gravitational mass of the particle or not. If it is, then gravitational mass and inertial mass are different. If it is not, then any electromagnetic energy should assign a mass. If any electromagnetic energy should assign a mass equivalence, then this would reject that a photon is massless and also special relativity. Thus, the electric energy should not be equivalent to mass.

The above approach is essentially the same as that of Pekeris[36], who gets a similar metric as follows:

$$ds^2 = e^{\nu}dt^2 - e^{-\nu}dR^2 - R^2 d\Omega^2 \text{ where } R^3 = r^3 + r_0^3 \qquad (13a)$$

$$e^{\nu} = \left(1 - \frac{2M_{mat}}{R} - \frac{2M_{em}}{R} + \frac{Q^2}{R^2}\right) = \left(1 - \frac{2M}{R} + \frac{Q^2}{R^2}\right),$$

$$\text{where } M_{em} = Q^2/r_0, \text{ and } M = M_{mat} + M_{em} \qquad (13b)$$

The difference is due to that Pekeris[36] requires that $|g_{\mu\nu}| = g = -1$. Thus, what Herrera et al.[37] does is essentially what Pekeris had done. Apparently, theorists have run out of ways that can be used against the repulsive force.

In summary, although the Riessner-Nordstrom metric and the other two metrics look the same, they are different because the mass M means differently in respective metrics. However the Reissner-Nordstrom metric can explain this force only for a special case. For the case of a charged capacitor, this is beyond general relativity.

THE CHARGE-MASS INTERACTION AND FIVE-DIMENSIONAL THEORY

To show the repulsive effect, one needs to consider only g_{tt} in metric (2). According to Einstein[15],

$$\frac{d^2x^{\mu}}{ds^2} + \Gamma^{\mu}{}_{\alpha\beta}\frac{dx^{\mu}}{ds}\frac{dx^{\nu}}{ds} = 0,$$

where $\Gamma^{\mu}{}_{\alpha\beta} = (\partial_{\alpha} g_{\nu\beta} + \partial_{\beta} g_{\nu\alpha} - \partial_{\nu} g_{\alpha\beta}) g^{\mu\nu}/2$ (14)

and $ds^2 = g_{\mu\nu} dx^{\mu} dx^{\nu}$ are defined by the metric $g_{\mu\nu}$. Consider the static case, $dx/ds = dy/ds = dz/ds = 0$. Thus,

$$\frac{d^2 x^{\mu}}{ds^2} = -\Gamma^{\mu}{}_{tt} \frac{dct}{ds}\frac{dct}{ds},$$

where $-\Gamma^{\mu}{}_{tt} = -\frac{1}{2}\left(2\frac{\partial g_{t\nu}}{\partial ct} - \frac{\partial g_{tt}}{\partial x^{\nu}}\right) g^{\mu\nu} = \frac{1}{2}\frac{\partial g_{tt}}{\partial x^{\nu}} g^{\mu\nu}$ (15)

since $g_{\mu\nu}$ would also be static. (Note that the gauge affects only the second order approximation of g_{tt}[49].) For a particle P with mass m at r, the force on P is

$$-m\frac{M}{r^2} + m\frac{q^2}{r^3} \quad (16)$$

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

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

$$\left(m\frac{M}{r^2} - m\frac{q^2}{r^3}\right)\hat{r}, \text{ where } \hat{r} \text{ is a unit vector} \quad (17)$$

since 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, the geodesic equation is inadequate for the equation of motion. Moreover, since the second term is proportional to q^2, it is not a Lorentz force[81]. Thus, 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. In conclusion, force (17) to particle Q is beyond current theoretical framework of gravitation + electromagnetism[82].

However, this problem would be solved in a five-dimension theory[1], where the geodesic equation would include the coupling of q^2. The geodesic is

$$\frac{d}{ds}\left(g_{ik}\frac{dx^k}{ds}\right) = \frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{ds}\frac{dx^l}{ds} + \left(\frac{\partial g_{5k}}{\partial x^i} - \frac{\partial g_{5i}}{\partial x^k}\right)\frac{dx^5}{ds}\frac{dx^k}{ds} - \Gamma_{i,55}\frac{dx^5}{ds}\frac{dx^5}{ds} - g_{i5}\frac{d^2x^5}{ds^2} \quad (18a)$$

$$\frac{d}{ds}\left(g_{5k}\frac{dx^k}{ds} + \frac{1}{2}g_{55}\frac{dx^5}{ds}\right) = \Gamma_{k,55}\frac{dx^5}{ds}\frac{dx^k}{ds} - \frac{1}{2}g_{55}\frac{d^2x^5}{ds^2} + \frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{ds}\frac{dx^k}{ds}, \quad (18b)$$

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 s, τ is used in (18), the Lorentz force suggests

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

Thus,

$$\frac{dx^5}{d\tau} = \frac{q}{Mc^2}\frac{1}{K}, \quad K\left(\frac{\partial A_i}{\partial x^k} - \frac{\partial A_k}{\partial x^i}\right) = \left(\frac{\partial g_{i5}}{\partial x^k} - \frac{\partial g_{k5}}{\partial x^i}\right),$$

$$\text{and } \frac{d^2x^5}{d\tau^2} = 0 \quad (19)$$

where K is a constant. It thus follows that

$$\frac{d}{d\tau}\left(g_{ik}\frac{dx^k}{d\tau}\right) = \frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{d\tau}\frac{dx^l}{d\tau} + \left(\frac{\partial A_k}{\partial x^i} - \frac{\partial A_i}{\partial x^k}\right)\frac{q}{Mc^2}\frac{dx^k}{d\tau} - \Gamma_{i,55}\left(\frac{q}{Mc^2}\right)^2\frac{1}{K^2} \quad (20a)$$

$$\frac{d}{d\tau}\left(g_{5k}\frac{dx^k}{d\tau} + \frac{1}{2}g_{55}\frac{q}{KMc^2}\right) = \Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau} + \frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{d\tau}\frac{dx^k}{d\tau} \quad (20b)$$

One may ask what the physical meaning of the fifth dimension is. Note that although the string theorists talk about space of much higher dimensional, they have no physical reason except for mathematical validity of their speculation. They claimed that those dimensions are curl up. Our position is that the physical meaning the fifth dimension is not yet very clear[1], except some physical meaning is given in equation (19). The fifth dimension is assumed as part of the physical reality, and the metric signature is (+,-,-,-,-). However, our approach is to find out the full physical meaning of the fifth dimension as our understanding gets deeper. Unlike mathematics, in physics things are not defined right at the beginning. For example, it took us a long time to understand the physical meaning of energy-momentum conservation.

For a static case, it follows (20) and (17) that the forces on the charged particle Q in the ρ-direction are

$$-\frac{mM}{\rho^2} \approx \frac{Mc^2}{2}\frac{\partial g_{tt}}{\partial\rho}\frac{dct}{d\tau}\frac{dct}{d\tau}g^{\rho\rho},$$

$$\text{and } \frac{mq^2}{\rho^3} \approx -\Gamma_{\rho,55}\frac{1}{K^2}\frac{q^2}{Mc^2}g^{\rho\rho} \quad (21a)$$

and

$$\Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau} = 0,$$

$$\text{where } \Gamma_{k,55} \equiv \frac{\partial g_{i5}}{\partial x^5} - \frac{1}{2}\frac{\partial g_{55}}{\partial x^k} = -\frac{1}{2}\frac{\partial g_{55}}{\partial x^k} \quad (21b)$$

in the ($-r$)-direction. Here particle P is at the origin of spatial coordinate system (ρ, θ', φ'). The meaning of (21b) is the energy momentum conservation. It is interesting that the same force would come from a different type of metric element depending on the test particle used. Thus,

$$g_{tt} = 1 - \frac{2m}{\rho c^2}, \text{ and } g_{55} = \frac{mMc^2}{\rho^2}K^2 + \text{ constant} \quad (22)$$

In other words, g_{55} is a repulsive potential. Since 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, since g_{55} is independent of q, $(\partial g_{55}/\partial \rho)/M$ depends only on the distant source with mass m. Thus, this force, though acting on a charged particle, would penetrate electromagnetic screening. This would make such a force easier to be identified. From (22), it is possible that a charge-mass repulsive potential would exist for a metric based on the mass M of the charged particle Q. However, since P is neutral, there is no charge-mass repulsion force (from $\Gamma_{k,55}$) on P.
In terms of physics, since the static repulsive force is independent of the charge sign, it should not be subjected to electromagnetic screening. From the viewpoint of the five-dimensional theory, the charge would create an independent field to react with the mass. To test this, one should observe whether there is a repulsive force from a charged capacitor to a mass particle since a capacitor would screen out the electromagnetic field outside the capacitor in current theories. Experimentally, such a force is observed since a charge capacitor reduces its weight[50-53].

THE CHARGE-MASS REPULSIVE FORCE ON A SPACE PROBE PIONEER

The Reissner-Nordstrom metric was first published in 1916, the same year that first paper on general relativity was published. Since Einstein advocated such unification[15], the necessary unification of gravitation and electromagnetism should have been recognized shortly. However, this was not recognized until 2006[35]. Because Einstein's accurate predictions, a faith has been created on him; and this makes a critical analysis overdue[54].
Note that, the calculation of (17) is essentially based on general relativity. The five-dimensional theory is invoked only to justify that the new force is not subjected to electromagnetic screening. However, this is theoretically crucial to establish a charge-mass repulsive force, which is independent of electromagnetism.
Then, the charge-mass repulsive force between a point charge q and a point mass m is

$$\mathbf{F} = \frac{\mathbf{q^2 m}}{\mathbf{r^3}} \qquad (23)$$

in the r-direction. The five-dimensional theory supports that it is not subjected to electromagnetic screening, and this is supported by the experiment of weighing charged capacitors. This new force would behave very differently from an attractive force, which is inversely proportional to the square of the distance r. However, due to the q^2 term, this formula should be modified for the case of a composite object consisting of many charged particles.
The space probes give a good opportunity to check the mass-charge interaction. If the repulsive force comes from the sun, then m in (23) would be m_p the mass of the pioneer, and distance r would be R the distance between the sun and the space probe. However, the charge term is not clear since for the sun we do not know what the non-linear term q^2 should be. Nevertheless, since such forces act essentially in the same direction, we could use a parameter P_S to represent the collective effect of the charges. Then, the effective repulsive force F_p would be (see also Section 6)

$$\mathbf{F_p} = \frac{\mathbf{P_s m_p}}{\mathbf{R^3}} \qquad (24)$$

Since the neutral sun emits light and is in an excited state, the sun has many locally charged particles, and P_S is not negligible. If the data fits well with an appropriate parameter P_S, then this would be another confirmation of the charge-mass interaction.
Since this force is much smaller than the gravitational force from the sun, in practice the existence of such a repulsive force would result in a very slightly smaller mass M_S for the sun, i.e.

$$\mathbf{F} = \frac{\mathbf{M_s m_p}}{\mathbf{R^2}} - \frac{\mathbf{P_s m_p}}{\mathbf{R^3}} \qquad (25a)$$

and $$\frac{\mathbf{M_s m_p}}{\mathbf{R_0^2}} - \frac{\mathbf{P_s m_p}}{\mathbf{R_0^3}} = \frac{\mathbf{M_{ss} m_p}}{\mathbf{R_0^2}} \qquad (25b)$$

for R_0. Then, we have

$$\mathbf{F} = \frac{\mathbf{M_{ss} m_p}}{\mathbf{R^2}} + \frac{\mathbf{P_s m_p}}{\mathbf{R^2}}\left(\frac{\mathbf{1}}{\mathbf{R_0}} - \frac{\mathbf{1}}{\mathbf{R}}\right) \qquad (26)$$

Thus, there is an additional attractive force for $R > R_0$, the distance of the earth from the sun. Of course, if the space probe is charged, then there is another repulsive force with M_S being the mass of the sun and P_s due to such charges. Moreover, such a force would not be noticeable from a closed orbit since the variation of the distance from the sun is small. However, for open orbits of the pioneers, there are great variations. When the distance is very large, the repulsive force becomes negligible, and thus an additional attractive force would appear as the anomaly. Such a force would appear as a constant over a not too long distance. Thus, the repulsive fifth force satisfies the overall requirements according to the data[55].
When the four planetary probes experienced unaccountable changes in velocity as they passed Earth, they experienced an additional repulsive force from the Earth because the core of the globe has charged currents. Moreover, depending on the way of approaching the globe, a planetary probe would also experience an additional attractive force due to current-mass interaction (see next

section). The related force would be more complicated just as the Lorentz force is more complicated than the Coulomb force. Thus, a planetary probe would experience an additional acceleration or de-acceleration[83].

CONCLUSIONS AND DISCUSSIONS

It has been shown that the theoretical framework of general relativity is inadequate, and modification is necessary. However, it should be noted that although unification of electromagnetism and gravitation is necessary, no new theory is compelling. All you can show is that it is a feasible way to solve the problem.

One may ask whether the force F_{cm} of charge to mass repulsion and the force F_{mc} of mass to charge repulsion are the same kind of force[84]. Since they have different origin; according to Einstein's equation, the repulsive term in g_{tt} is due to the electromagnetic energy, where the term in g_{55} is due to mass alone. Since the electromagnetic energy is subjected to electromagnetic screening, the force F_{cm} would also be subjected to screening although the force F_{mc} would not. This shows that there is a deficiency in current four-dimensional theory.

It should be pointed out that the screening effect to the force F_{cm} is only a result of the current four-dimensional theory. From the viewpoint of the five-dimensional theory, the charge would create an independent field to react with the mass. Moreover, one can have a large spherical capacitor to do the testing. Thus, this new force of gravity can be adjusted with the potential of the capacitor and thus this is potentially a new technology. Experimentally, such a force is observed since a charge capacitor reduces its weight[50-53,85].

In other words, the charge-mass repulsive force mq^2/r^3 is a prediction of the five-dimensional theory and is independent of the four known forces. It should be noted also that in electrodynamics the term $-\Gamma_{k,55}(dx^5/d\tau)^2$ is also necessary because it has been shown in 1981 that the terms $\partial g_{5k}/\partial x^5$ are related to the radiation reaction force[1]. Moreover, if the investigation of electric energy leads to a charge-mass repulsive force, it is expected that the magnetic energy would generate an additional current-mass force.

Recently, Martin Tajmar and Clovis de Matos[56], from the European Space Agency, found that a spinning ring of superconducting material increases its weight much more than expected. Thus, they believed that general relativity had been proven wrong. However, according to quantum theory, spinning superconductors should produce a weak magnetic field. Thus, they actually are measuring also the interaction between an electric current and the earth, i.e. an effect of the current-mass interaction. However, this is beyond the scope of this paper.

Gravitation was considered as producing attractive force only. Based on the speculation of unconditional validity of $E = mc^2$, Hawking and Penrose implicitly assumed in their space-time singularity theorems that all the coupling constants have the same sign. Recently, it is proven that for the radiation of binary pulsars the coupling constants must have different signs[11,21]. Thus, their singularity theorems are actually irrelevant to physics. Consequently, theories based on those singularity theorems must be revised. Now, even the electromagnetic energy would produce repulsive forces. Thus, the physical picture of only attraction provided by Newton is just too simple for a phenomenon as complicated as gravity that relates to everything.

Note that the five-dimensional theory is not a theory of everything since the issues of particle creation and annihilation are not addressed. Moreover, in this paper only the static case is considered, and formula (17) is essentially derived from general relativity. It is hope, however, that for the dynamic cases, a five-dimensional theory would help the necessary modification of the field equation of general relativity[1]. On the other hand, the string theorists should, at least, improve their understanding on general relativity first if they hope to have any progress[74].

Moreover, since many do not understand that $E = mc^2$ is only conditionally valid, and thus misunderstandings actually started from special relativity. They ignored issues such as the conflict between the "covariance principle" and Einstein's requirement on weak gravity[86], and they believed this invalid principle[9]. General relativity is not yet a self-consistent theory[9,11,18,20]. And the principle of causality was still inadequately understood[87].

Some theorists incorrectly regarded general relativity as a gauge theory[57] similar to electromagnetism because they failed to understand that such gauges means different meanings for coordinates, according to Einstein's equivalence principle[12,20,58]. Thus, it is unrealistic to expect the string theorists to perform a miracle in unification. Einstein is really a genius and the full meaning of general relativity is still emerging after 100 years of its creation. Now, it is clear that unification is a necessity.

In closing, we quote a remark by Einstein and Pauli (1943), who wrote in 1943

"When one tries to find a unified theory of gravitational and electromagnetic fields, he cannot help feeling that there is some truth in Kaluza's five-dimension theory."

It turns out that their observation would be a prophecy for the future advancement of such unification. Moreover, since a theory of weak interaction must be unified with electromagnetism, the necessity of unifying gravitation and electromagnetism would imply that the goal of the string theorists is, independent of their desire, a realistic problem.

Recently, it is found[59] that different kinds of heated up metals, in contrast to the claim of Einstein[26], all reduce weight, but no weight increase. It is very clear, $E = mc^2$ is not generally valid. Moreover, the researches in general relativity[33,39,40] have been largely misled, and thus need to have a thorough review. The major difference in this paper from others is that it is on verifiable predictions instead of speculation in cosmology.

APPENDIX: EXPERIMENTAL VERIFICATION OF THE MASS-CHARGE REPULSIVE FORCE

The repulsive force in (2) can be detected with a neutral mass. To see the repulsive effect, one must have

$$\frac{1}{2}\frac{\partial}{\partial r}\left(1-\frac{2M}{r}+\frac{q^2}{r^2}\right)=\frac{M}{r^2}-\frac{q^2}{r^3}<0 \qquad \text{(A1)}$$

Thus, repulsive gravity would be observed at $q^2/M > r$. For the electron the repulsive gravity would exist only inside the classical electron radius r_0 $(= 2.817\times10^{-13} cm)$. Thus, it would be very difficult to test a single charged particle[81].

However, for a charged metal ball with mass M and charge Q, the formula is similarly $0 > M/R^2 - Q^2/R^3$, where R is the distance from the center of the ball[35]. Consequently, the attractive effect in gravity is proportional to mass related to the number of electrons, but the repulsive effect in gravity is proportional to square of charge related to the square of the number of electrons. Thus, when the electrons are numerous enough accumulated in a metal ball, the effect of repulsive gravity will be shown in a macroscopic distance.

Consider Q and M is consist of N electrons, i.e., $Q = Ne$, $M = Nm + M_0$, where M_0 is the mass of the metal ball, m and e are the mass and charge of an electron. To have sufficient electrons, the necessary condition is

$$N>\frac{R}{r_0}, \quad \text{where } r_0=\frac{e^2}{mc^2}=2.817\times10^{-13}\,\text{cm}. \qquad \text{(A2)}$$

For example, if $R = 10\ cm$, then it requires $N > 3.550\times10^{13}$. Thus $Q = 5.683\times10^{-7}$ *Coulomb*. Then, one would see the attractive and repulsive additional forces change hands. For this case, the repulsive force is

$$\frac{Q^2 m_p}{R^3} \quad \text{where } m_p \text{ is the mass of the testing particle P.} \qquad \text{(A3)}$$

Similarly, the mass-to-charge repulsive force in metric (2) can be detected with a charge particle. However, since the repulsive force is very small, the interference of electricity would be comparatively large. Thus, it would be desirable to screen the electromagnetic effects out. The modern capacitor is such a piece of simple equipment.

When a capacitor is charged, it separates the electron from the atomic nucleus, but there is no change of mass due to increase of charged particles. Thus, after charged, the capacitor would have less weight due to the charge-mass repulsive force, a nonlinear force towards charges. This simple experiment would confirm the mass-charge repulsive force, and thus the unification in term of a five-dimensional theory.

One may ask whether the lighter weight of a capacitor after charged could be due to a decrease of mass. Such a speculation is ruled out. Inside a capacitor the increased energy due to being charged would not be pure electromagnetic energy such that, for the total internal energy, Einstein's formula is valid.

In the case of charged capacitor, the repulsive force would be proportional to the potential square, V^2 where V is the electric potential difference of the capacitor. This has been verified by the experiments of Musha[60]. However, the weigh reduction phenomenon is currently mixed up with the B-B effect which is directional to the electric field applied. However, the weigh reduction effect is no directional. This is verified by Liu[50], who measured the effect of weight reduction with the roll-up capacitors.

ACKNOWLEDGMENTS

The author gratefully acknowledge stimulating discussions with David P. Chan, S. J. Chang, A. J. Coleman, S. Crothers, Richard C. Y. Hui, G. R. Goldstein, A. Napier, D. Rabounski, and Eric J. Weinberg. This work is supported in part by Innotec Design, Inc., U. S. A. This publication is supported by Szecheon Co. Hong Kong.

REFERENCES AND NOTES

[1] C.Y.Lo; Hadronic Journal, **12(6)**, 275-276 **(1989)**.
[2] C.Y.Lo; J.of Space Exploration, **2(3)**, 207-224 **(2013)**.
[3] A.Pais; 'Subtle is the Lord ...', Oxford University Press, New York, **(1996)**.
[4] A.Einstein, W.Pauli; Ann.Math., **44**, 133 **(1943)**.
[5] R.Burton; Theory in particle physics, Physics Today, 8, October **(2006)**.
[6] J.Holt; Unstrung-In string theory, beauty is truth, truth beauty.Is that really all we need to know? New Yorker, October **(2006)**.
[7] H.Bondi, F.A.E.Pirani, I.Robinson; Proc.R.Soc.London A, **251**, 519-533 **(1959)**.
[8] F.Pring; The Royal Society, Board Member's Comments, Jan.8 **(2007)**.
[9] C.Y.Lo; Phys.Essays, **18(1)**, 112-124 **(2005)**.
[10] C.Y.Lo; Chin.Phys., **13(2)**, 159-167 **(2004)**.
[11] C.Y.Lo; Phys.Essays, **13(4)**, 527-539 **(2000)**.
[12] C.Y.Lo; Phys.Essays, **15(3)**, 303-321 **(2002)**.
[13] C.Y.Lo; Phys.Essays, **16(1)**, 84-100 **(2003)**.
[14] R.P.Feynman; The Feynman Lectures on Gravitation, Addison-Wesley, New York, **(1996)**.
[15] A.Einstein; The Meaning of Relativity (1921), Princeton Univ. Press, **(1954)**.

[16] C.Y.Lo, G.R.Goldstein, A.Napier; Th-101-81, Phys.Dept., Tufts Uni., MA, **(1981)**.

[17] A.Einstein, H.A.Lorentz, H.Minkowski, H.Weyl; The Principle of Relativity, Dover, New York, **(1923)**.

[18] C.Y.Lo; Phys.Essays, **18(4)**, 547-560, December **(2005)**.

[19] C.Y.Lo; Phys.Essays, **23(3)**, 491 **(2010)**.

[20] C.Y.Lo; Chinese J.of Phys.(Taipei), **41(4)**, 233-343 **(2003)**.

[21] C.Y.Lo; Astrophys.J., **455**, 421-428 **(1995)**.

[22] C.Y.Lo; Astrophys.Space Sci., **306**, 205-215 **(2006)**.

[23] C.Y.Lo; Phys.Essays, **12(3)**, 508-526, September **(1999)**.

[24] L.Infeld; Quest: An Autobiography, Chelsea, New York, **(1980)**.

[25] J.Norton; 'What was Einstein's Principle of Equivalence?' in Einstein's Studies, Einstein and the History of General Relativity, D.Howard, J.Stachel, (Eds); Birkhäuser, Boston, **1**, **(1989)**.

[26] A.Einstein; '$E = mc^2$' (1946) in Ideas and Opinions, Dover, New York, **(1982)**.

[27] C.Y.Lo; Phys.Essays, **25(1)**, 49-56 **(2012)**.

[28] C.Y.Lo; Progress in Phys., **4**, 14-18 **(2006)**.

[29] John Stachel, (Ed); Einstein's Miraculous Year, Princeton Press, 118 **(1998)**.

[30] C.Y.Lo; Astrophys.J., **477**, 700-704 **(1997)**.

[31] C.Y.Lo; Bulletin of Pure and Applied Sciences, **25D(1)**, 41-47 **(2006)**.

[32] H.C.Ohanian; Einstein's Mistakes: The Human Failings of Genius, Norton, New York, **(2008)**.

[33] C.W.Misner, K.S.Thorne, J.A.Wheeler; Gravitation, Freeman, San Francisco, **(1973)**.

[34] C.Y.Lo, C.Wong; Bulletin of Pure and Applied Sciences, **25D(2)**, 109-117 **(2006)**.

[35] C.Y.Lo; Gravitation, Physics, and Technology, Physics Essays, **25(4)**, 553-560, Dec., **(2012)**.

[36] C.L.Pekeris; Proc.Nat.L Acad.Sci.USA, **79**, 6404-6408 **(1982)**.

[37] L.Herrera, N.O.Santos, J.E.F.Skea; Gen.Rel.Grav., **35(11)**, 2057 **(2003)**.

[38] John Stachel, (Ed); Einstein's Miraculous Year, Princeton Press, 118 **(1998)**.

[39] R.M.Wald; General Relativity, The Univ. of Chicago Press, Chicago, **(1984)**.

[40] C.M.Will; Theory and Experiment in Gravitational Physics, Cambridge Univ. Press, Cambridge, **(1981)**.

[41] C.Y.Lo; Chin.Phys., **16(3)**, 635-639, March **(2007)**.

[42] E.T.Whittaker; Proc.R.Soc.(London) A, **149**, 384 **(1935)**.

[43] R.Tolman; Phys.Rev., **35**, 875 **(1930)**.

[44] C.Y.Lo, C.Wong; Bulletin of Pure and Applied Sciences (Physics), **30D(2)**, 177-194 **(2011)**.

[45] D.Yu.Tsipenyuk, V.A.Andreev; Physical Interpretations of the Theory of Relativity Conference, Bauman Moscow State Technical University, 4-7 July **(2005)**.

[46] G.'t Hooft; 'A Confontation with Infinity', Nobel Lecture, December **(1999)**.

[47] C.Y.Lo; Phys.Essays, **24(1)**, 20-27 **(2011)**.

[48] J.D.Jackson; Classical Electrodynamics, John Wiley & Sons, New York, **(1962)**.

[49] S.Weinberg; Gravitation and Cosmology, John Wiley Inc., New York, **(1972)**.

[50] W.Q.Liu; Private Communication, August **(2007)**.

[51] D.R.Buehler; J.of Space Mixing, **2**, 1-22 **(2004)**.

[52] T.Musha, T.Kanamoto; Electro-gravitational effect for dielectric material by high potential electric field, Proc. of the 38th Space Sci. and Tech.Conf., JSASS, 31-32 **(1994)**.

[53] T.Musha; Study on brown's propulsion system, Proc. of the 37th Conf. on Aerospace Propulsion, JSASS, 342-349 **(1997)**.

[54] C.Y.Lo; Phys.Essays, **23(2)**, 258-267 **(2010)**.

[55] Slava G.Turyshev, Viktor T.Toth; Space Science Reviews, **148(1-4)**, 149-167, December **(2009)**.

[56] http://news.softpedia.com/news/The-First-Test-That-Proves-General-Theory-of-Relativity-Wrong-20259.shtml, **(2006)**.

[57] C.N.Yang; Phys.Rev.Lett., **33**, 445 **(1974)**.

[58] C.Y.Lo; Chin.Phys., **13(2)**, 159-167 **(2004)**.

[59] C.Y.Lo; GJSFR, (Ver.1.0), **12(7)**, Sept. **(2012)**.

[60] Takaaki Musha; Theoretical explanation of the Biefeld-Brown Effect, 3-11-7-601 Namiki, Kanazawa-ku, Yokohama 236-0005 Japan.

[61] R.Schoen, S.-T.Yau; Commun.Math.Phys., **79**, 231-260 **(1981)**.

[62] E.Witten; Commun.Math.Phys., **80**, 381-402 **(1981)**.

[63] C.Y.Lo; GJSFR, Version 1.0, **13-A(4)**, August **(2013)**.

[64] C.Y.Lo; GJSFR, Version 1.0, **13-A(3)**, 59-73, June **(2013)**.

[65] A.Sharma; Phys.Essays, **(2013)**.

[66] H.C.Ohanian, R.Ruffini; Gravitation and Spacetime, Norton, New York, **(1994)**.

[67] Eric.J.Weinberg; Private Communication, March **(2006)**.

[68] L.D.Landau, E.M.Lifshitz; The Classical Theory of Fields, Pergamon Press, New York, **(1975)**.

[69] N.Straumann; General Relativity and Relativistic Astrophysics, Springer, New York, **(1984)**.

[70] P.Y.Zhou (Chou); Scientia Sinica (Series A), 1982, **25(6)**, 628-643 **(1982)**.

[71] P.Y.Zhou; 'On Coordinates and Coordinate Transformation in Einstein's Theory of Gravitation' in Proc. of the Third Marcel Grossmann Meetings on Gen.Relativ., Hu Ning, (Ed); Science Press & North Holland, 1-20 **(1983)**.

[72] P.Y.Zhou; 'Further Experiments to Test Einstein's Theory of Gravitation' in Proc. of the International Symposium on Experimental Gravitational Physics, Guang Zhou, China, August **(1987)**.

[73] C.Y.Lo; Bulletin of Pure and Applied Sciences, **27D(2)**, 149-170 **(2008)**.

[74] The string theorists led by E.Witten have the serious deficiency of a failure in understanding general relativity adequately. Witten**[61,62]** has misleadingly interpreted general relativity by his proof on the so-called Positive Energy Theorem. In essence, they fail to understand that the Einstein equation is invalid for the dynamic case**[2]**. Ironically, Witten was awarded the Fields Medal of 1990 for which his misleading proof of the positive energy theorem was cited as an achievement**[63]** because the pure mathematicians do not understand physics. Note also that the 1993 Nobel Prize Committee for Physics is also wrong on the Einstein equation**[64]**.

[75] In his 1909 Salzburg talk, Einstein strongly emphasized that inertial mass is a property of all forms of energy, and

therefore electromagnetic radiation must have mass[38].

[76] That Einstein's derivation of $E = \Delta mc^2$ is valid only for a special case and is not therefore general, has also been discussed in details by Sharma[65].

[77] The existence of a Euclidean-like structure is a necessary condition for a physical space[20]. Then, Einstein's condition for weak gravity can be defined[23] although the Royal Society failed to understand this[7,11].

[78] It is a general practice of members of the Wheeler School that they do not admit errors even it is obvious. For instance, they still do not acknowledge that their error on local time from their eq. (40.14)[33]. Since the members often support each other even on errors, they accumulate errors in their books[32,33,39,40,66] and they make little progress for a long time. Thus, this School often becomes an obstacle for scientific progress.

[79] The electric energy density at r is $q^2/8\pi r^4$[33]. Thus, the total electric energy outside a radius r is

$$\frac{1}{8\pi}\int_r^\infty \rho^2 d\rho \int_0^{2\pi} d\varphi \int_0^\pi \sin\theta d\theta \frac{q^2}{\rho^4} = \int_r^\infty d\rho \frac{q^2}{2\rho^2} = \frac{q^2}{2r}.$$

This result of Weinberg[67] is correct, since the distance in the frame of reference is decided by the Euclidean-like structure[20]; whereas the metric determines only the space contractions[1,18]. A similar calculation of total mass[39] gives a continuation from the internal to the external of the Schwarzschild solution. However, if a factor $(g_{rr})^{1/2}$ is added to the integration[39], this results in a larger mass, and would lead to another inconsistency[18,28]. However, some objected the above calculation as incorrect. They believed that a plane-wave is not bounded[8], and thus differ from Einstein and the Wheeler School[33]. They even claimed Einstein's requirement on weak gravity were incorrect because their knowledge in general relativity was out-dated.

[80] Some believed that the force, which is different from force generated with "equivalence mass", could be compensated. However, such an argument does not change the fact that the gravity is different.

[81] Currently, for a charged particle under the influence of gravity, the Lorentz force and the radiative reaction force are added to the geodesic equation to form an equation of motion. However, since there is no external electromagnetic field, the Lorentz force is absent. Since this is a static case, the radiative reaction force is absent[48].

[82] In this approach, we calculate the field generated by charge particle Q, then the force acting on particle P; and the field generated by particle P, then the force acting at Q. This approach, which is often used in electrodynamics, is valid because the field generated by a particle, does not make itself move. For the metric generated by particle P, the metric would be $ds^2 = (1- 2m/\rho)dt^2 - (1- 2m/\rho)^{-1}d\rho^2 - \rho^2 d\,\Omega^{\prime 2}$, where $(\rho, \theta', \varphi')$ is a new coordinate system with P at the center. Thus, the force on Q in the ρ-direction would be only $-M(m/\rho^2)$. Note that the distance between P and Q is $r = \rho$, and thus there should be another term in the ρ-direction as $q^2(m/\rho^3)$.

[83] It was claimed that the Pioneer Space-Probe Anomaly has been resolved by a heat-radiation model. However, a discoverer of the anomaly, Erik Anderson (April 1, 2011 at 12:57) commented, " … Science will have suffered the worst sort of dysfunction if the Pioneer Anomaly gets swept under the convenient rug of "the plausible." Even so, we will still have the Earth flyby anomalies and the so-called "A.U." anomaly left uncovered. All three anomalies seem to be manifestations of a singular phenomenon — the latter two cannot be dismissed as heat radiation. Heat-radiation models, like string theory, can be customized to fit any set of observational parameters. There is no limit on sophistication. We should not be so easily impressed. Nothing has been resolved.

[84] In general relativity, there are two views. One of the views is that there is no force but only geometry, and another view is that there are forces just as in other theories in physics. The view of pure geometry is questionable because one must consider the radiation reaction force due to the emission of gravitational waves.

[85] From the Internet, one would know that experiments of weighing capacitors have been performed for years. Experimentalist Liu thought this reduction of weight as a loss of mass. Since nobody was able to explain his experiment in terms of well-known theories, the general belief was that this reduction is due to experimental errors. Nobody thought of this having anything to do with electric charge since in a capacitor the electromagnetic force is screened. Mr. Liu considers his experiment challenges Newton's law of gravity and Einstein's formula $E = mc^2$.

[86] Validity of the plane-waves of Bondi, Pirani, & Robinson[7], is based on arguing that for a manifold, Einstein's requirement for weak gravity may not be applicable since a manifold may not relate to a physical frame of reference with the Euclidean-like structure[20]. Thus, the editor of the Royal Society[8] initiated a challenge to the Wheeler school[33] including Ohanian and Ruffini[66], Wald[39], Will[40], who claimed to have the standard theory, and others such as Landau & Lifshitz[68], Straumann[69], and those who believed Einstein's requirement on weak gravity and the so-called "covariance principle". Responding to such a challenge is important to Will, who has built his career essentially on the Parameterized Post-Newtonian Approximation, while claiming validity of the "covariance principle". Although the paper of Bondi *et al*[7] is well known, nobody responded to their challenge before. This seems to suggest unequivocally that few theorists such as Zhou[70-72] other than the editor of the Royal Society understand the implication of the so-called "covariance principle" in physics.

[87] For instance, Journals such as the Physical Review D[73] and Proceeding of the Royal Society[2,7] and theorists such as 't Hooft[47] and Penrose[11,73] still do not understand the principle of causality adequately.