



Errors Related to General Relativity, Repulsive Gravitation and the Question of Black Holes

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ABSTRACT

Galileo and Newton considered gravity to be independent of temperature, while Einstein claimed that the weight of metal will increase as temperature increases. Further, Maxwell maintained that charge is unrelated to gravity. Experiments show, however, that the weight of a metal piece is reduced as its temperature increases. Thus, charge-initiated repulsive gravitation exists. In fact, repulsive gravity has been demonstrated by the use of a charged capacitor hovering over Earth. Further, it is expected that a piece of heated metal would fall more slowly than a feather in a vacuum. Einstein developed an invalid notion of gravitational mass, and failed to establish the unification of gravitation and electromagnetism since he overlooked repulsive gravitation. Moreover, photons are a combination of the gravitational wave and the electromagnetic wave. For electromagnetic energy E , $E = mc^2$ is invalid, and is in conflict with the Einstein equation. The non-linear Einstein equation has no bounded dynamic solution, Space-time singularity theorems are based on an invalid implicit assumption that all the couplings have a unique sign. Since gravity is no longer always attractive, the existence of black holes is questionable. The fact that Penrose was awarded the 2020 Nobel Prize in Physics for the derivation of black holes is due to that the Nobel Prize Committee for Physics did not sufficiently understand the physics of general relativity. A distinct characteristic of Penrose's work, as usual, is that it is not verifiable.

Keywords: *Current-mass interaction; charge-mass interaction; repulsive gravitation; $E = mc^2$.*

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1. INTRODUCTION

In 1916, when general relativity was published, very few people had a good understanding of the theory. In fact, when Eddington was informed that there were three scientists who understood general relativity, his response [1] was to ask who the third person was. Now, even after more than 100 years have passed, there is still no-one, including Einstein, who has fully understood general relativity. It was an inaccurate comment made by Einstein himself [2] that led to these observations.

Thus, one should not be surprised that the Nobel Committee for Physics awards the 2020 prize to Roger Penrose, who is so uninformed in physics that he even failed to see a violation of causality (Appendix A).

In 1946, Einstein [2] explained $E = mc^2$ to Science Illustrated by pointing out that a piece of metal would have an increased weight when its temperature increases, although it would be too small to measure because of the large factor c^2 . Now, however, technology has improved such that we can measure the difference. To our surprise, a metal actually has a reduced weight when heated [3-5]. Thus, there is clearly an error in Einstein's theory. In this paper, we offer an analysis of some Einstein's miscalculations.

Einstein's central error is in overlooking the existence of repulsive gravitation [6]. This is also why he failed to achieve one of his principal goals, the unification of gravitation and electromagnetism [7]. His notion of gravitational mass was a source of his mistake, even though he was puzzled about why the inertial mass and the gravitational mass cannot be distinguished, since they have different physical origins [8,9].

While the errors related to the existence of repulsive gravitation are easier to identify, the errors related to the nonexistence of dynamic solutions are more difficult [10]. These errors are due to certain mathematical weaknesses in the work of Einstein and his followers [11]. Moreover, mathematicians such as S. T. Yau [12] and E. Witten [13], who are less schooled in physics, have mistakenly claimed that the Einstein equation has dynamic solutions. Yet to date, they have not provided an example for their claims [14].

Einstein [1] failed to see that one cannot produce the necessary perturbation approach to justify his calculation for the remaining perihelion of Mercury. This is perhaps the reason that D. Hilbert [1] gave all the credit for the field equation in general relativity to Einstein. It would seem Hilbert, a distinguished mathematician, understood the errors that escaped the notice of other mathematicians, including those presiding over the Fields Medals [15].

In general relativity, it is often the case that what are considered important new results, actually stem from new, yet flawed conclusions.⁴⁾ In physics, the existence of a singularity in a solution is a clear sign of error. However, the space-time singularity theorems [16] were used by many to justify the development of the big bang theory of an expanding universe, and the existence of black holes. This was developed by assuming, incorrectly, that gravity is always attractive [17], and is based on an implicit, incorrect assumption that all the coupling constants have the same sign [18].

Moreover, the space-time singularity theorems, instead of being recognized as invalid in physics, are used by Hawking and Penrose to claim, incorrectly, that general relativity is unsuitable for explaining microscopic phenomena.⁵⁾ A great deal of confusion arose from the inability of physicists to see that the linearization of the Einstein equation is incompatible with physics [19]. In fact, for the dynamic cases, the linearized equation and the non-linear Einstein equation are independent equations [19].

It turns out that to have a dynamic solution for the non-linear Einstein equation with massive sources, one must add an energy momentum tensor with an anti-gravity coupling [10], as Lorentz [20] and Levi-Civita [21] have suggested. However, many simply accept Einstein's work without sufficient analysis.

Rectifying such errors is a difficult task, since many of the errors originated from top theorists in general relativity, including Einstein and theorists from Princeton, Harvard, and Cambridge.⁷⁾ Entrenched views that Einstein could not make errors in classical physics makes it difficult to find those who would accept theoretical challenges to Einstein. Thus, it is necessary to establish that Einstein has been wrong in classical physics,

which we can do first by demonstrating the existence of the repulsive gravitation.

According to Wheeler's simulation, the existence of black hole is based on that gravity is always attractive. Thus, the existence of repulsive gravitation requires at least to justify the notion of black hole anew. Since Penrose failed to do this, his claim of deriving the black holes is groundless. Moreover, he also failed to see that space-time singularity theorems are irrelevant to physics because of an invalid implicit assumption [18]. Apparently, Penrose and the Nobel Committee also did not know the existence of repulsive gravitation and the need to extend general relativity to a five-dimensional theory [18].

Also the covariance principle is invalid, as shown by explicit examples [22]. Einstein's justification for it was based on an invalid application of special relativity [23]. Due to the invalid prediction of weight increment for metals as temperature increases, but experiments show weight reductions, Einstein's theory is wrong and cannot be corrected by modification. In particular, his notion of gravitational mass is invalid.

In short, for a dynamic situation, what has been derived from the linearized equation is correct, but what has been derived from the non-linear Einstein equation is questionable. This paper seeks to provide a starting point to correct some of the errors in the theory of Einstein.

2. THE REDUCTION OF GRAVITATION AS THE TEMPERATURE INCREASES

Physics is based on experiments. Einstein's theory was accepted because the bending of light was experimentally confirmed. His shortcoming, however, has now been confirmed because the weight of a metal piece is actually reduced as temperature increases [3-5].

In physics, a theoretical conclusion might not be considered valid until supported by experiments because implicit assumptions might unintentionally have been used, as in, Einstein's thought experiments. Thus, Einstein actually deviated from the teachings of Galileo on the importance of corroborative experiments. For example, an implicit assumption in the space-time singularity theorems is that all the coupling constants have the same sign. Such an assumption has been confirmed invalid for the photonic case [24,25] in agreement with the case with massive sources that also has different coupling signs [10].

Einstein [2] claimed that $E = mc^2$ means that a piece of heated-up metal would have an increment of weight. He reasoned that if an increment of energy for matter implies an increment of mass, this will result in the increment of weight [2]. Therefore, $E = mc^2$ is invalid if one can show that an increment of energy would reduce weight.

In 2003, Dmitriev, Nikushchenko and Snegov [3] established that a piece of heated-up brass has reduced weight. Their results can be shown in the following figures.

Fig. 1 shows the change of weight for the brass rod mounted in an open holder. Fig. 2 shows the time dependence of the temperature of a part of the surface of an ultrasonically heated brass rod (open holder). Fig. 3 shows the arrangement in an air-tight container. Fig. 4 shows the change of weight for the brass rod in a closed Dewar vessel, which controls for the influence of outside heat. The brass rod weighed 58.5 g before heating, with a length of 140.0 mm, and a diameter of 8.0 mm. These Figs. show that the Dewar vessel is not essential for the weight reduction experiment.

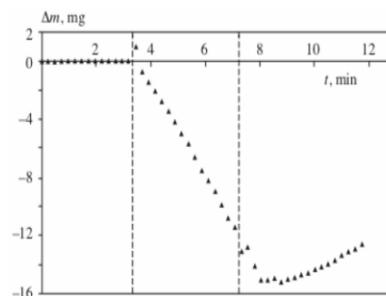


Fig. 1. Change in mass of a brass rod mounted in an open holder. Ultrasound frequency 131.25 kHz. The dashed lines indicate the moments when the ultrasound was switched on and off

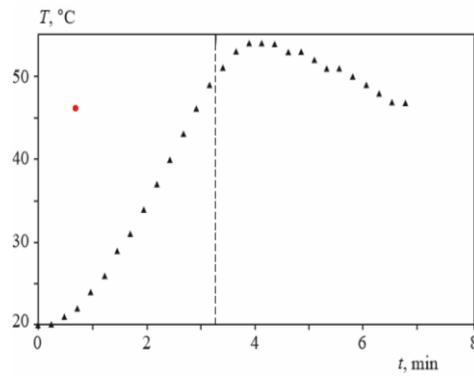


Fig. 2. Time dependence of the temperature of a part of the surface of an ultrasonically heated brass rod (open holder). Ultrasound frequency 131.28 kHz. The dashed line indicates the moment when the ultrasound was switched off

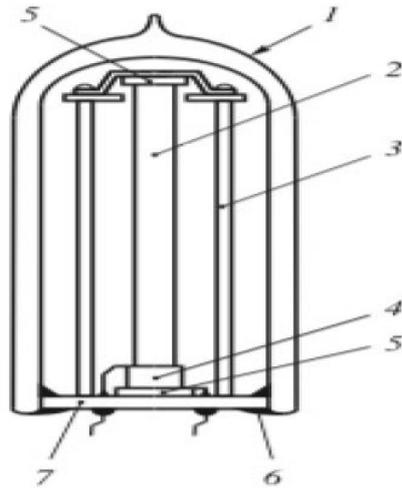


Fig. 3. Arrangement of the air-tight container: (1) Dewar vessel; (2) Metal rod; (3) Holder pillar (textolite cloth-based laminate); (4) Piezoelectric transducer; (5) Foam plastic spacers; (6) Cold weld; (7) Holder base (ebonite)

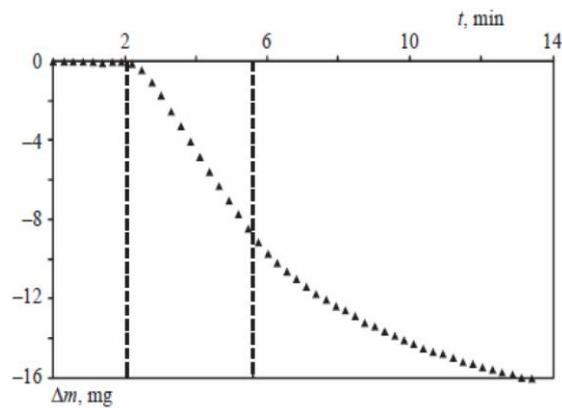


Fig. 4. Change in mass of a brass rod mounted in a closed Dewar vessel. Ultrasound frequency 131.27 kHz. The dashed lines indicate the moments when the ultrasound was switched on and off

Dmitriev et al. [3] are confident that their observed results, the reduction of weight as temperature increases, is correct. They point out, "It is well-known that the temperature regimes play an important role when weighing with high accuracy. The basic reasons for temperature influencing the results of such measurements are thermal expansion of the bodies, temperature changes in the magnetization of the weighed sample, adsorption of moisture by the surface of the sample (a change in the buoyancy), thermal convection of the air near the surface of the sample, the influence of the heated sample on the balance mechanism (through thermal radiation, heat conduction, or convection). These factors are quite well known in modern measurement technology and their contribution to the results of measuring the mass of samples can be estimated quantitatively."

Note that the temperature dependence of gravity also depends on the metal involved. Dmitriev et al. have measured such dependencies for lead, copper, brass, and duralumin, and found they are different. It would be interesting to find out the detailed rules for such dependencies. In 2010, Fan, Feng Jinsong and Liu [4] confirmed, using an electronic scale, that six kinds of metal have reduced weight after being heated.

Moreover, it has been verified by Lo [5], using a torsion balance scale, that lead balls have reduced gravitation after being heated. This confirms that it is, in fact, gravity that has been changed. In addition, a charged capacitor and a charged metal ball also have reduced weight [6]. Thus, an increase in electromagnetic energy need not mean an increase in mass, and thus also the weight. Then we can explain why the metal weigh is reduced when heated (see Section 8).

3. THE INERTIAL MASS AND EINSTEIN'S INVALID GRAVITATIONAL MASS

Although Dmitriev et al. [3] and Fan et al. [4] have shown that a piece of heated-up brass has reduced weight, they mistakenly believed that these experiments demonstrated the reduction of mass. However, it has been firmly established that mass is equivalent to energy [26]. Therefore, they needed to explain what became of the lost mass. As a result, their findings were incorrectly rejected by many physicists as errors.

Since physics is based on experiments, we must be able to explain the experiments consistently. According to experiments, although heat would increase energy, the increase of energy need not mean the increase of gravity [6,7]. Some theorists do not understand that if repulsive gravitation is present, to measure mass through gravitation is not valid. Moreover, $E = mc^2$ is not generally valid since the electro-magnetic energy is not equivalent to mass. Since David Gross won his Nobel Prize based on the general validity of $E = mc^2$ [27], their proof for asymptotic freedom for the strong interaction is still incomplete.

As Einstein pointed out, the inertial mass is related to the resistance to acceleration, and gravitational mass is related to the attraction to a mass. Thus, acceleration mass and gravitational mass should be distinguishable. However, Einstein was able to identify them because *the existence of repulsive gravity had not been recognized*. Thus, Einstein's notion of gravitational mass is a misconception created by a failure to recognize repulsive gravity.

Unfortunately, the invalid notion of gravitational mass is very popular. Although, as Einstein pointed out, the notion of inertial mass is different from the notion of weight (gravitational mass), many theorists still cannot distinguish the difference between mass and weight. Nevertheless, the mass and gravity can be distinguished with the first approximation of a formula for the period T of a pendulum as follows [28]:

$$T \approx 2\pi \sqrt{\frac{l}{g}}, \quad (1)$$

where l is the length of the pendulum and g is the gravitational acceleration.⁸⁾ Thus, the change of mass of the pendulum would not change the pendulum period, but if the g changes, the period T of the pendulum will be changed.⁹⁾ Since a piece of metal is a solid, a reduction of its mass or gravity can be distinguished by using it as a pendulum.

It has been verified by Liu [29] that the mass is essentially the same as Einstein [2] and Lo [30] predicted, but the period is extended after being heated-up. Thus, from the above weight reduction experiments [3,4], the repulsive gravitational force must exist. Moreover, it has been verified by Lo [5], using a torsion balance

scale, that lead balls have reduced gravitation after being heated-up.

Thus, measuring the mass through gravity is unreliable, and repulsive gravitation must exist. To see this in more details, we can consult the cases of a charged metal ball and a charged capacitor (see §7 and §8).

4. EINSTEIN'S INCOMPLETE PROOF OF $E = MC^2$

Einstein [31] has shown that the electromagnetic radiation energy L emitted from a body is equivalent to the mass L/c^2 , where c is the light speed. In his approach, the energy L is due to two waves $W1$ and $W2$, in opposite directions, each with energy $(1/2)L$. His motivation is to assume the two waves as two groups of massless particles. Because these two waves are in opposite directions, their momentums cancel each other, and thus what remains is the sum of the energies of the massless particles, i.e., L . Then, he shows the energy L is equivalent to a mass L/c^2 .

However, his proof is inconsistent with electromagnetism as follows: 1) the electromagnetic energy-stress tensor $T(E)_{\mu\nu}$ has a zero trace. 2) The sum of two electromagnetic energy-stress tensors is still an electromagnetic energy-stress tensor with zero traces. However, an energy-stress tensor of trace zero cannot be related to a mass whose energy-stress tensor has a non-zero trace. Thus, Einstein's proof is inconsistent with electromagnetism.¹⁰⁾

Einstein [31] claimed, without proof, that the relation between the energy l for a wave measured in the co-ordinate (x, y, z) and the energy l^* for the same wave measured in a new co-ordinate system (ξ, η, ζ) is

$$l^* = l \frac{1 - (v/c) \cos \phi}{\sqrt{1 - v^2/c^2}}, \quad (2)$$

where v is the relative velocity between these two coordinate systems, and ϕ is the angle between the propagating direction of the wave and the relative velocity v . He [31] also claimed that "The principle of the constancy of the velocity of light is of course contained in Maxwell's equations." However, we have just shown that the results being derived from eq. (2) are inconsistent with Maxwell's theory.

Note that the energy of massless particles is inconsistent with the electromagnetic energy-stress tensor related to an electromagnetic wave, although the energy-stress tensor of a massless particle is also traceless. On the other hand, Einstein's notion of photons that are assumed as quantized electromagnetic energy has successfully met all the experimental tests. In fact, Einstein obtained a Nobel Prize for his explanation of the photo-electric effects. Nevertheless, it is clear that Einstein did not understand Maxwell's theory well.

Although $E = mc^2$ has been demonstrated with the conversion of mass to energy in nuclear physics, for instance, the atomic bomb [26], the reverse conversion of energy to mass has never been proved. In fact, Einstein failed to show the mass-energy equivalence in his efforts from 1905 to 1909 [32]. The radiation energy L [31], being the photons' energy, is Einstein's assumption whose validity must be proved. Thus, Einstein's proof is incomplete, and the claim of $E = mc^2$ as unconditional shows not an achievement as commonly believed, but certain of Einstein's shortcomings in physics.

Einstein [31] did not know that the electromagnetic energy-momentum tensor alone is incompatible with the energy of the massless particles [33]. In other words, Einstein used the energy-momentum tensor of massless particles for the photons without a proof, although such proof is needed as shown by Lo [24,25] in 2006. The omission of such proof shows that Einstein did not fully understand Maxwell's theory.

Nevertheless, Einstein's invalid derivation on the loss of mass L/c^2 was accepted without any question since it has been known from special relativity that $E = m_0c^2$, where m_0 is the rest mass of a particle. Note that the energy-momentum tensor of the photons is compatible with the energy-momentum tensor of the mass [24,25]. However, many theorists just did not understand electromagnetism and gravity well enough to know the difference between the radiation L and electromagnetic energy. Thus, Einstein did not know that E/c^2 as mass may not always be valid.

Note that in 1912 Einstein invalidly changed the letter L to E in the formula to represent general energy [34]. Then, Einstein's proof for $E = mc^2$ is not incomplete as $L = mc^2$, but is invalid.

5. THE CONDITIONAL VALIDITY OF $E = MC^2$

The formula $E = mc^2$ appears in special relativity, but this only means that mass can be converted into energy. Einstein wants to have new content, $m = E/c^2$, i.e., any energy can be equivalent to mass. However, Einstein failed, although he made a great effort to prove this in 1905- 1909 [32].

The truth is that, for the electromagnetic energy E , $E = mc^2$ is inconsistent with the Einstein equation,

$$G_{\mu\nu} \equiv R_{\mu\nu} - (1/2)g_{\mu\nu} R = - K T_{\mu\nu} , \quad (3)$$

where $G_{\mu\nu}$ is the Einstein tensor, $R_{\mu\nu}$ is the Ricci tensor, $R = R_{\mu\nu}g^{\mu\nu}$ is the Ricci curvature, $T_{\mu\nu}$ is the sum of energy-stress tensor, and K is the coupling constant. Then, we have

$$R = K T_{\mu\nu} g^{\mu\nu}. \quad (4)$$

Note that eq. (4) is completely general.

For the case of electromagnetic energy E , the trace of the electromagnetic stress tensor $T(E)_{\mu\nu}$ is zero, i.e., $g^{\mu\nu} T(E)_{\mu\nu} = 0$. Thus, it cannot change the Ricci curvature. However, the mass m is able to do so since the trace for the massive energy-stress tensor is non-zero. Thus, electromagnetic energy and mass are not equivalent. Since eq. (4) was first derived by Einstein [9], the failure of seeing this inconsistency with $E = mc^2$, is Einstein's oversight.

Thus, Einstein's theory alone would show that $E = mc^2$ is not always valid, independent of the existence of repulsive gravitation. We shall show in the next section that this photonic energy is different from electromagnetic energy. It also includes the gravitational wave energy.

6. THE ENERGY-MOMENTUM TENSOR OF THE PHOTONS

Einstein proved that the energy of photons is equivalent to mass [31]. This does not mean, that electromagnetic energy is equivalent to mass, since it is actually based on Einstein's unproven assumption that photons are massless particles. Note that the energy-momentum tensor of the massless particles is incompatible with the electromagnetic energy-momentum tensor because a sum of electromagnetic energy-

momentum tensors is always traceless, but a sum of the energy-momentum of massless particles can become massive. To derive the photonic energy-momentum tensor, general relativity must be used [33].

Consider a source of electromagnetic "plane wave." Einstein believed that the Einstein eq. (3) can be used for this case [35], and Penrose [36] obtain a solution as follows:

$$ds^2 = dudv + Hdu^2 - dx_i dx_i ,$$

where

$$H = h_{ij}(u)x_i x_j , \quad (5)$$

where $u = ct - z$, $v = ct + z$. However, this metric is unbounded, and there are non-physical parameters (the choice of origin) that are unrelated to any physical causes. Thus Penrose [36], being primarily a mathematician, overlooked a violation of the principle of causality (Appendix A) in physics.

The verification of the bending of light rays made Einstein famous. Most of Einstein's followers, however, were not aware that the bending of light also exposed necessary modifications. Einstein's calculation of the bending of light implicitly assumes that the gravity created by an electromagnetic wave is negligible. Einstein also claimed that any energy-momentum tensor could be the source of his equation; one should be able to obtain a gravitational solution for the electromagnetic wave. Since such gravity is physically very weak, many were in agreement with Einstein, and believed that such gravity could be calculated with the perturbation approach (although they did not do it).¹¹⁾

Mathematically, for a perturbation approach to be valid, a necessary condition is, however, that this problem has a bounded solution. This compatibility between mathematics and physics is crucial for the validity of a theory in physics.¹²⁾ Thus, it was natural for Einstein [9] to believe that his equation could be used for such a case. Although Einstein claimed that his equation was valid for any energy-momentum tensor, he solved only a few cases [37]. Nevertheless, Einstein insisted only on his Einstein tensor G_{ab} in eq. (3), but otherwise allowed modifications.

Moreover, explicit calculation shows that it is impossible to have bounded solutions for an

electromagnetic wave's gravity. In order for Einstein's theory of general relativity to make sense, the related Einstein equation, with an electromagnetic wave as the source, must include a photonic energy-stress tensor with the anti-gravity coupling [24,25]. For this case, the related modified Einstein equation is the following:

$$G_{ab} \equiv R_{ab} - (1/2)g_{ab}R = -K[T(w)_{ab} - T(p)_{ab}], \quad (6)$$

and

$$T_{ab} = -T(g)_{ab} = T(w)_{ab} - T(p)_{ab}, \quad (7)$$

where $T(w)_{ab}$ and $T(p)_{ab}$ are the energy-stress tensors for the electromagnetic wave and the related photons, which are massless particles. Thus, the photonic energy must also include the energy of its gravitational-wave component. The energy, related to the photons, is clearly beyond special relativity. Further, a unique sign for all coupling constants in the Einstein equation is invalid for this case.

7. THE REPULSIVE GRAVITATION AND THE NECESSARY EXTENSION OF GENERAL RELATIVITY

Now, we address the nature of repulsive gravitation. In fact, a charge-mass repulsive force was derived from the Reissner-Nordstrom metric in 1916 for a particle with charge q and mass M [37] as follows:

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

(with $c = 1$) where r is the radial distance (in terms of the Euclidean-like structure [38] from the particle center.¹³) In metric (8), the gravity 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 [7]. This repulsion implies that the basic assumption for black holes, gravity being always attractive, is invalid, and it will be shown that general relativity must be extended.

For an elementary charged particle, the repulsive force would be very small. However, a similar metric can be derived for a charged ball. The only changes are that r becomes R , the

distance from the center of the ball, and q becomes Q , the total charge of the ball [39]. Thus, for a charged ball with a sufficiently large Q , the repulsive gravitational force can be macroscopically measured and calculated.¹⁵ Nothing had been derived from this metric, however, until 1997 [40], because theorists did not acknowledge the repulsive gravitational force.

In 2005, Tsipenyuk and Andreev [41] discovered that a charged metal ball becomes lighter in weight, but they did not know why because repulsive gravitation was not included in Einstein's general relativity. Moreover, theorists such as Herrera, Santos and Skea [42] argued that M in metric (8) involves electric energy. Then they obtained a metric that would imply a charged ball would increase its weight as the charge q increased [7], in disagreement with experiments [41]. Nevertheless, 't Hooft [43] and Wilczek [27] have also mistakenly assumed is universally true. Since Wilczek used $E = mc^2$ for the asymptotic freedom without any justification [27], the proof is incomplete.

On the other hand, if the mass M is the inertial mass of the particle, the weight of a charged metal ball would be reduced [7]. Thus, experiments on two metal balls [41] support the conclusion that the mass M does not include electric energy since a charged ball has a reduced weight. It will be shown, based on the principle of causality (see Appendix A), that such a force leads to the necessity to extend the theoretical framework of general relativity.

To see the need of extending general relativity, consider the force on a test particle with mass m , and

$$\frac{d^2 x^\mu}{ds^2} + \Gamma^\mu_{\alpha\beta} \frac{dx^\alpha}{ds} \frac{dx^\beta}{ds} = 0, \quad (9)$$

Where

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

and $ds^2 = g_{\mu\nu} dx^\mu dx^\nu$ and the gauge affects only the second-order approximation of g_{tt} [44].

Let us consider the static case. For a test particle p with mass m at r , the force on p is

$$-m \frac{M}{r^2} + m \frac{q^2}{r^3} \quad (10a)$$

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 acting on the charged particle P has the same magnitude

$$\left(m \frac{M}{r^2} - m \frac{q^2}{r^3} \right) \hat{r}, \text{ where } \hat{r} \text{ is a unit vector} \quad (10b)$$

because the action and reaction forces are equal but in 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.

It is necessary then to have a repulsive force with the coupling q^2 to the charged particle P in a gravitational field generated by mass m . Thus, force (10b) to particle P is beyond the framework of gravitation + electromagnetism. As predicted by Lo, Goldstein and Napier [45], general relativity would lead to the necessity of its extension to a five-dimensional space. However, Penrose as well as the Nobel Committee was unaware of this discovery in 2015 [18]. Thus, the Nobel Committee is not yet ready to consider awarding a price in the area related to black holes since the five-dimensional space is not clear.

The repulsive force in metric (8) comes from electric energy [7]. An immediate question would be whether such a charge-mass repulsive force mq^2/r^3 is subjected to electromagnetic screening. This force, being independent of a charge sign, should not be subjected to such screening. Moreover, the existence of the repulsive force mq^2/r^3 means also that Maxwell's theory is actually inadequate.

Note that this force can be considered a result of q^2 interacting with a field created by the mass m . Thus, such a field is independent of electromagnetism and is beyond general relativity, and the need for unification is established. To test such a possibility, one can measure whether there is such a repulsive force

outside a charged capacitor. ⁽²⁰⁾ Thus, to include the repulsive gravitational force, general relativity must be extended to a five-dimensional space.

A necessary step to test is to measure the force (10a). However, for a charged particle, force (10a) is too small. Nevertheless, we could test a similar force for a ball with charge Q . For a sufficiently large charge Q , the force $-m \frac{M^2}{R^2} + m \frac{Q^2}{R^3}$,

where R is the distance from the center of the ball should be verifiable experimentally. However, no experiment on this has been performed so far because physicists were not aware of the existence of repulsive gravitation. Thus, general relativity has not been properly tested.

As a result, gravity is mistaken as always attractive. This is the crucial error that leads to the claim for the existence of the black hole singularity [17]. Now, the existence of the black holes need a new justification.

8. THE WEIGHT REDUCTION OF A CHARGED CAPACITOR

The repulsive gravitational force was first discovered from measuring a charged capacitor. Thomas T. Brown initiated the study of charging a capacitor and later was joined by Paul A. Biefeld [46,47]. Since the B-B effects cannot be explained with current theories, many regarded such effects as experimental errors.

For instance, it is known that a charged capacitor has a reduced weight. Moreover, after being charged with a high voltage (about 40 kilovolts), without a continuous supply of electric energy, the lifter (a light capacitor) is able to lift its own weight plus a payload hovering over Earth. Also, a lifter could work by charging the wire to either a positive or a negative potential. It has been determined that the lift is not due to ion wind effects [46]. Thus, the lift is generated by changing something inside the lifter with a high voltage charge.

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 canceled 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

canceled by the force generated by the motion of the initially moving charges of the electrons. Note that string theorists still do not acknowledge repulsive gravitation.

This repulsive force, however, cannot be proportional to the charge density. We have equal numbers of negatively charged electrons and positively charged protons with equal charge. This would lead to the cancellation of the forces generated by particle charges. However, if such a force is proportional to the charge density square, these two kinds of forces would be added together instead of canceled out. Moreover, since the lifter has a limited height, one should expect that this repulsive gravitational force would diminish faster than the attractive gravitational force. Thus, if we assume that the force is proportional to mass, as usual, the static charge-mass interaction would be a repulsive force between particles with charge density D_q and another particle of mass m would have the following form,

$$F_r \approx KmD_q^2/r^n \text{ where } n > 2, \quad (11)$$

r is the distance between the two particles, and K is the coupling constant. In formula (11), the coupling constant K and n the power of r can be determined by experiments. The simplest case would be $n = 3$.

Formula (11) is derived from the observations with common physical sense. The experimental results are that the charged capacitors have reduced weight. If the lift force is large enough, it will hover over the Earth [46,47] since the repulsive gravitation force reduces faster than the gravitational force.

According to general relativity, if the electric energy leads to a repulsive force toward a mass, the magnetic energy would lead to an attractive force from a current toward a mass [17]. Due to a charged capacitor having reduced weight, it is necessary to have the current-mass interaction canceled out by the effect of the charge-mass interaction. Thus, the existence of the current-mass attractive force would solve a puzzle, i.e., why a charged capacitor exhibits the charge-mass repulsive force since a charged capacitor has no additional electric charges. In fact, the charge-mass repulsive force would be canceled by the current-mass force as Galileo, Newton, and Einstein implicitly assumed.

The existence of such a current-mass attractive force has been discovered by Martin Tajmar and Clovis de Matos [48] from the European Space Agency. Martin et al. found that a spinning ring of superconducting material increases its weight more than expected. Thus, they believed that general relativity was wrong. However, according to quantum theory, spinning superconductors should produce a weak magnetic field. Thus, they also measured the current-mass interaction to the Earth! The current-mass interaction would generate a force that is perpendicular to the current.

Since the additional weight from a current-mass interaction is directional, the weight of a magnet is directionally dependent, as our experiment verified [49]. This directional dependence of weight is a completely new phenomenon that verifies the existence of the current-mass interaction.

One may ask what the formula for the current-mass force is. Unlike the charge-mass repulsive force, which can be derived from general relativity, this general force would be beyond general relativity and since a current-mass interaction would involve the acceleration of a charge, this force would be time-dependent and generate electromagnetic radiation. Moreover, when radiation is involved, the radiation reaction force and the fifth-dimension variable must be considered [45]. Thus, we are not yet ready to derive current-mass interaction. Nevertheless, we may assume that for a charged capacitor, the resulting force is the interaction of net macroscopic charges with the mass.

Experimentally, the repulsive force would be proportional to the potential square, V^2 where V is the electric potential difference of the capacitor ($Q = CV$, C is the capacitance and Q is the charge). This has been verified by the experiments of Musha [50,51]. Thus, the factor of charge density square in heuristic Eq. (9) is correct. Moreover, the lifter's hovering shows that the repulsive force would diminish faster than the gravitational force. However, even if the $1/r^3$ factor in the repulsive force is verified, the calculation would still depend on the detailed modeling [52]. Although the initial thrust due to the electric field is directional, the weight reduction effect for charged capacitors is not directional, and it stays if the potential does not change. This was verified by Liu [29] with the

rolled-up capacitors. Thus, the repulsive force on the charged capacitor is the same force that derived from general relativity [37].

One may ask what the weight of a charged capacitor would be after it is discharged. It takes time for a capacitor to recover its weight after being discharged [53]. It needs time to dissipate the heat generated by discharging, and the motions of its charges would accordingly recover to the previous state. This was observed because rolled-up capacitors keep heat better. This also explains the weight reduction of a piece of heated-up metal [3] since heat would change some orbital electrons to more random electrons.

It follows that there are three factors that determine the weight of matter. They are: (1) the mass of the matter, (2) the charge-mass repulsive force, and (3) the attractive current-mass force. For a piece of a heated-up metal, the current-mass attractive force due to orbital electrons is reduced, but the charge-mass repulsive force increases. Therefore, a net result is a reduction of weight [7], instead of increased weight as predicted by Einstein. Thus, to test the inverse square law accurately, one must know exactly how temperature affects weight.

9. THE OVERSIGHTS OF MAXWELL, EINSTEIN, AND THE NOBEL COMMITTEE

In the experiment on the photoelectric effect, it was assumed that the photons consist entirely of electromagnetic energy. However, there is no evidence that photons consist of electromagnetic energy alone. In fact, it would be natural to conjecture that photons also consist of gravitational wave energy since all charged particles are massive. Historically, the formula $E = mc^2$ was proposed by Einstein in 1912 [34], well before the publication of general relativity in 1916. Understandably, Einstein failed to include the gravitational energy in the photons.

Moreover, Maxwell claimed that light is also an electromagnetic wave because light and the electromagnetic wave have the same speed. Maxwell did not consider that light could contain anything else since there was nothing other than the electromagnetic waves that could attain the speed of light. Thus, it was natural for Einstein to follow Maxwell.

Einstein did not modify his proposal since he was not sure of the existence of the gravitational

wave, although it could have the speed of light. He [54,55] was puzzled that his equation implied no gravitational wave while the linearized equation showed its existence. In fact, Einstein concluded his talk on gravitational waves at Princeton University by saying [56] "If you ask me whether there are gravitational waves or not, I must answer that I do not know. But it is a highly interesting problem."

Recently LIGO announced that the gravitational wave had been detected. However, the exact equation that produces the gravitational wave remains to be investigated. Although the Lorentz-Levi-Einstein equation

$$R_{\mu\nu} - (1/2)g_{\mu\nu}R = -K[T(m)_{\mu\nu} - t(g)_{\mu\nu}],$$

can produce the gravitational wave approximately [10], the exact gravitational energy-stress tensor $t(g)_{\mu\nu}$ remains to be investigated. However, Einstein rejected such a modification because he believed that his equation was correct for the dynamic cases [8,9], although mathematics shows otherwise [10].

Apparently, the claim of the Nobel committee that the Einstein equation produced the gravitational wave is due to a calculation error. It is well-known that a calculation with a computer can be highly unreliable because in such a calculation the result depends on how the calculating points are taken. Such a calculation can only be wrong if it disagrees with an analytic result.¹⁸⁾ note also that this is not the first time that the Nobel Committee made errors in gravitation [57].

10. DISCUSSION AND CONCLUSIONS

Note that for a massive source to have a dynamic solution [10], the modified Einstein equation is as follows:

$$G_{\mu\nu} \equiv R_{\mu\nu} - (1/2)g_{\mu\nu}R = -K[T_{\mu\nu}(m) - t_{\mu\nu}(g)], \quad (12)$$

where $t_{\mu\nu}(g)$ is the energy-momentum tensor of the gravitational field. This equation was first obtained by Lorentz [20] and Levi [21], but Einstein objected to it on the mistaken grounds that his field equation implies $t(g)_{ab} = 0$. However, eq. (12) was recovered by Lo [10] with the support of Einstein's radiation formula. Then, the gravitational radiation energy can be calculated in agreement with the binary pulsar experiments [10,57]. However, eq. (12) is limited

to show the existence of dynamic solutions only, but it does not have a repulsive gravitational force.

Thus, the unique sign of couplings is also not valid for the case of a massive source. There are three important conclusions: (1) The antigravity coupling is necessary for a dynamic case, (2) For the dynamic case, the Einstein equation has no bounded solution, and (3) The space-time singularity theorems, which requires a unique sign for coupling constants, are invalid for physics.

Eq. (12) also explains that, for a dynamic case, the linearized equation does not have a compatible solution from the nonlinear Einstein equation. The linear equation is a valid linearization for eq. (12), but an invalid linearization of the Einstein equation. Thus, Einstein failed to see the need for an anti-gravity coupling for a dynamic solution.

Note that Einstein [31] uses massless particles to represent photons but from eq. (6) and eq. (7) it is clear that this cannot be done without the gravitational wave [24,25]. Thus, Einstein failed to recognize that this energy problem is beyond special relativity. Between 1905-1909, Einstein also failed to show the general validity of $E = mc^2$ [32]. This failure to see the need for the anti-gravity coupling provides the basis for the space-time singularity theorems, which are based on the implicit assumption of a unique coupling sign.

If photons consist only of electromagnetic energy, then there is a conflict, since photonic energy can be equivalent to mass, but electromagnetic energy is not [33]. This conflict has now been resolved, since the photonic energy is the sum of electromagnetic energy and gravitational energy, and this confirms that $E = mc^2$ can be invalid.

The proof of photonic energy consisting of massless particles is a remarkable achievement of general relativity. This also shows an important example of the Einstein equation where a valid physical solution may not satisfy it. Thus, one cannot just conjecture a solution based only on "reasonable" physical considerations, without an explicit example.

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of the Nobel committee that the Einstein equation produced the gravitational wave is due to a calculation error. It is well-known that a calculation with a computer can be highly unreliable because in such a calculation the result depends on how the calculating points are taken. This is not the first time that the Nobel Committee made erroneous calculations in gravitation [57].

There is no bounded dynamic solution for the Einstein equation because the principle of causality is violated. Some physicists did not recognize this, even though they could not provide a dynamic solution to show otherwise. In fact, this can be further confirmed by explicit examples such as the metric of Bondi, Pirani and Robinson [58] for $G_{\mu\nu} = 0$, which violates the principle of causality because the energy-momentum tensor of a wave cannot be zero even in vacuum.

Einstein often regarded some partial successes of his theory as evidence that it was fully correct. For example, he did not know that the energy of photons must include the energy of the related gravitational wave [24,25]. Thus, the existence of the gravitational wave is assured. As Feynman commented, Einstein was followed by those incompetent theorists who believed that general relativity is applicable only to large-scale problems.¹⁹⁾ This is incorrect since general relativity assures the existence of the gravitational wave for photons. Thus, a thorough review of general relativity is necessary.²⁰⁾

The gauge invariance is incorrectly derived from the Yang-Mill-Shaw theory [59,60]. Einstein justifies the covariance principle with invalid applications of relativity [61]. Gauge theory did not produce anything meaningful until the broken symmetry was discovered [62]. Also, the equivalence principle was misunderstood even by Wheeler et al. [37].

The current academic review system often overlooks challenges to entrenched views, such as for example, the claims of Hawking, which are based on an invalid implicit assumption, or the idea that there are no bounded dynamic solutions. Yet new experiments provoke new insights. The speculation of black holes, for example, ignored repulsive gravitation, even though it was well-tested [7]. Progress in the current theory of general relativity is often stalled because physicists are not always sufficiently trained in mathematics, and mathematicians are

not always sufficiently trained in physics [14]. Thus, it is essential to review our progress to date and to identify errors with experiments.

Einstein's other major error is his failure to recognize repulsive gravitation and thus created an invalid notion of gravitational mass. We have provided a simple experiment showing that Einstein's thought experiment, for increased weight as temperature increases, is wrong. A common mistake among theorists, is to neglect the need for supporting examples. This is often why some mistakes are not discovered.

In 1905, Einstein represented the energy of photons with the energy of massless particles without necessary proof [31]. Apparently, he did not know that the energy-momentum tensor of massless particles alone is incompatible with the electromagnetic energy-stress tensor in Maxwell's theory [33]. Since Einstein proposed general relativity in 1915, he could not possibly know that the inconsistency between the electromagnetic energy-stress tensor and the energy-momentum tensor of massless particles can be removed with general relativity.

Einstein did, however, brilliantly consider photons as massless particles. Nevertheless, his shortcomings were exposed in 1912 [34] when he changed the radiation energy L [31] to a more general energy E , and thus made his proof [31] change from incomplete to invalid. Thus, it is clear that Einstein did not actually fully understand Maxwell's theory.

Since the notion of photons is due to gravitation, the assertion of Hawking and Penrose that general relativity is unsuitable for microscopic phenomena is incorrect. Note that $E = mc^2$ is the basis of the assumption in Hawking's space-time singularity theorems. Further, $E = mc^2$ is responsible for the rejection of repulsive gravitation, which is crucial for the unification of gravity and electromagnetism [7].

Einstein failed to include gravitational wave energy in the photons since he proposed the photons in 1905, well before he conceived general relativity in 1916. Since a charged particle is always massive, it is natural to include the gravitational wave energy in the photons.

Moreover, in all space-time singularity theorems of Hawking and Penrose. an implicit assumption of a unique sign for all coupling constants was used Thus, their claim that general relativity is

not suitable for microscopic phenomena is simply incorrect. Note that the unique coupling sign depends on the general validity of formula $E = mc^2$, which has been proven not valid. Thus, the space-time singularity theorem is actually unrelated to physics.

Penrose claimed that his "proof" for the existence of black holes is based on the singularity theorems, which are irrelevant in physics. Thus, his proof is actually invalid. The claim of the 2020 Nobel Committee for Physics that UK-born Penrose showed that Albert Einstein's general theory of relativity leads to the formation of black holes is simply groundless. This shows a collective error of the Nobel Committee.

Hawking and Penrose follow their mathematical results, but fail to consider the physics adequately. Since they do not understand the principle of causality, they accepted unbounded solutions and $E = mc^2$ as generally valid, Their space-time singularity theorem is the basis of the big bang theory and the existence of black holes, which are based on the assumption that gravity is always attractive. Their incorrect theorems have also led to the claim that general relativity is invalid for microscopic subjects.

Penrose and Hawking²²⁾ have ignored the simple experiments confirming the existence of repulsive gravitation. Thus, some crucial experiments that are related to repulsive gravity have not been addressed for a long time [7]. One may suspect that they play ignorance to avoid the inevitable. However, they may just have too much confidence on themselves. This problem of Penrose shows the importance of real experiments that Galileo taught us.

Errors in general relativity have evolved for over 100 years. We should learn from the teachings of Galileo that experimental confirmation is essential. Philosopher Hu Shih once remarked that in sciences, one can have daring assumptions, but one must also be careful in one's proof. A problem of many physicists is that they often adhere only to the first part. They also forget the teaching of Galileo on the importance of experiment This is why so many crucial errors in general relativity were not discovered but instead were perpetuated.

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ENDNOTES

- 1) Einstein's famous thought experiment on weight increment as temperature increased failed because repulsive gravity does exist.
- 2) Einstein failed to deal with the mathematical difficulty because of inadequate training in mathematics. Because of this, Einstein is also poor in logical deduction, although good in physical intuition.
- 3) To help physicists, mathematicians must understand physics sufficiently; otherwise they may make errors as Hawking [16] or Yau [12] did.
- 4) This is a problem that a mathematician turned physicist, such as Hawking [16], Penrose [36], and Yau [12] can cause.
- 5) Now, the damage to physics is to deepen wrong applications.
- 6) Physicists do not understand that a mathematical procedure can be incompatible with an invalid equation.
- 7) They believed that the truth is always within their circle of theorists. They forget the teaching of Galileo on experiments.
- 8) Some claim alternatively $T \approx 2\pi\sqrt{lm_i/m_a g'}$, this only means $g = g'm_a/m_i$, where m_a is the gravitational mass and m_i is the inertial mass.
- 9) A Napier and I have done the experiment to measure the frequency changes due to heating-up with a torsion balance scale. We did obtain an increment of the period from the small brass balls and a reduction of gravity for the large lead balls after heating up. However, we cannot get stable readings of the frequencies due to the interference of passing subway trains nearby. We shall publish our results after data are significantly improved.
- 10) It is a surprise that Einstein actually did not understand Maxwell's theory well. It is difficult to reconcile this with the fact that he proposed special relativity.
- 11) It is a common practice of relativists for an author to claim something without adequate supports. For instance, Wald [16] claimed that he has a second order approximation of the Einstein equation, but never provided one. Einstein claimed that he can have a perturbation approach to derive the remaining perihelion of Mercury [76], but never provided one.
- 12) Such compatibility is not a problem for a linear equation but could be a major problem for a non-linear equation.
- 13) The existence of the Euclidean-like structure in a physical space clarifies the difference between physical Riemannian space and a mathematical Riemannian space embedded in a higher-dimensional Euclidean space. This was the crucial point needed to settle the difference between Einstein and Whitehead [77].
- 14) The repulsive gravitational force was first obtained from the metric of a static Einstein equation for a charged particle. However, this new force was first recognized by Lo [78] with other then unexplainable experiments. Moreover, this repulsive force is initiated from charges. Unlike in electromagnetism, there is no negative mass.
- 15) It is expected that the repulsive force is very small from a single particle otherwise Maxwell could have found it.
- 16) G. 'tHooft [43] incorrectly believed that the mass of an electron includes its electric energy. He did not understand Newtonian mechanics or special relativity adequately.
- 17) Frank A. Wilczek [27] incorrectly believed that $E = mc^2$ is unconditional. Thus, their proof (Frank. A. Wilczek, along with David Gross and H. David Politzer) for asymptotic freedom is actually incomplete.
- 18) The MIT team claimed that they got a dynamic solution from the Einstein equation with a computer. However, it is known that a computer calculation is fast but can be unreliable. In my opinion, since it has been shown analytically that there is no bounded dynamic solution [10, 11], their calculation must be wrong. Apparently, unlike Prof. P. Morrison of MIT, they do not understand the principle of causality. Moreover, they did not know that Prof. Morrison has found out from Prof. Taylor that the binary gravitational radiation cannot be obtained from the Einstein

equation [57]. Since the Nobel Prize Committee had been wrong in the gravitational calculation in 1993 [57], it would appear that they made another error again.

- 19) Because this repulsive force is inconsistent with Maxwell's theory and Einstein's theory, many ignore this weak repulsive gravitational force as an experimental error or as if it did not exist. For instance, Michael Green and Edward Witten still do not know that experiments on the existence of repulsive gravitation have been confirmed. The real problem is that the existence of repulsive gravitation can prove Einstein wrong.
- 20) Such a review is necessary for Dr. Kate Kirby, the CEO of APS, to renew physics because erroneous theories have been in the dominating positions. For instance, even the Fields Medal and the Nobel Prize Committee have been mistaken. Moreover, erroneous theorists such as Wald [16] and Wheeler et al. [37] were incorrectly regarded as experts in general relativity [79-82]. In addition, Einstein himself has made serious errors [76].
- 21) The reduction of gravity can be observed in a vacuum tower. This error of Galileo can be verified in NASA.
- 22) Penrose and Hawking do not understand the principle of causality because they are mathematicians. Now, theoretically the existence of a black hole is clearly questionable because gravitation is no longer always attractive. What Penrose should do first is to justify the notion of black holes anew. Since we still do not have the Einstein equation that can have a dynamic solution, it is not possible that Penrose can prove the existence of a black hole theoretically. This is particularly true since it involves a theory of five-dimensional space that has not been fully established [18]. Moreover, their space-time singularity theorems are based on the invalid implicit assumption that all the couplings have the same sign [16]. Thus, their theorems are irrelevant to physics. Although we have observed very massive objects, there is no evidence to verify that they are black holes.

DISCLAIMER

The products used for this research are commonly and predominantly used in our area of research and country. There is absolutely

no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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Author has declared that no competing interests exist.

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APPENDIX A

The Principle of Causality in Physics

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

Normally causality means causes will lead to consequences. The principle assumed:

- (1) From the consequences that causes must exist even we do not know what they are.
- (2) The partial consequences of the cause are identified even its full consequences remain to be known.

Then, we can use such partial consequences as requirements to decide whether a solution or even an equation is valid in physics. This might often provide crucial steps to solve a problem correctly. For example, this is how the equation (6) for the electromagnetic wave as a source was modified.

Thus, this principle implies that any parameter in a solution for physics must be related to some physical causes. Moreover, the principle of causality implies that a weak source would produce a weak gravity. Here this principle will be elucidated first in connection with symmetries of a field, the boundedness of a field solution. Although this principle alone cannot derive a field equation or its solution, it can help determine whether they are valid in physics. This has made a difference in the investigation of gravity between success and failure [6,7,10,11,24,25,36].

In practice, when the considered field is absent, physical properties are ascribed to the space-time as in a "normal" state. For example, the electromagnetic field is zero in a normal state. Then, any deviation from the normal state must have physically identifiable causes. Thus, the symmetry must be preserved if no cause breaks it. The implication of causality to symmetry has been used in deriving the inverse square law from Gauss's law. The normal state of a space-time metric is the flat metric in special relativity. Thus, if a metric does not possess a symmetry, then there must be a physical cause(s) which has broken such a symmetry. For a spherically symmetric mass, causality requires that the metric is spherically symmetric and asymptotically flat. Also, a weak cause can lead to only weak gravity. Thus, Einstein's weak gravity is a consequence of causality.

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

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

A reason that the Einstein equation did not have a bounded dynamic solution is its violation of causality. In the Einstein equation the left side is the Einstein tensor $G_{\mu\nu}$ and the right side are the energy-momentum tensors. For the dynamic case, the energy-momentum tensor of the gravitational waves should have been included. Thus, for the dynamic case, the Einstein equation violates the principle of causality and thus has no bounded dynamic solution. The modified Einstein equation (12)

can have a dynamic solution because the missing energy-momentum tensor has been added back. It is surprising that physicists did not find this principle of causality for general relativity earlier.

Classical electrodynamics implies that the flat metric is an accurate approximation, caused by the presence of weak electromagnetic waves. This physical requirement is supported by the principle of causality, which implies such a metric to be a bounded periodic function. However, this required boundedness is not satisfied with many solutions in the literature [63-75]. If these authors understood the principle of causality, they would not have produced them.

Many theorists and journals do not understand the principle of causality adequately. For instance, the *Physical Review* accepted an unbounded solution as valid in physics. As well, the Royal Society (London) accepted Hawking, even though the space-time singularity theorems violate the principle of causality. A problem is that the teaching of Galileo on the importance on experimental verification is often forgotten.

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