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On the Weight Reduction of Metals Due to Temperature Increments

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Abstract - Based on $E = mc^2$, Einstein remarked that an increase of E in the amount of energy must be accompanied by an increase of E/c^2 in mass; and thus the increased temperature would lead to an increased weight. However, based on the recently discovered charge-mass interaction, it is predicted instead that a heated up matter would have a reduced weight. Experimentally, Fan, Feng, and Liu found that the weights of six kinds of metals including gold, silver, copper, nickel, aluminum, and iron decrease as the temperature increases from 100 degree to 600 degree. Nevertheless, Fan et al. regard these weight reductions as a result of modifying the mass in Newtonian gravity, but not due to a new repulsive force as the case of charged capacitors. Thus, they could have inadvertently created a problem with the notion of negative mass. Moreover, this would not help solving the NASA space-probe anomaly. Therefore, it is necessary to clarify that their experimental results are essentially due to a repulsive charge-mass interaction and that the theories of Galileo, Newton and Einstein are inadequate.

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Keywords : pioneer anomaly; repulsive force; charge-mass interaction; charged capacitors; $E = mc^2$.

I. Introduction

Based on the formula $E = mc^2$, Einstein [1] claimed, "an increase of E in the amount of energy must be accompanied by an increase of E/c^2 in the mass." He also claimed, "I can easily supply energy to the mass-for instance, if I heat it by ten degree. So why not measure the mass increase, or weight increase, connected with this change? The trouble here is that in the mass increase the enormous factor c^2 occurs in the denominator of the fraction. In such a case the increase is too small to be measured directly; even with the most sensitive balance." However, theoretical developments and experiments have shown that Einstein's claims are first questionable and actually incorrect [2-11]. In particular, the recent experiments on temperature dependency of weight by Fan, Feng, and Liu [12] are directly in conflict with Einstein's claims. They found that the weights of their metal samples all decrease (instead of increasing) as the temperature increases.

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Their results are also in conflict with the unconditional mass-energy formula, $E = mc^2$. In physics theorists often are not aware of making implicit assumptions [2, 7, 13-16]. Moreover, because of inadequate background in mathematics, some theoretical physicists use invalid mathematics without knowing their errors [4, 17-19]. To find out the implications of this heat-dependence of weight, we must first make clear notions such as energy, mass, and weight respectively.

II. Energy, Mass, and Conditional Validity of $E = mc^2$

In Newtonian theory, the principle of conservation of energy and the principle of conservation of mass are independent of each other. As Einstein [1] pointed out, the first of these was developed in the nineteenth century essentially as a corollary of a principle of mechanics. For a particle, the conservation of mechanic energy is the sum of its potential energy and the kinetic energy is a constant. When friction is involved, heat energy is accounted for. Because for any given amount of heat produced by friction, an exact proportional amount of energy had to be expended, we obtain the principle of the equivalence of work and heat. Thus, the principles of conservation of mechanical and thermal energies were merged into one. The physicists were thereupon persuaded that the conservation principle could be further extended to take in chemical and electromagnetic processes – in short, could be applied to all fields. It appeared that in our physical system there was a sum total of energies that remained constant through all change that might occur.

Now for the principle of conservation of mass: Mass is defined by resistance that a body opposes to its acceleration (inert mass). According to this principle, any interaction would not change the total mass. However, special relativity suggests that the rest energy E_0 of a particle P is m_0c^2, where m_0 is the rest mass of the particle P. Then, for a particle moving with velocity v, we have $E = mc^2$, where $m = m_0/[1 - v^2/c^2]^{1/2}$. Then, we might say that the principle of conservation of energy now proceeded to swallow that the conservation of mass- and holds the field alone. Experimentally, the conversion of Δm to $\Delta E = \Delta mc^2$ does occur in radioactive disintegration [1]. However, the reverse formula $\Delta m = \Delta E/c^2$ has never been generally proven [11].

Since the total energy is conserved, one might conjecture that all energies are equivalent. Thus, any energy E should be accompanied by an amount E/c^2 in mass. Einstein had tried to prove this until 1909, but failed [15]. It turns out that this is actually incorrect [8]. For instance, the electromagnetic energy is not equivalent to mass. This is because the trace of an electromagnetic energy-stress tensor is zero; whereas that of a massive energy-stress tensor is not. On the other hand, it is known that the meson π_0 can decay into two photons, but this only means that the photons contain non-electromagnetic energy [20].

Einstein thought that he had proved in 1905 that electromagnetic energy is equivalent to mass by showing the photons can be converted into mass [13, p. 69]. However, Ohanian [21] pointed out that Einstein's proof is incomplete because "He had proved $E = mc^2$ for the simple special case of slow-moving bodies and he blithely extrapolated this to fast-moving bodies." Ohanian [21] claimed that in 1911 Max von Laue has the first general proof of $E = mc^2$ because it is valid for slow-moving and fast-moving bodies. However, Ohanian is wrong because the implicit assumption of Einstein that the photons include only electromagnetic energy is not valid [16]. Thus, the famous formula $E = mc^2$ is actually only conditionally valid for some cases. [1)]

The non-equivalence of mass and energy opens the possibility that some types of energy may generate a field that cannot be generated by mass. In other words, the conditional validity of $E = mc^2$ exposes two misconceptions namely:

1) Gravity would always be attractive to mass since masses attract each other. Such a belief of attractiveness is at the foundation of the theories of black holes [22].
2) The coupling constants must have the same sign. The unique sign for couplings is the crucial physical assumption for the spacetime singularity theorems of Hawking and Penrose [23].

The Hulse-Taylor experiments of binary pulsars necessitate that there are different coupling signs for the massive energy-stress tensor and the gravitational energy-stress tensor [17]. [2)] In view of this, the unconditional validity of $E = mc^2$ should be questioned. Then, it is found that $E = mc^2$ is only conditionally valid [24]. Moreover, the assumption of unique sign for couplings actually violates the principle of causality [11, 17]. This is the physical reason that space-time singularities were obtained.

III. The Charge-Mass Interaction and the Question of Weight

Moreover, it is found also that a charge may generate a gravitational static field that repulses a mass [20, 24]. Then, according to the principle of equality between action and reaction, a mass should generate a static field that is repulsive and couples with the square of an electric charge (see Appendix A). Thus, there is a new neutral charge-mass interaction that is beyond electromagnetism and gravitation, and thus Einstein's unification is a necessity [7, 25].

The first direct verification of the static charge-mass repulsive force was reported by Tsipenyuk and Andreev [26]. After they had irradiated with high energy electrons to one of the two initially equal-weight balls, the irradiated ball became lighter.[3)] They did not have an explanation, but such a weight reduction due to a repulsive force had been recognized earlier by Lo [24] and subsequently Lo & Wong [18] derived a formula for the case of a charged metal ball. Since the discovery and the prediction are based on general relativity, Einstein's theory would also have another important confirmation [27].

Nevertheless, there is another theory that also explains the weight reduction of a metal ball. For example, Togla's theory [28] even assumes the validity of $E = mc^2$. He even accepts also Newtonian gravity, but rejects general relativity and Einstein's unification. His theory of weight reduction is not a result of a charge-mass interaction. Thus, his formula does not involve a factor of a charge square, or a different factor of distance. On the other hand, the anomaly of NASA's pioneer space-probe seems to support the different factor of distance (see Appendix A), and experiments on charged capacitors do confirm the factor of charge square (see Appendix B). Moreover, the theory based on unification predicts the weight reduction of heated metals [5, 10].

However, in general relativity, there is no field that couples with the square of a charge. Moreover, since this new force is independent of the charge sign, physically it should not be subjected to electromagnetic screening although general relativity would imply it does. Nevertheless, such a coupling exists in the five-dimensional relativity of Lo, Goldstein and Napier [29]. In addition, their theory would support that such a neutral force is not subjected to electromagnetic screening. It thus follows that the existence of this static neutral repulsive force can be tested by weighing a capacitor to see whether its weight is reduced after being charged [7, 25]. To verify their five-dimensional relativity, the existence of such a force on a capacitor was first performed by Liu [30] [4)] although the weight reduction of charged capacitors has been found much earlier [31-33].

Attempts to explain weight reduction of a capacitor after being charged have been made; but all failed since the 1950s. For instance, Buehler [31] concluded that the force could not be directly associated with the interaction of the electric and magnetic fields of the earth. Masha et al. [32, 33] also conceded that we must search for an explanation of their experiments. This is consistent with the fact that so

far the charge-mass repulsive force on a capacitor is not derivable from a four-dimension theory.

Thus, it is known that a weight reduction of a neutral object may not be due to a reduction of mass, but a neutral repulsive force, which was unknown to Gallieo, Newton, and Einstein [10]. However, Einstein's equivalence principle remains valid. Moreover, this new force is likely responsible for the Pioneer orbital anomaly discovered by NASA (see Appendix A).

If the electric energy leads to a repulsive force toward a mass, according to general relativity, the magnetic energy would lead to an attractive force from a current toward a mass [7, 34]. The existence of such a current-mass attractive force has been verified by Martin Tajmar and Clovis de Matos [35] from the European Space Agency. They 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 are also measuring the interaction between an electric current and the earth, i.e. an effect of the current-mass interaction!

IV. Weight Reduction by Heat

The existence of the current-mass attractive force would solve a puzzle, i.e., why a charged capacitor exhibits the charge-mass repulsive force since a charged capacitor has no additional electric charges? In a normal situation, the charge-mass repulsive force would be cancelled by other forms of the current-mass force as Galileo, Newton and Einstein implicitly assumed. This general force is related to the static charge-mass repulsive force in a way similar to the Lorentz force is related to the Coulomb force. One may ask what is the formula for the current-mass force? However, unlike the static charge-mass repulsive force, which can be derived from general relativity (see Appendix A); this general force would be beyond general relativity since a current-mass interaction would involve the acceleration of a charge, this force would be time-dependent and generates electromagnetic radiation. Moreover, when the radiation is involved, the radiation reaction force and the variable of the fifth dimension must be considered [29]. Thus, we are not ready to derive the current-mass interaction yet.

Nevertheless, we may assume that, for a charged capacitor, the resulting force is the interaction of net macroscopic charges with the mass.[5)] The irradiated ball has the extra electrons compared to a normal ball. A spinning ring of superconducting material has the electric currents that are attractive to the earth. This also explains a predicted phenomenon, which is also reported by Liu [30] that it takes time for a capacitor to recover its weight after being discharged. A discharged capacitor needs time to dissipate the heat generated by discharging. Then, the motion of its charges would recover to normal.

Thus, it should be expected that the heated metals would reduce their weight. It is conjectured that the heat would additionally convert some electrons to random motion and some orbits of electron to random orientations, but the increased mass due to heat energy is negligible as Einstein [1] pointed out. If this explanation of weight reduction is valid, then a metal would reduce its weight as the temperature increases. This should be further tested experimentally such that the related physics can be understood in depth. Moreover, since a heated metal is a solid, one can in principle test its mass by acceleration. In short, their experiments seem to be worthy for others to check their results with the same or similar experiments.

V. Discussions and Conclusions

It had been accepted that mass would also be measured by the weight of the body, in addition to be defined by resistance that a body opposes to its acceleration. As Einstein [1] pointed out, that these two radically different definitions lead to the same value for the mass of a body is, in itself, an astonishing fact. In other words, in his opinion, there should be some difference. Einstein is proven right because the weight of a body may not represent its mass. There is the mass-charge interaction that could make the weight of a body (such as a capacitor) different from its inertial mass [10]. The weight reductions of heated metals reinforce the recognition of this difference. We have no reason in physics to believe that some mass Δm disappears, but this is not accompanied with the release of a large amount of energy, according to $\Delta E = \Delta mc^2$.

The special equivalence between the gravitational and the inertial masses of a body for some common situations, was discovered by Galileo and Newton, and is served as the foundation of Einstein's equivalence principle (see Appendix C). However, this special equivalence has been mistakenly regarded as the equivalence principle in the 1993 press release of the Nobel Committee [36]. [6)] This error is due to that Einstein's equivalence principle was distorted by the Wheeler School [37] as the equivalence between acceleration and Newtonian uniform gravity, and also another error [17, 18] of believing the existence of dynamic solutions for the Einstein equation. The latter is also the error of the Shaw Prize Committee awarding Christodoulou with a half Shaw Prize in mathematics.[7)] Thus, the problem of accumulated errors due to authority worship [8)] is serious [2].

An implicit assumption of the second definition of mass is that there is only the mass-mass interaction between two neutral bodies. It has been shown that this implicit assumption is actually not valid because there is

the charge-mass interaction even among neutral matter such as charged capacitors [5, 7, 10]. Thus, the theories of Galileo, Newton, and Einstein are inadequate and the Nobel Committee has been incorrect if the charge-mass interaction is involved. Nevertheless, Einstein's equivalence principle remains valid because the charge-mass interaction is not involved [10].

The charge-mass interaction is initially derived from the static Einstein equation with a charged particle as the source [5]. This new force necessarily leads to the unification of gravitation and electromagnetism; and this in turn leads to a five-dimensional theory. It is based on this five-dimensional framework that a charge-mass interaction on a charged capacitor is conceived, and subsequently verified with experiments since related earlier work was not sufficiently well known.

Moreover, based on a five-dimensional theory, the static charge-mass interaction would also be responsible to the orbits of objects in the space [5, 6], and this is called the Pioneer anomaly discovered by NASA from 15 years of data [38]. After another 15 years of efforts in analyzing the data, so far, there is no theory other than the charge-mass interaction that can explain the Pioneer anomaly even just qualitatively [39, 40] (see Appendix A). Thus, from the space to the earth, there are many issues related to the charge-mass interaction that would be interesting to be investigated for the ambitious theorists.

However, Fan et al. [12] did not see the weight reduction as a result of a new charge-mass interaction, which is proportional to $1/r^3$, [9] but a modification of the Newtonian gravity, which is proportional to $1/r^2$. Thus, they would overlook the charge-mass interaction and Einstein's unification. Moreover, their modified force would not help solving the puzzle of NASA, the additional weak force that appears at very long distance from the sun [38] (see Appendix A). However, they have not addressed their own question whether there is any further properties change in ferromagnetic materials under external magnetic fields. Moreover, without a new force, they could have reached the conclusion that energy could generate negative mass.

The experiments of Fan et al. [12] confirm the predicted temperature dependence [7, 10, 11], and thus also raises a question, whether the current coupling constant for gravity is much smaller than the actual coupling? If the attractive gravitational force is reduced as the temperature increases, the gravitational attractive force would be increased as temperature decreases. Then, the gravitational attractive force could be much larger than what we have estimated with the coupling constant at room temperature. Therefore, one may ask whether the assumption of dark matter is, in part, a reflection of an inadequate gravitational coupling. To answer this question, it would be necessary to do experiments on gravity under extremely low temperature.

One might wonder why Fan et al. [12] did not give a clear motivation for their experiment since Liu is a coauthor, who is aware of the new force [5]. For this, one must understand that although Zhou Pei-Yuan [41, 42] is a brilliant theoretical physicist [43, 44], in China general relativity is still behind [45-47]. [10] They believe Wheeler et al. [37] although their interpretation of Einstein's equivalence principle has been proven invalid [44]. (In fact, the covariance principle has been proven invalid with examples [48].) Moreover, they need to acknowledge errors of Fock [49], Wald [23], Will [50], and Yang [51, 52] etc.

In particular, Yang still believes in the invalid gauge invariance [53, 54], [11] and thus he is against Zhou's view on invalidity of Einstein's covariance principle. Veltman [55] also commented, "So, while theoretically the use of spontaneous symmetry breakdown leads to renormalizable Lagrangians, the question of whether this is really what happens in Nature is entirely open." The crucial point is, however that for a non-Abelian theory in physics, there are different elements representing distinct particles, and thus the whole theory cannot be gauge invariant.

In a way, the experiment of Fan et al. [13] also supports the rejection of gauge invariance. Note that the recognition of invalidity of the covariance principle and the non-existence of dynamic solutions for the Einstein equation [56] are the steps of the necessity of rectifying general relativity; [7] and these lead to the discovery of the charge-mass interaction. Thus, without mentioning the new force due to the charge-mass interaction, they can circumvent such explanations; but have inadvertently created an even more serious problem that was luckily over looked by Engineer Sciences [12].

VI. Acknowledgments

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Appendix A: The Charge - Mass Interaction and Conditional Validity of $E = mc^2$

The non-equivalence between energy and mass is also confirmed by the Einstein equation [37],

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

where $T_{\mu\nu}$ is the sum of energy-stress tensors. The Reissner-Nordstrom metric [37] for a charge particle is as follows:

$$ds^2 = \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)dt^2 - \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)^{-1} dr^2 - r^2 d\Omega^2, \quad \text{(A1)}$$

where q and M are the charge and mass of a particle at the origin and r is the radial distance (in terms of the Euclidean-like structure [56]) from the particle center. Here, the gravitational components generated by electricity have not only a very different radial coordinate dependence but also a different sign that makes it a new repulsive gravity. Nevertheless, some still hold on to unconditional validity $E = mc^2$ [50], because of an inadequate understanding of general relativity [24].

Moreover, some argued that the effective mass could be considered as $M - q^2/2r$ ($c = 1$) since the total electric energy outside a sphere of radius r is $q^2/2r$ [8, 58]. Then, if any energy has a mass equivalence, an increase of energy should lead to an increment of gravitational strength. However, although energy increases by the presence of a charge, the strength of a gravitational force, as shown by metric (A1), decreases everywhere. Thus, the unconditional validity of $E = mc^2$ is a misinterpretation.

Nevertheless, theorists such as Herrera, Santos & Skea [59] argued that M in (A1) includes the external electric energy.[12] Thus, in contrast to experiments [26], there would be no repulsive gravitational effect due to the electric charge. They overlooked that this would create a double counting of the electric energy in two different ways [18, 40, 58]. In addition, if M included the external electric energy, then the inertial mass m_0 of the electron would be much smaller than M. Furthermore, according to the Einstein equation for the metric [23], since the electromagnetic energy-stress tensor is traceless, curvature R is independent of the electromagnetic energy-stress tensor, and the electric energy cannot be equivalent to a mass.

To show the repulsive effect, one needs to consider only g_{tt} in metric (A1). According to Einstein [13, 14],

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

where $\Gamma^\mu{}_{\alpha\beta} = (\partial_\alpha g_{\nu\beta} + \partial_\beta g_{\nu\alpha} - \partial_\nu g_{\alpha\beta})g^{\mu\nu}/2$ (A2)

and $ds^2 = g_{\mu\nu}dx^\mu dx^\nu$. Let us consider only the static case, dx/ds = dy/ds = dz/ds = 0. Thus,

$$\frac{d^2x^\mu}{ds^2} = -\Gamma^\mu{}_{tt}\frac{dct}{ds}\frac{dct}{ds}, \quad \text{where} \quad -\Gamma^\mu{}_{tt} = \frac{1}{2}\frac{\partial g_{tt}}{\partial x^\nu}g^{\mu\nu} \quad \text{(A3)}$$

since $g_{\mu\nu}$ would also be static. Note that the gauge affects only the second order approximation of g_{tt}. For example,

$$g_{tt} \approx \left(1 - \frac{2M}{r} + \frac{2M^2}{r^2} + \ldots\right) \quad \text{and} \quad g_{tt} = \left(1 - \frac{2M}{r}\right) \quad \text{(A4)}$$

are with respect to the harmonic gauge and the Schwarzschild solution, but the second order term is negligible.

For a particle P with mass m at r, since $g^{rr} \cong -1$, the force on P in the first order approximation is

$$-m\frac{M}{r^2} + m\frac{q^2}{r^3}. \quad \text{(A5)}$$

Thus, the second term is a repulsive force. If the particles are at rest, then the action and reaction forces are equal and 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. Thus, the geodesic equation is inadequate for the equation of motion.

Hence it is necessary to have a repulsive force with the coupling q^2 to the charged particle Q in a field generated by masses. It thus follows that, negative force (A5) to particle Q is beyond current theoretical framework of gravitation + electromagnetism. To accommodate the mass-charge interaction, unification between gravity and electromagnetism is necessary [7].

Thus, as predicted by Lo, Goldstein, and Napier [29], general relativity leads to a realization of its own inadequacy. For two point-like particles of respectively charge q and mass m, the charge-mass repulsive force is mq^2/r^3 , where r is the distance between these two particles. Clearly, this force is independent of the charge sign since a local concentration of electrons would increase such repulsion. The term of the repulsive force in (A1) comes from the electric energy [7, 20].

An immediate question would be whether such a charge-mass repulsive force mq^2/r^3 is subjected to electromagnetic screening. It is conjectured that this force, being independent of a charge sign, would not be subjected to such a screening [7] although it should be according to general relativity. From the viewpoint of physics, this force can be considered as a result of a field created by the mass m and the field interacts with the q^2. Thus such a field is independent of the electromagnetic field and is beyond general relativity [7]. In fact, this has been confirmed since a charged capacitor does reduce its weight [30-33].[13]

However, the r^{-3}-dependence (unlike r^{-2}-dependence) is difficult to test because it would be sensitive to the local surroundings [9]. Thus, such dependence being a long distance effect, the pioneer anomaly provides an excellent opportunity to test. In fact, this new charge-mass interaction explains the Pioneer anomaly very well qualitatively [5, 6] while others failed.

The calculation of (A5) 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 crucial to establish a charge-mass repulsive force, which is independent of electromagnetism. Then, the repulsive force between a point charge q and a point mass m is,

$$F = \frac{q^2 m}{r^3} \qquad (A6)$$

in the r-direction. This formula essentially comes from general relativity. 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 proportional to $1/r^2$.. However, due to the q^2 term, this formula should be modified for the case of a composite object consisting of many charged particles [20]. [14]

The space probes would check the mass-charge interaction over a long distance. If the repulsive force comes from the sun, then m in (A6) 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. Since such forces act essentially in the same direction, we could use a parameter P_s to represent the collective effect of the charges.[15]

Then, the effective repulsive force F_p would be

$$F_p = \frac{P_s m_p}{R^3}. \qquad (A7)$$

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 is 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_{ss} for the sun, i.e.

$$F = \frac{M_s m_p}{R^2} - \frac{P_s m_p}{R^3}, \qquad \text{and} \qquad \frac{M_s m_p}{R_0^{\,2}} - \frac{P_s m_p}{R_0^{\,3}} = \frac{M_{ss} m_p}{R_0^2} \text{ for } R_0. \qquad (A8)$$

Then, we have

$$F = \frac{M_{ss} m_p}{R^2} + \frac{P_s m_p}{R^2}\left(\frac{1}{R_0} - \frac{1}{R}\right). \qquad (A9)$$

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_q 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 over all requirements according to the data [39].

Appendix B: On the Weight Reduction of a Charged Capacitor and the Biefeld-Brown Effect

The weight reduction of a charged capacitor [32, 33] is a phenomenon that cannot be explained within the framework of conventional physics. A charged capacitor (particularly the rolled-up type) is effectively still a neutral object [10]. According to $E = mc^2$, a charged capacitor should have increased mass, and thus increased weight.

Currently, this phenomenon is often misidentified as due to the Biefeld-Brown (B-B) effect [60, 61]. However, a B-B effect is related to the process of electromagnetic polarization that produces a thrust toward the positively charged end; and would be saturated after a while even if the electric potential is still connected. On the other hand, the weight reduction continues as the capacitor remains charged even after the outside electric potential source is disconnected [30-33].

The current unconventional theory of Musha [61] was influenced by such a misidentification. Due to the above confusion, some important aspects of this weight reduction were overlooked. Moreover, the data support the crucial fact that the charge-mass interaction depends on the square of the charge as shown in eq. (A6).

B 1. Musha's Theoretical Consideration

To explain the effect of weight reduction, Musha [61] proposed two hypothesizes as follows:

1) Charged particle under a strong electric field generates a new gravitational field Φ_A around itself.
2) Additional equivalent mass due to the electric field is canceled by negative mass generated by the new gravitational field.

From Hypothesis (I), which is due to the misidentification as a B-B effect, the new gravitational field satisfies

$$g^{ij}\frac{\partial}{\partial x^j}\Phi_A = -\frac{q}{m}F^{i0}$$

which is derived from the relativistic equation of a moving charged particle, where $\boldsymbol{F'^{\circ}} = (0,-E_1,-\boldsymbol{E_2},-E_3)$ ($\boldsymbol{E_i}$: component of the electric field), q is charge of the particle , m is its mass and g^{ij} is a metric tensor of space. Then the new gravitational field gener-ated at the center of the charged particle becomes

$$\frac{\partial}{\partial x^j}\Phi_A = -\frac{q}{m}E\,, \qquad \text{(B2)}$$

where E is the electric field. Comparing q/m values of an electron, Φ_A is generated by an electron. Let δ be a length of the domain where the new gravitational field is

$$\alpha = -\delta^2\frac{e}{m_e}\left[\frac{1}{(a_0+\lambda)^2}+\frac{1}{(a_0-\lambda)^2}\right]E\,, \qquad \text{(B3)}$$

where λ is a displacement of charge with the field E and a_0 is an orbital radius of the electron around the nucleus.

Based on eq. (B3), he obtained, as seen in figure 1 (where m is that mass of the capacitor, κ is specific inductive capacity of the dielectric material) that induced acceleration by a high potential electric field exhibits a non-linear characteristic when the electric field exceeds 10^{11} v/m. For an electric field considerably smaller, the acceleration can be approximated as

$$\alpha \approx -\frac{\delta^2 e}{m_e a_0^2}E = -0.42\times10^{-8}\,\mathrm{E\ (m/s^2)}\,, \qquad \text{(B4)}$$

which shows the weight reduction of a capacitor is proportional to the impressed electric field.

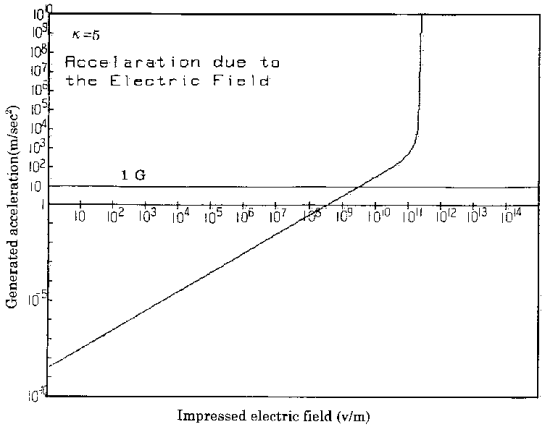

Fig.1 : Acceleration generated by high potential electric field

B 2. Experimental Results Of Musha

Experiment 1.

The capacitor for the experiment shown in Fig.2 was a plastic disk with thin copper films on both sides, the size of which was t=0.2mm, d=65mm, weight=4.2kg and K = 2.3. The experiment was conducted by applying high voltage 0 ~1200 volt to the capacitor placed inside the plastic casing to reduce the influence of electric wind as shown in Fig.3. Weight reduction of the capacitor measured by the electric balance with the precision of 0.1mg is shown in Table. 1.

Voltage	300V	600V	900V	1200V
Weight reduction of the capacitor (mg)	-1.0 -0.9 -0.6 -0.8	-3.7 -3.2 -4.0 -3.1 -3.5	-7.8 -7.4 -8.3 -7.7 -8.8 -8.2 -7.9	-10.3 -10.0 -11.1 -12.0 -11.1

Fig.4 shows the compared result between the experimental result and the theoretical value calculated by Eq.(5). From which, Musha [61] claimed that it is seen that the experiment coincides well with the theoretical calculation.

Experiment 2.

The successive experiment was conducted for a large size capacitor with thickness=2mm, diameter=10cm and weight=26g. Impressed voltage to the capacitor ranged 0 ~ 12000v. To estimate the influence of high voltage applied to the electric balance, the shift of the scale was measured in advance by suspending the capacitor not to contact the electric scale with supports as shown in Fig.5(A). We compared the shift of the scale with the successive measurement results as shown in Fig.5(B), it was seen that the influence of the high voltage electric field of the capacitor to the electric scale was negligibly small. Weight reduction of the measurement results is plotted in the figure below. At the experiment, maximum weight reduction observed was about 200mg, which is 0.8% of its own weight of the capacitor.

B 3. Comments

However, Musha [61] over looked the need to check the case when the potential is revised.

1) The weight reduction is not related to the direction of the E field. This has been clearly demonstrated by weighing the rolling-up capacitors [30]. In other words, both Hypothesis (I) and eq. (B1) are proven invalid for the static case.
2) From the data in figures 4 and 5, it is clear that they fit better to the parabola curves. Thus, the data actually support the charge-mass interaction as remarked earlier. In the experiments of Liu [30], the curves being parabola are not clear.

Thus, it is concluded that the experiments of Musha [61] further confirm the conjecture that the weight reduction of a charged capacitor is due to the charge-mass interaction acting on a charged capacitor. One can see this easily since the charge Q of a capacitor with a capacity C being charged with electric potential V has the relation Q = CV.

Since the B-B effect is often pretty dominating [60], understandably such a cautious step was overlooked. On the other hand, for a rolled-up capacitor, the thrust of a B-B effect is usually not observable.

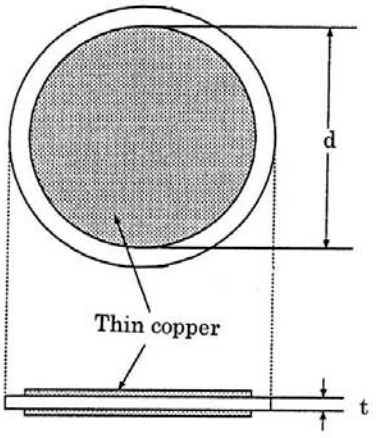

Fig.2 Capacitor used for the experiment

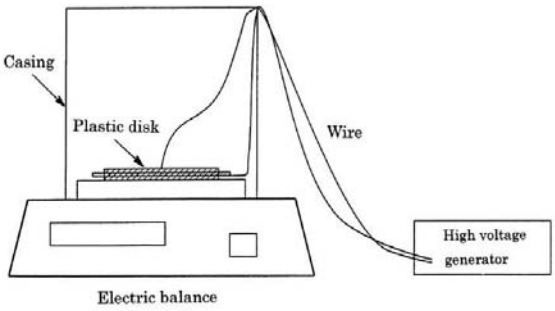

Fig.3 Experimental setup at the Experiment(1)

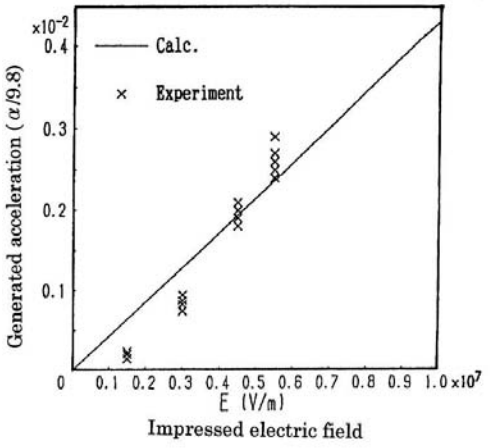

Fig.4 Experimental Result and the theoretical calculation

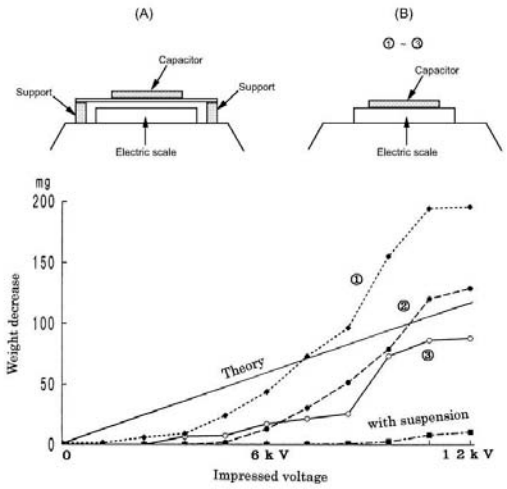

Fig.5 Measured result and theoretical calculation

Appendix C: Einstein's Principle of Equivalence, the Einstein-Minkowski Condition

It is commonly agreed that Einstein's equivalence principle is crucial [13, 14, 62]. However, many have mistaken that the 1916 Einstein's equivalence principle was the same as the 1911 assumption of equivalence that has been proven invalid by the light bending experiments in 1919 and/or as Pauli's version that Einstein explicitly pointed out to be a misinterpretation.

For instance, in "Gravitation" [37], there is no reference to Einstein's equivalence principle (i. e. [13] & [14]). Instead, they refer to Einstein's invalid 1911 assumption [63] and Pauli's invalid version [64]. Like Pauli, they also did not refer to the related mathematical theorems [65]. Thus, it would be necessary to tell the difference between them.

In 1911 Einstein [63] assumed the equivalence of a uniformly accelerated system K' and a stationary system of coordinate K with a uniform Newtonian gravitational potential ϕ. Many assume the related Newtonian metric is of the form,

$$d\tau^2 = (1 + 2\phi)\, dt^2 - dx^2 - dy^2 - dz^2. \qquad (C1)$$

From metric (C1), Einstein derived the gravitational redshifts, but an incorrect light velocity [63]. In the 1916 principle, Einstein [13, 14] also assumed the equivalence of a uniformly accelerated system K' and a stationary system of coordinate K but with a space-time metric form to be determined for the uniform gravity. The Einstein-Minkowski condition is a consequence [13, 14]; but there is no statement on the existence of a small neighborhood of Minkowski space.

Later in 1955, Fock [49] has proved that it is impossible to have a metric for uniform gravity related to Newtonian gravity ϕ; and thus he claimed Einstein's equivalence principle invalid. In 2007, a metric for uniform gravity [66] was obtained as follows:

$$ds^2 = (c^2 - 2U)dt'^2 - (1 - 2U/c^2)^{-1}dx'^2 - (dy'^2 + dz'^2), \qquad (C2)$$

where $c^2/2 > U(x', t') = (at)^2/2$, "$a$" is the acceleration of system K'(x' y' z') with respect to K(x, y, z, t) in the x-direction. Here, dt' is defined locally by $cdt' = cdt - (at/c)dx'[1 - (at/c)^2]^{-1}$. Also (C2) is equivalent to the metric that Tolman [67] derived. It was surprising that U is time dependent, and this explains the earlier failed derivation [68]. *Then, it is recognized also that the equivalence principle can be used to derive a field equation with the Maxwell-Newton Approximation* [67, 69]. Thus, Fock and the Wheeler School [70] are proven wrong.

Based on Einstein's equivalence principle, it is proven that a physical space must have a frame of reference with a Euclidean-like structure [56]. However, Einstein's equivalence principle was still not understood until the space contractions and the time dilation for the case of a rotating disk were explicitly derived [66]. In fact, in the 1993 press release on the Nobel Prize in Physics, Einstein's equivalence principle is implicitly rejected [36], in addition to other theoretical errors. Nevertheless, Zhou Pei-Yuan recognized the importance of Einstein's equivalence principle, but rejects his covariance principle [41, 42].

The Einstein-Minkowski condition [13, p. 161] has its foundation from mathematical theorems [65] as follows:

Theorem 1. Given any point P in any Lorentz manifold (whose metric signature is the same as a Minkowski space) there always exist coordinate systems (x^μ) in which $\partial g_{\mu\nu}/\partial x^\lambda = 0$ at P.

Theorem 2. Given any time-like geodesic curve Γ there always exists a coordinate system (so-called Fermi coordinates) (x^μ) in which $\partial g_{\mu\nu}/\partial x^\lambda = 0$ along Γ.

In these theorems, the local space of a particle is locally constant, but not necessarily Minkowski. What Einstein added to the theorems is that in physics such a locally constant metric must be Minkowski.

Pauli's version [64], which is a corrupted version of these theorems, is as follows:

"For every infinitely small world region (i.e. a world region which is so small that the space- and time-variation of gravity can be neglected in it) there always exists a coordinate system K_0 (X_1, X_2, X_3, X_4) in which gravitation has no influence either in the motion of particles or any physical process."

Thus, Pauli initiated that, for any given point P, there is a small neighborhood of local Minkowski space. He did not see that the removal of gravity in a small region is different from a removal of gravity at one point, but Einstein does.[16] Einstein [13; p.144] remarked, "For it is clear that, e.g., the gravitational field generated by a material point in its environment certainly cannot be 'transformed away' by any choice of the system of coordinates…"

Nevertheless, Misner et al. [37] claimed his equivalence principle as follows: -

"In any and every local Lorentz frame, anywhere and anytime in the universe, all the (nongravitational) laws of physics must take on their familiar special-relativistic form. Equivalently, there is no way, by experiments confined to infinitesimally small regions of spacetime, to distinguish one local Lorentz frame in one region of spacetime frame from any other local Lorentz frame in the same or any other region."

This is claimed as Einstein's Equivalence principle in its strongest form.[17] The Wheeler School combines errors of Pauli and the 1911 assumption, but ignores the Einstein-Minkowski condition, i.e. the physical essence of Einstein's equivalence principle.

The Wheeler School and their followers also do not seem to be aware of the related mathematical restrictions [2, 63]. As shown by their eq. (40.14), they [37] obtained an incorrect local time of the earth, in disagreement with Einstein and others.[18] Moreover, they can be factually incorrect. Thorne [22] criticized Einstein as *ignoring tidal forces, but* Einstein had explained to Rehtz [62] that not every gravitational field can be produced by acceleration of the coordinate system.

Although Einstein's equivalence principle was clearly illustrated only recently [66], the Wheeler School should bear the responsibility of their misinformation [37] by ignoring both crucial work of Einstein [13, 14], and related theorems [65], and giving a misleading version of such a principle. Consequently, invalid notion such as the local Lorentz symmetry was created; [19] and many mistakenly regarded a violation of the local Lorentz symmetry also as a violation of general relativity [71]. *Another main problem is that the Einstein-Minkowski condition [13, 14], which plays a crucial role in measurement, is eliminated.* The root of this problem is, however, that they tried to make things compatible with Einstein's invalid covariance principle [48].

Endnotes:

1) By combining the electromagnetic energy with other energy such as in the case of photons [16], the combined energy can be equivalent to mass. Einstein's error started from his inadequate assumption of photons having only electromagnetic energy. This is understandable since general relativity had not been conceived at the time of his proposal. Currently, popular, but misleading incorrect views on the formula $E = mc^2$ are given in Wikipedia and also British Encyclopedia.
2) As Gullstrand [4] suspected, the Einstein equation does not have dynamic solutions [17, 18]. The 1993 press release of the Nobel Committee [36] has errors in both mathematics and physics [17, 55]. There are at least a dozen of Nobel Laureates and two Fields Medalists who have made mistakes in general relativity [2].
3) Wong and I [20] had proposed such an experiment to a laboratory of gravitation in China, but the proposal was ignored because of their extremely conservative attitude toward science.
4) Experimentalist W. Q. Liu (http://www.cqfyl.com) performed the weighing of rolled-up capacitors in a Chinese Laboratory of the Academy of Science, and got certified results of lighter capacitors after charged [30]. He also observed the delay of weight recovery of a discharged capacitor, as the theory predicted [7, 11].
5) According to $m = E/c^2$, the mass increment of a charged capacitor is negligible. For a capacitor of 200μF charged to 1000 volt, the related mass increment would be about 10^{-12} gram.
6) Such errors are achieved by the collective efforts in the field of gravitation by practicing authority worship of the 16 century, instead of making judgments with evidence. Consequently, even the principle of causality, which is the basis of relevance for all sciences, is inadequately understood. Moreover, it is also discovered that many of the "experts" in general relativity actually also do not understand Einstein's equivalence principle and special relativity adequately; and even failed in crucial mathematical calculations, at the undergraduate level, for a wave solution of the Einstein equation [2].
7) Christodoulou & Klainerman claimed [17, 56] that dynamic solutions of the Einstein equation have been constructed [72]. Their error is simply that the need to show their dynamic initial data sets being non-empty was incomplete. The 2011 Selection Committee for the Shaw Prize in Mathematical Sciences seems to be without the necessary careful deliberations. A main problem is that both *Peter C. Sarnak,* Chairman of this selection committee and C. N. Yang, Chairman of Board of Adjudicators of the Shaw Prize do not know enough mathematics and physics in general relativity [56].
8) A problem is that many theorists and journals practice authority worship. Dr. Daniel Kulp [73], however, is an exception and has recently discontinued such practice. Thus, the current position of the Physical Review is that they are not yet convinced of the recent theoretical developments, but no longer object to the criticisms toward the Physical Review D.
9) Fan et al. [12] did not explain for their results of weight reduction as the temperature increases. Tolga's theory would be close to their line of thinking. However, he seems unable to explain the weight reduction of charged capacitors.
10) Note that, in the claims of Zhou [41], "coordinates do matter" actually means "a gauge does matter" because he still uses the terminology of Einstein [13, 14]. Zhou's proposal of the harmonic gauge for an asymptotically flat metric [74] was misrepresented as unconditional by L. Z. Fang, who also misinterpreted Einstein's equivalence principle [75]. These explain, in part, why Zhou's [41, 42] theory was not understood in China and there was little progress in the field of gravitation.
11) Many believed in Einstein's "covariance principle" because it can be related to the notion of gauge invariance. Starting from electrodynamics, the notion of gauge invariance has been developed to

non-Abelian gauge theories such as the Yang-Mills-Shaw theory [52] in 1954. However, as shown by Aharonov & Bohm [54] in 1959, the electromagnetic potentials are physically effective; and all the physical non-Abelian gauge theories, as shown by Weinberg [53], are not gauge invariant.

12) In his 1999 Nobel Speech [76], 't Hooft considered the inertial mass of an electron should include the external electric energy. This exposes that he actually does not understand special relativity as well as Newtonian mechanics adequately.

13) Based on theories of the four-dimensional space, the fifth force does not act on a charged capacitor. However, such an objection is irrelevant since the repulsive force has been confirmed by measuring the weight of a charged capacitor.

14) For a metal ball with charge Q and a point mass m, the r is replaced with R, the distance from the center of the ball.

15) The formula (A7) is based on the assumption that the total force is the sum of each individual force calculated separately. Of course, one cannot consider such an approach as completely accurate. However, we believe that this is a valid approximation since similar approach to the Newtonian gravity has been successful.

16) Einstein [13] has already given an example to illustrate that Pauli's version is a misinterpretation. However, the journals specialized in gravitation and mathematics such as General Relativity & Gravitation, Classical and Quantum Gravity, J. of Math. Phys. etc. failed to distinguish the difference between Einstein's equivalence principle and Pauli's version. This reflects that most physicists do not generally have adequate background in pure mathematics. Some theorists such as C. N. Yang & G. 't Hooft are well known for their ability in mathematics, but their expertise is usually not in the area of functional analysis. *Yang's expertise seems to be in the area of algebra as shown in his derivation of the Yang-Baxter equation.*

17) As pointed out by Einstein [13, 52], Einstein's equivalence principle is misinterpreted by Pauli's version [64]. The Wheeler School [37] follows Pauli, but claimed as Einstein's version. Nevertheless, due to the practice of authority worship, Liu Liao [45] gives both conflicting views as references [13, 37] to Einstein's equivalence principle. Yu [46] and Leung [47] make essentially the same mistakes. Many are just uninterested in examining the claims of the past. Thus, *due to the errors of Fang and Yang, the development of general relativity has been delayed about 15-30 years and could be even longer.*

18) Straumann [77], Wald [23], and Weinberg [78] did not make the same mistake, but Ohanian & Ruffini [70] do.

19) The local Lorentz symmetry is generally valid only for the case of special relativity. To show this, it is necessary to understand related theorems in topology. However, a journal of mathematical physics failed to see that topology is mathematics also for physics. This illustrates the underlying reason that errors of the Wheeler School were popularly accepted.

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