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Physics and Space Science

DISCOVERING THOUGHTS AND INVENTING FUTURE

Highlights

Temperature Increments

Elastic Scattering

The Effect of Co-Digestion

Dung on Biogas Generation

Aurora
above Bear Lake, Alaska

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Physics & Space Science

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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.

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

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Strictly as per the compliance and regulations of :

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C. Y. Lo

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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].

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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

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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].

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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:

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

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,

$$F = \frac{q^2 m}{r^3} \tag{A6}$$

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

$$F_p = \frac{P_s m_p}{R^3}. \tag{A7}$$

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.

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

Then, we have

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

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 F'^{o} = (0,-E_1,-E_2,-E_3) (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

$$\alpha \approx -\frac{\delta^2 e}{m_e a_0^2}E = -\,0.42\times 10^{-8}\,\mathrm{E}\ (\mathrm{m/s^2})\,, \qquad \text{(B4)}$$

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

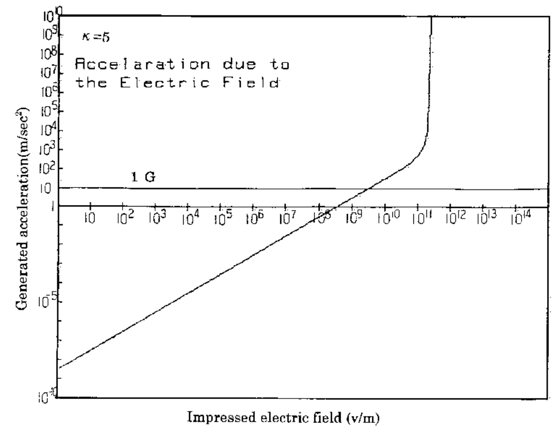

Fig.1 : Acceleration generated by high potential electric field

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	-3.7	-7.8	-10.3
	-0.9	-3.2	-7.4	-10.0
	-0.6	-4.0	-8.3	-11.1
	-0.8	-3.1	-7.7	-12.0
		-3.5	-8.8	-11.1
			-8.2	
			-7.9	

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.

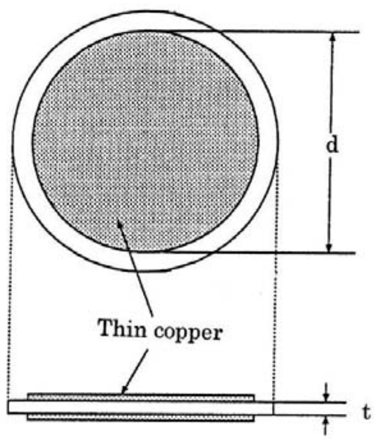

Fig.2 Capacitor used for the experiment

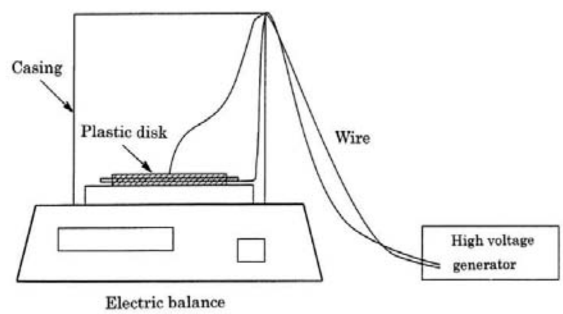

Fig.3 Experimental setup at the Experiment(1)

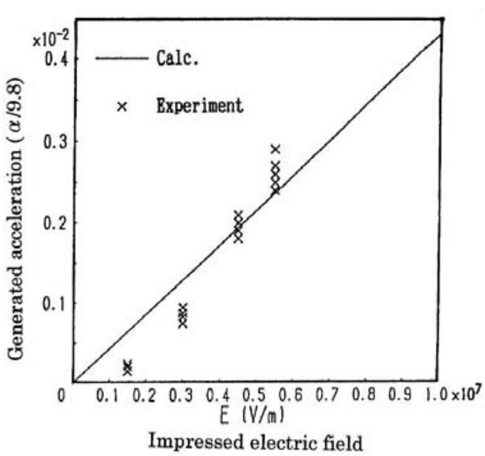

Fig.4 Experimental Result and the theoretical calculation

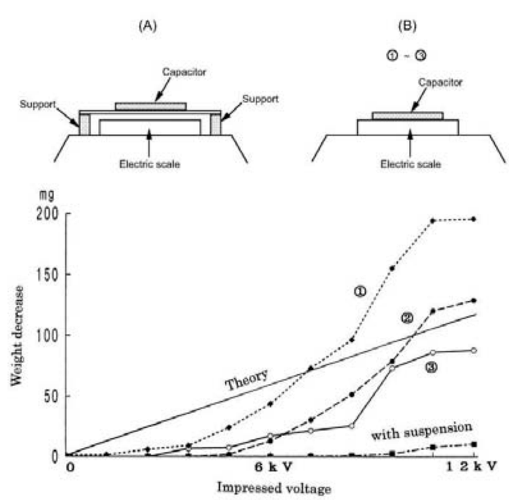

Fig.5 Measured result and theoretical calculation

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,

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

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:

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

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.

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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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Elastic Scattering of ^{28}Si from Target Nuclei ^{27}Al at Energies 70, 80, 90 and 100 MeV by Strong Absorption Model (SAM)

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Abstract - The differential cross-section for the elastic scattering of heavy ion 28Si from target nuclei 27Al at different projectile energies has been studied in terms of the Strong Absorption Model of Frahn and Venter[1] using the three parameters version of this model. In this paper we find that a reasonably good description to the angular distribution of the experimental elastic scattering data is possible.

Keywords : Elastic scattering, SAM, strong absorption model.

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I. Introduction

The scattering of p, n, d, τ, ^{3}He and alpha particles in particular, has been playing a very important and vital role in nuclear physics since the very beginning of the subject. The nuclear scattering experiment ascertains many properties of nuclei such as angular momentum, parity, nuclear size, nuclear density etc. Experimental techniques, so far have achieved greater perfection and theoretical interpretation of data has become correspondingly more accurate and detailed.

Nucleus is a complicated, many body problems and a bound system of nucleons, with very short range interaction. Nucleons or other strongly interacting particles can induce a variety of nuclear reactions, whose diversity is due to the individual properties, relative motions, energies of the colliding particles and the target nuclei. Simple and fundamental laws are required in interpreting data to unravel the known properties of the nuclei and this enables us to predict the unknown properties also.

The scattering involving complex nuclei represents a complicated quantum mechanical many-body problem and it is difficult to correlate the experimental data directly with the properties of fundamental nuclear interactions. It is necessary to devise simpler methods (models) which serve as an intermediary between the data and basic nuclear theory. These methods make use of simplifying assumptions by which certain average features of the many-body problem are connected directly with measurable quantities.

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Numerous analysis of the elastic and scattering data of different projectiles, carried out using the SAM formalism by Frahn and Venter [1] during the past several years as available in refs.[2-6] is quite successful in analyzing the scattering data. This model does not suffer from any ambiguities and the model yields a unique set of parameters to describe the experimental data.

In this present work elastic scattering have been analyzed by means of Strong Absorption Model (SAM). All the elastic scattering data are digitized at near barrier energies close to the Coulomb barrier. The analysis of elastic scattering data will help us to determine the parameters like the cut-off or critical angular momentum T, rounding parameter Δ, and the real nuclear phase shift μ. The elastic scattering data have been digitized from different references [7-11]

II. Strong Absorption Model Formalism

a) Strong Absorption Model

Here we introduce the strong absorption model formalism, which is frequently used. The strong absorption generally takes place at medium and high energy projectiles in nuclear reactions for the cases below:

1. Nucleons, mesons and hyperons of E $\geq$ 100 MeV.
2. Composite particles (deuterons, tritons, helium-3, alpha particles and heavy ions) above the Coulomb barrier.

The depletion of the elastic channels due to the presence of open reaction channels is termed as strong absorption. It is measured by the deviation from the unitarity of the elastic η_l sub-matrix. The condition of the effectiveness for the strong absorption of these partial waves is

$$\eta_l^j \ll 1 \qquad (1.1)$$

This condition holds well for some situations in a certain range of orbital angular momentum below a critical value l_0. From this point of view, the scattering is closely identical to diffraction by an opaque obstacle. The relevant approximations concerning such situations are called diffraction models. The description of the diffraction in nuclear processes is more accurate in momentum space than in configuration space as the relation $\Delta L.\Delta\theta \geq \hbar$ is valid in the former. We shall therefore express SAM formalisms in momentum space.

The transition of η_l from zero to unity is a gradual one, extending over a range of *l* values of width Δ in the vicinity of T, this follows semi-classically from the diffuseness of the nuclear interaction region. Particles, which are moving along classical orbits penetrating the diffuse region, will be only partially absorbed. If Δ is the range of orbital angular momentum that corresponds to the diffuseness d, we obtain Δ for nuclear particles.

$$\Delta = kd \qquad (1.2)$$

and for charged particles

$$\Delta = kd\frac{1-\left(\frac{n}{2kR}\right)}{\left[1-\frac{2n}{kR}\right]^{\frac{1}{2}}} \qquad (1.3)$$

It is possible to give a completely analytical formulation of the parameterized S-matrix model of η_l in *l* space with or without Coulomb interaction. This can be done by splitting η_l into real and imaginary parts;

$$Re[\eta_l exp(-2i\sigma_l)] = g(t) + \rho\frac{dg}{dt} + \varepsilon[1-g(t)] \qquad (1.4)$$

$$Im[\eta_l exp(-2i\sigma_l)] = \mu_1\frac{dg(t)}{dt} + \mu_2\frac{d^2g(t)}{dt^2} \qquad (1.5)$$

Here, g's are continuously differentiable function of ${}^{(T-t)}/_{\Delta}$, whose first derivatives are symmetric and peaked at around T but otherwise arbitrary. Furthermore the function g's are characterized by the cut-off angular momentum $T^{\pm} = \left(L \pm \frac{1}{2}\right)$ and rounding parameter $\Delta^{\pm}$ around $T^{\pm}$ in the *l* space and possessing the property that their derivatives should have simple Fourier transform; the parameter $\mu^{\pm}$ is associated with the real nuclear phase shift and $\varepsilon^{\pm}$ accounts for any possible transparency of partial waves less than $T^{\pm}$.

Equations (1.4) and (1.5) cover a large variety of structures of η_l in strong absorption situations; the real part changes from finite value at small *l* value to unity at high *l* value through some rapid transition in the vicinity of T; the form of the imaginary part is such that the real nuclear phase shifts are relevant only for partial waves in some vicinity of T, except for transparency contribution at lower l values. The first derivative of g(t) is the main term in Im η_l. The higher derivatives in the real and imaginary parts of η_l describe possible asymmetries and other complicated variations in the transition region. For charge particles, η_l is replaced by,

$$\eta_l \exp(-2i\sigma_l)$$

where, σ_l are Coulomb phase-shifts.

b) Coulomb Scattering Angle

The Coulomb scattering angle θ_C is related to cut-off parameter T through the relation

$$\theta_C = 2arctg\left(\frac{n}{T}\right) \qquad (1.6)$$

The angular distribution is divided into two regions:

a) Coulomb region for $\theta \leq \theta_C$
and

b) Diffraction region for $\theta > \theta_C$

c) Total Reaction Cross section

The total reaction cross section can be calculated using the following formulation

$$\sigma_r = \frac{\pi}{k^2}\sum_{l=0}^{\infty}(2l+1)\left(1-|\eta_l|^2\right) \qquad (1.7)$$

which, for spin zero charged particles becomes,

$$\sigma_r = \frac{\pi T^2}{k^2}\left[1 + 2\frac{\Delta}{T} + \frac{1}{3}\pi^2\left(\frac{\Delta}{T}\right)^2 - \frac{1}{3}\left(\frac{\mu}{\Delta}\right)^2\left(\frac{\Delta}{T}\right)\right] \qquad (1.8)$$

This formula has been used by Frahn and Venter[1] for calculating the value of total reaction cross-section.

III. Method of Analysis

Here, we discuss the method of theoretical analysis of the experimental elastic scattering cross-sections of heavy ions at various projectile energies. The elastic scattering analysis yields unambiguous elastic scattering parameter values.

The method of analysis and the effects of parameter variations on the angular distribution have been given by Rahman et al. [12]. The angular distribution of the elastically scattered particles from a target nucleus is obtained from the relation

$$\sigma(\theta) = |f(\theta)|^2 \qquad (1.9)$$

where $f(\theta)$ is the scattering amplitude. The amplitude can be calculated using the following parameters:

a. The cut-off angular momentum parameter, T

b. The rounding parameter , Δ

c. The real nuclear phase-shift parameters, μ_1 and μ_2

d. The symmetry parameter, ρ and

e. The transparency parameter, ε.

The cut-off angular momentum T is related to the interaction radius R through the semi-classical relation:

$$T = kR\left[1-\left(\frac{2n}{kR}\right)\right]^{1/2} \tag{1.10}$$

The rounding parameter is related to the diffuseness of the nuclear surface through the relation

$$\Delta = kd\left[\left(1-\frac{n}{kR}\right)\left(1-\frac{2n}{kR}\right)^{-1/2}\right] \tag{1.11}$$

where k is the wave number and n is the coulomb parameter respectively.
The total reaction cross-section is given by,

$$\sigma_r = \frac{\pi T^2}{k^2}\left[1+2\frac{\Delta}{T}+\frac{1}{3}\pi^2\left(\frac{\Delta}{T}\right)^2-\frac{1}{3}\left(\frac{\mu}{\Delta}\right)^2\left(\frac{\Delta}{T}\right)\right] \tag{1.12}$$

The frequency of the oscillation in $\sigma(\theta)$ is determined by the parameter T. By increasing T, the whole oscillation pattern moves towards the smaller angles. The parameter Δ controls the ratio of the backward to forward scattering through which the average slope of the angular distribution is fixed. The higher angle regions are mainly affected by an alteration in Δ value and an increase in Δ mainly lowers the maximum keeping the oscillatory pattern unaltered.

The parameter μ mainly affects the minimum and an increase in μ lowers the minimum keeping the angular position and magnitude of the maxima and the whole angular distribution pattern unaltered.

We use a computer program in analyzing scattering phenomena. The program takes the input from one file and produces output to another file. It is desirable that the output of such a program should be in a graphical presentation. The output file is imported onto a graphical program and then resulting graph is plotted.

First we make the three parameters ρ, ε and μ_2 equal to zero, because these parameters have very insignificant effects on the angular distribution for heavy ion projectiles. To determine the SAM parameters, T should be fixed first. The method followed in determining the parameters are:

1. At first we varied T, say we keep the value of T is 30, keeping Δ and μ fixed to a small value, say 0.5 and 0.1 respectively. (For Δ=0, the program will not run, division by zero error will occur).
2. Graphs are plotted simultaneously for various values of T, finally it is varied again with a smaller step size.
3. Since the minima are sharp in general, it is a helpful endeavor to reproduce the positions of minima while fixing T.
4. After having a good fixation of T, then the value of Δ is adjusted, which determines the slope of the angular distribution and whose effect is prominent in the larger angular region.
5. Once the values of T and Δ have been fixed, we vary μ in order to minimize the mean square difference between the experimental and theoretically computed cross-sections.

The mean square difference between experimental and computed cross-section, χ^2 is a measure of how good the fit is. The χ^2 is given by,

$$\chi^2 = \frac{1}{n}\sum\left|\frac{\sigma_{\exp}(\theta)-\sigma_{theo}(\theta)}{\delta\sigma_{exp}(\theta)}\right|^2 \tag{1.13}$$

Here n is the number of data points and other symbols carry the usual meanings.

Finally, all three parameters T, Δ and μ are varied slightly about the obtained values till the best fit parameters are obtained and hence the minimum value of χ^2.

The charge and mass numbers of the projectile and the target, the beam energy, the scattering angles and the corresponding experimental cross-sections and their errors together with the values of the parameters are given in the input of the program. The output gives $\sigma(\theta)$ corresponding to the scattering angle θ with χ^2 for each set of parameters. The interaction radius R, the diffuseness d, standard nuclear radius r_0 and the total reaction cross-section σ_r are computed from the best fit parameters.

IV. Results and Discussions

The differential cross-section for the elastic scattering of ^{28}Si from target nuclei ^{27}Al has been studied on the basis of the Strong Absorption Model formalism (SAM). Data analysis are carried out by a symmetric variation of SAM parameters using the criterion of minimum root square difference between the experimental and theoretical cross-sections.

The result of the SAM analysis rendering the best fit parameter values are summarized in tables 1 and 2. The experimental data along with the theoretically calculated angular distributions are graphically shown in figs.1-4. The quality of fit to the angular distribution throughout the distribution is satisfactory.

Now for further details of the fit quality, the angular distributions data in most of the nuclei are reasonably well reproduced over the angular range covered in the experiment.

a) The Sam Parameters T, Δ And μ

The cut-off angular momentum T and the rounding parameter Δ are respectively given by the expressions (1.10) and (1.11). Their values are shown in the tables 1 and 2. The cut-off angular momentum T increases smoothly with the increase in the incident energy.

The value of Δ is roughly the same for the same target masses for different energies, as for example, the Δ-value assumes 1.0 for the same target mass ^{27}Al for the projectile ^{28}Si for different projectile energies. The rounding parameter Δ controls the ratio of the backward to the forward scattering angle. An increase in Δ mainly affects the cross-sections in the higher angle regions, while the lower angle regions are not affected so much; an increase in Δ value lowers the whole diffraction pattern keeping the oscillatory structure unaltered. The value of real nuclear phase shift μ lies in the domain $0.5 \leq \mu \leq 0.7$.

b) Interaction Radius R, Surface Diffuseness d and Coulomb Scattering Angle θ_C

The interaction radius R and the surface diffuseness d are respectively given by the semi-classical expressions (1.10) and (1.11). They are presented in tables 1 and 2.

We find from the table 2 that the interaction radius R decreases with increase in beam energy as long as the mass of the projectile and target remain the same. As for example, the interaction radii R for ^{28}Si elastically scattered from ^{27}Al for the projectile energies 70.00 MeV and 80.00 MeV, are 9.97 fm and 9.94 fm respectively.

Our study further yields the fact that the values of surface diffuseness parameter d roughly spreads in the range 0.165-0.326 fm.

The value of θ_C given by the expression (1.6) and the value is presented in table 1. The value of θ_C generally decreases with the increase in the beam energy for the same projectiles and target nuclei i.e. the value of θ_C decreases as the value of T increases and vice versa. As for example the value of θ_C is 76.48° for the projectile energy 70 MeV at T value 23 and the value of θ_C is 60.62° for the projectile energy 80 MeV at T value 29.

c) The Total Reaction Cross-Section

The total reaction cross-section σ_r yielded by SAM formalism is given by the equation (1.8). These are shown in table 2. The value of σ_r, in general, increases for the same projectile and the target masses as the projectile energy increases. This may be due to the opening of many reaction channels as the beam energy is increased.

The parameter ${\sigma_r}/{\pi R^2}$ is more meaningful than σ_r itself. Its value is of the same order of magnitude (0.2-0.4), which is roughly the same as expected.

Our calculated cross section could not be compared for non availability of any other calculations for cross-sections from any other formalism.

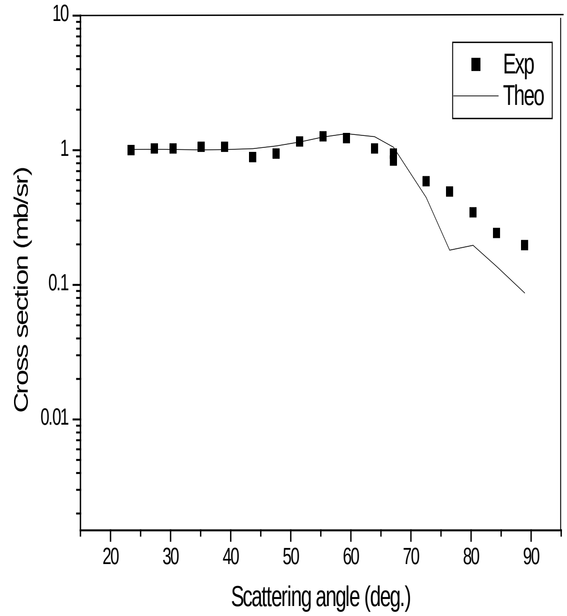

Fig. 1 : SAM analysis for elastic scattering of ^{28}Si from ^{27}Al at energy 70 MeV

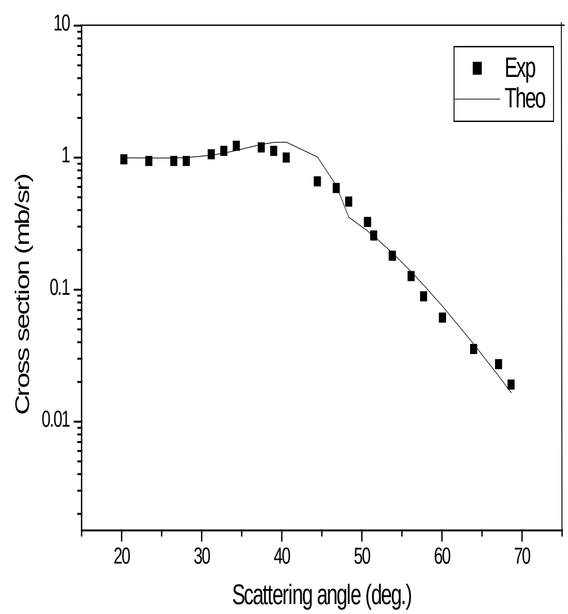

Fig. 2 : SAM analysis for elastic scattering of ^{28}Si from ^{27}Al at energy 90 MeV

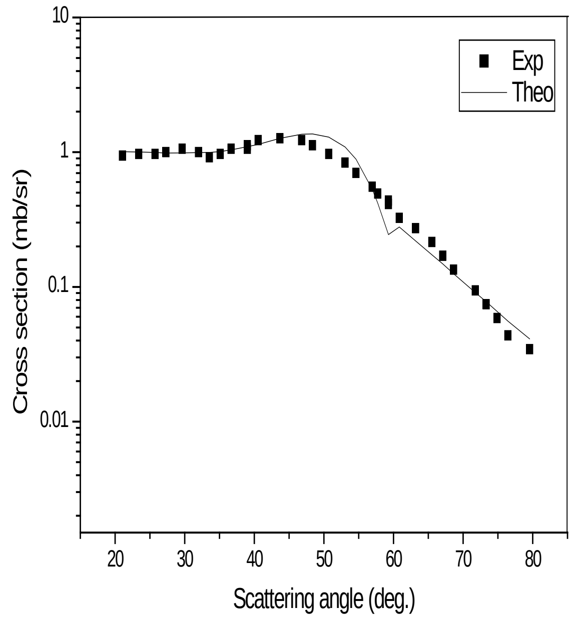

Fig. 3 : SAM analysis for elastic scattering of ^{28}Si from ^{27}Al at energy 80 MeV

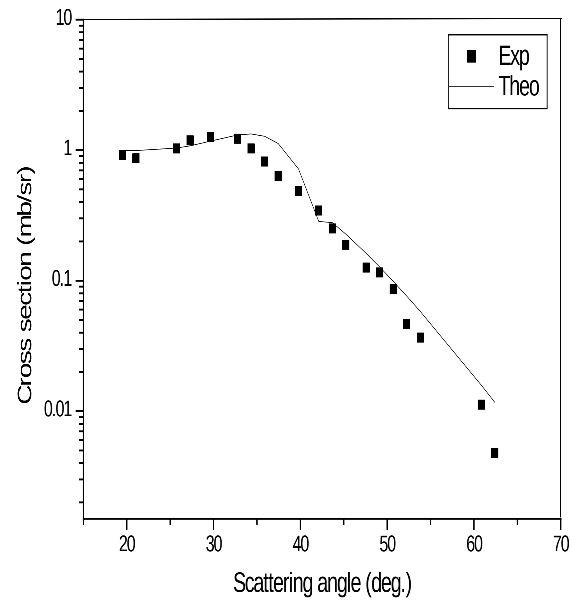

Fig. 4 : SAM analysis for elastic scattering of ^{28}Si from ^{27}Al at energy 100 MeV

Table 1

No	Incident particle + Target nucleus	Beam energy 'E' MeV	T	Δ	μ	$\mu/4\Delta$	θ_C
1	$^{28}Si + {}^{27}Al$	70	23	1	0.5	0.125	76.48
2	$^{28}Si + {}^{27}Al$	80	29	1	0.5	0.125	60.62
3	$^{28}Si + {}^{27}Al$	90	34	2	0.5	0.0625	50.36
4	$^{28}Si + {}^{27}Al$	100	38	2	0.7	0.0875	43.51

Table 2

No	Incident particle + Target nucleus	Beam energy 'E' MeV	r_0	R	d	σ_r	$\sigma_r/\pi R^2$
1	$^{28}Si + {}^{27}Al$	70	1.65	9.97	0.165	2565	0.246
2	$^{28}Si + {}^{27}Al$	80	1.64	9.94	0.169	3522	0.338
3	$^{28}Si + {}^{27}Al$	90	1.64	9.93	0.335	4546	0.438
4	$^{28}Si + {}^{27}Al$	100	1.63	9.87	0.326	5107	0.493

V. Conclusions

The present work was concerned with a study of the elastic scattering of heavy ion ^{28}Si at different energies (70 – 100) MeV from target nuclei ^{27}Al. The motivation was to see to what extent the simple geometrical model can explain the elastic scattering.

The angular distribution have been studied in terms of Strong Absorption Model due to Frahn and Venter[1] and it is evident from these analyses that three parameter SAM formalism provides a reasonable description to elastic scattering of heavy ions. The best fit parameters T, Δ and μ have been obtained. Analysis of the elastic angular distribution have resulted in a consistent set of SAM parameters from which interaction radius R and surface diffuseness d are obtained. The interaction radius increases smoothly as the target mass increases.

It is also observed that R in general decreases with the increases in the beam energy for the same target mass. The surface diffuseness d determined from this work over the incident energy and mass region covered remains roughly the same and agrees with other works [4-6].

The value of the Coulomb scattering angle θ_C generally decreases with the increase in the beam energy for the same projectiles and target nuclei. Coulomb scattering angle θ_C is directly proportional to Coulomb parameter n and related reciprocally with T.

The reaction cross-section σ_r was also calculated from the SAM parameters. The value of σ_r, in general, increases for the same projectile and the target masses as the projectile energy increases.

Finally from this present work we can say that SAM model is a useful, easier, simple method for obtaining various information about nuclear properties. We can also say that an overall good description of the scattering of heavy ions is given by the three parameters of SAM of Frahn and Venter [1].

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Assessment of the Effect of Co-Digestion of Chicken Dropping and Cow Dung on Biogas Generation

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Abstract - Biogas production from 5 batch digesters containing varying ratios of mixture of chicken droppings and cow dung was studied for a period of 30 days at ambient temperature. Results from this study show that co-digestion of chicken droppings and cow dung increased biogas yield as compared to pure samples of either chicken droppings or cow dung. The maximum biogas yield was attained with mixtures in the proportions of 1:4. Several regression models were used to adequately describe the cumulative biogas production from these digesters. The polynomial correlation with R2 = 0.98 seemed to be more reliable in predicting gas production in anaerobic digestion of animal wastes. This tool is useful in optimizing biogas production from energy materials, and requires further validation and refinement. Hopefully, this study advances this increasingly growing area of animal wastes research.

Keywords : cow dung, chicken droppings, anaerobic, regression, biogas.

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I. Introduction

Nigeria is abundantly blessed with different types of energy resources. The climate permits average solar radiation as high as 5.538kwh/m^2/day (World Energy Council, 1993), making the country operate mainly under mesophilic temperature at ambient conditions. This energy needs to be tapped especially as the energy supply of the country is grossly inadequate. Consequently, biogas production via anaerobic digestion can be a good resource channel if properly harnessed as in the case of China and India. Moreover, the effluent of this process is a residue rich in essential inorganic elements like nitrogen and phosphorus needed for healthy plant growth known as biofertilizer which when applied to the soil, enriches it with no detrimental effects on the environment (Bhat et al., 2001). This will further argument the inadequate supply of chemical fertilizers which are very expensive in spite of the fact that the country is a net food importer.

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Anaerobic digestion (AD) is a technology widely used for treatment of organic waste for biogas production. Anaerobic digestion that utilizes manure for biogas production is one of the most promising uses of biomass wastes because it provides a source of energy while simultaneously resolving ecological and agrochemical issues. The anaerobic fermentation of manure for biogas production does not reduce its value as a fertilizer supplement, as available nitrogen and other substances remain in the treated sludge (Alvarez and Lide'n, 2008).

Biogas production is a complex biochemical reaction found to take place under the action of delicately pH sensitive microbes mainly bacteria in the presence of little or no oxygen. Three major groups of bacteria (hydrolytic, acidogens/acetogens and methanogens) are responsible for breaking down the complex polymers in biomass waste to form biogas at anaerobic conditions and animal manure has been established as major sources of this gas (Bori et al., 2007).

Numerous studies had been conducted by several researchers in order to optimize biogas yield in Anaerobic digestion. For example, the anaerobic digestion of solid refuses like municipal solid wastes (Owens and Chynoweth, 1993; Watson et al., 1993; Welland, 1993; Beukering et al., 1999; Rao et al., 2000; Kivaisi and Mukisa, 2000; Lopes et al., 2004; Nordberg and Edstron, 2005;Igoni et al., 2008; Ojolo et al., 2008;), Barcelona's central food market organic wastes (Mata et al., 1992), Canteen wastes (Krishna et al., 1991), Market wastes (Ranade et al., 1987), Water hyacinth (Lucas and Bamgboye, 1998; Katima, 2001; Kivaisi and Mtila, 2001; Patil et al., 2011), Sugar mill press mud waste (Sanchez et al., 1996), fruit and vegetable processing wastes (Knol et al., 1978; Lane, 1984; Sumitradevi and Krishna, 1989; Mata et al., 1993), and animal wastes (Matthew, 1982; Abubakar, 1990; Lawal et al., 1995; Machido et al, 1996; Itodo and Kucha, 1998; Zuru et al.,1998; Sadaka and Engler, 2000; Bujoczek et al., 2000; Castrillon et al., 2002; Kivaisi, 2002;Gelegenis et al., 2007, Ojolo et al., 2007, Li et al., 2009; Budiyono et al., 2010; Ofoefule et al., 2010; Yusuf et al., 2011;) have been reported.

The main objective of this research is to employ anaerobic digestion process as a sustainable technology for digesting the animal wastes (Chicken droppings and Cow dung), produced in large amounts from poultry farms and Abbatoirs respectively, and to provide the renewable source of energy (biogas) that can reduce the potential green house gas emission. The specific objectives are (i) To optimize the biogas evolution from the animal waste. (ii) To analyze the operational parameters, such as pH, total solid, volatile solid, and ash content for the stability of anaerobic digestion system. (iii) To get an understanding of the anaerobic digestion of the animal wastes under ambient temperature conditions by conducting a large scale study and hence to investigate the biogas yield.

II. Materials and Methods

a) Substrate preparation and Characterization

The chicken droppings used for this study was collected from Phinoma poultry farms Nig. Ltd at Enugu Ngwo, Enugu State while cow dung was obtained from Abattoir at Sam Ugwu way, off Ogoja Road, Abakaliki, Ebonyi State. Chemical analyses of these substrates were carried out to determine their total solid, volatile solid, and ash content. The Total solid and volatile solid were determined in accordance with procedure outlined in standard methods (Meynell, 1982). The ash content of the undigested animal wastes were determined using AOAC (1990) method. The pH was measured using digital pH meter.

b) Experimental design

The experimental design for the anaerobic digestion of chicken droppings and cow dung was carried out at ambient temperature that ranged between 22°C to 35°C in a series batch digesters with 4.5 litre capacity each. The compositions of the digesters are presented in table 1.

Table 1 : Digesters composition

Chicken Droppings (g)	Cow Dung (g)	Quantity of water (L)
200.00	0.00	2.80
180.00	20.00	2.80
160.00	40.00	2.80
140.00	60.00	2.80
120.00	80.00	2.80
100.00	100.00	2.80
80.00	120.00	2.80
60.00	140.00	2.80
40.00	160.00	2.80
20.00	180.00	2.80
0.00	200.00	2.80

The main experiment apparatus consists of biodigester and biogas measurement. Biodigester were made from five improved-glass–ware and plastic calibrated prototypes. Biogas formed was measured by 'liquid displacement method'. The digesters were set up as described by (Itodo et al.,1992), (Chellapandi, 2004), and (Momoh and Nwaogazie, 2008).

Data Analysis: The data generated was analyzed by adopting regression models presented in table 2. Where K_T can be represented as total biogas yield, R as retention time for substrate loadings, and a, b, c are regression constants to be determined using SPSS computer software.

Table 2 : Regression models used in this work

Model Type	Regression Equation	Source
Linear	$K_T = a + bR_s$	Angstrom, 1924
Quadratic	$K_T = a + bR_s + cR_s^2$	Akinoglu and Ecevit, 1990
Polynomial	$K_T = a + bR_s + cR_s^2 + dR_s^3$	Samuel, 1991
Logarithmic	$K_T = a + b\log(R_s)$	Ampratwum and Dorvlo, 1999
Linear-Logarithmic	$K_T = a + bR_s + c\log(R_s)$	Newland, 1988
Exponential	$K_T = ae^{(bR_s)}$	Elagib and Monsell, 2000
Power	$K_T = e^a R_s^b$	Coppolino, 1994

III. Results and Discussion

From the experiment performed in the laboratory, a set of results were obtained that contain cumulative biogas yields for different substrate loadings.

Thus, the results of biogas production from chicken droppings and cow dung is documented in Table 3. The cumulative volume of gas was plotted against mixture of chicken dropping and cow dung (Fig. 1).

Table 3 : Volume of gas produced for different substrate loading

S/N	Chicken dropping to cow dung ratios (g)	Cumulative Gas Vol. (L)
1	200:00	1.8600
2	180:20	1.8600
3	160:40	2.0150
4	140:60	2.0630
5	120:80	1.8500
6	100:10	0.3050
7	80:120	2.1850
8	60:140	2.4100
9	40:160	2.7050
10	20:180	2.0670
11	00:200	0.8300

It was observed that Biogas production was slightly slow at the beginning and the end period of observation. This is predicted because biogas production rate in batch condition is directly proportional to specific growth rate of methanogenic bacteria in the biodigester (Nordberg and Edstrom, 2005). Comparing with the pure samples, mixing pig and cow dung generally increased biogas yield. The maximum biogas yield was attained with mixtures in the proportions of 1:4. From Table 3, the 100% chicken manure produced more gas per unit weight as compared to the 100% cow dung. This concurs with Hobson's (1981) findings that attributed the lower production to low biodegradable material in the cow dung. However, Yeole and Ranande (1992) attributed the higher biogas yield from the chicken dropping to the presence of native micro flora in the chicken dropping while Fulford (1988) attributed it to the low carbon-nitrogen ratio.

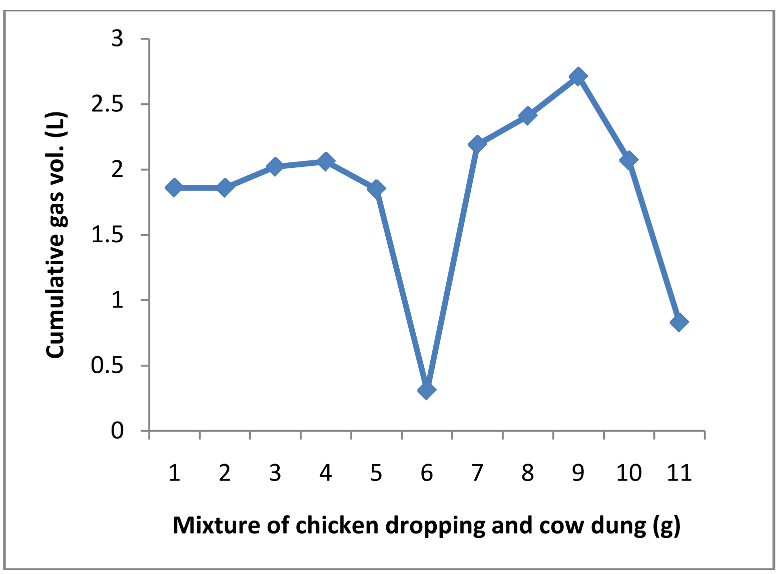

Fig. 1 : Cumulative gas volume against mixture of chicken dropping and cow dung

Effect of pH, TS, VS, ash content, on gas production: pH (%), TS (%),VS (%), and ash content (%), for chicken dropping and cow dung are presented in table 4. Optimum biogas production is achieved when the pH value in the digester is between 6 and 7 (Garba, 1996). Low pH value inhibits methanogenic bacteria and methanogenesis (Vicenta, 1984). The high pH value recorded in this study could be attributed to large

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ammonia losses resulting from C/N ratio of poultry waste (Gray et al, 1971). Determination for total solids of waste is an effective way of finding out the amount of nutrient that will be available for bacterial action during digestion. The total solids in this study are within the range for biogas production when compared with (Ofoefule et al., 2010). The amount of methane to be produced depends on the quantity of volatile solid that is the amounts of solids present in the waste and their digestibility or degradability (Sarba, 1999). Again, the volatile solids are within the range for biogas production (Ofoefule et al., 2010). Higher ash content also corresponded with higher volatile solids content as can be seen from table 4. Cow dung has higher potential for organic manure compared with chicken dropping because of its higher ash content.

Table 4 : Physiochemical properties of the undigested wastes

Waste Sample	pH	TS (%)	VS (%)	ASH (%)
Chicken dropping	9.39	83.80	17.20	37.50
Cow dung	9.53	77.38	36.38	41.00

Analysis of the predictive model: The daily and cumulative biogas generation monitored for different substrate loadings were used for developing predictive models for the generation of biogas for different substrate loading for various retention time. The various functions, which include linear, quadratic, polynomial, logarithmic, linear-logarithmic, and exponential were determined statistically using SPSS software. The regression models that give the highest level of coefficient of determination between the type of regression model and the data generated from the experiments were determined. After carrying out this analysis, a comparative study of R^2 values was observed. The highest values of R^2 were chosen as the best fit to the experimental data. The equations derived from the application of table 2 for biogas production are presented in table 6.

The best fit was observed only in the case of polynomial correlation with $R^2 = 0.78$ compared to quadratic one with $R^2 = 0.59$. So, polynomial function seemed to be more reliable in predicting gas production in anaerobic digestion of animal wastes.

Table 6 : Results of model analysis

Regression equations	R^2
$K_T = 0.0461 + 0.7494R_s$	0.53
$K_T = 0.0631 + 0.3549R_s + 0.2341R_s^2$	0.59
$K_T = 0.0558 + 0.7489R_s + 0.3234R_s^2 + 0.1231R_s^3$	0.78
$K_T = 0.1232 + 0.0748\log(R_s^2)$	0.43
$K_T = 0.1232 + 0.0431R_s + 0.2342\log R_s$	0.47
$K_T = 0.0322e^{0.0212R_s}$	0.34

IV. Conclusion

Biogas production from co-digestion of chicken dropping and cow dung was established here to be feasible at ambient temperature. Comparing with the pure samples, mixing pig and cow dung generally increased biogas yield. The maximum biogas yield was attained with mixtures in the proportions of 1:4. Co-digestion of chicken dropping and cow dung is therefore, one way of addressing the problem of lack of enough feedstock for biogas production in Nigeria. Mathematical models derived using regression analysis indicated that biogas production of animal wastes can be predicted based on digestion time. The polynomial function seemed to be more reliable in predicting gas production in anaerobic digestion of animal wastes. This tool is useful in optimizing biogas production from energy materials, and requires further validation and refinement. Hopefully, this study advances this increasingly growing area of animal wastes research.

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Past, Present and Future of the Avogadro Number

By U. V. S. Seshavatharam & Prof. S. Lakshminarayana
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Abstract - The definition of Avogadro number (N) and the current experiments to estimate it, however, both rely on the precise definition of "one gram". Hence most of the scientists consider it as an ad-hoc number. But in reality it is not the case. In atomic and nuclear physics, atomic gravitational constant is Avogadro number times the Newton's gravitational constant. Key conceptual link that connects the gravitational force and non-gravitational forces is - the classical force limit, $F_C \cong \left(c^4/G\right)$. Ratio of classical force limit and weak force magnitude is $\left(F_C/F_W\right) \cong N^2$. Thus in this paper authors proposed many unified methods for estimating the Avogadro number.

Keywords : Avogadro number, Gravitational constant, classical force limit, weak force magnitude, weak coupling angle, Planck mass, electron, proton & neutron rest masses, nuclear binding energy constants, Proton radius and nuclear magnetic moments.

GJSFR-A Classification: FOR Code: 020202, 020201

PAST, PRESENT AND FUTURE OF THE AVOGADRO NUMBER

Strictly as per the compliance and regulations of :

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U. V. S. Seshavatharam [α] & Prof. S. Lakshminarayana [σ]

Abstract - The definition of Avogadro number (N) and the current experiments to estimate it, however, both rely on the precise definition of "one gram". Hence most of the scientists consider it as an ad-hoc number. But in reality it is not the case. In atomic and nuclear physics, atomic gravitational constant is Avogadro number times the Newton's gravitational constant. Key conceptual link that connects the gravitational force and non-gravitational forces is - the classical force limit, $F_C \cong \left(c^4/G\right)$. Ratio of classical force limit and weak force magnitude is $\left(F_C/F_W\right) \cong N^2$. Thus in this paper authors proposed many unified methods for estimating the Avogadro number.

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I. Introduction

Considering strong gravity, Erasmo Recami says [1]: *A consequence of what stated above is that inside a hadron (i.e., when we want to describe strong interactions among hadron constituents) it must be possible to adopt the same Einstein equations which are used for the description of gravitational interactions inside our cosmos; with the only warning of scaling them down, that is, of suitably scaling, together with space distances and time durations, also the gravitational constant G (or the masses) and the cosmological constant* Λ.

In 3+1 dimensions, experiments and observations reveals that, if strength of strong interaction is unity, with reference to the strong interaction, strength of gravitation is 10^{-39}. If this is true, any model or theory must explain this astounding fact. At least in 10 dimensions also, till today no model including String theory [2-4] or Super gravity [5,6] has succeeded in explaining this fact. Note that in the atomic or nuclear physics, till today no experiment reported or estimated the value of the gravitational constant. Note that G is quite difficult to measure, as gravity is much weaker than the other fundamental forces, and an experimental apparatus cannot be separated from the gravitational influence of other bodies. Furthermore, till today gravity has no established relation to other fundamental forces, so it does not appear possible to calculate it indirectly from other constants that can be measured more accurately, as is done in other areas of physics. It is sure that something is missing in the current understanding of unification. This clearly indicates the need of revision of our existing physics foundations.

So far even in 10 dimensions also, no unified model proposed a methodology for estimating the rest masses of the basic constituents of matter like electron, proton & neutron and the nuclear binding energy. In this sensitive and critical situation, considering Avogadro number as an absolute proportionality ratio in 3+1 dimensions, in this paper an attempt is made to understand the basics of gravitational and non-gravitational interactions in a unified manner. This paper is the simplified form of the authors 15 published papers. Including "low and high energy super symmetry", authors made an attempt to understand the unification with only 4 simple assumptions.

a) Extra dimensions and the strong gravity

In unification, success of any model depends on how the gravitational constant is implemented in atomic, nuclear and particle physics. David Gross [7] says: *But string theory is still in the process of development, and although it has produced many surprises and lessons it still has not broken dramatically with the conceptual framework of relativistic quantum field theory. Many of us believe that ultimately string theory will give rise to a revolution in physics, as important as the two revolutions that took place in the 20th century, relativity and quantum mechanics. These revolutions are associated with two of the three fundamental dimensionful parameters of nature, the velocity of light and Planck's constant. The revolution in string theory presumably has to do with Newton's constant, that defines a length, the Planck length of* 10^{-33} *cm. String theory, I believe, will ultimately modify in a fundamental way our concepts at distances of order this length.*

In this connection the fundamental questions to be answered are: What is the 'physical base' for extra dimensions and their compactification? What is the physical entity next to length, area and volume? Why the

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assumed 10 dimensional compactification is ending at the observed (3+1) dimensions? During the dimensional compactification: 1) How to confirm that that there is no variation in the magnitude of the observed (3+1 dimensional) physical constant or physical property? 2) If space-time is curled up to the least possible (planck) size, how to interpret or understand the observed (3+1 dimensional) nuclear size and atomic sizes which are very large compared to the tiny planck size?

The concept of 'extra dimension' is very interesting but at the same time one must see its 'real existence' and 'workability' in the real physical world. Kaluza and Klein [8] showed that if one assumed general relativity in five dimensions, where one dimension was curled up, the resulting theory would look like a four-dimensional theory of electromagnetism and gravity. When gravity is existing in 3+1 dimensions, what is the need of assuming it in 5 dimensions? In the reality of (4+1) dimensional laboratory, how to confirm that, (3+1) dimensional gravity will not change in (4+1) dimensions? When gravity and electromagnetism both are existing in 3+1 dimensions, unifying them within 5 dimensions seems to be very interesting but impracticable. **More over to unify 2 interactions if 5 dimensions are required, for unifying 4 interactions 10 dimensions are required. For 3+1 dimensions if there exist 4 (observed) interactions, for 10 dimensions there may exist 10 (observable) interactions. To unify 10 interactions 20 dimensions are required. From this idea it can be suggested that- with 'n' new dimensions 'unification' problem cannot be resolved**.

Erasmo Recami says [1]: *Let us recall that Riemann, as well as Clifford and later Einstein, believed that the fundamental particles of matter were the perceptible evidence of a strong local space curvature. A theory which stresses the role of space (or, rather, space-time) curvature already does exist for our whole cosmos: General Relativity, based on Einstein gravitational field equations; which are probably the most important equations of classical physical theories, together with Maxwell's electromagnetic field equations. Whilst much effort has already been made to generalize Maxwell equations, passing for example from the electromagnetic field to Yang-Mills fields (so that almost all modern gauge theories are modeled on Maxwell equations), on the contrary Einstein equations have never been applied to domains different from the gravitational one. Even if they, as any differential equations, do not contain any inbuilt fundamental length: so that they can be used a priori to describe cosmoses of any size. Our first purpose is now to explore how far it is possible to apply successfully the methods of general relativity (GR), besides to the world of gravitational interactions, also to the domain of the so-called nuclear, or strong, interactions: namely, to the world of the elementary particles called hadrons. A second purpose is linked to the fact that the standard theory (QCD) of strong interactions has not yet fully explained why the hadron constituents (quarks) seem to be permanently confined in the interior of those particles; in the sense that nobody has seen up to now an isolated "free" quark, outside a hadron. So that, to explain that confinement, it has been necessary to invoke phenomenological models, such as the so-called "bag" models, in their MIT and SLAC versions for instance. The "confinement" could be explained, on the contrary, in a natural way and on the basis of a well-grounded theory like GR, if we associated with each hadron (proton, neutron, pion,...) a particular "cosmological model".*

b) Significance of large number ratios in unification

In his large number hypothesis P. A. M. Dirac [9, 10] compared the ratio of characteristic size of the universe and classical radius of electron with the electromagnetic and gravitational force ratio of electron and proton. If the cosmic closure density is, $\rho_0 \cong \frac{3H_0^2}{8\pi G}$, number of nucleons in a Euclidean sphere of radius (c/H_0) is equal to $\frac{c^3}{2Gm_n H_0}$ where H_0 is the Hubble's constant and m_n is the nucleon rest mass. It can be suggested that coincidence of large number ratios reflects an intrinsic property of nature.

It can be supposed that elementary particles construction is much more fundamental than the black hole's construction. If one wishes to unify electroweak, strong and gravitational interactions it is a must to implement the classical gravitational constant G in the sub atomic physics [11-13]. By any reason if one implements the planck scale in elementary particle physics and nuclear physics automatically G comes into subatomic physics. Then a large 'arbitrary number' has to be considered as proportionality constant. With this large arbitrary number it is be possible to understand the mystery of the strong interaction and strength of gravitation. Anyhow, the subject under consideration is very sensitive to human thoughts, experiments and observations.

In this critical situation here let us consider the valuable words of Einstein: *'The successful attempt to derive delicate laws of nature, along a purely mental path, by following a belief in the formal unity of the structure of reality, encourages continuation in this speculative direction, the dangers of which everyone vividly must keep in sight who dares follow it".*

II. About the Avogadro Number

Avogadro's number, N is the fundamental physical constant that links the macroscopic physical world of objects that we can see and feel with the submicroscopic, invisible world of atoms. In theory, N specifies the exact number of atoms in a palm-sized specimen of a physical element such as carbon or silicon. The name honors the famous Italian mathematical physicist Amedeo Avogadro (1776-1856), who proposed that equal volumes of all gases at the same temperature and pressure contain the same number of molecules. Long after Avogadro's death, the concept of the mole was introduced, and it was experimentally observed that one mole (the molecular weight in grams) of any substance contains the same number of molecules.

Determination of N, and hence k_B, was one of the most difficult problems of chemistry and physics in the second half of the 19th century. The constant N was (and still is) so fundamental that for its verification and precise determination every new idea and theory appeared in physics are at once used. Many eminent scientists devoted definite periods of their research life to the study of this problem: beginning from I. Loschmidt (1866), Van der Vaals (1873), S. J.W. Rayleigh (1871), etc. in the 19th century, and continuing in the 20th century, beginning from Planck (1901), A. Einstein and J. Perrin (1905-1908), Dewer (1908), E. Rutherford and Geiger (1908-1910), I. Curie, Boltwood, Debierne (1911), and many others. The value obtained by Planck on the basis of his famous black body radiation formula was, $N \approx 6.16\times10^{23}\ \text{mol}^{-1}$. More accurate definition of the value of N involves the change of molecular magnitudes and, in particular, the change in value of an elementary charge. The latter is related with N through the so-called "Helmholtz relation" $Ne = F,$ where F is the Faraday constant, a fundamental constant equal to 96485.3415(39) C.mol^{-1}.

Today, Avogadro's number is formally defined to be the number of carbon-12 atoms in 12 grams of unbound carbon-12 in its rest-energy electronic state [14-18]. The current state of the art estimates the value of $N,$ not based on experiments using carbon-12, but by using X-ray diffraction in crystal silicon lattices in the shape of a sphere or by a watt-balance method. According to the National Institute of Standards and Technology (NIST), the current accepted value for $N \cong (6.0221415 \pm 0.0000010)\times10^{23}$. The CODATA recommended value is $N \cong 6.02214179(30)\times10^{23}$. **This definition of N and the current experiments to estimate it, however, both rely on the precise definition of "one gram"! Hence most of the scientists consider it as an ad-hoc number. But in reality it is not the case**. Please see the following sections.

a) The Boltzmann constant: Bridge from macroscopic to microscopic physics

In statistical mechanics [19] that makes theoretical predictions about the behavior of macroscopic systems on the basis of statistical laws governing its component particles, the relation of energy and absolute temperature T is usually given by the inverse thermal energy $\frac{1}{k_B T}$. The constant k_B, called the Boltzmann constant is equal to the ratio of the molar gas constant R_U and the Avogadro number N.

$$k_B = \frac{R_U}{N} \cong 1.38065(4)\times10^{-23}\ \text{J}/{}^0\text{K} \tag{1}$$

where $R_U \cong 8.314504(70)\ \text{J/mol.}^0\text{K}$ and N is the Avogadro number. k_B has the same units as entropy. k_B plays a crucial role in this equality. It defines, in particular, the relation between absolute temperature and the kinetic energy of molecules of an ideal gas. The product $k_B T$ is used in physics as a scaling factor for energy values in molecular scale (sometimes it is used as a pseudo-unit of energy), as many processes and phenomena depends not on the energy alone, but on the ratio of energy and $k_B T.$ Given a thermodynamic system at an absolute temperature T, the thermal energy carried by each microscopic "degree of freedom" in the system is of the order of $(k_B T/2)$.

As Planck wrote in his Nobel Prize lecture in 1920, [20]: *This constant is often referred to as Boltzmann's constant, although, to my knowledge, Boltzmann himself never introduced it - a peculiar state of affairs, which can be explained by the fact that Boltzmann, as appears from his occasional utterances, never gave thought to the possibility of carrying out an exact measurement of the constant.* The Planck's quantum theory of light, thermodynamics of stars, black holes and cosmology totally depend upon the famous Boltzmann constant which in turn depends on the Avogadro number. From this it can be suggested that, Avogadro number is more fundamental and characteristic than the Boltzmann constant and indirectly plays a crucial role in the formulation of the quantum theory of radiation.

b) Current status of the Avogadro number

The situation is very strange and sensitive. Now this is the time to think about the significance of 'Avogadro number' in a unified approach. It couples the gravitational and non-gravitational interactions. It is observed that, either in SI system of units or in CGS system of units, value of the order of magnitude of Avogadro number $\cong N \approx 6\times10^{23}$ but not 6×10^{26}. But the most surprising thing is that, without implementing the gravitational constant in atomic or nuclear physics this fact cannot understood. It is also true that till today no unified model (String theory or Super gravity) successfully implemented the gravitational constant in the atomic or nuclear physics. Really this is a challenge

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to the modern nuclear physics and astrophysics. **Please note that, ratio of planck mass and electron mass is very close to** $(N/8\pi)$.

$$m_e c^2 \cong \frac{8\pi}{N}\sqrt{\frac{\hbar c}{G}}\cdot c^2 \cong 0.50952547 \text{ MeV} \tag{2}$$

This is a very strange coincidence[20]. But interpretation seems to be a very big puzzle. Any how it gives a clue for fitting and coupling the electron rest mass with the planck scale.

III. Mystery of the Gram Mole

If $M_P \cong \sqrt{\hbar c/G}$ is the Planck mass and m_e is the rest mass of electron, semi empirically it is observed that,

$$M_g \cong N^{-\frac{1}{3}}\cdot\sqrt{(N\cdot M_P)(N\cdot m_e)} \cong 1.004412\times10^{-3} \text{ Kg} \tag{3}$$

$$M_g \cong N^{\frac{2}{3}}\cdot\sqrt{M_P m_e} \tag{4}$$

Here M_g is just crossing the mass of one gram. If m_p is the rest mass of proton,

$$M_g \div m_p \cong N \cong 6.003258583\times10^{23} \tag{5}$$

$$\frac{\sqrt{M_P m_e}}{m_p} \cong N^{\frac{1}{3}} \tag{6}$$

Thus obtained $N \cong 5.965669601\times10^{23}$. More accurate empirical relation seems to be

$$\frac{\sqrt{M_P m_e}\; c^2}{\frac{m_p c^2 + m_n c^2 - B_a}{2} + m_e c^2} \cong N^{\frac{1}{3}} \tag{7}$$

where m_n is the rest mass of neutron and $B_a \cong 8$ MeV is the mean binding energy of nucleon. Obtained value of $N \cong 6.020215677\times10^{23}$. Here accuracy depends only on the 'mean binding energy per nucleon'. **Qualitatively and quantitatively - from this coincidence it is possible to say that, in atomic and nuclear physics, Avogadro number plays a very interesting role.** The unified atomic mass-energy unit $m_u c^2$ can be expressed as [20]

$$m_u c^2 \cong \left(\frac{m_p c^2 + m_n c^2}{2} - B_a\right) + m_e c^2 \tag{8}$$

$$\cong 931.4296786 \text{ MeV}$$

In this way, in a very simplified manner, Avogadro number can be estimated from the nuclear physics.

IV. The Key Assumptions in Unification

Assumption-1: In atomic and nuclear physics, atomic gravitational constant (G_A) is Avogadro number times the classical gravitational constant (G_C).

$$G_A \cong N G_C \tag{9}$$

Thus it is reasonable to say that - since the atomic gravitational constant is N times the classical gravitational constant, atoms are themselves arranged in a systematic manner and generate the "gram mole". In this paper mostly the subject under presentation is limited to this assumption only.

Assumption-2: The key conceptual link that connects the gravitational and non-gravitational forces is - the classical force limit

$$F_C \cong \left(\frac{c^4}{G_C}\right) \cong 1.21026\times10^{44} \text{ newton} \tag{10}$$

It can be considered as the upper limit of the string tension. In its inverse form it appears in Einstein's theory of gravitation [1] as $\frac{8\pi G_C}{c^4}$. It has multiple applications in Black hole physics and Planck scale physics [21,22]. It has to be measured either from the experiments or from the cosmic and astronomical observations.

Assumption-3: Ratio of 'classical force limit (F_C)' and ' weak force magnitude (F_W)' is N^2 where N is a large number close to the Avogadro number.

$$\frac{F_C}{F_W} \cong N^2 \cong \frac{\text{Upper limit of classical force}}{\text{nuclear weak force magnitude}} \tag{11}$$

Thus the proposed weak force magnitude is $F_W \cong \frac{c^4}{N^2 G_C} \cong 3.33715\times10^{-4}$ newton. Considering this F_W, Higgs fermion and boson masses can be fitted. In this connection please refer our earlier published papers [23,24,25].

Assumption-4: Ratio of fermion and its corresponding boson mass is not unity but a value close to $\Psi \approx 2.2627$. This idea can be applied to quarks, leptons, proton and the Higgs fermion. One can see "super symmetry" in low energies as well as high energies. This is a fact and cannot be ignored. Authors explained these facts in detail [23,24]. For the time being its value can be fitted with the relation, $\Psi^2 \ln\left(1+\sin^2\theta_W\right) \cong 1$ where $\sin\theta_W$ can be considered as the weak coupling angle. Please see section-5.

V. The Weak Mixing Angle

David Gross [7] says: *After sometime in the late 1920s Einstein became more and more isolated from the mainstream of fundamental physics. To a large extent this was due to his attitude towards quantum mechanics, the field to which he had made so many revolutionary contributions. Einstein, who understood after better than most the implications of the emerging interpretations of quantum mechanics, could never accept it as a final theory of physics. He had no doubt that it worked, that it was a successful interim theory of physics, but he was convinced that it would be eventually replaced by a deeper, deterministic theory. His main hope in this regard seems to have been the hope that by demanding singularity free solutions of the nonlinear equations of general relativity one would get an over determined system of equations that would lead to quantization conditions.* These statements clearly suggest that, at fundamental level there exists some interconnection in between quantum mechanics and gravity. It is noticed that

$$\hbar \approx \frac{N}{2}\sqrt{\left(\frac{e^2}{4\pi\varepsilon_0 c}\right)\left(\frac{G_C m_e{}^2}{c}\right)} \cong 1.135\times10^{-34} \text{ J.sec} \quad (12)$$

If it is really true, this may be considered as the beginning of unified quantum mechanics. From accuracy point of view here factor $(1/2)$ can be replaced with the weak mixing angle $\sin\theta_W$. Considering $\sin\theta_W$ as a characteristic number in fundamental physics,

$$\hbar \cong N\sin\theta_W \cdot \sqrt{\left(\frac{e^2}{4\pi\varepsilon_0 c}\right)\left(\frac{G_C m_e{}^2}{c}\right)} \quad (13)$$

Thus the weak mixing angle can be expressed as

$$\sin\theta_W \cong \left(\frac{\hbar}{m_e c}\right) \div \sqrt{\frac{e^2}{4\pi\varepsilon_0 F_W}} \cong 0.464433353 \quad (14)$$

Here $(\hbar/m_e c)$ is the Compton wave length of electron and $\sqrt{\frac{e^2}{4\pi\varepsilon_0 F_W}}$ seems to be a characteristic length of weak interaction.

VI. To Fit the Rest Masses of Proton and Neutron

Similar to the planck mass $\sqrt{\hbar c/G_C}$ and with reference to the elementary charge (e), it is possible to construct a mass unit as $\sqrt{\frac{e^2}{4\pi\varepsilon_0 G_C}}$. By considering the proposed atomic gravitational constant, it takes the form $\sqrt{\frac{e^2}{4\pi\varepsilon_0 G_A}}$. To a first approximation, guess that, nucleon rest mass is close to the geometric mean mass of m_e and $\sqrt{\frac{e^2}{4\pi\varepsilon_0 G_A}}$.

$$m_x c^2 \cong k\sqrt{m_e\sqrt{\frac{e^2}{4\pi\varepsilon_0 G_A}}}\cdot c^2 \quad (15)$$

where k is a proportionality number. When $k = \alpha\ln\left(\frac{1}{\alpha}\right) \cong 0.035904752$ it is noticed that, $m_x c^2 \cong 940.923$ MeV. Thus

$$\frac{m_x c^2}{m_e c^2} \cong \alpha\ln\left(\frac{1}{\alpha}\right)\left(\frac{e^2}{4\pi\varepsilon_0 G_A m_e^2}\right)^{\frac{1}{4}} \quad (16)$$

Then it is noticed that,

$$m_n c^2 \cong \frac{k}{1+k^2}\cdot\sqrt{m_e\sqrt{\frac{e^2}{4\pi\varepsilon_0 G_A}}}\cdot c^2 \cong 939.71 \text{ MeV} \quad (17)$$

$$m_p c^2 \cong \frac{k}{\left(1+k^2\right)^2}\cdot\sqrt{m_e\sqrt{\frac{e^2}{4\pi\varepsilon_0 G_A}}}\cdot c^2 \quad (18)$$

$\cong 938.50$ MeV. These obtained values can be compared with the experimental values [20]. But here the term $k = \alpha\ln\left(\frac{1}{\alpha}\right)$ seems to be a complicated one and needs a clear explanation. It plays a very interesting role in fitting the nuclear binding energy constants and the maximum mean binding energy per nucleon. With reference to the actual proton rest mass, $N \cong 6.028037223\times10^{23}$. From the above coincidences, it can be expressed as,

$$m_x c^2 - m_n c^2 \approx m_n c^2 - m_p c^2 \approx 1.21 \text{ MeV} \quad (19)$$

In this way 93.56% of the neutron, proton mass difference can be understood.

a) *Nuclear binding energy constants*

The semi-empirical mass formula (SEMF) is used to approximate the mass and various other properties of an atomic nucleus [26,27]. As the name suggests, it is based partly on theory and partly on empirical measurements. The theory is based on the liquid drop model proposed by George Gamow and was first formulated in 1935 by German physicist Carl Friedrich von Weizsäcker. Based on the 'least squares fit', volume energy coefficient is $a_v = 15.78$ MeV, surface energy coefficient is $a_s = 18.34$ MeV, coulombic energy coefficient is $a_c = 0.71$ MeV, asymmetric energy coefficient is $a_a =$ 23.21 MeV and pairing energy coefficient is $a_p = 12$ MeV. The semi empirical mass formula is

$$BE \cong Aa_v - A^{\frac{2}{3}} a_s - \frac{Z(Z-1)}{A^{\frac{1}{3}}} a_c - \frac{(A-2Z)^2}{A} a_a \pm \frac{1}{\sqrt{A}} a_p \tag{20}$$

In a unified approach it is noticed that, the energy coefficients are having strong inter-relation with the above defined number $k = \alpha \ln\left(\frac{1}{\alpha}\right)$. The interesting semi empirical observations can be expressed in the following way.

h) The maximum mean binding per nucleon is

$$(B_A)_{\max} \cong \frac{1}{2} k \cdot \tan\theta_W \cdot m_p c^2 \cong 8.8335 \text{ MeV} \tag{21}$$

i) The coulombic energy coefficient is (a_c)

$$\cong \sqrt{\alpha}\,(B_A)_{\max} \cong 0.7546 \text{ MeV} \tag{22}$$

j) The volume energy coefficient is (a_v)

$$\cong 2(B_A)_{\max} - 2a_c \cong 16.158 \text{ MeV} \tag{23}$$

k) The surface energy coefficient is (a_s)

$$\cong 2(B_A)_{\max} + 2a_c \cong 19.176 \text{ MeV} \tag{24}$$

l) The pairing energy coefficient (a_p)

$$\cong \frac{4}{3}(B_A)_{\max} \cong 11.778 \text{ MeV} \tag{25}$$

m) The asymmetry energy coefficient (a_a)

$$\cong 2a_p \cong \frac{8}{3}(B_A)_{\max} \cong 23.556 \text{ MeV} \tag{26}$$

n) $a_a + a_p \cong a_v + a_s \cong 2k \cdot \tan\theta_W \cdot m_p c^2 \cong 4(B_A)_{\max}$

$$\cong 35.334 \text{ MeV} \tag{27}$$

In table-1 within the range of $(Z = 26; A = 56)$ to $(Z = 92; A = 238)$ nuclear binding energy is calculated and compared with the measured binding energy [28]. Column-3 represents the calculated binding energy and column-4 represents the measured binding energy.

Table 1 : SEMF binding energy with the proposed energy coefficients

Z	A	$(BE)_{cal}$ in MeV	$(BE)_{meas}$ in MeV
26	56	490.8	492.254
28	62	543.62	545.259
34	84	725.65	727.341
50	118	1004.79	1004.950
60	142	1181.17	1185.145
79	197	1552.89	1559.40
82	208	1623.33	1636.44
92	238	1801.89	1801.693

Qualitatively and quantitatively - from these coincidences it is possible to say that, in atomic and nuclear physics, the operating gravitational constant is Avogadro number times the Newton's gravitational constant.

b) Proton-nucleon stability relation

It is noticed that

$$\frac{A_s}{2Z} \cong 1 + 2Z\left(\frac{a_c}{a_s}\right)^2 \tag{28}$$

where A_s is the stable mass number of Z. This is a direct relation. Assuming the proton number Z, in general, for all atoms, lower stability can be fitted directly with the following relation [26].

$$A_s \cong 2Z\left[1 + 2Z\left(\frac{a_c}{a_s}\right)^2\right] \cong 2Z + Z^2 * 0.0062 \tag{29}$$

if $Z = 21,\ A_s \cong 44.73;$ if $Z = 29,\ A_s \cong 63.21;$ if $Z = 47,\ A_s \cong 107.69;$ if $Z = 53,\ A_s \cong 123.42$ if $Z = 60,\ A_s \cong 142.32;$ if $Z = 79,\ A_s \cong 196.69;$ if $Z = 83,\ A_s \cong 208.71;$ if $Z = 92,\ A_s \cong 236.48;$

Stable super heavy elements can be predicted with this relation. In between $Z = 30$ to $Z = 60$ obtained A_s is lower compared to the actual A_s. It is noticed that, upper stability in light and medium atoms up to $Z \approx 56$ can be fitted with the following relation.

$$A_s \cong 2Z\left[1 + 2Z\left(\left(\frac{a_c}{a_s}\right)^2 + \left(\frac{a_c}{4(B_A)_{\max}}\right)^2\right)\right] \tag{30}$$

$$\cong 2Z + Z^2 * 0.008$$

From this relation for $Z = 56$, obtained upper $A_s \cong 137.09$. Note that, for $Z = 56$, actual stable $A_s \cong 137 \cong \frac{1}{\alpha}$ where α is the fine structure ratio. This seems to be a nice and interesting coincidence. In between 0.0062 and 0.008, for light and medium atoms up to $Z \approx 56$ or $A_s \approx 137$, mean stability can be fitted with the following relation.

$$A_s \cong 2Z + Z^2 * 0.00711 \tag{31}$$

Surprisingly it is noticed that, in this relation, $0.0071 \approx \alpha$. Thus up to $Z \cong 56$ or $A_s \approx 137$, mean stability can be expressed as

$$A_s \approx 2Z + \left(Z^2\alpha\right) \tag{32}$$

VII. To Fit the Rms Radius of Proton

Let R_p be the rms radius of proton. Define two radii R_1 and R_2 as follows.

$$R_1 \cong \left(\frac{\hbar c}{G_A m_p^2}\right)^2 \frac{2G_C m_p}{c^2} \cong 1.9637 \times 10^{-25} \text{ m} \tag{33}$$

$$R_2 \cong \left(\frac{\hbar c}{G_A m_p^2}\right)^3 \frac{2G_C m_p}{c^2} \cong 5.521 \times 10^{-11} \text{ m} \tag{34}$$

It is noticed that,

$$R_p \cong \left(R_1 R_2^2\right)^{\frac{1}{3}} \cong 8.4278 \times 10^{-16} \text{ m} \tag{35}$$

Thus,

$$R_p \cong \left(\frac{\hbar c}{G_A m_p^2}\right)^{8/3} \frac{2G_C m_p}{c^2} \tag{36}$$

This can be compared with the 2010 CODATA recommended rms radius of proton $0.8775(51)$ fm. Recent work on the spectrum of muonic hydrogen (an exotic atom consisting of a proton and a negative muon) indicates a significantly lower value for the proton charge radius, $R_p \cong 0.84184(67)$ fm and the reason for this discrepancy is not clear. This is 10 times more precise than all the previous determinations [29,30]. **Qualitatively and quantitatively - from this coincidence it is possible to say that, in atomic and nuclear physics, the operating gravitational constant is Avogadro number times the Newton's gravitational constant**. Thus from proton rest mass and rms radius,

$$G_A \cong \left(\frac{2G_C m_p}{R_p c^2}\right)^{3/8} \left(\frac{\hbar c}{m_p^2}\right) \tag{37}$$

$$N \cong \left(\frac{2G_C m_p}{R_p c^2}\right)^{3/8} \left(\frac{\hbar c}{G_C m_p^2}\right) \tag{38}$$

Here the most interesting thing is that, R_2 is very close to the Bohr radius of Hydrogen atom. It is very interesting to note that, with R_2 ionic radii of atoms can be fitted very easily as

$$(R)_A \cong A^{1/3} \cdot \left(\frac{R_2}{\sqrt{2}}\right) \cong A^{1/3} \cdot 3.904 \times 10^{-11} \text{m} \tag{39}$$

where $(R)_A$ is the ionic radius of mass number A. If $A = 7, (R)_A \cong 0.0747$ nm, if $A = 23, (R)_A \cong 0.111$ nm and if $A = 39, (R)_A \cong 0.132$ nm. Their corresponding recommended radii are 0.076 nm, 0.102 nm and 0.138 nm respectively [31,32].

a) Scattering distance between electron and the nucleus

If $R_0 \cong 1.21 \text{ to } 1.22$ fm is the minimum scattering distance between electron and nucleus [32] it is noticed that,

$$R_0 \cong \left(\frac{\hbar c}{G_A m_e^2}\right)^2 \cdot \frac{2G_C m_e}{c^2} \cong 1.21565 \text{ fm} \tag{40}$$

Qualitatively and quantitatively - from this coincidence also it is possible to say that, in atomic and nuclear physics, the operating gravitational constant is Avogadro number times the Newton's gravitational constant.

$$N \cong \sqrt{\frac{2\hbar^2}{G_C m_e^3 R_0}} \tag{40}$$

$$G_C \cong \frac{2\hbar^2}{N^2 m_e^3 R_0} \tag{41}$$

b) Vibrations of the basic charged leptonic string in 3+1 dimensions

Muon and tau rest masses can be fitted in the following way [33]. The key relation seems to be

$$\left(\frac{\hbar c}{G_A m_e^2}\right)^2 \cong \frac{R_0 c^2}{2G_C m_e} \tag{42}$$

Considering the ratio of the volumes $\frac{4\pi}{3}R_0^3$ and $\frac{4\pi}{3}\left(\frac{2G_C m_e}{c^2}\right)^3$, let

$$\ln\left(\frac{R_0 c^2}{2G_C m_e}\right)^3 \cong \gamma \cong 289.805 \tag{43}$$

Now muon and tau masses can be fitted with the following relation [23,24].

$$\left(m_l c^2\right)_x \cong \left[\gamma^3 + \left(x^2\gamma\right)^x \sqrt{N}\right]^{\frac{1}{3}} \cdot \frac{m_e c^2}{\gamma} \tag{44}$$

where x = 0,1 and 2. At x = 0, $\left(m_l c^2\right)_0 \cong m_e c^2$. This relation can be considered as the representation of the basic charged leptonic string in 3+1 dimensions. At x = 1, $\left(m_l c^2\right)_1 \cong 107.23$ MeV and can be compared with the rest mass of muon (105.66 MeV). At x = 2, $\left(m_l c^2\right)_2 \cong 1788.07$ MeV and can be compared with the rest mass of tau (1777.0 MeV). x = 0,1 and 2 can be considered as the 3 characteristic vibrating modes. Best fit can be obtained at, $\gamma \cong 295.0606338$. Please refer [23,24]. **Qualitatively and quantitatively - from these coincidences also it is possible to say that, in atomic and nuclear physics, the operating gravitational constant is Avogadro number times the Newton's gravitational constant.**

VIII. Magnetic Moments of Nucleons

In the earlier published papers [23-25] authors suggested that, magnetic moment of electron is due to weak force magnitude and similarly nucleon's magnetic moment is due to the strong force magnitude or strong interaction range. Based on the proposed concepts and representing $\hbar$ in terms of Avogadro number and $\sin\theta_W$, magnetic moment of electron [33,34] takes the following form.

$$\mu_e \cong \frac{1}{2}\sin\theta_W \cdot ec \cdot \sqrt{\frac{e^2}{4\pi\varepsilon_0 F_W}} \cong 9.274\times10^{-24}\,\text{J/tesla} \tag{45}$$

where F_W is the proposed weak force magnitude. Similarly the magnetic moment of proton can be expressed as

$$\mu_p \cong \frac{1}{2}\sin\theta_W \cdot ec \cdot R_0 \cong 1.356\times10^{-26}\ \text{J/tesla} \tag{46}$$

where $R_0 \cong 1.21565\times10^{-15}$ m. If proton and neutron are the two quantum states of the nucleon, by considering the "rms" radius of proton as the radius of neutron, magnetic moment of neutron can be fitted as

$$\mu_n \cong \frac{1}{2}\sin\theta_W \cdot ec \cdot R_P \cong 9.59\times10^{-27}\ \text{J/tesla} \tag{47}$$

where $R_P \cong 0.86\times10^{-15}$ m is the radius of proton. This seems to be a very nice and interesting fitting.

IX. To Fit the Characteristic Potential Radius of Nucleus

It is noticed that, gram mole is a black hole where the operating gravitational constant is (G_A) but not (G_C). That means for the simplest case of Hydrogen gram mole, there exist N number of protons and N number of electrons. Let it follows the concept of Schwarzschild radius. It can be expressed in the following way.

$$R_N \cong \frac{2G_A\left[N\left(m_p^2 m_e\right)^{1/3}\right]}{c^2} \tag{48}$$

Here the only change is that, instead of the proton mass or instead of the electron mass, $\left(m_p^2 m_e\right)^{\frac{1}{3}}$ is considered for fitting the experimental radius of 1.4 fm. Volume of R_N is

$$V_N \cong \frac{4\pi}{3}R_N^3 \tag{49}$$

The characteristic mean distance can be obtained as

$$\lambda_0 \cong \left(\frac{V_N}{N}\right)^{\frac{1}{3}} \cong 1.404\times10^{-15}\ \text{meter} \tag{50}$$

This can be compared with the characteristic alpha scattering experimental radius [31] of nucleus ≈ 1.4 fm. Based on the Yukawa's Pion exchange model nuclear interaction range is 1.4 fm [33,35,36]. Thus if $m_\pi^\pm$ is the charged pion rest mass,

$$N \cong \left(\frac{3}{32\pi}\right)^{\frac{1}{5}}\left(\frac{\hbar c}{G_C\left(m_p^2 m_e\right)^{1/3} m_\pi^\pm}\right)^{3/5} \tag{51}$$

X. To Fit the Rest Mass of Proton or Electron

Semi empirically it is also noticed that

$$\ln\sqrt{\frac{e^2}{4\pi\varepsilon_0 G_C m_p^2}} \cong \sqrt{\frac{m_p}{m_e} - \ln\left(N^2\right)} \tag{52}$$

where m_p is the proton rest mass and m_e is the electron rest mass. Considering this as a characteristic relation, and by considering the electron rest mass as a fundamental input, proton rest mass can be fitted accurately in the following way.

$$\left(e^{\sqrt{\frac{m_p}{m_e} - \ln\left(N^2\right)}}\right)^2 m_p^2 \cong \frac{e^2}{4\pi\varepsilon_0 G_C}. \tag{53}$$

Thus by trial-error method, proton rest mass can be estimated from this relation. Here interpretation seems to be a big puzzle. **Alternatively by considering the proton rest mass as a fundamental input, without considering the electron rest mass, the proton-electron mass ratio can be estimated from this relation. It comes out to be 1836.1 and is a very nice fitting. Thus the electron rest mass can be fitted!** Here the important question is: What is the role of squared Avogadro number in grand unified physics? Authors are working in this new direction.

The accuracy of the measured value of G has increased only modestly since the original Cavendish experiment. The 2007 recommended value of $G = 6.6742867 \times 10^{-11}\ \mathrm{m^3 Kg^{-1} sec^{-2}}$. Based on the newly developed "interferometry techniques" [9], measured value of $G = 6.693 \times 10^{-11}\ \mathrm{m^3 Kg^{-1} sec^{-2}}$. Fitting the gravitational constant with the atomic and nuclear physical constants is a challenging task. From equ. (52)

$$G_C \cong \left(e^{\sqrt{\frac{m_p}{m_e} - \ln\left(N^2\right)}}\right)^{-2} \cdot \frac{e^2}{4\pi\varepsilon_0 m_p^2} \tag{54}$$

$$\cong 6.666270179 \times 10^{-11}\ \mathrm{m^3 Kg^{-1} sec^{-2}}.$$

Avogadro number can be expressed as

$$N \cong \sqrt{exp\left[\frac{m_p}{m_e} - \left(\ln\sqrt{\frac{e^2}{4\pi\varepsilon_0 G_C m_p^2}}\right)^2\right]} \tag{55}$$

$$\cong 6.174407621 \times 10^{23}.$$

Qualitatively and quantitatively - from this coincidence it is possible to say that, in atomic and nuclear physics, Avogadro number plays a very interesting role.

XI. Conclusion

In this paper authors mostly discussed the first assumption and it is the base for the other assumptions and applications. **For any theory, its success depends on its mathematical formulation as well as its workability in the observed physical phenomena**. Initially string theory was originated in an attempt to describe the strong interactions. It is having many attractive features. Then it must explain the ratio of (3+1) dimensional strong interaction strength and the gravitational interaction strength. Till date no single hint is available in this direction. This clearly indicates the basic drawback of the current state of the art string theory. Proposed relations clearly show the applications in different ways.

Now this is the time to decide, whether Avogadro number is an arbitrary number or a characteristic unified physical number. Developing a true unified theory at 'one go' is not an easy task. Qualitatively and quantitatively proposed new concepts and semi empirical relations can be given a chance in understanding and developing the unified concepts. If one is able to fine tune the "String theory" or "Super gravity" with the proposed weak and strong force magnitudes (within the observed 3+1 dimensions), automatically planck scale, nuclear scale and atomic scales can be interlinked into a theory of "strong gravity" [37-50]. But this requires further observations, analysis, discussions and encouragement. Authors request the science community to kindly look into this new approach.

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- To the point depiction of the research
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Approach:

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Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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