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# A Re-Assessment of the Fundamental Laws of Science in the 21st Century

**Author Ajay Sharma Website www.AjayOnLine.us**
**Email ajay.pqr@gmail.com , 0091 94184 50899, 0091 177 2804546**

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## 1 Archimedes principle after 2265 years

**Ajay Sharma**

**Abstract**

It is observed in a critical analysis of completely submerged floating balloons in water, that under some feasible conditions, the volume of fluid filled in balloon takes an indeterminate form, i.e. V =0/0 in equations based upon Archimedes principle. These equations became feasible 1935 years after enunciation of the principle in 1685, when Newton defined g in *The Principia.* If in this case, definition of the principle is generalized, i.e. upthrust is proportional to the weight of fluid displaced, then results are consistent i.e. V=V. Thus, the co-efficient of proportionality, f comes into the picture, which accounts for factors not taken in account by the principle e.g. for shape of body, viscosity of medium, magnitude of medium, surface tension etc. Stokes law is justified under some assumptions and takes into account the shape of the body and viscosity of the medium. The value of f depends upon such factors. Furthermore some specific experiments have been suggested to confirm the effect of coefficient of proportionality. Such specific studies do not signify any comment or conclusion of the established status of the principle.

### 1.0 Completely submerged floating balloons lead to indeterminate volume of fluid filled in them

Archimedes principle was stated in 250BC, and serves a method for determination of densities of bodies [1]. It is also used for determining the conditions of floatation. But under certain conditions which can be easily experimentally achieved, the volume of medium filled in balloon becomes indeterminate i.e. V=0/0. It is not justified. The exact volume V is obtained if the principle is generalized. The generalized form of the principle is

*'the upthrust is proportional to the weight of fluid displaced by body'*

$U = fVD_m g$

(1)

where V is the volume of the body, $D_m$ is the density of medium displaced , g is acceleration due to gravity. f is the co-efficient of proportionality which depends upon the factors which are not taken into account by the principle i.e. shape of floating body, coefficient of viscosity of medium and surface tension etc. Experiments and mathematical equations have been mentioned to justify the inception of f. If f =1 then eq.(1) becomes the original form of Archimedes principle i.e $U = VD_m g$

Resultant weight (weight of body in fluid) =

weight – upthrust = $(D_b – D_m)Vg$ (2)

The body floats if the resultant weight is zero i.e.

$(D_b – D_m)Vg$ or $D_b = D_m$ (3)

If $D_b > D_m$, the body sinks or falls in the medium and if $D_m < D_b$, the body rises upward in the medium [2-3]. The modern mathematical equations became feasible on the 2265 years old Archimedes principle, after 1935 years of its enunciation [4-5] when Newton [6] published *The Principia* and defined acceleration due to gravity, g in 1685. Now when these are critically analysed then inconsistent results are obtained and the principle is purposely generalized.

**Floating balloon:** Consider a balloon filled with medium of density $D_m$ floating in water of density $D_w$. The volume of the sheath of the balloon /vessel is v which also includes a volume of mass if any, attached to it. The mass corresponding to volume v is m. The volume of the medium filled inside the balloon is V ( say air, wood, metal and gases ). According to Archimedes principle, the upthrust experienced by the balloon is equal to the weight of fluid displaced [2-5]. The body displaces fluid equal to its own volume. The condition of flotation of balloon is that the resultant weight becomes zero i.e.

$$V D_m g + mg = (V+v) D_w g \quad (4)$$

$$\text{Or} \quad m = (V+v) D_w - V D_m \quad (4)$$

Borowitz and Beiser have quoted a similar equation (general ) but neglecting volume v which is not quantitatively justified [3]. Thus, $M = V D_w - V D_m$

$$\text{or} \quad V = \frac{M}{(D_w - D_m)} \quad (5)$$

### 1.1 Indeterminate form of volume

(i) It is a basic requirement of an equation (equality of LHS and RHS) having n parameters, that if (n-1) parameters are given then, the remaining parameter ($n_{th}$ say) can be determined. It is a basic principle of algebra. If it is not so, then the equation is inconsistent. For example, in the law of gravitation, $F = Gm_1m_2/r^2$, if all other parameters except $m_1$ are given, then value of $m_1$ can be calculated, i.e.

$$m_1=Fr^2/Gm_2 \qquad (6)$$

Now volume V is required to be calculated which can support a mass equal to $vD_m$ in water. From eq.(4) the value of volume can be written as

$$V = \frac{(m - vD_w)}{(D_w - D_m)} \qquad (7)$$

Likewise, equations $D_m$, $D_b$ and v can be written. If m, $D_m$, $D_w$ and v are given in the equation, then V must be calculated from eq.(7) under experimentally consistant and achievable conditions. If it is not so, then it is a limitation of Archimedes Principle, not that of interpretation.

(ii) Now we can try to calculate the volume (V) of fluid filled in balloon ( air, wood, metal and gases, say ); the sheath of balloon is having volume v and mass m ($vD_w$) , such that density of fluid filled inside is equal to that of water ($D_m = D_w$). As in case of law of gravitation, in this case also experimentally consistent result is expected. Obviously volume should turn out equal to V, which is an actual value. Hence substituting mass from eq.(4) i.e. $m =vD_w$ in eq.(7), we get

$$V= \frac{(vD_w - vD_w)}{(D_w - D_w)} = \frac{0}{0} \qquad (8)$$

which is the indeterminate form i.e. volume of medium filled in balloon (wood, metal, air and gases) becomes undefined but in the actual experimental set up, volume is V consisting of metal, wood and gases. Thus there is a singularity in the equation of volume V under this condition, hence, other variables ( $D_m$, $D_w$, and v etc.) cannot be determined.

(a) If V is in indeterminate form, then there is a singularity in the equations of Archimedes principle, under this specific condition. Thus RHS of eq.(8) becomes devoid of units and dimensions which are not defined. The dimensions of the LHS are $M^0L^3T^0$ and units $m^3$. Incidentally, the dimensions of LHS and RHS of eq.(4) are of mass i.e. $ML^0T^0$ and units kg. But the eq.(8) which is derived from it is dimensionally inconsistent, hence eq.(4) must be re-defined under this condition. The dimensional homogeneity is the first and foremost condition for consistency of an equation and all equations have to obey it without exception. If any equation does not obey it then that equation loses its identity.

(b) Every equation needs to be checked for its consistency for various values of involved parameters. Although division by zero is not permitted, yet it smoothly follows from equations based upon Archimedes' principle as per its definition. Also in this case numerator of the equation also becomes zero. So it is only and only limitation of Archimedes principle. The conditions of interpretation can be experimentally achieved in number of ways, so interpretation is not under hypothetical conditions. In case due to certain reasons the equation does not give consistent results, then it does not mean it must not be interpreted under that condition. An equation has to inherently obey many conditions. This discussed situation i.e. equality of density of medium filled in balloon and that of density of water ($D_m = D_w$) can be achieved in many cases. Experimentally the volume of medium (say air, wood, metal and gases) filled in balloon is V not 0/0. This situation can be obtained in number of ways. This equation in this particular case is not applicable. This intrigue can only be solved by generalizing Archimedes principle. Thus this aspect regarding Archimedes principle remained unstudied, hence interpreted here. Such specific studies do not mean any comment or conclusion on the established status of the principle in other cases.

The mathematical equations (hence definition of the principle) should be such that this situation should not arise, and mathematically exact volume V is obtained. Further v, $D_m$, $D_w$ cannot be calculated as volume is indeterminate i.e. V = 0/0 as eq.(8) attains singularity. This experiment or perception has not been discussed even by Batchelor [7] in standard treatise*, An Introduction to Fluid Dynamics* in chapter I in relevant section 1.4, A body 'floating' in fluid at rest. This indicates the gravity and originality of the discussion. Einstein introduced a term cosmological term in his cosmological thesis, which became zero under some conditions.

Einstein while writing his thesis on static universe divided with cosmological term which became zero under some conditions. It was pointed out by Friedmann. Later on Einstein abandoned the concept calling it as the biggest blunder, according to George Gammow [8]. Thus alternate concept of non-static universe was accepted. Thus Einstein did not insist that his thesis involves division by zero is correct, and Friedman who showed the proof involves division by zero is wrong. It is obvious that if an equation involves division by zero, then it is limitation of equation, not that of interpreter.

## 2.0 Generalization of Archimedes Principle

It is confirmed in eq.(8) that under some achievable conditions, the volume becomes indeterminate which is not justified. Under above conditions (in application to floating bodies) Archimedes principle becomes invalid mathematically. Thus the principle has to be validated for all conditions; it can be so if definition of Archimedes principle is generalized. So the alternative follows from the principle itself. The generalized form of the principle [4] is

*' upthrust experienced by body is proportional to the weight of fluid displaced'*

$$U_{gen} \propto (V+v) D_w g \quad \text{or} \quad U_{gen} = f (V+v) D_w g \qquad (9)$$

where f is co-efficient of proportionality. The author [4-5] has already generalized the principle in view of the results obtained from the first stage experiments involving air filled balloons of different shapes floating in water. In such experiments the mass which balloon supported is found to depend upon the shape of balloon (spherical, long pipe, and umbrella shaped etc.). In preliminary or first stage experiments, an umbrella shaped balloon supported more mass (in general sense weight) than long pipe shaped balloon [4]. However, it is clearly added that final conclusion must be drawn from the specific, repeatable sensitive experiments , as preliminary experiments simply give qualitative trends. The subtle results from preliminary experiments compels some extremely sensitive experiments with sophisticated instruments[4], as under some conditions the same equation gives indeterminate form of volume i.e. Eq.(8). For final confirmation such experiments require the most sensitive and sophisticated equipments.

**Coefficient of Proportionality f :** f is co-efficient of proportionality like numerous others in science. If f=1 then both the generalized and original forms are the same. Its value is experimentally measured and depends upon the inherent characteristics of the experimental variables. The physical significance of the coefficient of proportionality can be understood by both methods.

**Theoretically** using the generalized form of Archimedes principle the exact volume V is obtained as in eq.(13). Thus the various other values of $D_m$, $D_b$, v etc can be calculated. Hence singularity is removed in the equations under the given conditions. Hence the value of f is theoretically justified. The magnitude of f can be determined experimentally in various experiments.

Now in this specific case the condition for floatation using generalized upthrust can be written as

$$V D_m g + mg = f (V+v) D_w g \tag{10}$$

Now equations for mass m, and volume V can be written as

$$m= f (V+v) D_w -VD_m \tag{11}$$

$$V = \frac{(m - fvD_w)}{(fD_w - D_m)} \tag{12}$$

Under the similar condition ($D_m = D_w$), the exact volume is obtained.

$$V = \frac{(f(V+v)D_w - VD_w - fvD_w)}{(fD_w - D_m)} = \frac{(f-1)D_w V}{(f-1)D_w} = V \tag{13}$$

Now consistent results are obtained if value of f is different from unity. Also now correct values of v, $D_m$ and $D_w$ are obtained. Unlike eq.(8), in this case, division by zero is not involved. Also numerator is non-zero, hence consistent and logical result is obtained. The condition of floatation is the same i.e. $D_m = D_w$. The dimensions and units are same in both LHS and RHS i.e. $M^0L^3L^0$ and $m^3$. Then these equations based upon the generalized form of Archimedes principle are mathematically consistent and don't have any limitation like these equations based upon Archimedes principle. Hence mathematically the generalization is justified. The magnitude of f can be determined experimentally.

**Experimentally** Archimedes principle has many applications, eq.(2) is also used to explain motion of rising, falling and falling bodies qualitatively. The density of body, density of medium, shape of body, magnitude of medium, surface tension etc are the various relevant parameters, when experiments are explained using Archimedes principle. In eq.(3) only $D_m$ and $D_b$ are taken in account; the other factors such as shape of body, viscosity of medium, magnitude of medium, surface tension etc. are taken in account by the coefficient of proportionality f. Thus the generalized form of Archimedes principle is the complete principle in this regard.To confirms such factors specific experiments are required.

## 3.0 Physical significance of co-efficient of proportionality or its experimental validity.

Archimedes Principle was initially established for measurement of densities of bodies, by attaching body to balance with help of string for weighing. But the rising, falling and floating bodies are not externally attached to balance/instrument. This is conceptual difference between original verification of Archimedes principle and its further applications. The applications of Archimedes principle i.e. eq.(2), are also extended to rising, falling and floating bodies. Hence value of f can be discussed in all such cases. Further original and generalized forms of Archimedes principle only differ by value of f. More the difference between f and unity, more significant will be the generalized form of Archimedes principle.

### 3.1 Floating bodies

According to Archimedes principle i.e. eq.(3) for floating bodies only densities of bodies and media are relevant, rest all others factors e.g. shape of body, magnitude, surface tension , viscosity of medium etc. are irrelevant. In terms of the generalized form of Archimedes principle,

weight of body = upthrust exerted by medium (buoyant force)

$$VD_b g = f VD_m g \qquad (14)$$

or $D_b = f\ D_m$ (15)

Thus when body floats then f takes in account other factors (other than $D_m$ and $D_b$ ) e.g. shape of body, magnitude of medium, surface tension , viscosity of medium etc. Thus theoretically generalized form of Archimedes principle is complete, as it takes all possible involved factors in account and original form only takes in account $D_b$ and $D_m$. The effect of these factors in such phenomena can be confirmed in specifically designed experiments. It can be confirmed by fabricating bodies of non-hygroscopic nature [8] of different shapes ( flat or umbrella shaped or distorted shape); if such bodies float in water of slightly more destiny then value of f other than unity will be confirmed. Then value of f will be $D_b / D_m$.

**Prospective Experiment:** The effect of shape may be specifically tested for completely submerged floating balloons/bodies in more viscous fluids. Normally the density of glycerine 1.26 times that of water but the co-efficient of viscosity of glycerine is1058 times that of water. If a body (typically flat, distorted or umbrella shaped) of density 1.26001gm/cc floats (completely submerged) in glycerine of density 1.26gm/cc, then coefficient of proportionality from eq.(15) can be calculated as 1.000008. The systematic study of viscosity started in the beginning of the 19th century [10] much after enunciation of Archimedes principle. Hence effect of viscosity has to be checked in all aspects. Generally effect of viscosity was studied with equation of viscous force ($F = 6\pi\eta rc$, $\eta$ coefficient of viscosity, r radius of sphere, and c is constant velocity) and Archimedes principle. The co-efficient of viscosity is related with force F and constant velocity c. In addition, the generalized form of Archimedes principle takes effect of viscosity in account explicitly via the coefficient of proportionality. In case of static floating bodies ($c = 0$) the effect of viscous force is irrelevant.

### 3.2 Stokes' Law and Arnold's experiments confirm significance of effects of shape and viscosity of medium on falling bodies.

This discussion is mainly addressed to completely submerged floating bodies in water. The experiments have been suggested to determine the value of f. In addition the same (effects of shape of body, viscosity of medium etc.) can be understood in case of falling bodies as discussed below.

**Falling bodies.** Stokes in 1845 put forth that under five postulates [11] small spheres of radius r, in fluid of coefficient of viscosity $\eta$ fall with constant velocity c or zero acceleration, which is given by

$$c = \frac{2r^2\left(1 - \frac{D_m}{D_b}\right)gD_b}{9\eta} \quad (16)$$

The eq.(16) is obtained with help of Archimedes principle and viscous force F = 6πηrc (η is co-efficient of viscosity) under certain assumptions. In 1910 Arnold [11] verified eq. (16) in water with an accuracy of a few tenths of 1% for sphere of rose metal of radii 0.002 cm i.e. V= $33.524 \times 10^{-9}$ cc. Thus it is applicable in extremely narrow range. Thus sphere of radii more than 0.002 cm fall with a variable velocity or motion is accelerated. The small spheres attain constant velocity due to viscous force of fluid. Thus it is concluded that shape of body and viscosity of medium (even magnitude of medium) influence the results of falling bodies e.g. sometimes bodies move with constant velocity (a=0) or variable velocity. it is confirmed experimentally while justifying Stokes Law. These observations are consistent with the generalised form of the principle. Hence such experiments can be conducted over wide range.

Archimedes principle implies that body sinks in medium if resultant weight is positive i.e. density of body is more than that of medium ($D_b > D_m$). It is evident from eq.(2). In general if we drop a flat steel sheet (5m$\times$ 5m or distorted shape) of mass 1kg or spherical body of steel of mass 1kg. Then spherical body falls quickly than flat sheet (5m$\times$ 5m or distorted shape) of mass 1kg. Both sphere of steel and flat sheet have same weight, upthrust, resultant weight (hence resultant acceleration) should fall equal distances in equal times, according to Archimedes principle. But the flat body or sheet falls slowly than spherical body, it is due to shape of body. Similar results can be obtained if bodies of different masses are studied. The similar explanation may be identically given for rising bodies and results can be critically checked. Thus generalized form of Archimedes principle is useful in understanding or explaining such phenomena.

### 3.3 Mathematical derivation of Archimedes principle is only for symmetric shaped body.

The effect of shape of body is not only significant in application of the principle but also in its mathematical derivation [2-3]. Consider in fluid of density $D_m$, block of height H floats (under precisely static conditions and density of fluid is precisely uniform) such that upper surface of body is at depth h in fluid. Also areas of upper and lower surfaces of body are regarded as precisely equal (say, A). The upthrust experienced by block [2-3] is difference between thrusts at lower and upper surfaces i.e.

u =Thrust at lower surface –thrust at upper surface

$$u= \{p+D_m g(h+H)\} A- (p+D_m gh) A=D_m HAg \quad (17)$$

$$\text{or } u = D_m Vg=\text{weight of fluid displaced} \quad (18)$$

Now upthrust is equal to weight of fluid displaced if areas of upper and lower surfaces of the block are the same. But this derivation is not applicable for body of arbitrary shape, hence shape has a role to play even in theoretical derivation of Archimedes principle. The similar conclusions can be drawn from applications of Archimedes principle. Thus some specific and sensitive experiments are required to determine effects of shape of body and viscosity of medium i.e. value of f in the generalized form of Archimedes principle. The various results are shown in Table I regarding original and generalized forms of Archimedes principle.

**Table I : Consequences of indeterminate form of volume.**

| Sr. No. | Characteristic | Original form of Archimedes principle | Generalized form of Archimedes principle |
|---|---|---|---|
| 1 | Definition | $U=VD_m g$ | $U=fVD_m g$ |

| | | | |
|---|---|---|---|
| 2 | Volume under certain conditions | $V=\frac{0}{0}$ | V=V (500cc, say) |
| 3 | Co-efficient of proportionality | f=1 | f< 1 or f >1 or f =1 |
| 4 | Status of parameters. | Does not account for shape of body and viscosity of medium. | Takes in account the shape of body and viscosity of medium. |
| 5 | Specific experiments | Break down under certain conditions | Some specific experiments are suggested to determine effects of shape and viscosity of medium for completely submerged floating bodies. In typical experiment value of f is assessed as1.000008. |

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## 2 Torricelli's Experiment in case of glycerine and water: A Critical Analysis.

**Ajay Sharma**

Fundamental Physical Society. His Mercy Enclave. Post Box 107 GPO Shimla 171001 HP India

Email; ajay.pqr@gmail.com,

**Abstract**

The pioneering experiment regarding measurement of pressure was conducted by Torricelli (1608-1647) in 1644. But real theoretical understanding of the phenomena began after 1685, when Newton defined acceleration due to gravity g. Mathematically pressure ( P =Dgh) is only dependent on density of fluid, and independent of other characteristics. The height of mercury column in barometer

is 0.76m. If the water and glycerine barometers are constructed then the height of water column must be 13.33m and that of glycerine column 8.202m. In the existing literature there are no quantitative observations that heights of liquid (water and glycerine) columns are confirmed quantitatively. If these predictions are precisely justified then these experiments can serve as alternate method for measurement of g ( P/Dh). The proposed experiments will be very significant in understanding the phenomena in basic physics as height of liquid column also involves, g, in case even slight deviations are confirmed.

## 1.0 Introduction

The understanding of the concept of pressure exerted by fluids can be understood in two phases i.e. before and after enunciation of law of gravitation [1-3]. The first phase is pre-gravitational period (before 1685) when basic and pioneering experiments regarding measurement of pressure were conducted without mathematical basis. Italian scientist Evangelista Torricelli (1608-1647) constructed a mercury barometer, consisting of is a long tube (about 1m) filled with mercury and inverted in a dish of mercury. In this simple barometer mercury column is held up to 0.76m. The original aim of Torricelli's pioneering investigation (1643) may not be to measure or invent a method for measurement of pressure [1,2].

The mathematical equation for measurement of pressure became feasible after 1685 when acceleration due to gravity g was defined. Now pressure is given by

$$P = Dgh \quad (1)$$

where D is density of liquid and h is height of liquid column.

French scientist Blaise Pascal (1623-1662) also believed to have constructed a barometer using red wine [2] and glass tube 46 feet long (about 12 m). But details are not available, that how Pascal estimated the height of red wine barometers. At that time there was no mathematical equation to estimate height. In this regard a German experimentalist Otto Van Guericke (1602 – 1686) known for Magdeburg hemispheres and vacuum pump; is also believed to have constructed a water barometer. At that time there was no mathematical equation to determine the height of the columns of red wine and water. If such equations are not confirmed quantitatively then reasons have to be investigated for the deviations. Thus such experiments are very-2 significant. Obviously mathematical equation for pressure i.e. P = Dgh, became feasible in 1685. So Torecilli's approaches may be regarded as pioneering but qualitative only as far as measurement of pressure is concerned.

### 1.1 A Critical Analysis Of P = Dgh

The unit of pressure, Pascal was defined by simply putting value of h equal to 0.76m. In case of mercury (h=0.76m). Eq.(1) becomes

$$P = 13{,}600 kgm^{-3} \times 9.8 ms^{-2} \times 0.76 m = 1.013 \times 10^5 \text{ Pascal} \quad (2)$$

Thus, according to eq.(1) pressure P only depends upon density of fluid; and is independent of all other characteristics of fluids i.e. co-efficient of viscosity, surface tension and angle of contact. It may also depend upon capillarity i.e. rise or fall of liquid in a tube of fine bore (diameter few mm). Now it has to be confirmed that whether these factors affect the height of liquid column in barometers. These characteristics are clearly independent of density and for comparison the various characteristics of water glycerine and mercury are shown in Table 1.

**Table 1: Comparison of various characteristics of water, glycerine and mercury.**

| Characteristic | Water | Glycerine | Mercury |
|---|---|---|---|
| Density | 1 | 1.26 | 13.6 gm/cc |
| Coeff. Of viscosity (poise) | $1.01 \times 10^{-2}$ | 10.69 | $15.5 \times 10^{-3}$ |

| | | | |
|---|---|---|---|
| Surface tension | 75.6 | 63.1 | 465 (dyne/cm) |
| Angle of contact | $8\text{-}9^0$ | -- | 137 |
| Capillarity | Rise | -- | Fall |
| Physical behaviour | Wets | Wets | Does not Wet |
| Height of liquid column (h) | 10.33 | 8.202m | 0.76m |

In this regard if we use water (1000 kg/m$^3$) instead of mercury in barometer then height of water column must be 10.336 m i.e.

$$H(water) = \frac{P}{D_w g} = \frac{1.013 \times 10^5 Pa}{1000 kg/m^3 \times 9.8 kg/s^2} = 10.33m \qquad (3)$$

If height of water column is found more than 10.33m, then it means value of g will be less than 9.8m/s$^2$. Similarly inverse is also true. Thus sensitive experiments are required for precise conclusions; as such experiments are very significant.

Also for glycerine

$$H\ (glycerine) = \frac{P}{D_w g} = \frac{1.013 \times 10^5 Pa}{1260 kg/m^3 \times 9.8 kg/s^2} = 8.202m \qquad (4)$$

Like this many other barometers are possible using different liquids, so for proper understanding the phenomena there are many possibilities. Such experiments have to be conducted in tubes of different dimeters including capillary tube. Due to capillarity the mercury is depressed and water rises in capillary tube. Practically viscosity offers internal resistance/friction to movement of fluid. Thus, consequently the glycerine column must attain desired height after certain interval. Further angle of contact for glass and mercury is obtuse (does not wet glass) and that of glass and water is acute (wets glass), apparently this effect also may influence the height of water column. The heights of liquid columns must be as above if eq. (1) is precisely obeyed for other liquids than mercury. If not then P will also depend upon other characteristics of fluids, then the method of measurement of pressure using mercury column would be regarded as standard and mercury as ideal liquid.

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Under preparation

4. **Alternate Theory On Rising, Falling and Floating bodies/Generalized form of Archimedes Principle**

Ajay Sharma

Fundamental Physics Society His Mercy Enclave

Post Box 107 GPO Shimla 171001 HP India

email: ajay.pqr@gmail.com

In the existing literature there are no equations which may explain the natural motion (when no external forces act on the system, and medium has sufficiently large magnitude and at rest) of falling and rising bodies (i.e. 0.1

mgm or less, 50 kg or more; and spherical, flat, thin foil or distorted shaped may have holes or twists at the surfaces such that density remains precisely the same) quantitatively i.e. distance travelled in certain time in various fluids. To explain such phenomena Archimedes' principle, Stokes' law and drag force are used.

According to Archimedes' principle in fluids the bodies rise or fall with constant acceleration or variable velocity.

Stokes' law has been put forth under five postulates in 1845. The has been experimentally verified with an accuracy of a few tenths of 1% by Arnold in 1910 in case of falling spheres of rose metal of radii 0.002 cm or V= $33.524 \times 10^{-9}$ cc. in water. Thus it is applicable in extremely narrow range. Stokes' law, is regarded as to hold good in rising bodies (if velocity is negative), but no experiments have been conducted to confirm it.

According to Archimedes' principle if $D_m$ and $D_b$ remains the same then theoretically all bodies should fall or rise in fluids (the principle sets no specific constraints on maximum magnitude of medium) with CONSTANT ACCELERATION. This prediction so for has not been quantitatively confirmed. However, bodies also move with constant velocity (Stokes' law). It is equally possible that bodies may also fall with VARIABLE ACCELERATION under suitable conditions.

**Constraints on existing theories**

### 1.2 Archimedes' Principle

According to Archimedes principle the decreases in weight of body is equal to weight of fluid displaced by body.

The equations based upon the principle became derivable, after 1935 years of its enunciation i.e. in 1685 when Newton published *The Principia* [2]. It is pertinent to mention here Archimedes enunciated the principle for determination of densities and at later stage its applications were extended to phenomena of rising, falling and floating bodies. Archimedes principle is qualitatively used to explain the basic phenomena of rising, falling and floating bodies. For example body falls in fluid if $D_b > D_m$ , body rises in fluid if $D_b < D_m$ and body floats in fluid if $D_b = D_m$. The resultant weight of body in medium is difference between weight ($VD_bg$) and upthrust ($VD_mg$ ) i.e.

$$W = (D_b - D_m)Vg = (1 - \frac{D_m}{D_b})V D_b g \quad (1)$$

If body is in vacuum then, W =mg and body falls with same acceleration. Due to the resultant weight W, the body is accelerated downwards [4]. So in fluids resultant acceleration G (acceleration in fluid) from downward weight can be determined from W as,

$$G = (1 - \frac{D_m}{D_b})g \quad (2)$$

Niebauer [5] has confirmed that bodies fall with maximum acceleration g in vacuum.

In vacuum $D_m=0$, $G = g$

(3)

Likewise analogously resultant upthrust u (when upthrust is more than weight )and resultant upward acceleration are,

$$u=(D_m V - D_b V)g = (\frac{D_m}{D_b} - 1)VD_b g \quad (4)$$

and $$H = (\frac{D_m}{D_b} - 1) g$$

(5)

These may be regarded as extended applications of Archimedes principle (as they appear to logically follow but not experimentally confirmed). It is pertinent to mention here Archimedes enunciated principle for determination of densities and at later stage its applications were extended to phenomena of rising, falling and floating bodies. But even now quantitative experiments over wise range of parameters have not been conducted yet The predictions from eq.(5) can be experimentally confirmed in sensitive experiments.

Thus according to Archimedes principle if $D_m$ and $D_b$ are the same; then all bodies irrespective of mass and shape (defined earlier) should fall or rise with precisely constant acceleration. But this fundamental prediction has not been experimentally confirmed yet.

**Archimedes' Principle and quantitative displacements of bodies.**

The displacements of bodies when fall with constant acceleration (the principle theoretically predicts the same) in vacuum and fluids are,

$$S=\frac{gt^2}{2} \qquad (6)$$

The eq.(6) follows from kinematical equation $S = ut+\frac{at^2}{2}$ in vacuum. If the resultant acceleration is constant in fluid as in eq.(6) then distance travelled is given by

$$S = \frac{\left(1-\frac{D_m}{D_b}\right)gt^2}{2} \qquad (7)$$

Conceptually and mathematically eq.(7) is applicable if resultant acceleration is constant. Similarly for various rising bodies displacement in fluids is,

$$S = \frac{\left(\frac{D_m}{D_b}-1\right)gt^2}{2} \qquad (8)$$

But theoretically according to the principle i.e. Eq.(5) the bodies (defined earlier) also rise with constant acceleration in fluids (irrespective of depth); that too against gravity i.e. inverse square law of attraction.

Theoretically Archimedes principle predicts that a body of cork ($240 kg/m^3$) irrespective of mass and shape, should rise through 139.324 m in 3s) in water.

To confirm the prediction from Archimedes' principle about the rising bodies (a body of cork ($240 kg/m^3$) irrespective of mass and shape in water should rise through 139.324 m in 3s) media of different dimensions should be considered; as magnitude of medium is likely to be very significant.

**Constraints on eq.(7-8):** The Eqs.(7-8) are only applicable if resultant downward and resultant upward accelerations are precisely constant. The resultant acceleration will be constant if medium has sufficient large in magnitude (and remain at rest) and symmetrical body moves in medium.

If the resultant downward acceleration is constant then according to Archimedes' principle i.e. Eq.(7) the bodies of aluminium of mass 10 gm (distorted) and 10 gm (spherical) or 1mgm ( flat) should fall through 27.7956m in 3s; in water but this prediction has not been experimentally confirmed, even at macroscopic level.

The equations based upon Archimedes principle are not applicable if motion is non-accelerated.

**1.5 Archimedes' Principle And Floating Bodies**

According to the principle the bodies (irrespective of mass and shape) float in media; if

Upthrust = weight or $VD_mg=VD_bg$ or $D_m=D_b$.

Density of medium = Density of body

Under this condition from Eqs (2,5) both resultant downward acceleration G and resultant upward acceleration H are zero; and the body is regarded at rest. According to it when body floats (completely submerged) its shape in completely insignificant by all means.

In first stage experiments the mass which balloon supports is found to depend upon the shape of balloon e.g. an umbrella shaped balloon of the same volume supported more mass than long pipe shaped balloon [ ]. The volume of balloon of both the shapes us same. Thus to account for the shape of balloon, purposely upthrust is regarded as proportional to weight of fluid displaced thus the principles has been generalised [2]. The constant of proportionality thus comes in picture is regarded as to account for shape of balloon and other relevant factors. To understand the completely submerged floating bodies critically, the bodies of non-hygroscopic plastic [ ] should be fabricated. The bodies should be of various shapes and densities slightly less or more than that of water should be fabricated to conduct experiments. Such experiments should be conducted in fluids of high density (mercury) and viscosity (glycerine).

| **Sr No** | Body ($kg/m^3$) | Resultant Acceleration $G=(1-\frac{D_w}{D_b})g$ | Distance travelled in water S = | Resultant acceleration dependent on upon $D_m$ and $D_b$ | Resultant acceleration is independent on all other |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| | | | $\frac{\left(1-\frac{D_m}{D_b}\right)gt^2}{2}$ | | factors. |
| **1** | Aluminium (2700 kg/m$^3$**)** | | | | |
| **2** | Steel ( 7800 kg/m$^3$**)** | | | | |
| **3** | Silver (10500 kg/m$^3$ **)** | | | | |
| **4** | Platinum (21,500 kg/m$^3$ **)** | | | | |
| **5** | | | | | |

### Factors not taken in account by Archimedes Principle

From the mathematical equations it is evident that Archimedes principle does not take in account the significant factors regarding body and medium.
**Body:** The principle does not take in account the shape of body and mass of body, as these two factors don't involve in mathematical equations.
**Medium**: The principle does not taken in account the magnitude of medium, motion of medium, convectional currents, surface tension and viscosity of medium etc. These are the factors not taken in account by the principle but can influence the results.

### 1.1 Stokes' Law

As equations based upon Archimedes principle are applicable if the bodies move with precisely constant acceleration. Stokes law is applicable if body moves with constant acceleration.
Stokes in 1845 put forth that under five postulates [2,6] small spheres of radius r, in fluid of coefficient of viscosity $\eta$ fall with Constant Velocity c or Zero Acceleration, which is given by

$$c = \frac{2r^2\left(1 - \frac{D_m}{D_b}\right)gD_b}{9\eta}$$

(3.1)9

In 1910 Arnold verified Eq. (9) in water with an accuracy of a few tenths of 1% for sphere of rose metal of radii 0.002 cm i.e. V= 33.524 × $10^{-9}$ cc. Thus it is applicable in extremely narrow range. Thus sphere of radii more than 0.002 cm fall with a variable velocity or motion is accelerated.
In this case the distance travelled can be given by

$$S = ct = \frac{2r^2\left(1 - \frac{D_m}{D_b}\right)gD_b}{9\eta}\ t$$

If all above conditions hold good for rising bodies then equation for velocity can be written as

$$C = \frac{2r^2\left(\frac{D_m}{D_b} - 1\right)gD_b}{9\eta} \qquad (10)$$

Similarly the distance travelled by body in this range is

$$S' = Ct = \frac{2r^2\left(\frac{D_m}{D_b} - 1\right)gD_b}{9\eta}t$$

Similarly the distance travelled by body in this range is

The Eq.(10) can be used to determine the $C = \frac{2r^2\left(\frac{D_m}{D_b} - 1\right)gD_b}{9\eta}$ viscosity of fluids, purposely a method has been described by the author[1].

So purposely experiments are required to be conducted to draw distinct boundary about characteristics of bodies and media for which

(i) Archimedes' principle (i.e. bodies fall with constant acceleration)

(ii) And Stokes' law (i.e. bodies fall with constant velocity) holds good.

It is just possible that Eqs.(2,5) may be justified under certain conditions (as in case of Stokes' law). For certain typical mass and shape bodies may fall with variable acceleration; then it will be accounted for by none of two.

### 1.3 Drag force

The total resistance of plate (body) in direction of fluid stream is called drag force [7] and in magnitude is given by,

$$D=CD_m AU^2 \qquad (11)$$

where C is drag coefficient, A is area of cross –section of body, and U is relative velocity (constant and high in magnitude) of body in medium. The drag force is calculated for moving submarine, airship, cars ,cyclists etc. The magnitude of U is very high. When bodies fall down in media then their speeds are variable. Thus U can be positive or negative or zero. In case of natural motion of bodies the drag force is not applicable. Resnick[8] has quoted the velocity of U in the following way,

$$U=\left(\frac{VgD_b}{CAD_m}\right)^{1/2} \qquad (12)$$

But Resnick has neglected a significant factor upthrust , if the same is taken in account then eq.(12 ) becomes

$$U=\left(\frac{Vg(D_b - D_m)}{CAD_m}\right)^{1/2} \qquad (13)$$

Now in vacuum ($D_m$ =0) both eqs.(12-13) attain infinite form i.e.

$$U = \infty \qquad (14)$$

The postulate of Special Theory of Relativity, restricts velocity more than speed of light. Also it is not experimentally achieved.

## 2.0 The Rigorous Requirement Of An Alternate Theory

An attempt has been made to develop a theory on rising, falling and floating bodies taking all relevant factors in account. In the existing physics Archimedes principle and Stokes law are two principles used for explaining the motion of rising, falling and floating bodies. Archimedes principle states that bodies fall with constant acceleration (but with reduced magnitude than g ) in media. But the observation that why a body of steel of mass 1mgm falls slowly in water than body of steel of mass 10 kg cannot be explained on the basis of these equations ((())). The reason is that equations of distance travelled are independent of mass. Theoretically bodies may rise upward with constant acceleration in the media. In addition equations are applicable if bodies fall with CONSTANT ACCELERATION or VARIABLE ACCELERATION. The conditions of applicability of Stokes law are different. It is applicable if body falls with CONSTANT VELOCITY or ZERO ACCELERATION. So both the laws are applicable in the respective range.

Hence to explain the phenomena over a wide range (motion may be with CONSTANT VELOCITY or CONSTANT ACCELERATION or VARIABLE ACCELERATION); taking all factors in account ( i.e. mass, shape and angle at which body is dropped, magnitude, characteristics motion of medium and convectional currents etc.); an alternate or complete theory on rising, falling and floating bodies has been formulated as below.

### 2.1 The Background Of An Alternate Or Complete Theory

An alternate or complete theory on rising, falling and floating bodies has been theoretically formulated taking in account the limitations of existing theories. Here approach may be initially appearing postulate like. Some factors are included to explain the phenomena which are not taken in account in Archimedes' principle.

**Force exerted by fluid**

The body may be in any fluid or medium (which has natural tendency to flow); primarily it is under the influence of gravity i.e. body exerts force ($F_b$) on the fluid as attracted by the earth. As a reaction medium also exerts force ($F_m$) on body. The force exerted by medium (may be in motion, of any magnitude, viscosity etc.) includes upthrust and other relevant factors. The magnitude of $F_m$ (which includes upthrust and other factors) may be regarded as proportional to density of medium $D_m$ mainly, (also upthrust, $u \propto D_m$).

So,

$$F_m = a_m D_m \qquad (12)$$

The coefficient $a_m$ which is obtained by removing the sign of proportionality (like coefficient of thermal conductivity, drag coefficient etc.), it depends upon the characteristics of medium and can be expressed in one of the simplest way as,

$$a_m = x_m\, y_m \qquad (13)$$

where $x_m$ accounts for magnitude and shape of medium; $y_m$ its state of motion along with other relevant factors like temperature, viscosity, convectional currents, surface tension etc.

**Justification Of $a_m$**

**Understanding effect of $x_m$ :** The significance of effect of magnitude of medium (i.e. $x_m$) can be understood in the following way. In falling bodies Stokes' law has been reasonably well studied but in limited range only, in this case magnitude and state of motion of medium has been clearly defined (i.e. infinite in extent; and at rest). If motion of spheres has been studied in containers then effect of walls leads to a correction factor. It is confirmed that bodies fall with constant acceleration g in vacuum only due to gravity. Also the bodies may fall with constant acceleration in fluids (but with reduced magnitude depending upon values of $D_m$ and $D_b$) under certain conditions as already mentioned.

If this prediction is experimentally confirmed even under certain conditions; then magnitude of medium and shape of container will be significant. According to the principle a body of cork (say, r=1cm) should rise through 3.8701m in 0.5s. Let there be four tanks filled with water having dimensions 10m☓ 10m☓ 10m, 5m☓ 5m☓ 5m, 4m☓ 4m☓ 3.8701m, and 0.4mx☓ 0.4mx☓ 3.8701 m. Now it has to be experimentally confirmed whether in all cases bodies rise upward through 3.8701m in 0.5 s or not as predicted by Archimedes' principle. If the prediction is not confirmed in some cases then it would be due to magnitude of medium only. In case of falling bodies of different shapes effect of magnitude of medium can be studied at different depths. Archimedes' principle is only valid if medium is at rest. But an alternate or complete theory is applicable even if medium is in motion; and this effect is taken in account in $y_{m.}$

**Understanding effect of $y_m$ :** Due to viscous force ($F=6\pi\eta rc$) bodies attain constant velocity, under the feasible conditions. At $20^0$C density of water is 998.23

kg/m$^3$ and that of glycerine near 1260 kg/m$^3$. Whereas coefficient of viscosity of water at 20$^0$C is 0.00101 deca poise; and that glycerine 1.069 deca poise. Thus coefficient of viscosity is 1058.4 times more than that of water, and density is only 1.2622 times more. As small spheres fall with constant velocity in viscous media thus effect of viscosity of medium is justified. It is confirmed by Arnold while justifying Stokes law. The motion can also be studied in highly viscous fluids like glycerine.

The surface tension is significant as small thin foil rests over the surface of water; whereas a small sphere of the same mass sinks in water.

**Force exerted by body**

Likewise the magnitude of force $F_b$ exerted by body (irrespective of mass, shape, distortion and angle at which body is dropped in medium) on the medium (includes weight and other factors) can be regarded as proportional to $D_b$ (also weight, $w \propto D_b$). So

$$F_b=a_bD_b \tag{14}$$

The coefficient $a_b$ is obtained after removing proportionality (like coefficient of viscosity, drag coefficient etc.) depends upon characteristics of body and may be expressed in one of the way as

$$a_b = x_b y_b \tag{15}$$

where $x_b$ accounts for magnitude of body, $y_b$ for shape or distortion of body and angle at which it is dropped and other relevant factors.

**Justification Of $a_b$**

**Understanding effect of $x_b$** :It has been experimentally confirmed, even in recent sensitive experiments that bodies fall with the same acceleration g in vacuum only. Thus in complete vacuum a minute particle of steel of mass a few macrogram or less and 50 kg or more (irrespective of shape) should fall through equal distances in equal intervals of time (i.e. with the same acceleration). This prediction is based upon eq.(7). But it is not true if the motion of bodies is observed in fluids (say, water). The small spheres (a particular shape) and of particular mass, (33.524 $\times$ 0$^{-9}$ $D_b$gm.) fall in fluids with constant velocity or zero acceleration (the essence of Stokes' law).

It is equally possible that bodies may fall or rise with variable acceleration depending upon the mass and distortion of body. Hence in fluids effects of mass and shape of body have to be taken in account. Such experiments can be confirmed in highly dense and viscous fluids.

**Understanding effect of $y_m$.** To understand the effect of shape ($y_b$) in a concrete way, consider two bodies of steel (7800kg/$m^3$) having masses 62.4 gm each i.e. V=8cc. Let one body is a cube of each side 2 cm i.e. 2cm X 2cm X 2cm; and the other body be thin foil i.e. 50 cm X 16cm X 0.01 cm. Now this flat body falls slowly in water (contrary to Archimedes' principle i.e. Eq.(7); so this effect is accounted for by $a_b$ in an alternate or complete theory. In case of this foil its weight (i.e. measure of force exerted by body), and hence $F_b$ on unit area of water decreases considerably compared to the cube of the same volume and density. But below the unit area of body water column (say, a tank of water) remain the same. The force $F_m$ exerted by medium (water), on effective unit area of body remains the same. So in case of this foil $F_b$ per unit area decreases but $F_m$, remains the same hence a thin foil compared to sphere or cube of same $D_b$ and V falls slowly in water considerably. To draw concrete conclusions about rising bodies some specific quantitative experiments are required, which have not been conducted yet. The units of $a_b$ and $a_m$ are $Nkg^{-1}m^{-3}$ or $m^4s^{-2}$ in SI system.

**Comparative study of $F_m$ and $F_b$ or Hidden Ratio**

The ratio of magnitudes of $F_m$ and $F_b$ is called Hidden –Ratio (HR),

$$HR = \frac{F_m}{F_b} = \frac{a_m D_m}{a_b D_b} = \frac{x_m y_m D_m}{x_b y_b D_b} \qquad (3.16)$$

**Explanation For Motion Of Bodies** If HR is more than one, then force exerted by medium dominate than that exerted by body; hence body rises in that medium. If HR is less than one then force exerted by body dominate than that exerted by medium and body falls in that medium. If HR is equal to unity then forces exerted by body and medium on each other are equal and body floats. The Falling Factor (FF) and Rising Factor (RF) are measures of tendency of body to fall or rise. Thus higher the FF and RF, higher is the tendency of body to fall or rise. The FF and RF can be calculated as

$$FF=1-HR= (1-\frac{x_m y_m D_m}{x_b y_b D_b}) \qquad (3.17)$$

$$RF=HR-1= (\frac{x_m y_m D_m}{x_b y_b D_b}-1) \qquad (3.18)$$

**2.2 Standard Conditions.** Under certain conditions (may be termed as standard conditions) the values of $a_b$ and $a_m$ are regarded as unity for simplicity. Thus under standard conditions HR, FF and RF become

$$HR= \frac{D_m}{D_b} \qquad (19)$$

$$FF= (1-\frac{D_m}{D_b}) \qquad (20)$$

$$RF= (\frac{D_m}{D_b}-1) \qquad (21)$$

The standard conditions can be understood in the following way. According to the existing literature bodies fall with CONSTANT VELOCITY as in Eq.(9); and also with CONSTANT ACCELERATION (variable velocity) as in Eq.(2). However this prediction is yet to be experimentally confirmed precisely that up to which extent the equations are obeyed. This prediction may be true under certain conditions. Also in some cases the bodies may fall with VARIABLE ACCELERATION. Under these three types of motion the standard conditions are different. The conditions under which these predictions are obeyed, need to be determined.

(i) The bodies only fall with constant velocity under five postulates as put forth by Stokes, theoretically. These postulates are regarded as standard conditions i.e. if these postulates are satisfied then values of $a_m$ and $a_b$, may be regarded as unity. The conditions under which these predictions are obeyed, need to be determined. (ii) The standard conditions of body and media have been discussed in the forth coming discussion. These are conditions of body and media (mass, magnitude etc.) under which the equations are likely to be obeyed, and the state of other bodies may be compared with this. For specification of standard conditions sensitive experiments with the most sophisticated equipments must be conducted. These conditions may be relative

(ii) If the bodies fall with constant acceleration; then in one of the ways the body may be regarded as standard if it is of steel (7800kg/$m^3$) of mass 10 gm ($x_b$=1$m^2$s-$^1$) and spherical in shape ($y_b$=1$m^2s^{-1}$). Similarly medium may be regarded as standard in one of the ways if water is filled in cube of each side 5m or 10m ($x_m$=1$m^2s^{-1}$) and water is at rest ($y_m$=1$m^2s^{-1}$).

If the motion of the bodies is observed in air in closed hall of each side 10m, then medium may be regarded as standard ($a_m$=1$m^4s^{-2}$). Also the standard conditions may be attributed in different ways.

Then body of wood (600kg/$m^3$) of mass 10gm ($x_b$=1$m^2s^{-1}$) and spherical in shape ($y_b$=1$m^2s^{-1}$) may be regarded as standard ($a_b$=1$m^4s^{-2}$). Similarly medium may be regarded as standard if water at 20$^0$C is filled in cube of each side 5m or 10m ($x_m$=1$m^2s^{-1}$) and is at rest ($y_m$=1$m^2s^{-1}$). Thus standard conditions are similar to in case of falling bodies.

### 2.3. The displacement in terms of FF and RF

(i) **Falling bodies:** Higher the FF, higher is the displacement through which body falls, in time t. Thus.

$$S \alpha \ (FF)t \quad \text{or} \quad S = A\,(FF)t \qquad (22)$$

Where A is co-efficient of proportionality. Its value depends upon involved experimental variables and has units $ms^{-1}$. With help of eqs.( 17,20), Eq.(22) becomes,

$$S = A\left(1 - \frac{x_m y_m D_m}{x_b y_b D_b}\right)$$

(23)

$$S = A\left(1 - \frac{D_m}{D_b}\right)t \qquad (24)$$

The bodies may fall with constant velocity, constant acceleration (variable velocity) and variable acceleration; the general Eqs.(23-24) remain the same, but only the value of A varies depending upon the situation. The values of A are determined as below.

**(a) When bodies fall with constant velocity:** The constant velocity of body in fluids is given by Eq. (1); also in this case the constant velocity is equal to average velocity i.e. $V_{av}$=c. Also calculating average velocity from eq.(24) we can write,

$$V_{av}=c= A(1-\frac{D_m}{D_b}) \qquad (25)$$

Thus comparing Eq. (25) with Eq. (9), as velocity remains constant, we get

$$A=\frac{2r^2 D_b g}{9\eta} \qquad (26)$$

$$V_{av} = \frac{2r^2\left(1-\frac{D_m}{D_b}\right)gD_b}{9\eta} \qquad (27)$$

So,

Arnold verified Eq.(4) for small spheres of rose metal of radii 0.002 cm in water. The value of $\eta$ for water at 20$^0$C is 0.01 poise then

$$A=0.8888888 \times 10^{-4} D_b g \qquad (28)$$

and $$V=0.8888888\ 10^{-4} D_b(1-\frac{D_m}{D_b})g \qquad (29)$$

From Eq.(29) velocities for steel and aluminium bodies in water at 20$^0$C are 0.5925cm/s and 0.1482 cm/s. Thus there is a complete agreement between predictions of Eq. (29) based upon an alternate theory and existing experimental findings.

**(b) When bodies fall with constant acceleration:** It has been confirmed that the bodies fall with constant acceleration equal to g in vacuum. Also according to Archimedes' principle i.e. Eq.(2) bodies fall with constant acceleration but with reduced magnitude in fluids depending upon values of $D_m$ and $D_b$. So far it has not been experimentally confirmed; yet under certain conditions it may be true. Both the cases are discussed as below.

(i) When bodies fall with constant acceleration in vacuum; In this case displacement depends upon time as $t^2$ as in Eq.(6). Thus value of A in Eq.(22) should be of the form

$$A=kt \tag{30}$$

k can be written as $k_0$ for vacuum. So

$$A=k_0\, t \text{ (in vacuum)} \tag{31}$$

In vacuum, Eqs.(23-24) become

$$S=At=k_0\, t^2 \tag{32}$$

Now Eq.(6) and Eq.(32) both give displacements in vacuum, hence

$$k_0 = \frac{gt}{2} \tag{33}$$

The value of A and displacement S in vacuum becomes,

$$A=\frac{gt}{2} \tag{34}$$

and $$S=\frac{gt^2}{2} \tag{35}$$

(ii) When bodies fall with constant acceleration in fluids.

In this case also displacement depends upon time t as t. Thus value of A will be of the form ($k=k_m t$ for the medium)

$$A=kt=k_m t^2 \quad \text{(in medium)} \tag{36}$$

Thus Eqs. (23,24) become

$$S = k_m \left(1-\frac{x_m y_m D_m}{x_b y_b D_b}\right)t^2$$

(37)

$$S=k_m \left(1-\frac{D_m}{D_b}\right)t^2 \tag{38}$$

If the body is under standard conditions and falls with precisely with constant acceleration in fluids; then value of $k_m$ can be determined after estimating the distance S travelled in time t.

**(c) When body falls with variable acceleration:** The displacement depends upon time t as $t^2$ only if it falls with constant acceleration. In this case it may depend upon time as t. Further $k_m$ may have some complex dependence on involved factors i.e. mass, shape, distortion and angle at which body is dropped; magnitude of medium, shape of its container and its state of motion along with other factors like temperature, viscosity etc. In such cases the value of $k_m$ can be established after some sensitive tests.

**Rising Bodies:** Similarly the displacement when bodies rise upward is proportional to the RF and time t. Hence displacements are analogous to Eqs.(23,24) and can be written as

$$S=B\left(\frac{x_m y_m D_m}{x_b y_b D_b}-1\right)t \qquad (39)$$

$$S=B\left(\frac{D_m}{D_b}-1\right)t \qquad (40)$$

where B is coefficient and determined experimentally. Its nature and magnitude are precisely identical to A. In the existing literature there is no quantitative data about rising bodies to draw concrete conclusions. So some quantitative experiments are required to ascertain the characteristics to B.

### 3.1 The falling bodies and alternate theory

According to alternate theory, the bodies fall down if HR is less than one i.e. force exerted by body is more than that exerted by medium. The measure of tendency of body to fall is Falling Factor, given by Eqs.(17,20) ; thus higher the FF, higher the tendency of body to fall.

(i) **In vacuum.** In complete vacuum $D_m$ can be regarded as zero and also HR is zero; which is less than one hence bodies fall down. Further FF for all bodies in vacuum is unity, hence possess equal tendency to fall. Thus according to Eqs.(37,38) all bodies travel equal distances in equal intervals of time. In language of existing science all bodies fall with the same acceleration. It is justified from eq.(35) starting from eq. (24).

(ii) **In air.** The HRs from Eq.(19) i.e. under standard conditions for bodies of aluminium (2700 $kg/m^3$), steel (7800 $kg/m^3$), Silver (10500 $kg/m^3$) and platinum (21500 $kg/m^3$) in air (1.293 $kg/m^3$) are 0.0004788, 0.0001657, 0.0001213 and 0.0000601 which are less than one hence bodies fall down. The FFs for these bodies from **eq. (23)** are 0.999251, 0.999834, 0.999877 and 0.999939; hence fall down. Now the values of FFs for these bodies in air are less than one (i.e. that for in vacuum); hence the bodies fall down in air slowly that in vacuum.

If the body of steel of mass 10 gm ($x_b$=1$m^2s^{-1}$) and spherical in shape ($y_b$=1$m^2s^{-1}$) is regarded as standard and it falls through distance 100 cm in time t. Let $k_m$=$k_{sa'}$ for body of steel in air. Then for body of steel in air Eq.(38) becomes,

$$S=100=k_{sa}\,(0.999834)\,t^2 \quad \text{or} \quad k_{sa}=100/0.999843t^2$$

(41)

The body of aluminium in air can be regarded as standard in air in the following way. Let value of $k_m$ for body of aluminium in air is $k_{aa}$ and is equal to $k_{sa}$ i.e. $k_{sa}$= $k_{aa}$ ; if fall with constant acceleration in air. Let in air the body of aluminium falls through distance S, then eq.(38) with help of eq.(41) becomes

$$S=k_{aa}\,(0.999521)t^2=99.9677$$

(42)

Thus the body of aluminium spherical in shape will be regarded as standard in air which travels distance equal to 99.9687 cm in time t; in which body of steel of mass 10 gm, spherical in shape falls through 100cm. It is just possible that this prediction may be confirmed for body of aluminium of mass precisely equal to 10 gm or nearly equal to 10 gm ( the shape of body can be slightly different from spherical shape).

(iii) **In water:** The HRs for bodies of aluminium, steel, silver and platinum in water (998.23 $kg/m^3$) are 0.3697148, 0.1279782, 0.0950695 and 0.0464293 which are less than one. The FFs for these bodies in water from **Eq.(3.23)** are 0.630285, 0.872022, 0.872022, 0.904931 and 0.953571 respectively. Thus the FFs for same bodies are less in water than air; hence bodies fall slowly in water comparatively which is true.

But it is required to be quantitatively confirmed. It means exact distance travelled by body in time must be measured.

As in previous case the bodies can be regarded as standard. The body of aluminium can be regarded as standard in water in the following way. For standard body of steel ($a_b$=1$m^4s^{-2}$), in water ($a_m$=1$m^4s^{-2}$ i.e. tank of water of such side equal to 5 m and water is at rest) if it travels distance 100 cm in time t, the Eq.(38) becomes

$$100=k_{sw}\,(0.872022)\,t^2 \quad \text{or} \quad k_{sw} = \frac{100}{0.872022t^2} \qquad (43)$$

Here $k_{sw}$ is value of $k_m$ for body of steel in water. Let value of $k_m$ for body of aluminium in water is $k_{aw}$ which is equal to $k_{sw}$ i.e. $k_{aw}=k_{sw'}$ if falls with constant acceleration. If in tank of water of each side 5 m ($x_m$=1$m^2s^{-1}$) and water is at rest ($y_m$=1$m^2s^{-1}$), body of aluminium fall through distance S in time t. Then the distance S from Eq.(3.41)38 becomes

$$S=k_{sw}\,(0.630285)t^2=72.2785 \text{ cm} \qquad (44)$$

Now that body of aluminium in water can be regarded as standard which falls through distance 72.2785 cm in time t, in which a body of steel of mass 10 gm spherical in shape falls through 100cm in the same time. If this prediction is nearly confirmed for body of aluminium of mass 10gm, then slight deviations from the spherical shape can be considered for the precise confirmation.

### 3.2 The rising bodies and alternate theory

(i) In air. To discuss the upward motion of hydrogen and helium filled balloons in air; it is hypothetically assumed that for simplicity that the densities of balloons are equal to those of gases; or the densities of balloons have to be precisely measured The densities of hydrogen and helium gases are 0.0899 kg/$m^3$ and 0.1785 kg/$m^3$; thus for these HRs in air are 14.3826 and 7.2436. The RFs for balloons from **Eq. (3.24)** in air are 13.3826 and 6.2436; thus hydrogen filled balloon (or bubble) rises quickly than helium filled one.

**Justification of Maxwell's distribution Law:** According to Maxwell's law of distribution of molecular speeds[10] lighter gases escape easily from the earth's atmosphere. It can be justified on the basis of alternate theory. Here let us discuss motion of hydrogen, helium, oxygen (1.428 kg/m$^3$) and carbon dioxide (1.977 kg/m$^3$); considering or assuming each as individual body in air. In this case HRs for $O_2$ and $Co_2$ are less than one in air i.e. 0.905462 and 0.65402. The FFs for these are 0.094537 and 0.34598; hence fall down in air. Thus lighter gases ($H_2$ and $He_2$) escape easily from the earth's atmosphere due to higher $RF_s$ i.e. 13.382 and 6.24; and heavier gases ($CO_2$ and $O_2$) fall down or settle at the bottom due to higher FFs i.e. 0.34598 and 0.65402. The FFs for these are 0.094537 and 0.34598; hence fall down in air. Thus lighter gases ($H_2$ and $He_2$) escape easily from the earth's atmosphere due to higher RFs i.e. 13.382 and 6.24; and heavier gases ($Co_2$ and $O_2$) fall down or settle at the bottom due to higher FFs i.e. 0.34598 and 0.094537. Thus deductions from an alternate theory are consistent with Maxwell's law of distribution of molecular speeds; hence with experimental observations.

(ii) **In water:** The RFs for bodies of cork (240 kg/m$^3$) and wood (600 kg/m$^3$) from Eqs. (21) i.e. under standard conditions are 3.1593 and 0.66372, hence rise upward. As RF for cork is more than that of wood; hence cork rises upward quickly than wood. The bodies of cork and wood are fabricated such that they don't absorb water or non-hygroscopic bodies[ ] having densities equal to wood and cork.

Let standard body of wood ($a_b$=1 m$^4$ s$^{-2}$), in water (tank of each side equal to 5 m and water is at rest i.e. $a_m$=1m$^4$ s$^{-2)}$ travels distance 100 cm in time t. If value of B for wood in water is $B_{ww}$ then Eq.(40) becomes

$$S=B_{ww}(0.66372)t \quad \text{or} \quad B_{ww} = \frac{100}{0.66372t} \qquad (46)$$

Then body of cork in water can be regarded as standard in the following way. Let value of B for cork in water is $B_{cw}$ which is equal to $B_{ww}$ i.e. $B_{cw}=B_{ww}$ if rises with constant acceleration. If in tank of water ($a_m$=1m$^4$ s$^{-2}$) a body of cork ($a_b$=1m$^4$s$^{-2}$) rises through distance S in time t. Then value of S for body of cork from Eq. (40) with help of eq.(46) can be calculated as

$$S=B_{cw}\,(3.1593)\,t= 475.9989 \text{ cm} \qquad (47)$$

Now that body of cork in water ($a_m$=1m$^4$s$^{-2}$) will be regarded as standard which rises through 475.9989 cm in time t, in which body of wood rises through 100 cm.

Now slight variations in shape of body of cork of mass 10gm can be considered: so that this prediction is precisely confirmed for body of mass 10gm.

In case this prediction is justified for some other body of cork of mass other than 10 gm in tank of water of different dimensions than 5 m (water is at rest) then that body and tank is regarded as standard. Further such experiments can be conducted in highly viscous fluids like glycerine to understand the effect of viscosity in case of rising bodies.

### 3.3 The floating bodies and alternate theory

According to this theory the body floats, if HR is equal to unity, the magnitudes of forces i.e. $F_m$ and $F_b$ become equal. Thus in Eqs.(17-18,20-21) both RF and FF become equal to zero, hence also the distances travelled from Eqs.( 23-24) and eq. (39-40).

(i) **In air:** Let hydrogen filled balloon has RF equal to 3 (under standard conditions), thus it rises upward. As it rises upward the density of air decreases, hence HR. At some stage the force exerted by balloon and medium on each other become equal, then HR becomes unity. Both RF and FF and distances travelled from Eqs.( 20-21, 23-24, 39-40) become zero. Thus body floats at that stage i.e. neither rises nor falls.

(ii) A body of cork falls in air (FF=0.994612) and rises upward in water (RF=3.1593) and rests over the surface of water partially submerged. The small pins of steel sink in water due to definite FF equal to 0.872022. But if these pins are pricked to cork start resting at the surface of water and system (cork and steel) is partially submerged. As pins are continuously picked to cork; then density of system gradually increases and HR decreases. As soon as the force exerted by the system becomes more than that exerted by water due to gradual pricking of the pins to cork HR becomes less than one and body sinks.

### 4.0 Measurement Of $a_m$ And $a_b$.

So far phenomena under standard conditions are discussed. The values of $x_m$ $y_m$ and

$y_b$ can be determined easily in the following way; by comparing the unknown values with known ones.

(i) **Measurement of $x_b$:** Consider a steel body of standard mass 10 gm ($x_m$=1m$^2$ s$^{-1}$) and spherical in shape ($y_b$ =1 m$^2$ s$^{-1}$) is dropped in tank of water of each side 5 m ($x_m$=1m$^4$ s$^{-2}$) and water is at rest ($y_m$ =1m$^2$s$^{-1}$). Let body travels distance equal to 100 cm in time t. So Eq. (38) becomes,

$$100=k_{sw}(0.872022)\,t^2 \text{ or } k_{sw} = \frac{100}{0.872022t^2} \quad (49)$$

Let heavier body of steel of mass 10 kg or more ($x_m$≠1m$^2$s$^{-1}$) and spherical in shape ($y_b$=1m$^2$s$^{-1}$) travels distance 104 cm in time t (say $k_{sw}$ remains the same). So,

$$104=k_{sw}(FF)\,t^2$$

or FF = 104 / $k_{sw}t^2$ = 0.906903 (50)

Thus $x_b$ (now body is not standard) can be determined from Eq.(17) as;

$$0.906903=1-\frac{0.12798}{x_b} \text{ or } x_b=1.374679 \text{ m}^2\text{s}^{-1}$$

(51)

Thus value of $a_b$ ($x_by_b$) in this case is 1.374691 m$^4$s$^{-2}$

(ii) **Measurement of $y_b$.** Let a body of steel of mass 10 gm i.e. V=1.282051 cc ($x_b$=1m$^2$ s$^{-1}$) and flat in shape ($y_b$≠1m$^2$s$^{-1}$ i.e. 2X 2X 0.325127 cc or 2X 4X 0.1602563 cc is dropped in tank of water under standard condition ($a_m$=1m$^4$s$^{-2}$). Let this flat body (or even distorted travels distance 98 cm in time t, then FF can be 0.854581 as in Eq. (3.49). Then value of $y_b$ from Eq. (17) can be determined as,

$$0.854582=1-\frac{0.127978}{y_b} \text{ or } y_b=0.880069 \text{ m}^2\text{s}^{-1} \quad (52)$$

Thus in this case value of $a_b$ ($x_by_b$) will be 0.880069 m$^4$s$^{-2}$

**Measurement of $a_m$**

(iii) **Measurement of $x_m$.** Let steel body of mass 10 gm ($x_b$=1m$^2$s$^{-1}$) and flat in shape ($y_b$=0.880069 m$^2$s$^{-1}$) is dropped in tank of water of each side equal to 15 m ($x_m$=1m$^2$s$^-$

$^2$) and water is at rest ($y_b$=1m$^2$s$^{-1}$). The effect of magnitude of medium (if significant) can be understood in the following way. Let at some stage in first half (0-7.5m) a body of steel travels distance 99.998 cm in time t. Then in this case FF can be calculated equal to 0.872004 as in Eqs.(49).

$99.998=k_{sw}(FF)t^2$ or $k_{sw} = \dfrac{100FFt^2}{0.872022t^2}$

FF =0.872004

So $x_m$ from Eq.(17) is,

$$0.872004=1-\frac{0.127978x_m}{0.880069}$$

or $x_m$=0.8807931 m$^2$ s$^{-1}$ (53)

So in this case value of $a_m$ will be 0.8807931m$^4$s$^{-2}$.

Let at some stage the same body in second half (5-10m) falls through distance 100.002 cm in time t, then in this case FF can be calculated as 0.872039).

$100.002 = k_{sw}FFt^2 = \dfrac{100FFt^2}{0.872022t^2}$ or FF = 0.872039

Thus from Eq.(17) $x_m$ will be

$$0.872039=1-\frac{0.127978x_m}{0.880069}$$

or $x_m$=0.879952 m$^2$s$^{-1}$ (54)

Thus value of $a_m$ ($x_m y_m$) in this case will be 0.872039 m$^4$ s$^{-2}$.

(iv) **Measurement of $y_m$.** Consider a body of steel of mass 10 gm ($x_b$=1m$^2$s$^{-1}$) and flat in shape ($y_b$=0.880069 m$^2$s$^{-1}$) as in Eq.(52). Let it is dropped in tank of water of each side equal to 5m ($x_m$=1m$^2$s$^{-1}$) and water is in motion ($y_m \neq 1$m$^2$s$^{-1}$); may be rotated externally or shaken such that density of water remains the same. Let in this case distance travelled by body is 97cm, then FF can be calculated equal to 0.845861. as in eqs.(49-50). Then value of $y_m$ can be calculated from Eq.(17) as,

$$0.845861=1-\frac{0.127978y_m}{0.880069} \quad \text{or} \quad y_m=1.05997\text{m}^2\text{s}^{-1} \qquad (55)$$

So value of $a_m$ ($x_m y_m$) will be 1.05997 $m^4s^{-2}$. Likewise the value $a_m$ and $a_b$ in other cases (including rising bodies) can be calculated.

Thus determining the values of $x_i$'s and $y_i$'s the distances travelled can be calculated. But the process requires specific and precise experiments.

**Table1-Comparison of existing theories on rising, falling and floating bodies with an alternate theory in natural motion of bodies**

| Characteristics | Existing Theories | Alternate Theory |
|---|---|---|
| | **1. The Falling Bodies.** | |
| (i) Term | Resultant downward acceleration.<br><br>$G=(1-\frac{D_m}{D_b})g$. | $FF=(1-\frac{x_m y_m D_m}{x_b y_b D_b})$. |
| (ii) Displacement | $S=1/2\ Gt^2$ ( $S=at^2/2$) | S=A(FF) t. |
| (iii) Applicable if | G is constant. | No such constraint. |
| (iv) Preliminary predictions | All bodies fall with constant acceleration in fluids if $D_m$ and $D_b$ remain the same. | All bodies may not fall with constant acceleration depending upon $a_m$ and $a_b$. |
| (v) Typical predictions | All bodies of steel of mass 10 gm (distorted) and 10 gm (sphere) should fall in fluids equal distances in equal times. | These bodies should not fall through equal distances in equal times depending upon $a_i$' s. |
| (vi) Contradictions | In denser fluids | No such constraint. |
| (vii) Reasons for contradictions | G only depends upon $D_m$ and $D_b$ | Not applicable. |
| (viii) Stokes' law | Required, if applicable. | Not required. |
| (ix) Drag force | Not applicable | Not required. |
| | **2. The Rising Bodies** | |
| (i) Term | Resultant upward acceleration | Rising Factor |

| | | |
|---|---|---|
| | H=( $\frac{D_m}{D_b}$ -1)g | RF=( $\frac{x_m y_m D_m}{x_b y_b D_b}$ -1) |
| (ii) Displacement | S=1/2H$t^2$ | S=B(RF)t |
| (iii) Applicable if | H is constant. | No such constraint. |
| (vi) Dependence | H does not depend on mass and shape of body. | RF takes all such factors in account. |
| (v) Preliminary predictions | All bodies should rise with constant acceleration in fluids if $D_m$ and $D_b$ remain the same. | All bodies may not rise with constant acceleration depending upon $a_m$ and $a_b$. |
| (vi) Typical predictions | A body of cork of mass 10 gm (distorted) and 10 gm (sphere) should rise in water through 3.8701 m in time 0.5 s. | These bodies may not rise through 3.8701 m in 0.5 s depending upon values of $a_m$ and $a_b$. |
| (vii) Verification | Specific tests have not been conducted so far. | Quantitative tests have been suggested. |
| (viii) Stokes' law | Required, if applicable. | Not required |
| (ix) Drag force | Not applicable | Not required. |
| | **3. Floating bodies** | |
| (i) Term | Resultant acceleration, G&H | RF and FF |
| (ii) Condition | G and H are zero | RF and FF are zero |
| (iii) Equation | $D_m$=$D_b$ | $D_m$=$D_b$ |
| (iv) Typical prediction | A pallet of mass (flat) of mass 1 gm or less of density 13.60001 gm per cc should sink in mercury. The observation can be repeated with sphere. | The pallet may not sink depending upon values of values of $a_m$ and $a_b$. |

| | | |
|---|---|---|
| (v) Verification | In preliminary floating balloon tests in water it has not been found correct. | This has been justified in these balloons tests. |

# Part II Einstein's $E=mc^2$ and its generalized form

## Derivation of $\Delta E=\Delta mc^2$ : Revisited

Ajay Sharma

Fundamental Physics Society. His Mercy Enclave Post Box 107 GPO Shimla 171001 HP India

Email ajay.pqr@gmail.com

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[LENGTH CAN BE REDUCED ACCORDING TO REQUIREMENTS]

### Abstract

Einstein's Sep. 1905 paper in which $\Delta L=\Delta mc^2$ (light energy –mass equation) is derived, is not completely studied; and is only valid under special conditions of involved parameters.
The origin of $\Delta E=\Delta mc^2$ from $\Delta L=\Delta mc^2$ is completely speculative in nature, as $\Delta L=\Delta mc^2$ was initially derived for light energy –mass interconversion, then it was generalized for every energy $\Delta E=\Delta mc^2$. The factor $c^2$ has been arbitrarily brought in picture by Einstein. To obtain $L=\Delta mc^2$ Einstein retained term $v^2/2c^2$ ( compared to unity) without giving numerical values to v . If the value of v is considered in typical classical region , 1cm/s say ($v^2/2c^2 =5.55\times10^{-22}$ is negligible) then result is $M_b =M_a$. Thus conversion factor $c^2$ is arbitrarily brought in the picture as both the results i.e. $\Delta L=\Delta mc^2$ and $M_b =M_a$ are equally probable.
If body emits light energy, but measuring system is at rest even then Einstein's derivation is not applicable or valid. Einstein derived $\Delta L=\Delta mc^2$ under special conditions and speculated from it $\Delta E=\Delta mc^2$ without mathematical derivation. These are the limitations of the derivation.
If all values of parameters are taken in account then the same derivation also gives L $\alpha$

$\Delta mc^2$ or $L = A\,\Delta mc^2$, where A is coefficient of proportionality. There are numerous values of coefficients of proportionality in the existing physics. This is mathematically critical analysis, have no implications on experimentally established status of $\Delta L=\Delta mc^2$ ( $E=\Delta mc^2$).

**1.0 Description and critical analysis of Einstein's Thought Experiment**

In Einstein's derivation basic equation is

$$\ell^* = \ell\frac{\left[1-\frac{v}{c}\cos\phi\right]}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (1)$$

where $\ell$ is light energy emitted by body in frame (x,y,z) and $\ell^*$ is light energy measured in system (ξ, η, ζ ), and v is velocity with which the frame or system (ξ, η, ζ ) is moving. This is equation for Doppler principle for light for any velocity whatever [2].

**Einstein's perception[1]:** Let a system of plane waves of light, referred to the system of coordinates (x, y, z), possesses the energy l; let the direction of the ray (the wave-normal) makes an angle ϕ with the axis of x of the system [1]. Energy is a scalar quantity, having magnitude only, but according to eq.(1) it depends upon angle also.

If we introduce a new system of co-ordinates (ξ, η, ζ ) moving in uniform parallel translation with respect to the system (x, y, z), and having its origin of coordinates in motion along the axis of x with the velocity v.

Thus v is the relative velocity between system (x, y, z) and system (ξ, η, ζ ) . The body which emits light energy is considered stationary in the system (x,y,z) and also remains stationary after emission of light energy in the system (xy,z).

Let $E_0$ and $H_0$ are energies in coordinate system (x, y, z) and system (ξ, η, ζ ) before emission of light energy, further $E_1$ and $H_1$ are the energies of body in the both systems after it emits light energy. $E_i$ and $H_i$ include all the energies possessed by body in two systems. The various meanings of $E_i$'s and $H_i$'s are shown in Table I.

**Table I. Energies emitted before and after emission by body in Einstein's Sep. 1905 derivation.**

| Sr No | System (x,y,z) at rest | System(ξ, η, ζ ) moving with velocity v |
|---|---|---|
| 1 | **Before Emission $E_0$** | **Before Emission $H_0$** |
| 2 | **After Emission $E_1$** | **After Emission $H_1$** |

Then Einstein concluded that body emits two light waves of energy 0.5L each in system (x,y,z) where energy is $E_0$. Thus,

Energy before Emission = Energy after emission +0.5L + 0.5L

$$E_0 = E_1 + 0.5L + 0.5L = E_1 + L \tag{2}$$

Energy of body in system (ξ, η, ζ )

$$H_0 = H_1 + 0.5\,\beta\, L\,\{(1 - \frac{v}{c}\cos\phi) + (1 + \frac{v}{c}\cos\phi)\} \tag{3}$$

where $\beta = \dfrac{1}{\sqrt{1 - \dfrac{v^2}{c^2}}}$ (4)

$$H_0 = H_1 + \beta L \tag{5}$$

Or $(H_0 - E_0) - (H_1 - E_1) = L\,[\beta - 1]$ (6)

Einstein maintained as

$(H_0 - E_0) = K_0 + C = \frac{M_b v^2}{2} + C$

$(H_1 - E_1) = K_1 + C = \frac{M_a v^2}{2} + C$

Einstein defined C as additive constant which depends on the choice of the arbitrary additive constants of the energies H and E. The arbitrary additive constant C is regarded as equal in both the cases. Kinetic energy of body before emission of light energy, $K_0$ ( $\frac{M_b v^2}{2}$ ) and kinetic energy of body after emission of light energy, $K_1$ ( $\frac{M_a v^2}{2}$ ).

$$K_0 - K_1 = L \left\{ \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} - 1 \right\} \quad (7)$$

Einstein considered the velocity in classical region thus applying binomial theorem,

$$K_0 - K_1 = L \left( 1 + \frac{v^2}{2c^2} + 3\frac{v^4}{8c^4} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots - 1 \right) \quad (8)$$

Further Einstein quoted [1]

Neglecting magnitudes of fourth ( $v^4/c^4$) and higher( $v^6/c^6$, $v^8/c^8$ …….) orders, we may place.

$$K_0 - K_1 = L \frac{v^2}{2c^2} \quad (9)$$

$$\frac{M_b v^2}{2} - \frac{M_a v^2}{2} = L \frac{v^2}{2c^2} \quad (10)$$

or $L = (M_b - M_a)\, c^2 = \Delta mc^2$ (11)

or Mass of body after emission ( $M_a$ ) = Mass of body before emission ( $M_b$ ) – $\frac{L}{c^2}$ . (12)

Then Einstein generalized the result for every energy and called mass of body is measure of energy content (every energy that is included in a collection). Fadner [11] has mentioned that in the paper Einstein neither wrote E= $\Delta mc^2$ nor E in the paper. It is concluded that Einstein's statement means E= $\Delta mc^2$ **.** It can be obtained by replacing $L$ (light energy) by $E$ (energy-content or every energy). Einstein wrote,

$E$ = ( $M_b - M_a$ ) $c^2$ = $\Delta mc^2$ (13)

or Mass of body after emission ( $M_a$ ) = Mass of body before emission ( $M_b$ ) $- \frac{E}{c^2}$ (14)

When energy is emitted the mass decreases. Thus Einstein did not differentiate between Light Energy and other energies in the derivation.

**1.1 Typical comments regarding classical region of velocity (not given by Einstein).**

Einstein's derivation also offers the most mysterious situation in science. It is explained below, it is explained below with help of equation,

$$M_{motion} = \frac{M_{rest}}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (15)$$

Let the velocity is in classical region i.e. 10m/s (36 km/hr i.e. ordinary speed of vehicle), then no increase in mass of object when it moves with this velocity. The speed of aeroplane is over 400km/hr, and no increase in mass is observed.

$M_{motion}$ = $M_{rest}$ [ 1+ $\mathbf{v^2/2c^2}$ +$3v^4/8c^4$ + ..............] (16)

(i) If v =0 , then

$M_{motion}$ = $M_{rest}$

(ii) If v = 1cm/s (0.036 km/hr)

$M_{motion}$ = $M_{rest}$ [ 1+ $\mathbf{5.55\times10^{-22}}$ +$\mathbf{4.166\times10^{-42}}$ + ................] (17)

$M_{motion}$ = $M_{rest}$ + $M_{rest}$ $\mathbf{5.55\times10^{-22}}$ **+** $M_{rest}$ $\mathbf{4.166\times10^{-42}}$ + ..........

Here even term $\mathbf{5.55\times10^{-22}}$ is regarded as negligible compared to unity , and $\mathbf{4.166\times10^{-42}}$ is further negligible thus

$M_{motion}$ = $M_{rest}$ (18)

Thus term $5.55\times10^{-22}$ can be neglected only then both masses are equal.

(iii) Similarly the orbital velocity of the earth is 30km/s or 3,0000m/s i.e. v/c =$10^{-4}$ thus

$M_{motion}$ = $M_{rest}$ [1+ $\mathbf{v^2/2c^2}$ +$3v^4/8c^4$ + ..............]

= $M_{rest}$ [ 1+ $\mathbf{5\times10^{-9}}$ + $3.75\times10^{-17}$+ ……………..]

$\mathbf{M_{motion} = M_{rest} + M_{rest}\, 5\times10^{-9} + M_{rest}\, 3.75\times10^{-17}}$ (19)

The mass of earth remains same i.e. $5.98\times10^{24}$ kg always. Thus here also the term $v^2/2c^2$ ($5\times10^{-9}$) is neglected compared to unity. If the term $v^2/2c^2$ ($\mathbf{5\times10^{-9}}$) is neglected then

$M_{motion}$ [mass of earth in motion] = $M_{rest}$ [mass of earth at rest] (20)

The various terms neglected compared to unity are shown in Table II

**Table II: Terms neglected in calculations and their effects.**

| Sr. No. | velocity | $M_{rel} = M_{rest}[ 1+v^2/2c^2+3v^4/8v^4 +$ …. ] | Neglected term | Result |
|---|---|---|---|---|
| 1 | 0 | $M_{rel} = M_{rest}$ | none | $M_{rel} = M_{rest}$ |
| 2 | Earth's orbital velocity 30km/s or $3\times10^4$m/s | $M_{rel} = M_{rest}$ [ 1+ $\mathbf{5\times10^{-9}}$ + $3.75\times10^{-17}$ + ………] | $\mathbf{5\times10^{-9}}$ | $M_{rel} = M_{rest}$ |
| 3 | v=1cm/s or 0.036km/s | $K_b - K_a$ = L [ 1+ $\mathbf{5.55\times10^{-22}}$ +$4.166\times10^{-42}$ + ………-1] or $M_b = M_a$ | $\mathbf{5.55\times10^{-22}}$ | $M_b = M_a$ Mass before emission = Mass after Emission |

**1.2 Appearance of $c^2$ in L= $\Delta mc^2$ is apparently arbitrary**.

$$K_0 - K = L\left(1 + \frac{v^2}{2c^2} + 3\frac{v^4}{8c^4} + ..................... - 1\right) \quad (8)$$

Now consider the same case when velocity is 1cm/s or 0.036km/hr , under this conditions eq.(8) becomes

$$\frac{M_b v^2}{2} - \frac{M_a v^2}{2} = \text{L [ 1+ } \mathbf{5.55\times10^{-22}} + \mathbf{4.166\times10^{-42}} + \text{...........-1]} \quad (21)$$

(i) Einstein has neglected term $3v^4/8c^4$ retained the term as $v^2/2c^2$ , and obtained equation

$L = \Delta mc^2$

(ii) If the velocity is very-2 small then $v^2/2c^2$ can be neglected compared to unity. If velocity is 1cm/s (classical region), then $v^2/2c^2$ is $5.55\times10^{-22}$. Depending upon the orbital velocity of the earth (30km/s or 3,0000m/s i.e. $v/c = 10^{-4}$ ) the term $\mathbf{v^2/2c^2}$ **($5\times10^{-9}$)** can be neglected compared to unity, only then the equation i.e

$M_{motion}$ [mass of earth in motion] = $M_{rest}$ [mass of earth at rest]

is justified.

In typical classical region ( v =1cm/s ) $\mathbf{v^2/2c^2}$ **=** $5.55\times10^{-22}$ is neglected compared to unity ( as $\mathbf{5\times10^{-9}}$ is neglected ) then

$M_b$ (mass before emission) = $M_a$ ( mass after emission) (22)

Thus both $L = \Delta mc^2$ and $M_b = M_a$ are equally probable and but have entirely different nature. This discussion also validates the necessity of categorisation of sub ranges of velocity in the classical region or up to which magnitude of the term to be neglected comparatively.

**2.0 Einstein took only *super special* values of variables and its effects.**

The following arguments can be given that Einstein's derivation is true under special conditions [11-37].

**1.** Einstein [1] has put condition on state of the body: Let there be a **stationary body** in the system (*x, y, z*), and let its energy--referred to the system (*x, y, z*) be $E_0$. Let the energy of the body relative to the system (ξ, η, ζ ) moving as above with the velocity *v*, be $H_0$. The body also remains stationary in system (x, y, z) after emission of energy.

**Einstein also assumed that the body also remains stationary before and after emission of light energy, which is super special condition.**

But practically this condition (Light emitting body is stationary) is not obeyed in other many or numerous cases.

(i) The nuclear fission is caused by the thermal neutrons which have velocity 2,185m/s. The uranium atom also moves as it is split up in barium and krypton, and emit energy.

(ii) When a gamma ray photon of energy at least 1.02MeV, moves near the field of nucleus it is split up in electron and positron pair [2]. The gamma ray photon is in motion

and so is the state of electron and positron pair.

(iii) Similarly the particle and antiparticle moves towards each other for annihilation. The particle and antiparticle collide then annihilation takes place. In nuclear fusion the atoms are set in motion. The fission is only caused by thermal neutrons (0.025eV or having velocity 2,185m/s). Thus there are characteristic or inherent conditions on the process in inter-conversion of mass and energy. These phenomena were not discovered in Einstein's time.

(iv) When a paper burns then it is also sets in motion and energy in various forms is emitted.

(v) When deuterium and titanium fuse, but only after these are set in motion under conditions of high temperature. In nuclear fusion of deuterium –tritium the energy of emitted neutrons is 14.1MeV (moving at 52,000km/s) their mass must increase about 15.36%. It may increase the mass considerably. The velocity of the reactants is not necessarily uniform and gradually they overcome the force of electrostatic repulsion. Chemical reactions were discovered in Einstein's time. Einstein never discussed this phenomenon in his works.

Thus derivation under the condition that body remains stationary in the emission process, is not conceptually useful or applicable in other case. The body remains stationary after emission of light energy, is only a theoretical perception.

**Other conditions on Einstein's derivation.**

Einstein's Sep. 1905 derivation [1] of $\Delta L = \Delta mc^2$ is true under *super special conditions or handpicked conditions* only. It is justified below. In the derivation of $\Delta L = \Delta mc^2$ there are FOUR variables e.g.

(a) Number of waves emitted,

(b) *l* magnitude of light energy,

(c) Angle $\phi$ at which light energy is emitted and

(d) Uniform velocity (relative velocity), v. The fast neutrons are slowed down and called thermal neutron thus their velocities are not necessarily uniform as can be variable while they cause fission of other nuclei.

**Nature of v**

**According to Einstein:** v is the relative velocity between system (x, y, z) and system (ξ, η, ζ ). If system (x,y,z) is at rest and system ( ξ, η, ζ ) moves with velocity v, then v is relative velocity. If the system (x,y,z) and system (ξ, η, ζ ) both move with same velocity then relative velocity v is zero. Further Einstein strictly took the value of velocity as uniform. The law of inter-conversion of mass and energy holds good if

(i) Velocity v is in classical region
(ii) Velocity v is in relativistic region
(iii) Velocity v is zero i.e. if both systems move with same velocity or system (ξ, η, ζ ) is at rest.
(iv) Velocity v is variable or uniform

These variables have numerous values. The law of inter conversion of mass and energy holds good under all conditions, but Einstein has considered just one i.e. velocity is in classical region. It does not hold good under relativistic conditions. Such significant derivation must be independent of velocity.

### 2.1 Genuine cases neglected in Einstein's derivation

Einstein has taken super *special or handpicked* values of parameters. Thus for complete analysis the derivation can be repeated with all possible values of parameters. In all cases the law of conservation of momentum is obeyed (which is discussed in next sub-section).

(i) The body can emit large number of light waves but Einstein has taken only **TWO light waves emitted by luminous body.**

Why one or n light energy waves are neglected?

(ii) The energy of two emitted light waves may have different magnitudes but **Einstein has taken two light waves of EQUAL magnitudes (0.5L each).**

Why other magnitudes (0.500001L and 0.499999L) are neglected by Einstein?

(iii) Body may emit large number of light waves of different magnitudes of energy making different angles **(other than 0º and 180º as assumed by Einstein).**

Why other angles (such as 0º and 180.001º**,** 0.9999 º and 180º etc.) are neglected by Einstein?

Thus body needs to be specially fabricated; other forms of energy such as invisible energy are not taken in account. Further body should emit light energy only, not other forms of energy.

(iv) Einstein has taken velocity in classical region (v<<c and applied binomial theorem at the end) and has not at all used velocity in relativistic region. If velocity is regarded as in relativistic region (v is comparable with c), then equation for relativistic variation of mass with velocity i.e.

$$M_{rel} = \frac{M_{rest}}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (15)$$

is taken in account. It must be noted that before Einstein's work this equation was given by Lorentz [3-4] and firstly confirmed by Kaufman [5] and afterwards more convincingly by Bucherer [6]. Einstein on June 19, 1948 wrote a letter to Lincoln Barnett [7] and advocated abandoning relativistic mass and suggested that it is better to use the expression for the momentum and energy of a body in motion, instead of relativistic mass.

It is strange suggestion as Einstein has used relativistic mass in his work including in the expression of relativistic kinetic energy [8] from which rest mass energy is derived [9-10]. So Einstein's equation of inter-conversion of mass to energy highly depends upon velocity theoretically whereas practically the mass energy inter-conversion phenomena are applicable in all cases.

(v) Einstein has considered body emits light energy, but simultaneously body may also emit heat energy which is not taken in account in Einstein's derivation. A burning body emits heat, sound, light energies and energy in form of invisible radiations simultaneously, along with invisible radiations. For proper description of heat energy-mass inter-conversion we need equation equivalent to eq.(1). Similar is the case of other energies. In nuclear explosion energies exist in many forms e.g. light energy, sound energy, heat energy , energy in form of invisible of various radiations. Einstein has only considered Light Energy and other energies are neglected in derivation of $L = \Delta mc^2$.

Further Einstein has considered that body emits light energy in visible region. But energy can also be emitted in the invisible region and Einstein did not mention at all about heat and sound energies (emitted along with light energy). Thus energies other than light energy are also emitted but neglected by Einstein in the derivation. So energies are not taken in account completely. Thus Einstein's perception may be ideally regarded as thought experiment. In realistic scientific approach all the factors have to be taken in account to draw conclusions. The various values of parameters neglected and taken in account in derivation are shown in Table III.

**Table III The values of various parameters considered by Einstein and neglected by Einstein in the derivation of Light Energy Mass equation $L = \Delta mc^2$.**

| Sr No | Parameters | Einstein considered | Einstein neglected<br>(No reason was given by Einstein why parameters are neglected). |
|---|---|---|---|
| 1 | No. of light waves | Two Light Waves | One, three, four or n waves |
| 2 | | | Energies of the order of 0.500001L and |

| | | | |
|---|---|---|---|
| | Energy of light wave | Equal<br>0.5L and 0.5L each | 0.499999L are also possible. There are numerous such possibilities, which need to be probed. Bodies can emit more than two waves. The invisible waves of energy are not taken in account. |
| 3 | Angle | 0̂ and 180̂ | The angles can be 0̂ and 180.001̂ or 0.9999̂ and 180̂ are also possible. There are numerous such possibilities which need to be probed. |
| 4 | Velocity | Classical region | The velocity can be in relativistic region.<br>The velocity v can also be zero i.e. v = 0<br>v~c mass increases |
| 5 | Velocity | Uniform<br>In classical region | The law of inter-conversion of mass to energy also holds good, when velocity is variable. |

Deductions: Einstein has taken only super-special values of parameters, and neglected many realistic values.

**3.0 Effects of general values of variables**

If body recoils when waves of different light energy are emitted. The eq.(1) is the main equation in Einstein derivation

(i) If light emitting body is at rest then relative velocity of measuring system (ξ, η, ζ) is only 'v'.

(ii) If light emitting body recoils away from the body $V_R$ , then relative velocity will be

$v + V_R$

(iii) If light emitting body is drifted towards the measuring system(ξ, η, ζ) with velocity $V_R$ then relative velocity will be

$v - V_R$

But in this case the recoil velocity $V_R$ is of the order of $5\times10^{-33}$ m/s and with velocity body can travel a distance of $1.57\times10^{-24}$ m in 10 years ( which is undetectable , hence by definition body is at rest**).** Thus in this case body is regarded as at rest.

If upon emission of light energy, the body may move towards or away from the observer velocity becomes ( **v±** $V_R$) or say (**v +** $V_R$). Thus

$$\ell^* = \ell \frac{\left[1 - \frac{v + V_R}{c}\cos\phi\right]}{\sqrt{1 - \frac{[v + V_R]^2}{c^2}}} \qquad (23)$$

Now this equation can be applied to study variation in mass when light energy emitted as in case of eq.(1).

### 3.1 Conservation of momentum in general cases helps in calculations of recoil velocity.

The law of conservation on energy and momentum are two significant laws.

(i) In the derivation of $L = \Delta mc^2$, the law of conservation of energy is taken in account as in eqs.(2-3). Similar is the status in derivation under general conditions.

(ii) Further the law of conservation of momentum holds good in such cases and can be used to calculate the recoil velocity, $V_R$. The value of recoil velocity in this case turns out to be too less i.e. $5\times10^{-33}$ m/s.

This case is similar to recoil of the gun when bullet is fired, but here two waves are emitted. The momentum is conserved irrespective of the fact that body remains at rest or recoils after emission of light energy [38].

In case of Einstein's derivation momentum is confirmed in special and general cases.

(i) **When light emitting body remains at rest after emission.** In this case recoil velocity is zero i.e. $V_R$ =0, it is calculated by applying law conservation of momentum.

(ii) **When light emitting body recoils due to emission of two waves in different directions**. In this case velocity of recoil is non-zero and calculated by applying law of conservation of momentum. Einstein did not consider that case.

**Calculations recoil velocity in system (x,y,z)**

The recoil velocity can be calculated by applying law of conservation of momentum, then $V_R$ will affect equation of relativistic Doppler principle of light as in eq.(23). If a bullet is fired from gun then system recoils in backward direction.

The law of conservation of momentum can be used to calculate the velocity of recoil in this case also. Let the body of mass 1 kg emits in two waves in visible region of wavelength 5000ºA , it corresponds to 2hc/λ or $7.9512\times10^{-19}$ J , and the energy is divided in two waves.

Let body emits light energy (towards the observer, ϕ= 0º) 0.50001L i.e.

$E_1 = 3.975607\times10^{-19}$ J (24)

and momentum

$p_1 = E_1/c = 1.325202\times10^{-27}$ kg m/s (25)

Secondly, the body emits light wave of energy (away from the observer, ϕ= 180º) 0.49999L i.e.

$E_2 = 3.975592\times10^{-19}$ J ( 26)

momentum $p_2 = E_2/c = 1.325197\times10^{-27}$ kg m/s. (27)

Let us assume that when the body emits light waves of energy in system (x,y,z) and recoils (if it actually does) with velocity $V_R$ (say), the body will recoil opposite to direction of wave having energy $E_1$ ( more energetic wave).

Initial momentum of waves + initial momentum of luminous body = 0 +0 ( 28)

Final momentum of waves + final momentum of body due to recoil= $-p_1 + p_2 - MV_b$ (29)

One wave having momentum $p_2$ moves towards the direction in which body recoils and other wave moves in the opposite direction ( M =1kg).

Here the energy of wave 1 is $E_1$ ($E_1 = 3.975607\times10^{-19}$ J, $p_1 = E_1/c = 1.325202\times10^{-27}$ kg m/s ), which is more than energy of wave $E_2$ ( $E_2 = 3.975592\times10^{-19}$J , $p_2 = E_2/c = 1.325197\times10^{-27}$ kg m/s. ) .The wave 1 is emitted towards the observer system(ξ, η, ζ ) .

Thus body recoils in direction opposite to wave 1 is emitted. It is like a bullet is fired from gun, then system recoils in backward direction. Hence here momentum $p_1$ (bigger in magnitude) have backward direction to measuring system is taken as negative.

The direction of $V_R$ is also regarded as same as that of $p_1$.The recoil velocity is calculated as $5\times10^{-33}$ m/s, hence relative velocity of the (ξ, η, ζ ) becomes ($v+V_r$) .

Then according to law of conservation of momentum we get

$$0 = -p_1 + p_2 - M_b V_r \qquad (30)$$

$$V_R = (-p_1 + p_2)/M_b = (-1.3252202\times10^{-27} + 1.325197\times10^{-27})\times10^{-27} = -0.000005\times10^{-27}$$

$$= -5\times10^{-33} \text{ m/s} \qquad (31)$$

The velocity $5\times10^{-33}$ m/s means body remains at rest, as $5\times10^{-33}$ m/s. A body is said to at rest if it does not change its position w.r.t. to surroundings. The velocity is too less to be detected. It is analogous to observation that a CAR cannot move when head and rear lights are switched on.

Thus conservation of momentum requires that body should move with velocity $5\times10^{-33}$ m/s towards the observer. With this velocity the body will recoil for distance equal to

$$S(100 \text{ years}) = 5\times10^{-33} \text{ m/s} \times 3.14\times10^{7} \times 100 = 1.57\times10^{-23} \text{ m} \qquad (32)$$

$$S(10 \text{ years}) = 1.57\times10^{-24} \text{ m}$$

which is undetectable by all means hence body can be regarded as at rest.

Thus body will tend to move with velocity $5\times10^{-33}$ m/s( towards the observer) which is immeasurably small or undetectable by all means, hence the body remains at rest by definition of the rest.

This recoil velocity ($V_R$ ) i.e. $5\times10^{-33}$ m/s is negligible compared to the velocity of the measuring system i.e. $v+V_R = v+5\times10^{-33}$ m/s $= v$

$$\text{Size of nucleus} = 10^{-14} \text{ m} \qquad (33)$$

$$S(100 \text{ years}) = 1.57\times10^{-9} \text{ size of nucleus} \qquad (34)$$

$$S(10 \text{ years}) = 1.57\times10^{-10} \text{ size of nucleus} \qquad (35)$$

Thus body moves a distance of $1.57\times10^{-24}$ m which is immeasurable. Hence body can be regarded as at rest, as in case of Einstein's derivation when two waves are emitted. Even if this velocity is taken in account for the sake of completeness then results are same as in previous case.

Even bigger numerical values are neglected in Physics e.g. in the relativistic variation of mass

$$M_{motion} = \frac{M_{rest}}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (15)$$

$M_{motion} = M_{rest}$ [ $1+ v^2/2c^2 + 3v^4/8c^4 +$ ……………..]

= $M_{rest}$ [ $1+ 5.55\times10^{-18} + 4.629\times10^{-31} +$ ……………..]

Here velocity is regarded as 1m/s (3.6km/hr) in classical region and even term **$5.55\times10^{-18}$** is regarded as negligible, thus

$M_{motion} = M_{rest}$

Hence recoil velocity **$5\times10^{-33}$ m/s** is also negligible. Thus equations for recoil momentum and recoil kinetic energy KE recoil will be

$P_{recoil} = 5\times10^{-33}$ kgm/s (36)

$KE_{recoil} = 1.25\times10^{-65}$ $kgm^2/s^2$ ( 37)

This energy i.e. $1.25\times10^{-65}$ J is equivalent to $2.99\times10^{-66}$ calories.

Due to this uniform relative velocity v of the system (ξ, η, ζ ) will not change within measurable limits, however effect of $V_R$ can be considered for completeness.

If body does not change its position so it can be regarded at rest by definitions, as $v+5\times10^{-33}$ m/s =v , $x+ 1.57\times10^{-24}$ m = x , in 10 years. Thus the law of conservation of momentum helps us in calculations of recoil velocity, which changes the magnitude of v. Hence equation of relativistic variation of light energy i.e. Doppler principle for light for any velocities whatever , becomes as eq.(23).

$$\ell^* = \ell\frac{\left[1 - \frac{v+V_R}{c}\cos\phi\right]}{\sqrt{1 - \frac{[v+V_R]^2}{c^2}}} \qquad \textbf{(23)}$$

Now if body recoils then eq.(23) has to be used instead of eq.(1) in calculation of energy. However the magnitude of eq.(23) and eq.(1) is the same practically as $v+V_R = v+5\times10^{-33}$ m/s $= v$

**4.0 L $\alpha$ $\Delta mc^2$ or L =A $\Delta mc^2$ is equally feasible**

In the derivation Einstein [1] has included all types of energies of body in E and H [and speculated with this basis, equation for every energy (or energy -content)]. While body recoils small amount of heat energy, sound energy etc. may also be produced and energy is dissipated against friction, depending upon velocity of recoil. In Einstein's case recoil velocity is zero. Thus when body recoils then energies after emission are denoted by $E_1$ and $H_1$ or different notations may be given to it. These energies ($E_i$'s and $H_i$'s) include all types of energies and Einstein has applied law of conservation of energy. Einstein has considered a body emitting two light waves of energy 0.5L each just in opposite directions. Let in this case the luminous body emits two light waves of energy 0.500001L and 0.499999L in system (x,y,z) emitted in opposite directions. Then amount of light energies measured in both systems are related as (equivalent to case of Einstein)

$$E_0 = E_1 + L \qquad (2)$$

$$H_0 = H_1 + 0.500001\, L\, \beta\, \{(1 - v/c\cos 0)\} + 0.499999\, L\, \{1 - v/c\, \cos 180\} \qquad (38)$$

where

$$\beta = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (39)$$

The eqs.(37-38) corresponds to law of consevation of energy, like eqs.(2-3).

$$H_0 = H_1 + L\beta\ [1 - 0.000002\ \frac{v}{c}\ ] \qquad (40)$$

$H_0 - E_0 \ = H_1 - E_1 + L\ \beta\ [1- 0.000002\ \frac{v}{c}] - L$ (41)

$(H_0 - E_0) - (H_1 - E_1) = L\{\beta\ [1- 0.000002\frac{v}{c}]-1\}$ (42)

$K_0 - K_1 = L\{\beta\ [1- 0.000002\frac{v}{c}]-1\}$

$= L\ (1+v^2/2c^2)[\ (1- 0.000002\frac{v}{c})-1]$

$= L\ [1-\frac{0.000002v}{c} + \frac{v^2}{2c^2} + ... \ -1]$

$K_0 - K_1 = L[-\frac{0.000002v}{c} + \frac{v^2}{2c^2}]$ (43)

$M_b v^2/2 - M_a v^2/2 = L\ [- 0.000002\left(\frac{v}{c}\right) + \frac{v^2}{2c^2}]$ (44)

$M_b v^2/2 - M_a v^2/2 = \frac{-0.000004L}{cv} + \frac{L}{c^2}$

$M_b - M_a = L\ [\ \frac{-0.000004L}{cv} + \frac{1}{c^2}]$ (45)

$\Delta mc^2 = L[\frac{-0.000004L}{cv} + 1]$ (46)

$L = \Delta mc^2 / [-0.000004\ \frac{v}{c} + 1]$ (47)

$-0.000004\ \frac{v}{c} = -0.000004 \times 3 \times 10^8 / 10 = -120$ (48)

$L = \Delta mc^2 / [-120 + 1] = \Delta mc^2 / -119$ (49)

$L\ \alpha\ \Delta mc^2$ or $L = A\ \Delta mc^2$ (50)

Whether the effects of recoil velocity are incorporated or not, the result remains the same as velocity of recoil is $5\times10^{-33}$ m/s.

**4.1** In the derivation Einstein used eq.(1) for relativistic variation of light energy, which was speculated in the previous paper [8]. But this equation is only meant for light energy not at all for other energies; hence any deduction from it must be applicable for light energy only.

The equation

$$\ell^* = \ell \frac{\left[1 - \frac{v}{c}\cos\phi\right]}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (1)$$

is not meant for

(i) sound energy,

In Doppler effect change in frequency of sound is estimated, not variation in mass. Thus eq.(1) is not used. Likewise eq.(1) is not associated with any other energy. The speed of sound is 332m/s.

(ii) heat energy

There is no equation like eq.(1) which relates variation of heat energy. The similar is the case of other types of energies.

(iii) chemical energy

(iv) nuclear energy (v) magnetic energy (vi) electrical energy

(vii) energy emitted in form of invisible radiations

(viii) attractive binding energy of nucleus

(xi) energy emitted in cosmological and astrophysical phenomena

(x) energy emitted in volcanic reactions

(xi) energies co-existing in various forms etc. etc.

Then why results based upon eq.(1) are applied to above energies (i –xi).

The reason is that all energies have different type of nature, and the energies are not confirmed to obey the same equation.

Einstein initially derived 'light energy'–mass inter-conversion equation $L = \Delta mc^2$, then speculated 'every energy' –mass inter conversion equation $E = \Delta mc^2$ from $L = \Delta mc^2$. As eq. (1) is only meant for light energy, not for other energies. Hence speculative transition to $E = \Delta mc^2$ from $L = \Delta mc^2$ is absolutely without any mathematical basis.

**4.2 If the measuring system is at rest (v=0) and body emits two light waves as in Einstein's derivation then derivation is not applicable. v can also zero if system (x,y,z) and system (ξ, η, ζ ) move with same velocity.**

However in this case experimentally when light energy is emitted mass decreases. It is serious limitation of Einstein's derivation.

When the measuring system (ξ, η, ζ ) is at rest v = 0 then

$$\ell^* = \ell \qquad (50)$$

$$H_o = H_1 + L/2 + L/2 \qquad (51)$$

$$E_o = E_1 + L \qquad (2)$$

$$(H_o - E_o) - (H_1 - E_1) = 0 \qquad (52)$$

As body is at rest and measuring system **(ξ, η, ζ )** is also at rest, then $(H_o - E_o)$ or $(H_1 - E_1)$ cannot be interpreted as kinetic energy. Hence further derivation is not applicable. This is mathematically critical analysis, have no implications on experimentally established status of $\Delta L = \Delta mc^2$ ( $E = \Delta mc^2$).

**4.3** In addition it is already justified that in derivation of $L = \Delta mc^2$, the factor $c^2$ is arbitrarily brought in the picture by Einstein in retaining only values $v^2/2c^2$ (compared to unity) without giving numerical values to v. If numerical values to v (say, v=1cm/s) are given then result is $M_a = M_b$ , it is justified in the section (2.1). Further Einstein has taken super special values of parameters to derive $L = \Delta mc^2$. Initially Einstein derived $L = \Delta mc^2$ for inter-conversion of light energy to mass , but then speculated (without proof ) that the derivation is true for every energy which is not justified which is not scientific. If all the factors are taken account, then result is different i.e.

$L \propto \Delta mc^2$ or $L = A\,\Delta mc^2$.

Einstein derived $L = \Delta mc^2$ under certain conditions, its complete analysis lead to very significant results. Thus critical analysis of Einstein's derivation leads to many interesting facts.

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# 5. The Formation of Primeval Atom in Big Bang Theory.

Ajay Sharma

Fundamental Physics Society His Mercy Enclave
Post Box 107 GPO Shimla 171001 HP India

email: ajay.pqr@gmail.com

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**Abstract**

The big bang theory assumes that whole mass of universe was initially in singular state **(**infinitely dense exceptionally hot and having atomic dimensions) and suddenly exploded. But how the mass was formed? How it changed to singular state? These basic questions are not discussed neither in big bang theory or nor any other existing theory. Such questions are addressed for the first time in Primeval Theory, as the universe started its life from zeroans (the particles of zero mass ) moving with infinitely large velocities. Here postulatory assumption is that the zeroans moving with infinitely large velocities got transformed to Primeval Pulse (wave) of Energy of magnitude tending to zero. The one or n Primeval Pulse (s) of energy changed to mass according to generalized equation $\Delta E = Ac^2\Delta m$ (A is coefficient of proportionality depends upon experimental parameters). The equation $\Delta E = Ac^2\Delta m$ follows from complete and critical analysis of derivation of $\Delta E = \Delta mc^2$. It is put forth that as mass changes to heat, light, sound energies etc. the mass also changes to gravitational energy. Due to exceptionally high values of gravitational energy and heat energy, the mass changed to singular state. Then it exploded when its size became smaller than optimum size

(like intermolecular force becomes repulsive in nature).

## 1.0 Mass and Energy of Universe

The understanding of origin of universe is the most complex thing as there are no earliest experimental evidences. All such theories are based upon hypothesis and postulates. The various theories have been put forth to understand it by mathematicians, scientists, intellectuals and clerics, but concrete conclusions are yet to be drawn [1]. The various studies regarding origin of the universe have not discussed anything about the 'Primeval atom' [2-4]. What is the origin of 'Primeval atom' in singular state (infinitely dense exceptionally hot and having atomic dimensions) ? None of existing theories address this issue. However this aspect is discussed in The Primeval Theory only. Thus it is innovative theory of the earliest origin of the universe. In the universe there is continuous transformation of mass and energy to one another.

**Total Mass of Universe:** The limits of universe extend beyond observable or detectable distances. The total mass of universe is sum of various parts. The total mass includes visible mass of universe, antimatter, dark matter, mass existing in inaccessible space , mass which is converted to energy etc. Here mass of universe in totality is considered right since beginning of universe. The big bang theory assumes that at time of big bang equal amount of matter and antimatter were produced. The mass of heavenly bodies receding with speed approaching to that of light is exceptionally high.

Normally in calculations mass equal to $10^{55}$ kg is taken, for realistic calculations the mass in totality must be considered. Also considerable mass may have converted to energy. Thus actual mass of universe is far higher than general estimates of mass of universe. Thus the theoretical possibility of existence of unimaginably large amount of mass in universe ( accessible and inaccessible ) cannot be denied.

**Total Energy of universe.** If energy of the universe is expressed in totality then it is far more than normal estimates. The total energy includes the visibly measureable energy, energy emitted in inaccessible space, energy which is converted to mass, energy which compressed the mass of universe to singular state, gravitational energy and kinetic energy within constituents of the universe, energy required for explosion of the Primeval Atom, energy responsible for outward acceleration of universe, energy emitted in universe etc. Thus since inception of universe unimaginably large amount of energy may have been exchanged in the universe (accessible and non-accessible). These are the most mysterious and bizarre phenomena of universe.

Thus universe may consist of infinitely large amount of mass and energy. Logically such huge magnitudes cannot exist as such. How this infinitely large mass and energy is produced in the universe? This is the sole point of discussion in the 'Primeval Theory of Universe', using the generalised form of energy $\Delta E = Ac^2\Delta m$.

**2.0 Big Bang is Theory of explanation of 'effect' not of origin of 'effect'**

According to The Big Bang Theory, Primeval Atom ( infinitely large density and exceptionally-2 hot having atomic dimensions ) existed inherently and spontaneously exploded. This theory assumes that big bang took place at time t =0. The big bang theory assumes time started after bang and at that instant space was created. This theory does not explain how Primeval Atom was formed and exploded ? However it explains the facts after big bang occurred. Thus Big Bang Theory is a theory of explanation of 'effect' not of origin of 'effect'.

The big bang theory does not discuss following questions.

(a) How mass equal to $10^{55}$kg is produced?

(b) How mass changed into singular state?

(c) How and why the 'primeval atom' (infinitely large dense, exceptionally hot and having atomic dimensions) exploded?

(d) Which is the source of energy, causing universe to expand?

(e) Is it being caused by internal repulsion or energy emitted during the explosion? It signifies both attractive and repulsive energies in the universe.

(f) What is the reason of gravitation within the constituents of universe?

(g) Is it being caused by repulsion or energy emitted during the explosion or energy is continuously being produced in heavenly bodies for their movements?

(h) How infinitely large amount of energy is created which is responsible for these processes?

So this theory is simply description of effect after big bang not of origin of big bang. In simple words, there is belief think about beauty not about her mother. In the Primeval Theory of Universe all above questions are addressed.

## 3.0 The Primeval Theory of universe

**The purpose of Primeval Theory:** The Primeval Theory is enunciated for explaining or understanding the earliest origin of Primeval Atom (infinitely large dense exceptionally hot and having atomic dimensions in singular state) and its explosion. How 'Primeval Atom ' was created and exploded ?' The Primeval Theory tries to answer the basic question that how the 'Primeval Atom' was formed and big bang took place i.e. how it exploded ?. It is not explained or even addressed by any existing theories.

In the big bang theory or any other existing theory the reason of formation of 'Primeval Atom' is not speculated or thought at all. The ambit of this theory vanishes just at moment of explosion. After big bang the currently persisting understanding, theories and perceptions prevail without interference of The Primeval Theory.

3.1 **Postulates of Primeval Theory of Universe or The first step of formation of universe.**

The Primeval Theory is based upon following postulates.

(i) This theory postulates the masses exactly equal to zero, moving with infinitely large velocities changed into 'Primeval Pulse(Wave) of Energy' (PPE) of magnitude tending to zero.

(ii) In pre-big bang era, the conversion factor between mass and energy may not be exactly $c^2$, thus equation $\Delta E \propto \Delta mc^2$ or $\Delta E = Ac^2\Delta m$ is feasible instead of $\Delta E = \Delta mc^2$. It is valid only in this case, not in other cases when $\Delta E = \Delta mc^2$ is justified. This postulate is justified from critical analysis of derivation of $\Delta L = \Delta mc^2$ ($\Delta E = \Delta mc^2$).

(iii) The time and space inherently existed in universe. This postulate does not require any assumption.

Then this energy is converted to mass as gamma ray photon materialises to electron and positron pair. Where as The Big Bang Theory postulates that unimaginably high amount of mass is created out of nothing. How did it happen? No reason is given.

Einstein speculated $\Delta E = \Delta mc^2$ from derivation of Light Energy Mass inter-conversion equation, $\Delta L = \Delta mc^2$. From critical analysis of derivation of $\Delta L = \Delta mc^2$, the equation $\Delta L \alpha \Delta mc^2$ or $\Delta L = Ac^2 \Delta m$ also obtained[5-31]. Thus as $\Delta E = \Delta mc^2$ is derived from $\Delta L = \Delta mc^2$, likewise $\Delta E = Ac^2 \Delta m$ also follows from $\Delta L = Ac^2 \Delta m$. Further the equation $\Delta E = Ac^2 \Delta m$ can also be derived by other methods [5-31]. In pre big bang era both the equations i.e. $\Delta E = \Delta mc^2$ and $\Delta E = Ac^2 \Delta m$ are critically analysed and later is found more useful.

### 3.2 **Conceptual basis of 'Primeval Atom'**

In 'Primeval Theory ' an attempt has been made to understand the formation of the primeval atom. The Primeval Theory explains how and why 'primeval atom' was formed and exploded ? It is assumed that initially vast and unlimited space was filled with infinitely large number of particles (say) of zero mass and undetectable by any means. These may be termed as *Zeroans*. The *Zeroans* are the most primitive perceptions of the universe in space, may be moving with infinitely large velocities. Thus this theory assumes that universe started its life from the state of cipher. The existing perceptions are based upon fact that unimaginably large amounts of mass and energy existed in universe inherently. Its origin is not discussed at all.

### **3.3 No contradiction with existing laws with perception of Zeroans.**

All such existing theories are based upon postulates as no ancient observations are available for foundation of the thesis. No law prohibits the perception of zeroans ( mass = 0 ) and moving with infinitely large velocities. The perception of zeroans having no mass is quiet natural. Such perception is very logical as zero mass can be easily perceived; and these can move with infinitely large velocities without influence of external agent. Thus no conservation law is violated here. The zeroans can move with infinitely large velocity, without influence of external force. Newton's second law of motion, F=ma permits this.

### 3.4 **First glimpse of creation of mass**

After exceptionally long time, the numerous Zeroans were moving with infinitely large velocities transformed as the smallest possible pulse of energy (but just perceivable or imaginable). This pulse of energy may be coined as Primeval Pulse of Energy or Primeval Wave of energy (PPE). The magnitude of Primeval Pulse of Energy may be infinitesimally small may be tending to zero or magnitude just conceptually imaginable. It is the only the postulatory assumption in this theory, based upon inter-conversion of mass to energy.

Whereas existing theories assumed that unimaginably high mass and energy inherently existed in the universe.

Then it can be assumed that in due course of time numerous Primeval Pulses of Energy resulted or combined together to form Enhanced Pulse(Wave) of Energy (EPPE)of magnitude , $10^{-100}$ J or less. Such 'Enhanced Primeval Pulse of Energy' (EPPE) changed to mass, as Gamma Ray Photon materialises to electron positron pair. It is very common observation, even now.

## 4.0 **Equations of mass energy inter-conversion in pre-big bang era i.e. $E = \Delta mc^2$ and $\Delta E = Ac^2\Delta m$**

**Mass is converted to energy.** Currently $E = \Delta mc^2$ and $\Delta E = Ac^2\Delta m$ are two main equations which describe the conversion of mass to energy or vice versa. The equation $\Delta E = Ac^2\Delta m$ follows from critical analysis of derivation of $E = \Delta mc^2$. Both the equations are applied in the pre-big bang era.

**Application of $\Delta E = \Delta mc^2$ :** There are different estimates of mass of universe but let us take mass of universe as $10^{55}$ kg in calculations. The dark matter, antimatter and mass of inaccessible universe etc. are not taken in account. The creation of mass $10^{55}$ kg (generally accepted value of mass of universe), requires mammoth amount of energy i.e.

$$E = 10^{55}\ \text{kg} \times 9\times10^{16}\ \text{m}^2/\text{s}^2 = 9\times10^{71}\ \text{J} \qquad (1)$$

How energy equal to $9\times10^{71}$ J is originated? But it is another question. This energy should have been produced from mass $10^{55}$ kg. Then how this mass is produced? Thus endless questions and answers continue without any conclusion. It is like whether an egg is born earlier or hen. In addition huge amount of energy is required to change it to singular form at very high temperature. $\Delta E = \Delta mc^2$ cannot explain the origin of energy. Thus alternatively generalized mass energy equation $\Delta E = Ac^2\Delta m$ is used to explain the facts, which is originated from the same derivation of $E = \Delta mc^2$. If value of co-efficient of proportionality is unity then $\Delta E = Ac^2\Delta m$ reduces to $E = \Delta mc^2$. Here the conversion factor between mass and energy is different from $c^2$.

### 4.1 Super Special Creation Reaction:

Practically when a gamma ray photon (energy) when passes near the nucleus, it materialises into electron and positron pair. Identically similar reaction took place with 'Enhanced Primeval Pulse of Energy'. It is the 'Super Special Creation' reaction of the universe, in which miniscule energy is converted into mammoth mass. Thus significant amount of mass is created from minuscule amount of energy so such reaction is called 'Super Special Creation' reaction. The earliest mass in universe is created in such reaction. Such reaction is mathematically feasible from $\Delta E = Ac^2\Delta m$. Thus, the equation $\Delta E = Ac^2\Delta m$ theoretically predicts that in this primeval era, diminishingly small pulse of energy, say $10^{-100}$ J (or smaller), manifested or transformed itself to mass $10^{55}$kg (or whatever is the assessed mass of the universe), in due course of time. For mathematical calculations some amount of energy has to be assumed, and here energy $10^{-100}$ J is assumed. Such a reaction in which small energy is converted into mammoth amount of mass is known as 'Super Special Creation' reaction. It can be only explained on the basis of $\Delta E = Ac^2\Delta m$. Thus theory does not assume that unbelievably large amount of mass in singular state has been created automatically out of nothing.

4.2 **Mathematical Basis of 'Super Special Creation' reaction**

In pre- big bang era the creation of mass may be understood mathematically in the following way. In the formation of mass or conversion of energy to mass the reactions are known as the 'Super Special Creation' reactions. It is the most bizarre reaction ever occurred in universe. Depending upon values of $\Delta E$ and $\Delta m$ the magnitude of $A_{uni}$ can be calculated. For such reactions the value of $A_{uni}$ can be determined as:

$$A_{uni} = \frac{\Delta E}{c^2 \Delta m} = \frac{10^{-100}}{9\times 10^{16} \times 10^{55}} = 1.111\times 10^{-172} \qquad (2)$$

These values are the most peculiar, as this event is 'one and only one' in nature. Now if the value of energy is $10^{-100}$ J (say) and value of $A_{uni}$ is $1.111\times10^{-172}$ then mass can be calculated as

$$\Delta m = \frac{\Delta E}{c^2 A_{uni}} = \frac{10^{-100}}{1.111\times 10^{-172} \times 9\times 10^{16}} = 10^{55} \text{ kg} \qquad (3)$$

The mass $10^{55}$ kg may have been created from one or n Enhanced Primeval Pulses of Energy Thus $\Delta E = Ac^2\Delta m$ is the first equation which at least theoretically and logically predicts that universe has been created (and resulted to 'primeval atom' ) from minuscule or immeasurably small amount of energy ($10^{-100}$J or less). However actual process of creation of mass may be quite mysterious, tedious and time consuming process. The universe may have been created in small fragments or parts. In free space the motion of Zeroans hence process of creation of mass is continuous processes. This is one way of understanding the origin of universe on the basis of inter-conversion of mass and energy. The mass of universe is regarded as $10^{55}$ kg which is generally agreed or different estimates can be taken here.

### 4.3 **No contradiction of existing cosmological theories**

The primeval theory assumes that universe started its life from state of cipher. This theory tries to explain how 'primeval atom' (infinitely large dense, exceptionally hot and having atomic dimensions) was formed and exploded. None of the existing theories address this issue. There are no contradictions in this explanation of existing theories as an attempt has been made to explain how primeval atom was created and big bang took place. None of existing theories address this aspect. The ambit of the Primeval Theory of Universe vanishes at the point when Big Bang Theory starts. Afterwards the universe developed or Big Bang took place in such way as currently understood.

### 4.4 The Primeval Theory is consistent with findings based upon NASA's Wilkinson Microwave Anisotropy Probe (WMAP)

Erickcek and colleagues [32] deduced on the basis of NASA's Wilkinson Microwave Anisotropy Probe (WMAP) that existence of time is possible before Big Bang and universe may be created in empty space. Normally microwave background radiations are mostly smooth. It implies universe is homogenous and isotropic. But Cobe's satellite discovered some fluctuations. Erickcek and colleagues believed that these fluctuations contain hints that our universe 'bubbled off' from previous one. Thus some other universe existed before this universe. Thus time, space and other universe existed before Big Bang. The Primeval Theory assumes that primeval atom is gradually formed i.e. universe existed before big bang. Obviously time and space existed before Big Bang.

## 5.0 The origin of gravitation.

The cause of origin of gravitational energy is mass i.e. mass is converted to gravitational energy as like other energies.

**Mass is converted into Gravitational Energy:** The mass may be regarded is primary form of energy in nature. The one form of energy can be transformed to other forms. If mass changes to other forms of energy then it can also be changed to Gravitational Energy. In nuclear explosion or chemical reactions mass is converted to heat energy, light energy, energy in invisible form etc. In nucleus, the nucleons weigh less in nucleus thus mass is converted to binding energy. Mass is also changed to heat energy, sound energy or light energy etc. In uncontrolled nuclear fission or in nuclear reactors mass is converted to light energy, heat energy, sound energy and energy in form of invisible radiations is emitted or energy may co-exist in various forms.

In nucleus the mass is converted or transformed into the binding energy (attractive like gravitational energy). The attractive binding energy exists within nucleus and attractive gravitational energy exists on large scale. It is confirmed that binding energy is result of annihilation of mass, likewise gravitational energy may be regarded as result of annihilation of mass, but both arise from the annihilation of mass. Thus law of conservation of matter is obeyed. Electrons move around the nucleus and heavenly bodies move around the sun due to attraction. As mass is created in space, a suitable fraction of that mass is simultaneously converted to gravitational energy and other forms of energy.

If mass can be changed to other forms of energy, then it can also be changed to attractive gravitational energy. It is already justified that mass of universe created is more than generally accepted mass $10^{55}$ kg ( used in calculations as standard for simplicity) , the excess mass ( actual mass created – $10^{55}$kg ) is converted into various forms of energy.

Excess Mass = [Actual mass created – $10^{55}$kg] (4)

This mass is converted to various forms of energy.

### 6.0 Basis of mathematical equation

The energy is transformed from one form to other. In electric bulb electrical energy changes to light energy, in heater electrical energy is converted to heat energy, in radio electrical energy is converted into sound energy, in cell chemical energy is changed to electrical energy, in photocell light energy changes to electrical energy, in a.c. dynamo mechanical energy is converted or transformed to electrical energy there are many such examples. The inter-conversion of energy from one form of mass to other may be written as

Energy in newly converted or transformed form = $k$ (energy in the first form) (5) where '$k$' is transformation factor just like Joule's Mechanical Equivalent of Heat J (4.2 $\times 10^7$ erg $cal^{-1}$) in

$$W = JH \qquad (6)$$

$E = \Delta mc^2$ states that mass is converted into energy or vice versa, whereas according to eq. (5) energy changes from one form to other.

In view of eq. (5) the analogous relation between mass annihilated and gravitational energy produced (measure of gravitational force or pull) can be written as

Gravitational energy ($U_g$) = k Energy emitted in annihilation of mass ($Ac^2\Delta m$)

$$= k\, Ac^2\Delta m \qquad (7)$$

where $k$ is transformation factor which determines the extent of transformation of energy to gravitational energy. Thus higher the value of $A$ and higher the value of $k$ more gravitational energy will be produced. The values of $A$ and $k$ depend upon inherent characteristics of the process. Their nature is like other existing coefficients in science. So,

*" creation of mass of universe and origin of gravitation are both simultaneous processes".*

The inter conversion of energy to mass is continuous process. The fraction of mass (so produced) also changed into gravitational energy as described by eq.(7). This gravitational energy held together the created mass, if the gravitational energy simultaneously produced in one particular case is considerable then that matter remained in cohesive state. The gravitational energy is universally prevalent and is inherent property of bodies; it unites the bodies as these are produced. If gravitational energy produced is less in some cases then mass remained in un-cohesive or comparatively free state.

**Smaller particles:** At the same time it is just possible that some particles which were created from 'Primeval Pulse of Energy', may have not developed considerable amount of gravitational energy, hence not condensed to bigger units. The heavenly phenomena are bound by general rules, but may not be by specific rules i.e. one rule which applies to one specific situation may not be specifically and exactly applicable for the other situation. Thus matter may be present here in continuous amount. These particles are present in universe in continuous form and largely may be undetectable. Thus possibility of quarks, sub-quarks, axions etc. or further lighter particles are completely feasible. Further smaller particles are existing which may be immeasurable by current precision. These may have mass trillion-trillion times smaller than axions hypothetical particles proposed by Peccei [33] or their mass is so smaller to be compared with axions. These particles may constitute dark matter in category of Weakly Interacting Massive Particle. Thus mass in pre big bang era has been continuous not discrete ( not whole number multiple of some 'minimum mass'). In other words there is no quantisation of mass as that of charge (nq).

These particles developed charge due to friction while in motion (the particles are charged by this method even now). The different charges can be understood due to friction of particles in different directions. Thus charges of the order of fraction of electronic charges are possible i.e. so smaller to be detected by current instruments. Thus charges are continuously distributed. As particles are in state of continuous motion so they attain considerable charge while moving. The build up of particles of similar charge, like electron and proton was formed in due course of time.

### 6.1 How mass condensed to Primeval atom?

The prevalent big bang theory assumes whole mass of universe was present in singular form (infinitely large density, high temperature and possesses atomic dimensions). But this theory which hints that how of universe was created. However Primeval Theory does so. The 'Primeval Atom' is formed due to exceptionally high value of gravitational energy. The formation of Primeval Atom i.e. the most bizarre and 'one and only one' incidence in the universe can be understood in the following way.

Initially mass is converted to energy due to high value of A in $\Delta E = Ac^2\Delta m$ , thus corresponding to small mass mammoth amount of energy is produced. This reaction may be termed as 'Super Special Annihilation Reaction' i.e. for small annihilation of mass, enormous amount of energy is produced. The perception of 'Super Special Annihilation ' reaction is very natural and can be understood as below

In chemical reactions the energy emitted is least, it is more in case of nuclear fission and maximum in nuclear fusion. The super special annihilation reaction is next in the series. At this stage even intermediate elements similar to iron (high binding energy per nucleon) may have fissioned or heavier elements may have fused together and unimaginably high amount of energy can be emitted. Or there may be newer elements at that time (not existing now) which were more congenial for fusion and energy releasing with exceptionally high value of A. So the emission of energy varies from one form of reaction to other. The reactions in which energy emitted is unimaginably high, are known as Super Special Annihilation' reactions had occurred in pre-big bang era.

These are inherent characteristics of heavenly process, as temperature at the core of the sun is $10^7$ K or more causing fission of hydrogen and helium. This high temperature is automatically obtained in such heavenly reactions. The various elements are created itself from process of transformation of energy from one form to other, likewise mass was created in the pre-big bang era. Under exceptional circumstances in pre-big bang era the temperature may rise trillion times more than this. Such high temperature is essential for 'Super Special Annihilation' reactions. In these reactions unimaginably high amount of energy is emitted corresponding to materialization of infinitesimally small mass. It is assumed that majority of the energy is exhibited as gravitational energy which compresses the mass to small size. Thus amount of t energy emitted vary from one reaction to other. The unimaginably high amount of energy produced is further transformed in various forms e.g., heat energy, light energy, sound energy, energy in invisible forms etc.

As the process of annihilation of mass to energy continued so the rise in temperature and increase in gravitational energy simultaneously continued. As the process of annihilation of mass to energy continued, a part of heat energy so produced is utilised in increasing the temperature to higher degrees. Thus due to this mass melted and temperature rose very high and enormous amount of heat is produced. Hence due to gravitational energy mass condensed to a point.

Firstly if just balanced or proportionate amount of energy is converted to gravitational energy and heat energy then the various constituents of universe remained at their normal respective positions. Secondly if exceptionally large amount of energy is transformed to gravitational energy i.e. tremendous amount of gravitational energy is produced then the various constituents of universe came closer. These are inherent conditions of 'Super Special Annihilation' reactions. These conditions are responsible for formation of universe.

The lighter particles or bodies stuck together (under extreme conditions of temperature, pressure and gravitational energy) then their masses increased. Thus high temperature and high gravitational pull caused constituents of universe to contract to a single point. The mass was annihilated to energy continuously, more and more gravitational energy is produced. This process was repeated again and again and whole mass of the universe condensed to a single point in infinitely dense state. Thus bodies were quickly attracted and condensed as being extremely hot they compressed to small size due to high gravitational energy consequently radius of the universe decreased. Thus the primeval atom was formed. Even when Primeval Atom was formed, the mass energy inter conversion reaction continued which lead towards its explosion.

### 6.1 **How Big Bang took place?**

In brief the process can be understood as below. Due to gravitational energy whole mass of universe is condensed to single point and further compressed. It causes decrease in size of universe. When size of universe decreases beyond optimum size repulsion increased and eventually big bang took place. Moreover this situation is analogous to variation of intermolecular force (after attractive nature the force becomes highly repulsive). When the sufficient amount of gravitational energy, heat energy etc. are produced, then constituents of universe came closer and closer. Due to increase in temperature whole the mass of universe melted and due to high value of gravitational energy, it came closer and closer. Unimaginable amounts of gravitational energy and heat energy were produced thus the size of universe decreased beyond optimum size.

At this stage (size of universe is decreased beyond optimum size) universe was in unstable, repulsive and reactive state, and the 'primeval atom' exploded. When constituents of universe came closer than optimum limits then suddenly repulsive force dominated. This explosion may have been facilitated due to repulsion of similar charges as universe assumed atomic dimensions. When size decreased beyond the optimum level then the primeval atom exploded. This explosion may be termed as 'super-super special annihilation' reaction and tremendous amount of energy is emitted in the reaction for annihilation of small mass in equation $\Delta E = Ac^2\Delta m$. Analogously it is like explosion of nuclear bomb which when explodes huge amount of energy is emitted. Mostly this energy exhibited as kinetic energy causing universe to accelerate and recede.

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# Part III Applications of $\Delta E = Ac^2 \Delta m$

# 6 Relativistic energy of neutron in nuclear fission: A critical analysis.

**Ajay Sharma**

*Fundamental Physical Society. His Mercy Enclave Post Box 107 GPO Shimla 171001 HP India*

Email; ajay.pqr@gmail.com,

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**Abstract**

In the fission reactions neutrons produced are known as fast neutrons having energy 2MeV (1. 954×$10^7$ m/s or ~ 7% speed of light or ~ 7% speed of light). With help of moderator the velocity of neutrons is reduced to classical limits i.e. 0.025eV (2185m/s). The velocity of fast neutron is in relativistic region hence relativistic variation of mass must be taken in account. Thus the mass of fast neutrons must be 1.01080879u (%age increase of 0.2125% ) i.e. more than rest mass 1.0086649156u. But in the determination of Q-value, relativistic mass of neutron is taken just equal to rest mass i.e. Relativistic mass (1.954×$10^7$m/s) = Rest mass, which is not justified. If the relativistic variation of mass is taken in account then magnitude of energy theoretically predicted is 5.99MeV (2.295×$10^{-13}$ J) less. The exact measurement of relativistic mass in various reactions may lead to significant results.

## 1.0 Initially fast neutrons are emitted in nuclear fission

Neutron was discovered by Chadwick [1] in 1932. O. Hahn and F. Strassmann **reported to** *Naturwissenschaften* the nuclear fission and new element barium was obtained [ 2]. The discovery of fission and production of barium from uranium was also confirmed [3-4] by Lise Meitner and O. R. Frisch. In fission of $U^{235}$, the various fission fragments with different isotopes are possible. In first ever nuclear fission one of the fission fragment was barium, hence this reaction is considered in discussion. In nuclear fission the energy of neutron is nearly 2MeV (velocity $1.954\times10^{7}$ m/s), such neutrons cannot cause further fission. Thus with help of moderator its velocity is reduced to 0.025eV (2185m/s).

## 2.0 Q value in reactions.

Q value for the reaction is the amount of energy released in a reaction,

Q Value = E (Reactants) –E (Products) (1)

According to law of conservation of matter, matter can neither be created nor be destroyed but can be transformed from one form to other. Energy is other form of mass, according to Einstein $c^2$ is the conversion factor, when mass is converted to energy. Further energy emitted may exhibit in different forms, heat, light or invisible forms etc. Every energy emitted is at cost of mass. Realistically all the energies must come from annihilation of mass ($\Delta$m), according to mass energy inter-conversion equation, $E = \Delta mc^2$. Energy or mass cannot be produced out of nothing. According to Einstein energy emitted can neither be more nor less than $E = \Delta mc^2$. For example,

Energy emitted = (mass annihilated)$c^2$

= KE of the fragments + Heat energy + Light energy+ Sound energy +Energy of various particles and rays + other forms of energy if any (2)

Here origin of all energies is mass. The general reaction for nuclear fission is,

$${}_0n^1 + {}_zX^A \rightarrow {}_zY^{A+1} \rightarrow 2FF + {}_0n^{1}\text{'s} + \gamma + E \quad (3)$$

Now consider fission of ${}_{92}U^{235}$ with neutrons

$${}_{92}U^{235} + {}_0n^1 \rightarrow [{}_{92}U^{236}]^* \rightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3\,{}_0n^1 + \gamma \quad (4)$$

Further barium and krypton are unstable and further decay in due course of time. A=144 Ba(11s) → La(41s) → Ce (285d) → Pr(17m) → Nd

A=89 Kr (3m) → Rb(15m) → Sr(51) → Y

Barium has half life 11s and final stable product is Neodymium, whereas Krypton has half life 3m and final product is Yttrium. The final products i.e. Neodymium and Yttrium are virtually stable.

### 2.1 Insights in Q value

The law of conservation of mass-energy is obeyed in the reactions; the energy emitted in nuclear reactions is due to annihilation of mass. Thus energy released in the process can be considered in two main parts

(i) When uranium ${}_{92}U^{235}$ and neutron ${}_{0}n^{1}$ change to compound nucleus by radiative capture reaction. It gets into excited state $U^{236*}$, the excitation energy tends to distort the shape further.

$${}_{92}U^{235} + {}_{0}n^{1} \rightarrow U^{236*} \rightarrow U^{236} + \gamma \text{ ray} \qquad (5)$$

Then compound nucleus comes to ground state by emitting gamma ray photon of energy 6.54MeV and get split up in fission fragments. The energy required to excite nucleus or energy emitted when compound nucleus come to ground state.

$$\text{Excitation Energy} = [(235.0439299+1.008665)-(236.045568)]\ 931.49\text{MeV}$$
$$= 0.007026 \times 931.49 = 6.54\text{MeV} \qquad (6)$$

When compound nucleus $[{}_{92}U^{236}]^*$ is transformed to ${}_{56}Ba^{141}$ and ${}_{36}Kr^{92}$ along with $\gamma$ ray of energy ( 6.53MeV or 0.007026u.). The energies calculated in eq.(14) and eq.(20) are calculated for this stage.

(ii) Then radioactive isotopes of ${}_{56}Ba^{141}$ and ${}_{36}Kr^{92}$ decay to stable products. The final products i.e. Neodymium and Yttrium are virtually stable. At this stage energy is emitted in form of beta rays, neutrinos emitted in beta rays, gamma rays accompanying beta rays etc.

The energy emitted in each stage is currently explained by $E = \Delta mc^2$, as is at the cost of mass. Thus now the Q value in terms of various three contributions may be summed up as

Q-Value = [mass of reactants] $c^2$ – [Actual mass of fission fragments+ mass equivalent to excitation energy]$c^2$ + Energy due to unstable decay products. (7)

The $\gamma$ ray (6.53MeV or 0.007026u ) is also a product.

Now various possibilities can be considered.

1. The energy emitted in decay products is produced after fission, hence this energy may be neglected if this stage is not considered. However the excitation energy cannot be neglected.

Q-Value = [mass of reactants] $c^2$ – [Actual mass of fission fragments+ mass equivalent to excitation energy]$c^2$ (8)

The mass equivalent to excitation energy is 0.007026u as measured in eq.(6).

Further sub-cases are also considered depending upon velocity of fission fragments. 1(a). If the velocity of fission products is in classical region, v<<c, then

Q-Value = [mass of reactants]$c^2$ – [ mass of fission fragments when v<<c + mass equivalent to excitation energy] $c^2$ (9)

1(b). If velocity of fission products is in relativistic region i.e. v~c then, Q Value = [mass of reactants]$c^2$ – [ mass of fission fragments when v~c + mass equivalent to excitation energy] $c^2$ (10)

**Experimental value**

When uranium is split up in $Ba^{141}$ and $Kr^{92}$ then experimentally energy 175.7 MeV is emitted. Out of this kinetic energy of fission fragments [5] is 168.2 MeV (64.40×$10^{-13}$ calories) and energy of the prompt gamma rays is 7.5MeV. Now if $Ba^{141}$ and $Kr^{92}$ have kinetic energy 168.2MeV, then how gigantic amount of heat energy is emitted in uncontrolled chain reaction. How kinetic energy is converted into heat energy? For example conversion of kinetic energy of vehicle to heat energy can be speculated. The energy 168.2MeV is equivalent to 64.40×$10^{-13}$ calories. It may not be easy to measure this energy precisely when numerous nuclei are fissioned in exceptionally small time. Einstein's E =$\Delta mc^2$ gives energy in terms of Joules not in terms of calories. The energy emitted by decay products is not considered here as at the moment it is not focus of discussion. Some other experiments give different values of kinetic energy of fragments. Thus precise, sensitive and repeatable experiments are required for various nuclides.

## 2.2 Magnitude of Q value

(a) Thermal Neutrons (0.025eV or 2185m/s): If it is assumed that velocity is in classical region i.e. v<<c, then according to eq.(9) the Q value can be written as

Mass of reactants = (235.0439299 +1.0086649156) u = 236.0525948u (11)

Mass of products = (143.922 953 + 88.917 630 +3.02599473+0.007026) u =235.8736037 (12)

Obviously 0.007026u is mass equivalent to energy of $\gamma$ ray as in eq.(6).

Mass annihilated = $\Delta$m =0.1789911u (13)

Energy released (Q Value) =166.728MeV (14)

(b) Fast Neutrons (2MeV or $1.954\times10^7$ m/s).

The neutrons which are emitted in the fission are fast neutrons having energy nearly equal to 2MeV ($3.2\times10^{-13}$ J). With this energy (2MeV) neutron moves with relativistic velocity i.e. $1.954\times10^7$ m/s (~7% that of light). The mass of neutron is 1.0086649156u. If velocity is in relativistic limits then mass of particle increases [6-10], according to equation

$$M_{motion} = \frac{M_{rest}}{\sqrt{1-\frac{v^2}{c^2}}} \quad (15)$$

As velocity is $1.954\times10^7$ m/s (2MeV) then relativistic mass has to be taken in account, otherwise eq.(15) will be irrelevant or relativistic effects will be insignificant. The relativistic effects cannot be neglected otherwise it would mean

$M_{motion}$ ($1.954\times10^7$m/s) = $M_{rest}$ (16)

which is not justified. Thus when neutrons move with relativistic velocity then relativistic mass has to be taken in account.

The relativistic mass of neutron can be calculated from equation of relativistic kinetic energy.

$K = [M_m - M_r]c^2$

$M_m = K/c^2 + M_r = 3.204\times10^{-13} / 9\times10^{16} + M_r$ (17)

$M_m = 0.002143883u + 1.0086649156u = 1.010808793u$

Thus the mass of fast neutrons must be 1.01080879u (%age increase of 0.2125% ) i.e. more than rest mass 1.0086649156u. It cannot be neglected. The mass of product neutrons (2MeV, $1.954\times10^7$ m/s, ~ 7% that of light) must be different from reactant neutron (0.025 eV, 2185m/s). Now substituting various values in eq.(10), in this case Q-value further decreases as mass of products is higher.

Mass of reactants = 236.0525948u (18)

Mass of products = (143.922 953 + 88.917 630 +**3.032426394** +0.007026) u

=235.8800354u (19)

$\Delta m = 0.179584606$ u

Q = 160.7373MeV (20)

Hence when relativistic mass of neutrons is considered then energy predicted is 5.99 MeV ($2.29\times10^{-13}$J) less. So energy predicted is over estimated by 3.45%, if relativistic mass of neutrons is neglected and mass of neutron is regarded as same as rest mass.

Thus such relativistic effects need to be studied for the other fission fragments, for this the velocity or energy of other fragments $Ba^{141}$ and $Kr^{92}$ is required to be known precisely for calculations and final conclusions. Heat energy is also emitted in fission. Here case of neutron is discussed, as its velocity is precisely known and reduced in moderator. If the relativistic mass of neutrons is taken in account then energy emitted is less i.e.3.45% less.

In this regard experiments involving Relativistic Radioactive Beams utilising secondary beam facilities as available at GSI are useful.[12]. In these experiments the velocity and total kinetic energy of fission fragments are measured along with other parameters. With such experiments or specifically improved experiments the relativistic mass of the fission fragments can be calculated. In the present experiment the relativistic fragments are $Ba^{141}$ and $Kr^{92}$. The exact measurements of relativistic masses are required in calculations as in eq. (19). With accurate determination of relativistic mass, the calculations existing in literature and reported in paper can be experimentally tested.

The similar are experimental observations from uncontrolled chain reaction in atom bomb, Serber [11] has reported that efficiency of atom bomb is only 2%. The rest of energy is unaccounted for. In uncontrolled fission final mass of products is not measured hence equation $E = \Delta mc^2$ is not quantitatively assessed. Hence in this regard it is only verified qualitatively.

The various results when classical and relativistic masses are taken in account in calculation of Q value are shown in Table II.

**Table II. Significance of relativistic mass of neutron in mathematical calculations.**

| Sr No. | Velocity | Mass (u) | % age difference in mass(u) | Energy emitted (MeV) | Difference in energies (MeV) | %age difference |
|---|---|---|---|---|---|---|
| 1 | Classical 2185m/s | 1.0086649156u | NA | 166.72MeV | NA | ---- |
| 2 | Relativistic $1.954\times10^7$ m/s | 1.010808793u | 0.2125 | 160.73MeV | 5.99 | 3.59 |

**2.3 Conclusions.**

The discussion can be concluded in the followings way.

(i) The variation of mass with velocity is well known and it is experimentally established

fact when velocity of body is comparable to that of light. In nuclear fission there are two types of neutrons.

Firstly reactant neutrons which have energy 0.025MeV (or velocity v=2185m/s), it is in classical limits hence mass of neutron is taken as classical mass 1.0086649156u. Secondly the energy of secondary neutrons is 2MeV ($1.954\times10^7$ m/s) which is relativistic region. Thus relativistic mass must be 1.010808793u.

(ii) But mass of secondary neutron is regarded as same as rest mass i.e. 1.0086649156u. In the existing literature masses of slow and fast neutrons (having energy 0.025MeV or 2185m/s, and 2MeV or $1.954\times10^7$ m/s or ~ 7% speed of light) are regarded as rest masses (1.0086649156u). Thus Q-value of reaction is 166.72MeV i.e. eq.(14).

If the mass of reactants neutrons (0.025MeV or 2185m/s ) is regarded as classical mass i.e. 1.0086649156u and mass of product neutron (2MeV or $1.954\times10^7$ m/s) equal to 1.0086649156u; then Q-value of reaction is 160.73MeV i.e. eq.(20). Thus energy emitted in reaction is 3.45 % less if realistic values of parameters are used.

(iii) According to relativistic variation of mass, if the velocity of particle is in relativistic region then mass is given by eq.(15). This effect is not used in this case even velocity (2MeV or $1.954\times10^7$ m/s or ~ 7% speed of light) is in relativistic region.

(vi) Segre [5] has pointed out that energy emitted in fission of $U^{235}$ is 175.7MeV , whereas other scientists give different values for the same. The precise, specific and independent experimental measurements of energy emitted in **single fission event** will be helpful in this regard. The various observations give different values of energy, for the same reaction every observation must give same value of energy. It may be due to experimental observations. In view of it, some standard measurements (combined effects of various laboratories) must be done in specific and precise way so that data obtained is regarded as yardstick. There are many fissionable nuclei, so experiments should be conducted individually and specifically.

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# 7 Binding energy and mass defect of deuteron: Revisited

**Ajay Sharma**

Fundamental Physics Society, His Mercy Campus, Post Box 107 GPO Shimla

171001 HP INDIA

Email: ajay.pqr@gmail.com

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**Abstract**

There are two inherent observations; firstly masses of nucleons are fundamental constants (masses are same inside and outside the nuclei) in all cases and secondly nuclei possess BE ($\Delta E=\Delta mc^2$) due to mass defect. Currently the experimental observations of deuteron (BE= 2.2244 MeV ) are explained on the basis of $\Delta E=\Delta mc^2$ , and difference in masses of nucleons must be $2.388\times10^{-3}$ u . It is not justified as masses of nucleons are fundamental physical constants i.e. should be same inside and outside the nucleus. But the generalized equation $\Delta E = Ac^2 \Delta m$ is capable of explaining both the observations simultaneously i.e. equality of masses of nucleons and binding energy of nucleus. The reason is that according to $\Delta E = Ac^2$

$\Delta m$ ( if A is regarded as $10^{10}$ ) even infinitesimally small mass defect ( $2.388\times10^{-13}$ u , say) predicts binding energy 2.2244MeV. If mass defect is $2.388\times10^{-13}$ u then masses of nucleons both inside and outside nucleus must be the same. Hence $\Delta E = Ac^2\,\Delta m$ explains both observations simultaneously which $\Delta E=\Delta mc^2$ cannot explain. This generalization has no effect in those cases where $\Delta E=\Delta mc^2$ is established.

**1.0 Decrease in masses of proton and neutron in deuteron; explains Binding Energy.**

In the experimental and theoretical nuclear physics the masses of nucleons (protons and neutrons) are fundamental physical constants in category of atomic and nuclear constants, and binding energy (energy required to break the nucleus) is an inherent property of all nuclei. The mass energy inter conversions are universally explained on the basis of $E=\Delta mc^2$, where $\Delta m$ is mass defect.

Mass defect = Mass of nucleons out side nucleus – Mass of nucleons inside nucleus (1)

Binding energy = $\Delta mc^2$ (2)

The mass defect and BE in terms of mass of atom

$$\Delta m = \{[\, Z(m_p + m_e) + (A- Z)m_n \,] - M_{atom} \} \qquad (3)$$

with all terms usual meanings.

$$BE = \{[\, Z(m_p + m_e) + (A- Z)m_n \,] - M_{atom} \}\, c^2 \qquad (4)$$

Eq.(4) gives definition of binding energy right from elementary level and is used in all cases. It is based upon Einstein's mass energy inter-conversion. This aspect is critically discussed in view of **deuteron**, which contains just one neutron and proton.

(a) The mass of proton is experimentally measured equal to $1.672621\times10^{-27}$ kg, (1.007276u or 938.272029 MeV) and is same in all cases. Also the mass of neutron is $1.674927\times10^{-27}$ kg (1.008664u or 939.565360 MeV). These masses are fundamental physical constants in category of atomic and nuclear constants.

(b) Experimentally binding energy (BE ) of deuteron is measured by various methods[1-3] has been found to be 2.2244MeV (1amu = 931.494MeV, 1amu =$1.660\,5381\times10^{-27}$ kg ), which is equivalent to 0.002388u ($3.984\times10^{-30}$ kg ) on the basis of $\Delta E = \Delta mc^2$.

The expected mass of $_1H^2$ atom is 2.0165 u which is sum of mass of $_1H^1$ atom (1.0078 u) plus mass of neutron (1.0087 u) . However the measured mass of $_1H^2$ is 2.0141u. Thus it is the mass defect (2.0165 u –2.0141u = 0.0024u) which is converted to binding energy, which is law of conservation of matter. According to $\Delta E = \Delta mc^2$, conversion factor between mass and energy is $c^2$.

**2.0 $\Delta E=\Delta mc^2$ implies mass of nucleons decreases in nucleus, which is against universal constancy of mass of nucleons.**

The binding energy of the deuteron is experimentally [1-3] observed as 2.2244 MeV. According to $\Delta E = \Delta mc^2$ it is equal to mass defect 0.002388 u. It means in the nucleus of deuterium, mass 0.002388u (of proton and neutron) is converted into binding energy.

The mass defect i.e. 0.002388 u is comparable with sum of masses of the neutron and proton (2.01594 u), the masses must decrease in nucleus considerably i.e. 0.11845 % (compared to mass in free state). In deuteron there are only proton and neutron, hence theoretically decrease in mass or mass defect 0.002388u is only at the cost of mass of proton ($M_p$) and mass of neutron ($M_n$).

The mass of proton is 1.007276 u and let decrease in mass of proton is half the mass defect (0.002388 u) i.e. 0.001194 u (which contributes towards the binding energy of deuterium). Then theoretically mass of proton in nucleus must be 1.006082 u ($1.67009\times10^{-27}$ kg) and then decrease in mass of proton must be 0.1185 %. Also mass of neutron is 1.008664 u and let decrease in mass of neutron is half the mass defect i.e. 0.001194 u. Then mass of neutron in nucleus must be 1.00747 u ($1.6724\times10^{-27}$ kg). Similarly the decrease in mass of neutron in nucleus is 0.1185%. These estimates are based upon $\Delta E = \Delta mc^2$.

These processes are simply law of conservation of matter. According to $E = \Delta mc^2$ , the conversion factor between mass and energy is precisely $c^2$, and in $\Delta E = Ac^2\,\Delta m$ conversion factor is $Ac^2$ . However, no such conversion factor is defined when law of conservation of mass or energy was enunciated.

**2.1 For simultaneous explanation of binding energy and mass defect $\Delta E=\Delta mc^2$ is generalized as $\Delta E \propto \Delta mc^2$ or $\Delta E=Ac^2\Delta m$**

$\Delta E=\Delta mc^2$ is unable to explain simultaneously 'universal equality of nucleons' and 'binding energy' of deuteron. In $\Delta E=\Delta mc^2$ the conversion factor between mass and energy is precisely equal to $c^2$. For explanation of both the phenomena simultaneously, a postulate can be used.

**Postulate :** ' Conversion factor between mass and energy may not be always $c^2$.'

To explain this particular observation $\Delta E=\Delta mc^2$ is generalized as $\Delta E=Ac^2\Delta m$ . It implies that conversion factor between mass and energy is different from $c^2$.

**Justification of postulate from Einstein's Sep.1905 derivation.**

This postulate can be easily justified from Einstein's Sep. 1905 derivation. Einstein [4] initially derived light energy mass equation, $\Delta L = \Delta mc^2$, then speculated from it $\Delta E = \Delta mc^2$ by replacing L by E for all energies ( sound energy, heat energy, chemical energy, nuclear energy, magnetic energy, electrical energy, energy emitted in form of invisible radiations, energy emitted in cosmological and astrophysical phenomena, energy emitted in volcanic reactions , energies co-existing in various forms etc. etc. ) without derivation and any mathematical or conceptual proof. The limitations of Einstein's derivation can be in following way. In Einstein's derivation there are four main variables[4]

(i) Number of light waves

(ii) Magnitude of energy of light waves.

(iii) Angles at which waves are emitted.

(vi) Velocity of the system

In the derivation Einstein has just taken two waves whereas many are possible. The magnitude of light waves can be different but Einstein has taken magnitude of each wave as 0.5L each. The waves can be emitted at different angles , but Einstein has taken just opposite angles. The body may move with classical velocity or relativistic velocity, but Einstein has considered velocity in the classical region (applied binomial theorem). Why relativistic velocity is neglected ? The inter-conversion of mass to energy takes place even under relativistic conditions i.e. v is comparable with c [5-12].

Thus under special conditions of the variables Einstein derived $\Delta L = \Delta mc^2$, and from this equation $\Delta E=\Delta mc^2$ was speculated. If all possible values of variables are considered, then results is $\Delta L \propto \Delta mc^2$ or $\Delta L = Ac^2\Delta m$. From here equation $\Delta E=A c^2\Delta m$ is considered, as described above [5-12]. Thus according to $\Delta E = Ac^2\Delta m$ *like* Einstein's equation mass is converted to energy but *unlike* Einstein's equation conversion factor is not always $c^2$. Hence in this case the conversion factor is other than $c^2$ , so the postulate that 'conversion factor between mass and energy can be different than $c^2$ ' is justified.

**3.0 $\Delta E = Ac^2 \Delta m$ implies infinitesimally small mass defect (equality of masses of nucleons) can give binding energy 2.2244MeV.**

Let us consider the followings.

(i) The masses of proton and neutron are same both inside and outside the nucleus; it is universal equality of masses of nucleons which are fundamental constants in the category of atomic and nuclear constants. Thus

Mass of neutron in free state($m_n$) =Mass of neutron inside nucleus($m_n$) (5)

or Mass of proton in free state($m_p$) =Mass of proton inside nucleus($m_p$) (6)

(ii) Universal equality of masses of nucleons implies zero mass defect ($\Delta m=0$), hence zero binding energy on the basis of $\Delta E = \Delta mc^2$ . Thus

$$\Delta E = \Delta mc^2 = 0.c^2 = 0 \quad (7)$$

which implies the instability of the deuteron. It is contradictory to experimental observations.

In this perception the universal equality of masses of nucleons can be understood as 'mass defect is infinitesimally small' or imperceptible. If mass defect is infinitesimally small then masses of neutron and proton are virtually equal as differences in masses are imperceptible. Thus this speculation or insight is consistent with universal equality of masses of nucleons. When this perception or speculation of 'infinitesimally small mass difference' is used in the generalized form of mass energy equation $\Delta E = Ac^2 \Delta m$, then it can explain BE of deuteron as well.

Let us perceive that the mass defect in this regard is $2.388\times10^{-13}$ u or $3.965\times10^{-40}$ kg ( or may be even less), then masses of nucleons inside and outside the nucleus are equal as difference is too less to be measured. Now in this case masses of nucleons must decrease in nucleus by infinitesimally small amount i.e. $1.18455\times10^{-11}$ % (or may be even less). Now the mass of proton (1.007276u) inside the nucleus will be 1.0072759999998806u and in previous case (based upon $\Delta E = \Delta mc^2$) it was 1.006082u.

Similarly mass of neutron (1.008662 u) inside the nucleus will be 1.0086619999998806 u and in previous case (based upon $\Delta E = \Delta mc^2$) it was 1.00747 u. Thus mass of proton and neutron will decrease in nucleus by insignificant amount, such that universal equality of masses of nucleons is obeyed. In this case mass defect is insignificant even then binding energy (2.2244MeV) can be explained with $\Delta E = Ac^2\,\Delta m$ (value of conversion coefficient A is very high). Thus deuteron is stable.

According to the generalized form of mass-energy inter-conversion equation i.e. $\Delta E = Ac^2\,\Delta m$, for annihilation of infinitesimally small mass defect, large amount of energy can be emitted. It means conversion factor is much higher than $c^2$, in this particular case. Now applying equation $\Delta E = Ac^2\,\Delta m$ under these conditions ( BE= 2.2244MeV = $3.579\times10^{-13}$ J, $\Delta m = 2.388\times10^{-13}$ u = $3.965\times10^{-40}$ kg ), the value of A can be determined as

$$A = \Delta E / c^2\,\Delta m = [3.5634\times10^{-13}]/[8.987524\times10^{16}\times3.965\times10^{-40}]$$

$$3.5634\times10^{10}/3.5634 = 10^{10} \qquad (8)$$

Thus in this case we have

$$\Delta E = Ac^2\,\Delta m = 10^{10}\,c^2\,\Delta m \qquad (9)$$

Thus according to generalized mass energy inter conversion equation, corresponding to small mass defect , large amount of energy is emitted in this case. The value of conversion co-efficient ( 'A') have resemblance with co-efficients of proportionality in C. F. von Weizsacker's semi-empirical formula [13] for binding energy (associated with Bohr's Liquid Drop Model).

Thus generalized equation explains both intrigues e.g. universal equality of masses of nucleons and binding energy of nucleus 2.2244MeV. According to both equations i.e. $\Delta E = Ac^2\,\Delta m$ and $\Delta E = \Delta mc^2$ the mass is converted to energy or vice-versa, but only the difference is in magnitudes of conversion factors. This explanation is only meant for this case, not in other cases where $\Delta E = \Delta mc^2$ is experimentally confirmed. The universal equality of masses of nucleons and BE on the basis of both the equations is shown on the Table I.

## 4. Conclusions

The mass of nucleus is found to be less than individual masses of nucleons. The difference in mass is converted to energy known as binding energy ($\Delta E = \Delta mc^2$). In case of deuteron, binding energy is 2.2244MeV, and mass of nucleus must decrease by 0.002388u

($3.984\times10^{-30}$ kg ). Thus masses of neutrons and protons decrease in nucleus i.e. they become lighter. Thus masses of nucleons in nucleus and outside are different. It is contradictory to universal equality of masses of nuclei.

However if $\Delta E = Ac^2 \Delta m$ is used then , negligible decrease in mass i.e. $2.388\times10^{-13}$ u or $3.965 \times10^{-40}$ kg yields binding energy is 2.2244MeV. Thus the generalized form mass energy equation i.e. $\Delta E = Ac^2 \Delta m$ or the postulate

' conversion factor between mass and energy can be different than $c^2$'

is justified in this case as consistent results are obtained.

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**Table 1 Comparison of universal equality of masses of nucleons on the basis of $\Delta E = \Delta mc^2$ and $\Delta E = Ac^2 \Delta m$ in deuteron.**

| Sr. No. | Characteristics of $_1H^2$ | On basis of **$E = \Delta mc^2$** | On basis of **$\Delta E = Ac^2 \Delta m$** |
|---|---|---|---|
| 1 | Binding Energy (MeV) | 2.2244 | 2.2244 |
| 2 | Mass defect ($BE/c^2$) in amu | $2.388\times10^{-3}$ | $2.388\times10^{-13}$ |
| 3 | Decrease in mass per nucleon (amu) | $1.194\times10^{-3}$ | $1.194\times10^{-13}$ or $1.982\times10^{-40}$ kg |
| 4 | $M_p$ and $M_n$ in nucleus | $M_p$=1.006082 $M_n$ =1.00747 | Virtually same |
| 5 | %age Decrease | | |

| | | | |
|---|---|---|---|
| | in $M_p$ | 0.1185 | $1.185\times10^{-11}$ |
| 6 | %age Decrease in $M_n$ | 0.1183 | $1.183\times10^{-11}$ |
| 7 | Universal equality of masses of $M_p$ and $M_n$ | Not obeyed | Obeyed |

## Part IV Scientific , mathematical and practical aspects.

# 8. Origins of Rest Mass Energy in Einstein's derivations.

**AJAY SHARMA**

**Fundamental Physics Society. His Mercy Enclave Post Box 107 GPO Shimla 171001 India**

Email ajay.pqr@gmail.com

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**Abstract**

Einstein derived five equations relating to mass (rest mass, mass exchanged) and energy. From the relativistic form of kinetic energy KE = $(M_{motion} - M_{rest})c^2$, Einstein derived the classical form of kinetic energy (under the conditions when v<<c). Also writing relativistic kinetic energy in typical way Einstein derived Rest Mass Energy $E_{rest} = M_{rest}\,c^2$ , under the condition when body is at rest v = 0, dx = 0. The determination of Rest Mass Energy is inconsistent in the sense that it is obtained under this condition, when very first equation ( dK = dW = Fdx ) is zero. Thus the first equation which leads to relativistic form of KE vanishes, and hence other equations are non-existent. So $E_{rest}$ is derived from NON-EXISTENT equation which is not justified. There is no such example in science. So how there can be non-zero output without any input? Further equation of rest mass energy can be obtained or understood from Einstein's mass energy inter-conversion equation.

**1.0 Einstein obtained $KE_{rel} = (M_{motion} - M_{rest})\, c^2$, when Force Acts in Direction of Displacement**.

Einstein has derived five types of energies e.g . mass energy inter conversion equation $E = \Delta mc^2$ , light energy mass inter conversion equation $L = \Delta mc^2$ , relativistic energy ( $E=M_{motion}c^2$ ), kinetic energy ($M_{rest}v^2/2$) and Rest mass energy $E_{rest} = M_{rest}c^2$. The units and dimensions of all energies are the same. Each energy is derived under different conditions, hence have different meanings. For complete understanding the author [1-7] has critically studied Einstein's mass energy inter-conversion equation and the study has lead to new findings. Einstein [8] initially derived relativistic form of kinetic energy and later interpreted the rest mass energy [9, 10-12, 6].

Consider a body moves in the direction of force then, according to Work–Kinetic Energy equation

$$dK = dW = Fdx$$

(1)

$$dK = dW = \frac{d}{dt}[M_{motion}v]dx$$

$$= \left[ M_{motion}\frac{dv}{dt} + v\frac{dM_{motion}}{dt} \right]dx \qquad (2)$$

$dK= \{ M_{motion}\, dv + v\, d\, (M_{motion}) \}v \quad [\, v = dx/dt \,]$

$= [\, M_{motion}\, vdv + v^2\, d\, (M_{motion})\, ]$

(3)

The relativistic mass is

$$M_{motion} = \frac{M_{rest}}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (4)$$

Eq.(4) is applicable when v is comparable with c.

or $M^2_{motion}\, c^2 - M^2_{motion}\, v^2 = c^2\, M_{rest}$

Differentiating w.r.t. time

$$\frac{c^2 d\left(M^2{}_{motion}\right)}{dt} - \frac{d\left(M^2{}_{motion} v^2\right)}{dt} = \frac{d\left(c^2 M_{resr}\right)}{dt} \tag{5}$$

Now eq.(5) can be further written as

$$c^2 \frac{dM^2{}_{motion}}{dt} - \frac{d(M^2{}_{motion} v^2)}{dt} = \frac{dc^2 M_{rest}}{dt}$$

$$c^2 \frac{dM^2{}_{motion}}{dt} = \frac{d(M^2{}_{motion} v^2)}{dt}$$

$$c^2 2M_{motion} \frac{dM_{motion}}{dt}$$
$$= 2M_{motion} \frac{dM_{motion}}{dt} v^2 + M^2{}_{motion} 2v \frac{dv}{dt} \tag{6}$$

Dividing both sides of eq.(6) by $2M_{motion}$,

$$c^2 dM_{motion} = v^2 dM_{motion} + M_{motion} v dv \tag{7}$$

Now eq.(3) with help of eq.(7) can be written as

$$dK = dW = c^2 d(M_{motion}) \tag{8}$$

.

$$\int dK = \int dW = c^2 \int d(M_{motion}) \tag{9}$$

$$K = W = c^2 (M_{motion} - M_{rest})$$

Or $K = W = c^2 ( M_{motion} - M_{rest} )$

Or $K = W = M_{motion} c^2 - M_{rest} c^2$ (10)

Applying binomial theorem , the classical form of kinetic energy and work done is obtained i.e.

$$K = W = \frac{M_{rest} v^2}{2}$$

**2.0 Conditions of derivation of $K = W = M_{motion} c^2 - M_{rest} c^2$**

(i) Eq.(10) is obtained if the force actually displaces the body in its own direction through displacement dx. If dx=0 then , dW = Fdx = 0.

(ii) Eq.(10) is obtained when velocity of body is comparable to speed of light i.e. v ~c , only then eq.(4) gives noticeable results.

(iii) In case considerable amount of force acts on body and body does not move (dx=0), then eq.(10) is not derivable, as eq.(1) is zero.

Now it is obvious that equation can only be interpreted under those conditions, it is originated. The eq.(10) has been interpreted to obtain $E_{rest} = M_{rest}c^2$ , under the condition (v = 0, dx=0) . If v=0, dx=0, then eq.(1) vanishes hence from NON-EXISTENT equation non-zero results , $E_{rest} = M_{rest}c^2$ cannot be drawn. In fact no result is feasible from non-existent equation. This aspect is discussed with its implications. The eq.(10) is interpreted in view of this deduction and interesting results are obtained.

**3.0 Interpretation of Eq.(10) in Terms of Kinetic Energy and Work**

Now eq.(10) can be physically interpreted as below.

The kinetic energy attained by a body due to the influence of external force in accelerated motion when a body moves in the direction of force with velocity v, which is comparable to c

$$= c^2 ( M_{motion} - M_{rest} ) = c^2 \left[ \frac{M_{rest}}{\sqrt{1 - \frac{v^2}{c^2}}} - M_{rest} \right]$$

= [Increase in mass of body when due to application of external force in accelerated motion, when force displaces body in own direction with velocity v which is comparable to c] $c^2$

(11)

Or

The kinetic energy attained by body due to influence of external force in accelerated motion when force displaces the body in its own direction with velocity v which is comparable to c, $+M_{rest} c^2 = M_{motion}c^2$

(11)

Further, Einstein termed $M_{motion}c^2$ as total energy or relativistic energy [9, 10-12,6 ]. Then eq. (11) is

$$E_{motion} = E_T = KE + M_{rest}c^2 = M_{motion}c^2 \qquad (12)$$

In terms of work

The work done by body due to influence of external force in accelerated motion when body moves in direction of force with velocity v which is comparable to c, the speed of light

$$= c^2 ( M_{motion} - M_{rest} ) = c^2 \left[ \frac{M_{rest}}{\sqrt{1 - \frac{v^2}{c^2}}} - M_{rest} \right]$$

Similarly

$$KE + M_{rest}c^2 = M_{motion}c^2 = \text{Relativistic work done} \qquad (13)$$

These are relativistic equations i.e. exist when v~c, as only under this condition relativistic increase in mass is observable.

**4.0. The Rest Mass Energy is not derivable when v = 0, dx = 0**

In 1907, Einstein [9, 10-12, 6 ] interpreted the eq.(12) i.e.

$K = c^2 (M_{motion} - M_{rest})$

as rest mass energy i.e. $E_{rest} = M_{rest}c^2$ or $W_{rest} = M_{rest}c^2$.

But conceptually and mathematically it is not justified, as when body is at rest i.e. (v = 0, dx =0) then the very first equation i.e.

dK = dW = Fdx

vanishes as there is situation of mathematical void in the beginning and rest of the equations cannot be perceived. Thus other equations are NON-EXISTENT. So the origin of rest mass energy lies in the equation which itself has no origin, if this condition is applied (v = 0, dx = 0). Therefore equation for rest mass energy ($E_{rest} = M_{rest}c^2$ ) is obtained from NON-EXISTENT equation. This conclusion is illogical and arbitrary. An equation can be only interpreted under the condition it is originated or derived. Hence above interpretation is justified. It can be understood in the following way.

(i) **Rest mass energy is not obtained from eq.(10).**

Also we have equation for relativistic form of kinetic energy (**when v~c** ) or work done

$$W = K = c^2 (M_{motion} - M_{rest}) \quad (10)$$

Applying the condition that body is at rest, i.e. v = 0, dx = 0, dW = dK = 0,

$$0 = c^2 (M_{rest} - M_{rest})$$

$$\text{Or} \quad M_{rest}\, c^2 = M_{rest}\, c^2$$

$$\text{Or} \quad 1 = 1 \quad (14)$$

which is true. Nevertheless, result is in no case is rest mass energy ($E_{rest} = M_{rest}c^2$) in any way as obtained by Einstein.

(ii) **Rest mass energy not obtained if eq.(10) is written in slightly different way.**

The eq.(10) can be written as

$$KE + M_{rest}\, c^2 = M_{motion}\, c^2 \quad (15)$$

When a body is at rest, i.e. v = 0, dx = 0, dW = dK = 0, then under this condition eq.(15) becomes,

$$0 + M_{rest}\, c^2 = \frac{M_{rest}}{\sqrt{1 - \frac{0}{c^2}}}\, c^2 = M_{rest}\, c^2$$

$$M_{rest}\, c^2 = M_{rest}\, c^2$$

$$\text{Or} \quad 1 = 1 \quad (14)$$

which is true. Hence in no way the rest mass energy equation ($E_{rest} = M_{rest}c^2$) is obtained. Similar is the case if this condition is applied to eq.(10). These cases are not discussed by Einstein.

**(iii) Also in terms of work.** The kinetic energy is obtained from equation of work, it is evident from eq.(1), if work done is zero then energy is also zero. The conclusions can be transparently understood if the results are explained on the basis of work.

Or eq.( 13 ) can be written as

KE + $M_{rest}$ $c^2$ = $M_{motion}$ $c^2$ = Relativistic Work done (13)

When a body is at rest i.e. v = 0, dx = 0, dW = dK = 0, then under this condition eq.(13) becomes

0 +$M_{rest}$ $c^2$ = $M_{rest}c^2$ = Relativistic Work done ( when v = 0) = 0 (16)

$M_{rest}$ $c^2$ = 0

But neither $M_{rest}$ is zero nor c is zero, thus eq.(13 ) cannot be interpreted under this condition. This interpretation does not lead to $E_{rest}$ = $M_{rest}$ $c^2$ as in case of eq.(14). An equation can be only interpreted under the condition it is originated. So it is concluded that an equation cannot be interpreted under the conditions it does not exist. Hence Einstein's deduction of $E_{rest}$ = $M_{rest}$ $c^2$ is not justified.

**5.0 Einstein's arbitrary way to get Rest Mass Energy by re-writing and interpreting eq.(10).**

Einstein wrote eq.(10) in arbitrary way applying opposite conditions i.e. body is moving with simultaneously with speed comparable to that of light (v ~c ) and is at rest (v=0). Body cannot be at rest while moving with v~c and when body is at rest it can not move with v~c. According to Einstein,

$M_{motion}$ $c^2$ = Total Energy due to motion **when v~c** or $E_T$ (17)

$M_{motion}$ $c^2$ = Work done due to motion **when v~c** or $E_T$

Thus eq.(15) becomes

KE + $M_{rest}$ $c^2$ = $M_{motion}$ $c^2$ = Total Energy due to motion **when v~c** (18)

or KE + $M_{rest}$ $c^2$ = $M_{motion}$ $c^2$ = Work done due to motion **when v~c**

In eq.(15) there is only one sign of equality.

When a body is at rest, i.e. v = 0, dx = 0, dW = dK = 0, then under this condition eq.(18) becomes

0 +$M_{rest}$ $c^2$ = $M_{rest}c^2$ = Total energy due to motion when **v ~c** (v = 0) (19)

0 +$M_{rest}$ $c^2$ = $M_{rest}c^2$ = Work done due to motion **when v~c** (v=0)

Einstein wrote

Total energy due to motion defined when v~c (v = 0) = $E_{rest}$ (20)

Total work done due to motion defined when v~c (v = 0) = $W_{rest}$ =$E_{rest}$

But it is not logical to assume velocity at rest (v=0) when body is moving with speed comparable to that of light .When body is at rest (v=0) then it cannot move with speed comparable to that of light. So it is illogical and self contradictory assumption by Einstein, hence bound to give incorrect results. It can be further understood below. When v = 0, eq. (1) is zero, the momentum of body is zero , classical kinetic energy is zero, work done is also zero, but mathematically total energy or relativistic energy of body is non-zero.

It is quite arbitrary, as in this case the total energy or relativistic energy (v~c) is not defined. All the energies follows from eq.(1) which is zero under this condition. Mathematically, Einstein wrote

$$M_{rest} c^2 = M_{rest}c^2 = E_{rest} \quad (21)$$

Further Einstein interpreted eq.(21) as

$$E_{rest} = M_{rest}c^2 \quad (22)$$

If body is at rest v = 0, then eq.(1) i.e.

dK = dW = Fdx =0

and rest of equations including eq.(10) are NON-EXISTENT, then no conclusions be derived from non-existent equation. It is like getting NON-ZERO output from no input, thus it is not justified.

Further eq.(18) is nothing but other form of eq.(10) and eq.(15) which under similar conditions (v=0) don't lead to $E_{rest} = M_{rest}c^2$ . Under these conditions eq.(10) or eq.(15) gives 1 =1 , which is in no way rest mass energy.

In a physical example it can be understood in the following way. Consider a 7 story building is constructed. Now if first story is demolished then rest of six floors collapse. But according to analogous Einstein's interpretation of mathematical equation of eqs.(21-22 ) , if the first floor is demolished then rest of six floors must float in air. The reason is that Einstein has put forth that if first equation is zero ( W=K=Fdx=0), even then non-zero results ($E_{rest} = M_{rest}c^2$ ) can be derived from this. Einstein derived from non-existent equation, a non-zero result, $E_{rest} = M_{rest}c^2$. Analogously demolishing the first story, the remaining six floors float in air.

Ives [13] has commented in critically analyzing Einstein's work on inter conversion of mass and energy equation that Einstein had assumed what he wanted to prove. Similar approach is apparently here also.

### 6.0 Alternate way to obtain Rest Mass Energy

The equation for rest mass energy can also be obtained [11] with help of eq.(12) and equation for relativistic momentum

$$E_T = M_{motion}c^2 = c^2 \frac{M_{rest}}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (12)$$

$$P = \frac{M_{rest}}{\sqrt{1 - \frac{v^2}{c^2}}} v \qquad (23)$$

The eq.(12) is also derived from eq.(1). Now it can be easily shown that

$$E^2 - P^2c^2 = \frac{c^4 M^2_{rest}}{\left[1 - \frac{v^2}{c^2}\right]} - \frac{v^2 c^2 M^2_{rest}}{\left[1 - \frac{v^2}{c^2}\right]} = M^2_{rest}\, c^4$$

Or $E^2 = M^2_{rest}\, c^4 + P^2c^2$

$$E = [M^2_{rest}\, c^4 + P^2c^2\,]^{1/2} \qquad (24)$$

The rest mass energy can be obtained from eq.(24) applying condition when body is at rest i.e. v = 0,

E (Total energy when v = 0) = $M_{rest}\, c^2$

or $E_{rest} = M_{rest}\, c^2$

But again the situation is similar when (body is at rest, v = 0 ) then eq.(23) is zero i.e. it does not exist.

$$P \text{ (when } v = 0) = v \frac{M_{rest}}{\sqrt{1 - \frac{v^2}{c^2}}} = 0 \qquad (25)$$

When body is at rest v = 0 or dx = 0 , eq.( 23) is zero, and equation of relativistic energy i.e. eq.(12) is defined when v~c. The origin of eq.(12) is based upon eq.(10), which is zero under this condition. Further eq.(10) is based upon eq.(1) which is also zero under this condition. Thus this derivation of $E_{rest} = M_{rest} c^2$ is also inconsistent.

## 7. Logical and alternate way to obtain rest mass energy

The origin of rest mass energy can also be understood from Einstein's derivation of mass energy inter-conversion equation. Einstein has derived mass energy inter conversion equation [14] as

$$E = (M_b - M_a) c^2 = \Delta mc^2 \qquad (26)$$

or Mass of body after emission ( $M_a$ ) = Mass of body before emission ( $M_b$ ) $- \frac{E}{c^2}$ (26)

If whole mass is annihilated ( $M_a = 0$ ) i.e. no mass is left after emission , then

$M_b c^2 = E$ (27)

In Einstein's derivation $M_b$ is mass before emission and body is regarded at rest [14] , thus $E = M_b c^2$ may be regarded as rest mass energy i.e. $E_{rest} = M_{rest} c^2$. It is energy equivalent to rest mass energy. It is logical deduction from Einstein's this derivation. In Einstein's this derivation $E_{rest} = M_{rest} c^2$ is not obtained from non-existent equation as in previous derivation, hence this derivation is correct.

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