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THE BASIS OF GENERALIZATION OF $\Delta E = mc^2$ TO $\Delta E = Ac^2\Delta M$ AND ITS JUSTIFICATION IN PHYSICAL PHENOMENA

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Abstract

Einstein's (Sep. 1905) derivation theorizes that when light energy (L) is emanated by luminous body then its mass diminishes as Δm =L/c^2 and this equation is speculative origin (without proof) of ΔE = c$^2\Delta$m. This derivation is true under special conditions only, not in general. Einstein's derivation L = Δmc^2 involves four variables e.g. magnitude of energy of light waves, number of light waves, angle at which light waves are emitted and velocity of observer, v. Einstein derived L = Δmc^2 choosing special values of variables. If general values of variables are considered then Einstein's derivation predicts that as body emits light energy, then its mass must increase, which is inconsistent result. Alternate equation ΔE = Ac$^2\Delta$M has been suggested, which implies that energy emitted on annihilation of mass (or vice versa) can be equal, less and more

than predicted by $\Delta E = \Delta mc^2$. $\Delta E = c^2 \quad \Delta m$ is yet unconfirmed in the most abundant chemical reactions. The total kinetic energy of fission fragments of U^{235} or Pu^{239} is found experimentally 20-60 MeV less than Q-value predicted by Δmc^2, it is explainable with $\Delta E = Ac^2 \quad \Delta M$ with value of A less than one. Energy emitted by Gamma Ray Bursts (most energetic event after Big Bang) in duration 0.1-100s, is 10^{45}J , can be explained with help of $\Delta E = Ac^2 \Delta M$. The mass of particle Ds (2317) discovered at SLAC, have mass lower than current estimates; it can be explained with value of A more than one. $\Delta E = Ac^2 \Delta M$, explains that mass of universe 10^{55}kg was created from dwindling amount of energy (10^{-4444}J or less) and A is 2.568×10^{-4516} J or less. This perception implies gravitational energy is another form of mass (like other energies) and has been originated simultaneously with mass.

1 Inter-conversion of mass and energy before Special Theory of Relativity

The French chemist Antoine Lavoisier (1743-1794) was the first to formulate a law of conservation of matter in chemical reactions. The concept of inter-conversion of mass and energy has been studied by various scientists qualitatively, even before Einstein.

Newton [1] has quoted in his book 'Opticks' in 1704 that "Gross bodies and light are convertible into one another...", After about 200 years Einstein [2] derived mathematical equation for Newton's perception *i.e.* $\Delta L = \Delta mc^2$ where ΔL is light energy emitted when mass Δm is annihilated and c is speed of light. It is the rarest coincidence in between Newton's hypothesis and Einstein's mathematical derivation.

S. Tolver Preston [3] proposed that a vast amount of energy can be produced from matter in his book *Physics of the Ether* in 1875. Preston determined that one grain could lift a 100,000-ton object up to a height of 1.9 miles. This deduction yields $\Delta E \propto \Delta mc^2$.

Jules Henri Poincaré [4, 5] in 1900 applied the calculations in a recoil process and reached at the conclusion in the form, $mv = (E/c^2)c$. From the viewpoint of dimensional analysis, E/c^2 takes on the role of a 'mass' associated with radiation, which yields $E=mc^2$.

Olinto De Pretto [6] speculated $E=mc^2$, implying that when $v=c$, then $E= mv^2$ becomes $E=mc^2$, in **1903-04.** But Pretto neither gave specific derivation nor mathematical calculations. Bartocci [7] claimed that Einstein was aware of De Pretto's speculation of $E=\Delta mc^2$, which was published about a year before.

Fritz Hasenohrl [8,9] in 1904, concluded: "to the mechanical mass of our system must be added an apparent mass which is given by, $m=8E/3c^2$where E is the energy of the radiation." In a later paper he further improved result that mass exchanged is, $m=4E/3c^2$. Ebenezer Cunningham [10] in 1914 in the book The Principles of Relativity showed that F. Hasenöhrl, had made a slight error in his calculations. If errors are removed then the mass exchanged is $m =E/c^2$ or $E = mc^2$. Thus in this regard Hasenohrl's contribution is the most significant, before Einstein.

Frederick Soddi [11] and M. Henri Becquerel both have predicted that in radioactive emissions the mass of body decreases i.e. energy of radiations is at the cost of mass.

Max Planck [12-13] in 1907 made an in-depth investigation of the energy "confined" within a body, but he did not use Einstein's approach at all. Planck derived an expression m-M= E/c^2, for heat energy and mass and interpreted that

" The inertia mass of body is altered by absorption or emission of heat energy. The increments of mass of body are equal to heat energy divided by square of speed of light."

Planck acknowledged Einstein's previous derivation but did not agree with correctness of Einstein's derivation.

2 Einstein mass energy inter-conversion equation

Einstein [2] perceived that let there be a luminous body at rest in co-ordinate system (x, y, z). The system (ξ, η, ζ) is in uniform parallel translation w.r.t. system (x, y, z); and origin of which moves along x-axis with velocity v. Let a system of plane light waves have energy ℓ relative to system (x, y, z), the ray direction makes angle ϕ with x-axis of the system (ξ, η, ζ). The quantity of light measured in system [ξ, η, ζ] has the energy [14].

$$\ell* = \ell\{1 - v\cos\phi/c\}/\sqrt{[1 - v^2/c^2]} \tag{1}$$

Einstein has given eq.(1) in his paper known as Special Theory of Relativity [14] and called eq.(1) as Doppler principle for any velocities whatever.

Einstein calculated the decrease in mass of luminous body corresponding to emission of light energy. Let E_0 and H_0 denote energy of body before emission of light, measured relative to system (x, y, z) and system (ξ, η, ζ) respectively.

Einstein assumed that

(i) Let this body emits plane waves of light of energy 0.5L (measured relative to x, y, z) in a direction forming an angle ϕ with x-axis. And at the same time an equal amount of light energy (0.5L) is emitted in opposite direction (ϕ+180^o).

(ii) The body remains at rest before and after emission of light energy. According to the Einstein's original remarks ……..

Meanwhile the body remains at rest with respect to system (x,y,z).

Further E_1 and H_1 are the energies of body in the both systems after it emits light energy. Energy of body in system (x,y,z)

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

Energy of body in system (ξ, η, ζ)

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

where $\beta = 1/[1 - v^2/c^2]^{1/2}$. Energy of body in system (ξ, η, ζ)

$$H_o = H_1 + \beta L \tag{4}$$

or

$$(H_o - E_o) - (H_1 - E_1) = L[\beta - 1] \tag{5}$$

Thus Einstein related the various values of energy with kinetic energy (KE) before emission and KE after emission of light energy by body as

$$H_o - E_o = K_o + C \tag{6}$$

$$H_1 - E_1 = K_1 + C \tag{7}$$

where K is kinetic energy of body, C is additive constant which depends upon the choice of the arbitrary additive constants in the energies H and E [2]. These are the equations which Planck [15] has objected as to as being "permissible only as first approximation" which Ives objected to as containing the result that Einstein sought to prove [16] and which Stachel and Torretti [17] claimed to be exact. Einstein calculated , kinetic energy of body before emission of light energy, K_0 ($m_b v^2/2$) and kinetic energy of body after emission of light energy, K ($m_a v^2/2$) as

$$K_o - K = L\{1/\sqrt{1 - v^2/c^2} - 1\} \tag{8}$$

Einstein considered the velocity in classical region thus applying binomial theorem

$$K_o - K = L\{1 + v^2/2c^2 + 3v^4/8c^4 + 15v^6/48c^6 + 105v^8/384c^8 + ... - 1\} \tag{9}$$

Further Einstein quoted [2]

Neglecting magnitudes of fourth and higher orders, we may place.
K_o – K = L $v^2/2c^2$ (9)
Fadner [18] and Sharma [3, 19-24] has justified and elaborated Einstein's approach by writing the values of kinetic energy before emission ($K_0 = m_b v^2/2$) and after emission (K =$m_a v^2/2$) as

$$M_b v^2/2 - M_a v^2/2 = Lv^2/2c^2 \quad or \quad L = (M_b - M_a)c^2 = \Delta mc^2 \tag{10}$$

Then Einstein generalized light energy-mass equation for all energies without explanation as

$$E = \Delta mc^2. \tag{11}$$

Here E stands for all types of energies e.g. 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 or energies co-existing in various forms etc. However the mathematical basis used by Einstein is only for light energy as the equation for relativistic variation for light energy is used, but generalized the result for all energies. Also the result is not eq.(10) i.e. $L = \Delta mc^2$ if higher orders e.g. v^4/c^4, v^6/c^6 ..... are not neglected.

3 The body remains at rest while emitting energy in numerous cases

Einstein's condition that body remains at rest before and emission of light energy is justified in many cases, which are not considered by Einstein. The radioactive sample remains at rest when they emit radiations, also a light emitting body can be fixed to avoid its motion.

When two waves of different energies are emitted. If body emits two light waves of slightly different energies i.e. 0.5001L and 0.4999L (Einstein has used light waves of energy 0.5L and 0.5L) in opposite directions. Now using the law of conservation of momentum, it can be easily justified that in this case body remains at rest.
Let the body of mass 10kg emits light energy in two waves in visible region equal to 7.9512×10^{-19} J, this energy corresponds to TWO light waves in visible region having wavelength 5000^oA or energy, $2hc/\lambda$ or 7.9512×10^{-19} J.
Let towards the observer the body emits light energy 0.5001L i.e. 3.97639512×10^{-19} J i.e. will have momentum

$$(p_1 = E/c)\ \ 1.32546504 \times 10^{-27}\ m/s.$$

Secondly, the body emits light wave of energy 0.4999L i.e.

$$3.97480488 \times 10^{-19}\ J,$$

away from the observer (ϕ=180^o) i.e. will have momentum (p_2= E/c) 1.32493496×10^{-27} m/s. Let us assume that when the body emits light waves of energy and moves (if it actually does) with velocity V_b , then according to law of conservation of momentum we get

$$0 = p_1 + p_2 + M_b V_b \quad or \quad V_b = -(p_1 + p_2)/M_b = -5.3 \times 10^{-32} m/s \tag{12}$$

Thus body will tend to move with velocity 5.3×10^{-32} m/s (away from the observer) which is immeasurably small by all means , hence the body remains at rest. Due to this uniform relative velocity v of the system (ξ, η, ζ) will not change, if body moves then v will vary accordingly. Similarly other cases can be justified that body remains at rest and Einstein's derivation is applicable, however result may not be L = Δmc^2 always. If the body moves then value of v will vary accordingly. The radioactive samples remain at rest when they emit radiations.

4 Violation of law of conservation of mass and energy i.e. Einstein's derivation predicts that mass and energy are created out of nothing or cipher simultaneously

In the derivation of ΔL= Δmc^2 there are FOUR variables e.g. l magnitude of light energy, number of waves emitted, angle ϕ at which light energy is emitted and velocity v. Each variable have many values experimentally. Einstein has derived eq.(10) taking special values of parameters only, if the parameters are just changed then results are entirely different. The luminous body may emit one, two or more waves, the magnitude of energy of the waves can be different, thus angles of waves w.r.t x-axis can vary. Similarly velocity v may be uniform or variable velocity in classical or relativistic regions or body may be at rest, the law of inter-conversion of mass and energy holds good in all cases. Thus Einstein's incomplete derivation has been completed, and ultimate generalized equation is suggested.

(i) When two light waves are emitted with slightly different energies.

Let the body emits two light waves of slightly different energies i.e. 0.5001L and 0.4999L in opposite directions and other parameters

remain the same as assumed by Einstein. In this case the equation equivalent to eq.(3) can be written as

$$H_o = H_1 + 0.5001\beta L(1 - v/c\cos 0^o) + 0.4999\beta L(1 - v/c\cos 180^o) \quad (13)$$

or

$$H_o = H_1 + \beta L(1 - 0.0002v/c)$$

Now proceeding in the similar way as above we get

$$K_o - K = -0.0002v/c + Lv^2/2c^2$$

or

$$\begin{aligned} \Delta m = &\, Mass\ of\ body\ before\ emission\ (M_b) \\ &- Mass\ of\ body\ after\ emission\ (M_a) \\ = &\, -0.0004L/cv + L/c^2 \end{aligned} \quad (14)$$

or

$$M_a = 0.0004L/cv - L/c^2 + M_b$$

which implies that when Light Energy, L (0.4999L along x-axis, 0.5001L in opposite direction) is emitted, then mass of luminous body increases, as 0.0004L/cv is always more than L/c^2(v<<c). The %age difference between eq.(10) and eq.(14) is 0.04c/v or 1.2 x10^6 if velocity is 10m/s (36km/hr) i.e. in classical region. The following inconsistent results follow from above discussion.

(a) Thus Einstein's 1905 derivation also predicts that luminous body emits energy and simultaneously mass of body increases. Both the creation of energy and mass is at cost of nothing or cipher. It is clear contradiction of law of conservation of matter and energy.

(b) Contradiction with relativistic variation of mass i.e.

$$M_{rel} = M_{rest}/(1 - v^2/c^2)^{1/2}. \quad (15)$$

The eq.(15) was suggested by Lorentz before Einstein , who used the same in his paper of Special Theory of Relativity [14]. It is confirmed by Kauffman [25] in 1902 and Bucherer [26] that mass of body increases when it moves with velocity comparable to that light . But according to Einstein in this derivation mass of body also increases when it moves with classical velocity emitting energy, which is not

justified.

(ii) When one light wave is emitted at angle 180.1^o instead of 180^o.

When magnitude of angle at which one wave is emitted is 180.1^o rather than 180^o, the other angle and magnitude of energy of light waves remains the same. Then equation equivalent to eq.(3) is given by

$$H_o = H_1 + 0.5\beta L(1 - v/c\cos 0^o) + 0.5\beta L(1 - v/c\cos 180.1^o), \quad (16)$$

$$H_o = H_1 + \beta L(1 - 0.000000761v/c),$$

$$K_o - K = -0.000000761Lv/c + Lv^2/c^2, \quad (17)$$

$$\Delta m = -0.000000761L/cv + L/c^2, \quad (18)$$

or

$$M_a = 0.000001522L/cv - L/c^2 + M_b,$$

which implies mass of body increases when light energy is emitted, as in classical region as 0.000001522 L/cv is more than L/c^2 . Thus if difference in ϕ is 0.1^o, then Einstein's derivation implies that body emits light energy and its mass also increases, which is never experimentally justified.

(iii) When body emits four waves of energy simultaneously.

Let the body emits two light waves of energy 0.255L each at angles 0^o and 30^o towards the system (ξ, η, ζ) and two light waves each of energy 0.245L at angles 180^o and 210^o, away from the system (ξ, η, ζ) . Now we can write

$$H_0 = H_1 + 0.255L\beta[1 - v/c\cos 0^o] + 0.255L\beta[1 - v/c\cos 30^o] +$$

$$+0.245L\beta[1 - v/c\cos 180^o] + 0.245L\beta[1 - v/c\cos 255^o] \quad (19)$$

or

$$H_o = H_1 + L\beta[1 - 0.167425811v/c], \quad (20)$$

$$K_o - K = L[-0.167425811v/c + v^2/2c^2], \quad (21)$$

$$\Delta m(M_b - M_a) = -0.334851622L/cv + L/c^2 \quad (22)$$

or

$$M_a(mass\ after\ emission) = 0.334851L/cv - L/c^2 + \\ + M_b(mass\ before\ emission), \qquad (23)$$

which again implies (as v<<c) that when body emits light energy its mass also increases and can be interpreted like eq.(14). This deduction is again not experimentally justified. Like this such results are obtained from many other cases.

5 Some feasible cases neglected by Einstein, also leads to inconsistent results

In fact Einstein's derivation is very compact and is of nearly three pages, without abstract, sub-sections and without references of the previous literature. According to Max Born [27] the striking point is that it contains not a single reference to the previous literature. But the following genuine possibilities (which are absolutely essential) have neither been discussed by Einstein [2] and nor by others [18]. Thus Einstein's incomplete work is completed. Such aspects are discussed by author in recent critical analysis [3, 19-24].

(i) Single wave is emitted.

Consider a body is placed in the system (x,y,z) and emits a single wave of light energy L, which is perpendicular to ray direction i.e. $\phi = 90^o$. Then equation equivalent to eq.(3) can be written as

$$H_o = H_1 + \beta L\{(1 - v/c\cos 90^o)\}$$

or

$$H_o = H_1 + \beta L,$$

$$E_o = E_1 + L,$$

or

$$\Delta m = L/c^2.$$

This is the same result as obtained by Einstein but is not discussed by him. However this result is not obtained if the angle is considered 90.1^o or 89.9^o.

(ii) Angle at which light waves are emitted.

When magnitude of angle at which one wave is emitted is 179.1^o, other wave is emitted at 0^o and the magnitude of light energy is regarded as same as considered by Einstein. Thus

$$H_o = H_1 + 0.5\beta L(1 - v/c\cos 0^o) +$$

$$+0.5\beta L(1 - v/c\cos 179.1^o), \tag{24}$$

$$H_o = H_1 + \beta L(1 - 0.000061683v/c)$$

or

$$K_0 - K = -0.000061683Lv/c + Lv^2/2c^2,$$

$$M_a = 0.000123367L/cv - L/c^2 + M_b. \tag{25}$$

Thus this result is similar to eq.(14). Similar other results can be obtained if other angles are considered.

(iii) Magnitude of light waves. When two waves of energy 0.901L and 0.099L are emitted.

In this case it is assumed that the body emits plane waves of light energy 0.901L along x-axis i.e. $\phi = 0^o$. The other wave of light energy 0.099L is emitted in exactly opposite direction i.e. forming angle 180^o. Then equation equivalent to eq.(3) becomes

$$H_o = H_1 + 0.901\beta L(1 - v/c\cos 0^o) +$$

$$+0.099\beta L(1 - v/c\cos 180^o), \tag{26}$$

$$H_o = H_1 + \beta L(1 - 0.802v/c),$$

$$K_o - K = -0.802v/c + Lv^2/2c^2, \tag{27}$$

$$\Delta m = -1.604Lv/c + L/c^2,$$

or

$$M_a = 1.604L/cv - L/c^2 + M_b. \tag{28}$$

Thus results can be interpreted as in eq.(14) as it implies that when light energy is emitted the mass of body increases.

(iv) When body is at rest i.e. v=0

Velocity v is regarded as zero (v = 0) if system (ξ, η, ζ) is at rest or v is also zero if both the systems move with the same velocity in the same direction. Let body emits light energy as considered by Einstein. Under this condition eq.(1) becomes

$$\ell^* = \ell \tag{29}$$

Re-writing eq.(3) in view of above we get

$$H_o = H_1 + 0.5L + 0.5L = H_1 + L \tag{30}$$

or

$$(H_o - E_o) - (H_1 - E_1) = 0. \tag{31}$$

As the observer is at rest in this case so eq.(31) can not be expressed in terms of change in kinetic energy, hence change in mass. In previous case when observer system (ξ, η, ζ) moved with velocity v and body in system (x, y, x) was at rest; then Einstein expressed quantity ($H_o - E_o$) – ($H_1 - E_1$) in terms of kinetic energies of body before and after emission of light energy as K_0– K. As the system (ξ, η, ζ) is at rest and hence the perception of kinetic energy is non-existent as in eqs.(5-6) in Einstein's derivation. Thus change in KE (hence change mass, as v is uniform) cannot be calculated, the value of emitted light energy (L) has already been disappeared from eq.(31). Thus in this case Einstein's derivation does not lead to any conclusion about annihilated mass (Δm) and energy emitted (L) , hence is not applicable. However practically in this case light energy is being emitted and mass of body decreases but Einstein's derivation does not provide any information.

(v) Self contradictions.

Contradiction of $\Delta m = L/c^2$ itself i.e. energy emitted is more than $L = \Delta\, mc^2$

(a) Let all the parameters remain the same as considered by Einstein and simply magnitude of angle of one wave is changed to 0.5^o rather than 0^o. Then

$$H_o = H_1 + 0.5\beta L\{(1 - v/c\cos 0.5^o) +$$

$$+(1 - v/c\cos 180^o)\} \tag{32}$$

or

$$H_o = H_1 + \beta L[1 + 0.000018038v/c]$$

or

$$K_0 - K = 0.000019038lLv/c + Lv^2/2c^2$$

$$\Delta m(M_b - M_a) = 0.000038077L/cv + L/c^2. \tag{33}$$

According to Einstein if body emits two light waves of energy 0.5L, each in opposite directions, then decrease in mass is given by eq.(10) i.e. $\Delta m = L/c^2$. Thus in this case decrease in mass is more than as predicted by Einstein. Thus Einstein's derivation leads to the self contradictions. Scientifically all results must be considered before reaching at final conclusions.

(b) Similarly consider that source emits a single wave of energy L, such that it makes angle 180^o with x-axis. Thus

$$H_o = H_1 + \beta L(1 + v/c) \tag{34}$$

or

$$K_o - K = \beta L[1 + v/c] - L$$

or

$$\Delta m = 2L/cv + L/c^2, \tag{35}$$

which is again the similar case as in eq.(33). Many other cases lead to such deductions.

(vi) Einstein's speculative generalization of $\Delta\ m = L/c^2$ for all energies i.e. $\Delta\ m = \Delta E/c^2$

Further Einstein generalized the eq. (10) without any justification in the following way [8] , *"The mass of a body is a measure of its energy content: if the energy changes by L, the mass changes in the same sense by $L/9x10^{20}$ if the energy is measured in ergs and mass in grams."*

It implies that mass can be converted into every possible type of energy existing in nature. The eq.(10) meant for light energy, just in analogous way it can be written as $\Delta E = \Delta mc^2$.

In the discussion no equation for sound energy or other forms of energy equivalent to eq.(1) and eq.(10) has been mentioned. Now

it is regarded as true for all types of energies It means that when sound energy is produced from source, then mass of body decreases. When mass is annihilated then huge amount of sound or noise may be produced which can be termed as sound bomb or noise bomb analogous to nuclear bomb. The conceptual and mathematical basis of Einstein's derivation [2,14] is only meant for the light energy but its applications are universally extended in all cases wherever there is inter-conversion of mass to energy.

About its experimental confirmation Einstein [2] quoted that *"...It is not excluded that it will prove possible to test this theory using bodies whose energy content is variable to a high degree (e.g., radium salts) "* The radium is over one million times radioactive than uranium. It decays 3.7 x 10^{10} disintegrations per second, its salts like RaF_2 , $RaCl_2$,RaI_2 etc are also extremely radioactive. After radioactive decay the sample remains at rest.

(vii) Nature and limitations of eq.(1)

Einstein's equation of relativistic variation of light energy i.e. eq. (1) is different from other equations which gives relativistic variation in quantities such as mass, length and time (which existed before special theory of relativity). These quantities are independent of angle, ϕ. The eq.(1) is different from these equations, as it involves additional term in numerator [1–v/c cos ϕ] and was quoted by Einstein [14].

Let the body emits a ray of light such that makes an angle 0^o (towards the observer) and Einstein [14] has applied this condition ($\phi = 0^o$) to eq.(1) and quoted eq.(37).

$$\ell* = \ell\{1 - v/c \cos 0^o\}/\sqrt{[1 - v^2/c^2]} = \ell(1 - v/c)/\sqrt{[1 - v^2/c^2]} \quad (36)$$

or

$$\ell* = \ell[(1 - v/c)/(1 + v/c)]^{1/2}. \quad (37)$$

The eq.(1) has mainly two limitations i.e. under some conditions ($\phi = 0^o$) it does not obey law of dimensional homogeneity and also does not comply with of identity $a^2 - b^2 = (a+b)(a-b)$.

(a) Inconsistency of **dimensional homogeneity** when velocity v approaches to c i.e. v→c,

If the system (ξ, η, ζ) moves with velocity equal to that of light

which realistically or actually means that velocity v tends to c . The heavenly bodies like Quasars move with such velocities (v→c) Thus eq.(36) becomes

$$\ell^* \rightarrow 0/0$$

[from unsolved eq.(36)] which is undefined or ℓ^* tends to 0/0 which has the same meaning.

The dimensions of LHS are M L^2T^{-2} [energy] and that of RHS undefined. It is the inherent requirement that an equation must obey the principle of dimensional homogeneity [28-29] i.e. dimensions of LHS and RHS must be the same, but it is not so in case of eq.(1) under this condition. Hence under this condition the central equation which leads to $\Delta m = L/c^2$ is not applicable. Such central equation which leads to such a basic principle should be free from such limitations.

(b) **Non-compliance** of identity $a^2 - b^2 = (a+b)(a-b)$ by eq.(36). Further contradictory results are also self-evident if eq.(36) is solved with identity, and Einstein has quoted eq.(37) in this regard. Now again if we apply the same condition the velocity v tends to c i.e. v → c, then eq.(37) becomes,

$$\ell^* \rightarrow 0$$

[from solved eq.(37)] Now if $\phi = 0^o$ the eq.(1) , in unsolved form i.e. eq.(36) and solved form i.e. eq.(37) under similar conditions (v → c) gives different results ($\ell^* \rightarrow 0/0$ and $\ell^* \rightarrow 0$), which is never justified. The eq.(1) is meant for relativistic velocities but does not yield correct results under this case. Further Einstein [14] has quoted eq.(37) but did not discuss this case as above. However Einstein [14] discussed an entirely different case i.e. v = – c, then ℓ^*(frequency) = ∞.

Also according to eq.(1), the observer in system (ξ, η, ζ) will notice maximum light energy ℓ^* if ray of light moves away from the observer ($\phi = 180^o$) as in this case numerator is maximum (1+v/c). The light energy will be minimum if the body emits light energy towards the observer ($\phi = 0^o$) and numerator is minimum (1–v/c). It is not consistent with sound energy, as the pitch of siren is minimum when train moves away from the observer. Einstein has not discussed such results, however he used this equation in the derivation of mass–energy equation. Energy observed must be assessed more

when emitted towards the observer.

(viii) Velocity v may be non-uniform.

Einstein considered systems which are in uniform relative motion, v w.r.t. each other. The velocity of system may be uniform or non-uniform, may be in classical or relativistic region or at rest the law of inter-conversion of mass and energy holds good under all circumstances. Thus the derivation should have been applicable for all values of velocities. Obviously Einstein's derivation is only meant for visible energy, but large amount energy is emitted in the invisible region also. In the existing literature there are prospective proposals [30-31] that speed of light can be less or more than c. If it is finally confirmed then only $\Delta E = Ac^2 \quad \Delta m$ will be applicable to explain the energy emitted.

6 The generalized mass energy equation $\Delta E = Ac^2 \Delta m$

There are various types of reactions involving inter-conversion of mass to energy. These reactions are e.g. chemical reactions, nuclear reactions (fission, fusion and annihilation of matter and antimatter), volcanic reactions, astrophysical and cosmological reactions and process of creation of mass before Big Bang. Here we start with calculations of infinitesimally small amount of energy dE, when infinitesimally small amount of mass dm, is converted (in any process) into energy. dE may be the energy in any form i.e. light energy, heat energy, sound energy, chemical energy, electrical energy, energy in form of invisible radiations or energy co-existing in various forms etc. is called *energy evolved or energy emitted*.

Hence, dm and dE are related as $dE \propto dm$. Thus, magnitude of energy created or emitted and mass annihilated (destroyed or disappeared) are proportional to each other, it can be further discussed.
(i) When Einstein derived $E=\Delta mc^2$ chemical reactions were the most abundant source of energy in nature. Till date $E=\Delta mc^2$ is not confirmed in the chemical reaction and reason cited for this is that equipments are not enough sensitive [32]. Consider burning of 1kg straw or paper or petrol in controlled way, ashes, gases and energy produced can be estimated. Even if 0.001 kg or 1gm of matter is annihilated

then energy equal to 9×10^{13}J (can drive a truck of mass 1000kg to distance of 9×10^7 km) will be produced. Until the equation is not confirmed in such reactions, then scientifically it may be not be regarded as precisely true in such cases. It is equally possible that energy emitted may be less than predicted by $E=\Delta mc^2$ or $E \propto \Delta mc^2$.
(ii) In laboratory it is confirmed [**33-35**] that using thermal neutrons the total kinetic energy (TKE) of fission fragments that result from of U^{235} and Pu^{239} is 20-60MeV less than Q-value (200MeV) of reaction predicted by $\Delta E= \Delta mc^2$. Similarly mass of particle Ds (2317) has been found more than current estimates based upon $\Delta E= \Delta mc^2$. Thus in this case $E \propto dmc^2$ is justified.
(iii) The most successful theory of understanding of formation of universe, the Big Bang theory (the biggest energy releasing process universe) assumes that whole mass of universe (10^{55}kg, say) was in form of 'primeval atom' and then suddenly exploded. According to $E=\Delta mc^2$ this would have been created from energy 9×10^{71} J, but how this enormous amount of energy was created in space out of nothing. Thus one query leads to another query. Hence creation of mass or energy in formation of 'primeval atom' is not consistent with $E=mc^2$, hence proportionality $E \propto dmc^2$, may be considered.
The characteristic conditions of electron-positrons annihilation process are different from chemical reactions (nucleus remain unaffected e.g. burning of wood), and those of chemical reactions are different from astrophysical or cosmological reactions. The energy emitted in Gamma Rays Bursts is of the order of 10^{45}J even in a fraction of second, these are different from chemical reactions. Thus in all reactions $E=mc^2$ needs to be specifically confirmed.
(vi) The efficiency of the nuclear weapons as well as nuclear reactors is far less than the theoretical value predicted by $E=\Delta mc^2$. Robert Serber (member of first American team entered Hiroshima and Nagasaki in September 1945 to assess loses), has indicated [36] that the efficiency of "Little Boy" weapon [U^{235}, 49kg] that was used against Hiroshima was about 2% only. It is assumed that all the atoms don't undergo fission, thus material is wasted. But no such waste material is specifically measured quantitatively. Thus the waste material (nuclear reactor or weapon) must be measured and corresponding energy is calculated, and it must quantitatively explain that why efficiency is less. It may require the measurements of all types of energies (may

co-exist in various forms) in the processes and experimental errors. Until such calculations are not precisely confirmed experimentally; it is equally feasible to assume that the energy emitted may be less than $E=mc^2$ (or $E \propto dmc^2$) when reactants are in bulk amount and various types of energies are simultaneously emitted. Thus both the possibilities are equally probable until one is not specifically rules out. In view of weirdness in reactions emitting energy, some theoretical inconsistencies in the derivation and non-availability of data, one can explore the second possibility even as a postulate.

All the equations in science are regarded as confirmed when specifically justified in all experiments. The reactions involving interconversion of mass and energy are utmost diverse, weird and new phenomena are being added regularly, thus $E=mc^2$ needs to be confirmed in all cases. Thus in general, in view of above proportionality it may be taken in account as $dE \propto c^2 dm$. The above proportionality $dE \propto c^2 dm$ can be changed into equation by introducing a constant of proportionality. The inception of proportionality constant is consistent with centuries old perception of constant of proportionality in physics since days of Aristotle and Newton. In second law of motion (F=kma) the value of constant of proportionality, k is always unity (like universal constant) i.e. F=ma. When more and more complex phenomena were studied or values of constants of proportionality were determined then it showed dependence on the inherent characteristics of the phenomena. In such cases constant of proportionality is regarded as co-efficient of proportionality e.g. co-efficient of thermal conductivity or viscosity etc. Thus removing the proportionality between dE and $c^2 dm$, we get

$$dE = Ac^2 dm \tag{38}$$

where A is (a co-efficient) used to remove that sign of proportionality; it depends upon inherent characteristics of the processes in which conversion of mass to energy takes place and it is dimensionless. It has nature precisely like Hubble's constant {50 and 80 kilometers per second-Megaparsec (Mpc)} or coefficient of viscosity (1.05×10^{-3} poise to 19.2×10^{-6} poise) or co-efficient of thermal conductivity ($0.02 Wm^{-1}K^{-1}$ to 400 $Wm^{-1}K^{-1}$) etc. Thus, in fact Hubble's constant may be regarded Hubble's variable constant or Hubble's coefficient, as it varies from one heavenly body to other. If 'A' is equal

to one, then we will get dE=dmc^2 i.e. same as Einstein's equation.

In eq.(38) 'A' is regarded as conversion factor as it describes feasibility and extent of conversion of mass into energy. For example out of bulk mass, the mass annihilated to energy is maximum in matter-antimatter annihilation, apparently least in chemical reactions, undetermined in volcanic reactions and cosmological reactions. It (the co-efficient A) depends upon the characteristic conditions of a particular process. It may be constant for a particular process and varies for the other depending upon involved parameters or experimental situation. Thus 'A' cannot be regarded as universal constant, just like universal gravitational constant G and k in Newton's Second Law of Motion. The reason is that mass energy inter-conversion are the bizarre processes in nature and not completely studied. Even some increase in value of G has been observed by scientists of University of Washington reported by J.H. Gundlach [37].

Now consider the case when mass is converted into energy. Let in some conversion process mass decreases from M_i(initial mass) to M_f (final mass), correspondingly energy increases from E_i (initial energy) to E_f (final energy). The eq. (38) gives infinitesimally small amount of energy dE created on annihilation of mass dm. To get the net effect the eq. (38) can be integrated (similar is the case when Einstein obtained relativistic form of kinetic energy in June 1905 paper)

$$\int dE = Ac^2 \int dm.$$

Initial limit of mass = M_i, initial limit of Energy = E_i, final limit of mass = M_f, final limit of Energy = E_f.
Initially when mass of body is M_i , then E_i is the initial energy of the system. When mass (initial mass, M_i) is converted into energy by any process under suitable circumstances the final mass of system reduces to M_f. Consequently, the energy of system increases to E_f the final energy. Thus M_f and E_f are the quantities after the conversion. Hence, eq. (38) becomes

$$E_f - E_i = Ac^2(M_f - M_i) \tag{39}$$

or

$$\Delta E = Ac^2 \Delta m, \tag{40}$$

$$Energy\ evolved = Ac^2\ \ (decrease\ in\ mass). \tag{41}$$

If the characteristic conditions of the process permit then whole mass is converted into energy i.e. after the reaction no mass remains ($M_f = 0$)

$$\Delta E = -Ac^2 M_i \tag{42}$$

In this case energy evolved is negative implies that energy is created at the cost of annihilation of mass and the process is exo-energic nature (energy is emitted which may be in any form). Energy is scalar quantity having magnitude only, thus no direction is associated with it.

Thus the generalized mass-energy equivalence may be stated as

"The mass can be converted into energy or vice-versa under some characteristic conditions of the process, but conversion factor may or may not always be c^2 *(*$9 \times 10^{16} m^2/s^2$*) or* c^{-2}

6.1 Applications of $\Delta E = Ac^2 \Delta m$ in various phenomena

The relation $\Delta E = Ac^2 \Delta m$ is applicable in every possible phenomena which involves inter-conversion of mass and energy directly and indirectly, its main feature is the conversion factor may or may not be c^2 always depending upon the inherent characteristics of the processes.

6.2 Total Kinetic Energy of fission fragments is 20-60 MeV less than predicted by $\Delta E = \Delta m\, c^2$

In laboratory it is confirmed **[33-35]** that using thermal neutrons the Total Kinetic Energy (TKE) of fission fragments that results from of U^{235} and Pu^{239} is 20-60MeV less than Q-value of reaction predicted by Einstein's famous $\Delta E = \Delta mc^2$ (200MeV for U^{235}). These observations are more than three decades old [35]. Some alternate suggestions has been made to explain the total kinetic energy of fission fragments by extending the successful Liquid-Drop Model of Bohr and Wheeler [38-39]. Bakhoum [35] has attempted to explain the same with Wave Mechanical equation $E=mv^2$.

Let the TKE of fission fragments is 175MeV (as experimentally it is observed less), instead of expected 200MeV. It can be explained with help of $\Delta E = Ac^2 \Delta m$ with value of A is 0.875 i.e.

$$A = \Delta E/c^2 \Delta m = 175/200 = 0.877. \tag{43}$$

Thus energy of fission fragments of U^{235} and Pu^{239} is given by

$$\Delta E = 0.877c^2\Delta m. \tag{44}$$

Thus value of A less than one is justified experimentally in this case.

6.3 Discovery of particle having mass less than predicted mass

Recent work led by A. Palano [40] and his collaborators, at Stanford Linear Accelerator Centre confirmed discovery of a new particle dubbed as Ds (2317) having mass 2,317 mega-electron volts. But this mass is far less than current estimates based upon E=mc^2. The Generalized Mass-Energy Equation

$$\Delta E = Ac^2\Delta m$$

or

$$\Delta m = \Delta E/Ac^2$$

can be used to explain the same. Obviously the problem of lower mass can be solved by conversion co-efficient A, which have slightly higher value than unity in this case.

6.4 Applications in Astrophysical and cosmological reactions or processes

All the theories are silent about the pre-Big Bang origin of the universe, however $\Delta E = Ac^2 \quad \Delta m$ is not only capable of explaining this intrigue but also provides explanation to other phenomena.
The mass is primary form of energy in nature, is converted to other forms of energies which may co-exist in various forms. In electric bulb electrical energy changes to light 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, there are many such examples.

$$Energy\ in\ one\ form = a\ \ (energy\ in\ the\ other\ form) \tag{45}$$

where 'a' is conversion factor just like J (4.2×10^7 erg cal^{-1}) in W=JH. E=mc^2 states that mass is converted into energy or vice versa, whereas according to eq.(45) energy changes from one form to other.

6.4.1 Creation of Mass 10^{55} kg on the basis of $\Delta E=\Delta mc^2$.

Georges Lemaître was the first to propose that the universe began from "primordial atom" i.e. whole mass (10^{55} kg, say) of the universe was condensed to a point, in superheated state, all mass was concentrated at volume virtually negligible with unimagineably high density. The big bang took place at the time t=0, and uncertainty principle prevents our speculating on the times shorter than 10^{-43} seconds after big bang. Even Einstein himself did not apply $E=\Delta mc^2$ to explain how the mass of universe is produced and Big Bang took place.
A gamma ray photon of energy at least 1.02 MeV i.e. $1.634x10{-}13\ J$ when passes near the field of nucleus gives rise to electron and positron pair of mass i.e. 18.2×10^{-31} kg and vice versa , it is consistent with $\Delta E=\Delta mc^2$. It can be determined from $E=\Delta mc^2$ that mass of the universe 10^{55}kg would have been created from 9×10^{71}J i.e.

$$\Delta E = \Delta mc^2 = 10^{55}kg \times 9 \times 10^{16}m^2/s^2 = 9 \times 10^{71}J. \qquad (46)$$

Thus energy 9×10^{71} J has been materialized to mass, 10^{55} kg. How the energy of the order of 9×10^{71}J was produced along with additional energy (which may be unimaginably high) ? Obviously it is due to this additional energy, whole mass of the universe condensed to a point and its temperature became exceptionally high and finally exploded. Thus, this energy has been created from mass. Then how mass was created? Thus answer of a query is another query, which is not scientific answer.

6.4.2 Creation of mass on the basis of $\Delta E=Ac^2\Delta m$.

Initially the whole space was filled with infinitely large number of particles of zero mass or undetectable by any means, may be termed as *Zeroans* . The Zeroans (m=0) are the most primitive constituents of the universe in space, may be moving with infinitely large velocities. The numerous numbers of Zeroans moving with infinitely large velocities acted as the smallest possible (but just perceivable) units of energy of nearly similar magnitudes. It is the postulatory assumption in this perception.
In due course of time infinitely large number of Zeroans may have

resulted or combined together to form pulse of energy, 10^{-4444} J or less (smallest permissible units of energy). It may be called the 'primordial quantum of energy ', which is subdivided in numerous parts or pulses of energy in empty space.

The relation $\Delta E = Ac^2 \quad \Delta m$ is applicable to all peculiar cases where mass-energy inter-conversion takes place, as in this case the conversion factor is not rigidly c^2. Due to its general nature $\Delta E = Ac^2 \quad \Delta m$ was applicable even in pre big bang era. Thus the equation $\Delta E = Ac^2 \Delta m$ specifically predicts that in this primordial era, diminishingly small pulse of energy, say 10^{-4444} J (or less), manifested itself in mass 10^{55}kg , in due course of time. Under this condition the value of A_{uni} can be determined as ($\Delta E / c^2 \quad \Delta m = A_{uni}$)

$$A_{uni} = 10^{-4444}/9 \times 10^{16} \times 10^{55} = 1.111x10^{-4516}. \qquad (47)$$

Now if the value of energy is 10^{-4444} J and the value of A_{uni} is $1.111x10^{-4516}J$ then mass can be calculated as

$$\Delta m = \Delta E/Ac^2 = 10^{-4444}J/1.111x10^{-4516}x9x10^{16} = 10^{55}kg. \quad (48)$$

Thus $\Delta E = Ac^2 \Delta m$, is the first equation which at least theoretically predicts that universe (10^{55}kg) has been created from minuscule or immeasurably small amount of energy (10^{-4444}J or less). However actual process of creation of mass may be quite tedious and time consuming process.

6.4.3 Annihilation of mass to gravitational energy

The mass may be regarded as first or primary form of energy. 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 etc. In nucleus the mass is converted into the binding energy (attractive like gravitational energy). The attractive binding energy exists within nucleus and attractive gravitational energy exists on large scale, but both arise from the annihilation of mass. In view of eq.(45) the analogous relation between mass annihilated and gravitational energy produced (measure of gravitational force or pull) can be written as

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

$$= k \;\; Gravitational\ energy\ (U_g)$$

or

$$Gravitational\ energy\ \ (U_g) =$$

$$= Energy\ \ emitted\ in\ annihilation\ of\ mass\ (Ac^2\Delta m)/k,$$

where k is conversion factor which determines the extent of conversion of mass to gravitational energy. Thus higher the value of A and smaller the value of k more gravitational energy will be produced. The values of A and k depend upon inherent characteristics of the process.

The inter conversion of energy to mass is a continuous process. The fraction of mass (so produced) simultaneously changed into gravitational energy as described by eq.(49). This gravitational energy held together the created mass, if the gravitational energy produced in one particular case is considerable then that matter remained in cohesive state. So,

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

The gravitational energy is universally prevalent and is inherent property of bodies, hence is held together as it is produced.

At the same time it is just possible that some particles which were created from 'primordial energy', may have not developed considerable amount of gravitation energy, hence not condensed to bigger units and may be even as such now. These may have mass trillion-trillion times smaller than axions, hypothetical particles proposed by Peccei [41], and are virtually isolated. Such particles are constituents of dark matter.

6.4.4 Formation of "primordial atom" and its explosion or Big Bang

Thus lighter particles or bodies stuck together (under extreme conditions of temperature, pressure and gravitational energy) then their mass increased. Thus high temperature and high gravitational pull caused constituents of universe to contract to a single point. As the process of annihilation of mass to energy continued the rise in temperature and increase in gravitational energy continued. 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. This process was repeated again and again and whole mass of the universe condensed to a single point in super heated and super dense state in due course of time. The nature of gravitational force so developed, may be regarded as similar to interatomic force. The interatomic force is attractive up to some extent (maximum r = $5A^o$) and when distance between the molecules decreases it turns strong repulsive force. As the gravitational energy increases (higher A, less k), the size of constituents of universe decreases. As long as the size of compressed mass of universe is optimum, there is no considerable repulsion between constituents. When the size of the universe is further decreased (due to extreme conditions of heat and gravitational energy) i.e. distance between nuclei decreased beyond the optimum distance. At this stage (size of universe decreased beyond optimum size), the 'primordial atom' exploded as universe was in extremely unstable, repulsive and reactive state. At this stage, even small mass may have been converted to mammoth amount of energy as permissible by equation $\Delta E = Ac^2 \Delta m$, in weird reaction. It is called Big Bang and ever since constituents of universe are receding away.

6.4.5 Annihilation of antimatter in hadron epoch

After time 10^{-35} seconds of Big Bang , in the Universe roughly equal amounts of matter and antimatter were created. Now the observable mass of universe is regarded as 10^{55} kg. But so far, no antimatter domains have been detected in space within 20 megaparsecs of the Earth [42]. The antimatter has been annihilated at 10^{-6}s, in the end of hadron epoch ($10^{-35} - 10^{-4} s$, temperature, $10^{27} - 10^{12} K$) and temperature of the universe in next lepton epoch ($10^{-4} - 10^{2} s$), reduced to temperature $10^{12} - 10^{9} K$.

It leaves a ticklish situation which has been overlooked, when huge amount of antimatter is instantly annihilated , then huge amount of energy according to $\Delta E = c^2 \Delta m$ would have been created further increasing the temperature. But temperature of universe decreased simultaneously, which implies no heat has been generated on annihilation of anti-matter. Thus the generalized equation $\Delta E = Ac^2 \Delta m$ can be used to explain the same, with value of A exceptionally less than

one. Thus at the end of hadron epoch huge amount of antimatter is annihilated and exceptionally small amount of energy (unnoticeable) is emitted. Hence as universe expanded it cooled in usual way. Thus $\Delta E = Ac^2\Delta m$ (with value of A less than one) explains both the aspects i.e. why antimatter is not observable now and temperature of universe decreased usually. Thus value of conversion factor between mass and energy is not always c^2.

6.4.6 Black Holes and Gamma Ray Bursts

On the basis of $\Delta E = Ac^2\Delta m$ the reason for formation of black hole (density of the order of $10^{18}kg/m^3$) is that due to small annihilation of mass, enormous amounts of heat and gravitational energies are produced. If the gravitational pull of a heavenly body is exceptionally-2 higher then even visible light does not escape from it and remains invisible. According to this perception the pre-requisite for formation of the black hole is that it must have unimaginably high value of gravitational energy. According to eq.(49) it is only possible if the value of A must be exceptionally high and that of k must be exceptionally small . Thus for small mass annihilation, huge amount of gravitational energy is gained by body which even does not allow light to escape

If this condition is satisfied then even bodies of smaller mass may become black holes. The lightest black holes are also possible, and reside in the youngest galaxies.

Gamma ray bursts (GRBs) are intense and short (approximately 0.1-100 seconds long) bursts of gamma-ray radiations and originate at very distant galaxies (several billion light years away). GRBs are the most energetic events after the Big Bang in the universe and emit energy up to 10^{47} J in exceptionally short time. The origin of GRB can be understood on the basis of this perception. If for black hole (formation described above) the value of A is higher and value of k is less and remains active, then it contracts beyond an optimum limit due extreme conditions of gravitation and temperature. Thus it may further result in a detonation known as black bang emitting exceptionally high amount of energy in form of GRBs, due high value of A. The Gamma Ray Bursts may be originated in this way also. Thus the explosion like Big Bang are continuing even now but at much

smaller scale emitting energy in form of GRBs and corresponding to annihilation of small mass huge energy is emitted with high value of A. This discussion permits then GRBs may be emitted from black holes of smaller bodies comparatively.
According to E=mc^2 if energy emitted is 10^{47} J, then mass annihilated will be 1.11x10^{30}kg, that too in few seconds. This annihilated mass is comparable with mass of Sun is 1.99x10^{30}kg . In GRB, the energy equal to 10^{47} J can be emitted from 10 kg of mass is annihilated in body if value A_{grb} in $\Delta E = Ac^2\Delta M$, is 1.11x10^{29}. Likewise explanation for other cosmological phenomena and bodies can be given on the basis of the generalized mass energy inter-conversion equation, $\Delta E = Ac^2\Delta m$.

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References.

[1] Sir Isaac Newton, *Opticks,* pp. CVX (1704; reprinted by Dover Publications, Inc., New York, 1952).
[2] Einstein, A., *Annalen der Physik* **18**, 639 (1905).
[3] Sharma , A. To be published in Galilean Electrodynamics, Massachusetts USA
[4] Poincaré, J.H. , Arch. neerland. sci., **2**, 5,232 (1900)).
[5] Poincaré', J.H. , *In Boscha* 1900:252,
[6] Pretto, O. De "Ipotesi dell'etere nella vita dell'universo", Reale Istituto Veneto di Scienze, Lettere ed Arti, Feb. 1904, tomo LXIII, parte II, pp. 439-500 (1904).
[7] Bartocci, U. *Albert Einstein e Olinto De Pretto: la vera storia della formula più famosa del mondo* (Ed. Andromeda, Bologna, 1999).
[8] Hasenöhrl, F. Wien Sitzungen IIA, **113**, 1039 (1904).
[9] Hasenöhrl, F. Ann. der Phys. 16, 589 (1905).
[10] Cummingham, E. *The Principle of Relativity*, p. 189 (Cambridge University Press, 1914).

[11] Soddy, F, Radioactivity: An Elementary Treatise from Standpoint of the Disintegration Theory ("The Electrician " Printing and Publishing, London, 1904).
[12] Planck, M, *Ann. Phys.* 26, 1(1908)
[13] Planck, M, *Sitz. der preuss.* Akad.Wiss., Physik. Math. Klasse. 13 (June, 1907).
[14] Einstein, A *Ann. der Phys.* **17**, 891-921 (1905).
[15] Planck , M *Akad. Weiss. Physik.* Math. K1. 13, 542(1907);
[16] Ives, H. *J. Opt. Soc. Am.* 42, 540 (1952)
[17] Stachel, J., Torretti, R. Am. J. Phys. 50, 750 (1982).
[18] Fadner, W.L. Am. J. Phys. 56 2 , 144 (1988).
[19] . Sharma , A. *Physics Essays* **17** 195-222 (2004)
[20]. Sharma, A *Acta Ciencia Indica* Vol. XXIV P No .4 pp.153-158 (1998).
[21]. Sharma A. *Abstract Book* , Physics 2005 – *A Century after Einstein* (Institute of Physics, Bristol England) University of Warwick pp 144 2005
[22] Sharma, A. Book of Abstracts GR17, the *17th International Conference on General Relativity and Gravitation,* Ireland July 2004
[23]. Sharma, A. *Proceedings of International Conference on Computational Methods in Sciences and Engineering* 2003 World Scientific Co. USA , 585-586 (2003)
[24] Sharma, A , *Proceedings of International Conference on Number, Time, Relativity* United Physical Society of Russian Federation, Moscow , pp.81-82 August 2004
[25] Kaufmann , W. Phys. Z 4, 55 (1902) and Gott. Nacchr. Math. Phys. 4, 90 (1903)
[26] Bucherer , A.H. Phys. Z, 9,755 (1908) ; Ann. Phys. 28, 513 (1909)
[27] Born, M, *Physics in My Generation*, p. 193 (Pergamon Press, London, 1956).
[28] Resnick, R. and D. Halliday, Physics Part I, Forty Second reprints (Wiley Eastern Limited, New Delhi) 2, 45-46, 81-87, 1987
[29] McNish. A.G, *Physics Today*, Dimensions, Units, and Standards, pp.19-25, April 1957
[30]. Davis, T.M. & Lineweaver, C. *Nature* **418**, 602 (2002).
[31] Wang, L. J. Kuzmich, A. and Dogariu, A *Nature* **406**, 277-9 (2000).

[32] Beiser Arthor, *Concepts of Modern Physics.* (McGraw Hill International Edition, New York, 4^{th} Edition) pp. 25, 27-30,420-422 6(1987).
[33]. Hambsch, F.J. et al. *Nucl. Phys.A,* 491,p.56 (1989)
[34]. Thiereus, H. et al., *Phys. Rev. C,* 23 P 2104 (1981)
[35] Bakhoum, E. G. *Physics Essays*, Vol.15, No 1 2002
(Preprint archive : physics/0206061)
[36] Serber , R The Los Alamos Primer (U.S. Govt. first published as LA1, April 1943), declassified 1965 , annotated book , 1992. also R . Serber (editor) , The Los Alamos Primer pp. 38 (Univ. of California Press, 1992)
[37] Gundlach, J.H. et al., *Phys. Rev. D* **54**, 1256R (1996).
[38]. Straede, C. et al. *Nucl. Phys. A.* 462 p 85 (1987)
[39] Wilkins, B. D et al. *Phys. Rev. C.* 14 p.1832 (1976)
[40] Palano,A. *et al., Phys.Rev.Lett.* 90 (2003) 242001
[41] R. Peccei, R , Quinn, H *Phys. Rev. Lett.* **38** (1977) 1440.
[42] Taubes, G, Theorists nix distant antimatter galaxies, *Science,* **278**:226, 1997.

Comment

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Comment on THE BASIS OF GENERALIZATION OF $\Delta E = mc^2$ TO $\Delta E = Ac^2\Delta M$ AND ITS JUSTIFICATION IN PHYSICAL PHENOMENA

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(i) This paper does not mean E=Δmc^2 is incorrect. Author has admitted, in discussions at various levels, as E=Δmc^2 is confirmed in nuclear physics and true beyond any doubt. In view of his work its extended version is required, in some cases.

(ii) The author has simply highlighted Einstein's old forgotten derivation of E=Δmc^2 which was given by the legend in September 1905 paper. Initially Einstein has derived the Light Energy mass equation L =Δmc^2 an then speculated from it E= Δmc^2 for all energies (e.g. light energy, heat energy, sound energy, chemical energy, electrical energy, energy in form of invisible radiations or energy co-existing in various forms etc). Although Einstein's mathematical basis is only meant for light energy, yet is regarded as true for energies.
The interesting point of the discussion is that the Einstein's deriva-

tion is not completely studied, thus Einstein's unfinished work has been completed in the paper. Einstein has derived the same under special conditions. If all aspects of the derivation are taken in account, then some inconsistent results are obtained. Also the hidden aspect of Einstein's derivation is that when light energy is emitted the mass of body must increase, it is violation of law of conservation of mass. It has been mathematically established.
The law of inter conversion of mass and energy holds good under all circumstances e.g. body may be at rest, moving with uniform or non-uniform velocity in classical or relativistic region. But Einstein has derived the equation for only when body moves with uniform velocity in classical region. The other velocities are not taken in account. This is main reason is that author has derived the mass energy equation by new method.

(iii) Now while deriving mass energy equation by new method, existing experimental data has been critically analyzed and some speculations regarding possible forthcoming observations are made. It is important part of the research. On the basis of inconsistency in Einstein's derivation in some cases, author has derived the mass energy equation directly by other method as $\Delta E = Ac^2\Delta m$.

The energy emitted by the generalized equation $\Delta E = Ac^2\Delta m$, may be equal, less or more than $E = \Delta mc^2$. Thus mathematically $E=\Delta mc^2$ is the special case of $\Delta E = Ac^2\Delta m$.

Then generalized mass energy inter conversion equation $\Delta E = Ac^2\Delta m$, will incite the imagination of scientists and general scientific audience. The details are discussed in the paper clearly in very simple and logistic way.