

DOI: <https://doi.org/10.24297/jap.v22i.9642>**New Physics II – Quantum-Dialectical Derivation of New Mass-Energy Relation Invalidates Einstein's Famous Equation  $E = mc^2$** 

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**Abstract:**

The notion that human scale inertial mass and the various forms of tangible energy, like kinetic, heat, light, chemical, gravity, etc., have some kind of equivalence; existed since the time of Isaac Newton. Historically, based purely on epistemological and phenomenological perspective, there has been speculative, theoretical, and experimental attempts based on electrostatic, electrodynamic and relativistic, etc., consideration to deduce a quantitative relation between mass and energy. By the turn of 20<sup>th</sup> century, a vastly oversimplified and wrongly derived relation  $\Delta E = \Delta mc^2$ , where E is energy, m inertial mass, and c the velocity of light; has been unjustly attributed to Albert Einstein. This relation presumed to be universally valid for all forms of inertial mass and energy, but without valid evidence, along with the physically and mathematically invalid arbitrary derivation by Einstein; have enjoyed acceptance and is venerated by official science for more than hundred years and still continue. Einstein's false mass-energy formulation, seems to be due to the unfortunate combination of a number of factor: 1) epistemological misunderstanding; 2) the ill effects of the use of unscientific axiomatic truth of the universal constancy of the (zero-mass) light velocity c, that has given rise to unphysical objects, concepts and notions of reality; 3) workings of (even if unended) mathematical tricks; and 4) most of all, as implied in the mass-energy equation, the wrong conception that the kinetic motion of any object leads to the increase of its inertial mass by the Lorentz gamma factor. All these combined in a negative way to result in the irrational replacement of the velocity v of classical kinetic energy equation with relativistic c. The falsity of the claim of relativistic mass-energy relation would be clear from recent reports that one can derive Einstein's mass-energy equation from Newtonian mechanics alone, simply by using the wrong concept of relativistic mass increase, instead of a constant inertial mass of classical mechanics. All the concerns about Einstein's formulation of the mass-energy relation, raise serious doubt about its scientific validity. A more comprehensive ontological approach based on an understanding of the origin of matter and motion in their elementary form, seems to be imperative, to settle the issue of mass-energy relation. Hegel's philosophy of space and time and his dialectical ontology of the origin of matter and motion, now realized through quantum-dialectics, offers such a paradigm for a scientific and rational derivation of the mass-energy relation.

**Keywords:** Quantum-Dialectics, Mass-Energy Relation, Relativistic Mass, Albert Einstein, Inertial Mass**Introduction:****Historical Background:**

A comprehensive history of the concept of the equivalency of (particle) matter/mass and tangible energy, has recently been compiled by a number of researchers, specially by Sharma [1], Rabinowitz [2] and Rothman [3]. The concept that mass and energy must have some identity was speculated since Isaac Newton and a quantitative relation of  $\Delta E = \Delta mc^2$ , where E is energy and m is mass were intuitively proposed by a number of scientists without any experimental proof or theoretical deduction, since the English scientist S Tolver Preston [4] proposed it in 1875.

By late 19<sup>th</sup> century with the discovery of electric and magnetic field and light as an electromagnetic field by J.C. Maxwell (1831 -1879), physicists believed that electromagnetism was more fundamental than Isaac Newton's "inertial mass" and that the electromagnetic field itself should provide the origin of mass. Although electromagnetic mass required that the object be charged and moving, and so clearly does not apply to all matter, it was nonetheless the first serious attempt to connect mass with energy [3], first by J.J. Thompson in 1881 and later more clearly in 1889 by Oliver Heaviside who simplified Thompson's work to show that the



effective mass should be  $m = (4/3) E / c^2$ , where  $E$  is the energy of the sphere's electric field. Meanwhile inspired by J.H. Poynting's celebrated theorem on the conservation of energy for the electromagnetic field in 1884, H. Poincaré [5,6] in 1900, wrote that if one required that the momentum of any particles present in an electromagnetic field *plus* the momentum of the field itself to be conserved *together*, then Poynting's theorem predicted that the field acts as a "fictitious fluid" with mass such that the relation  $E = mc^2$  holds. Poincaré, however, failed to connect  $E$  with the mass of any real body.

More serious attempt for the derivation of the mass-energy relation before A. Einstein was made in 1904; when Fritz Hasenöhl [7,8] created a thought experiment involving heat energy in a moving cavity, and got the relation, after suggested correction by Abraham,  $m = (4/3) E / c^2$ , the same obtained earlier by Heaviside.

After the formulation of the Lorentz transforms (LTs); the Dutch physicist. H. A. Lorentz (1854-1928), suggested that the mass-energy relation could possibly be experimentally justified from the relativistic mass in equation (1)

$$m_{\text{motion}} = m_{\text{rest}} / (1 - v^2/c^2)^{1/2} \quad (1)$$

This was experimentally justified by W. Kaufman [9] in 1901, who showed that transverse mass increases with velocity. Also, Bucherer [10] later, in 1908 found that specific charge ( $e/m$ ) is smaller for fast moving electrons, convincingly justified eq. (1).

The historical account given above, brings us to the real problem (as would be discussed later) of the mass-energy equation, a) whether the exclusive authorship claimed by Einstein in his 1905 publication [11] is justified or not. Einstein tried to claim that  $\Delta E = \Delta mc^2$  was conceptually conceived and derived by him only, thus he is sole contributor of this famous equation; contrary to historical facts [1-3] and also b) whether it is a valid formulation at all. Some scientists including Planck [12], Stark [13], Ives [14] etc. has pointed out inconsistencies in Einstein's mathematical derivation when the paper was published. Max Born (1882-1970), a close friend of Einstein, and co-originator of Quantum Mechanics, put the final nail on Einstein's claim of sole authorship of this equation, when he stated [15] "*The striking point is that it contains not a single reference to the previous literature*".

A key to the problem b) whether the quantitative relation of  $\Delta E = \Delta mc^2$  is a valid universal formulation of the mass-energy relation as claimed by Einstein and accepted in modern physics, is valid or not; can be discerned from the following rather terse comment by Einstein in 1907 [16]; "*Herr Kaufmann has determined the relation between [electric and magnetic deflection] of  $\beta$ -rays with admirable care. ... Using an independent method, Herr Planck obtained results which fully agree with Kaufmann. ... It is further to be noted that the theories of Abraham and Bucherer yield curves which fit the observed curve considerably better than the curve obtained from relativity theory. However, in my opinion, these theories should be ascribed a rather small probability because their basic postulates concerning the mass of the moving electron are not made plausible by theoretical systems which encompass wider complexes and phenomena.*"

The reason for the last paragraph of Einstein's statement above, is that he never approved of Relativistic Mass [17], even though it is generally attributed to him! This little secret is kept in ambiguity by official science! Einstein never used the relativistic mass in his derivation of the mass-energy relation, even though he alluded to it in his June 30, 1905 paper [18], "*ON THE ELECTRODYNAMICS OF MOVING BODIES*". Einstein derived his mass-energy relation from electro-magnetic mass conceived from Maxwell's electrodynamics, in a separate paper published [11] in September 1905 with the title, "*DOES THE INERTIA OF A BODY DEPEND UPON ITS ENERGY-CONTENT?*". This is a significant point hardly discussed in the mainstream literature. Einstein wrote in his September, 1905 paper [11], "*The results of the previous investigation [18] lead to a very interesting conclusion, which is here to be deduced. I based that investigation on the Maxwell-Hertz equations for empty space, together with the Maxwellian expression for the electromagnetic energy of space and in addition... (principle of relativity)*". What is important to note in this mystery, is that in his June 1905 paper [18] the chapter, § 10. "Dynamics of the Slowly Accelerated Electron: Einstein derived the

$$\begin{aligned} \text{Longitudinal mass} &= \frac{m}{(\sqrt{1 - v^2/c^2})^3} \\ \text{Transverse mass} &= \frac{m}{1 - v^2/c^2} \end{aligned} \quad (2)$$

And cautioned against “comparing different theories of the motion of the electron”, with the following words, “With a different definition of force and acceleration we should naturally obtain other values for the masses. This shows us that in comparing different theories of the motion of the electron we must proceed very cautiously”. But then immediately makes the following generalization, “We remark that these results as to the mass are also valid for ponderable material points, because a ponderable material point can be made into an electron (in our sense of the word) by the addition of an electric charge, **no matter how small**”. Einstein then generalises the relation  $\Delta E = \Delta mc^2$ , for all kinds of matter and energy without any justification at all, a point that Sharma [19] very strongly objects.

What is more, as many people [1-3] pointed out; in his derivation of the mass-energy relation, Einstein used the result of relativistic variation of light energy, suggested in eq. (3) in his June 1905 paper [18].

$$l^* = l \frac{1 - \frac{v}{c} \cos \phi}{\sqrt{1 - v^2/c^2}} \quad (3)$$

where  $l$  is light energy of plane wave of light in co-ordinate system  $(x,y,z)$ , which is at rest. The ray direction i.e. wave normal makes angle  $\phi$  with the  $x$ -axis of the system  $(x,y,z)$ . This light energy as measured in system  $(X,Y,Z)$ , which is in uniform translation w.r.t.  $(x,y,z)$  along  $x$ -axis with velocity  $v$  is  $l^*$ . Although Einstein started derivation of  $\Delta L = \Delta mc^2$  using relativistic variation of light energy as in eq. (3), yet final result was obtained under classical conditions using *Binomial Theorem*, only first two expansion terms and neglecting the higher order terms, which is valid only if  $v \ll c$ . In other words, classical condition! It is clear from equation (3) that under relativistic condition  $v \sim c$ , the increase of  $l^*$  will be unwieldy and Einstein could never get the simple relation  $\Delta L = \Delta mc^2$  he desired for!

So, Einstein began by employing the relativistic relationships (the relativistic Doppler shift) he had derived a few months earlier but finally approximated away the relativistic bits, leaving an answer one can get from purely classical physics and which may or may not remain true at the higher velocities where relativistic effect comes into play. In fact, Rabinowitz [2] in a recent report made a derivation of mass-energy relation without Electrodynamics or Einstein’s Postulates; simply from Newton’s equation of motion in combination with Lorentz gamma factor, eq. (1) for relativist mass increase; which Einstein rejected!

## Results and Discussion

The Quantitative Validity of  $\Delta E = \Delta mc^2$  as a Mass-Energy Relation:

With all negative aspects and concerns about the presently accepted mass-energy relation, it may be worthwhile to consider how the term  $c^2$  appeared in the speculative mass-energy relation by Preston [4] as early as 1875. This probably arose from the idea of kinetic energy relation  $K = 1/2mv^2$ . Since mass-transformed energy is supposed to come as electromagnetic radiation,  $c^2$  seems to be the obvious choice. The velocity  $c$  as an ordinary constant also appeared in Maxwell’s electromagnetic equation as the constant velocity of light ( $c = 1/\epsilon_0^{1/2} \cdot \mu_0^{1/2}$ ); the required constant for an equation of any wave propagation like sound. But the unease in face of the quantum uncertainty at the turn of the 20<sup>th</sup> century and the Michaelson-Morley experiment showing the velocity of light to be constant, convinced the physicists to accept Einstein’s axiomatic truth about the absolute constancy of the velocity  $c$  of light in vacuum; which since 1905 have turned objective reality upside down, led physics to the realm of ideal mathematics; to un-physical objects and phenomena etc.; in attempts to make physics conform to this absolute truth. But light like most other things in the universe must be a material entity and cannot be something esoteric and absolute or a Kantian thing-in-itself. Light is absorbed by and emitted from material bodies; the speed of light

slows down while passing through dense and transparent media, a light pulse can be slowed down to crawl speed while passing through a Bose-Einstein condensate near absolute zero temperature etc.

The Lorentz Transforms, the gamma factor, “spacetime” 4-D abstract manifold of objective reality, SR, GR, and most of official theoretical physics and cosmology, in a general way are derived and influenced by the absolute truth of constant  $c$ ! It is considered by official physics, so absolute that since 1983, the constant  $c$  is used to define the standard metre in SI system. But does this make any sense? It has been shown by this author [20] that all concepts, notions, tools etc. (cited above) with which; the edifice of modern official theoretical physics and cosmology are built are nothing but abstractions of mathematics and of mind; which have nothing to do with reality. So, the theoretically derived mass-energy relation in the universal form  $\Delta E = \Delta mc^2$ , using dodgy mathematics by Einstein [11], does not deserve validity. Even the mass-energy relation, which could possibly be experimentally justified in 1901 by W. Kaufman [8] from the relativistic mass equation (1) is not valid. These measurements with beta-particles were done at low and classical velocities of the beta-particles, hence the use of the Lorentz gamma factor was unwarranted and relativistic mass increase [17] as Einstein himself asserted; has no validity. The Lorentz gamma factor used in equation (1) is fictitious [20]. It now seems that the use of the theory of special relativity and the Lorentz gamma factor is just a mathematical trick, (even if unintended) to surreptitiously replace kinetic velocity  $v$  with the velocity of light  $c$  in the classical kinetic mass energy relation,  $K.E. = 1/2 mv^2$ ! This can be easily demonstrated by replacing  $c$  with  $v$  in the relativistic energy-momentum equation as shown below. The observed relativistic mass effect by Kaufman, also in modern particle accelerators and the related apparent exponential curve simulating the gamma factor, can be explained by the progressively increasing loss of energy of the accelerating particles to the virtual particles of the quantum vacuum making them real particles. In fact, such stray particles generated during particle acceleration are known to damage the inner linings of the pipes used in the accelerators. Considering all these factors discussed above it is safe to assume that the currently accepted mass-energy relation must be faulty and terribly wrong, hence a new relation must be derived.

#### New Mass-Energy Relation:

As the discussion above shows, Einstein’s derivation of the mass-energy relation in his Sept. 1905 paper is invalid or at least controversial. The mass-energy relation implied by the experimental work of Kaufman [9] and Bucherer [10], is also doubtful, since they used the invalid gamma factor for relativistic mass increase with velocity. Most of all, hitherto any consideration, derivation and practice of the mass-energy relation are based on epistemological and phenomenological grounds alone. It is assumed that mass, energy including space, time and all other things in the universe are given as they are; through the mystery of “Big Bang” creation by God. So, throughout the history of physics (at least from Isaac Newton), the origin of mass and energy remains a mystery or at best Kantian things-in-themselves. If one starts from the mystery of the origin of anything; then any subsequent knowledge of that thing is also a mystery, unless it is supported by real-life human social/historical practice, experience, technology etc.; - a basis of positive knowledge of the universe, so far for natural science.

G.W.F. Hegel was the first in history, who following the dialectical world-view of Heraclitus, proposed a non-casual, non-theological origin of matter, motion and everything else in this infinite, eternal and ever-changing universe, mediated by chance and necessity and the ontological triad, “Being-Nothing-Becoming”. In his philosophy of space and time, Hegel posited that space and time are abstract entities, that have the attribute only of quantity; but no quality. Matter and motion arise from the contradiction of space and time and give the ontological basis of any physical existence in the universe. For Hegel, space, time, matter and motion are in a dynamical and dialectical relationship among themselves giving rise to the observable phenomenology of the universe: Like Leibniz, Hegel’s space and time are abstract entities, without any tangible quality, but only have potential quantitative nature of infinity. Space and time become meaningful only in the context of matter and motion. Space and time are the dialectical unity of the opposites that resolves itself into matter and motion.: *“Motion is the process, the transition from time into space and vice versa: matter on the other hand, the relation of space and time, as latent identity. Matter is the primary reality, the existing Being-in-itself; it is not only abstract being, but positive persistence*



of space, as excluding, however, other space". [21]

Hegel elaborated the dialectical view of motion in the following way: "Its essence [of motion, AM] is to be the immediate unity of space and time; it is time really persisting through space, of space which is only made truly distinct through time. Thus, we know that space and time belong to motion; the velocity, the quantum of motion is space in relation to a definite time that has elapsed. One says also, motion is the relation of space and time; the deeper manner of this relation, however, remained to be grasped [Hegel did not elaborate the "deeper meaning" of this relation, AM]. Only in motion have space and time reality" [22]

The "deeper meaning" of the relation of space and time become apparent now only after the concept of virtual particles of the quantum vacuum; since Paul Dirac's revolutionary works. The abstract contradiction of space and time can transition to the virtual particles of the quantum vacuum as particle/antiparticle pairs, which continuously pop in and out of existence as "Being-Nothing" of the ontological first as well as the last dialectical contradiction [23]. As we now know, the virtual particles can transition to real particles; and vice versa; through quantum tunnelling or some other yet unknown processes. Virtual particles can become really existing particles when equivalent energy becomes available; mediated by blind chance but an iron dialectical necessity inherent in chance itself. For Hegel's dialectics, a quantum of matter is the chance persistence a quantum of space in time, and a unit of motion is the chance persistence of time in space in the form of virtual particles, eternally flipping in and out of existence, in the infinite quantum vacuum.

This can be expressed quantitatively as a quantum energy-action relation [24] as follows:

$$\Delta L^3 \times \Delta t = h/4\pi \quad (4)$$

where  $\Delta L^3$  represent a quantum unit cube of space of length  $L$ ;  $\Delta t$ , represent a quantum of time of the existence of the quantum of energy and  $h$  is the Planck constant. The cube of space could also be represented by a unit sphere of radius  $r$  and volume  $4/3(\pi r^3)$ , but for simplicity, we will consider only the cube of space.

As shown in a previous publication [24], equation (4) can be expressed in terms of mass  $m$  of any real quantum particle created from its virtual state, as follows

$$m = h/2\pi/(v^3 \times t^2) = \bar{k} \times E/(v^3) \quad (5)$$

Where  $v$  is its velocity and  $\bar{k}$  is a proportionality constant. It is to be noted that the life time  $t$  of a free quantum particle is a constant as long as it remains in a free state and hence can be included in the proportionality constant  $\bar{k}$

From equation (5), the quantum-dialectical mass-energy relation can be written as:

$$E = \bar{k}mv^3 \quad (6)$$

For the quantum-dialectical relation like the equation (6) to be valid, any quantum particle at all, must have mass, otherwise the original contradiction of space and time and hence "Being-Nothing" will vanish, which is an impossibility for dialectics! The notion of relativistic physics that the mass of any photon must be zero, for it to have absolute velocity  $c$ , is therefore falsified by quantum dialectics. This is a new and revolutionary intuition that comes from the quantum-dialectical consideration of objective reality, for which, no restriction of the mass of a tangible particle has to be made. This is consistent with classical mechanics or even electromagnetism, but grossly in variation with the theories of relativity.

If all quantum particles are assumed to have mass, no matter how small and if the distinction between the velocity of light and that of massive particle is eliminated in Lorentz energy-momentum relation, then the energy of any single and free quantum particle becomes simple kinetic energy and the mass  $m$  of a particular quantum particle becomes proportional to the inverse square ( $1/v^2$ ) of its velocity., as shown below:

$$E^2 = (pc)^2 + (m_0c^2)^2 \quad (7)$$

Replacing  $c$  with a general term  $v$  and  $m$  as the invariable mass, eliminates the Pythagorean geometry; which as is shown elsewhere [20] was the basis of LTs, the gamma factor, "spacetime", SR, GR and the whole edifice of Einstein's theories of relativity, modern official theoretical physics and cosmology.



We now get

$$E^2 = (mv^2)^2 + (mv^2)^2 \quad (8)$$

$$\text{Or } E = \sqrt{2} \times mv^2 \quad (9)$$

$$\text{Or } m = E / (\sqrt{2} \times v^2) \quad (10)$$

### Conclusions:

It has been shown in this work that Albert Einstein's much venerated so-called relativistic mass-energy relation  $E = mc^2$ , derived from epistemological and phenomenological considerations is wrong and illusory. This must be replaced by  $E = \sqrt{2}mv^2$ , which in opposition to the faulty relativistic method, is derived from an ontological and quantum-dialectical methodology. The new quantum-dialectical derivation of the mass-energy relation is qualitatively and quantitatively very different from the presently accepted one. This is likely to have profound implications for modern theoretical physics and cosmology. The mass-energy relation,  $E = \sqrt{2}mv^2$ , is strictly valid for free elementary particles and can possibly be confirmed by experiments involving matter-antimatter annihilation reactions, where total mass is converted to radiant energy and no new particles are formed. This may be relevant for understanding the cosmic Gamma-Ray Bursts (GRBs). The quantitative validity of this relation for non-elementary particles, i.e., for any relation  $\Delta E = K\Delta mv^2$  has to be evaluated through experiments for each specific type of interconversion and probably would be feasible only for very high energy, involving nuclear transformations.

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