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From $E = mc^2$ to $E = mc^2/22$—A Short Account of the Most Famous Equation in Physics and Its Hidden Quantum Entanglement Origin*

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Abstract

Einstein's energy mass formula is shown to consist of two basically quantum components $E(O) = mc^2/22$ and $E(D) = mc^2(21/22)$. We give various arguments and derivations to expose the quantum entanglement physics residing inside a deceptively simple expression $E = mc^2$. The true surprising aspect of the present work is however the realization that all the involved "physics" in deriving the new quantum dissection of Einstein's famous formula of special relativity is actually a pure mathematical necessity anchored in the phenomena of volume concentration of convex manifold in high dimensional quasi Banach spaces. Only an endophysical experiment encompassing the entire universe such as COBE, WMAP, Planck and supernova analysis could have discovered dark energy and our present dissection of Einstein's marvelous formula.

Keywords

Special Relativity, Varying Speed of Light, Hardy's Quantum Entanglement, Dark Energy, Measure Concentration in Banach Space, 'tHooft Fractal Spacetime, Witten Fractal M-Theory, E-Infinity Theory, Transfinite Cellular Automata, Golden Mean Computer, Endophysics, Finkelstein-Rössler-Primas Theory of Interface

1. Introduction

The arguably most famous equation in science, *i.e.* $E = mc^2$ has a highly interesting history [1]-[18] which dates back mainly to A. Einstein and may be a little earlier to H. Poincaré [8] [14] [18]. Recently with the advent of a major discovery, *i.e.* the mysterious cosmic dark energy [17] and connecting that to the even earlier and no lesser mystery of the quantum wave [8], a new insight by the present author led to a new reinterpretation of this eq-

*This paper is dedicated to the memory of immensely admired, truly great humans who were not scientists—L. Tolstoy, M. Gandhi, A. Schweitzer and N. Mandela.

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uation to mean that $E = mc^2$ is actually the sum of two parts [19]-[30]. The first part is $E(O) = mc^2/22$ which represents a quasi position "potential" energy of the quantum particle at the instance of measurement [28]-[30]. The second part $E(D) = mc^2(21/22)$ is *de facto* the kinetic energy, *i.e*. the energy of the propagation of the quantum wave which is devoid of measureable ordinary energy and can therefore be interpreted as dark energy [22]. The sum of $E(O)$ and its compliment $E(D)$ restores Einstein's original glorious picture [22]-[26]. However the meticulously accurate way of writing the jewel of special relativity is now $E = (mc^2/22) + mc^2(21/22) = mc^2$.

The present paper gives a very short account of the genesis of $E = mc^2$ to $E = E(O) + E(D)$ and exposes its hidden quantum entanglement deep roots which even Einstein could not have noticed or in fact accepted if he had noticed it because ironically he abhorred the very notion of quantum entanglement [3] [7] [25].

It is generally presumed, and in our opinion rather wrongly that $E = mc^2$ was experimentally verified in many accurate local tests [5] [31]-[33]—some quite recently and therefore its universal validity is beyond reproach. However this is a rather misleading prejudice similar to the widespread wrong belief that $E = mc^2$ has much to do with the atomic bomb. In fact the only accurate test of Einstein's formula as far as the present author is concerned, is the cosmic measurements and observations leading to the famous 4.5% ordinary measureable energy found by COBE, WMAP and Planck [22]-[30]. In turn this result is an experimental validation of our present reinterpretation of $E = mc^2$. One not minor problem with attempting to extend or modify the theory of relativity is undoubtedly bigger than life prestige of A. Einstein [34]-[37] and the understandable cult around his personality, not only as a scientist, but as a humanist and philosopher [7] [35] [38]. It is stressed here that no exophysical experiment could have discovered the present dissection of Einstein's formula and dark energy [39]-[42]. By contrast, COBE, WMAP, Planck and supernova analysis are endophysical experiments and that is why dark energy was discovered. In fact O. Rössler stressed long ago in a paper co-authored by the present writer that wave interference is exophysically absent [39]-[42].

The tacit philosophy implied by the present analysis and reinterpretation is that when two equally mysterious and paradoxical physical phenomena are explained in terms of each other, more often than not both mysteries simply evaporate and disappear into thin air like quantum vacuum pair annihilations. We stress that we could not reach any of our results and conclusions, *i.e*. neither the present nor any previous ones without pairing Hardy's quantum entanglement with Einstein's relativity as well as Witten's M-theory and 'tHooft's dimensional regularization. However to do that we need E-infinity theory [36] with its highly structured golden-random Cantor sets and the associated golden mean based binary system [37]. All this together could be referred to in one short sentence as a transfinite cellular automata functioning as a golden mean Turing computer [36] [37].

2. First the Theory Decides on the Experiment

2.1. Background Information

Einstein's $E = mc^2$ is without a trace of a doubt the most recognizable equation in the history of physics and may be even in history full stop [1] [4] [6]. Why it is so may be debatable but for sure there are many reasons, some objective, other historical and many may be due to the persona of Einstein [7]. To start with the equation is quite short and sweet. Three words are used and all are important in daily life, particularly energy (E) and light (c). The mass indicates massiveness, *i.e*. weight in layman's perception. The historical context is also very important. Einstein and his theories lived through World Wars one and two as well as the hyper inflation and great depression [7]. Thus you had a free spirited Jew addressing God as the old man who is "Raffiniert ist der Herrgott aber boshaft ist er nicht" [7] seeing and suffering from a brutally ignorant fascistic regime and when he arrived in the USA, land of dreams he found at the end McCarthy persecutions [7] and Edgar G. Hoover FBI paranoia [5]-[7]. In this poisonous political landscape Israel was born as a new hope for the Jew and the backward Middle East alike and Einstein became the hero for humanity and particularly the Semitic race combining Jews and Arabs in equal measure [38] [43]-[46]. Einstein and his theory became bigger than life for almost everyone who could read and write, the present author included [34]. In fact with special delight the author remembers how his teachers in the elementary school used to call him a little Einstein although Frankenstein would have been a more apt description besides the fact that neither the teacher nor the child knew exactly what Einstein did nor what relativity is all about except that only 12 people in the whole world understood it and that the Director of the University of Cairo, Prof. Dr. Musharaffa is one of them [34]. Non-conformist and a highly spirited revolutionary in the best tradition of the Semitic race, Einstein was what the media was searching for [7]. His mundane language when explaining physics and his marvelous Jewish, sometimes even Egyptian, sense of humor made him the ideal interview for radio and newspapers [7]. All this would have been nothing if it were not

backed by a real great theory and Einstein's relativity is a great theory [18]. However it is not the first and the last great theory nor is it the last word in science as real scientists very well know, especially Einstein himself [1] [3] [5] [7] [8]. Never the less the cult around Einstein and his relativity have sometimes been counterproductive when people who really understand and appreciate relativity are fired at with fury by those who sense revision as danger and anyone who attempts to change relativity in any major or even moderate way his action was regarded as subversive. Many years later a similar malady would affect string theory in a milder form [8]. Others who are more contemplative and also more cultured mathematically, philosophically and understand modern physics felt that all experiments to date have vindicated at least $E = mc^2$ beyond any reasonable doubt [31]-[33]. However it is again Einstein who would cast principle doubt on such prejudice utterance because he was always the one who insisted that "first the theory is what decides upon what we observe" [3]. On the other hand what observations mean and the complexity it entails is what we discuss next with a fleeting reference to endophysics [39]-[42].

2.2. The Meaning of an Experiment for E. Einstein and W. Heisenberg—Endophysics versus Exophysics [39] [41]

Observation is a highly complex process and a meticulous probing of the inaccurately so called final confirmation of $E = mc^2$ would reveal countless loop holes because classical mechanics, quantum mechanics and relativistic effects are mingled in complex subtlety undisciplined ways and interpreted without being aware of the various limitations in almost all the claimed experiments of $E = mc^2$ the author is aware of [31]-[33]. The author remembers a talk by one of his lifelong scientific heroes and teachers, W. Heisenberg [3] who recounted a discussion between Einstein and himself in which Heisenberg thought to include only directly observable quantities in a theory and thought that this is what guided Einstein to his relativity but Einstein vehemently disagreed [3]. Clearly this is again Einstein's principle stance that it is the theory which decides on what are the fundamental observables [3]. The situation with our present revision or more accurately reinterpretation of $E = mc^2$ as $E = \left(mc^2/22\right) + mc^2\left(21/22\right) = mc^2$ is even more compelling. This is because we have some of the most accurate measurements and observations in connection with the discovery of dark energy [17] which if correct, and the present author thinks they are correct, cannot be easily reconciled with relativity [9] [10] [26]. Of course one would think this is a problem in general relativity and not in special relativity of $E = mc^2$. However the present author thinks that this is more complex than meets the eye and the problem could be viewed from various angles as connected to general relativity or special relativity or both [9] [10] [26]. In fact dark energy of the empty set, ergo of the quantum wave could be found only via an endophysical experiment [39]-[41] like the WMAP and supernova analysis encompassing the entire universe.

2.3. The Speed of Light and Its Fractal Variation

Many deep scientists, for instance Magueijo and Smolin as well as Moffat [9] [10] [23] think that the problem with relativity start with special relativity and particularly with the doctrine, experimental or otherwise, of the constancy of the speed of light. Now in a fractal-Cantorian spacetime as our spacetime here is, the constancy of the speed of light is something in a direct and fundamental contradiction with fractality and cannot be kept as it is in the conventional relativity [9] [23]. There are many roads which lead to the admittedly startling realization that Einstein discovered quantum entanglement before quantum mechanics was found by its pioneer and that he did that by pure luck or providence and more over, never realized that he did [22].

In the present paper we will discuss very briefly various avenues leading to the quantum dissection of $E = mc^2$ into a quantum particle part $E(O) = mc^2/22$ modelled by a five dimensional zero set and a quantum wave part $E(D) = mc^2(21/22)$ modelled by a five dimensional empty set [28] [29]. Never the less we think that the road via quantum entanglement is probably the most conventional one [25] while arguing the case via 'tHooft's renormalization $D = 4 - \epsilon$ may be the simplest [24]. On the other hand the pure geometrical mathematical explanation via the theory of measure concentration in high incredibly wonderful and mathematical way to approach the subject as was realized by the author only very recently [35].

3. The Electroweak Master Equation for All Fundamental Interactions and the Dark Energy Density of the Cosmos

This section is mainly concerned with quantification of ordinary energy, dark energy as well as ordinary matter

and dark matter [17]. It is by now reasonably well known that transfinitely harmonized renormalization equation for the unification of all fundamental forces is not a perturbative solution but rather an exact equation emanating from the very structure of what has been termed golden quantum field theory [28] [29]. The equation which reconstructs the exact E-infinity theoretical value of $\bar{\alpha}_o = 137 + k_o = 137.082039315$ where $k_o = \phi^5\left(1-\phi^5\right)$ and ϕ^5 is Hardy's quantum entanglement is given by [28] [29]

$$\bar{\alpha}_o = \bar{\alpha}_1\left(1/\phi\right) + \bar{\alpha}_2 + \left(\bar{\alpha}_{3,1} + \bar{\alpha}_{3,2}\right) + \bar{\alpha}_4 \tag{1}$$

where $\bar{\alpha}_1 = 60$, $\bar{\alpha}_2 = 60/2 = 30$, $\bar{\alpha}_{3,1} = 8$, $\bar{\alpha}_{3,2} = 1$, $\bar{\alpha}_4 = 1$ and $\phi = \left(\sqrt{5}-1\right)/2$. Here $\bar{\alpha}_1$ is the electroweak inverse coupling at the electroweak scale found experimentally to be $\bar{\alpha}_1 \simeq 58.5$, $\bar{\alpha}_2$ is the inverse weak force coupling also at the electroweak and found experimentally to be $\bar{\alpha}_2 \simeq 29$. Furthermore, $\bar{\alpha}_3$ is the inverse coupling constant of the strong force and found experimentally to be between $\bar{\alpha}_3 \simeq 7$ to $\bar{\alpha}_3 \simeq 9$ depending upon the experimental resolution of the electroweak energy scale probing of this coupling. Finally $\bar{\alpha}_4 = 1$ is a theoretically universally excepted value for the quantum gravity coupling of a Planck mass to be Planck Aether [26]. We note that $\bar{\alpha}_4 = 1$ inclusion in the reconstruction of $\bar{\alpha}_o \cong 137$ is a remarkable feature of our general E-infinity theory which on reflection, truly makes a great deal of sense because there can be no exact solution in relativistic physics with quantum gravity. Inserting the above value in our exact renormalized equation, one finds [26]-[29]

$$\bar{\alpha}_o = \left(97 + k_o\right) + 30 + \left(9+1\right) = 137 + k_o = 137.082039325.$$

The most important observation with respect of the present work is that

$$\sum_{i=1}^{4} \bar{\alpha}_i = \left(10\right)^2 \tag{3}$$

for the above equation. That means our master equation is in its core dependent upon exactly one hundred dimensions representing a finite unitarity renormalization of the infinitely many but hierarchal dimensions of E-infinity theory. We could write this in a formal symbolic notation as follows:

$$\text{Heirarchal}\left(\dim\ \text{E-}\infty\right) = \infty \to \sum_{1}^{4} \bar{\alpha}_i = 100. \tag{4}$$

It is of course not surprising to look upon inverse coupling as being dimensions and coupling as being normed probability with the formalism and mathematics of E-infinity. Consequently 4 of these dimensions are the normal topological dimensions of spacetime. Considering that the bosonic string theory required 26 dimensions, we conclude that 26 − 4 = 22 are twenty two compactified dimensions so that we are left with 100 − 26 = 74 dimensions. These dimensions represent the dark dimension of pure dark energy while the compactified 22 dimensions represent the dimension of dark matter leaving only 4 dimensions for real energy and real matter. Thus in a manner of G. Orwellian speech the 22 dimensions of dark matter are compactified but the 74 dimensions of dark energy are more compactified than the first. From the above to the conclusion that

$$E\left(O\right) = 4/100 = 4 \text{ percent}, \tag{5}$$

$$E\left(D_m\right) = 22/100 = 22 \text{ percent}, \tag{6}$$

and

$$E\left(D_E\right) = 74/100 = 74 \text{ percent} \tag{7}$$

represents the percentage energy density for ordinary energy and matter $E(O)$, pure dark matter $E(D_m)$ and pure dark energy $E(D_E)$ it is only one simple step. We conjecture that splitting the 4 spacetime dimensions into 1 + 3 dimensions gives us a justification for believing that this would correspond to 1 percent real matter and 3 percent real radiation [17] [22]-[26]. Now our above result agrees completely with the measure concentration theorems on manifold with very high dimensionality in quasi Banach space where 96%, *i.e.* 100 − 4 = 96 quasi dimensions are concentrated near to the surface of the manifold [35]. The highly interesting picture for this result comes to the fore when we project the manifold onto the Poincaré-Beltrami plane and see that it is exactly like a

compactified Klein modular space or a fractal Penrose tiling, *i.e.* a projection of a fiber bundle manifold with infinitely many increasingly small hyperbolic degrees of freedom or "triangular" dimensions concentrated at the "circumferential" edge at infinity [28] [36]. The weight of this infinitely many degrees of freedom is a "volume" of 96 percent while the center is made of 336 quasi dimensions of the SL(2, 7) Lie symmetry group weight compared to infinity as a mere 100 − 96 = 4 percent. This is the 4% ordinary measurable energy and matter while the rest is the 96% dark energy and matter that cannot be measured in any ordinary way because of the Hawking-Hartle collapse of the quantum wave of the cosmos [29]. It is almost too beautiful to believe that one could reach such a profound cosmological conclusion using pure reason in the form of a stringent geometrical theorem [35].

4. All Roads Lead to $E=\left(mc^2/22\right)+mc^2\left(21/22\right)\simeq mc^2$

What we did so far is essentially add more weight to our basic thesis that $E=mc^2$ consists of two parts with very strong quantum connection [28] [29]. Numerous theories were used and all led smoothly to the very same result. It turned out that dark energy and the quantum wave are really two names for essentially the same thing and this conclusion is not simply fancy theorization but something very real, substantiated by accurate measurement of the increased rather than decreased rate of cosmic expansion [17] [25] [26]. To arrive at our exact solution we could regard the entanglement energy of a single quantum particle as half of Hardy's entanglement ϕ^5 where $\phi=\left(\sqrt{5}-1\right)/2$. Consequently intersecting $E=mc^2$ of "pure" relativity with the $\left(\phi^5/2\right)$ quantum entanglement leads immediately to $E(O)=\left(mc^2\right)\left(\phi^5/2\right)\simeq mc^2/22$. Consequently $E(D)$ must be $1-E(O)$ which means $E(D)=mc^2\left(21/22\right)$. The same result could be found from the ratio of 'tHooft's renormalization dimension $D(\text{tHooft})=4-\epsilon=4-k$ where $k=2\phi^5$ to the dimension $D(\text{Einstein})=4$. Consequently we have $E(D)=\left[(4-k)/4\right]\left(mc^2\right)\simeq mc^2\left(21/22\right)$. The icing on the cake of the present theory is the fact that a theorem in pure mathematics of convexed manifolds in high dimensional Banach spaces asserts that 96% of the volume of such a manifold is located near to the surface while the bulk of the manifold contains paradoxically only 4% of the volume [35]. This confirms our various derivations in the most pure mathematical way possible.

5. Conclusion

The present analysis shows in a clear and somewhat unexpected way that the demarcation lines between pure mathematics and real physics are completely blurred when it comes to the Planck length or the Hubble radius [26]. Both the unimaginably small and the unimaginably large are two sides of the same Witten T-duality [8] [23]. Seen at moderate resolution exophysically [39]-[41] we always have $E=mc^2$. However at the extremities of quantum gravity and quantum cosmology we still have at the very end $E=mc^2$ but the two quantum parts of which it is made make themselves noticeable endophysically [39]-[41]. This is so because we can measure a "real" part of *E*, namely $E(O)=mc^2/22$. However we also notice the absence of $E(D)=mc^2\left(21/22\right)$ dark energy density which manifests itself at these scales only as the driving force behind the antigravity force pushing the universe apart as confirmed by the endophysical experiments of COBE, WMAP, Planck and the relevant supernova analysis recognized by the 2011 Nobel Prize [21]-[30].

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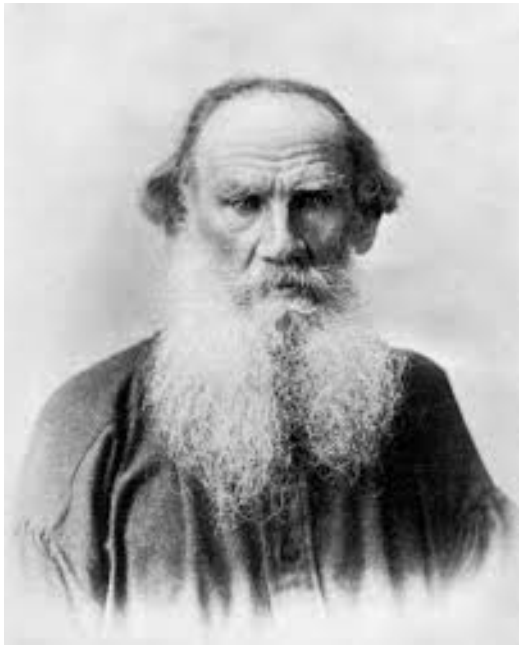
Appendix



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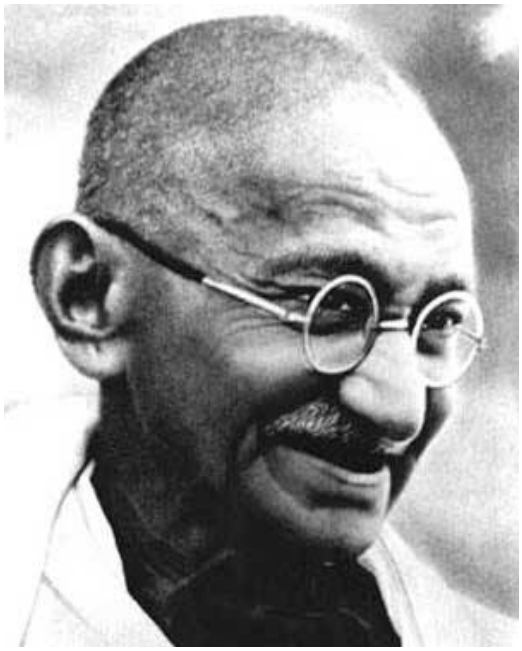

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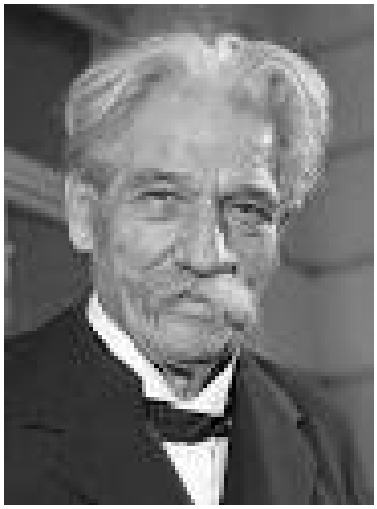

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