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From Nikolay Umov $E = kmc^2$ via Albert Einstein's $E = \gamma mc^2$ to the Dark Energy Density of the Cosmos $E = (21/22)mc^2$

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Abstract

The paper starts from the remarkable classical equation of the great nineteenth century Russian physicist Nikolay Umov $E = kmc^2$ where $1/2 \le k \le 1$, m is the mass, c is the speed of light and E is the equivalent energy of m. After a short but deep discussion of the derivation of Umov we move to Einstein's formula $E = \gamma mc^2$ where γ is the Lorentz factor of special relativity and point out the interesting difference and similarity between Umov's k and Lorentz-Einstein γ. This is particularly considered in depth for the special case which leads to the famous equation $E = mc^2$ that is interpreted here to be the maximal cosmic energy density possible. Subsequently we discuss the dissection of $E = mc^2$ into two components, namely the cosmic dark energy density $E(D) = (21/22)mc^2$ and the ordinary energy density $E(O) = mc^2/22$ where $E(D) + E(O) = mc^2$. Finally we move from this to the three-part dissection where we show that E is simply the sum of pure dark energy $E(PD)$ plus dark matter energy $E(DM)$ as well as ordinary energy $E(O)$.

Keywords

N. Umov Energy, A. Einstein Energy, El Naschie Energy, Ordinary Cosmic Energy, Cosmic Dark Energy, F. Hasenöhrl's Electromagnetic Energy, H. Poincaré History of Special Relativity

1. Introduction

The intention of the present paper is to give probably for the first time a coherent accurate picture of the scientific adventure leading to the discovery of a new meaning for Einstein's $E = mc^2$ [1] [2] [3] [4] as the maximal cosmic energy density [5] [6] [7] [8] and its dissection into two quantum components, namely the ordinary cosmic density $E(O) = mc^2/22$ and the dark energy density $E(D) = (21/22)mc^2$ where m is the mass and c is the speed of light [9] [10] [11] [12]. The motivation for the need of such a coherent picture incorporating the historical development [13] [14] [15] came to our consciousness with the passing of time since the above mentioned discovery was first announced some six years ago [6]. The immediate reason is closely connected to the fact that we, like many other scientists, were not really familiar with the pioneering work of N. Umov [16] [17] [18] [19] and we did not ponder the deep meaning of the mainly classical mechanics derivation of Umov's $E = kmc^2$ [16] [17] [18] [19] [20] and even less how it could relate to Einstein's $E = \gamma mc^2$ [14] [20]. In fact this is also the same situation with the formalistically similar but physically and mathematically quite different $E = (mc^2/22) + (21/22)mc^2 = mc^2$ of E-infinity theory [8] [18] [19] and that although for $k = \gamma = 1$ we have on its face value the same famous equation, namely $E = mc^2$ [1]-[21].

It is the hope of the Author that the present paper will not only provide a better motivation and a deeper understanding of the dissection of $E = mc^2$ into ordinary energy density and dark energy density components, but will also motivate in a natural way the second dissection of the 95.5% dark energy into 22% dark matter energy density and 73.5% pure dark energy density [10] [11] [12]. This pure dark energy is strongly suspected to be the force behind the mysterious accelerated expansion of our cosmos [22].

Finally we should mention that in an attempt to keep the present paper within a manageable length and at the same time render the work self contained, a reasonably comprehensive bibliography and references have been adduced to our list of essential papers [11]-[35].

2. On the Umov Formula $E = kmc^2$ and Hasenöhrl's $E = (3/4)mc^2$

Scientific honesty compels us to unqualified admitting that when we wrote our paper [6] entitled "Revising Einstein's $E = mc^2$: A theoretical resolution of the mystery of dark energy" we were not aware of the seminal work of the great Russian scientist Nikolay Umov [14] [16] [17] [18] [19] [20]. Note only that we also painfully admit that we thought that Einstein made a mistake and that $E = mc^2$ is wrong. We even reasoned the error by the fact that at the time when Einstein derived his formula, only one messenger particle, namely the photon, was known and consequently his would be Lagrangian was restricted by only one degree of freedom [5] [6] [7] [8] while we know today from the standard model that his Lagrangian should have 12 degrees of freedom. Consequently a scaling $\lambda = 12 - 1 = 11$ must be applied to $E = mc^2$ to correct it [2] [4] [5] [6] [7] [8] [23] [24]. Of course Einstein never wrote a Lagrangian but $E = mc^2/22$ would have been quantitatively the correct answer if he would have taken all the

12 degrees of freedom $\left|SU(1)SU(2)U(1)\right|=12$ of the standard model into account. However this would not have explained why actual cosmic measurement failed to find $E=mc^2$. At the end we were correct because $E=mc^2/22$ accounts for what we know as the ordinary (measurable) energy density of the universe while there is also another component $E=(21/22)mc^2$ which is the dark energy density of the cosmos. However the point is that we cannot measure this dark energy using the present day technology because of the so called wave function collapse [25]. Adding both the ordinary and dark energy components together one miraculously finds that Einstein somehow got the right answer without knowing or using quantum mechanics [14] [16] [18] nor did he know at that time that there is anything called dark energy [22] [24] [25]. We will discuss all this in some more detail in later paragraphs and we will concentrate in what follows on N. Umov's remarkable derivation leading to $E=kmc^2$ [14]-[19]. Of course N. Umov's creative period was much earlier than Einstein and he knew nothing about relativity nor of course quantum mechanics because both theories were developed after his time [13]-[25]. However N. Umov understood Newto's work and philosophy very well and that light could be thought of as "photon" like energy particles which can interact with matter [16] [17]. This Umov model was as follows: He considered a mass from which a tiny small m was emitted. Since m is emitted with the speed of light, then it has a translation impulse, *i.e.* a momentum equal mc. This will create in the opposite direct an equal momentum amounting to whatever is left after emitting m which he denoted as capital "M" multiplied with the velocity v and the momentum is thus MV. The total energy is consequently equal the energy of m which is the momentum of m, namely mc multiplied with c again then divided by 2. Similarly the energy of M is the momentum MV multiplied with v and divided by 2. Thus the total energy is simply [16]

$$E=\frac{1}{2}mc^2+\frac{1}{2}MV^2 \tag{1}$$

Next Umov considered two limits [16]. The first limit is when the large M becomes smaller and smaller approaching the small m. In this case v becomes larger and larger approaching the speed of light c. Therefore in this case the total energy becomes [16]

$$\begin{aligned} E&=\frac{1}{2}mc^2+\frac{1}{2}mc^2 \\ &=\frac{1}{2}mc^2 \end{aligned} \tag{2}$$

The second limit is when m becomes increasingly small compared to M, *i.e.* $m \ll M$ and consequently V will approach zero $(v \to 0)$ and the total energy would become [16]

$$\begin{aligned} E&=\frac{1}{2}mc^2+\text{zero} \\ &=\frac{1}{2}mc^2 \end{aligned} \tag{3}$$

Finally Umov wrote both Equations (2) and (3) in a compact form using the factor k which reads [16]

$$E = kmc^2, \quad \frac{1}{2} \le k \le 1 \tag{4}$$

Somehow the present Author and his colleague Alex Babchin who is incidentally a distinguished Russian Israeli scientist, opted consciously or unconsciously to use a similar notation to N. Umov where k takes several values summarizing the different energy densities of the cosmos [20].

Having come that far we must appreciate that setting k of Umov to be equal to unity leads to the same result as setting the Lorentz factor γ equal to unity in Einstein's formula. However it would be a major misunderstanding to think that k and γ or for that matter, the k used by the Author in [20] has the same meaning because they are not as we will explain in the next paragraph. In concluding this section however, we stress the Newtonian classicality of N. Umov's derivation of his formula and stress even more the fact that rotational momentum is totally ignored because quantum mechanical spin was of course not known at all to Umov [16] [17]. Needless to say, the division and duality of quantum particles and quantum wave played no role what so ever in the Umov derivation which is in stark contrast to the Author's derivation of his corresponding formula [4]. Last but not least, and as a tribute to the Austrian physicist, *Friedrich Hasenöhrl* who lived between 1874 and 1915 and died needlessly in the absurd first World War, we should mention his remarkable formula $E = (3/4)mc^2$ which is discussed in Refs. 13 and 14 and which we surmised may be related to the 74% pure dark energy of the universe as well as Kepler's sphere packing density in $D = 3$ [18] [19].

3. Comparison between Einstein's Equation $E = \gamma mc^2$ and Umov's Equation $E = kmc^2$

The most important aspect of Einstein's E as obtained from special theory of relativity is that it is not simply $E = mc^2$ but more accurately stated it is [21]

$$E = (\gamma)(mc^2), \quad \gamma = \frac{1}{\sqrt{1-(v/c)^2}} \tag{5}$$

where v is the speed relative to the observer [1] [2] [3] [4]. This v will play a very important role in our understanding of the deep meaning of the theory for the following reasons. First when $v = 0$ then we could infer that m is stationary and we have $\gamma = 1$ for which we find the same result as when we set $k = 1$ in Umov's formula. Second we could imagine at least theoretically that an observer is moving "or riding" on m so that we find again $\gamma = 1$ and the familiar famous $E = mc^2$. Thus by coincidence or providence $k = 1$ and $\gamma = 1$ leads to the same $E = mc^2$ although it is for very different reasons. We warn at this point from the regrettable fact that in our earlier publications we were not sufficiently careful to use different letters in our notation instead of γ and k which could mislead the fleeting reader. Never the less, the fact that $\gamma = 1$ is associated also with an observer standing exactly in the same point where m is located and moving with the same speed as m so that the relative speed v being equal to zero means after little contemplation that $E = mc^2$ could be given a second interpretation, namely as a generic maximal energy density at this particular spacetime point for any conceivable measurement. This conclusion brings with it great simplification in calculating the various types of cosmic energy densities as we will see in the next paragraph.

4. The E-Infinity Decomposition of $E = mc^2$

Before reviewing our E-infinity result regarding the decomposition of $E = mc^2$ into the three main components [20]-[25] of the cosmic energy densities, namely the ordinary measurable cosmic energy $E(O) \simeq 4.5\%$, the dark matter cosmic energy $E(DM) \simeq 22\%$ and the pure dark cosmic energy density $E(PD) \simeq 73.5\%$, we should mention that $E = \gamma mc^2$ is not the most general and accurate formula of our special theory of relativity [21]. The best way to state this equation is the following [21] [22] [23] [24] [25]

$$E^2 = (PC)^2 + (mc^2)^2 \tag{6}$$

where P is the momentum [26]. Setting again the relative speed equal to zero, then $P = 0$ and we find

$$\begin{aligned} E &= \pm\sqrt{(mc)^2} \\ &= \pm mc \end{aligned} \tag{7}$$

This result is exactly what led *P.* Dirac to interpret the negative sign as an anti-particle energy and that long before the positron was first discovered [26]. Now we have reached the point in time when quantum mechanics was discovered and formulated by Heisenberg and his school as a matrix theory [26]. In addition to that the Schrödinger formulation as a conjugate complex diffusion equation was established, all apart from the later fusion of the Schrödinger equation [26] and the special theory of relativity giving us the Dirac equation as well as the particle wave duality [25] [26]. Furthermore we gained more understanding of relevant mathematics relatively recently due to the effort of too many researchers all over the world in the last half a century which culminated in additional understanding of noncommutative geometry [26] [27] [28] dimensional theory [28] [31] as well as transfinite set theory [30] [31]. These new insights were used by the present Author in his E-infinity Cantorian spacetime theory to resolve nagging problems such as the paradoxical outcome of the two slit problem as well as the notorious quantum wave collapse, *i.e.* the state vector reduction of orthodox quantum mechanics [26] [30] [31]. Following this line of research, it turns out that the pre-quantum particle could be modelled via the zero set [30] [31] [32] and the pre-quantum wave can be modelled by the empty set [32] both in a Kaluza-Klein five dimensional space [30] [31] [32] [33] [34]. In addition it became obvious that the preceding model is confirmed by the exact Hardy model of quantum entanglement [35] enshrined into his by now very famous result stating that the maximal quantum entanglement of two quantum particles is equal to the golden mean $\phi = \left(\sqrt{5}-1\right)/2$ to the power of 5 [35]. Furthermore it becomes abundantly clear that Cantorian correlation by union and intersection is a more generic case of general quantum entanglement than the spin up and spin down famous actual experiment [26]. Putting all these facts together, it became evident that the quantum pre-particle topological volume is where the particle ordinary measurable energy resides in a five time intersection of the zero set Hausdorff dimension divided by two [8]-[12]. This means it is the Hardy probability divided by 2, *i.e.* $\phi^5/2$ [30]-[35] while the corresponding topological volume for the empty set quantum wave is a five dimensional union of five empty sets given by the Hausdorff dimension ϕ^2. This means we have $5\phi^2/2$ [30]-[35]. Finally it turned out that $\phi^5/2$ is the exact correlated measurable ordinary energy density of the cosmos while $5\phi^2/2$ is the uncorrelated not directly measurable dark energy density of the cosmos [30]-[35]. Adding ϕ^5 to $5\phi^2/2$ we find a factor equal one in an astonishing analogy to the $k = \gamma = 1$ factor found for the Umov equation and the Einstein equation respectively. In other words, we have [4] [30]-[35]

$$\begin{aligned} E &= \left(\phi^5/2 + 5\phi^2/2\right)\left(mc^2\right) \\ &= mc^2 \end{aligned} \tag{8}$$

where

$$\begin{aligned} E(O) &= \left(\phi^5/2\right)mc^2 \\ &\cong mc^2/22 \\ &\simeq 4.5\% \end{aligned} \tag{9}$$

and

$$\begin{aligned} E(D) &= \left(5\phi^2/2\right)\left(mc^2\right) \\ &\cong (21/22)\left(mc^2\right) \\ &\simeq 95.5\% \end{aligned} \tag{10}$$

in full agreement with cosmic measurements and observations [22] [30]-[35]. The next step of computing the exact value for pure dark energy and dark matter energy was given in detail in various previous publications [4]-[12] [23] [25] [28]-[35]. However an almost elementary assumption that pure dark energy is a self similar Kepler cells of dense sphere packing in three dimensions leads us directly to the conclusion that pure dark energy density is equal $\pi/\sqrt{8} \simeq 74\%$ [36] and consequently dark matter energy must be $96 - 74 = 22\%$ in agreement with our previous conclusions [10] [11] [12].

5. Conclusion

Due to a lucky coincidence or a truly grand design, $k = 1$ of Umov, $\gamma = 1$ of Einstein and a similar combination $\gamma(O) + \gamma(D) = (\phi^5 + 5\phi^2)/2 = 1$ of E-infinity theory leads to a maximum energy density $E(\max) = mc^2$ which is formally identical to the most recognizable equation in theoretical physics [1]-[20]. The most astonishing fact is that Nikolay Umov obtained his result using solely Newtonian mechanics while the Einstein equation made no use whatsoever of quantum mechanics. It was only with the help of the work of A. Connes [27] [28] [29] [30] combined with E-infinity Cantorian spacetime theory that we were able to slice $E(\max) = mc^2$ into its quantum components, namely the ordinary cosmic energy density and the dark cosmic energy density. This result could lead us to a sweeping general conjecture, namely that classical, relativistic and quantum mechanics are just manifestation or the very same spacetime geometry and topology at different resolution [30]. Thus fractal geometry is the most general kind of geometry and is the real geometry of nature while the golden mean number system of E-infinity theory is the lingua franca of nature and its fractal geometry and topology. At long last we can understand nature's language directly without using differential equations and Lagrangian dictionaries which are open to misunderstanding as we know from real life.

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