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On the Real Einstein Beauty $E = Kmc^2$

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Abstract

The paper suggests that $E = mc^2$ may be open to misinterpretation and that in this form it is not what Einstein advanced first. It is further suggested to return to the slightly less compact formula $E = Kmc^2$ where $a < K < 1$ which has the merit of accounting for the measured ordinary energy density of the cosmos ($K = 1/22$) and the conjectured missing dark energy density of the universe ($K = 21/22$) from the view point of economical notation.

Keywords

Special Relativity, Nuclear Physics, Quantum Relativity, Quantum Entanglement, $E = Kmc^2$, Dark Energy, Ordinary Energy, Pair Annihilation, Pair Creation, Dvoretzky's Theorem, Bohm Guiding Wave

1. Introduction

The present paper started by the following innocent but for at least historical reasons, a justified question [1] as we will see:

DOES THE FORMULA $E = mC$^2 BELONGS TO EINSTEIN?

Now those of us who are passionate readers of the classical work of Einstein [1]-[12], will not find this Formula as his work as a result [1]-[5] [10]-[12]. Instead one will notice that Einstein came to the result that $l = E/C$^2, where (l) is the famous mass defect due to the fission of Radium salts, E is the energy generated by fission and C is the speed of light. Thus, being the most basic equation of nuclear physics, Einstein result did not claim that mass of arbitrary chemistry can be entirely transformed to energy due to nuclear reaction. Such a leap is justified under certain circumstances in high energy physics and astrophysics but as certain, not in chemistry.

It's hard to nail down those responsible for transforming the Einstein original but they probably proceeded in the following way. As l is a very small mass (defect of mass in reality), it was suggested to rename $l = \mathrm{d}m$, and

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the small energy, associated with dm was taken as dE. As a result the following formula appeared:

$$\mathrm{d}E = \mathrm{d}m \cdot C^2$$

There is nothing wrong with this formula as it corresponds to Einstein's result in a slightly different notation. The misleading error occurred upon integration of dm from 0 to entire mass m of the body of arbitrary Chemistry, and dE is integrated to give the energy E, corresponding to the mass of the entire body. The fact is however this formula cannot be integrated, unless dm is treated as small portion of the defect of mass, then the integration limits are from 0 to l, resulting in the initial Einstein formula.

Unfortunately, this practically incorrect result $E = mC$^2 [1]-[5] can be found in almost any textbook on General Physics [2], usually without derivation, and is ascribed to Einstein, who really does not bear any responsibility for this widespread error of interpretation.

1.1. About the Present Article

The present article has grown out of an extensive open discussion invited by a question posed by the first author (A.J.B.) on Research Gate which is nowadays a leading and popular forum for research in general science, engineering, medicine and technology as well as humanities and social sciences [1]. The debate included at the time of writing 12 scientists and filled about 14 pages when downloaded. Since the subject is probably the most famous equation in the history of physics, in fact arguably in the history of science, the present authors who were able to come to a general consensus about the merit of the different arguments, decided to go ahead and publish the outcome as a formal paper in the reputable peer reviewed journal. We do not presume that this paper is the last word on a vast subject [1]-[18] but we are confident that it is a non-trivial and fundamental contribution to a pillar of modern physics [1]-[19].

1.2. About $E = mc^2$

L.B. Okun, a world renowned expert on Einstein relativity and particularly on $E = mc^2$, put his misgivings plainly in a formal scientific paper by entitling it "The Einstein formula; $E_o = mc^2$. Isn't the Lord laughing?" published in 2008 in a leading Russian physics journal [2]. The controversy about $E = mc^2$ has a long history and an even longer list of published papers [1]-[14]. However in our present work we advance other arguments showing that the highly popular but open to misunderstanding interpretation for converting mass to energy, *i.e.* $E = mc^2$ is first not due to Einstein and second Albert Einstein is not responsible for all these misunderstandings in the first place. Subsequently we show that writing $E = Kmc^2$ is more general and accounts for the deeper meaning of Einstein's intention as well as for ordinary energy and dark energy by setting $K = 1/22$ for the first and $K = 21/22$ for the second so that at the end we find $E = (mc^2/22) + mc^2(21/22) = mc^2$ as should be [6] and in full agreement with cosmological measurements and observations which led twice to the Nobel Prize, once for COBE and the second in 2011 for Type 1a supernova and WMAP [6] [8] [13].

2. The Conventional Widespread Derivation of $E = mc^2$

The most common way used in deriving $E = mc^2$ is via the following example of electron-positron production and annihilation:

If a photon enters the coulomb field of a nucleus or another charged particle, this photon can disappear by so called pair production if the energy of the photon is above an energetic threshold, the pair production minimal energy. For the production of an electron-positron pair this minimal energy is 1022 keV plus a small rest of recoil energy for the coulomb field spending nucleus or another particle like atomic shell electron or free unbound electrons. The value of m_e/M_n is typically about 10^{-6}, the threshold formula (**Figure 1**)

$$E_{\gamma,\min} = 2m_e c^2 \left(1 + m_e/M_n\right)$$

The symbolic formula for the process is

$$\gamma = e^+ + e^-$$

This is a well known elementary particle process. Its probability depends on the square of the atomic number of the field producing nucleus and increases with about the logarithm of the photon energy above the threshold.

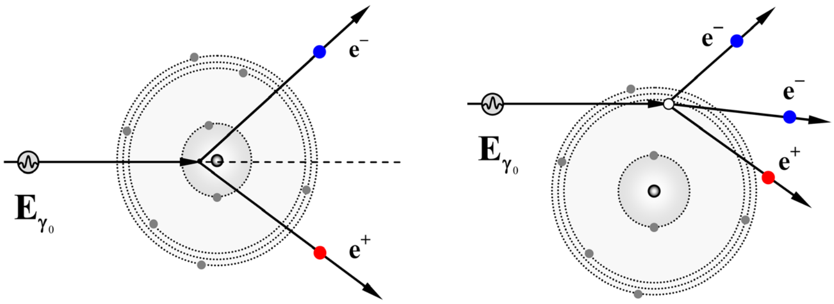

Figure 1. Illustration for electron-positron production.

The energy of the photon is changed into particle masses, and if then a difference of energy remains as kinetic energy of the two particles. From conservation laws this particle pair must consist of a matter-antimatter pair to keep the particle numbers etc. at zero.

$$E_{kin} = E_{\gamma} - 2 \cdot m_0 \cdot c^2 = E_{\gamma} - 1022\text{ keV}$$

In the case of zero remainingkineticenergy,wefinddirectly the famous Einstein mass- energy relation

$$E = mc^2$$

which means the direct equivalence of energy and mass.

The revised process of pair production is pair annihilation. It happens if a particle and the corresponding anti-particle collide. The example here is the electron-positron annihilation.

If this process happens with zero rest kinetic energy of the two colliding leptons, we immediately get the equation

$$e^+ + e^- = 2m_0c^2 = 2 \times 511\text{ keV}$$

The two annihilation photons are emitted in a typical 180 degree angle, which is applied in nuclear medicine imaging as PET technology. Or in a more symbolic way you can write again

$$mc^2 = E$$

the direct equivalence again of mass and energy (**Figure 2**).

If the annihilation takes place with remaining energy of the electron or the positron, the two annihilation photons are emitted under a sharp labor angle smaller than 180 degree.

3. Dissecting $E = mc^2$ into Its Two Quantum Relativity Components

Let us start from the generally accepted De Broglie-Bohm pilot wave picture, which is probably the only quantum theory which Einstein was ready to at least partially "swallow" to put it mildly. We take this picture because it agrees completely with von Neumann-Connes' pointless noncommutative geometry as our spacetime and consequently also with the fundamental equation [8] [9]

$$D = a + b\phi,\ \ a, b \in Z\ \text{ and }\ \phi = \left(\sqrt{5} - 1\right)/2$$

which shows that the "pilot" quantum wave is the cobordism, *i.e.* "surface" of the quantum particle. In particular the "pilot" pre-quantum wave would be fixed by the empty set bi-dimension

$$D(\text{empty}) = \left(-1, \phi^2\right)$$

while the pre-quantum particle would be fixed by the zero set

$$D(\text{zero}) = (0, \phi).$$

Let us calculate the quasi volume of the pre-quantum particle and the quasi area of its surface, *i.e.* the surface constituting the "pilot" wave. Noting that the basic dimensionality of spacetime is that of Kaluza-Klein five dimensions [14] then it follows that the volume of the quantum particle must be the correlated multiplicative value

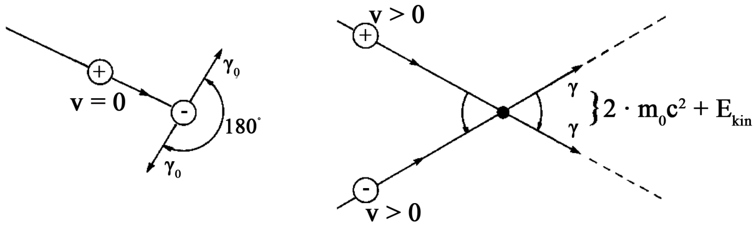

Figure 2. Illustration for pair annihilation process.

$$\mathrm{vol}_5(5) = (5)(\phi)^2$$

where ϕ and ϕ^2 are the corresponding Hausdorff dimensions given by $D = a + b\phi$ and interpreted as a Hausdorff volume measure. Now taking Newton's kinetic energy as our canonical equation, we see easily that the energy density corresponding to the above measures must be [8] [9]

$$E(O) = \frac{1}{2}m(v \to c)^2(\phi^5) = (\phi^5/2)(mc^2) \simeq mc^2/22$$

and

$$E(D) = \frac{1}{2}m(v \to c)^2(5\phi^2) = (5\phi^2/2)(mc^2) \simeq mc^2(21/22)$$

Adding ordinary energy $E(O)$ to dark $E(D)$ it is delightful to see that we retrieve Einstein's correct formulas [6] [8] [9]

$$\begin{aligned} E &= (\phi^5/2)(mc^2) + (5\phi^2/2)(mc^2) = \left[(\phi^5/2) + (5\phi^2/2)\right]mc^2 \\ &= [k_1 + k_2]mc^2 = Kmc^2 = mc^2 \end{aligned}$$

where $K = k_1 + k_2 = (\phi^5 + 5\phi^2)/2 = 2/2 = 1$. This remarkable result could be obtained more directly from the pure mathematics of measure theory of Banach spaces [15]-[19]. To do that we simply resort to Dvoretzky's theorem and regard particle and wave as a high dimensional sphere. Consequently such a sphere would have 96 percent of its volume concentrated on the higher dimensional surface while 4 percent constitutes the deceptive internal bulk of the sphere. This is practically the same previous result. In conclusion we must say that there is hardly any doubt about this result because it is in astounding nearly surreal agreement with unprecedented high precision cosmic measurements and observations connected to COBE and Type 1a supernova which we repeatedly refer to.

4. Discussion

It is not always easy to set an exact limit for where we become relativistic or render quantum starting from classical physics. Consequently we should not be astonished when we see that at the edge of the universe at hyperbolic infinity of the boundary of the holographic boundary we have an accumulation of dark energy which accounts for 95.5% of the total energy density of the universe given by $E \cong mc^2(21/22)$, *i.e.* $K = (21/22)$ in the formula $E = Kmc^2$ which we propose to replace with $E = mc^2$. However for $K = 1$ we have a very special situation indeed for which by chance or providence we found $E(\max) = (1)(mc^2)$ and that by a totally ingenious leap of faith rather than a systematic derivation as noted by the grand connoisseur of relativity, Professor Wolfgang Rindler [7]. All of the present derivation follows actually smoothly and almost effortlessly from the Rindler wedge of the Rindler spacetime geometry and topology where everything was encoded in the hyperbolic geometry without us noticing, nor in fact Rindler himself noticing that it is telling us all about $E = Kmc^2$, ordinary energy and dark energy density of the universe but in a very subtle language and quite different from the language used in the present work. Never the less, $E = Kmc^2$ is the physical incarnation of the old proverb which says that all roads lead to Rome or $E = Kmc^2$.

5. Conclusion

The celebrated formula $E = mc^2$ has a long history dating back to before Einstein, for instance Poincare. Not only that but it is also somewhat misleading and better replaced by $E = Kmc^2$. In this second form E becomes the sum of two types of energy, the measurable ordinary energy $E(O) = mc^2/22$ and the supposedly missing dark energy $E(D) = mc^2(21/22)$ [19]. This reveals hitherto unsuspected quantum roots for $E = mc^2$. In fact classical relativity already implies the total unity of Einstein's relativity, classical mechanics and quantum mechanics. This is so because it is the relative size of what we are measuring vis-à-vis our own size and the size of our experimental device is what makes things relatively very large where relativity is applicable or relatively very small where quantum mechanical description takes over. No wonder then that the quantum relativity formula $E(O) = mc^2/22$ when added to the quantum cosmology formula $E(D) = mc^2(21/22)$ gives us the famous formula $E = mc^2$ which is only a scaling of Newton's $E = 1/2mv^2$ sending $1/2v^2$ to c^2. Nothing could possibly be more astoundingly simple than that.

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