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THE QUANTUM ENTANGLEMENT BEHIND THE MISSING DARK ENERGY

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Abstract: By adding quantum entanglement effects to Einstein's energy equation ($E = mc^2$) where E is the energy, m is the rest mass and c is the velocity of light, we arrive at a new exact formula for the energy of the quantum particle $E = (0.045085) mc^2$ which implies that the missing dark energy is the energy of the quantum wave and is given by $(1 - 0.045085)(100) = 95.4915$ percent in astonishing agreement with the best currently known measurements.

Keywords: Quantum Entanglement; Quantum Gravity; Revising theory of Relativity; Ordinary Energy of Quantum Particle; Dark Energy of Quantum Wave; Wave-Particle Duality; Negative gravity.

1. Introduction

The relatively recent discovery of dark matter and even more so dark energy sent shock waves throughout astrophysics and cosmology apart from capturing the public interest at large [1]. The present rather brief note is thought to give a short and accurate quantitative resolution to the problem which we hope is both convincing and simple.

The idea is to improve the fundamental energy formula of special relativity [4] by taking quantum mechanics into consideration [5-10]. This is done by accounting for the effect of quantum entanglement [11, 12] which reduces the total energy predicted via Einstein's classical equation $E = mc^2$ by almost 95.4915 percent. This agrees completely with the

current best measurement of the total non-dark energy in the universe being about 4 to 5 percent of what it should be [1-3].

Various short derivations leading to precisely the same quantitative result and physical implications are presented.

2. The quantum entanglement effect on Einstein's energy formula

Before giving a formal derivation of Einstein's mass-energy relation, including the quantum mechanical effects as will be done in the next section we give first an informal argument using various plausibility explanations.

All correct physical theories must be evidently compatible, interconnected and in an ideal situation derivable from each other frequently in a democratic way. The formula $E_R = Mc^2$ where M is the mass and c is the velocity of light is the crowning result of special relativistic mechanics [14] which improves on Newton's mechanics. We know of course how special relativity was added to the nonlocal Schrödinger equation and produced the relativistic Dirac equation [14]. This in turn predicted the existence of anti-matter asymmetry which exists in nature [14]. Here we will do just the opposite by adding quantum mechanics to the energy formula of special relativity. However maybe it is better for a deeper understanding to start from the nonlocal Newtonian mechanics and then add quantum mechanics in a way reminiscent in principle to Hawking adding quantum mechanics to the classical gravitational theory of black holes and in the course of doing that discovering black hole radiation [14].

Newton's energy expression is well known from elementary mechanics to be $E_N = (1/2) mv^2$ where v is the velocity [14]. On the other hand Newtonian gravity is a truly spooky action at distance and happens immediately with infinite speed [11-14]. By contrast quantum mechanical action at distance, which we call entanglement, has a basic probabilistic nature [11-14]. The probability of quantum entanglement is given here by a general universal value which was verified with great precision in many actual experiments [12, 14]. This is the celebrated Hardy entanglement formula

$$P(\text{Hardy}) = \left(\frac{2}{\sqrt{5}+1} \right)^5 \quad (1)$$

Seen that way one could interpret Newton's energy expression as being based on a probability equal unity

$$P(N) = 1 \quad (2)$$

Consequently

$$\begin{aligned} E_N &= (P_N)(1/2)(mv^2) \\ &= (1) (1/2)(mv^2) \end{aligned} \quad (3)$$

could be transformed to E_{QR} by letting $P_N \rightarrow P(\text{Hardy})$ and $v \rightarrow c$ and find that

$$\begin{aligned} E_{QR} &= \frac{1}{2} \left(\frac{2}{\sqrt{5}+1} \right)^5 (mc^2) \\ &= \frac{1}{2} (0.09016994)(mc^2) \\ &= 0.0450849 mc^2 . \end{aligned} \quad (4)$$

This is a reduction in the value of total energy which matches excellently the value of the missing dark energy of the universe, namely $(1 - 0.0450849)(100) = 0.9549150281)(100) = 95.4915\%$. In fact by showing that a quantum particle is the Zero set, then it becomes clear that Dark Energy must be its cobordism i.e. the Empty Set. In other words, dark energy is the negative energy of the quantum wave which induces negative gravity.

The measurement of WAMP four years [15] and WAMP seven years [15] is 96% and 95% respectively, the average of which is 95.5 percent in excellent and in fact astonishing agreement with the above theoretical result.

3. Formal derivation for the inclusion of Hardy's quantum entanglement in Einstein's energy formula

In what follows we derive the preceding expression using the light cone relativistic quantization coordinate employed in string theory [7-9] in conjunction with the theoretical work of L. Sigalotti [16,17] and other authors[18]. The two coordinates that follow [7-9] are

$$x^+ = \frac{1}{\sqrt{2}}(x^0 + x^1) \quad (5)$$

and

$$x^- = \frac{1}{\sqrt{2}}(x^0 - x^1) \quad (6)$$

Introducing the velocity parameter β in the usual way we can write that [7,18]

$$\frac{dx^-}{dx^+} = \frac{1-\beta}{1+\beta} \quad (7)$$

Initially this seems to be a strange way to define velocity (dx^-/dx^+ is similar to dx/dt where t is time). However we intentionally bypassed the natural velocity definition of $\beta = v/c$. The main reason is the advantage of looking at β as somewhat more classical and can in principle allow for infinite speed [7]. Now we know that the well known relativistic expression for energy

$$E_R = \gamma mc^2 \quad (8)$$

where γ is the Lorentz factor, becomes the familiar classical expression for $\gamma=1/2$ and $c = v$

$$E_R \rightarrow E_N = (1/2) mv^2 \quad (9)$$

However, as we mentioned earlier, the above formula insists upon Newtonian's spooky action at distance and infinite velocity for travelling signals and gravitation [1]. By contrast

Einstein's formula E_R puts the speed of light as insurmountable so that $\gamma \neq 1/2$ and is a function of v

$$\beta = v/c \quad (10)$$

However first Sigalotti [16, 17] and then an Iranian team [17] followed by the results of various Authors [18] showed that we should put β equal to ϕ

$$\begin{aligned} \beta &= \phi = 2 \cos (2 \pi / 5) \\ &= 0.618033989 \end{aligned} \quad (11)$$

and that

$$\gamma = (\beta^2) \left(\frac{1-\beta}{1+\beta} \right) \quad (12)$$

which the present Author derived in previous work [12] and demonstrated that it is nothing else but Hardy's probability for quantum entanglement [13]

Letting

$$P_N \rightarrow P(\text{Hardy}) = \phi^5, \quad v \rightarrow c$$

and inserting in E_N one finds that

$$E_N \rightarrow E_{QR} = \frac{1}{2} (\beta)^2 \left(\frac{1-\beta}{1+\beta} \right) (mc^2) \quad (13)$$

Thus we have

$$\begin{aligned} E_{QR} &= (1/2) (\phi)^5 (mc^2) \\ &= (0.04508497197) (mc^2) \end{aligned} \quad (14)$$

which agrees completely with the result and conclusion of the previous paragraph. In a sense Hardy's quantum entanglement plays a role which could be said to resemble a quantum cosmological constant.

4. Derivation using the E8E8 Exceptional Lie Symmetry Group of Super String Theory.

The quantum entanglement correction of Einstein's formula was incredibly straight forward as it turns out to be simply taking the intersection of two theories, namely

$$E = \frac{1}{2} m(v=c)^2$$

and

$$P(\text{Hardy}) = \phi^5 \tag{15}$$

and find that

$$\begin{aligned} E(\text{Hardy}) &= E_{\text{QR}} \\ &= (E)(P\text{Hardy}) \\ &= (1/2) (\phi^5) (mc^2) \end{aligned} \tag{16}$$

Thus the quantum correction is simply a factor $\phi^5/2$ which reminds us of M. Milgrom's modified gravity [19] apart of Einstein's cosmological constant [1-3]. Recalling that the golden mean was found inside the quantum mechanics of Ferromagnetic Ising systems in the famous Helmholtz-Oxford experiment [20] and that this finding was in connection with the E8 exceptional Lie group [21] then it is highly stimulating to notice that Hardy's quantum entanglement factor is found from the inverse of the square root of the dimension of E8E8 after subtracting the 12 gauge bosons of the standard model [14, 21]. Restricting our accuracy to integers and rational numbers we find that

$$\begin{aligned} E_{\text{QR}} &= \frac{mc^2}{\sqrt{|E8E8| - N_{(SM)}}} \\ &= \frac{mc^2}{\sqrt{496-12}} \end{aligned}$$

$$\begin{aligned}
&= \frac{mc^2}{22} \\
&= 0.0454545 (mc^2) \\
&\simeq 0.045 (mc^2) \tag{17}
\end{aligned}$$

This indicates a 4.5% non-dark energy. To obtain the exact result we should take the exact $\dim|E8E8| = 496 - k^2$ given for instance in [21] and subtract only the dimension of Einstein's relativity spacetime $D = 4$ to find that

$$\begin{aligned}
E_{QR} &= \frac{mc^2}{\sqrt{496 - k^2 - 4}} \\
&= \frac{mc^2}{\sqrt{491.967477}} \\
&= \frac{mc^2}{22 + k} \\
&= 0.04508497187 (mc^2) \tag{18}
\end{aligned}$$

where $k = \phi^3 (1 - \phi^3) = 0.18033989$. This is exactly the value found in the previous paragraphs as well as experimentally.

Conclusion

Quantum correction to $E = mc^2$ is equivalent to simply multiplying mc^2 with a constant

$\phi^5 / 2$ where $\phi^5 = (\sqrt{5} - 1) / 2$. The value is Hardy's generic probability of quantum entanglement which was tested and confirmed via numerous excellent experiments. The agreement of our calculations with sophisticated experimental measurements makes it impossible to doubt that the reason for the apparent missing dark energy is the existence of quantum entanglement throughout the cosmos which has a noticeable effect on energy only at intergalactic scales. The theoretical value predicted here for dark energy is 95.4915028%, i.e. almost 95.5%. The four years analysis of the WAMP [15] gave 74% for

dark energy, 22% for dark matter which comes to 96% as compared to our 95.49%. For the seven years WAMP [15] we have 72.8% for dark energy and 22.7% for dark matter giving us 95.5% in astounding agreement with our theoretical calculations.

In conclusion we must say that we are tempted to call ϕ^5 a constant of nature and liken $\phi^5/2$ to M. Milgrom's factor for modified gravity or Einstein's cosmological constant. The only vital difference however is that ϕ^5 is a fundamental quantum mechanical value obtained theoretically and confirmed experimentally and by no means put by hand to make data fit the theory. On the other hand ϕ^5 is an intrinsic property of the geometry and topology of quantum micro spacetime while Einstein's cosmological constant, if it exists, is a property of the large scale structure of spacetime. To put it in a nutshell and at the risk of being too brief or provocative, the missing dark energy is due to the missing spacetime in a fractal-Cantorian spacetime cosmos [13]. Looking at the situation in this way gives us another interpretation of the multiplication of the classical energy with ϕ^5 , namely as scaling in the sense of Nottale's theory of scale relativity [22]. In future publications we intend to show the role of the particle-wave duality in the present context and that ordinary energy is the energy of the quantum particle while the negative dark energy of negative gravity $E(\text{Dark}) = \phi^5/2$ is the energy of the quantum wave. Einstein's $E = mc^2$ is thus blind to the distinction between Ordinary and Dark Energy.

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