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Quantum Disentanglement as the Physics behind Dark Energy

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Abstract

A straightforward simple proof is given that dark energy is the natural consequence of a quantum disentanglement physical process. Thus while the ordinary energy density of the cosmos is equal to half that of Hardy's quantum probability of Entanglement *i.e.* $\phi^5/2$ where $\phi=\left(\sqrt{5}-1\right)/2$, the density of cosmic dark energy is consequently one minus ϕ^5 divided by two *i.e.* $\left(5\phi^2\right)/2$. This result is in full agreement with all the numerous previous theoretical predictions as well as being in remarkable agreement with the overwhelming majority of cosmic accurate measurements and observations.

Keywords

Quantum Gravity, Quantum Entanglement, Quantum Disentanglement, E-Infinity Theory, Dark Energy

1. Introduction

Although relatively short we should say from the outset that this paper covers a large part of modern cutting edge research in quantum physics and cosmology [1]-[432]. The work is essentially and mainly motivated by the desire to show more clearly than ever before the deep connection between quantum entanglement [47] [423] and the absence of almost 95.5% of the energy supposed to be contained in our cosmos [290]. We intend to give a short, simple and exact theoretical proof based on the reverse of quantum entanglement with which we mean of course Quantum Disentanglement [1] [2]. In particular we start from Hardy's exact experimentally well-established probability of quantumly entangled of two particles ϕ^5 [22] [26] [28] where $\phi=\left(\sqrt{5}-1\right)/2$ [196] [212] and then reason that the corresponding quantum probability of disentanglement [1] [2] is $5\phi^2$. Subsequently we show that while the ordinary measureable energy density of the cosmos is given by half of Hardy's quantum entanglement, *i.e.* $\phi^2/2$, the corresponding Dark Energy density is given by half of the quantum probability of disentanglement *i.e.* $5\phi^2/2$ [185] [194]. This is all in full agreement with highly accurate cosmic measurement and observations as well as numerous previous derivations [167] [169] [177]. The strategy and details of our analysis will be given in the next two sections.

2. Background Information and Outline of the Paper

Hardy's probability of entanglement is one of the most important exact results in quantum mechanics and was found to be exactly equal to $\phi^5 = 0.9016994393$ for two quantum particles [139] [154]. It is thus an elementary almost trivial step to conclude from this result that the probability of not being quantumly entangled must be $1-\phi^5$ [123] [126] [135]. Subsequently it is not difficult to show that $1-\phi^5$ could be written as $5\phi^2$ [424]. Now remembering that ϕ is the Hausdorff dimension of a Zero set modeled by a one-dimensional random Mauldin-Williams random Cantor set [7], then ϕ^5 could be interpreted as an entropic measure. It follows then that ϕ^5 maybe seen as a five-dimensional entropy from which we could deduce the energy density after multiplication with a dimensional constant. In analogy to the above and knowing that ϕ^2 is the Hausdorff dimension of an empty set modeled by the Cantor set left from the unit interval used in constructing the said Random Mauldin-Williams Cantor set [73] [80], we see that $5\phi^2$ is also a five-dimensional entropy [21]-[29]. The only difference between ϕ^5 and $5\phi^2$ is that the first is multiplicative intersection and represents an entangled state, while $5\phi^2$ is an additive union which represents a disentangled state [26] [248]. In fact even the reader who is not familiar with our previous work on fractal Cantorian spacetime and Dark Energy must have guessed by now that the entanglement probability ϕ^5 would lead to the ordinary measureable energy density of the cosmos [29] [119] [121]

$$\gamma(O) = \phi^5/2 \tag{1}$$

while $5\phi^2$ will lead us to the Dark Energy density of the cosmos which due to this very disentangled nature of $5\phi^2$ cannot be measured in any direct way at least with our present technology [29] [70] [72] [78]

$$\gamma(D) = 5\phi^2/2 \tag{2}$$

Finally it is also not difficult to guess that it will turn out as a surprise which on little reflection is not really a surprise that the dimensional constant needed to move from entropy to energy is given by nothing else but Einstein's marvelous equation

$$E = mc^2 \tag{3}$$

so that at the end we will find from Equation (1) that [39] [62] [65]

$$E(O) = \left(\phi^5/2\right)mc^2 \tag{4}$$

and from Equation (3) we find that

$$E(D) = \left(5\phi^2/2\right)mc^2 \tag{5}$$

In other words Einstein's beauty derived long before quantum mechanics harbored all the time two quantum components namely $E(O)$ and $E(D)$ which when added together give the most famous formula in physics [32] [33]

$$\begin{aligned} E &= E(O)+E(D) \\ &= E(\text{Einstein}) \\ &= mc^2 \end{aligned} \tag{6}$$

3. Analysis and Proof of Ordinary Energy and Dark Energy Theorems

In the following we give in all earnest an embarrassingly short analysis leading to a proof of the following theorems:

Theorem One:

The ordinary energy density of the cosmos is half of Hardy's probability of quantum entanglement

Theorem Two:

The Dark Energy Density of the Cosmos is half of the Hardy type Quantum Probability of disentanglement.

To prove the first Theorem we could do nothing better for the sake of brevity than repeat any of the two dozen or so previous proofs published in numerous papers over the last 4 years [23] [24] [28] However we recommend References [23] [28] and [39] as well as [32].

On the other hand proving Theorem Two becomes trivial because $\phi^5/2$ which we just considered proven is the complement of $5\phi^2$ which we want to prove. In other words proving that Hardy's quantum entanglement ϕ^5 means $\gamma(O)=\phi^5/2$ is automatically a proof that Hardy's disentanglement probability $5\phi^2$ means that the Dark Energy density $\gamma(D)$ is simply [24] [26] [28]

$$\begin{aligned} \gamma(D) &= 1-\phi^5/2 \\ &= 5\phi^5/2 \end{aligned} \tag{7}$$

This is the end of the proof which has the unusual disadvantage of being too simple to believe and we have only to mention the additional obvious insight that $\gamma(O)$ can be measured because it is coherent while $\gamma(D)$ cannot be directly measured and we only infer its existence from the accelerated expansion of the universe because it is disentangled [1] [2]. This is a different view of the same good old particle-wave duality [7]. We recall our earlier conclusion that $\gamma(O)$ is the kinetic energy of the pre-quantum particle modeled by the Zero set while $\gamma(D)$ is the position or potential energy of the quantum wave modeled by the empty set [26] [28]. Now since any interference or measurement on an empty set quantum wave make the set non empty, we have to invite first quantum wave non-demolishing measuring devices before being in a position to measure dark energy directly [23] [26] [28].

4. Zeno's Paradox and Dark Energy

We mentioned on passing in the previous section a distinction between the kinetic energy of the particle and potential energy of the wave [432]. This seems a little odd because it is the quantum wave which is responsible in quantum mechanics for propagation. We have touched on this subject in a recent paper and here we should give a clear cut answer to his contradictory viewpoint [432]. This clear cut answer will resonate century old philosophical problems connected to Zeno's [43] [431] and reflection on the notion that motion is illusion [43]. From the viewpoint of the entire universe motion could be considered an illusion indeed or maybe we should express this in a more conservative way and say that the distinction between kinetic energy and potential energy when it comes to regarding dark energy and the entire universe is fuzzy and fundamentally so [432]. This is easily demonstrated when we realize that in five dimensional unit universe, the largest height must be half the unit radius $(h = 1/2)$ and that the topological acceleration [432] is the down scaling of the topological (Sigalotti) speed of light (ϕ) [344] which means $g = \phi\phi = \phi^2$. Now let us look at Kinetic energy [432]

$$E(K) = \frac{1}{2} m (v \to c)^2 \tag{8}$$

where v is the Velocity and c is the speed of light. Taking m to 3D we find the topological $m = \phi^3$ so that the topological energy becomes

$$\begin{aligned} E_T(K) &= \frac{1}{2}(\phi^3)(\phi^2) \\ &= \phi^5/2 \end{aligned} \tag{9}$$

Next we look at the potential energy [432]

$$E_T(P) = mgh \tag{10}$$

Setting $m = \phi^3$, $g = \phi^2$ and $h = 1/2$ as reasoned earlier on we find

$$\begin{aligned} E_T(P) &= \phi^3\phi^2\, 1/2 \\ &= \phi^5/2 \end{aligned} \tag{11}$$

which is the same formula as $E_T(K)$. Of course this is a fundamentally different fuzzy situation and is not the same as the conservation of Energy Theorem of classical mechanics. To stress this quantum fuzziness when it comes to regarding the entire cosmos and the possibility for a rational resolution of Zeno's paradox [431], let us do the same thing for the "Universe" *i.e.* for $m_T = D = 5$ of the Kaluza-Klein manifold. This would lead to [432]

$$E_T(K) = \frac{1}{2} m_T g = \frac{1}{2} 5\phi^2 \tag{12}$$

which is $\gamma(D)$ of the quantum wave as we though initially should be. However even for the potential energy, we find [432]

$$\begin{aligned} E_T(P) &= mgh \\ &= 5\phi^2/2 \end{aligned} \tag{13}$$

which is the same result [432].

In a sense we could conclude from the above that the most important modern result in the quantum physics is that of Hardy's quantum entanglement probability [21] [23] [28]

$$P(\text{Hardy}) = \phi^5 \tag{14}$$

With that we rest our case at least for the moment.

5. Conclusion

In this paper we have stated two Theorems and proved them. The First Theorem asserts that the measurable ordinary energy density of the cosmos is half that of the Hardy Probability of quantum entanglement. The second Theorem is complimentary to the first and states that the Dark energy density of the cosmos is half the quantum probability of the Hardy disentanglement. In addition we have shown that when regarding the universe as a whole, the sharp distinction between Kinetic energy and Potential energy of classical Newtonian mechanics ceases to be true and we are faced with a fundamentally and irreducibly fuzzy situation.

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