The Quantum Entanglement Roots of Newton's Gravitational Inverse Square Law Via E-Infinity Platonic Transfinite Set Theory

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Abstract- Using the E-infinity Cantorian spacetime formalism, i.e. transfinite platonic set theory, we show that Newton's gravitational inverse square law strictly implies quantum entanglement and visa versa to the extent that they are derivable from each other. Noting that the same inverse square law is quasi generic for electrical and magnetic field the unifying role of the Cantorian spacetime of E-infinity becomes evident. The implication and generalization of the above will be explored but its ramifications within physics and beyond is not easily assessed at this early stage of what may amount to a paradigm shift prompted by the simple but very effective golden mean number system, which was suspected recently of being the rationale behind the fine tuning of the universe and the standard model of high energy elementary particle physics.

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I. Introduction

Newton's famous inverse square law has a long history associated not only with classical mechanics and astronomy [1-2] but also with electricity and magnetism [1-6] and more recently in connection with the issue of hidden large extra dimensions and modified gravity [2-3] which we assume the reader is familiar with for the purpose of a smooth reading of the present relatively short note [1-27]. It is in this larger context of Newton's formula stating that the force of attraction between two planets with m_1 and m_2 masses is proportional to the product (m_1) times (m_2) divided by the square of the distance between the two planets R^2 [1], [6] that we conduct the present investigation and analysis [10-27].

In modern times this formula was stretched to account for even the forces between the atomic constituents of matter [12] and was the basic inspiration for N. Bohr's famous model of the hydrogen atom [4]. Never the less the author must admit that he did not notice for a long time that for natural units where G = 1 it turns out that Newton's square law may be transformed via the noncommutative E-infinity

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methodology to Hardy's famous quantum probability of entanglement [2-3],[9],[11],[26-27]. It is this result which will first be derived and then further examined to see if there are even more surprizing connections lurking behind this unexpected result [5-12],[27].

II. E-Infinity Analysis of Newton's Inverse Square Law Leading to Quantum Entanglement

The reader familiar with E-infinity theory will recall that a pre-quantum particle is fully determined by the bi-dimension [13-14],[22]

$$D(O) = \left(o, \phi \right) \qquad (1)$$

where $\phi = \left(\sqrt{5} - 1 \right) / 2$ is the golden mean, i.e. the zero set while the pre-quantum wave is fixed in an analogous way by [13-14],[22]

$$D(W) \equiv \left(-1, \phi^2 \right) \qquad (2)$$

i.e. the empty set by a simple extrapolation of A. Connes' noncommutative geometry to bear on R. Penrose fractal tiling universe [2-3],[13-14]. Thus while m_1 and m_2 planets are characterized exactly via their mass m_i, the counterpart of m_1 and m_2 in Penrose universe according to equations (1) and (2) must clearly be ϕ_1 and ϕ_2 where we have

$$\phi_1 = \phi_2 = \phi \qquad (3)$$

This is our first analogical correspondence revealed by E-infinity theory. The second correspondence must relate the distance between the planets which is analogous to R [1], [12-14], [22]. In a Penrose fractal tiling universe there is a natural distance which is the isomorphic length [10-11], [13-14]. This isomorphic length is well known to be equal to

$$L = \left(4 + \phi^3 \right) / 2 \qquad (4)$$

However in a five dimensional spacetime entanglement is intersectional and rather than taking the

arithmetic mean of Penrose Hausdorff dimension of E-infinity Cantorian spacetime as given by equation (4) [10-15], we should use instead of that the geometrical mean corresponding to the following equation [1], [14-15]

$$R = \sqrt{4 + \phi^3} \qquad (5)$$

Simple computation shows then that the force of attraction of Newton translates via equations (3) and (5) to [7-15],[22-27]

$$
\begin{aligned}
F(\phi, R) &= \frac{\phi_1 \otimes \phi_2}{R^2} \\
&= \frac{\phi \otimes \phi}{\left(\sqrt{4 + \phi^3}\right)^2} \\
&= \left(\phi^2\right) / \left(\phi^3\right) \\
&= \phi^5 \\
&= \text{Hardy's probability of quantum entanglement}
\end{aligned}
\qquad (6)
$$

By any standard to any open minded thinker this is a marvellous result that made us embrace an interpretation even for the author who likes to think of himself as open minded would have been inclined before deriving equation (6) that such uttering is heresy even for a theoretical physicist let alone a mathematical physicist. The uttering is that Hardy's quantum entanglement is the quantum counterpart analogous to Newton's inverse square law. The next section will try to say more on this and speculate on further generalization of what we considered not long ago to be heresy [7-15].

III. I "Speculate" and thus I "am" a Theoretical Physicist

The above title of this section is meant to join in an informal way to where Descartes cogito left us [16]. Thus in a spiritual version of Descartes-like cogito, let us have a second look at quantum vacuum fluctuation in conjunction with our newly gained 'Theory of Knowledge' exemplified by our finding of the previous section [16].

We established the fact that two pre-quantum particles represented by ϕ and ϕ would produce in intersection an empty set $(\phi) \otimes (\phi) = \phi^2$ pre-quantum wave [13-15]. However the reverse process could be $\phi^2 = (\phi) \otimes (\phi)$ as well as the antiparticle analogue $\phi^2 = (-\phi)(-\phi)$. In addition, following our fundamental convection that we would like to elevate to an axiom dictating that anything that is mathematically consistent will find the corresponding physical reality [17-27] so

that we could have the intersection $(+\phi)(-\phi) = -\phi^2$ which corresponds to a negative empty set that could evade the annihilation on the union side, namely $(+\phi) + (-\phi) = 0$. On the other hand the o is the topological part of the zero set pre-quantum particle given by o, ϕ. It would therefore seem that we need to first do some pretty sophisticated real experiments based on equally sophisticated thoughts experiments before we can understand quantum vacuum fluctuation down to the very nitty gritty minute detail. Going on further in the same direction we could replace ϕ with $\sqrt{\phi}$ and apply the same picture of Newton's inverse square law to find out that [7-14]

$$
\begin{aligned}
F &= \frac{\left(\sqrt{\phi}\right)\left(\sqrt{\phi}\right)}{4 + \phi^3} \\
&= \phi^4
\end{aligned}
\qquad (7)
$$

which we recognize as the E-infinity topological Unruh temperature [13-15]. Similarly we could look at the following mixed F, namely [7-15]

$$
\begin{aligned}
F &= \frac{\left(\phi\right)\left(\phi^2\right)}{4 + \phi^3} \\
&= \phi^4
\end{aligned}
\qquad (8)
$$

which is the Barbero-Immirzi parameter [7-15]. This parameter plays a pivotal role, as is well known, in making superstring theory and loop quantum gravity compatible [7-14]. We can go on and on but we do not want to overwhelm the reader with too much unconventional interpretations and suffice today that we established the incredible analogy between gravitational attractors [1-14] and Hardy's quantum entanglement [10-15]. Needless to mention here, the additional bonus of Newton's non-local attraction is just like quantum entanglement in being non-local [1],[7],[27].

IV. A Brief Outline of E-Infinity Road from Schrödinger to Connes

To discover E-infinity Cantorian spacetime is not an intellectual effort only but a considerable portion of good fortune and luck is definitely instrumental in the processes [1-27]. It is a natural urge to try to look back with great satisfaction and attempt to pinpoint the most important road marks on the way from $E = mc^2$ to $E = mc^2 / 22$ where dividing the iconic equation by 22 causes a stir and even restrained mild anger in some quarters to say the least [2-4],[7-11], [13-15],[17-26]. We mention in the title of this section two names that definitely were the most immediate sources of the main

ideas, namely E. Schrödinger and A. Connes. From Schrödinger we have his enormously important insight that quantization may be seen as an Eigenvalue problem [1]. From Connes we have the indispensible golden mean dimensional function [2-4],[7-27]. However that is only the skeleton of the theory. To give even the caricature of this theory we must add the fractal tiling universe of R. Penrose and adorn it with M. Feignbaum's golden mean renormalization groups and then after, filling in numerous gaps with numerous great, pure and applied mathematicians like K. Menger, P. Urysohn, J. von Neumann, E. Witten, L. Smolin, G. Ord, L. Nottale, D. Gross and G. 'tHooft [17-27] then we start to realize that we have found a theory which may explain all what we thought to be unreasonable fine tuning which is just another name of what some call Spinoza's God [25].

V. Conclusion

Newton's inverse square law seems to be far more fundamental to nature than we personally ever suspected although it is gained from piercing observation of the large scale structure of a classical non-quantum universe. As incredible as it may seem, gravitational attraction and quantum entanglement happens to share the same local topological origin implied by E-infinity, Penrose fractal tiling universe and A. Connes' noncommutative geometry as well as von Neumann's pointless geometry. It is quite conceivable therefore that the golden mean number system is the true universal language of nature to translate classical mechanics to quantum mechanics and visa versa. Only future intensive theoretical and very accurate experimental investigation can show if our theory and predictions are correct and precise in all its details and ramifications.

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