Journal of Quantum Information Science, **2013, 3, 23-26**
http://dx.doi.org/10.4236/jqis.2013.31006 Published Online March 2013 (http://www.scirp.org/journal/jqis)

Scientific Research

A Resolution of Cosmic Dark Energy via a Quantum Entanglement Relativity Theory

Mohamed S. El Naschie
Department of Physics, Faculty of Science, University of Alexandria, Alexandria, Egypt
Email: Chaossf@aol.com

Received January 22, 2013; revised February 26, 2013; accepted March 9, 2013

ABSTRACT

A new quantum gravity formula accurately predicting the actually measured cosmic energy content of the universe is presented. Thus, by fusing Hardy's quantum entanglement and Einstein's energy formula, we have de facto unified relativity and quantum mechanics in a single equation applicable to predicting the energy of the entire universe. In addition, the equation could be seen as a simple scaling of Einstein's celebrated equation $E = mc^2$ when multiplied by a scaling parameter $\gamma = \frac{\phi^5}{2}$, where ϕ^5 is Hardy's quantum entanglement and $\phi = \frac{\sqrt{5}-1}{2}$. Furthermore, $\gamma = \frac{\phi^5}{2} = \frac{1}{22.18033989}$ could be approximated to $\gamma \cong \frac{1}{22}$ and thus may be interpreted as the inverse of the compactified bosonic strings dimension $26 - 4 = 22$.

Keywords: Golden Mean; Quantum Entanglement; Probabilistic Quantum Entanglement; Quantum Relativity Energy Formula

1. Introduction

By way of indirectly equating the fundamental equation of the probability of quantum entanglement with that of Einstein's maximal energy of special relativity, an exact intersection between relativity and quantum mechanics is obtained. The quintessential result of this quantitative intersection is an effective quantum gravity formula relating energy (E) to mass (m) and speed of light (c):

$$E_{QR} = (\gamma_{QR})(mc^2) = \left[\frac{1}{2}\frac{(1-\beta)^2}{1+\beta}\right](mc^2). \tag{1}$$

The formula generalizes Einstein's famous equation $E = mc^2$ via simple multiplication by γ_{QR}. Setting $\beta = 0$ or 3 in $\gamma_{QR} = \left[\frac{1}{2}\frac{(1-\beta)^2}{1+\beta}\right]$ Newton's kinetic energy, $E = (1/2)m(v=c)^2$ is obtained while $\beta = 4+\phi^3$ or $\beta = \phi^3$, where $\phi = 1/2(\sqrt{5}-1)$ leads to Einstein's non quantum but relativistic formula $E = mc^2$. Finally and most importantly, setting $\beta = \phi$ or $\beta = -1/\phi$ in $E_{QR} = (\gamma_{QR})(mc^2) = \frac{1}{2}\frac{(1-\beta)^2}{1+\beta}(mc^2)$, we obtain the effective quantum gravity formula $E_{QR} = \frac{mc^2}{22.18033989} = \frac{\phi^5}{2}mc^2$ where ϕ^5 is the well-known Hardy probability of quantum entanglement. **Figures 1** and **2** summarize the basic assumption and main results of the present analysis.

2. Preliminary Remarks

It is well known that at the esoterically small scale of the Planck length $(l_\rho \sim 10^{-33}\,\text{cm})$, the feeble gravity which can normally be ignored as far as quantum mechanics and the standard model of particle physics is concerned [1-4], becomes important again and comparable in strength to that of the rest of the fundamental forces, *i.e.* electromagnetic force, weak force and strong force [3-9]. On the other hand and as could be reasoned using Witten's T-duality [3,4], at the other extreme of unimaginably large distance comparable to the Hubble radius [6-11] the effect of quantum corrections accumulate (see **Figures 1** and **2**) and relativity could not ignore the quantum [7-9]. In other words the beauty of Einstein's relativity $E = mc^2$ must be a candidate for major overhaul when the quantum mechanical effect of entanglement is taken into account [12,13]. In the present work we develop the

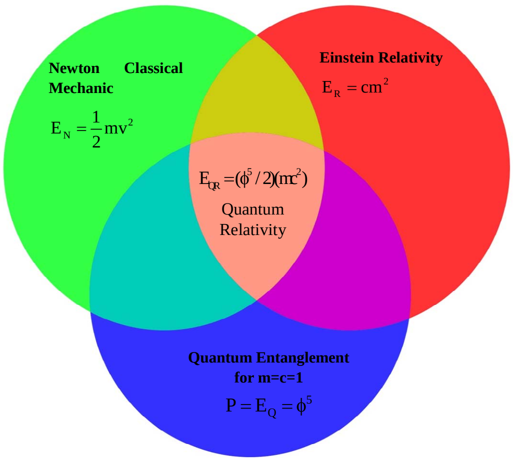

Figure 1. Quantum Relativity theory as an intersection of the three major Fundamental theories of Physics. Note that $\left(\phi^5/2\right)$ $1/22 \cong 0.45$. Consequently E_{QR} predicts 4.5% only of the energy which the classical equation of Einstein $E = mc^2$ predicts. In other words E_{QR} does not contradict the cosmological measurement but rather confirms the data of References [17-19]. This is a clear cut resolution of the mystery of Dark Energy.

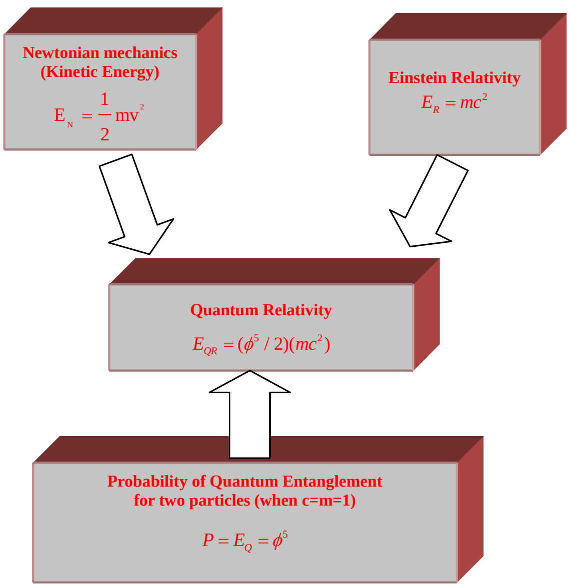

Figure 2. The Effective Quantum Gravity Energy Formula $E_{QR} = \left(\phi^5/2\right)\left(mc^2\right)$ as a synthesis of Newton, Einstein and Quantum Theories. Note that E_{QR}/E (Einstein) ~ 0.045. This agrees with the correct energy content of the cosmos measured by WMAP and the supernova analysis of References [17-19].

preceding basic ideas into an effective theory of quantum gravity leading to a revision of Einstein's $E = mc^2$ to $E_{QR} = \dfrac{mc^2}{22.18033989}$, where the factor $1/22.18033989$ is simply half that of Hardy's probability of quantum entanglement $P = \dfrac{1}{\left(11+\phi^5\right)} = \phi^5$ where $\phi = \dfrac{2}{\left(1+\sqrt{5}\right)}$. In **Figures 1** and **2** our methodology is represented graphically. In other words E according to Einstein overestimates the energy by almost 95.5% in situations where quantum effects play a major role like when considering the mass and energy content of the entire universe [14-20]. Thus the agreement of the energy prediction of the new equation with the sophisticated cosmological measurements of dark matter and dark energy [14] could be regarded as a clear, simple and rational explanation of the missing dark energy of the universe [14-20].

3. Theory

The analysis generalizing $E = mc^2$ of special relativity to quantum relativity [21,22] *i.e.* effective quantum gravity formula $E_{QR} = \left(mc^2\right)/\left(22.1803989\right)$ consists of four main steps. The first is to transform space, time and mass to a probabilistic space, time and mass using quantum mechanics leading to $E_P = \left(P/2\right)mc^2$ where P is a quantum entanglement probability. Second we devise a special form of $E_R = \gamma mc^2$ where γ is a function of a unit interval boost β. Third we equate E_P to E_R and find the exact value of β for which E becomes a maximum. (see **Figures 1** and **2**).

3.1. Probabilistic Quantum Entanglement *E*

In [12] Mermin gives unrivalled lucid derivations and interpretations of quantum non-locality and entanglement of two quantum particles relevant to the movement from a point 1 to a point 2. The probability P of the generic Hardy entanglement [12,13] is given by Equation (10) of [12] as

$$P = \frac{p_1\left(1-p_1\right)p_2\left(1-p_2\right)}{1-p_1p_2} \tag{2}$$

For $p_1 = p_2 = d$ one finds

$$P = d^2\left(\frac{1-d}{1+d}\right). \tag{3}$$

Now we introduce the following probabilistic transformation [21,22]

$$\begin{aligned} &\text{Space}\left(X\right) \to xp \\ &\text{Time}\left(T\right) \to tp \\ &\text{Mass}\left(M\right) \to mp \end{aligned} \tag{4.}$$

Inserting into Newton's kinetic energy one finds the following probabilistic energy for $v \to c$

$$E_P = \frac{1}{2}mp\left(\frac{xp}{tp}\right)^2 = \frac{mp}{2}\left(v \to c\right)^2. \tag{5}$$

That means [12,13]

$$E_P = \frac{1}{2} d^2 \left(\frac{1-d}{1+d} \right) mc^2. \quad (6)$$

3.2. Relativistic *E*

From relativity theory we are familiar with three phenomenological effects namely: 1) time delineation; 2) rod shortening; and 3) mass increase when the velocity v tends to the speed of light c [21,22]. Theoretically all the three effects are beyond doubt while experimentally there is reasonable evidence for the reality of all these effects [21,22].

Now we introduce an unspecified boost $1+\beta$ and anti boost $1-\beta$ in conjunction with the following space, time and mass transformation akin to Lorentz transformation [21-23].

$$\begin{aligned} x &\to x(1-\beta) \\ t &\to t(1+\beta) \\ m &\to m(1+\beta) \end{aligned} \quad (7).$$

Consequently Newton's "Relativistic" kinetic energy becomes

$$E_R = \frac{1}{2} mc^2 (1+\beta) \left(\frac{1-\beta}{1+\beta} \right)^2 = \frac{1}{2} \frac{(1-\beta)^2}{1+\beta} mc^2. \quad (8)$$

3.3. Determining the Magnitude Probabilistic Quantum Entanglement *d* and the Relativistic β

The next step in our strategy to arrive at an effective quantum gravity E is to require that both E_P and E_R be equal (for further elucidation, see **Figures 1** and **2**). That means

$$E_P = E_R \quad (9)$$

Therefore we have

$$\frac{mc^2}{2} d^2 \frac{1-d}{1+d} = \frac{mc^2}{2} \frac{(1-\beta)^2}{1+\beta}. \quad (10)$$

Clearly this is only possible for $d = \beta$ and inserting back in (9) one finds that

$$\beta^2 \frac{1-\beta}{1+\beta} = \frac{(1-\beta)^2}{1+\beta} \quad (11)$$

This leads to a simple quadratic equation

$$\beta^2 + \beta - 1 = 0, \quad (12)$$

with the well known and rather expected solution

$$\beta_1 = \phi, \beta_2 = -\frac{1}{\phi} \quad (13)$$

where $\phi = \frac{\sqrt{5}-1}{2}$ is the golden mean as in the work of Mermin [12] and Styer [13].

3.4. The Quantum Relativity Energy Formula

Now we have reached the fourth and final step to obtain the generalization of $E = mc^2$ to an effective quantum gravity formula by setting $d = \beta = \phi$ in the corresponding expression and find that

$$\begin{aligned} E_{QR} &= \frac{1}{2} \phi^2 \frac{1-\phi}{1+\phi} mc^2 \\ &= \frac{1}{2} (\phi^2)(\phi^3) mc^2 = \frac{\phi^5}{2} mc^2 = \frac{mc^2}{22.18033989} \\ &= (P(\text{quantum entanglement})/2)(mc^2) \end{aligned} \quad (14).$$

4. Discussion, Conclusion and Future Work

Looking closely at our generalization of $E = mc^2$ to $E_{QR} = \frac{mc^2}{22.18033989}$, we notice that the integer approximation

$$E_{QR} \cong mc^2/22 \quad (15)$$

is amenable to different simple interpretations of which we give two obvious ones. Firstly, the factor 22 can be intuitively viewed as what remains of the 26 dimensions of string spacetime of the original bosonic strong interaction theory after subtracting Einstein's 4 dimensions [1,3,4]. Then, the $26 - 4 = 22$ dimensions "dilute" the energy content of the cosmos and reduce it from 100% to $(100/22)\%$ *i.e.* to ~4.5%, in full agreement with the well known cosmological measurement of the three 2011 Nobel Laureates [18,19]. Secondly, we could interpret the factor 22 as the 11 elementary gauge bosons of the standard model not included in Einstein's one photon degree of freedom theory [21-23]. It is well known that the standard model is based on $|SU(3)SU(2)U(1)| = 12$, while in 1905 Einstein knew only one of the 12 namely the photon leaving the rest out in one way or another [21,22]. Adding super-symmetric partners, this leads to (2) (11) = 22. See References [1,3].

There are numerous other intuitive as well as strictly mathematical ways to show that $E_{QR} = \frac{\phi^5}{2} mc^2$ is indeed the correct energy formula that includes both the relativistic as well as the quantum effects in one equation which was analyzed by the present author.

REFERENCES

[1] P. Davies, "The New Physics," Cambridge University

Press, Cambridge, 1989.

[2] P. Halpern, "The Great Beyond: Higher Dimensions, Parallel Universes and the Extraordinary Search for a Theory of Everything," John Wiley & Son Inc., Hoboken, 2004.

[3] R. Penrose, "The Road to Reality," Jonathan Cape, London, 2004.

[4] M. Kaku, "Introduction to Superstrings and M-Theory," Springer, New York, 1999. doi:10.1007/978-1-4612-0543-2

[5] B. Booss-Bavnbek, *et al.*, "New Paths towards Quantum Gravity," Lecture Notes in Physics, Springer, 2010.

[6] B. G. Sidharth, "Frontiers of Fundamental Physics," University Press, Hyderabad, 2007, pp. 1-32.

[7] J. Mageuijo, "Faster than the Speed of Light," William Heinemann, London, 2003.

[8] L. Nottale, "Fractal Space-Time and Microphysics: Towards a Theory of Scale Relativity," World Scientific, Singapore, 1998.

[9] L. Smolin, "Three Roads to Quantum Gravity," Weidenfeld and Nicolson, London, 2000.

[10] P. Steinhardt and N. Turok, "Endless Universe," Weidenfeld and Nicolson, London, 2007.

[11] Y. Baryshev and P. Teerikorpi, "Discovery of Cosmic fractals," World Scientific, New Jersey, 2002.

[12] D. Mermin, "Quantum Mysteries Refined," *American Journal of Physics*, Vol. 62, No. 10, 1994, pp. 880-887. doi:10.1119/1.17733

[13] D. F. Styer, "The Strange World of Quantum Mechanics," Cambridge University Press, Cambridge, 2000, pp. 54-55.

[14] L. Amendola and S. Tsujikawa, "Dark Energy: Theory and Observations," Cambridge University Press, Cambridge, 2010.

[15] R. Panek, "Dark Energy: The Biggest Mystery in the Universe," 2010. http:/www.smithsonianmagazine.com/science.Nature/Dark-Energy

[16] Planck-Spacecraft, "Wikipedia," 2012. http://en.wikipedia.org/wiki/planck

[17] E. Komatsu, *et al.* (WMAP Collaboration), "Seven Years Wilkinson Microwave Anisotropy probe (WMAP) Observations: Cosmological interpretation," *The Astrophysical Journal Supplement Series*, Vol. 192, No. 2, 2011, p. 18. doi:10.1088/0067-0049/192/2/18

[18] A. G. Reiss, *et al.* (Supernova Search Team Collaborations), "Observation Evidence from Supernova for an Accelerating Universe and a Cosmological Constant," *The Astronomical Journal*, Vol. 116, No. 3, 1998, pp. 1009-1038. doi:10.1086/300499

[19] S. Perlmutter, *et al.* (Supernova Cosmology Project Collaboration), "Measurements of Omega and Lambda from 42 High-Redshift Supernova," *The Astronomical Journal*, Vol. 517, No. 2, 1999, pp. 565-585. doi:10.1086/307221

[20] C. Toni, "Dark Matter, Dark Energy and the Fate of Einstein's Theory of Gravity," AMS Graduate Student Blog. Mathgrablog.williams.edu/dark-matter-darkenergy=fate-einsteins-theory=gravity/#print

[21] W. Rindler, "Relativity," Oxford University Press, Oxford, 2001, pp. 111-112.

[22] W. Rindler, "General Relativity before Special Relativity: An Unconventional Overview of Relativity Theory," *American Journal of Physics*, Vol. 62, No. 10, 1994, p. 887.

[23] J. Mageuijo and L. Smolin, "Lorentz Invariance with an Invariant Energy Scale," 18 December 2001, arXiv: hep-th/0112090V2.

