Scientific Research Publishing

Journal of High Energy Physics, Gravitation and Cosmology, 2017, 3, 62-67
http://www.scirp.org/journal/jhepgc
ISSN Online: 2380-4335
ISSN Print: 2380-4327

Examination of *h*(*x*) Real Field of Higgs Boson as Originating in Pre-Planckian Space-Time Early Universe

Andrew Walcott Beckwith

Physics Department, College of Physics, Chongqing University Huxi Campus, Chongqing, China
Email: Rwill9955b@gmail.com, abeckwith@uh.edu

How to cite this paper: Beckwith, A.W. (2017) Examination of *h*(*x*) Real Field of Higgs Boson as Originating in Pre-Planckian Space-Time Early Universe. *Journal of High Energy Physics, Gravitation and Cosmology*, **3**, 62-67.
http://dx.doi.org/10.4236/jhepgc.2017.31009

Received: November 1, 2016
Accepted: December 16, 2016
Published: December 20, 2016

Abstract

We initiate working with Peskin and Schroder's quantum field theory (1995) write up of the Higgs boson, which has a scalar field write up for Phi , with "lower part" of the spinor having *h*(*x*) as a real field, with $\langle h(x) \rangle = 0$ in spatial averaging. Our treatment is to look at the time component of this *h*(*x*) as a real field in Pre-Planckian space-time to Planckian Space-time evolution, in a unitarity gauge specified potential $V(\text{Potential-energy-by-}\Delta h) = -\left(\frac{m_h^{\ 2}}{2}\cdot(\Delta h)^2 + \sqrt{\frac{\lambda}{2}}\cdot m_h(\Delta h)^3 + \frac{\lambda}{4}\cdot(\Delta h)^4\right)$, using a fluctuation evolution equation of the form $\left(\frac{\Delta h}{\Delta t}\right)^2 - \left(\frac{m_h^{\ 2}}{2}\cdot(\Delta h)^2 + \sqrt{\frac{\lambda}{2}}\cdot m_h(\Delta h)^3 + \frac{\lambda}{4}\cdot(\Delta h)^4\right) = \Delta E$ which is in turn using $\Delta E \Delta t \sim \hbar/g_{tt} \sim \hbar/a_{\min}^2 \phi(\inf)$ with this being a modified form of the Heisenberg Uncertainty principle in Pre-Planckian space-time. From here, we can identify the formation of Δh in the Planckian space-time regime. The inflaton is based upon Padmanabhan's treatment of early universe models, in the case that the scale factor, $a \approx a_{\min} t^{\gamma}$ and t a time factor. The initial value of the scale factor is supposed to represent a quantum bounce, along the lines of Camara, de Garcia Maia, Carvalho, and Lima, (2004) as a non zero initial starting point for expansion of the universe, using the ideas of nonlinear electrodynamics (NLED). And from there isolating Δh.

Keywords

Inflaton Physics, Modified HUP, Higgs Boson

1. Introduction

We begin this inquiry with a Higgs Boson scalar field along the lines of [1]

$$\Phi = \frac{U(x)}{\sqrt{2}}\begin{pmatrix} 0 \\ v + h(x) \end{pmatrix} \tag{1}$$

Here, the expression we wish to find is the change in the real field $h(x)$ in time, whereas we have spatially

$$\langle h(x) \rangle = 0 \tag{2}$$

Our supposition is to change, then the evolution of this real field as having an initial popup value in a time Δt, such that

$$h(x) \xrightarrow[\text{Pre-Planckian} \to \text{Planckian}]{} \Delta h(x, \Delta t) \tag{3}$$

The potential field we will be working with, is assuming a unitary gauge for which

$$V(\text{Potential-energy-by-}\Delta h) = -\left(\frac{m_h^{\ 2}}{2} \cdot (\Delta h)^2 + \sqrt{\frac{\lambda}{2}} \cdot m_h (\Delta h)^3 + \frac{\lambda}{4} \cdot (\Delta h)^4 \right) \tag{4}$$

The above, potential energy system, is defined as a minimum by having reference made to [1] Equation (4) as

$$\begin{aligned} &V(\text{Potential-energy-by-}\Delta h) = -\left(\mu^2 \cdot (\Delta h)^2 + \lambda v (\Delta h)^3 + \frac{\lambda}{4} \cdot (\Delta h)^4 \right) \\ &V(\text{Potential-energy-by-}\Delta h)\min \Rightarrow v = \sqrt{\frac{\mu^2}{\lambda}} \end{aligned} \tag{5}$$

And the quantum of the Higgs field, will be ascertained by [1] as having

$$m_h = \sqrt{2}\mu^2 = \sqrt{\frac{\lambda}{2}} v \tag{6}$$

Our abbreviation as to how the real valued Higgs field $h(x)$ behaves is as follows

$$\left(\frac{\Delta h}{\Delta t} \right)^2 - \left(\frac{m_h^{\ 2}}{2} \cdot (\Delta h)^2 + \sqrt{\frac{\lambda}{2}} \cdot m_h (\Delta h)^3 + \frac{\lambda}{4} \cdot (\Delta h)^4 \right) = \Delta E \tag{7}$$

With, if $\phi(\inf)$ is the inflaton, as given by [2] [3], part of the modified Heisenberg U.P., as in [3] with $a_{\min}^2$ specified by [3] [4]

$$\Delta E \Delta t \sim \hbar / g_{tt} \sim \hbar / a_{\min}^2 \phi(\inf) \tag{8}$$

The above eight equations will be what is used in terms of defining the change in the real Higgs field, $h(x)$ in the subsequent work done in this paper. With the inflaton defined via [2] and the energy defined through [5].

$$\phi \approx \sqrt{\frac{\gamma}{4\pi G}} \cdot \ln\left\{ \sqrt{\frac{8\pi G V_0}{\gamma \cdot (3\gamma - 1)}} \cdot t \right\} \tag{9}$$

2. Analyzing Equation (7) and Equation (8) and Equation (9) to Ascertain Δh

We will be using by [2]

$$\begin{aligned} &a \approx a_{\min} t^{\gamma} \\ &\Leftrightarrow \phi \approx \sqrt{\frac{\gamma}{4\pi G}} \cdot \ln\left\{ \sqrt{\frac{8\pi G V_0}{\gamma \cdot (3\gamma - 1)}} \cdot t \right\} \\ &\Leftrightarrow V \approx V_0 \cdot \exp\left\{ -\sqrt{\frac{16\pi G}{\gamma}} \cdot \phi(t) \right\} \end{aligned} \tag{10}$$

Note that the last line of Equation (10) is for the potential of the inflaton. We will be using, the first two lines for Equation (7), Equation (8) and Equation (9) in order to ascertain.

Leading to

$$\frac{\hbar}{a_{\min}^2\left|\sqrt{\frac{\gamma}{4\pi G}}\cdot\ln\left\{\sqrt{\frac{8\pi GV_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t\right\}\right|}+(\Delta h)^2\left(1-\frac{m_h^2(\Delta t)^2}{2}\right)-\left(+\sqrt{\frac{\lambda}{2}}\cdot m_h(\Delta h)^3+\frac{\lambda}{4}\cdot(\Delta h)^4\right)(\Delta t)^2=0 \quad (11)$$

Using the CRC abbreviation of the expansion of the Logarithm factor [6], we have, with H.O.T. higher order terms

$$\phi\approx\sqrt{\frac{\gamma}{4\pi G}}\cdot\ln\left\{\sqrt{\frac{8\pi GV_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t\right\}\sim\sqrt{\frac{\gamma}{4\pi G}}\left\{\left(\sqrt{\frac{8\pi GV_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t\right)-1\right\}+\text{H.O.T.} \quad (12)$$

If we set coefficients in the above so that

$$\left\{\left(\sqrt{\frac{8\pi GV_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t\right)-1\right\}\sim\varepsilon^+;0\le\varepsilon^+\ll 1 \quad (13)$$

Then, Equation (11) takes the form

$$\frac{\hbar\sqrt{\frac{4\pi G}{\gamma}}}{a_{\min}^2\left|\left\{\sqrt{\frac{8\pi GV_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t-1\right\}\right|}+(\Delta h)^2\left(1-\frac{m_h^2(\Delta t)^2}{2}\right)-\left(+\sqrt{\frac{\lambda}{2}}\cdot m_h(\Delta h)^3+\frac{\lambda}{4}\cdot(\Delta h)^4\right)(\Delta t)^2=0 \quad (14)$$

To put it mildly, Equation (11) and Equation (14) are wildly nonlinear Equations for Δh. What we can do to though is comment upon the equation for Δt and also consider what if we consider

$$\left\{\left(\sqrt{\frac{8\pi GV_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t\right)-1\right\}\sim\varepsilon^+;0<\varepsilon^+\ll 1 \quad (15)$$

Equation (14) and Equation (15) lead to a different dynamic as given as to Δh which is commented upon below.

3. What If We Look at a Time Step Δt as Real Valued, Due to Δh?

In doing this we are examining Equation (14) as a way to isolate an equation in Δt and to ascertain what inputs of Δh are effective in giving real value solutions to Δt

We will re write Equation (14) as follows, to get powers of Δt

$$1+a_{\min}^2\frac{\left|\left\{\sqrt{\frac{8\pi GV_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t-1\right\}\right|}{\hbar\sqrt{\frac{4\pi G}{\gamma}}}\left((\Delta h)^2\left(1-\frac{m_h^2(\Delta t)^2}{2}\right)-\left(+\sqrt{\frac{\lambda}{2}}\cdot m_h(\Delta h)^3+\frac{\lambda}{4}\cdot(\Delta h)^4\right)(\Delta t)^2\right)=0 \quad (16)$$

To put it mildly, this will give cubic equation values for Δt and according to [6] only one of the three roots for this would avoid having complex time solutions for Δt. Accordingly, we have come up with an approximation to the energy, ΔE which would be a potential way out of this problem.

4. Using Nonlinear Electrodynamics, for a Value of the ΔE

What we are doing is finding a way to avoid having cubic roots, and worse for the Δh and Δt values. To do this we will make the following approximation based upon [7], namely consider the energy density from a nonlinear Magnetic field, *i.e.* in this case set the E (electric) field as zero, and then

$$\begin{aligned}\Delta E(\text{energy}) &= V(\text{volume})\cdot\rho_{\text{magnetic}} \sim V(\text{volume})\cdot 2^{\beta}\left(B_0^2\right)^{\beta}\tilde{\gamma}a_{\min}^{-4\beta} \\ &\sim l_{\text{Planck}}^3\cdot 2^{\beta}\left(B_0^2\right)^{\beta}|\tilde{\gamma}|a_{\min}^{-4\beta}\end{aligned} \tag{17}$$

The scale factor $a_{\min} \sim 10^{-55}$

Here, we have that the Lagrangian defined by [7]

$$\begin{aligned}&L(\text{Lagrangian}) \sim -|\tilde{\gamma}|\cdot F^{\beta} \\ &F\cdot a^4 = \text{const.} \\ &B(\text{magnetic}) = B_0 a^{-2}\end{aligned} \tag{18}$$

If so then the Equation (7) above, with this input into Equation (7) from Equation (17) will lead to using

$$\Delta E(\text{energy})\Delta t \sim l_{\text{Planck}}^3\cdot 2^{\beta}\left(B_0^2\right)^{\beta}|\tilde{\gamma}|a_{\min}^{-4\beta}\Delta t \sim \hbar/a_{\min}^2\phi(\inf) \tag{19}$$

Then going to put it together

$$\begin{aligned}&(\Delta h)^2\left(1+\frac{m_h^2}{2}+\sqrt{\frac{\lambda}{2}}\cdot m_h(\Delta h)^1+\frac{\lambda}{4}\cdot(\Delta h)^2\right) \\ &= \Delta E(\Delta t)^2 \sim \Delta E(\text{energy})(\Delta t)^2 \sim l_{\text{Planck}}^3\cdot 2^{\beta}\left(B_0^2\right)^{\beta}|\tilde{\gamma}|a_{\min}^{-4\beta}(\Delta t)^2 \\ &\sim \hbar\Delta t/a_{\min}^2\phi(\inf) \sim \frac{\hbar\Delta t}{a_{\min}^2\sqrt{\frac{\gamma}{4\pi G}}\left\{\left(\sqrt{\frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t\right)-1\right\}}\end{aligned} \tag{20}$$

If the right hand side of Equation (20) is chosen to be a constant, it fixes a value for the initial magnetic field which in turn fixes B_0^2 which in turn fixes a value for Δt. Once this fixing of the term Δt occurs, we have then

$$(\Delta h)^2\left(1+\frac{m_h^2}{2}+\sqrt{\frac{\lambda}{2}}\cdot m_h(\Delta h)^1+\frac{\lambda}{4}\cdot(\Delta h)^2\right) \sim \text{const.} \tag{21}$$

Equation (21) in terms of solving for Δh is tractable, in terms of numerical input, depending upon defacto finding a minimum value of Δh which could be obtained by taking the derivative of both sides of Equation (21) to obtain

$$\begin{aligned}&(\Delta h)^2\left(1+\frac{m_h^2}{2}+\sqrt{\frac{\lambda}{2}}\cdot m_h(\Delta h)^1+\frac{\lambda}{4}\cdot(\Delta h)^2\right) \sim \text{const.} \\ &2\Delta h\cdot\left(1+\frac{m_h^2}{2}\right)+3\sqrt{\frac{\lambda}{2}}\cdot m_h(\Delta h)^2+\lambda\cdot(\Delta h)^3 = 0 \\ &\Rightarrow 2\cdot\left(1+\frac{m_h^2}{2}\right)+3\sqrt{\frac{\lambda}{2}}\cdot m_h(\Delta h)+\lambda\cdot(\Delta h)^2 = 0 \\ &\Leftrightarrow \frac{2}{\lambda}\cdot\left(1+\frac{m_h^2}{2}\right)+\sqrt{\frac{9}{2\lambda}}\cdot m_h(\Delta h)+(\Delta h)^2 = 0\end{aligned} \tag{22}$$

It would then be a straightforward matter to take the quadratic equation for Δh

$$(\Delta h)^2 + \sqrt{\frac{9}{2\lambda}} \cdot m_h (\Delta h) + \frac{2}{\lambda} \cdot \left(1 + \frac{m_h^2}{2}\right) = 0 \tag{23}$$

This is assuming that we find a special Δt and an initial configuration of the magnetic field for which we can write

$$\begin{aligned} & l_{\text{Planck}}^3 \cdot 2^\beta \left(B_0^2\right)^\beta |\tilde{\gamma}| a_{\min}^{-4\beta} (\Delta t)^2 \sim \hbar \Delta t / a_{\min}^2 \phi(\inf) \\ & \sim \frac{\hbar \Delta t}{a_{\min}^2 \sqrt{\frac{\gamma}{4\pi G}} \left\{ \left(\sqrt{\frac{8\pi G V_0}{\gamma \cdot (3\gamma - 1)}} \cdot \Delta t \right) - 1 \right\}} = \text{const.} \end{aligned} \tag{24}$$

5. Conclusion: Is NLED, Really That Important Here for *h*(*x*)?

Frankly the answer is that the author does not know. *i.e.* the idea is that NLED would enable the formation of Equation (24) which may be sufficient in the Pre-Planckian to Planckian regime to form Equation (23) which may be in initial configuration a first ever creation of the real valued Higgs field from Pre-Planckian space-time physics considerations.

Like many simple black board experiments, the frank answer is that the author does not know the answer, but finds that the above presented blackboard exercise intriguing and worth sharing with an audience.

The author hopes that additional extensions of this exercise may enable ties in with [8] below.

It is very important to note that in [9] [10] the foundations of nonlinear electrodynamics as outlined for cosmological implications for an initial scale factor less than zero is made a function of electromagnetic fields, and this will undoubtedly with additional study be in tandem with the inflaton physics details as outlined in this text.

Furthermore, in [11], there is a proof that NLED (nonlinear electrodynamics) also is vital for the purpose of black hole physics, to avoid singularities, as well.

We do, indeed, have ample reason to suppose that nonlinear electrodynamics also ties into the $h(x)$ field given and this tie in is part of a general modus operandi we are referencing in this paper.

Acknowledgements

This work is supported in part by National Nature Science Foundation of China grant No. 11375279.

References

[1] Peskin, M. and Schroeder, D. (1995) An Introduction to Quantum Field Theory. Perseus Books, Cambridge, Massachusetts.

[2] Padmanabhan, T. (2005) Understanding Our Universe, Current Status and Open Issues. In: Ashatekar, A., Ed., 100 *Years of Relativity*, *Space-Time Structure*: *Einstein and Beyond*, World Scientific Publishing Co. Pte. Ltd., Singapore, 175-204. http://arxiv.org/abs/gr-qc/0503107

[3] Beckwith, A. (2016) Gedanken Experiment for Refining the Unruh Metric Tensor Uncer-

tainty Principle via Schwarzschild Geometry and Planckian Space-Time with Initial Nonzero Entropy and Applying the Riemannian-Penrose Inequality and Initial Kinetic Energy for a Lower Bound to Graviton Mass (Massive Gravity). *Journal of High Energy Physics, Gravitation and Cosmology*, **2**, 106-124. https://doi.org/10.4236/jhepgc.2016.21012

[4] Camara, C.S., de Garcia Maia, M.R., Carvalho, J.C. and Lima, J.A.S. (2004) Nonsingular FRW Cosmology and Non Linear Dynamics. http://arxiv.org/abs/astro-ph/0402311

[5] Beckwith, A. (2016) Can Thermal Input from a Prior Universe Account for Relic Graviton Production and Imply Usage of the Bogomolnyi Inequality, as a Bridge between Brane World Models and Loop Quantum Gravity in Early Universe Conditions? *Journal of High Energy Physics, Gravitation and Cosmology*, **2**, 412-431. https://doi.org/10.4236/jhepgc.2016.23036

[6] Beyer, W. (1987) CRC Standard Mathematical Tables, 28th Edition, CRC Press, Boca Racon Florida, USA.

[7] Montiel, A., Breton, N. and Salzano, V. (2014) Parameter Estimation of a Nonlinear Magnetic Universe from Observations. *General Relativity and Gravitation*, **46**, 1758.

[8] Poisson, E. and Will, C. (2014) Gravity, Newtonian, Post Newtonian, Relativistic. Cambridge University Press, Cambridge, UK. https://doi.org/10.1017/CBO9781139507486

[9] Corda, C. and Cuesta, H.J.M. (2011) Inflation from R^2 Gravity: A New Approach Using Nonlinear Electrodynamics. *Astroparticle Physics*, **34**, 587-590. https://doi.org/10.1016/j.astropartphys.2010.12.002

[10] De Lorenci, V.A., Klippert, R., Novello, M. and Salim, J.M. (2002) Nonlinear Electrodynamics and FRW Cosmology. *Physical Review D*, **65**, Article ID: 063501. https://doi.org/10.1103/PhysRevD.65.063501

[11] Corda, C. and Cuesta, H.J.M. (2010) Removing Black-Hole Singularities with Nonlinear Electrodynamics. *Modern Physics Letters A*, **25**, 2423-2429. https://arxiv.org/abs/0905.3298 https://doi.org/10.1142/S0217732310033633