Examination of h(x) real field of Higgs Boson as originating in pre planckian space-time early universe

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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 <h(x)>=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= c1 h(x)^2 + C2 h(x)^3 + C3 h(x)^4, using a fluctuation evolution equation of the form (d (delta h)/dt)^2 + V(delta h)= Delta E, which is in turn using (Delta E) times (Delta t) ~ h(bar)/ g(t,t), with this being a modified form of the Heisenberg Uncertainty principle in Pre-Planckian space-time. From here, we can identify the formation of delta h(x) in the Planckian space-time regime. Furthermore, it gets a special dependence upon the change in the metric tensor g(t,t)~(a(t))^2 times (inflaton). The inflaton is based upon Padmanabhan's treatment of early universe models, in the case that the scale factor, a(t) ~ a(initial) times t ^ (beta), with beta a numerical value, and t a time factor. The a(initial) 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 delta h(x)

Key words, 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

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

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

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

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

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

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

Leading to

$$
\frac{\hbar}{a_{\min}^2\left|\sqrt{\frac{\gamma}{4\pi G}}\cdot\ln\left\{\sqrt{\frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t\right\}\right|}+(\Delta h)^2\left(1-\frac{m_h{}^2(\Delta t)^2}{2}\right)-\left(+\sqrt{\frac{\lambda}{2}}\cdot m_h(\Delta h)^3+\frac{\lambda}{4}\cdot(\Delta h)^4\right)(\Delta t)^2=0 \tag{11}
$$

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

$$
\phi \approx \sqrt{\frac{\gamma}{4\pi G}}\cdot\ln\left\{\sqrt{\frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t\right\} \sim \sqrt{\frac{\gamma}{4\pi G}}\left\{\left(\sqrt{\frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t\right)-1\right\}+H.O.T. \tag{12}
$$

If we set coefficients in the above so that

$$
\left\{\left(\sqrt{\frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t\right)-1\right\} \sim \varepsilon^+ ; 0 \le \varepsilon^+ << 1 \tag{13}
$$

Then, Eq. (11) takes the form

$$
\frac{\hbar\sqrt{\frac{4\pi G}{\gamma}}}{a_{\min}^2\left|\left\{\sqrt{\frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t-1\right\}\right|}+(\Delta h)^2\left(1-\frac{m_h{}^2(\Delta t)^2}{2}\right)-\left(+\sqrt{\frac{\lambda}{2}}\cdot m_h(\Delta h)^3+\frac{\lambda}{4}\cdot(\Delta h)^4\right)(\Delta t)^2=0 \tag{14}
$$

To put it mildly, Eq. (11) and Eq. (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

$$\left\{\left(\sqrt{\frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t\right)-1\right\}\sim\varepsilon^{+};0<\varepsilon^{+}<<1 \quad (15)$$

Eq. (14) and Eq. (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 Eq. (14) as a way to isolate a equation in Δt and to ascertain what inputs of Δh are effective in giving real value solutions to Δt

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

$$1+a_{\min}^{2}\frac{\left|\left\{\sqrt{\frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}}\cdot\Delta t-1\right\}\right|}{\hbar\sqrt{\frac{4\pi G}{\gamma}}}\left((\Delta h)^2\left(1-\frac{m_h{}^2(\Delta t)^2}{2}\right)-\left(+\sqrt{\frac{\lambda}{2}}\cdot m_h(\Delta h)^3+\frac{\lambda}{4}\cdot(\Delta h)^4\right)(\Delta t)^2\right)=0 \quad (16)$$

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 Non linear 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

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

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

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

$$\begin{aligned}&L(Lagrangian)\sim-\left|\tilde{\gamma}\right|\cdot F^{\beta}\\&F\cdot a^4=const.\\&B(magnetic)=B_0a^{-2}\end{aligned} \quad (18)$$

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

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

Then going to put it together

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

If the right hand side of Eq. (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

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

Eq. (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 Eq. (21) to obtain

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

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

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

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

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

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 Eq.(24) which may be sufficient in the Pre Planckian to Plackian regime to form Eq.

(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.

6.. **Acknowledgements**

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