Showing Fjortoft's Theorem does not apply for defining instability for early universe potentials. Asking if nucleated particles at/before EW era due to injection of matter-energy at the big bang?

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Abstract. This paper uses the "Fjortoft theorem" for defining necessary conditions for instability. The point is that it does not apply in the vicinity of the big bang. We apply this theorem to what is called by T. Padmanabhan a thermodynamic potential which becomes would be unstable if conditions for the applications of "Fjortoft's theorem" hold. In our case, there is no instability, so a different mechanism has to be appealed to. In the case of vacuum nucleation, we argue that conditions exist for the nucleation of particles as of the electroweak regime. Due to injecting material from a node point, in spacetime. This regime of early universe creation, coexits with the failure of applications of "Fjortoft" theorem in such a way as to give necessary and sufficient conditions for matter creation, in a way similar to the Higgs Boson

1.Introduction

We first start off with a review of the classicial *Fjortoft theorem* [1] and from there apply it to an early universe thermodynamic potential described by T. Padamanabhan [2] in Dice 2010. The objective will be to show that one can come up with a first principle creation of nucleated "particles", likely from a semi classical stand point which can be introducing the creation of mass without appealing directly to the Higgs Boson in the first place. That due to the fact that the Fjortoft theorem does not apply.There is an inflection point for the speed up of acceleration of the universe which exists one billion years ago for reasons which we will introduce in this manuscript. But no such inflection point at the origin of the big bang itsel, or at the electroweak era either.

2 Describing the Fjortoft theorem

From [1] we have that the theorem to be considered should be written up as follows, namely, look at Fjortoft theorem:

A **necessary condition for instability** is that if z_* is a point in spacetime for which $\frac{d^2U}{dz^2}=0$ for any given potential U, then there must be some value z_0 in the range $z_1 < z_0 < z_2$ such that

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$$\left.\frac{d^2U}{dz^2}\right|_{z_0}\cdot\left[U(z_0)-U(z_*)\right]<0 \tag{1}$$

For the proof, see [1] and also consider that the main discussion is to find instability in a physical system which will be described by a given potential U. Next, we will construct in the boundary of the EW era, a way to come up with an optimal description for U

2. Constructing an appropriate potential for using Fjortoft theorem in cosmology for the early universe cannot be done. We show why

To do this, we will look at Padamanabhan [2] and his construction of in Dice 2010 of thermodynamic potentials he used to have another construction of the Einstein GR equations. To start, Padamanabhan [2] wrote

If P_{cd}^{ab} is a so called Lovelock entropy tensor, and T_{ab} a stress energy tensor

$$\begin{aligned}
&U(\eta^a)=-4\cdot P_{ab}^{cd}\nabla_c\eta^a\nabla_d\eta^b+T_{ab}\eta^a\eta^b+\lambda(x)\,g_{ab}\eta^a\eta^b\\
&=U_{gravity}(\eta^a)+U_{matter}(\eta^a)+\lambda(x)\,g_{ab}\eta^a\eta^b\\
&\Leftrightarrow U_{matter}(\eta^a)=T_{ab}\eta^a\eta^b;U_{gravity}(\eta^a)=-4\cdot P_{ab}^{cd}\nabla_c\eta^a\nabla_d\eta^b
\end{aligned} \tag{2}$$

We now will look at

$$\begin{aligned}
&U_{matter}(\eta^a)=T_{ab}\eta^a\eta^b \quad ;\\
&U_{gravity}(\eta^a)=-4\cdot P_{ab}^{cd}\nabla_c\eta^a\nabla_d\eta^b
\end{aligned} \tag{3}$$

So happens that in terms of looking at the partial derivative of the top (2) equation, we are looking at

$$\frac{\partial^2 U}{\partial\left(\eta^a\right)^2}=T_{aa}+\lambda(x)\,g_{aa} \tag{4}$$

Thus, we then will be looking at if there is a specified η_*^a for which the following holds.

$$\frac{\left[\frac{\partial^2 U}{\partial\left(\eta^a\right)^2}=T_{aa}+\lambda(x)\,g_{aa}\right]_{\eta_0^a} *}{\left[\begin{array}{l}-4\cdot P_{ab}^{cd}\left(\nabla_c\eta_0^a\nabla_d\eta_0^b-\nabla_c\eta_*^a\nabla_d\eta_*^b\right)+\\ T_{ab}\cdot\left[\eta_0^a\eta_0^b-\eta_*^a\eta_*^b\right]+\lambda(x)\,g_{ab}\cdot\left[\eta_0^a\eta_0^b-\eta_*^a\eta_*^b\right]\end{array}\right]}<0 \tag{5}$$

What this is saying is that there is no unique point, using this η_*^a for which (5) holds. Therefore, we say there is no official point of **instability of** η_*^a due to (4). The Lagrangian structure of what can be built up by the potentials given in (4) with respect to η_*^a mean that we cannot expect an inflection point with respect to a 2nd derivative of a potential system. Such an inflection point designating a speed up of acceleration due to DE exists a billion years ago [3]. Also note that the reason for the failure for (5) to be congruent to (1) is due to

$$\left[\frac{\partial^2 U}{\partial\left(\eta^a\right)^2}=T_{aa}+\lambda\left(x\right)g_{aa}\right]\neq 0,\ for\,\forall\,\eta_*^a choices \qquad (6)$$

What (6) tells us is that there is an embedding structure for early universe geometry. This embedding structure leads to a different initial space-time regime for how to produce gravitons as given by Beckwith [3], and a situation where massive gravitons so produced will lead to a very different form of template for massive gravitons being produced. Brane structure and non linear equations for the graviton mass as given by Beckwith[3] , for graviton mass m look like, due to embedding structures, where y is defined in [3] to give

$$\frac{(my)^4}{2^2\cdot 2!}\cdot\frac{1}{y}\left[\begin{array}{l}\left(1-\frac{(my)^2}{2^2\cdot 3}+\frac{(my)^4}{2^4\cdot 2!\cdot 3\cdot 4}-\frac{(my)^6}{2^6\cdot 4!\cdot 3\cdot 4\cdot 5}+...\right)\\ -\left(\frac{2\cdot(my)^2}{2^2\cdot 3}+\frac{4\cdot(my)^4}{2^4\cdot 2!\cdot 3\cdot 4}-\frac{6\cdot(my)^6}{2^6\cdot 4!\cdot 3\cdot 4\cdot 5}+...\right)\end{array}\right] \qquad (7)$$
$$=\frac{\delta^+\cdot\exp\left[\mp i\omega t\right]}{A}\cdot\left[1-\frac{\pi}{4}\cdot\left(m\cdot\ell\right)^2\right]$$

This mass expression is usually simplified by having the right hand side of Eq.(7) almost zero. To which we have an almost Bessel function style expansion to solve for graviton mass m. This will lead to conditions given in [3] as far as GW and gravitons which are massive , below.

3. Conclusion, semi classical method of obtaining graviton mass procedure cannot be ruled out , and it impacts relic GW searches

For the semi classical sort of analogy referred to , look at [4] and [5], and [6] , for examples of how quantum artifacts may be obtained via semi classical procedures. Also, let us consider if there is a massive graviton.

First of all, review the details of a massive graviton imprint upon h_{ij}, and then we will review the linkage between that and certain limits upon h. As read from Hinterbichler [7],*if* $r=\sqrt{x_i x_i}$, and we look at a mass induced h_{ij} suppression factor put in of $\exp(-m\cdot r)$, then if

$$h_{00}(x)=\frac{2M}{3M_{Planck}}\cdot\frac{\exp(-m\cdot r)}{4\pi\cdot r} \qquad (8)$$

$$h_{0i}(x)=0 \qquad (9)$$

$$h_{ij}(x)=\left[\frac{M}{3M_{Planck}}\cdot\frac{\exp(-m\cdot r)}{4\pi\cdot r}\right]\cdot \left(\frac{1+m\cdot r+m^2\cdot r^2}{m^2\cdot r^2}\cdot\delta_{ij}-\left[\frac{3+3m\cdot r+m^2\cdot r^2}{m^2\cdot r^4}\right]\cdot x_i\cdot x_j\right) \qquad (10)$$

Here, we have that these h_{ij} values are solutions to the following equation, as given by [3] ,[7], [8], with D a dimensions value put in. D is the dimensions of the geometry

$$\left(\partial^2 - m^2\right) h_{\mu\nu} = -\kappa \cdot \left[T_{uv} - \frac{1}{D-1} \cdot \left(\eta_{uv} - \frac{\partial_\mu \partial_\nu}{m^2} \right) \cdot T \right] \tag{11}$$

To understand the import of the above equations, set use m = $m_{massive-graviton} \sim 10^{-26} eV$ and

$$\begin{aligned} M &= 10^{50} \cdot 10^{-27} g \equiv 10^{23} g \propto 10^{61} - 10^{62} eV \\ M_{Plank} &= 1.22 \times 10^{28} eV \end{aligned} \tag{12}$$

In reviewing what was said about Eq.(11), and Eq.(12) we should keep in mind the overall Fourier decomposition linkage between $h_\bullet, h_{ij}$ which is written up as

$$h_{ij}(t,x;k) = \frac{1}{(2\pi)^{3/2}} \int d^3k \sum_{\bullet=+,\otimes} e^{ik\cdot x} e^{\bullet}_{ij} h_\bullet(t,y;k) \tag{13}$$

The bottom line is that the simple de composition with a basis in two polarization states, of $+,\otimes$ will have to be amended and adjusted, if one is looking at massive graviton states, Having a simple set of polarization states as given by $+,\otimes$ will have to be replaced, mathematically by a different de composition structure, with the limit of massive gravitons approaching zero reducing to the simpler $+,\otimes$ basis states., which could influence giving a semi classical interpretation as to entropy origins of gravity, along the lines stated by Lee [9]. And indirectly is similar to what is brought up by t'Hooft [10] about gravity as semi classical.

Bibliography

[1] U.K J. Pringle and A. King; "Astrophysical Flows," Cambridge University Press, New York, 2007

[2] T. Padmanabhan 2011 J. Phys.: Conf. Ser. 306 01200;"Lessons from Classical Gravity about the Quantum structure of space-time", DICE 2010, editor T. Elze, http://iopscience.iop.org/1742-6596/306/1/012001

[3] A. Beckwith, http://vixra.org/pdf/1207.0077v1.pdf

[4] C.F. Monnin, and G.M. Prok, "Comparison of Gryzinski's and Born's Approximation for Inelastic scattering in Atomic Hydrogen", http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19650017671_1965017671.pdf

[5] M. Gryzinski, "Classical theory of Electronic and Ionic Inelastic Collisions"**Phys Rev** Vol. 115, no2, July 15, 1959, pp 374-383.

[6] A. Beckwith, "Gravitons, Gravitinos, and Using Mach's Principle to Make a Statement of Equivalent Information in a Gravitino-Graviton Correspondence of Critical Information Exchange from Electroweak to Present Era", http://vixra.org/abs/1204.0089

[7] K.Hinterbichler, "Theoretical Aspects of Massive Gravity", http://arxiv.org/abs/1105.3735.pdf

[8] http://web.mit.edu/redingtn/www/netadv/Xgravitati.html

[9] Jae-Weon Lee, *"On the Origin of Entropic Gravity and Inertia"*, http://arxiv.org/abs/1003.4464

[10] G. t' Hooft, "Quantum Mechanics as a dissipative deterministic system" http://arxiv.org/PS_cache/gr-qc/pdf/9903/9903084v3.pdf