Domain Wall Start to "Inflation" with Contributions to Off Diagonal GR Stress Energy Tensor Terms

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Abstract

We represent how an off diagonal representation of stress energy in GR as given by Dodelson can be affected by an axion style domain wall treatment of a stress energy tensor in GR, as given by Kolb and Turner.We argue that this is a way of presenting how domain wall physics may impact graviton production which in turn has, through Dodelson and his off diagonal stress energy terms consequences as to non uniform evolution of space time cosmology. We close with a treatment of axions (a candidate for DM) as impacting GW, and through Dodelson having consequences which we outline at the end of this document. The off diagonal terms of the stress energy tensor $T_{\mu\nu}$ alluded to are allegedly for large scale space-time evolution, but the transition for space-time from the big bang to the Electroweak regime is many thousands of times larger than Planckian space-time, so we argue that the off diagonal relation so used still holds.

1. Introduction

To begin with, we will review what Kolb and Turner suggested for a domain wall treatment for initial stress energy tensor terms in the early universe. This treatment makes use of an 'axion' type of contribution to GR spacetime evolution and we write out a domain wall treatment for a Lagrangian as given by Kolb and Turner [1] , page 214, leading to, in turn an equation of motion for ϕ

$$-\frac{\partial^2\phi}{\partial z^2}+\lambda\cdot\phi\cdot\left(\phi^2-\lambda^2\right)=0 \tag{1}$$

This in turn will lead to an equation for phi, in Eq.(1) which we write as contributing to a Strese energy tensor contribution we give as given by Kolb and Turner as , with z the axis of domain wall evolution, so that the GR expression becomes [1]

$$T_{\nu}^{\mu}=\frac{\lambda}{2}\cdot\sigma^4\cdot\cosh^{-4}\left(z/\Delta\right)diag\left(1,1,1,0\right) \tag{2}$$

This will constitute the pressure term of a stress energy term. Taking the pressure as the negative of 'density' according to the initial inflation condition given as $p=-\rho$ [1]. We will then go to the Visser expression for graviton contributions to the Stress energy Tensor which we will write up as [2]

$$T_{uv}\Big|_{m\neq0}=\left[\left(\frac{\hbar}{l_P^2\lambda_g^2}\right)\cdot\left(\frac{GM}{r}\right)\cdot\exp\left(\frac{r}{\lambda_g}\right)+\left(\frac{GM}{r}\right)^2\right]\times\begin{bmatrix}0&0&0&0\\0&0&0&0\\0&0&0&0\\0&0&0&4\end{bmatrix} \tag{3}$$

In writing up Eq. (3) this way we are treating it as the 'time' component of the GR stress energy tensor, so as to make it in magnitude equal_to the terms in Eq. (2) above, a relationship which we will use to good effect in this document. What we will do is to assume that the massive gravitons in Eq. (3) above have their genesis in the domain wall contributions given in Eq. (2) and from there make some order of magnitude contributions to a change in energy as given by Lee [3], below which will influence how energy is adjusted and affected by entropy production, which for the sake of comparison will be conflated with early universe graviton production. The term M refers to the initial mass of the universe which is enormous. This provides, also for a tie in for graviton production at the onset of DM, which may lead to the dynamics of DE as given by [4]

2. Energy, change in entropy and the creation of early universe gravitons

Lee [3] makes a statement of a change in entropy as given by the following expression

$$m \cdot c^2 = \Delta E = T_U \cdot \Delta S = \frac{\hbar \cdot a}{2\pi \cdot c \cdot k_B} \cdot \Delta S \tag{4}$$

If the mass m, for the initial mass is set to M, as consistent with Eq. (3) above, and $a \sim \frac{c^2}{\Delta x}$ is acceleration (of the net universe) and a change in enthropy between the start of inflation, essentially no entropy, to $\Delta S \sim 10^{50}$ about the electroweak regime, we are essentially buying Ng's [5] counting algorithm approach to entropy, which then says it is necessary to have enormous initial acceleration for the onset of inflation, as well as the following relationship between the terms as we relate them in proportional ratios. Namely let the change in 'x' be conflated with z, in Eq. (2) above, and we then get the following proportionality relationships, namely if z is the distance a domain wall travels up to near the electroweak regime, and [1], [3]

$$\begin{aligned}
&\left|T_\nu^\mu\right| = \frac{\lambda}{2} \cdot \sigma^4 \cdot \cosh^{-4}\left(z / \Delta\right) \sim \\
&\left|T_{uv}\big|_{m\neq 0}\right| = \left[\left(\frac{4\hbar}{l_P^2 \lambda_g^2}\right) \cdot \left(\frac{GM}{z}\right) \cdot \exp\left(\frac{r}{\lambda_g}\right) + 4\left(\frac{GM}{z}\right)^2\right] \sim \\
&\left|\Delta E\right| = T_U \cdot \Delta S = \frac{\hbar \cdot a}{2\pi \cdot c \cdot k_B} \cdot \Delta S
\end{aligned} \tag{5}$$

Note that in Eq. (5) we are assuming following Kolb's convention that the 'axion' domain wall has a thickness given by [1]

$$\Delta \sim \sqrt{\lambda} / \sigma \tag{6}$$

Also, for the σ term for the minimum of the potential term [1]

$$V(\phi) = \frac{\lambda}{4} \cdot \left(\phi^2 - \sigma^2\right)^2 \tag{7}$$

Leads to representing $\sigma^2 \equiv \left(\pm\sqrt{m^2 / \lambda}\right)^2$ with the plus and minus terms representing what to do with assorted maxima and minima values, according to the convention that for when z goes to infinity, that the plus term is picked, and for when z goes to – infinity that the minus term is picked, leading to an energy term of the vacuum being proportional to having vacuum energy equal to mass, and the lamda term as given by Kolb and Turner [1] as:

$$\rho_V = -m^4 / 4\lambda \tag{8}$$

These terms play a role in the subsequent off diagonal stress energy terms we allude to next.

3. Looking at the formation of off diagonal terms for initial GR $T_{\mu\nu}$

To do this, we look at the relation given to us by Dodelson, as to off diagonal $T_{\mu\nu}$ which is given as, by page 168 of Dodelson as [6]:

$$\begin{aligned} &3Ik_I \delta T_I^0 H / k^2 \equiv 3Ik_I \delta T_I^4 H / k^2 = \delta T_0^0 \equiv \delta T_4^4 \\ &\Leftrightarrow 3Ik_I \delta T_I^4 H / k^2 = \delta T_4^4 \propto Vacuum - energy \end{aligned} \tag{9}$$

This means that if $H = \frac{\dot{a}}{a}$ is an early universe Hubble parameter, and k_I derivable from the tensor relationship for GW given by $h_\oplus$ and $h_\otimes$ where we have when

$k^2 \equiv \sum_{I=1}^{4} k_I^2$ that then we have, for the $h_\oplus$ and $h_\otimes$ k_I obeying, if $H = \frac{\dot{a}}{a}$

$$\ddot{h}_\alpha + 2\frac{\dot{a}}{a} \cdot \dot{h}_\alpha + k^2 h_\alpha = 0 \tag{10}$$

This is true for the Fourier transform of space-time x, so that by [6]

$$\ddot{h}_\alpha + 2\frac{\dot{a}}{a}\cdot\dot{h}_\alpha + k^2 h_\alpha = 0 \Rightarrow \frac{\ddot{h}_\alpha}{h_\alpha} + 2\frac{\dot{a}}{a}\cdot\frac{\dot{h}_\alpha}{h_\alpha} = -k^2 \tag{11}$$

Where the significance of Eq.(11) is in that the 'diagonal vacuum energy' given by $\delta T_4^4 \propto Vacuum - energy$ has the opposite sign of the off diagonal δT_I^4 terms. We will comment upon what the sign difference tells us next

4. **Conclusion: Examing what Dodelson's cross term contribution to GR stress-energy say about what Eq.(5) can tell us about inhomogenities in the early universe.**

The opposite signs of the diagonal to off diagonal vacuum energy terms as given by Eq. (9) and Eq. (11) with their scaled dependence, allude to inhomogeneties being inevitable likely well before the CMBR decoupling of photons to shine forth 310 thousand years after the start of inflation. That Eq. (9) with Eq. (11) suggest that there are opposite signs of terms contributing to the variation of vacuum energy space-time, and that this is tied into GW tensors, suggest that turbulence is inevitable, and not a by product of just initial E and B fields in quark - gluon plasmas, as of about the Electroweak era, as implied by Duerrer [7]. More exactly, that a simple model of axion type domain walls, as given by Eq. (1) and Eq. (2) as suggested by Kolb and Turner [1] , with axions another model of DM, suggest this is tied into GW, which may be an emerging dynamic contributing to DE, as suggested by both Beckwith [8] , and Alves, Miranda. and de Araujo [3] . The idea, that if DM is tied into initial axion wall dependence, and an initial DM space-time is inevitably sheared into a DE contribution by the off diagnonal δT_I^4 terms, with I = 1,2,3,4, that the off diagonal terms are the beginning of GW generation, with GW closely linked to a DE style speed up of the universe later on. Also to consider is what δT_I^4 terms contribute to the development of Magueijo style non Gaussian contributions to the CMBR spectra [9]. That will be a later project by the Author. Note that this assumes an early universe infinite quantum statistics counting algorith for gravitons, in lieu of Ng's [5], [10], [11] work which has yet to be experimentally verified.

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