<u>Representing the Massive Graviton in the Metric Tensor</u> $g_{u,v}$

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Abstract

We quantify the $h_{1,0}$, $h_{2,0}$, and $h_{3,0}$ contributions to massive gravitons in the $g_{u,v}$ metric tensor, with $h_{1,0}$ representing (1+1) geometry, and ~ 1/50,000 in magnitude to $h_{3,0}$ of (3+1) geometry. The non vanishing of the $h_{1,0}$ term representing (1+1) geometry contravenes predictions of no relic gravitational waves and makes predictions if the prior universe was a single event a la Steinhardt or a multiverse in the form suggested by Tegmark. I.e. change in the application of $\ddot{\phi} \cong 0$ of inflation. To perhaps $\ddot{\phi} \neq 0$

Introduction

We introduce here how to work with a formulation of the $h_{1,0}$, $h_{2,0}$, and $h_{3,0}$ contributions to massive gravitons in the $g_{u,v}$ metric tensor, with $h_{1,0}$ representing (1+1) geometry, and ~ 1/50,000 in magnitude to $h_{3,0}$ of (3+1) geometry The formulation takes into account that massive gravitons are a direct result of a Lorentz violation, i.e. the terms $h_{1,0}$, $h_{2,0}$, and $h_{3,0}$ do not arise otherwise, and are sensitive to the background magnetic field strength, i.e. the B field as specified by [1] Kahniashbvili and Duerrer as of 10^{-11} Gauss in the CMBR regime cannot exceed 10^{-8} Gauss in the region of the big bang. Also, the $h_{1,0}$ contribution which is 1/50,000 the size of $h_{3,0}$, representing (1+1) geometry is non zero, very small [2] i.e. Mureika and Stojkovic being corrected, with a non zero, tiny GW contribution still present

Forming the $h_{1,0}$, $h_{2,0}$, and $h_{3,0}$ massive graviton contributions

The idea was to mix in work initially done by [3] , i.e. Banerjee and Gavai as to nucleation of 'particles' with the work by Lin [4] as to an emergent electron-positron pair as to form a change in pressure which would be a way to give input into the stress energy tensor . i.e. far within the confines of initial inflation

$$\frac{\Delta F}{T_{crit}} = \int \omega(x)dx \cong \omega(r_{crit}) \cdot r_{crit} \tag{1}$$

Where ΔF is the change in free energy, and T_{crit} is a critical temperature as of about the Planck regime, and $\omega(x)$ is the rate of nucleation of positron-electron pairs in a 'vacuum', due to an applied electric field, and r_{crit} being an initial spatial difference, i.e. the terms in Eq. (1) above reflect equating the rate of nucleation of particles according to a thermodynamic free energy argument, with the left and right hand side of Eq. (1) being influenced by setting $\omega(r_{crit}) = 4\pi\Delta P \cdot r^2 / 3T_{crit}$, with ΔP being a pressure shift.

The pressure change in before and after a phase transition. Now using the values of Lin [2], in $\omega(x)$ for the (3+1), (2+1) and (1+1) geometries, we have then after employing the uncertainty relationship[5]

$$\delta g_{uv} \delta T_{uv} \geq \hbar / V_{3-\dim} \tag{2}$$

$$h_{3,0} = 4\hbar\pi^3 \tilde{\alpha}^2_{crit} \Bigg/ \left[(r_{crit} \cdot T_{crit}) \cdot m^2_{eff} \cdot \sum_{n=1}^{\infty} \frac{\exp[-n\pi\tilde{\alpha}_{crit}]}{n^2} \right] \quad \text{for (3+1) geometry} \tag{3}$$

$$h_{2,0} = 4\hbar\pi^2 \tilde{\alpha}_{crit}^{3/2} \Big/ \left[(r_{crit} \cdot T_{crit}) \cdot m^{3/2}{}_{eff} \cdot \sum_{n=1}^{\infty} \frac{\exp[-n\pi\tilde{\alpha}_{crit}]}{n^{3/2}} \right] \text{ for (2+1) geometry} \quad (4)$$

$$h_{1,0} = 2\hbar\pi \ \alpha \ {}_{crit} \Big/ \left[(r_{crit} \cdot T_{crit}) \cdot m_{eff} \cdot \sum_{n=1}^{\infty} \frac{\exp[-n\pi\alpha_{crit}]}{n} \right] \text{ for (1+1) geometry} \quad (5)$$

Here for (3+1) , and (2+1) geometry, with $\xi = \sqrt{E^2 - B^2} \to eff \cdot B$, i.e. an effective B field applied to an effective graviton mass, so that

$$\tilde{\alpha}_{crit}(3+1) = \tilde{\alpha}_{crit}(2+1) = m_{eff}^2 \big/ |e\xi|, \quad (6)$$

As well as , if $E \to B$ applied to the following 1+1 geometry

$$\alpha_{crit}(1+1) = m_{eff}^2 \big/ |eE| \quad (7)$$

Here, we have that the effective mass is what the graviton would be if it is of the order of 10 to the -62 grams or so. At most increased to 10 to the – 57 grams. With a temperature of at least 10 to the 12 power Kelvin to 10 to the 15 power Kelvin. These temperatures and values can be understood if the effective mass is like a phonon excitation . So being the case, we find that there exist mean values of

$$\begin{aligned} h_{1,0} &= 10^{-5} \pi^{-2} \cdot h_{3,0} \\ h_{2,0} &= 10^{-3} \cdot \pi \cdot h_{3,0} \end{aligned} \quad (8)$$

Also, if $h_{\otimes} \approx h_{\oplus}$ represent the values of the metric tensor due to massless gravitons that

$$h_{3,0} \approx h_{\otimes} \approx h_{\oplus} \quad (9)$$

We can make an argument that a “massive” Graviton is formed due to a Lorentz violation, and that due in part to the argument made by Bjorken [6] in his “ Zeldovitch relationship”, i.e.

$$\frac{4\pi \cdot \gamma \cdot \rho_A}{\sqrt{1+\gamma^2}} \approx 10^{-60} M_{Planck} \approx \left[\Delta_{QCD} \right]^3 \quad (10)$$

Here, we have that the Lorentz violating term has a magnitude due to

$$b_{\mu} = \frac{\eta_{\mu} \cdot 2\pi\rho_A\gamma}{M_{Planck} \cdot \left(1+\gamma^2\right)} \leq 10^{-33} eV \quad (11)$$

Then if there is a Lorentz violating Lagrangian term of [6]

$$L_{Lorentz-Violation} \approx b_{\mu}\bar{\psi}\gamma^{\mu}\gamma_5\psi \quad (12)$$

We make the argument that if we go from QCD energies to, say 10 to the 15 times larger, in Eq (12) that b_{μ} Eq. (12) is 10 to the 45 times larger, leading to a change from 10 to the 9 times too small to well night observable Lorentz violating effects showing up. This is tantamount to having the Hubble parameter changed to being, in the scale factor expansion of $a(t) = a_0 \cdot \exp(Ht) \cong a_0 \approx 0^+$ due to H_{OC} the non Lorentz violating axial density so that if $\rho_A \sim \left[\Delta_{QCD} \right]^3$ becomes , $\rho_A \sim 10^{45} \cdot \left[\Delta_{QCD} \right]^3$. So then

$$H = H_{OC} - \frac{(4\pi\gamma\rho_A)^2}{M_{Planck}^2 \cdot \left(1+\gamma^2\right)} \approx 0^+ \quad (13)$$

The massive increase in $\rho_A \sim 10^{45} \cdot \left[\Delta_{QCD} \right]^3$ pre supposes an active temperature increase. I.e. if so then,

If the temperature for forming $\rho_A \sim 10^{45} \cdot \left[\Delta_{QCD} \right]^3$ is lower than the Planck temperature for a pre universe, it probably lends credence to Tegmarks multi verse [7] as compared with the typical repeating single universe. This even if after the Lorentz violating regime, that for large H_{OC} , So , if

$$H\big|_{after-Lorentz-violation} = H_{OC} - \frac{(4\pi\gamma\rho_A)^2}{M_{Planck}^2 \cdot (1+\gamma^2)} >> 0^+ \quad (14)$$

Then after the Lorentz violating regime that we have, typically

$$\frac{\Delta\rho}{\rho} \sim H\Delta t \sim \frac{H^2}{\dot{\phi}} \sim \left(\frac{m}{M_{Planck}}\right) \times \left(\frac{\phi}{M_{Planck}}\right) \sim 10^{-5} \quad (15)$$

But initially,

$$\left.\frac{\Delta\rho}{\rho}\right|_{Lorentz-violation} \to 0^+ \quad (16)$$

Conclusion, how $h_{1,0} = 10^{-5}\pi^{-2} \cdot h_{3,0}$, due to temperature T initial is leading to discriminating condtions for either a multiverse, or a repeating single universe.

Dr. Li will use the values of Eq. (8) to to find curved space time entries into the Maxwell equation as an extension of his work done in 2003 [8],. We hope that this work will lead to conditions for the formation of experimentally verifiable parameters as to the beginnings of GW astronomy. If temperature T is much less than a Planck temperature, initially, we argue that there is a modification of, also the following equation

$$\frac{\dot{a}}{a} \equiv H \approx -m \cdot \frac{\phi}{3 \cdot \dot{\phi}} \text{, where we assume } \ddot{\phi} \cong 0 \text{ due to inflation} \quad (17)$$

Doing so will lead to improving upon a linkage to SO(4) gauge theory and gravitons as was brought up by [9] Kuchiev, M. Yu, and we think it leads to a kink-anti kink pair tie in for attendant gravitons. This will still be in fidelity to the entropy, s, and also the viscosity η of early universe models done in field theory[10].

$$\left|\frac{\eta}{s} \approx \varepsilon^+\right| << \frac{1}{4\pi} \quad (18)$$

The difference will be in setting an investigation of what happens, if

$$\ddot{\phi} \neq 0 \quad (19)$$

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