Examination of sufficient conditions for forming mass of "massive graviton", from early universe

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Abstract

We start with a formulation of a modified 'Poisson' equation from Poissons and Will from 2014, and then use the Padmanabhan inter relationship between an inflaton and a an early universe potential system. Then from there, we come up with a quadratic equation for a minimum radius, for producing a "massive graviton' value. We then close with observations as to what this implies as to gravitational physics.

Key words, Modified Poisson Equation , massive gravity, inflaton physics.

1. What is important about the modified Poissons equation [1]?

We will first of all refer to two necessary and sufficient conditions for the onset of a massive graviton given in [1], and combined with Padmanablan's reference [2].

I.e. what we will be doing is to re do the reference calculations given in [1] with

$$\left(\nabla^2+\left[\lambda^{-2}=\left(\frac{m_{graviton}c}{\hbar}\right)^2\right]\right)\left[U=\frac{Gm}{r}\cdot\exp\left[\left(-r/\lambda\right)=\left(\frac{r\cdot m_{graviton}c}{\hbar}\right)\right]\right]=-4\pi G\rho \qquad (1)$$

Here, we will be using in the Pre Planckian potential the inputs from the data usually associated with [2]

$$\begin{aligned}&a\approx a_{\min}t^{\gamma}\\&\Leftrightarrow\phi\approx\sqrt{\frac{\gamma}{4\pi G}}\cdot\ln\left\{\sqrt{\frac{8\pi GV_0}{\gamma\cdot(3\gamma-1)}}\cdot t\right\}\\&\Leftrightarrow V\approx V_0\cdot\exp\left\{-\sqrt{\frac{16\pi G}{\gamma}}\cdot\phi(t)\right\}\end{aligned} \qquad (2)$$

In other words, we will be using the inflation given by

$$\phi\approx\sqrt{\frac{\gamma}{4\pi G}}\cdot\ln\left\{\sqrt{\frac{8\pi GV_0}{\gamma\cdot(3\gamma-1)}}\cdot t\right\} \qquad (3)$$

If so, then our approximation is to call the Potential in Eq. (2) to be the same as U in Eq.(1), and then with re arrangements we come up with the following

$$\left[\frac{d^2}{dr^2}+\left(\frac{m_{graviton}c}{\hbar}\right)^2\right]\cdot\left(\frac{r^{-1}\alpha\cdot(3\alpha-1)}{32\pi^2}\right)=G\cdot\rho \qquad (4)$$

Then, after algebra, we have the following

$$\left(m_{graviton}\right)^2\approx\left[\frac{32\pi^2 r\cdot\hbar^2\cdot G\cdot\rho}{c^2\cdot\alpha\cdot(3\alpha-1)}-\frac{16\pi^2 r^{-1}\cdot\hbar^2\cdot G^{-2}}{c^2\cdot\alpha\cdot(3\alpha-1)}\right] \qquad (5)$$

The quadratic Equation this engenders is, how to say

$$\left(m_{graviton}\right)^2 \approx \left[\frac{32\pi^2 r\cdot\hbar^2\cdot G\cdot\rho}{c^2\cdot\alpha\cdot(3\alpha-1)} - \frac{16\pi^2 r^{-1}\cdot\hbar^2\cdot G}{c^2\cdot\alpha\cdot(3\alpha-1)}\right]$$

$$\Rightarrow r^2 - \frac{r\cdot\left(m_{graviton}\right)^2}{\left(\frac{32\pi^2\hbar^2\cdot G\cdot\rho}{c^2\cdot\alpha\cdot(3\alpha-1)}\right)} - \frac{\left(\frac{16\pi^2\cdot\hbar^2\cdot G}{c^2\cdot\alpha\cdot(3\alpha-1)}\right)}{\left(\frac{32\pi^2\hbar^2\cdot G\cdot\rho}{c^2\cdot\alpha\cdot(3\alpha-1)}\right)} \quad (6)$$

$$\doteq r^2 - \frac{r\cdot\left(m_{graviton}\right)^2}{\left(\frac{32\pi^2\hbar^2\cdot G\cdot\rho}{c^2\cdot\alpha\cdot(3\alpha-1)}\right)} - \frac{1}{2\rho} = 0$$

A candidate for the density functional will come next, with the way of obtaining a critical value for r\

II . Density functional inserted into Eq. (6)

In [3] we make the assumption, namely

$$V_{\mathrm{Pr}e-Planckian} \sim \left(\Delta E \sim \frac{\hbar}{\delta t\cdot a_{\min}^2\phi_{\inf}}\right) \quad (7)$$

As far as applications to:[1]

$$r^2 - \frac{r^4\cdot\left(m_{graviton}\right)^2 a_{\min}^2\cdot\delta t\cdot\sqrt{\frac{\gamma}{4\pi G}}\cdot\ln\left\{\sqrt{\frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}}\cdot t\right\}}{\left(\frac{32\pi^2\hbar^2\cdot G}{c^2\cdot\alpha\cdot(3\alpha-1)}\right)} - \frac{r^3 a_{\min}^2\delta t\cdot\sqrt{\frac{\gamma}{4\pi G}}\cdot\ln\left\{\sqrt{\frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}}\cdot t\right\}}{2} = 0 \quad (8)$$

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

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$$r^2 - \frac{r^4 \cdot \left(m_{graviton}\right)^2 a_{\min}^2 \cdot \delta t \cdot \phi}{\left(\dfrac{32\pi^2\hbar^2 \cdot G}{c^2 \cdot \alpha \cdot (3\alpha - 1)}\right)} - \frac{r^3 a_{\min}^2 \delta t \cdot \phi}{2} = 0$$
$$\Rightarrow 1 - \frac{r^2 \cdot \left(m_{graviton}\right)^2 a_{\min}^2 \cdot \delta t \cdot \phi}{\left(\dfrac{32\pi^2\hbar^2 \cdot G}{c^2 \cdot \alpha \cdot (3\alpha - 1)}\right)} - \frac{r \cdot a_{\min}^2 \delta t \cdot \phi}{2} = 0 \tag{9}$$

Then if we are looking at extremely small times in the inflaton, the above becomes

$$1 + \frac{r^2 \cdot \left(m_{graviton}\right)^2 a_{\min}^2 \cdot \delta t \cdot |\phi|}{\left(\dfrac{32\pi^2\hbar^2 \cdot G}{c^2 \cdot \alpha \cdot (3\alpha - 1)}\right)} + \frac{r \cdot a_{\min}^2 \delta t \cdot |\phi|}{2} = 0 \tag{10}$$

Or

$$r^2 + \frac{\left(\dfrac{32\pi^2\hbar^2 \cdot G}{c^2 \cdot \alpha \cdot (3\alpha - 1)}\right)}{\left(m_{graviton}\right)^2} \cdot r + \frac{\left(\dfrac{32\pi^2\hbar^2 \cdot G}{c^2 \cdot \alpha \cdot (3\alpha - 1)}\right)}{\left(m_{graviton}\right)^2 a_{\min}^2 \cdot \delta t \cdot |\phi|} = 0 \tag{11}$$

We claim, that warts and all, this is a first order approximation as to the distance, from the moment of creation, for definitive acquisition for a ‘mass’ to a massive graviton, and it is a definitive restraint.

III. Conclusion. A very strange, not necessarily real valued initial radial condition

Possibly to incorporate some sort of measurement protocol, for Eq. (8) this equation would have to be the absolute magnitude. This has yet to be determined in discussions the author will have with members of the HFGW in Chongqing University. But what is noticeable, is that the inflaton equation as given by Padmanabhan [2] hopefully will not be incommensurate with the physics of the Corda Criteria given in the Gravity’s breath document [4].

$$N_{e-foldings} = -\frac{8\pi}{m_{Planck}^{2}} \cdot \int_{\phi 1}^{\phi 2} \frac{V(\phi)}{\left(\frac{\partial V(\phi)}{\partial \phi}\right)} d\phi \geq 65 \qquad (12)$$

We should also attempt to assure fidelity with Eq. (8) above, in what work we are doing.

6.. Acknowledgements

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Reference

[1] Poisson, E., and Will, C., " Gravity, Newtonian , Post Newtoninan, Relativistic", Cambridge University Press, Cambridge, UK, 2014

[2] Padmanabhan, T., "understanding our universe, current status and open issues", pp 175-204, of 100 Years of Relativity, Space-Time Structure: Einstein and Beyond, Editor, A. Ashatekar, World Scientific Publishing Co. Pte.Ltd, Singapore, Republic of Singapore, 2005; http://arxiv.org/abs/gr-qc/0503107

[3] Beckwith, A. (2016) Gedanken Experiment for Refining the Unruh Metric Tensor Uncertainty 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. doi: 10.4236/jhepgc.2016.21012

[4] . Corda, C. " Gravity's Primordial Breath, " Electronic Journal of Theoretical physics, EJTP 9, No. 26 (2012) 1–10; http://www.ejtp.com/articles/ejtpv9i26p1.pdf

[5] Freese, K. "Natural Inflation", pp 408- 428, of "Particles, Strings, and Cosmology, Northeastern University , March 25-30, 1991, edited by Nath, P., and Recucroft, S. World Scientific Publishing company, Pte. Ltd, Singapore, Republic of Singapore, 1992