REVIEWING THE UNCERTAINTY PRINCIPLE FOR EARLY UNIVERSE CONDITIONS AND GRAVITON MINIMUM MASS

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First of all, we restate a proof of a highly localized special case of a metric tensor uncertainty principle first written up by Unruth. Unruth did not use the Roberson-Walker geometry which we do, and it so happens that the dominant metric tensor we will be examining, is variation in the δg_{tt}. The metric tensor variations given by δg_{rr}, $\delta g_{\theta\theta}$, and $\delta g_{\phi\phi}$ are almost nonexistent, as compared to the δg_{tt} contribution. Afterwards, what is referred to by Barbour as the increment of emergent duration of time δt is extracted from the HUP applied to δg_{tt} in such a way as to give, in the Planckian space-time regime a nonzero minimum non zero lower ground to a massive graviton, $m_{graviton}$.

1.**Introduction**

We will discuss the implications of a non zero smallest scale factor . Secondly the fact we are working with a massive graviton , as given will be given some credence as to when we obtain a lower bound, as will come up in our derivation of modification of the values[1,2,3]

$$\left\langle \left(\delta g_{uv}\right)^2 \left(\hat{T}_{uv}\right)^2 \right\rangle \geq \frac{\hbar^2}{V_{Volume}^2}$$
$$\xrightarrow[uv \to tt]{} \left\langle \left(\delta g_{tt}\right)^2 \left(\hat{T}_{tt}\right)^2 \right\rangle \geq \frac{\hbar^2}{V_{Volume}^2} \tag{1}$$
$$\& \quad \delta g_{rr} \sim \delta g_{\theta\theta} \sim \delta g_{\phi\phi} \sim 0^+$$

The reasons for saying this set of values for the variation of the non g_{tt} metric will be in the next section and it is due to the smallness of the square of the scale factor in the vicinity of Planck time interval.

2.Non zero scale factor, initially. Starting with a configuration from Unruth.

Begin with the starting point of[2]

$$\Delta l \cdot \Delta p \geq \frac{\hbar}{2} \tag{2}$$

We will be using the approximation given by Unruth [2,3], of a generalization we will write as

$$(\Delta l)_{ij} = \frac{\delta g_{ij}}{g_{ij}} \cdot \frac{l}{2} \tag{3}$$
$$(\Delta p)_{ij} = \Delta T_{ij} \cdot \delta t \cdot \Delta A$$

If we use the following, from the Roberson-Walker metric, which have three of the four trivially vanishing

$$\begin{aligned} g_{tt} &= 1 \\ g_{rr} &= \frac{-a^2(t)}{1-k\cdot r^2} \\ g_{\theta\theta} &= -a^2(t)\cdot r^2 \\ g_{\phi\phi} &= -a^2(t)\cdot \sin^2\theta \cdot d\phi^2 \end{aligned} \qquad (4)$$

Following Unruth [2,3] , write then, an uncertainty of metric tensor as, with the following inputs

$$a^2(t) \sim 10^{-110}, r \equiv l_P \sim 10^{-35} meters \qquad (5)$$

Then, the surviving version of Eq. (4) and Eq. (5) is, then, if $\Delta T_{tt} \sim \Delta\rho$

$$\begin{aligned} & V^{(4)} = \delta t \cdot \Delta A \cdot r \\ & \delta g_{tt} \cdot \Delta T_{tt} \cdot \delta t \cdot \Delta A \cdot \frac{r}{2} \geq \frac{\hbar}{2} \\ & \Leftrightarrow \delta g_{tt} \cdot \Delta T_{tt} \geq \frac{\hbar}{V^{(4)}} \end{aligned} \qquad (6)$$

We then relate this to the Barbour "emergent time" structure [4] via, if we are in the sub Planckian to Planckian regime of space time, that

$$(\delta t)^2_{emergent} = \frac{\sum_i m_i l_i \cdot l_i}{2\cdot(E-V)} \rightarrow \frac{m_{graviton} l_P \cdot l_P}{2\cdot(E-V)} \qquad (7)$$

Then,

$$m_{graviton} \geq \frac{2\hbar^2}{(\delta g_{tt})^2 l_P^2} \cdot \frac{(E-V)}{\Delta T_{tt}^2} \qquad (8)$$

And we are examining if the (E-V) part of the numerator may be approximated by the time derivative of the inflaton[5]

$$K.E. \sim (E-V) \sim \dot{\phi}^2 \propto a^{-6} \qquad (9)$$

3.Conclusion: GW generation due to the Thermal output of Plasma burning

We have that the mass of a graviton appears to be bounded below by about 10^-70 grams, As opposed to 10^-62 grams by the upper bound [6]. We hope to get further confirmation of these figures in 2016 . See [7] for more details .

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