Berry Phase for initial “Pre Planckian” space-time?

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Abstract

We look at early universe space-time which is characterized by a transition from Pre Planckian to Planckian space-time. In doing so, we look at, using Crowell’s book, a Berry phase, which in our case is proportional to the area integration of 1 over the square of variation of change in energy. Our variation of the change in energy in this case is due to the Pre Planckian space-time HUP (Heisenberg uncertainty principle). The change in the energy, times change in time, is in this case, is in minimization of the HUP, equal to Planck’s constant divided by the square of the minimum scale factor, times 1 over the initial inflaton value. Our result as derived, gives substance to the supposition that a change in pre Planckian space-time is, indeed a phase transition, in line with work the author has done earlier. And does it in line with the inflaton, as given by Padmanabhan.

Key words, Modified HUP, Berry phase, inflaton.

1. Introduction, what is a Berry phase?

Our definition comes straight from Crowell [1] with a Phase given by

$$\Phi_{berry} = (\hbar \cdot g) \cdot \iint_{area} \frac{d^2 x}{(\Delta E)^2} \qquad (1)$$
$$g \sim (l_{Planck} / L)^2 c$$

II. What do we do to fill in the background for a Berry phase at the start of the expansion of the Universe?

Furthermore, we will be engaging using an inflaton, and a P.E. as given by [2] where

$$a(t) = a_{initial} t^{\gamma}$$
$$V(\phi) = V_0 \exp\left[-\sqrt{\frac{16\pi G}{\gamma}} \cdot \phi \right] \qquad (2)$$
$$\phi(t) = \sqrt{\frac{\gamma}{4\pi G}} \cdot \ln\left[\sqrt{\frac{8GV_0}{\gamma \cdot (3\gamma - 1)}} \cdot t \right]$$

The results of the inflaton, will be used in the HUP which we derive next, from Beckwith, [3]. We will be using the approximation given by Unruh [4, 5], of a generalization we will write as

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

If we use the following, from the Roberson-Walker metric [3] [9].

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

Following Unruh [4, 5], write then, an uncertainty of metric tensor as, with the following inputs

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

(8)

Then, if $\Delta T_{tt} \sim \Delta\rho$

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

This Eq.(6) is such that we can extract, up to a point the HUP principle for uncertainty in time and energy, with one very large caveat added, namely if we use the fluid approximation of space-time [3]

$$T_{ii} = diag(\rho, -p, -p, -p) \qquad (7)$$

\\

Then [3]

$$\Delta T_{tt} \sim \Delta\rho \sim \frac{\Delta E}{V^{(3)}} \qquad (8)$$

Then, Eq. (6) and Eq. (7) and Eq. (8) together yield

$$\begin{aligned} &\delta t \Delta E \geq \frac{\hbar}{\delta g_{tt}} \neq \frac{\hbar}{2} \\ &Unless \quad \delta g_{tt} \sim O(1) \end{aligned} \qquad (9)$$

And we will be using the Giovannini approximation of [6]

$$g_{tt} = \phi \cdot a_{\min}^2 \qquad (10)$$

The upshot is that if one uses the CRC handbook expansion, of the logarithm, [7] that then for up to first order we get the following expression for the Berry phase, at the Pre Planck space-time.

$$\begin{aligned} &\Phi_{berry} = (\hbar \cdot g) \iint_{area} \frac{d^2 x}{(\Delta E)^2} \sim \left(\frac{l_{Planck}^2 c^2 \cdot a_{\min}^2 \cdot (\delta t)^2}{L^4} \right) \left(\frac{4\pi G}{\gamma} \right) \frac{4\pi r_{\min}^2}{\left(\ln\left[\sqrt{\frac{8GV_0}{\gamma \cdot (3\gamma - 1)}} \cdot t \right] \right)^2} \\ &\xrightarrow[\ln\left[\sqrt{\frac{8GV_0}{\gamma \cdot (3\gamma-1)}} \cdot t\right] \sim \varepsilon^+]{} \left(\frac{l_{Planck}^2 c^2 \cdot a_{\min}^2 \cdot (\delta t)^2}{L^4} \right) \left(\frac{4\pi G}{\gamma} \right) \frac{4\pi r_{\min}^2}{\left(\left[\sqrt{\frac{8GV_0}{\gamma \cdot (3\gamma - 1)}} \cdot t \right] - 1 \right)^2} + H.O.T \end{aligned} \qquad (11)$$

III. Conclusion. Filling in the parameters of Eq. (11) and the consequences.

We claim that the consequence of understanding the numerical inputs into Eq. (11) will be to get confirmation of Crowell's [1] formula in his section in Pre Planckian space-time.

$$\left\lfloor x_j , p_i \right\rfloor = -\beta \cdot \left(l_{Planck} / l\right) \cdot \hbar T_{ijk} x_k \xrightarrow[Transition-to-release-of-relic-Gravitational-waves-in-flat-space]{} Planckian-Era-Generated-GW \tag{12}$$

Here, the following inputs into the Pre Planckian regime of space time in Eq. (11) will be of the form

$$\begin{aligned}
& a_{\min} \sim 10^{-55} \\
& r_{\min} \sim 10^{-\beta} l_{Planck}, \\
& 0 < \beta < 10 \\
& 0 < \gamma < 3 \\
& t \sim 10^{-\theta} t_{Planck}, \\
& 0 < \theta < 10 \\
& \delta t \propto 10^{-\theta} t_{Planck} \\
& L \sim r_{\min} \\
& \left[\sqrt{\frac{8GV_0}{\gamma \cdot (3\gamma - 1)}} \cdot t \right] - 1 \approx \varepsilon^{+} \\
& 0 < \varepsilon^{+} << 1
\end{aligned} \tag{13}$$

The upshot of this will be to try to get more definition on the following phase transition

$$\begin{aligned}
& \delta t \Delta E \geq \left. \frac{\hbar}{\delta g_{tt}} \right|_{\Pr e-Octonionic} \xrightarrow[change\ in\ phase,\ given\ byp\ \ phase\ \ \delta_0]{} \delta t \Delta E \geq \hbar \big|_{Octonionic} \\
& with \quad \delta t \geq \frac{\hbar}{\delta g_{tt} \Delta E} FIXED
\end{aligned} \tag{14}$$

In addition, we hope to explain the import of this manuscript as to issues raised in [8, 9, 10, 11, and 12]

Acknowledgements

This work is supported in part by National Nature Science Foundation of China grant No. 11375279

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