

IS TEMPERATURE QUENCHING IN THE EARLY UNIVERSE DUE TO  
PARTICLE PRODUCTION, OR QUANTUM OCCUPATION STATES, OR  
THE INFLUENCE OF QUANTUM TELEPORTATION?

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**Key words:** weak measurements, modified HUP, entropy,  
quantum teleportation

### **Abstract**

We examine the role of particle nucleation in the initial universe, and argue that there is a small effect due to particle nucleation in terms of lowering initial temperature, in tandem with energy density and scale factor contributions. If such scaling exists as a major order effect, then quenching of temperature proportional to a vacuum nucleation at or before the electroweak era is heavily influenced by a number,  $n$ , which is either a quantum number (quantum cosmology) or a 'particle count before the electro weak era. If the supposition is for a particle count, say of gravitons from a prior universe to today's universe, initially, we can compare via a thermodynamic argument compared as to a modified Heisenberg uncertainty principle as to what this says about particle count information, we have a richer cosmological picture to contend with. We close with a speculation as to how a quantum teleportation picture for Pre-Planckian space-time physics may influence our physics discussion.

### **A. Introduction**

We start off with a treatment of entropy initially using Muller and Loustos results [1] as of 2007 as to black hole entropy and entropy of the early universe. Afterwards, we refer to a paper by Crowell [2] as to a treatment of black hole entropy and a partition function argument which we generalize to work with early entropy. In doing so, we also refer to an argument given by Park et al [3] as far as the temperature dependence of the vacuum energy via quintessence (string theory result) to come up with an early universe model as far as how to isolate temperature of the early universe. Once this is done, the next step will be, seeing that this derived temperature, which is decreased by a certain amount depending upon energy, numerical count and other factors while being divided by a time interval to a given power. This relationship as stated establishes the role

which nucleation of particles or essential quanta plays in lowering temperature. Afterwards, the author initiates a discussion as to what role a reinterpretation of the HUP as far as uncertainty may play as far as entropy-temperature dynamics as well as what may initiate the quintessence phenomenon, as alluded to in [3]

### **B. Construction of Temperature quenching. Preliminary argument.**

The main point of the formalism is to establish first order contributions as to the quenching of temperature phenomena. We will set up the initial phenomenological formula for temperature quenching and sequentially explain its constituent parts.

To begin with. Look at how to construct entropy for black holes and the early universe.

Note that for gravity one has, if  $k$  is Boltzmann's constant, and  $N$  the number of Microstates. Note that formula 1 turns to formula 2 if  $N$  is large

$$S = k \ln N \tag{1}$$

Now, by Muller and Luosto [1] as well as Crowell [2] one can write for the early universe:

$$S = kA / 4l_p^2 \tag{2}$$

**B1. What if one looks at a treatment of black holes?**

The area  $A$  is such, that by Crowell [2] we can write this area as, for a black hole of mass  $M$

$$A = 16\pi M^2 \tag{3}$$

For a string theory treatment of black holes we will write [2]

$$A = 16\pi\alpha \sum_{i=1}^N n_i \quad (4)$$

So what is  $\alpha$  ?

If what Ng writes for Quantum infinite statistics [4], [5] is true, then

$$E = \alpha E_p \sqrt{n} \Leftrightarrow \alpha = \frac{1}{2} \frac{\sqrt{\ln 2}}{\pi} \quad (5)$$

B2. Partition function treatment of black holes. [2]

Crowell wrote having a partition function for Black holes defined by

$$Z = \sum_n \exp[4\pi\omega_n] \cdot \exp[-\beta\alpha\sqrt{n}] \quad (6)$$

This was achieved by normal modes for black holes, of mass  $M$  which was of the form [2]

$$\omega_n = \alpha^2 = \frac{\ln 3}{8\pi M} + \frac{i}{4M} \cdot \left( n + \frac{1}{2} \right) + \quad (7)$$

The imaginary component to (7) above is what is not used if one uses the (5) result, which will lead to a bridge to early universe results. We will differentiate between the early universe result and (7) above by keeping fidelity with respect to the early universe, if one is looking at the real component of (7) above, while not looking at the imaginary results. This is in tandem with looking at the full expression of (7) for black holes, with real and imaginary results, while speculating that by way of contrast, if we have only the real part of (7), we are looking at a re do of the Ng entropy result, which would be in tandem with having (6) having no appreciative imaginary component.

How we wish to interpret how to interpret the rise of entropy from a black hole and entropy of the early universe. Note that [1] has an alternative expression for the early universe which can be written as, if  $a$  is the scale factor, of radii  $r_H$  for a horizon radius, with

$$S = \frac{.3r_H^2}{a^2} \quad (8)$$

And [1], [4]

$$r_H = \sqrt{3/\Lambda} \quad (9)$$

Here, the cosmological constant as given by [4] by Park, et al is of the form with T the background temperature, as given by

$$\Lambda \propto T^{\tilde{\beta}} \sqrt{3/\Lambda} \Rightarrow r_H = \sqrt{3/\Lambda} \cong \sqrt{3}T^{-\tilde{\beta}/2} \Rightarrow S \approx .3 \cdot 3T^{-\tilde{\beta}} / a^2 \quad (10)$$

Above almost scales exactly as having the universe with entropy proportional to one over the temperature to the minus beta power times one over the square of the scale factor for early universe conditions.

To make it more revealing, note from [1] that one can write

$$S_{\text{Early-Universe}} \sim 16\pi\alpha^2 n \quad (11)$$

Here also, from [1] we have an energy expression from (5) above, as well as employing the string theory result of

$$\begin{aligned} S_{\text{Early-Universe}} \sim 16\pi\alpha^2 n \sim T^{-\tilde{\beta}} / a^2 \Rightarrow T^{-\tilde{\beta}} \propto 16\pi\alpha^2 na^2 \\ \Rightarrow T \approx \frac{1}{(16\pi\alpha^2 na^2)^\beta} \end{aligned} \quad (12)$$

Assuming we have a condition for which  $\alpha$  is in a short period of time a constant in the early universe and that we have for H the initial Hubble expansion parameter, and the time, then if what is below, is

$$a \sim a_0 \exp(H \cdot t) \sim a_0 (\text{Planck} - \text{time}) \quad (13)$$

Then in the regime of Planck time we are looking at

$$T \approx \frac{1}{(16\pi\alpha^2 na^2)^\beta} \sim \left[ \frac{(1 - H \cdot t)^{\tilde{\beta}}}{a_0^{\tilde{\beta}}} \right] \cdot \frac{1}{n^{\tilde{\beta}}} \propto \frac{1}{n^{\tilde{\beta}}} \quad (14)$$

The proportionality of temperature, T, in the Planck time regime is saying that as n is “nucleated” or created, that the temperature scales down. Note

that beyond the Planck interval of time, one will be beginning to look at a time dependence, according to the coefficient  $\left[ \frac{(1 - H \cdot t)^{\tilde{\beta}}}{a_0^{\tilde{\beta}}} \right]$  with H a constant. Before then the dominant effect of scaling down will be on the creation of  $\frac{1}{n^{\tilde{\beta}}}$  contributions to dropping of the temperature.

### C. Conclusion. Looking at Arguments as to applying Eq. (14) near the big bang

Equation (14) is, if Stoica is correct about there being no cataclysmic real break with physics at the beginning of the big bang [6] and if Beckwith is also correct in saying a string theory embedding of the initial cosmic singularity is mandatory [6], saying something very profound. Note that Beckwith earlier [7] wrote that earlier, that

*“The main problem as the author sees it, is insuring the existence of disjoint sets at a point of space-time. If one views a finite, infinitely small region of space-time, as given by Plank’s interval as 1.616 times 10<sup>-35</sup> meters as contravening a space-time singularity, in relativity, then even in this incredibly small length, there can be disjoint sets, and then the math construction of Surya [8] goes through verbatim. Classical relativity theory though does not have a Planck interval, i.e. the singularity of space-time, so in effect in General relativity in its classical form will not have the construction (...). [6] written by Cristi Stoica gives a view of a beginning of space-time starting that does away completely with the space-time singularity, so mathematically, in a cosmos as constructed, if there is no singularity problem, there is then no restriction as to the collapse of space-time to an infinitely small point. In which then there would be no reason to appeal to a Planck’s length graininess of space-time to enforce some rationality in the behavior of (quantum?) cosmology.”*

The existence of n can be as given by [1] also predicated upon

$$n = \sum_{i=1}^N n_i \quad (15)$$

**The problem with Eq. (15) above can be states simply in that one does not have a finite basis in a point of space time [1], [7].** As in the argument by Beckwith [7]

*In essence, for making a consistent cosmology, our results argue in favor of a string theory style embedding of the start of inflation and what we have argued so far is indicating how typical four-dimensional cosmologies have serious mathematical measure theoretic problems. This quantum measure theoretic problem are unphysical especially in light of the Stoica findings [6]*

Temperature scaling initially at the start of a big bang, according to (14) then raises the issue of where did the ‘information’ for Eq. (15) come from? We guess it is from the embedding structure alluded to by Beckwith in [7]. The main issue to clarify in future research is, if Eq. (15) is due to occupation numbers of early variants of particle production, or are an artifact of quantum states in the guise of the SHO, damped or otherwise as is seen in elementary physics quantum texts worldwide.

Finally, it is useful to consider if a magnetically generated early universe value gravitational constant is possible, as given by Sanchez, [9] may play a role , i.e. does G change from the initial conditions to the universe, or is invariant? A changing G, may in fact alter particle production from Planckian to post-Planckian domain physics. We have in [9] conditions for calculating a Gravitational constant as given by electromagnetic forces, and if a magnetic field, as given by [10], with a specific value of the magnetic field could set an initial value for the gravitational constant,

If gravitational constant, G, instead of being sent by an early universe magnetic field as given by [9] remains invariant, with no variation of G, ensuring, due to [11] there also is the issue of the type of Heisenberg Uncertainty principle is applied.

I.e. as given in [11]

$$\Delta E \Delta t \geq \frac{\hbar}{g_{tt}} \tag{16}$$

$$\& g_{tt} = a_{\min}^2 \phi_{\text{initial-inf}}$$

With a convenient treatment of [12]

$$\begin{aligned}
a &\approx a_{\min} t^\gamma \\
\Leftrightarrow \phi &\approx \sqrt{\frac{\gamma}{4\pi G}} \cdot \ln \left\{ \sqrt{\frac{8\pi G V_0}{\gamma \cdot (3\gamma - 1)}} \cdot t \right\} \\
\Leftrightarrow V &\approx V_0 \cdot \exp \left\{ -\sqrt{\frac{16\pi G}{\gamma}} \cdot \phi(t) \right\}
\end{aligned} \tag{17}$$

This could, in the minimum radii expected by a quantum induced scale factor,  $a_{\min}$  [13, 14], as well as the details of [15] as to how to form  $g_{tt}$ , lead to in time to, if we take the minimum uncertainty given by Eq. Eq. (16) lead to making the following equivalence, i.e.

$$\begin{aligned}
\Delta E &\approx \frac{\hbar}{g_{tt} \Delta t} \approx \frac{k_B}{2} \cdot T_{\text{initial}} \\
\Leftrightarrow T_{\text{initial}} (\text{initial} - \text{temperature}) &\approx \frac{2\hbar}{k_B \cdot g_{tt} \cdot \Delta t}
\end{aligned} \tag{18}$$

Comparing this Eq. (18) with Eq. (12) and picking  $\Delta t$  say of the order of Planck time may indeed add more structure as to this problem.

Finally, we should note that we need to give more evaluation as to why [16] by Penrose is disregarded. i.e. our answer is in use of [13,14] but we need to show rigorously that the Penrose singularity theorem is not possible to implement here, and why. Our hope is that the presumed existence of initial magnetic fields as given in [15] will be important.

As to our results they cannot in the end contravene [17, 18,19,20], i.e. Corda did foundational work on the inflaton, in Gravity's breath, which should ultimately play a role in the comparison of Eq. (12) and Eq. (18). Reference [18] in addition is a constraint as to known inflationary expansion which would also affect the suppositions as to the inflaton, i.e. as given by Freeze. In addition if the particle count so referenced is due to gravitons, in Eq. (12) and Eq. (18) we cannot contravene gravitational physics as given by [19, 20]

We then can close with [21, 22]. I.e. Corda's treatment of if scalar – tensor gravity is indicated here, or General relativity is decisively important. Secondly, the magnitude of Planckian space-time to positive energy states, by the mechanism discussed in [22], with the magnitude of this energy switch given by Eq. (18),

I.e. the audacity of the idea of this energy shift, as given in Eq. (18) could be in fact set by a switch from initial low negative energy values to positive energy at the Planckian boundary.]

One of the weirder consequences of teleportation say from a prior to a present universe, could be the existence of negative energy states which get switched at the boundary of Planckian space-time, to a positive energy value, which would in turn give impetus to the idea of the initial temperature,  $T$ , as in Eq. (18) being of the Planckian space-time temperature regime [15, 23]

This is now speculation with the author wishes to make more substantial in future publications.

Note that some of the physics as given in [24] may be relevant toward our discussion of appropriate time lengths, as given in our comparison of Eq.; (12) and Eq. (18)

### **Acknowledgements**

The author is indebted to Johnathan Dickau for cogent advice as to refocusing of the document [7] onto topological themes which are vital, to understand the difference between four and five-dimensional space-time geometry.

The temperature scaling themes of Eq. (14) and by extension Eq. (15) are extensions of the same issue, albeit from a different perspective.

The author also thanks another friend who wishes to be unnamed for making him aware of reference [22] as to the astounding implications of negative energy states, as a result of quantum teleportation. This is a venue on a Pre Planckian to Planckian regime of space-time in conjunction with the change in energy as brought up in Eq. (18) with a presumed initial negative energy states, as far as teleportation, which may be a link between a prior to a present universe, and also account for the sheer magnitude of the temperatures which may ensue.

This detail, of course will need further work, but the author is grateful for the introduction by Angleton of this very informative document which the author thinks is crucial to early Pre Planckian to Planckian physics.

This work is supported in part by National Nature Science Foundation of China grant No. **11075224**

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