The Cosmic Microwave Background

### Measure

<table>
<thead>
<tr>
<th>Measure</th>
<th>Measurement Data</th>
<th>MQ Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMB Age: $A_0$</td>
<td>378,000 years</td>
<td>363,309 years</td>
</tr>
<tr>
<td>Mass Equivalent: $M_{tot}$</td>
<td>$-$ kg</td>
<td>1.50159 $10^{30}$ kg</td>
</tr>
<tr>
<td>Density: $\rho$</td>
<td>$4.005 \times 10^{-14}$ J m$^{-3}$</td>
<td>$4.17041 \times 10^{-14}$ J m$^{-3}$</td>
</tr>
<tr>
<td>Temperature: $T$</td>
<td>$2.72548 +/- 0.00057$ K</td>
<td>$2.72468$ K</td>
</tr>
</tbody>
</table>

### Discussion

An understanding of those events making up the quantum inflationary epoch and the trigger event that ends this period and initiates expansion is strongly correlated to the principles of Measurement Quantization (MQ) \cite{(3),sec 2.3} and the physical support on which it stands \cite{(4),sec 11}. As such, we should briefly review what MQ is and the physical evidence that supports the approach.

Firstly, MQ is a nomenclature applied to existing expressions in modern theory. Terms that make up expressions are each broken down into their fundamental measures \cite{(5),Eqns 67-79} – $I_p$, $m_f$ and $t_f$ - and multiplied by a count of those measures - $n_p$, $n_{mf}$ and $n_{tf}$ By example, when applying MQ to an analysis of Heisenberg’s uncertainty principle \cite{(4),Eqns 6-10} we find that all the measure terms drop out of the expression leaving only the count terms. From this we are able to resolve the values of the count terms \cite{(4),sec 11} and the values of the fundamental measures \cite{(5),Eqns 67-79}. We are also able to resolve three properties of measure: discreteness, countability and in reference to the three frames of reference \cite{(4),sec 11}.

The first historical insight into the geometry of an observer/target system came with Einstein’s introduction of those expressions we identify as relativity. That is to emphasize, the geometry of a spatial system defines its physical characteristics with respect to the observer. While the principles of relatively are broadly accepted in the community, the physical foundation on which they stand are somewhat less understood.

MQ identifies the quantum properties of measure \cite{(4),sec 11} and in turn allow us to precisely define why geometry is so essential in describing the physical characteristics of observed phenomena \cite{(2),Eqns 28, 30 & 31}.

At this juncture, we refer the reader to several articles that provide a greater explanation of MQ, notably the initial analysis of Heisenberg’s uncertainty principle \cite{(4),Eqns 6-10} which identifies three properties of measure. We also highlight articles on the fundamental measures \cite{(5),Eqns 67-79}, bounds to measure \cite{(3),Eqns 15-17}, quantum gravity \cite{(4),Eqns 29-33} and the Schwatz and Harris quantum entanglement experiments \cite{(4),Eqns 56, 70 & 91}.

Collectively, these articles will help establish a foundation of physical significance for MQ and why spatial referencing is so important to the early years of our universe.

### Terms

- $R_U$ is the radius of the universe.
- $A_0$ is the age of the universe.
- $A_{ref}$ is the dilated age of the universe as measured from our point of view inside an expanding universe.
- $M_{tot}$ is all the mass in the universe.
- $\rho$ is the energy density of mass/energy accumulated at a given age of the universe.
- $a$ is the total energy radiated as described with respect to blackbody radiation (i.e. the Stefan-Boltzmann law).
- $\sigma$ is the radiation constant.
- $T$ is the temperature of the Cosmic Microwave Background.

### Inputs

- $\theta_{fi}$ is 3.26239 radians or kg m/s (momentum) or no units at all a function of the chosen frame of reference. This is a new constant to modern theory and exists in nearly every equation of the model. It may be measured macroscopically given specific Bell states necessary for quantum entanglement of X-rays such as those carried out by Shwartz and Harris.
- $I_p$, $m_f$ and $t_f$ are effectively Planck’s Units for length, mass and time, but not precisely the same. In MQ we recognize them as the fundamental units.
- $n_{mf}$ is a count of $t_f$ equal to the age of the universe.
- $\sigma$ is the radiation constant.
- $k_B$ is the Stefan-Boltzmann constant.
- $c$ is the speed of light which may also be written as $c=\text{f}_p=299,792,458$ m/s.
- $h$ is Planck’s constant adjusted to reflect the quantum effects of the informativity differential.
Thus, upon this foundation we immediately launch into a quality of the early universe that without MQ goes unnoticed in modern theory. That is, the very first moments of the universe cannot expand at the speed-of-light because a quantum bubble with a radius of 1 or 2 units of $l_f$ is unable to reference a point outside of the bubble\(^{(2,p. 23)}\). The whole-unit measure of distance (i.e. the hypotenuse—1.414—of a triangle with remaining sides 1 and 1) has a value closer to one than two and as such rounds down. Thus, from no point within the bubble can a reference to a point outside of the bubble be made. This constrains the rate of inflation to\(^{(1, Eq. 1.50)}\)

\[
V_1 = \frac{2l_f}{\Theta^2 A_c^2}
\]

Not until the universe reaches a radius equal to the square root of three $l_f$ specifically\(^{(2, Eqs. 98-99)}\)

\[
\sqrt{a^2 + b^2} = \sqrt{a^2 + \sqrt{a^2 + b^2}^2} = \\
\sqrt{a^2 + a^2 + b^2} = \sqrt{1^2 + 1^2 + 1^2} = \sqrt{3}
\]

can the universe reference an external point. At that time, $A_u=363,309$ years\(^{(2, Eq. 87)}\), the universe begins expanding at the speed-of-light.

One might also note that the square root of five rounds down and as such the expansion of the universe should halt. But once the universe has reached that size, there are now new points in the internal space that will always be a distance of square root of three $l_f$ from the edge, thus allowing the universe to continue to expand at the speed-of-light\(^{(2,p. 23)}\). Using the square root of three trigger point, the quantity, age, density and temperature of the CMB may each be calculated\(^{(2, Sec. 3.10)}\) constrained by the mass/energy accumulated\(^{(1, Eq. 1.50)}\) to that point in time. Further, because the maximum density of baryonic mass\(^{(2, Eq. 70)}\) may not exceed a maximum density of two units of $m_f$ per unit of $l_f$

\[
n_{sf} > 2n_{sf}.
\]

there is support for radiation as the most likely candidate form of the accumulated mass. Taken together, the quantity, density and temperature may then be resolved (see calculations above)\(^{(1, Sec. 3.15)}\).

Notably, measurement data for the CMB has had some variation over the last ten years. In an effort to resolve a best fit result, a study by Fixsen considers the data and resolves a cumulative value to four significant digits with variation in the fifth and sixth. It is this study that we find the calculations above match to four significant digits. In the published literature, Informativity is the first model to present an unfitted calculation of the age and quantity of the CMB\(^{(2, Sec. 3.15)}\)

**Experimental Support—Inflation & the CMB**

A study of temperature measurements of the CMB literature was published by D.J. Fixsen in November of 2009.\(^1\) He found that the best measure of temperature corresponded to a value of 2.72548 +/- 0.00057 K. The study supports the Informativity expressions to four significant digits.