A model dimensioning the space-time by parametric down-conversion

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Abstract

It was assumed that primordial energy could be described as a wave function. A simulation using parametric down-conversion which increments the number of photons, but at a longer wavelength, allows to show a natural unfolding of the space-time. The process, from the Planck energy limit to the present Cosmic Microwave Background radiation (CMB), could be described as a gradient or continuum. In this, the length of the primordial wave, the number of photons and the associated time double 107 times. Thus, allowing the natural surging of parameters for time and wavelength of localization which could be added to the usual time-energy or temperature axis. Cosmic volume grows naturally as a function of multiplying the continuous increments in volume of localization by that of photon number. The end of Inflation corresponds to the time of localization needed for the change of phase involved in scission of forces.

The simulation initiates at the joint Planck localization volumes instead that at a singularity

The parameters of the changing space-time during the Inflationary Era are described using a different model than the positive vacuum mechanism of Guth et al [1, 2, 3, 4] and Linde [5, 6, 7, 8, 9]. One of the major objections to the presence of a singularity at the initiation of the Big-Bang [10, 11] is that conceptually it should be described as a dimensionless point. The problematic resulting from a physical description of the universe initiated from a non-dimensional geometry with matter at infinite density was an incentive for the development of alternative hypothesis like String Theory [12]. To overcome these objections it was inferred that primordial energy could be conceptualized as a radiation that even if not yet characterized its evolution could be described in terms of wave functions.

There is not a theoretical limit to how high could be the frequency of a radiation; the simulation starts at the initial energy quanta the Planck energy limit $1.22x10^{22}$ MeV. This allows that the number of primordial photons, required to reach the energy equivalent to the critical mass, could be confined [13] in a very small but still tri-dimensional space. Accordingly, a radiation of ultra-high frequency could emanate from confinement [14] within space restrictions which would not hold the kinetic energy required for baryonic particles to reach the temperature needed to start the hot Big-Bang [15, 16].

Anton Zeilinger [17] and Y. S. Lee [18] showed that the ultra-violet laser incidence on a non-lineal crystal through the process of parametric down-conversion from high to lower energy photons, allows each photon to divide into two of longer wavelengths. The individual photons energy is inversely proportional to their wavelength. The simulation correlates the evolution of cosmic energy by the increase in the number of photons and their wavelength increment.

Radiation temperature and radiation energy are equivalents, but the simulation uses units of energy rather of temperature because the latter, conceptually could be related to the kinetic energy of matter. The latter plays the initial role in the hot big-bang whereas the simulation assumes that primordial energy could be regarded as a mass-less intertwined complex of strong, weak and electromagnetic forces. Even if is not fully characterized, primordial energy could fit the description of electromagnetic radiation through its treatment as a wave function which shows that the possibility to find an energy quanta in a given space-time parameter is a function of the square of its amplitude.

Accordingly, a time-temperature parameter could configure only a thermodynamic arrow, whereas a wave function not only provides this arrow, but also allows associating amplitude increases to quantum mechanics description. The increase in wave amplitude decreases the probability density that could be attributed to a single energy quantum. However, if the individual wave functions are expressed as interconnected as a train of continuously decreasing energy and concomitant wave amplitude increment, it configures a probability arrow. If such thermodynamic entity is described as a continuum [[18]], it would have a thermodynamic tendency to irreversibility [[19, 20, 21]]. Hence, if cosmic evolution could be described as the continuum, individual photons and matter particles would show the characteristic quantum mechanics behavior of individual energy quanta. However, the expanding of primordial energy would create a decreasing probability arrow that would integrate causality into the relationship of coupling between time-dependent thermodynamic events [[22, 23, 24]].

Electro-magnetic energy itself subject to gravity, by its elongation from smaller to larger wave localization dimensions oppose the force of gravity. This propagation will appear as an arrow of time [[25, 26, 27]] and of space expansion. On the other hand, since the volume of localization of particles bearing mass could not evolve from smaller to larger values, as waves do, would only be able to oppose expansion through their mutual gravitational attraction.

Simulation parameters

Assuming that primordial energy in the form of energy packets is not subject to interactions at the initial stages of the cosmos, it could be discussed according to the solution of Schrödinger's equation for a harmonic oscillation known as a wave function $\Psi(x)$: $\Psi(x) = \mathrm{A}\cos(kx - \omega t + \varphi)$.

Where A is the maximum amplitude of the function; k is the number of wave; w is the angular frequency; is the phase of the movement; and x and t are the spatial and the temporary variables. This approach allows that, independently of the lack of characterization of primordial energy, this one could be described in terms of frequency evolution.

Hence, time of localization and volume (space) of localization, emerge naturally. Wavelength is the space or distance for the wave function between two peaks. The wave amplitude could increase as the wave propagates. A time dependent cosmic relationships with quantum mechanics are reflected in that the probability to find the particle in an interval x, x+dx is the square of the module of the wave function $|\psi(x)|^2 dx$, which integrated is: $\int_{-\infty}^{\infty} |\psi(x)|^2 dx = 1$.

Then, the probability per unit of length (or probability density) to find the particle in x is $|\psi(x)|^2$ and is related to the square of the wave amplitude.

Number of stage (N): shows decreasing by half the Planck energy limit (E_{Pl}) according to progression (1, 1/2, 1/4, 1/8, etc.) ending at $1/2^{106} = 1/(8.11\times10^{31})$, or the presently residual energy of CMB photons after 106 stages plus initial (0) total 107 stages.

Planck energy limit (E_{Pl}): the three fundamental constants: G (Newton's constant=6.67×10^{-11} $m^3\times kg^{-1}\times s^{-2}$), $\hbar$ (Planck constant=4.135×10^{-21} MeV×Hz^{-1}) and c (velocity of light = 2.997×10^{10} cm×s^{-1}), $E_{Pl} = \sqrt{\hbar c^5 / G} = 1.22\times10^{22}\,\mathrm{MeV}$ initial energy of primordial photon.

CMB photon packets, best fit thermal distribution of a black-body spectrum: actual mean temperature (T) of 2.725 K° converted to 2.35×10^{-10} MeV. Frequency peak: 1.604×10^{11} Hz; and wavelength peak: 1.9×10^{-1} cm.

To calculate, according to Wien Law, emission peak for a black body: T=2.897×10^{-3} m °K/λ_{peak}. For a temperature (T) of 2.73 °K, the wavelength peak: 1.06×10^{-1} cm.

Calculation of critical energy: 2.35×10^{-10} MeV multiplied by the actual number of CMB photons (3.74×10^{87}) equals 8.79×10^{77} MeV, which only represent 0.005 % of the total energy or critical mass for a self-contained universe (1.702×10^{82} MeV), equivalent to about 2 protons per cubic meter.

Energy of wavelength (E_λ): starts at the value of E_{Pl} and each stage decreases by half the energy to end at the actual value of CMB. This procedure yielded a total number of 107 stages; and allows the dimensioning of the energy parameter.

In Table 1 denominated for primordial energy: Radiation Wavelength (λ) and a Table 2 average λ (black body to the photon packets corresponding to each stage), according to the formula: $c = \nu\times\lambda$, where ν is frequency.

Time of λ-localization ($t_{\lambda-loc}$) corresponding to each wavelength. According to the relationship for frequency: $t_{\lambda-loc} = \hbar / E = 1/\nu = \lambda / c$, expressed in centimeters.

Time (t) expressed in seconds: $t\times c = 2r$, was used to calculate the time of localization for photons, calculated considering 2r = λ results in value of localization for E_{Pl} limit that equals 5.40×10^{-44} s. Similar value could be obtained according to: $t_{Pl} = \sqrt{\hbar G / c^5} = 5.39\times10^{-44}$ s.

Photon number: nγ incrementing according to the progression initial value x $(2)^N$. The critical mass divided by the Planck Energy Limit results in the initial value 1.40×10^{60} photons.

The values of energy per photon (E_λ) in accordance to the equation: $E_\lambda = \hbar\times\nu$, were used to obtain the frequency values in Hz, which were calculated but not included in the table.

Volume of λ-localization ($V_{\lambda-loc}$) according to the formula in cm^3: $V_{\lambda-loc} = 4/3\times\pi\times\lambda_c{}^3$. In the formula of a sphere, r^3 was replaced by $\lambda_c{}^3$.

Radius of localization (λ_c) based in the Compton wavelength of an electron ($\lambda_c = \hbar / m_e c$) value: 2.426×10^{-12} m. This is considered analogous to a radius of localization (λ_c) according to $\lambda_c = \lambda / 2\pi$. The λ_c value allows relating of particles to wavelength and therefore, $V_{\lambda c-loc}$ has a similar expression to volumes of localization for particles $V_{p-loc} = 4/3\times\pi\times r^3$, used in Table 2.

Range of values of λ_c: Table 1: from stage 0: 1.62×10^{-33} cm, duplicating in value until stage 56: 1.17×10^{-16} cm.; Table 3: from stage 96: 8.19×10^{-5} cm, duplicating in value until stage 106: 8.39×10^{-2} cm.

Radius of the Universe (R_U) calculated by compounding the lengthening of photon trains by simultaneous doubling the number of photons and doubling the wavelength and amplitude according to $R_U = [(V_{\lambda c-loc}\times n\gamma)\times(3/4)\times(1/\pi)]^{1/3}$ in cm × 1.05805×10^{-18}, equivalent in light years as unit of length.

This formula came from the formula for a Universe volume: $V_U = V_{\lambda c-loc}\times n\gamma = (4/3)\times\pi\times(R_U)^3$. It was assumed that the transversal polarization of the oscillatory axis of the electromagnetic force results from the scission of the strong force at 10^{16} MeV, and the weak at 10^{12} MeV. The separation of these forces according to the two complementary axes allows volume to increase according to a cubic exponential associated to the rate of lengthening of each photon train up to stage 33. Up to this stage, was considered that the predominant force for Inflation was the increment in time of localization from the Planck 3.39×10^{-43} s to the Higgs boson 2.44×10^{-26} s. From stage 56 to 96, in order to obtain a comparative particle chronology as shown in table 2, it was discontinue this parameter and was included an energy (temperature)-time axis. In table 3, to describe Expansion after recombination, the parameter radius of Universe was calculated using the value for stage 96 or 4.03×10^5 light years multiplied by the progression from $(2.84)^0$ to reach $(2.84)^{10}$ or the present stage 106.

Time of particle localization (t_{p-loc}) according to the relativistic formula which allows to relate radius of particles (r), to the velocity of light and time (t) expressed in seconds: $t \times c = 2r$. The Planck particle corresponds with the Planck radius of 1×10^{-33} cm, energy equivalent to 1×10^{32} K°. The values for the radius of localization in centimeters, quark charm: 10^{-16}, pion: 10^{-12}, proton: 10^{-13} and electron: 3×10^{-10}. However, it has been postulated that in the earlier space-time the value of the radius of particles were smaller than in the present. If so, a proportionality factor, alpha (α), should be used to correct these values: $\alpha \times r = c \times t / 2$.

Temperature-time axis (t) could be correlated with E_λ, on the basis that to decrease energy either as a wavelength or temperature by half requires a corresponding doubling of the preceding elapsed time. This rate of 4 relating the decrease in energy to an expansion of the associated time may reflect a rhythm for the enlargement of the space time. This may relate to a relationship in which it is required that the time of localization increase by 2 to allow that the radius of localization could also simultaneously increase by 2.

The relationship between the thermodynamics of wavelength elongation and observation

At temperature equilibriums, photons radiate with the energetic distribution of a black body. The finding that at 3.79×10^{5} light years from the Big-Bang, a surface of "last scattering" with a temperature equilibrium of 3000 K° originates the CMB photon-packets which could be interpreted as a red shift, z = 3000 K°, to the 2.73 K° observable at present. However, it is commonly accepted that this temperature gradient is a part of the time-temperature axis correlating the chronology of the Big-Bang [[28, 29, 30, 31, 32]] and furthermore a shift on a continuum may only displace the values delimiting the gradient.

This correlates with a decreasing progression from 2.59×10^{-7} to 2.35×10^{-10} MeV, halved 10 times or about $(1/2)^{10}$. The increase in the Universe radius from the time of last scattering to the present could be expressed as a 3.63×10^{4} radius increment or a progression of about $(2.84)^{10}$. Calculation by parametric down-conversion shows that during the same period the number of photons would multiply by 2^{10}, which is a partial increment of the total one. Accordingly, the simulation adopted a gradient or continuum of decreasing energy in terms of frequency, scaled to show that an increment of wavelength not only decreases energy by half, but also requires the doubling of the associated elapsing time.

This approximation was regarded as acceptable in terms of the simulation requirements, and astronomical observations were extrapolated to initial conditions according to Planck energy limit, which allow calculating that after 107 stages of decreasing energy by half, it would reach a value concordant with the present one. The time elapsed from the Era of equal particle to radiation number to the present shows that a photon number increase over particles by about 2^{31}, suggesting a partial energy conservation mechanism by parametric down-conversion. The discrepancy disappears by taking in account that most of the energy present as primordial energy was diverted for the formation of ordinary matter and dark matter and dark energy [[33]]. Hence, preventing that photon number could increase by only accounting their formation by parametric down-conversion, the stages allocated for this process are indicated by the question marks in Table 2. Thus, allowing that only 1/20,000 of the total initial energy could reach the frontier of last scattering.

A supercontinuum laser light obtained under laboratory conditions [[34, 35]] shows a progressive wavelength elongation, but it would require conditions no leading to entropy or ideal, to show energy conservation as a number of photons increment. A model, taking in account parametric down-conversion allows an elegant solution for energy conservation. The mathematical artifice of dividing by two the energy levels was adopted because it was assumed to help to pinpoint the levels of CMB energy within time and space parameters. This process allows showing that the dissipative potential created by wavelength elongation could be the transducer into a cumulative potential [[19]] of increasing photon number. The model adopted reference values shown in bold characters from observationally and theoretically accepted concepts to determine best-fitting of the several treated simulations. This coupling not only allows a dissipative potential in a self-contained Universe, but also brakes time symmetry. This effect not only results from a thermo dynamic down flow, but also from the fact that the vector direction for a single packet of energy generating two or more packets is kinetically the favorable direction. Consequently, the multiple interactions required for more than one energy packet to regenerate a previous single stage of the continuum, would be a much less probable event.

Time and volume of wavelength localization are additional limits to the energy axis

The velocity of the changes of phase of a sinusoidal wave generated by a laser pulse in a cell of cesium gas exceeded by 300 times the velocity of propagation of light in a vacuum [36]. Therefore, the primordial radiation changes of phase resulting from the continuous decrease in its frequency and the dissociation of strong, weak and electromagnetic forces and/or transition between a virtual and ordinary time and space of localization could be assumed to occur within the time parameters of the Inflationary Era [36, 37, 38]. The time lapse of inflation has to include the time of localization for wavelengths at the energy level characterizing the events. Therefore, it may better define the time limits of Inflation. The latter could not to be limited by the velocity of light propagation in space because its contribution during the Inflationary period would be non-significant. Accordingly, the rate of increase of cosmic radius and that of the number of photons formed by the multiplication chain during the Inflationary period were assumed not to be influenced by the insignificant distance travelled by light during this period.

Table 1: *Simulation defining Inflation as a function of time of λ-localization and space by wavelength elongation and photon increment by parametric down-conversion Initial (in.).N equals 57 stages in progression. 7 reported. In bold: Energy for scissions of strong (1×10^{16} MeV) and weak forces (1×10^{12} MeV) and for Higgs boson (1.6×10^{5} MeV). Time of λ-localization: 2.91×10^{-33} s end of Rapid Inflationary Period. The Universe Radius* $R_U = [(V_{\lambda c-loc} \times n\gamma)\times(3/4)\times(1/\pi)]^{1/3}$ *was calculated from the Universe volume* $V_U = V_{\lambda c-loc} \times n\gamma$ *, assumed to be spherical:* $V_U = (4/3)\times\pi\times(R_U)^3$.

# of stage (N)	Energy of Wavelength (E_λ)	Radiation Wavelength (λ)	Time of λ Localization ($t_{\lambda-loc}$)	Photon Number ($n\gamma$)	Vol. λc-loc ($V_{\lambda-loc}$)	Universe Radius (R_U)
	in. $\times(1/2)^{N-1}$ (MeV)	$\hbar c/E$ (cm)	λ/c (s)	in. $\times(1/2)^{N-1}$ (photons)	$(4/3)\times\pi\times\lambda_c^{\ 3}$ (cm^3)	(Light years)
0	1.2×10^{22}	1.0×10^{-32}	3.4×10^{-43}	1.4×10^{60}	1.8×10^{-98}	1.9×10^{-31}
1	6.1×10^{21}	2.0×10^{-32}	6.8×10^{-43}	2.8×10^{60}	1.4×10^{-97}	4.8×10^{-31}
4	7.6×10^{20}	1.6×10^{-31}	5.4×10^{-42}	2.2×10^{61}	7.3×10^{-95}	7.7×10^{-30}
19	**2.3×10^{16}**	5.3×10^{-27}	1.8×10^{-37}	7.3×10^{65}	2.5×10^{-81}	8.1×10^{-24}
33	**1.4×10^{12}**	8.7×10^{-23}	**2.9×10^{-33}**	1.2×10^{70}	1.1×10^{-68}	3.4×10^{-18}
49	2.2×10^{07}	5.7×10^{-18}	1.9×10^{-28}	7.9×10^{74}	3.2×10^{-54}	8.9×10^{-12}
56	1.7×10^{05}	7.3×10^{-16}	2.4×10^{-26}	?	6.6×10^{-48}	?

The emerging from confinement of primordial radiation into a continuously unfolding space-time indicates the convenience to relate the decrease in frequency to a time of wave localization rather than to relate directly energy evolution to an ordinary time scale. Accordingly, in Table 1, this parameter allows not to ignore that the theoretical meaning of time of localization provides, as a function of its energy, a physical lower limit for the cosmos existential time required for a wave dimensioning into or within the space-time. Example: If a shutter timer allows only the emission of a single violet photon, the same timing would not allow the emission of a red photon, which would occur only, if the timer is set to the time dimension of the latter photon.

The Planck energy limit (E_{Pl}) is the same quantity for an energy packet either particle or wave (1.22×10^{22} MeV). However, it could be assumed based in that duality as either photon or wave allows description in terms of different space-time conformations, but could be useful to only differentiate by assigning the denomination time of λ-localization for waves ($t_{\lambda-loc}$) and in the equation refers 2*r* as equal to λ, and for particles or photons, the time of particles localization (t_{p-loc}) referring 2*r* as equal to the diameter. Table 1, in order to emphasize the mass-less primordial energy condition, equates E_{Pl} in terms of time of λ-localization as 3.39×10^{-43} s.

The dispersion of trains of increasing number of photons conform an arrow of time according to the increment in time of localization and would inflate space by the increase in their number and volume of photon localization. In Table 1 the scission of strong force at 10^{16} MeV and weak at 10^{12} MeV relates to a change of phase that would occur at much greater velocity than that allowed by the celerity of light. Table 1 emphasizes the role of time localization in generating the Inflationary time and its ending at the time of the scission of the weak force.

At stage 33, the energy per photon corresponds to a $t_{\lambda-loc}$ of 2.91×10^{-33} s, a time usually assumed to end Inflation. At the end of inflation the initial number CMB photons (1.40×10^{60} photons) multiplied by 2^{33} (or 8.59×10^{9}) have increased to 1.20×10^{70} photons, but since the radius has increased according to $(4)^{N-1}\times r_{\lambda c}$ to 2.35×10^{20} cm the Universe radius has reached 249 light years. Also it could be calculated that the number of photon density decreases to 2.21×10^{8} photons per cm^3. At stage 56, the energy of wavelength (E_{λ}) has decreased to 1.69×10^{5} MeV, which according to Connes mathematical treatment [39] is the value that allows the appearance of the Higgs boson.

When the dimensions of the cosmic time axis exceed that required for $t_{\lambda-loc}$ for a single wave, the tendency to further expansion becomes less dependent of subsequent $t_{\lambda-loc}$ increment and more of the incremental volume of photons localization and their increase in number. During the expansionary time the velocity of light propagation in space could make a substantial contribution to the rate of increase in the value of the cosmic radius. Table 2 shows that at the moment of the Higgs boson formation corresponds to a value 2.5×10^{-11} s in the time-temperature axis. This value greatly exceeds the t_{p-loc} required for localization of all the listed particles, which indicates that particle formation is not limited by time requirements and will mainly depend of the cosmic energy level.

Table 1 also shows that matter particles could not have occupied ordinary three-dimensional space during most of the Inflationary Era but only at its ending. The generation of mass would thereafter oppose the expansionary tendency of radiation.

Table 2: *N equals 41 stages in progression. 11 reported. Symbol (?): not extrapolated. In bold: nγ at time of equality between radiation to particle (p);* t_{p-loc}*:* $t \times c = 2r$ *, radius (r), velocity of light (c) and time (t). The time-temperature axis shows a space time rhythm of 4, compounding a time of localization incrementing by 2 to a simultaneously increase by 2 of the radius of localization.*

# of stage (N)	Event	Energy of Wavelength (E_λ)	Photon Number ($n\gamma$)	Time of p-loc (t_{p-loc})	Time of λ-loc ($t_{\lambda-loc}$)	Vol. λc-loc ($V_{\lambda c-loc}$)	Time Axis (t)
		(MeV)	(photons)	(s)	(s)	(cm^3)	(s)
56	Higgs boson	1.7×10^{05}	?	- - - -	2.4×10^{-26}	6.6×10^{-48}	2.5×10^{-11}
61	Quarks: charm	5.3×10^{03}	?	$\mathbf{6.7\times10^{-27}}$	7.8×10^{-25}	2.2×10^{-43}	2.6×10^{-08}
62	Bottom	2.6×10^{03}	?	$\mathbf{6.7\times10^{-25}}$	1.6×10^{-24}	1.7×10^{-42}	1.0×10^{-07}
63	Proton	1.3×10^{03}	?	$\mathbf{6.7\times10^{-24}}$	3.1×10^{-24}	1.4×10^{-41}	4.1×10^{-07}
66	Up, Down, Strange	1.7×10^{02}	?	$\mathbf{6.7\times10^{-27}}$	2.5×10^{-23}	7.1×10^{-39}	2.6×10^{-05}
67	Pion	8.3×10^{01}	?	$\mathbf{3.3\times10^{-22}}$	5.0×10^{-23}	5.7×10^{-38}	1.1×10^{-04}
68	Strongly interacting	4.1×10^{01}	?	- - - -	1.0×10^{-22}	4.6×10^{-37}	4.2×10^{-04}
74	Electron (?)	6.5×10^{-01}	8.1×10^{77}	$\mathbf{2.0\times10^{-20}}$	6.4×10^{-21}	1.2×10^{-31}	1.7×10^{00}
75		3.2×10^{-01}	$\mathbf{1.6\times10^{78}}$	- - - -	1.3×10^{-20}	9.6×10^{-31}	7.2×10^{00}
93	Nuclei formation	1.2×10^{-06}	4.2×10^{83}	- - - -	3.4×10^{-15}	1.7×10^{-14}	9.9×10^{11}
95	Formation of atoms	3.1×10^{-07}	1.7×10^{84}	- - - -	1.3×10^{-14}	1.1×10^{-12}	1.7×10^{13}

Table 2 takes into account that, after formation of ordinary matter and dark matter and energy, only 1/20,000 of the total initial energy would reach the frontier of last scattering. Therefore, transformation of an energy gradient of radiating wave packets into dark energy and matter, and ordinary matter, may have followed a sequence of stages. At these stages, photons still would be duplicating, but also disappearing by converting their energy into the equivalent resting mass of particles. The corresponding extrapolation for the number of photons column was not done because it could have been less than accurate. This was resolved bypassing stages 56 to 70 by using the question mark symbols.

Table 2 shows that at the stage 60 the energy level still exceeds that required to create the masses corresponding to quarks (according to $E=mc^2$) expressed in MeV, which are: charm: 5×10^3, bottom: 1.6×10^3 and up, down and strange below 1.5×10^2. Quantum physics assigns to each particle a minimum volume of localization which corresponds to the radius of 3×10^2 Fermi for an electron and 1/10th of Fermi or 10^{-14} cm for a more massive proton.

Table 3: *The final 11 stages from 96 plus an unnumbered initial one, at the frontier of last scattering, to present are shown under the premise that the value of critical or initial energy:* 1.71×10^{82} *MeV have decreased, after formation of ordinary matter, dark energy and dark matter, to a total remnant energy of* 8.89×10^{77} *MeV. The remnant energy emerges from the frontier of last scattering as the radiation spectra from a black body at 3,000K. Elongating of this radiation spectra ends at that of a black body at 2.725K, the presently detectable temperature of relic CMB. Energy conservation at all 11 stages in table 3 could be shown by multiplying the energy of the respective wavelength by the number of photons:* $E_\lambda \times n\gamma$ *. Some of the obtained values could be correlated with astronomically observable ones which are shown in bold characters.*

# of stage (N)	Energy of Wavelength (E_λ)	Average λ (black body) (λ)	Volume of localization ($V_{\lambda c-loc}$)	Photon Number ($n\gamma$)	Universe Radius (R_U)
	(MeV)	(cm)	(cm^3)	(photons)	(light years)
	2.59×10^{-07}	4.79×10^{-04}	1.86×10^{-12}	3.44×10^{84}	**3.79×10^{05}**
96	2.41×10^{-07}	5.14×10^{-04}	2.30×10^{-12}	3.69×10^{84}	4.03×10^{05}
97	1.20×10^{-07}	1.03×10^{-03}	1.84×10^{-11}	7.38×10^{84}	1.15×10^{06}
98	6.02×10^{-08}	2.06×10^{-03}	1.47×10^{-10}	1.48×10^{85}	3.25×10^{06}
99	3.01×10^{-08}	4.12×10^{-03}	1.18×10^{-09}	2.95×10^{85}	9.23×10^{06}
100	1.51×10^{-08}	8.23×10^{-03}	9.43×10^{-09}	5.91×10^{85}	2.62×10^{07}
101	7.53×10^{-09}	1.65×10^{-02}	7.54×10^{-08}	1.18×10^{86}	7.45×10^{07}
102	3.76×10^{-09}	3.29×10^{-02}	6.03×10^{-07}	2.36×10^{86}	2.12×10^{08}
103	1.88×10^{-09}	6.58×10^{-02}	4.83×10^{-06}	4.73×10^{86}	6.01×10^{08}
104	9.41×10^{-10}	1.32×10^{-01}	3.86×10^{-05}	9.45×10^{86}	1.71×10^{09}
105	4.71×10^{-10}	2.63×10^{-01}	3.09×10^{-04}	1.89×10^{87}	4.85×10^{09}
106	**2.35×10^{-10}**	5.27×10^{-01}	2.47×10^{-03}	**3.78×10^{87}**	**1.38×10^{10}**

Table 2 and 3 shows that from the era in where radiation and particles were in equal proportion (2×10^{78}) to the present, the photon number increased as illustrated from about stage 75 to the present by a factor close to the one reported in the literature of 1.9×10^{9} CMB photons per each baryonic particle.

Table 3 includes observational values obtained by the astronomical survey of CMB, within the parameter from the era of last scattering to the present, which shows these photons as decreasing in energy, but as we assumed increasing in number. At the CMB emerging from recombination temperature of 3,000 Kº, the corresponding number of photons would be 3.44×10^{84}, which will progressively increment from stage 97 to 107 to reach a photon number of 3.78×10^{87}, which closely corresponds to the observed one.

These 10 stages of halving energy were related to the exponential increase of Universe Radius according to the exponential 2.84. Hence, from the actual age of the universe, 13.76×10^{9} light years, were subtracted first 8.92×10^{9} light years to obtain the initial time framing of the last division. To the resulting number 4.85×10^{9} was thereafter subtracted 3.14×10^{9} light years. The ten-stage subtractions ended at 3.79×10^{5} light years which is regarded as the time of recombination at the end of last scattering. This is one of the relationships that allow extrapolating astronomically observable values with those obtained by simulation. The Radius in light years corresponds to the chronometric scale of time based in the velocity of light.

Dividing the actual Universe volume (9.34×10^{84} cm^3) by the CMB packets photon number (3.78×10^{87}), it obtained a volume of λ-localization of about 2.43×10^{-3} cm^3 similar to the one calculated using the mean value of the CMB wavelength packet.

Obviously, it is unlikely, that the present time could correspond to the end of the last division. Therefore, Table 3 partial simulation of a period of the expansionary time should be regarded as only an illustrative draft. However, it may provide a theoretical framework for a more rigorous computational analysis plotting the elongation and cooling down of CMB radiation to characterize the Expansionary Era.

Conclusions

The purpose of the simulation is to illustrate that there are energy-space-time relationships, which are physically ingrained in wavelength elongation as described by the model and may be verifiable by concordance with astronomical observation. The NASA, COBE and WASP space probes [29, 30, 31, 32] show a flat cosmic geometry that, if not to require a very exact critical mass, indicates that at the Universe origin, a mass-less primordial energy describable by a wave function could have preceded the formation of matter.

The concept of frequency leads to the conclusion that elongation of a wavelength would allow to develop a chronology in which time naturally appears as a function of changes in E_{λ} of expanding space. The latter process could be characterized as resulting from simultaneous increments in the intrinsic time of λ-localization ($\Delta t_{\lambda-loc}$), in the volume of λ_c-localization ($\Delta V_{\lambda c}$) and in the photon number $\Delta n\gamma$ by parametric down-conversion. Hence, Inflation at much greater velocity than light may be explained as a phase transition for the increasing time, volume of localization and photon number decompressing the space-time dimensions. Starting from the Planck time, the dynamics of the increment of the wave amplitude would continuously decrease probability at the quantum level of the thermodynamic structure, but, summing up to integrate from past to future a causality arrow within the cosmic energy field.

The model suggests that by describing primordial energy not shaped as particles, but as if it had the frequency property of photons, their energy dissipative potential when surging from confinement by increasing in number and dispersing in unfolding space evolve as expected according to the dynamics of an Einstein universe [18, 40]. In this one, the continuous nature of the space-time requires that time and space could expand simultaneously. The linkage to time dilation would not surge naturally from the description of a universe emerging by the inflow of particles to conform space according to the prevalent mechanistic description of Inflation [4]. The Expansionary tendency of a radiation, subject to gravity, could be explained because the process of elongation itself is not subject to the centripetal tendency of gravity, which results from the events of creation of dark and ordinary matter.

Hence, the time-dependent CMB-elongation process which corresponds by spontaneous parametric down-conversion to a continuous increment in the sizes of the photons and their numbers could dynamically dimension the vacuum, to spread in opposition to gravity, to separate the galaxies. Therefore, acts as a quintessence or Einstein's cosmological constant, but at a rate related to an expanding time metric. The latter may explain the recently observed reacceleration of the Universe expansion.

These observations appear to suggest that astronomical verification could be used to analyze the validity of the model on the basis of the included partial Table 3 of the Expansionary Era simulation. The expansionary time scale required for inflation associated to the time of quantum localization, responds to the equation $\lambda / t_{\lambda-loc} = c$. The scaling of universe radius from 1.9×10^{-31} to 1.38×10^{10} light years could be made to correspond with an equation for a universe time of localization: $t_{U-\lambda-loc} = \lambda_c \times (n\gamma)^{1/3} / c$. The obtained as corresponding values, from 6.04×10^{-24} to 4.36×10^{17} s.

The complementation between continuum and non-continuum geometries, described by Connes [39] requires additional characterizations. One may surge from Schrödinger's equation, which shows that probability density is a function of the square of the amplitude module of the wave. According to the Heisenberg principle, a continuum of wavelength increments with concomitant increments in amplitude would yield a gradient of increasing uncertainty. However, this is a cause-effect relationship. Therefore, the evolution of primordial energy into relic CMB and, maybe, dark energy, may have a thermodynamic structure describable as a continuum with predictability equivalent to a causality vector. The non-continuous geometry would be describable in terms of quantum properties of ordinary and, maybe, dark matter. Hence, either could show time dependent energy arrows which link within cosmic evolution relativity and quantum mechanics.

Evolution of cosmic energy as a wave function of primordial energy packets could be simulated by treatment as a continuum, linking uncertainty with causality. A Universe inflated by matter, in which the modification of the kinetic energy of particles occurs without that of their resting mass eludes the concept of a continuum. Hence, matter particles that disperse according to temperature-gravitation equilibriums will rather reflect properties that fit within the non-continuum description of the Universe by Connes [39]. Both geometries could be differentiated in terms of how they structure the space time interrelationships. The continuum surges from the thermodynamic structuring of primordial radiation and relic CMB without time-reversibility. The non-continuum surges from the quantum structuring of matter, which allow time symmetry restricted to the particle and atomic levels. At the molecular or higher levels, apparent violations of microscopic reversibility may be observable, but, this could be explained by synchronized coupling between downhill and uphill energy flows. Therefore, the simulation by treating the evolution of primordial energy as a radiation focalizes into the characterization of the continuum and shows some of its interrelationships with the non-continuum as constituents of a single self-contained Universe.

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