

1. Planck unit scaffolding to Cosmic Microwave Background correlation (a Simulation Hypothesis model)

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In this article we compare the parameters for a hypothetical Planck unit universe (sans particles) with the Cosmic Microwave Background. The model postulates a Planck unit scaffolding upon which the particle universe resides and supposes that within the CMB parameters can be found evidence of this non-baryonic background. The model uses only Planck mass and Planck length as the primary structures and a spiral geometry as the ‘guard-rail’. We begin with the peak frequency of the CMB, 160.23(3) GHz, to establish an age of the universe in Planck time units and use this as our sole variable. From it we derive the radiation energy density, the CMB temperature, the Hubble constant and a mass density. The model contains no baryonic matter, yet its mass density is exactly one quarter of the critical density, close to the cold dark matter value $\Omega_c = 0.265$ (Planck 2018): it lies 6.8% below the observed dark matter density and five times above the baryon density. This suggests that dark matter may be non-baryonic, deriving from the Planck scaffolding. The CMB temperature differs from the measured value by 0.08%, which is the ratio of the SI Boltzmann constant to the geometrical Boltzmann constant of the model, so the CMB gives an independent measure of the Boltzmann-constant gap found among the physical constants (article 6). The Casimir force equation reduces to the equation for radiation density implying that the universe has finite boundaries, albeit these are expanding at a constant rate. This article is part of a Planck scale Simulation Hypothesis project that attempts to demonstrate that the universe could in sum total be dimensionless, relying on geometrical artifice to create actual physical structures.

Table 1	Planck lattice	observed	diff.
Age (billions of years)	14.619 (eq. 11)	13.797(23) [9]	+6.0%
Age (units of Planck time)	$0.85582 \times 10^{61} (2t_{age})$		
Dark matter density	$0.2101 \times 10^{-26} \text{ kg.m}^{-3}$ (eq. 13)	$0.2254(23) \times 10^{-26} \text{ kg.m}^{-3}$ [9]	−6.8%
Density/critical density	1/4 (eq. 15)	$\Omega_c = 0.265$ [9]	−5.5%
Radiation energy density	$0.4175 \times 10^{-13} \text{ J.m}^{-3}$ (eq. 19)	$0.4175 \times 10^{-13} \text{ J.m}^{-3}$ [10]	identity
Hubble constant	66.89 km/s/Mpc (eq. 22)	67.36(54) km/s/Mpc [9]	−0.7%
CMB temperature	2.7277 K (eq. 7)	2.72548(57) K [10]	+0.08%

The radiation energy density agrees by construction (section 6); the temperature difference is the ratio k_B/k_B^* of the SI and geometrical Boltzmann constants (section 3.1).

keywords:

cosmic microwave background, CMB, cosmological constant, black-hole universe, dark energy, dark matter, Hubble constant, expanding universe, Casimir, Planck units, Simulation Hypothesis;

1 Introduction

The idea that the observable universe might manifest features arising from discrete, information-like processes at the smallest scales has attracted attention both in speculative literature and in attempts to interpret cosmological anomalies. Here we present a transparent, quantitative variant of that idea in which Planck-scale quantities and a simple geometric/algorithmic ansatz are used to compute large-scale cosmological parameters, with particular attention to properties of the cosmic microwave background (CMB).

The goal is not to defend any metaphysical conclusion, but rather to show that a straightforward mapping between Planck units and CMB observables can reproduce order-unity features of the observed universe.

This aspect of the model uses the Planck units for time, length and mass t_P, l_P, m_P as the base units. The universe is

not a closed system but instead resembles a computer ‘loop’ in which for each increment to the time variable t_{age} , units of t_P, l_P, m_P are added. This process is described in detail in the article on physical constant anomalies [7].

FOR $t_{age} = 1$ TO (the end): add Planck units; NEXT

Series Context: This article serves as the first in a series exploring a simulation hypothesis framework (whereby the universe is following explicit mathematical rules). While focusing here on the Cosmic Microwave Background (CMB), the foundational concepts introduced—specifically the geometric separation of integer and non-integer domains—form the basis for a complete physical model. As developed in subsequent articles (particularly relating to the electron and atomic structure), the fine structure constant α emerges as the sole fundamental physical constant required to couple these

domains, the dimension-ed constants derived from geometric relationships [7].

2 Spiral of Theodorus

The Spiral of Theodorus is used as the geometric guardrail. It is a spiral figure created by connecting a sequence of right triangles. It begins with an isosceles right triangle with legs of length 1, and each subsequent triangle is built on the hypotenuse of the previous one.

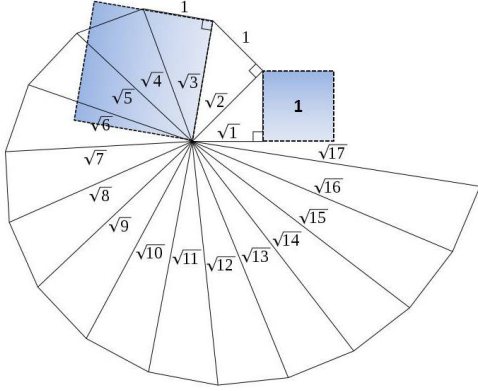


Fig. 1: spiral lattice geometry (from wikipedia)

2.1 Domain Duality: Matter vs. Radiation

The spiral geometry encodes a fundamental duality between two distinct properties of the universe, which we define as the **Matter (Integer) Domain** and the **Radiation ($\sqrt{\text{Integer}}$) Domain**.

- **Matter (Integer) Domain:** Corresponds to the spiral circumference. This domain tracks quantities with integer dimensional powers (kg, m, s). It governs mass, spatial extent, and time, scaling linearly with the age of the universe t_{age} (a dimensionless clock-rate; universe age = $t_{age}2t_p$).
- **Radiation ($\sqrt{\text{Integer}}$) Domain:** Corresponds to the spiral radius. This domain tracks quantities involving non-integer dimensional roots, such as charge and radiation temperature. It scales with the square root of the universe's age $\sqrt{t_{age}2t_p}$. Later analysis (Article 7) identifies this radial direction as a perpendicular physical dimension, the “ w -axis”.

Philosophy: This separation explains the scaling differences observed in cosmology. Mass density ($\propto 1/t_{age}^2$) resides in the circumference (Integer) domain, while CMB temperature ($\propto 1/\sqrt{t_{age}}$) resides in the radius (Radiation) domain. The interaction between these domains is mediated by the sqrt of Planck momentum $\sqrt{kg.m/s}$ —which serves as the link between the integer and $\sqrt{\text{integer}}$ domains.

Note: As there is no baryonic matter included in this discussion, the CMB peak frequency $f_{peak} = 160.23(3)$ GHz is used to determine a value for number of increments t_{age} until ‘now’. This is the peak of the measured CMB spectrum, a blackbody at 2.72548(57) K [10], since $f_{peak} = xk_B T/h$ (eq. 10); the original version of this article used 160.2 GHz.

3 Black body peak frequency

Hawking temperature T for a Schwarzschild (non-rotating, uncharged) black hole is given by

$$T = \frac{hc^3}{32\pi^2 G M k_B} \quad (1)$$

If we replace M with Planck mass m_P then we can re-define T in terms of Planck temperature T_p (A is an Ampere).

$$T_p = \frac{Ac}{2\pi} \quad (2)$$

$$G = \frac{c^2 l_p}{m_P} \quad (3)$$

$$h = 2\pi m_P c l_p \quad (4)$$

$$k_B = \frac{2\pi c m_P}{A} \quad (5)$$

$$T = \frac{hc^3}{32\pi^2 G m_P k_B} = \frac{T_p}{8\pi} \quad (6)$$

According to the spiral framework, temperature is considered as a radiation parameter and so follows the spiral radius whereby the temperature drops according to the sqrt of t_{age} (1, sqrt(2), sqrt(3)...). Therefore the temperature of the Planck lattice would be a function of (the sqrt of) time;

$$T_{cmb} = \frac{T_p}{8\pi \sqrt{t_{age}}} \quad (7)$$

Inserting T_{cmb} in the following

$$\frac{x e^x}{e^x - 1} - 3 = 0, x = 2.82143937... \quad (8)$$

$$\frac{k_B T_p}{h} = \frac{1}{2\pi t_p} \quad (9)$$

$$f_{peak} = \frac{k_B T_{cmb} x}{h} = \frac{x}{8\pi^2 \sqrt{t_{age} 2t_p}} \quad (10)$$

If $f_{peak} = 160.23(3)$ GHz then $t_{age} = 0.42791(16) 10^{61}$

giving present universe age = $2t_{age}t_p = 0.85582 10^{61} t_p$

In years this is 6.0% higher than the Planck 2018 value of 13.797(23) billion years [9]; section 8 shows that this difference follows from the constant expansion rate of the lattice.

$$\frac{t_{age} 2t_p}{365.252 * 24 * 3600} = 14.619(6) 10^9 \quad (11)$$

3.1 CMB temperature and the Boltzmann constant

Inserting t_{age} into eq. 7 gives $T_{cmb} = 2.7277(5)$ K, against $2.72548(57)$ K measured [10]. The difference, $+0.083\%$, is four times the uncertainty of the measurement, but it is not a misfit in t_{age} . Combining eqs. 7 and 10,

$$T_{cmb} = \frac{hf_{peak}}{x k_B}, \quad (12)$$

so the lattice and the measurement describe the same spectrum, and their temperatures can differ only through k_B . The lattice uses the geometrical Boltzmann constant of eq. 5, $k_B^* = 2\pi cm_P/A = 1.379\,510 \times 10^{-23}$ J/K (article 6 [7]), whereas the measured temperature uses the SI value $k_B = 1.380\,649 \times 10^{-23}$ J/K, exact since 2019. The ratio of the two temperatures, $1.000\,825$, equals k_B/k_B^* to one part in 10^7 . Article 6 finds the same gap of 8×10^{-4} between the geometrical and the thermal Boltzmann constants among the physical constants; the CMB measures it independently, through the radiation domain. With the 160.2 GHz used originally the difference was 0.06% and was quoted as zero; the precise peak frequency resolves it.

4 Mass density

The mass/length domain resides in the spiral length

$$t_p = \frac{l_p}{c} \text{ (s)}$$

$$m_{cmb} = (2t_{age})m_p = 0.186289 \, 10^{54} \text{ (kg)}$$

$$v_{cmb} = \frac{4\pi r^3}{3} = 0.886507 \, 10^{80} \text{ (m}^3\text{)}$$

$$r = (2t_{age})2l_p = 2ct_{sec} = 0.276608 \, 10^{27} \text{ (m)}$$

$$\frac{m_{cmb}}{v_{cmb}} = \frac{3m_p}{4\pi(2t_{age})^2(2l_p)^3} = 0.21014(16) \, 10^{-26} \left(\frac{\text{kg}}{\text{m}^3}\right) \quad (13)$$

Via the Friedman equation, replacing p with the above mass density formula reduces to ($G = c^2 l_p/m_P$);

$$\lambda = \frac{3c^2}{8\pi G p} = (2ct_{sec})^2 = r^2 \quad (14)$$

Dark matter density (Planck 2018, $\Omega_c h^2 = 0.1200(12)$ [9]):

$$\rho_{dm} = \Omega_c h^2 \times 3(100 \text{ km s}^{-1} \text{ Mpc}^{-1})^2 / 8\pi G = 0.1200 \times 1.8783 \times 10^{-26} = 0.2254(23) \times 10^{-26} \text{ kg/m}^3$$

Note 1. The mass density calculated here uses only Planck mass and Planck length, without any baryonic matter, yet at $0.2101 \times 10^{-26} \text{ kg/m}^3$ it lies 6.8% below the observed dark matter density, $0.2254(23) \times 10^{-26} \text{ kg/m}^3$, and is five times the baryon density, $0.042 \times 10^{-26} \text{ kg/m}^3$ ($\Omega_b h^2 = 0.0224$ [9]). The lattice density is therefore closest to the dark matter density; it lies 22% below the total matter density, $0.268 \times 10^{-26} \text{ kg/m}^3$, and far above the baryons. The comparison can also be made

in dimensionless form. With $G = c^2 l_p/m_P$ and $t = 2t_{age}t_p$ the age in seconds, eq. 13 becomes

$$\frac{m_{cmb}}{v_{cmb}} = \frac{3}{32\pi G t^2} = \frac{1}{4} \frac{3H^2}{8\pi G}, \quad (15)$$

with $H = 1/t$ (eq. 22): the lattice density is exactly one quarter of the critical density, against $\Omega_c = \rho_{dm}/\rho_{crit} = 0.265$ for cold dark matter [9], a difference of 5.5%. If dark matter is not baryonic then such a close correlation is worth examining. Note 2. To equate with the CMB radius of the universe our radius requires an additional 2π term

$$r_l = 2\pi r = 2\pi(t_{age})2l_p = 8.7 \times 10^{23} \text{ km}$$

5 Temperature

The *mass/volume* formula (Matter Domain) uses t_{age}^2 , while the *temperature* formula (Radiation Domain) uses $\sqrt{t_{age}}$. We may therefore eliminate the age variable t_{age} and combine both formulas into a single constant of proportionality that resembles the radiation density constant.

$$T_p = \frac{m_P c^2}{k_B} = \sqrt{\frac{hc^5}{2\pi G k_B^2}} \quad (16)$$

$$\frac{m_{cmb}}{v_{cmb} T_{cmb}^4} = \frac{2^5 3\pi^3 m_P}{l_p^3 T_p^4} = \frac{2^8 3\pi^6 k_B^4}{h^3 c^5} \quad (17)$$

6 Radiation energy density

From Stefan Boltzmann constant σ_{SB}

$$\sigma_{SB} = \frac{2\pi^5 k_B^4}{15h^3 c^2} \quad (18)$$

$$\frac{4\sigma_{SB}}{c} T_{cmb}^4 = \frac{c^2}{1440\pi} \cdot \frac{m_{cmb}}{v_{cmb}} = 0.41748(31) \, 10^{-13} \text{ J m}^{-3} \quad (19)$$

This equals the energy density of the measured spectrum, $0.41747 \times 10^{-13} \text{ J/m}^3$ for 2.72548 K [10], as it must: the energy density of a blackbody is fixed by its peak frequency, and k_B cancels from it, so the agreement is a consistency check rather than an independent test. What eq. 19 adds is the link between the radiation energy density and the matter-domain density m_{cmb}/v_{cmb} .

7 Casimir formula

The Casimir force per unit area for idealized, perfectly conducting plates with vacuum between them, where $d_c 2l_p =$ distance between plates in units of Planck length;

$$\frac{-F_c}{A} = \frac{\pi \hbar c}{480(d_c 2l_p)^4} \quad (20)$$

if $d_c = 2\pi \sqrt{t_{age}}$ then eq. 19 = eq. 20, equating the Casimir force with the background radiation energy density and the

spiral circumference.

$$\frac{\pi \hbar c}{480(d_c 2l_p)^4} = \frac{c^2}{1440\pi} \cdot \frac{m_{cmb}}{v_{cmb}} \quad (21)$$

Note: This connection defines the Casimir force as a Radiation Domain phenomenon. Article 7 extends this to the atomic scale, showing that both macroscopic Casimir forces and atomic binding energies arise from vacuum polarization along the perpendicular w -axis dimension, scaling as $1/r^4$.

$$r_c = 2\pi \sqrt{t_{age}} 2l_p = .000420\text{m (present Casimir distance)}$$

Compares with

$$r_l = 2\pi(t_{age})2l_p \text{ (radius of the universe)}$$

Fig. 2 plots Casimir length $d_c 2l_p$ against radiation energy density pressure measured in mPa for different t_{age} with a vertex around 1Pa.

Fig. 3 plots temperature T_{cmb} . A radiation energy density pressure of 1Pa gives $t_{age} \sim 0.8743 \cdot 10^{54} t_p$ (2987 years), length = 189.89nm and temperature $T_{cmb} = 6034 \text{ K}$.

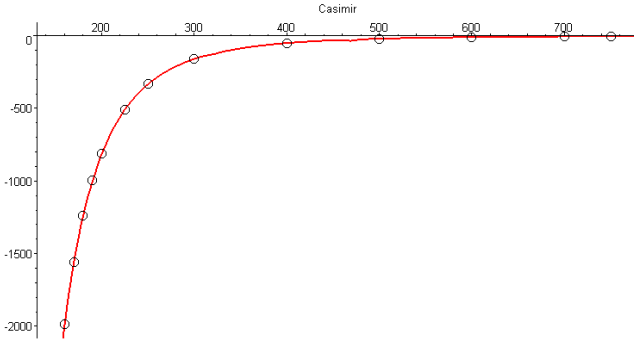


Fig. 2: y-axis = mPa, x-axis = $d_c 2l_p$ (nm)

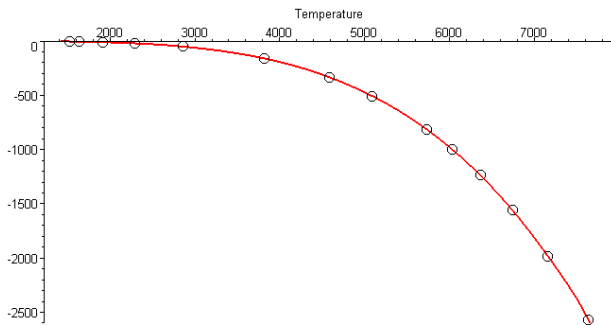


Fig. 3: y-axis = mPa, x-axis = T_{cmb} (K)

8 Hubble constant

$$H = \frac{1}{2t_{age}t_p} = 0.216764 \cdot 10^{-17} \text{ s}^{-1} \quad (22)$$

In conventional units this translates to 66.886(25) km/s/Mpc. The lattice expands at a constant rate, so $Ht = 1$, where $t = 2t_{age}t_p$ is the age, whereas Λ CDM gives $H_0 t_0 = 0.950$ (67.36 km/s/Mpc and 13.797 billion years [9]). With H within 0.7% of the Planck value, the lattice age is therefore 6% greater: the age and Hubble comparisons are not independent, and the 6% reflects mainly the difference between constant expansion ($Ht = 1$) and Λ CDM ($H_0 t_0 = 0.95$).

9 Cosmological constant

Riess and Perlmutter (notes) using Type 1a supernovae calculated the end of the universe $t_{end} \sim 1.7 \times 10^{-121} \sim 0.588 \times 10^{121}$ units of Planck time;

$$t_{end} \sim 0.588 \times 10^{121} \quad (23)$$

The maximum temperature T_{max} would be when $t_{age} = 1$. What is of equal importance is the minimum possible temperature T_{min} - that temperature 1 Planck unit above absolute zero, for in the context of this model, this temperature would signify the limit of expansion (the black-hole could expand no further). For example, if we simply set the minimum temperature as numerically the inverse of the maximum temperature then;

$$T_{min} \sim \frac{1}{T_{max}} \sim \frac{8\pi}{T_p} \sim 0.177 \cdot 10^{-30} \text{ K} \quad (24)$$

Reversing eq. 7

$$0.177 \cdot 10^{-30} \text{ K} = \frac{T_p}{8\pi \sqrt{t_{age}}} \quad (25)$$

Gives

$$t_{age} = \left(\frac{T_p}{8\pi}\right)^4 = 1.014 \cdot 10^{123} \quad (26)$$

This would then give us a value 'the end' in units of Planck time ($\sim 0.35 \cdot 10^{73}$ yrs) which is close to Riess and Perlmutter;

$$t_{end} \sim 1.014 \cdot 10^{123} t_p \quad (27)$$

The mid way point ($T_{mid} = 1\text{K}$) becomes

$$T_{max}^2 \sim 3.18 \cdot 10^{61} \sim 108.77 \text{ billion years.}$$

Note ... in 1998, two independent groups, led by Riess and Perlmutter used Type 1a supernovae to show that the universe is accelerating. This discovery provided the first direct evidence that Ω is non-zero, with $\Omega \sim 1.7 \times 10^{-121}$. This remarkable discovery has highlighted the question of why Ω has this unusually small value. So far, no explanations have been offered for the proximity of Ω to $1/t_u^2 \sim 1.6 \times 10^{-122}$, where $t_u \sim 8 \times 10^{60}$ is the present expansion age of the universe in Planck time units. Attempts to explain why $\Omega \sim 1/t_u^2$ have relied upon ensembles of possible universes, in which all possible values of Ω are found [11].

10 Mathematical universe at the Planck scale

This is the article 1 of a series on the theme of a dimensionless mathematical universe at the Planck scale. The model assigns Planck units as constructs of discrete geometrical objects, themselves the geometry of 2 dimensionless constants; the fine structure constant alpha and a mathematical constant Omega such that $M=1$, $T=\pi$, $V=2\pi\Omega^2 \dots$ (article 5) .

$$\Omega = \sqrt{(\pi^e e^{(1-e)})} = 2.0071349543... \quad (28)$$

The fine structure constant alpha is the only physical constant used in this model, for example, the formula for the electron ψ can be constructed from the Planck objects $(AL)^3/T$,

$$\psi = 4\pi^2(2^6 3\pi^2 \alpha \Omega^5)^3 = 0.238954531 \times 10^{23} \quad (29)$$

As the universe expands in discrete steps, from the dimensionless clock-rate t_{age} we can construct π and e in series, as such, and given the simplicity of the inherent geometries and alpha as the only initializing variable, we may propose this as evidence of coding (the Simulation Hypothesis) rather than ad hoc mathematical structures. The Simulation Hypothesis is the proposal that all of reality, including life-forms, could be an artificial simulation, analogous to a computer simulation.

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