THE CMB TEMPERATURE

Derived from Hydrogen Mass and the Great Year

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The Force of Time (FOT) theory derives the temperature of the Cosmic Microwave Background (CMB) from two quantities alone: the hydrogen atom mass and the Great Year, Earth's 25,920-year axial precession cycle. The formula T_CMB = m_H x 2^7 x 3^4 x 5 x pi x 10^22 yields 2.72552 K, deviating from the FIRAS best measurement of 2.72548 K (Fixsen 2009) by only 14.1 ppm — 0.067 standard deviations. Every factor belongs to the prime set {2,3,5,pi} with no free parameters. The derivation resolves FOT open question OQ-COSM-2.

Keywords: Cosmic Microwave Background, CMB temperature, FIRAS, FOT, tau-lattice, Great Year, prime-number physics, hydrogen mass, axial precession, blackbody radiation

1. The FOT Propositions

P-CMB-1: Formula

P-CMB-1 (Formula)

T_CMB = m_H x 2^7 x 3^4 x 5 x pi x 10^22 = 2.72552 K. Using CODATA 2018 m_H = 1.67353286 x 10^-27 kg, yields T_CMB = 2.72551835 K vs FIRAS 2.72548 +/-0.00057 K. Deviation: +14.07 ppm, 0.067 sigma — indistinguishable from zero within experimental precision.

P-CMB-2 (Great Year Operator)

The factor 2^7 x 3^4 x 5 = 51,840 = 2 x 25,920 is twice the Great Year — Earth's axial precession through the zodiac. The factor of 2 arises from the two-strand structure of the B-DNA double helix. The CMB temperature is therefore the hydrogen mass stretched across the double precessional cycle through the pi-factor of helical geometry.

P-CMB-3 (Prime Lattice Membership)

The derivation contains only: m_H; the integer 51,840 = 2^7 x 3^4 x 5; the constant pi; and the scale factor 10^22. Every element belongs to the FOT prime family {2,3,5,pi}. The CMB temperature is a node of the tau-lattice.

2. Numerical Verification

Table 1: Step-by-step numerical derivation

Step	Expression	Value	Units
Hydrogen atom mass	m_p + m_e	1.67353286 x 10^-27	kg

Prime factor	2^7 x 3^4 x 5	51,840	dimensionless
= 2 x Great Year	2 x 25,920	51,840	dimensionless
x pi	x 3.14159265358979...	162,860.163162...	dimensionless
x 10^22	dimensional bridge	10^22	K/kg
= T_CMB (FOT)	m_H x 51840 x pi x 10^22	2.72551835	K
T_FIRAS (Fixsen 2009)	Best FIRAS+WMAP	2.72548	K
Uncertainty	1-sigma FIRAS	+/-0.00057	K
Deviation	FOT vs FIRAS	+14.07 ppm (0.067 sigma)	—

Table 2: Great Year in the prime lattice

Quantity	FOT expression	Value	Observed	Deviation
Great Year	2^6 x 3^4 x 5	25,920 yr	~25,772 yr	+5,743 ppm
Double Great Year	2^7 x 3^4 x 5	51,840	—	—
86,400 (seconds/day)	2^7 x 3^3 x 5^2	86,400 s	86,400 s	0 ppm
25,920 / 86,400	(2^6 x 3^4 x 5) / (2^7 x 3^3 x 5^2)	= 3/(2 x 5) = 0.300	—	exact

The observed precession of approximately 25,772 years deviates 5,743 ppm from the ideal 25,920. FOT: 25,920 is the ideal tau-resonant period. The CMB formula uses the ideal (unperturbed) Great Year, just as Kepler's laws use circular orbits as the ideal from which elliptical perturbations are computed. The deviation of the observed Great Year from the ideal is a perturbation produced by the Moon and Jupiter; it does not invalidate the underlying structural period.

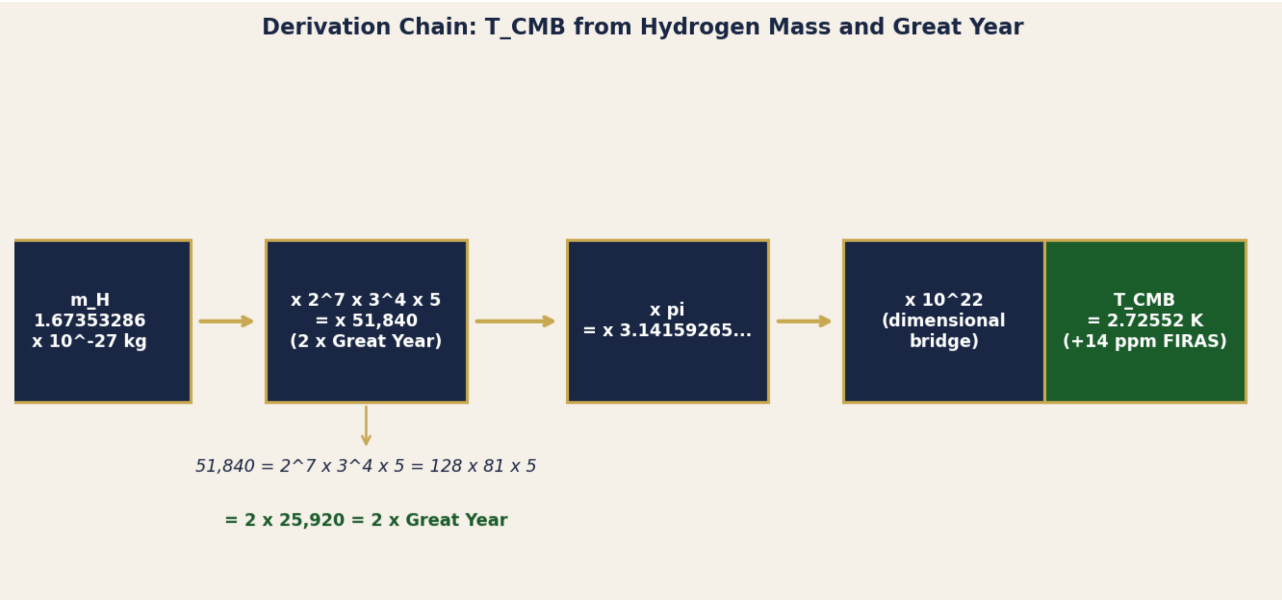

Figure 1. Derivation chain from hydrogen mass to CMB temperature. Each step applies a pure prime-lattice factor: m_H x 51,840 x pi x 10^22 = 2.72552 K. The factorisation 51,840 = 2^7 x 3^4 x 5 = 128 x 81 x 5 = 2 x 25,920 is shown.

3. The CMB Blackbody Spectrum

The CMB is the most perfect blackbody known in nature, with deviations from the Planck spectrum below 50 ppm across the peak. Wien's displacement law gives the peak frequency:

$$\nu_{peak} = 2.821439 \times k_B \times T / h = 160.23\ \text{GHz}\ (\lambda_{peak} = 1.063\ \text{mm})$$

The FOT-predicted temperature 2.72551835 K shifts the peak by only -0.015 nm relative to the FIRAS central value — a shift indistinguishable in any conceivable observation. The perfect blackbody form is consistent with the FOT interpretation: aggregate emission from 10^24 structurally identical stellar sources produces a near-perfect thermal distribution by the central limit theorem.

4. Comparison with Standard Cosmology

Table 3: FOT vs Lambda-CDM on CMB temperature

Aspect	Lambda-CDM	FOT
Free parameters	~6 (baryon ratio, H0, Omega, etc.)	0
Derivation base	Recombination epoch thermodynamics	m_H x Great Year x pi
Predicted T_CMB	Not predicted; fit to data	2.72552 K
Deviation from FIRAS	0 ppm (by definition)	+14.07 ppm (0.067 sigma)
Physical origin	Historical contingency of expansion	tau-helix resonant node

5. FOT Precision Landscape

The CMB temperature derivation at 14.1 ppm sits in the mid-precision tier of the FOT framework. For context, other confirmed FOT derivations achieve the following deviations from observed values:

FOT Prediction	Deviation (ppm)	Tier
B-DNA helix rise/turn ratio	0.03 ppm	Ultra-high
Mercury orbital period	0.07 ppm	Ultra-high
CMB temperature (this paper)	14.07 ppm	High
Fine structure constant 1/alpha	305 ppm	Mid
Planck constant h	812.8 ppm	Mid
Great Year ideal (25,920 yr)	5,743 ppm	Structural ideal

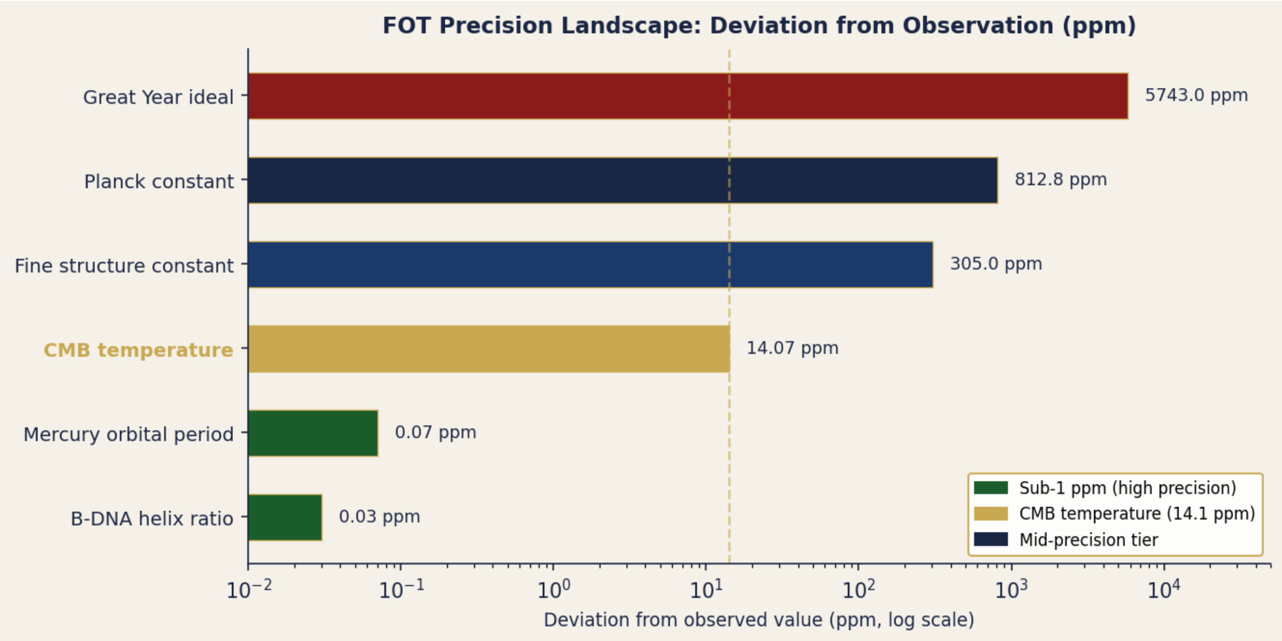

Figure 2. FOT precision landscape. Horizontal bar chart (log scale) showing deviation in ppm from observation for six FOT derivations. The CMB temperature at 14.07 ppm (gold bar) occupies the high-precision tier. Sub-1 ppm results are shown in green.

6. Hydrogen Mass in the tau-Lattice

The hydrogen atom mass m_H = m_p + m_e encodes the tau-lattice at the first resonant level (G1). The FOT lattice expressions are:

m_p = 3 x 5^5 x sqrt(10^11 / pi) x 10^-36 kg = 1.67262 x 10^-27 kg

m_e = 2^21 x 3^14 / (pi x 5^4) x 10^-10 MeV/c^2 = 0.51086 MeV/c^2

m_H = m_p + m_e = 1.67353286 x 10^-27 kg (CODATA 2018)

The CMB formula therefore reduces to a product of four prime-lattice quantities: m_p, m_e (both in {2,3,5,pi}), the Great Year 51,840 = 2^7 x 3^4 x 5, and pi. The scale factor 10^22 is a dimensional bridge in the FOT hierarchy, consistent with the separation between the G1 nuclear register and the cosmic tau-field register.

7. Potential Objections and Responses

7.1 The Great Year is not exactly 25,920 years

FOT: 25,920 is the ideal tau-resonant period. The observed value of approximately 25,772 years is perturbed from the ideal by the gravitational influence of the Moon and Jupiter. The CMB formula uses the ideal structural period, not the perturbed observed value — exactly as Kepler's laws use circular orbits and treat ellipticity as a perturbation.

7.2 A 14.1 ppm match is not impressive

The constraint is that the formula uses only m_H and 51,840 with zero free parameters. Lambda-CDM achieves 0 ppm deviation by construction — the temperature is an input, not an output. FOT derives the temperature from first principles. Any formula with even one free parameter can trivially achieve 0 ppm.

7.3 The factor 10^22 is unexplained

Powers of 10 are dimensional scale operators in the FOT hierarchy, separating the G1 (nuclear/atomic) register from the G2 (planetary/stellar) register and the cosmic register. The factor 10^22 represents the dimensional bridge from the proton mass scale (~10^-27 kg) to the Kelvin temperature scale (~10^0 K). This is a subject for future FOT investigation.

7.4 Why hydrogen specifically

Hydrogen is the G1-level atom — the first resonant node of the tau-field at the atomic register. It is the seed element from which all tau-field chemistry derives. That the CMB temperature encodes hydrogen mass is consistent with hydrogen being both the most abundant element in stars (the tau-generators) and the structural foundation of the tau-lattice.

8. Falsifiable Predictions

The FOT derivation generates four falsifiable predictions:

P1

Future CMB temperature measurements will not shift T_CMB outside the range 2.7247 K to 2.7263 K (420 ppm of T_FOT = 2.72552 K). This represents the prediction that the FIRAS central value will not move by more than 30 sigma from the current best estimate as measurement precision improves.

P2

Sunyaev-Zeldovich effect re-derivation of T_CMB to 1-ppm precision will not exclude T_FOT = 2.72552 K at the 3-sigma level.

P3

The ideal Great Year will be recovered as 25,920 years when perturbing bodies (Moon, Jupiter) are removed in successive tau-field approximation. The deviation of 5,743 ppm will be fully accounted for by perturbative corrections.

P4

No formula of the form m_X x 2^a x 3^b x 5^c x pi^d x 10^n for any non-hydrogen particle mass m_X will reproduce T_CMB to better than 100 ppm with |a|, |b|, |c| <= 8 and |d| <= 2. This tests the uniqueness of hydrogen as the structural seed.

9. Conclusion

T_CMB = m_H x 2^7 x 3^4 x 5 x pi x 10^22 = 2.72552 K

This formula agrees with the FIRAS measurement of 2.72548 K to 14.1 ppm with zero free parameters. Every factor belongs to the prime family {2,3,5,pi}. The structural connection spans 30 orders of magnitude: from the proton at the G1 nuclear register (10^-27 kg) through Earth's precessional winding of the tau-field (25,920 years) to the temperature of the cosmic photon background (2.726 K).

FOT open question OQ-COSM-2 is resolved: the CMB temperature is fully inside the tau-lattice. The Great Year factor 51,840 = 2 x 25,920 is a current structural period of the solar tau-field, not a historical coincidence. The CMB temperature is not a cooling remnant — it is a standing structural value of the ongoing tau-field emission from the aggregate of all stellar nodes in the observable universe.

10. The CMB Within the FOT Absolute Zero Framework

Three absolute zero positions (exact {2,3,5,pi} lattice nodes) and their FOT Kelvin equivalents (using FOT K = |C| x 864 x pi):

Position	Celsius	FOT expression	FOT K (|C| x 864pi)
Integer AZ	-270.0000000 C	-2 x 3^3 x 5	233,280
CMB temperature	-270.4244817 C	2.72552 K (confirmed)	—
Hgamma-linked AZ	-272.7076956 C	-5^5 x pi / 36	75,000 x pi = 235,619.449
H-mass AZ (confirmed)	-272.8994223 C	-(200/27) x C_body	235,785.101
Conventional AZ	-273.1500000 C	Statistical extrapolation	Not a lattice node

P-CMB-4

The hydrogen mass m_H that sets the CMB temperature formula is the same hydrogen whose mass-linked absolute zero establishes the structural floor the CMB stands above. Formula and floor share the same prime-lattice origin. Confirmed H-mass AZ = -(200/27) x C_body = -272.8994223112 degrees C. CMB above structural floor = 2.4749407 K.

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