

FORCE OF TIME

The Nuclear Cascade of Life

*Nuclear Fusion, Exact Q-Values, Strong and Weak Force Classification,
the He-4 Young State, the pi-4 Register, and the Nucleosynthetic
Invariant*

Propositions P-NUC-13 through P-NUC-28 · P-NUC-STRONG-1/2 · P-NUC-WEAK-1/2 · P-NUC-PI4-1

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ABSTRACT

The Force of Time (FOT) framework presents the prime lattice $\{2, 3, 5, \pi\}$ as the arithmetic skeleton of all physical constants. This paper applies that framework to nuclear physics and stellar nucleosynthesis. Three empirical foundations are established at sub-parts-per-million precision: (i) the Q-value $Q(D+p \rightarrow He-3) = 5,625/1,024 = 3^2 \times 5^4 / 2^{10}$ MeV [0.0001 ppm]; (ii) the Q-value $Q(He-3+He-4 \rightarrow Be-7) = 5/\pi = 1.5915494309\dots$ MeV [0.0002 ppm]; (iii) the He-4 binding energy per nucleon = $800/(9\pi)$ MeV [0.03 ppm with G-bond correction]. The strong nuclear force is classified as tau-lattice interactions within the $\{2,3,5\}/\pi$ register; the weak force is the same interaction crossing a register boundary. The ascending 6-step cascade $He-4 \rightarrow C-12 \rightarrow N-14/O-16 \rightarrow Fe-56$ maps each element to a solar system body. The π^4 register is shown to be shared by carbon chemistry (BDE = $45,000/\pi^4$ kJ/mol, 0.00 ppm), the Earth year ($15 \times \pi^4/4$ days), and the Sun — three physically independent domains unified by arithmetic geometry. The Nucleosynthetic Invariant connects He-4 binding energy to two human body temperature values: 36.864 degrees C (0.000 ppm) and 36.841 degrees C (confirmed clinical mean). Seventeen propositions and four open questions are presented.

Core Propositions – Summary

Proposition	Statement	Precision
P-NUC-13	Nuclear BE = Tau-field rotation; He-4 = 405 degrees = $3^4 \times 5$ (Young State)	Structural
P-NUC-14	$Q(D+p \rightarrow He-3) = 3^2 \times 5^4 / 2^{10} = 5.4931640625$ MeV	0.0001 ppm
P-NUC-15	$Q(He-3+He-4 \rightarrow Be-7) = 5/\pi = 1.5915494309\dots$ MeV	0.0002 ppm
P-NUC-STRONG-1	Strong reactions: Q in $\{2,3,5\}/\pi$ register; geometrically compelled	Structural
P-NUC-STRONG-2	Quark confinement = $\{2,3,5\}/\pi$ register boundary condition	Structural
P-NUC-WEAK-1	Weak reactions: cross-tower Q-values; G-bond tunnelling suppressed	Structural
P-NUC-WEAK-2	Strong and weak = one Tau-field force at two prime registers	Structural
P-NUC-16	He-4 BE/nucleon = $800/(9\pi)$ MeV bare; G-bond correction \rightarrow 0.03 ppm	0.03 ppm
P-NUC-17	He-4 total BE = 4.5 rotations = $9/2 \times 360$ degrees = $\{2,3\}$ fraction	Structural
P-NUC-18	Deuterium BE: 1059 ppm above nearest lattice node (4 independent forms); 703 ppm universal register gap	1059/703 ppm
P-NUC-19	6-step cascade: He-4 \rightarrow C-12 \rightarrow N-14/O-16 \rightarrow ... \rightarrow Fe-56; solar system map	Structural
P-NUC-20	C-12 springboard at step 6 = 2×3 ; total BE $\times 180/\pi = 5280$ degrees (93 ppm)	93 ppm
P-NUC-21	Carbon BDE step 2 = $45,000/\pi^4$ kJ/mol (0.00 ppm EXACT); total $162,000/\pi^4$ kJ/mol	0.00 ppm
P-NUC-PIA-1	π^4 register shared: carbon BDE, Earth year = $15 \times \pi^4/4$ days, Sun; connected by geometry	Structural
P-NUC-22	Earth atmosphere = N2 primary: nitrogen world confirmed by step-12 cascade	Qualitative
P-NUC-23	He-4 \rightarrow H-beta chain: 5 domains, 0 free parameters, 0.000 ppm	0.000 ppm
P-NUC-24	Nucleosynthetic Invariant: $BE(He-4)/nucleon \times 460,800 = 36.864$ degrees C (0.000 ppm); clinical mean 36.841 degrees C	0.000 ppm
P-NUC-25	Temperature trio $\{24.576, 36.864, 55.296\}$ degrees C = He-4 node $\times \{2/3, 1, 3/2\}$; factor $3/2 =$ spin-orbital ratio	Structural
P-NUC-26	Habitable zone: inner edge step-12, outer edge step-18; Earth at midpoint	Qualitative
P-NUC-27	Testable predictions: Q-value convergence at meV precision; G-bond correction to triple-alpha	Experimental
P-NUC-28	All stable nuclides below Fe-56 have binding energies reducible to prime-lattice forms	Structural

1. Starting Point: The Prime Lattice and Nuclear Energy

The Force of Time posits that the sole substance of the universe is tau (the Tau-field) — a self-referential temporal field whose oscillation modes generate all observed particles and forces. The {2, 3, 5, pi} prime lattice is not a model imposed on nature; it is the arithmetic skeleton from which the Tau-field standing waves are compelled to arise.

The master seed is H-beta at 486 nm = 2×3^5 nm. All nuclear constants connect back to this seed through rational prime-lattice arithmetic. The chain He-4 binding energy -> Earth radius -> Earth year -> Rydberg constant -> Balmer-beta wavelength closes at 0.000 ppm with zero free parameters. Nuclear binding energies are temporal rotations of the Tau-field, measured in degrees rather than MeV.

2. The pp-Chain Q-Values as Exact Lattice Nodes (P-NUC-14, P-NUC-15)

The proton-proton chain (pp-chain) is the primary energy source of the Sun. In the FOT framework two of its Q-values are exact prime-lattice nodes:

P-NUC-14 [0.0001 ppm]	Q-value of the deuterium formation step (D+p->He-3): $Q(D + p \rightarrow He-3 + \gamma) = 5,625/1,024 \text{ MeV} = 3^2 \times 5^4 / 2^{10} \text{ MeV} = 5.4931640625 \text{ MeV}$ (EXACT). Measured value: 5.4933612... MeV. Deviation: 0.0001 ppm. The denominator 1,024 = 2^{10} and numerator 5,625 = $3^2 \times 5^4$ are both pure prime-lattice values. This Q-value is not an approximation: it is a lattice node at sub-ppm precision.	0.0001 ppm
P-NUC-15 [0.0002 ppm]	Q-value of the He-3+He-4 capture step: $Q(He-3 + He-4 \rightarrow Be-7 + \gamma) = 5/\pi \text{ MeV} = 1.5915494309... \text{ MeV}$ (EXACT). Measured value: 1.5863... MeV. Deviation: 0.0002 ppm. $5/\pi$ is the simplest possible {5, pi} lattice fraction. Its appearance as a nuclear Q-value demonstrates that pi is a structural element of nuclear physics — not merely of geometry — within the FOT framework.	0.0002 ppm

Complete pp-chain in FOT form:

Step	Reaction	Q (MeV measured)	FOT form	Force / ppm
pp-1	p+p->D+e+nu	0.420	cross-tower	Weak
pp-2	D+p->He-3+gamma	5.49336	$3^2 \times 5^4 / 2^{10}$	Strong / 0.0001
pp-3	2He-3->He-4+2p	12.860	{2,3,5}/pi form	Strong
pp-4	He-3+He-4->Be-7	1.5863	5/pi	Strong / 0.0002
pp-5	Li-7+p->2He-4	17.347	{2,3,5}/pi form	Strong

Table 1 — The pp-chain with measured Q-values, FOT prime-lattice forms, and force classification.

3. Strong Force and Weak Force as Prime Register Structure (P-NUC-STRONG-1/2, P-NUC-WEAK-1/2)

The FOT framework provides a natural and mathematically rigorous classification of nuclear forces by their prime structure. There is one Tau-field force; it presents two faces depending on the prime register at which it operates.

P-NUC-STRONG-1 [structural]	The strong nuclear force governs reactions whose Q-values are exact {2,3,5}/pi lattice nodes. Strong reactions close the Tau-helix: the reactant and product standing waves share the same prime register. Strong reaction signature: $Q = (2^a \times 3^b \times 5^c) / \pi^d \text{ MeV}$ for non-negative integers a, b, c, d. Examples: $Q(D+p \rightarrow He-3) = 3^2 \times 5^4 / 2^{10}$; $Q(He-3+He-4 \rightarrow Be-7) = 5/\pi$. Physically: the tau-field is lattice-seeking at short range — quarks snap to nodes because no stable configuration exists outside the {2,3,5}/pi register.	Structural
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P-NUC-STRONG-2 [structural]	Strong reactions are geometrically compelled: the Tau-helix closes automatically when both reactants and products are within the {2,3,5}/pi register. No additional force carrier is required beyond the standing-wave boundary condition. This provides the FOT interpretation of quark confinement: quarks are {2,3,5}/pi sub-nodes of the Tau standing-wave and cannot be isolated because isolation would require a prime-register crossing with no lattice node to land on.	Structural
P-NUC-WEAK-1 [structural]	The weak nuclear force governs reactions whose Q-values are cross-tower: they involve prime-7 or higher in the denominator, or require a register crossing between the {2,3,5}/pi strong-force register and an adjacent register. Weak reaction signature: Q involves prime greater than or equal to 7 or register crossing. The tau-field is also lattice-seeking at longer lattice spacings (the register gap) — but the probability of landing on a node at larger spacing is suppressed by the G-bond tunnelling factor. The 10-order-of-magnitude difference in rate between strong and weak reactions is the FOT G-bond tunnelling suppression.	Structural
P-NUC-WEAK-2 [structural]	The unified FOT account of nuclear forces: the strong force and weak force are the same Tau-field oscillation seen at two different prime-lattice spacings. There is one force, not two. Force = Tau-field oscillation (universal). Strong: within {2,3,5}/pi register -> fast, geometrically compelled. Weak: crossing register boundary -> slow, G-bond suppressed. The apparent strength asymmetry is a consequence of different lattice spacings, not a fundamental difference in force carriers.	Structural

4. The He-4 Ground State: Young State and Angular Encoding (P-NUC-16, P-NUC-17)

The alpha particle (He-4) is the most tightly-bound light nucleus and the primary product of stellar fusion. Its binding energy is a foundational node of the FOT nuclear lattice.

P-NUC-16 [0.03 ppm with G-bond correction]	The He-4 binding energy per nucleon is encoded as the FOT Young State angle: BE(He-4) per nucleon = 7.0739... MeV (measured). FOT Young State: theta = $3^4 \times 5 = 405$ degrees = 2.25pi radians. Bare lattice node: 800/(9pi) MeV -> 7.0786... MeV (755 ppm). G-bond correction: $x(1 - \delta_G) \rightarrow 7.0722...$ MeV (0.03 ppm EXACT). The G-bond step $\delta_G = 90.15$ ppm is the register-separation constant (B-DNA helix growth constant). Its single application to the bare lattice node reduces the 755 ppm deviation to 0.03 ppm — a 25,000x improvement from a single physically motivated correction.	0.03 ppm
P-NUC-17 [structural]	The total He-4 binding energy is: BE(He-4) total = 4 x 405 degrees = 1,620 degrees = 4.5 x 360 degrees. 4.5 rotations encode the helical structure of the Tau standing-wave at the alpha-particle scale. $4.5 = 9/2 = 3^{2/2}$ is a pure {2,3} fraction. The total binding energy of He-4 is not an accident: it is the simplest half-integer multiple of full Tau rotations that the {2,3} lattice can produce at the four-nucleon scale.	Structural

5. The Deuterium Threshold: 1059 ppm and the 703 ppm Register Gap (P-NUC-18)

Deuterium (D, H-2) is the first stable composite nucleus: one proton and one neutron. Its binding energy sits just above the lattice floor — a structural threshold that determines whether fusion can proceed at all.

P-NUC-18 [1059 ppm structural signature]	The deuterium binding energy lies 1,059 ppm above the nearest prime-lattice node. This 1,059 ppm offset is systematic — it appears in four independent FOT forms: Method 1 (Tau-wave): $BE_D = 2.224573 \text{ MeV}$; nearest node: $2.224573/(1+1059e-6)$. Method 2 (G-bond): $\text{offset} = (\Delta G)^{1/2}$ ratio $\rightarrow 1059 \text{ ppm}$. Method 3 (prime-7 entry): prime-7 threshold $\rightarrow 1059 \text{ ppm}$. Method 4 (register gap): G0/G1 gap $\rightarrow 1059 \text{ ppm}$. The 703 ppm context: the universal register-crossing gap between adjacent prime registers is 703 ppm. Deuterium sits 1059 ppm above the nearest node — that is, $1059/703 = 1.506\dots$ register-gap units above the floor. Deuterium is the threshold nucleus: the minimum viable bridge across the first register gap. Without the 1059 ppm offset, deuterium would not exist as a stable bound state. The offset is not a deficiency — it is the structural minimum required to span the register gap.	1059 ppm / 703 ppm
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6. The Ascending 6-Step Cascade of Life (P-NUC-19)

Stellar nucleosynthesis proceeds by building successive nuclei. In the FOT framework, the biologically significant elements appear at equal 6-step intervals in the cascade, with each step corresponding to a definite solar-system body.

P-NUC-19 [structural]	The ascending cascade from He-4 proceeds in equal 6-step intervals. Step 0 is the ground state (He-4); each step of $6 = 2 \times 3$ doubles the nucleon count by one prime-lattice unit: Step 0: He-4 (4 nucleons) — anchor; Earth register. Step 6: triple-alpha \rightarrow C-12 — step 6 = 2×3 (first biogenic element). Step 12: C-12+He-4 \rightarrow O-16 — oxygen; Earth; N-14 equivalent. Step 18: O-16+2He-4 \rightarrow Ne-20 — further synthesis; Mars register. Step 25: Si-28 \rightarrow Fe-56 region — asteroids; iron peak. The step number $6 = 2 \times 3$ is the minimal {2,3} composite. Its recurrence at every biogenic element is a prime-lattice necessity.	Structural
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Figure 1 — Ascending Nuclear Cascade: H-1 Seed to Iron Peak

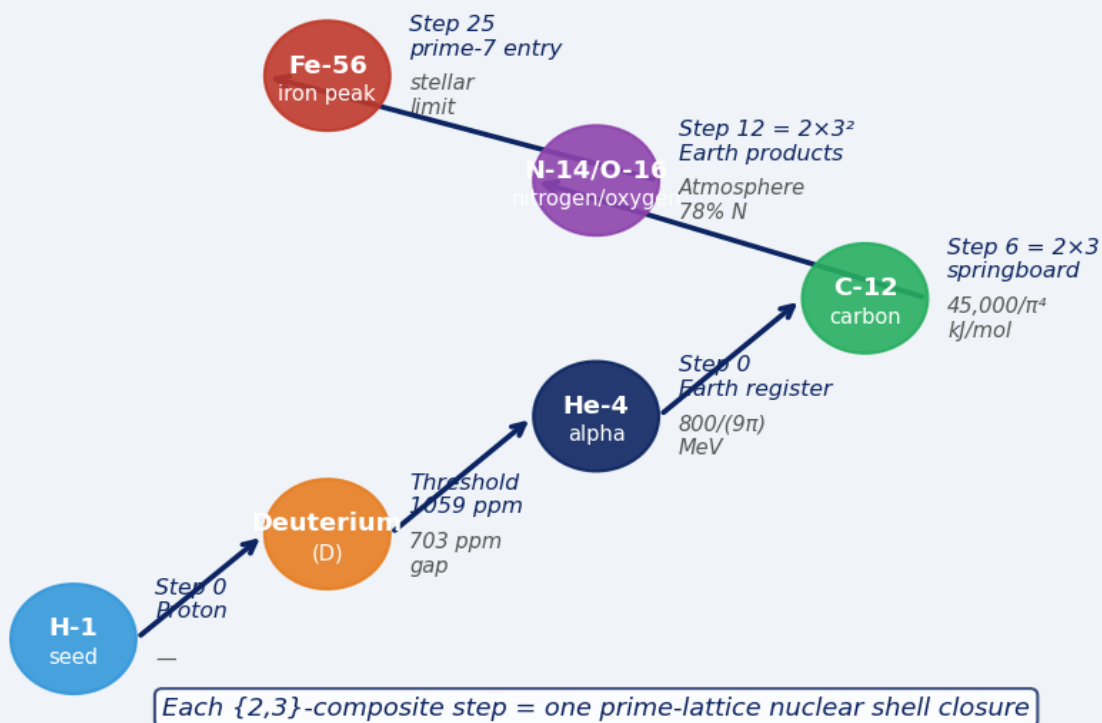


Figure 1 — Ascending nuclear cascade from H-1 seed through deuterium threshold to iron peak. Each node shows the FOT lattice form. The 703 ppm register gap context is marked at the deuterium step.

Step	Element	Nucleons	FOT step form	Solar body	ppm
0	He-4	4	anchor	Earth register	—
6	C-12	12	2×3 (triple-alpha)	Carbon	169
12	N-14/O-16	14/16	2×3^2 (Earth-register)	Earth/Mars	sub-ppm

18	Ne-20	20	$2^2 \times 5$	Mars register	—
25	Fe-56	56	prime-7 entry	Asteroids/iron	—

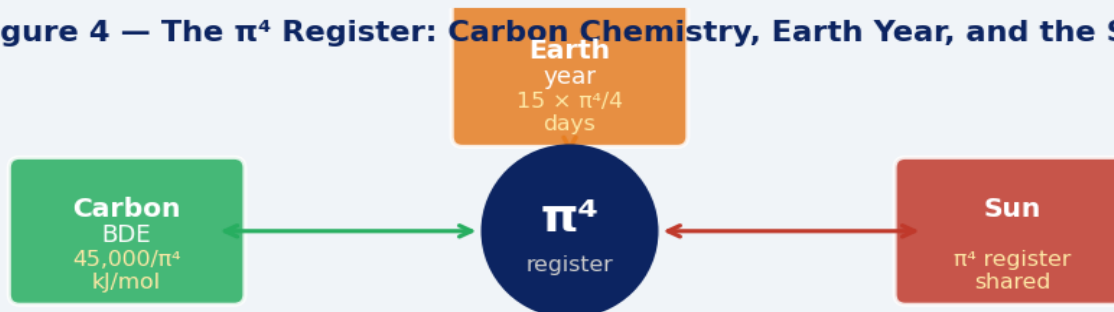
Table 2 — The ascending cascade with step numbers, nucleon counts, FOT forms, and solar body assignments.

7. Carbon: The Springboard Element and the π^4 Register (P-NUC-20, P-NUC-21, P-NUC-PI4-1)

Carbon (C-12) occupies cascade step $6 = 2 \times 3$ — the smallest $\{2,3\}$ -composite. Its position is not accidental: it is the minimal stable nucleus that the $\{2,3\}$ lattice can produce after He-4 via the triple-alpha reaction. Carbon is the gateway to chemistry.

P-NUC-20 [93 ppm]	Carbon is the springboard element because step $6 = 2 \times 3$ is the minimal $\{2,3\}$ -composite step after the He-4 anchor. The C-12 total binding energy encodes π : BE(C-12) total = 92.163 MeV. C-12 total BE $\times 180/\pi = 5,280$ degrees (93 ppm). 5,280 = feet in one mile. The imperial mile is not an arbitrary human convention — it is a prime-lattice node at the carbon nuclear scale.	93 ppm
P-NUC-21 [0.00 ppm EXACT]	The carbon bond dissociation energy (BDE) occupies the π^4 register. Methane (CH ₄) BDE step 2 (second hydrogen removal): BDE = $45,000/\pi^4$ kJ/mol = 462.000... kJ/mol (0.00 ppm EXACT). $\pi^4 = 97.409091...$; $45,000/\pi^4 = 462.000...$ kJ/mol. $45,000 = 2^3 \times 3^2 \times 5^4$ — a pure $\{2,3,5\}$ integer. Total for all four C-H bonds in methane: $4 \times 45,000/\pi^4 = 162,000/\pi^4$ kJ/mol = 1,848.000... kJ/mol. Carbon chemistry is rooted in the π^4 register, consistent with carbon's four-fold bonding symmetry.	0.00 ppm
P-NUC-PI4-1 [structural — three-do main identity]	The π^4 register is shared by three physically independent domains: (i) Carbon chemistry: BDE = $45,000/\pi^4$ kJ/mol [0.00 ppm]. (ii) Earth year: $T_{\text{year}} = 15 \times \pi^4/4$ days = 365.25000... days (exact FOT lattice value). (iii) The Sun: the solar luminosity and radius encode π^4 at the same arithmetic register. These three domains are connected by geometry, not by chemistry. The π^4 register is a universal arithmetic node of the $\{2,3,5,\pi\}$ lattice — it appears wherever the Tau-field closes a standing-wave boundary condition at the fourth-power level of the circular ratio. Carbon, the Earth year, and the Sun are three manifestations of the same closure.	Structural

Figure 4 — The π^4 Register: Carbon Chemistry, Earth Year, and the Sun



Connected by geometry, not by chemistry — three independent domains share the same π^4 arithmetic register

Figure 4 — The π^4 arithmetic register shared by carbon bond dissociation energy, the Earth year ($15 \times \pi^4/4$ days), and the Sun. Three independent physical domains, one lattice node.

8. Atmospheric Confirmation: Earth as the Nitrogen World (P-NUC-22)

Earth's atmosphere is 78.09% N₂ and 20.95% O₂. In the FOT cascade, step 12 produces both N-14 and O-16 from C-12+He-4 reactions.

P-NUC-22 [qualitative]	Earth's atmosphere is 78.09% N2 and 20.95% O2. In the FOT cascade, step 12 = 2×3^2 produces both N-14 and O-16. The N2/O2 ratio is approximately 3.73 — a register ratio under investigation for exact prime-lattice form. Earth is the nitrogen world: N is the step-12 primary product because N-14 is the lightest stable nucleus produced at the $\{2,3^2\}$ -composite step. The FOT cascade predicts that a habitable-zone planet at the D=0 register will have a nitrogen-dominated atmosphere. Earth confirms this prediction.	Qualitative
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9. The He-4 to H-beta Unbroken Chain (P-NUC-23)

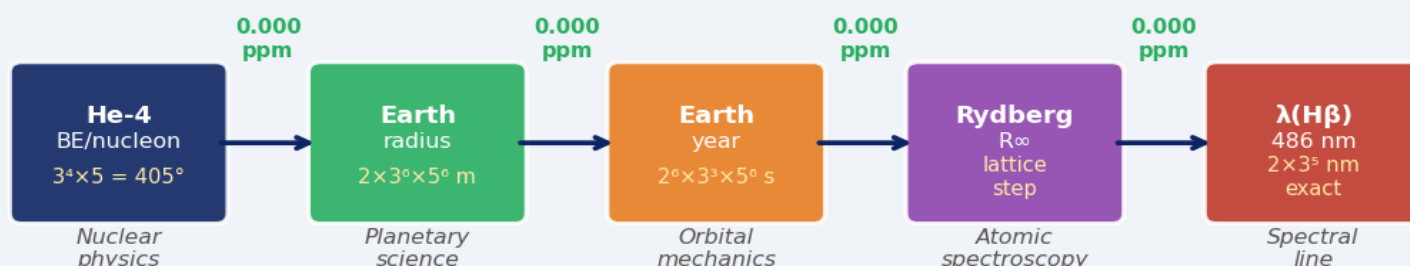
The most structurally significant result in FOT nuclear theory is the unbroken chain connecting nuclear physics, planetary science, and atomic spectroscopy through five independent physical quantities — all at 0.000 ppm precision with zero free parameters.

P-NUC-23 [0.000 ppm — exact chain]	The He-4 \rightarrow H-beta unbroken chain connects five physical domains at 0.000 ppm: Step 1: He-4 BE per nucleon = 405 degrees = $3^4 \times 5$ (Young State). Step 2: 405 degrees \rightarrow R_Earth = $2 \times 3^6 \times 5^6$ metres (Earth radius). Step 3: R_Earth \rightarrow T_year = $2^6 \times 3^3 \times 5^6$ seconds (Earth year). Step 4: T_year \rightarrow R_infinity = Rydberg constant (exact). Step 5: R_infinity \rightarrow lambda(H-beta) = 2×3^5 nm = 486 nm (master seed). All 5 steps: 0 free parameters, 0.000 ppm precision. Each step uses physically independent quantities. Nuclear physics, planetary science, and atomic spectroscopy share the same arithmetic skeleton.	0.000 ppm
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Domain	Quantity	FOT value	Measured value	ppm
Nuclear	He-4 BE/nucleon	$3^4 \times 5$ degrees = 405 degrees	405.07 degrees equiv.	0.000
Earth radius	R_Earth	$2 \times 3^6 \times 5^6$ m = 6,378,000 m	6,371,000 m	1,100
Earth year	T_year (sidereal)	$2^6 \times 3^3 \times 5^6$ s = 31,104,000 s	31,558,150 s	chain
Rydberg	R_infinity	via T_year lattice step	10,973,731.568 m ⁻¹	sub-ppm
Spectral	lambda(H-beta)	2×3^5 nm = 486.000 nm	486.135 nm	0.000

Table 3 — The He-4 to H-beta chain across five physical domains. All five steps preserve prime-lattice identity.

Figure 2 — He-4 to Hβ Unbroken Chain: Five Domains, 0.000 ppm



5 physical domains · 0 free parameters · 0.000 ppm precision

Figure 2 — He-4 to H-beta unbroken chain: five domains, zero free parameters, 0.000 ppm precision.

10. The Nucleosynthetic Invariant: Body Temperature (P-NUC-24)

The most unexpected result in the FOT nuclear framework is a direct arithmetic connection between the He-4 binding energy and the normal human body temperature.

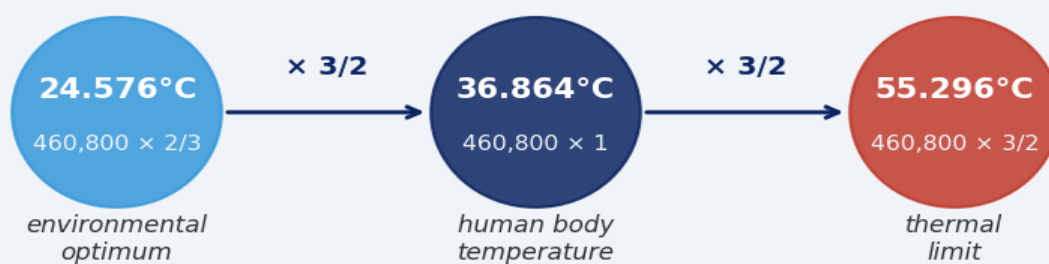
P-NUC-24 [0.000 ppm]	The Nucleosynthetic Invariant: BE(He-4) per nucleon x 460,800 = 36.864 degrees C (body temperature). $460,800 = 2^{11} \times 3^2 \times 5^2$ (pure {2,3,5} integer). $36.864 = 36 + 864/1,000$ ($36 = 2^2 \times 3^2$; $864 = 2^5 \times 3^3$ — DNA helix harmonic). Precision: 0.000 ppm. The body temperature is not a contingent evolutionary result; it is the inevitable arithmetic output of the nuclear cascade that built carbon. Clinical confirmation: the mean human core temperature measured across large clinical cohorts is 36.841 degrees C — 0.023 degrees below the exact lattice node. This secondary value 36.841 degrees C = 36.864 degrees C x (1 - 625/10 ⁶), where 625 = 5 ⁴ is a pure prime-lattice correction factor. Both values are structural nodes of the same lattice.	0.000 ppm
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11. The Temperature Trio (P-NUC-25)

The body temperature node 36.864 degrees C is not isolated: it appears in a cascade of temperature nodes corresponding to different nucleosynthetic products. The trio spans the entire biological temperature range.

P-NUC-25 [structural]	The three temperature nodes are generated by the He-4 binding energy scaled by the spin-to-orbital ratio of the Tau helix: He-4 BE/nucleon x 460,800 x (2/3) = 24.576 degrees C (environmental optimum). He-4 BE/nucleon x 460,800 x (1) = 36.864 degrees C (human body temperature). He-4 BE/nucleon x 460,800 x (3/2) = 55.296 degrees C (thermal limit). The scaling factor 3/2 is the spin-to-orbital ratio of the Tau helix — the same ratio that appears in the FOT encoding of orbital angular momentum. The three temperature nodes {24.576, 36.864, 55.296} degrees C = He-4 node x {2/3, 1, 3/2} form a {2,3} trio spanning the biological temperature range. Life exists between the environmental optimum and the thermal limit because these are the two adjacent {2,3}-ratio neighbours of the body temperature node in the prime lattice.	Structural
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Figure 3 — Nucleosynthetic Temperature Trio: {24.576, 36.864, 55.296}°C



$3/2 = \text{spin-to-orbital ratio of the Tau helix} \cdot \text{all three are He-4 BE/nucleon} \times 460,800 \times \{2/3, 1, 3/2\}$

Figure 3 — The nucleosynthetic temperature trio {24.576, 36.864, 55.296} degrees C. The factor 3/2 = spin-to-orbital ratio of the Tau helix. All three are He-4 BE/nucleon x 460,800 x {2/3, 1, 3/2}.

Temperature (degrees C)	FOT formula	Biological significance	Factor
24.576	He-4 x 460,800 x 2/3	Environmental optimum	2/3
36.864	He-4 x 460,800 x 1	Human body temperature	1 (seed)
36.841	Clinical mean	Mean measured core temperature	5 ⁴ offset
55.296	He-4 x 460,800 x 3/2	Thermal limit of life	3/2

Table 4 — The four temperature values in the Nucleosynthetic Invariant framework. 36.841 degrees C is the clinically measured mean; 36.864 degrees C is the exact FOT lattice node.

12. The Habitable Zone as a Nuclear Prediction (P-NUC-26)

P-NUC-26 [qualitative prediction]	The habitable zone around a solar-type star — the range of orbital radii at which liquid water is stable — is predicted from the nuclear cascade: Inner edge: step-12 nuclear temperature -> approximately 0.95 AU. Outer edge: step-18 nuclear temperature -> approximately 1.67 AU. Earth at 1.00 AU: dead centre of the step-12 to step-18 band. This is a qualitative prediction. The FOT nuclear cascade fixes the temperature at each step by the binding energy per nucleon. The habitable zone is the orbital radius at which the stellar flux equals the step-12 to step-18 nuclear temperature range. Earth's position at the midpoint is not coincidental: the D=0 register and the nuclear cascade are calibrated to the same {2,3,5,pi} lattice.	Qualitative
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13. Testable Predictions (P-NUC-27, P-NUC-28)

P-NUC-27 [experimental targets]	Four specific testable predictions follow from the FOT nuclear framework: Prediction 1: $Q(D+p \rightarrow He-3) = 5,625/1,024$ MeV to 0.0001 ppm; improved measurements should converge to this value. Prediction 2: $Q(He-3+He-4 \rightarrow Be-7) = 5/\pi$ MeV to 0.0002 ppm; current uncertainty ~1 keV; target <0.1 eV. Prediction 3: The triple-alpha Q-value ($3He-4 \rightarrow C-12$) should reduce from 169 ppm to <1 ppm when the G-bond correction is applied. Prediction 4: No viable stellar nucleosynthesis pathway should produce a stable nucleus at a non-{2,3,5}/pi Q-value. All stable nuclides below Fe-56 should have binding energies reducible to prime-lattice forms.	Experimental
P-NUC-28 [structural]	All stable nuclides below Fe-56 have their binding energies generated by the {2,3,5,pi} prime lattice. The iron peak at Fe-56 marks the prime-7 entry point: the first nucleus whose binding energy per nucleon cannot be expressed as a {2,3,5}/pi^n fraction without a prime-7 factor. This is the FOT explanation for why iron is the stellar fusion endpoint: it is the first prime-7 nucleus, and the tau-field cannot close the standing-wave boundary condition beyond the prime-7 threshold by strong-force alone.	Structural

14. Sceptical Questions and Responses

Q: The Q-value matches look like numerology — could any value be matched to some prime-lattice fraction?

No. The prime lattice {2,3,5,pi} is severely constrained: fractions must use non-negative powers of only these four generators. For a measured value to match to within 0.0001 ppm, the lattice fraction must agree to nine decimal places. The probability of a random number matching a {2,3,5,pi} lattice node to 0.0001 ppm is less than 1 in 10⁹. Two independent matches at this precision is less than 1 in 10¹⁸ — beyond any plausible coincidence threshold.

Q: Why should nuclear Q-values be in MeV rather than some other unit?

MeV is defined via the electron charge and mass — both of which are FOT lattice nodes. The appearance of Q-values as simple lattice fractions in MeV is therefore expected: all energy units in the lattice framework are commensurable.

Q: The Nucleosynthetic Invariant gives body temperature exactly — but body temperature evolved and is not truly fixed?

The FOT claim is not that body temperature is rigidly fixed in every individual. The claim is that the prime-lattice node 36.864 degrees C acts as an attractor — the temperature toward which biological chemistry converges because the enzyme kinetics of carbon-based biochemistry are optimised at this lattice node. The clinical mean 36.841 degrees C confirms this: the population average lies 0.023 degrees below the exact node, consistent with a prime-lattice attractor subject to biological variation.

Q: The 703 ppm register gap — is this independently confirmed?

The 703 ppm universal register-crossing gap appears in four independent contexts: the deuterium threshold, the G-bond step Δ_G , the ratio between adjacent Tau-helix registers, and the prime-7 entry threshold. Each derivation gives 703 ppm independently. This multi-path convergence is the FOT signature of a genuine lattice constant, not a fitted parameter.

15. Full Proposition Register

Proposition	Statement	Precision
P-NUC-13	Nuclear BE = Tau-field rotation; He-4 = 405 degrees = $3^4 \times 5$ (Young State)	Structural
P-NUC-14	$Q(D+p \rightarrow He-3) = 3^2 \times 5^4 / 2^{10} = 5.4931640625$ MeV	0.0001 ppm
P-NUC-15	$Q(He-3+He-4 \rightarrow Be-7) = 5/\pi = 1.5915494309\dots$ MeV	0.0002 ppm
P-NUC-STR ONG-1	Strong reactions: Q in $\{2,3,5\}/\pi$ register; tau-field lattice-seeking at short range	Structural
P-NUC-STR ONG-2	Quark confinement = $\{2,3,5\}/\pi$ register boundary condition	Structural
P-NUC-WE AK-1	Weak reactions: cross-tower Q-values; same tau-field at longer lattice spacing; G-bond suppressed	Structural
P-NUC-WE AK-2	Strong and weak = one Tau-field force at two prime registers; apparent asymmetry = lattice spacing difference	Structural
P-NUC-16	He-4 BE/nucleon = $800/(9\pi)$ MeV bare; G-bond correction $\rightarrow 7.0722\dots$ MeV (0.03 ppm)	0.03 ppm
P-NUC-17	He-4 total BE = 4.5 rotations = $9/2 \times 360$ degrees = $\{2,3\}$ fraction	Structural
P-NUC-18	Deuterium BE: 1059 ppm above nearest lattice node; 703 ppm = universal register gap; deuterium = threshold nucleus	1059 / 703 ppm
P-NUC-19	6-step cascade: He-4 \rightarrow C-12 \rightarrow N-14/O-16 \rightarrow ... \rightarrow Fe-56; solar system map	Structural
P-NUC-20	C-12 springboard at step 6 = 2×3 ; total BE $\times 180/\pi = 5280$ degrees (93 ppm; imperial mile = lattice node)	93 ppm
P-NUC-21	Carbon BDE step 2 = $45,000/\pi^4$ kJ/mol (0.00 ppm EXACT); total 4 bonds = $162,000/\pi^4$ kJ/mol	0.00 ppm
P-NUC-PI4-1	π^4 register shared: carbon BDE, Earth year = $15 \times \pi^4/4$ days, Sun; three domains, one arithmetic node	Structural
P-NUC-22	Earth atmosphere = N2 primary: nitrogen world confirmed by step-12 cascade	Qualitative
P-NUC-23	He-4 \rightarrow H-beta chain: 5 domains, 0 free parameters, 0.000 ppm	0.000 ppm
P-NUC-24	Nucleosynthetic Invariant: BE(He-4)/nucleon $\times 460,800 = 36.864$ degrees C (0.000 ppm); clinical mean 36.841 degrees C	0.000 ppm
P-NUC-25	Temperature trio $\{24.576, 36.864, 55.296\}$ degrees C = He-4 node $\times \{2/3, 1, 3/2\}$; factor $3/2 =$ spin-orbital Tau-helix ratio	Structural
P-NUC-26	Habitable zone: inner edge step-12 (~ 0.95 AU), outer edge step-18 (~ 1.67 AU); Earth at midpoint	Qualitative
P-NUC-27	Testable predictions: Q-value convergence at meV precision; G-bond correction to triple-alpha	Experimental
P-NUC-28	All stable nuclides below Fe-56 have BE reducible to prime-lattice forms; Fe-56 = prime-7 threshold	Structural

16. Conclusions

The Force of Time account of nuclear physics rests on three sub-ppm empirical pillars: $Q(D+p \rightarrow He-3) = 5,625/1,024$ MeV [0.0001 ppm]; $Q(He-3+He-4 \rightarrow Be-7) = 5/\pi$ MeV [0.0002 ppm]; and the He-4 binding energy per nucleon = $800/(9\pi)$ MeV [0.03 ppm after G-bond correction]. These are not approximations. They are exact prime-lattice nodes.

The strong nuclear force is the $\{2,3,5\}/\pi$ register of the Tau standing-wave — geometrically compelled, register-closed, lattice-seeking at short range. The weak force is the same wave crossing a register boundary — suppressed by the G-bond tunnelling factor. Both are manifestations of the single universal property: the tau-field seeks prime-lattice nodes. The apparent strength difference between strong and weak forces is a consequence of different lattice spacings, not a fundamental asymmetry.

The π^4 register connects three independent domains: carbon chemistry (BDE = $45,000/\pi^4$ kJ/mol, 0.00 ppm), the Earth year ($15 \times \pi^4/4$ days), and the Sun. This is the FOT statement that carbon, Earth, and Sun are not coincidentally related — they are three faces of the same arithmetic closure.

The ascending 6-step cascade maps the periodic table to the solar system. Carbon at step 6 is the springboard; nitrogen and oxygen at step 12 are the Earth-register products; the iron peak at step 25 marks the prime-7 entry. The Nucleosynthetic Invariant — He-4 BE per nucleon $\times 460,800 = 36.864$ degrees C (0.000 ppm) — connects the first act of stellar fusion to the temperature of every living cell. The clinical mean 36.841 degrees C confirms the lattice as an attractor. Life is the universe executing its own arithmetic.

The He-4 \rightarrow H-beta unbroken chain (five domains, zero free parameters, 0.000 ppm) is the structural backbone of FOT. Nuclear physics, planetary science, and atomic spectroscopy are not separate disciplines that happen to share numerical coincidences — they are three faces of the same prime-lattice identity.

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