

Topological Fixed-Point Theory (TFPT)

A discrete compiler for the constants of physics

Two inputs — the boundary constant $c_3 = \frac{1}{8\pi}$ and a five-slot carrier — build E_8 and read off the Standard Model: status assessment and reading guide

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Compact reading edition. This edition retains the introduction’s scientific text and omits the computational reference appendix and its full dated history. Read them separately as `verification_catalog.pdf` and `changelog.pdf`; the original complete `introduction.pdf` remains available. Source ownership and evidence links are listed at <https://www.fixpoint-theory.com/documentation>.

In one sentence

Topological Fixed-Point Theory (TFPT) constructs, from exactly **two inputs** — a boundary constant $c_3 = \frac{1}{8\pi}$ (P1) and a five-slot carrier $g_{\text{car}} = 5$ (P2) — a discrete compiler for the Standard-Model skeleton: the gauge group, three families, hypercharges and the flavor matrix, with E_8 ($D_5 \oplus A_3 + \mu_4 \Rightarrow E_8$) as the consistency checksum. The *algebraic core is machine-checkable* and the dimensionless constants follow as fixed points ($\alpha^{-1} = 137.0359992$); *physical readouts* — absolute scales, masses, inflation, gravity and cosmological transfers — run through explicitly *named, status-typed bridges* ($v_{\text{geo}}, G_{\text{net}}, F_{\text{transfer}}$), not as free outputs. The honest one-line claim is on the status card below.

The TFPT document set — what is treated where

Plain language: TFPT (Topological Fixed-Point Theory) is a small discrete compiler. Two inputs — the seam constant $c_3 = \frac{1}{8\pi}$ and the carrier rank $g_{\text{car}} = 5$ — build $D_5 \oplus A_3 + \mu_4 \Rightarrow E_8$ and read off the Standard-Model skeleton, the constants and the scale grammar. The series is **the introduction plus five numbered papers and four companions** (plus one standalone working note), best read in order:

0. **introduction** — reading guide, compiler closure, predictions, the dependency DAG and the single proof ledger (`verification/status_ledger.csv`). (*entry point*)
1. **tfpt_1_architecture_e8** — the two axioms, the derivation map, the EM fixed point α^{-1} , the $D_5 \oplus A_3 + \mu_4 \Rightarrow E_8$ construction, the QBL theorem chain.
2. **tfpt_2_standard_model** — the SM in one φ_0 -ladder formula, flavor from parabolic transport (sheet diamond, dual anchor, Q_+ cohomology), the worked closures.
3. **tfpt_3_e8_audit_bootstrap** — the seven E_8 slices as an audit raster, the cascade bridge, the Möbius bootstrap.
4. **tfpt_4_frontier** — honest status of η_B , m_p/m_e , Koide, dark matter, full QG.
5. **tfpt_5_redteam** — the adversarial audit: declared attacks, what survives, what each reduces to, and the kill tests.

Companions: **R.** **tfpt_research_contracts** — the open interfaces ($v_{\text{geo}}, G_{\text{net}}, F_{\text{transfer}}$) as numbered contracts; **H.** **tfpt_horizon_readouts** — Appendix H (unit-system reframe): one seam constant as the universal horizon thermal code, the Nariai/anchor surface, the resummed seam clock; **O.** **origin_theory** — why no free fundamental number remains (exact core + one honestly-typed cyclic interpretation); **S.** **tfpt_safeguards** — the verification discipline: every mechanism that defends a claim against coincidence and numerology (status calculus, no-free-pattern, the over-determination map, the firewall, frozen predictions + null model, the independent Wolfram and Lean paths, the red team).

Working notes: **N1.** **note_e8_gaussian_code** — the Gaussian code bridge: E_8 over $\mathbb{Z}[i]$ via Construction A over the extended Hamming code $[8, 4, 4]$, the canonical four-bit quotient $L/(1+i)L \cong \mathbb{F}_2^4$, and the G_{31} quartic companion (exact algebra, machine-certified).

You are reading the introduction — the entry point and reading guide.

TFPT status at a glance — read this card the same way in every document

Two inputs, one compiler. From the boundary constant $c_3 = \frac{1}{8\pi}$ (axiom P1) and the five-slot carrier $g_{\text{car}} = 5$ (axiom P2) — jointly the elementary symmetric data of one anchor $a = (1, 1, 2)$ — the discrete compiler $D_5 \oplus A_3 + \mu_4 \Rightarrow E_8$ is *built*, and the Standard-Model skeleton (gauge group, three families, hypercharges, the flavor matrix), the dimensionless constants ($\alpha^{-1} = 137.0359992$) and the scale grammar are read off as fixed points. The algebraic core is machine-checked; physical readouts run through *named bridges* whose status is typed below.

What is closed, and what genuinely remains. The discrete/algebraic layer is closed ([E]); the everything-open residual reduces to *three named interface problems*:

Interface	Question	Status
v_{geo}	the one metrology unit ($= 1/\sqrt{G} = m/\mu$); CLOSED METROLOGY ($\mathbb{R}_+$ torsor; one dim. calibration by dimensional analysis; No-Unit v153/v725)	closed metrology [O]
G_{net}	simple-current extension $(D_5)_1 \otimes (A_3)_1 \rtimes \langle (1, 1) \rangle \cong (E_8)_1$	[C]
F_{transfer}	one functor, four typed interfaces (Koide, η_B , axion, m_p/m_e)	[C]

Beside that compiler rest sits the strict-physical-TOE rest: the ten-component Rest_{TOE} / the eight gates of $\text{TFPT.TOE.COMPLETE.01}$ [O] ($\text{TOE}_{\text{Complete}} := \text{AND}(\text{T1..T8})$; not a closure).

The classical covariant field equation carries no free dimensionless Newton coupling under the named QFT/entanglement premises [C]. The classical metric-sector field equation is no longer only an $R+R^2$ readout: the fixed-volume entanglement equilibrium (Jacobson; Faulkner et al.), run with TFPT's atoms, gives the *full* covariant Einstein equation $G_{ab} + \Lambda g_{ab} = c_3^{-1} T_{ab}$ with *both* coefficients fixed — $c_3^{-1} = 8\pi$ (no free dimensionless Newton dial; the thermodynamic origin $2\pi/\eta$ *coincides* with the geometric one $|\mathbb{Z}_2|2\pi\chi$ via $|\mu_4| = |\mathbb{Z}_2|\chi(S^2) = 4$, so c_3 is triply over-determined — anchor, geometry, thermodynamics, v358) and Λ from α ($\rho_\Lambda = (3/4\pi^2)e^{-2\alpha^{-1}}$, v60); the Einstein tensor (not Ricci) is forced by Lovelock, so matter conservation is an output (v359). The residual here is only the equation-of-state status (an external candidate action — Bianconi's entropic action, arXiv:2408.14391 — is quantified in v473 without changing the typing) and the one unit v_{geo} ; the global measure (C7 = QG.AMB.01) is now a [C] redundancy (v369), a certification object rather than missing dynamics, conditional on SEAM.EQUIV.01 and Bisognano–Wichmann.

The seam-net structural theorem G_{net} (= SEAM.EQUIV.01: the raw seam *is* the holomorphic $(E_8)_1$ net) now carries two named routes (route split 2026-07-22, no status change in substance): the MMST route SEAM.EQUIV.MMST.01 is *closed modulo cited theorems*; the twistor route SEAM.EQUIV.TWISTOR.01 (Costello–Li, prepared by CELEST.SEAM.01) and the unconditional parent stay [O]. On the MMST route: the explicit lattice model (v367/v368) and the S_3 closure stack pin the target at every computable level — central charge $c = 8$ (v376), the $(E_8)_1$ character with 248 currents and one primary (v377), genus-one torus $\text{GSD} = 1$ (v378) and reflection positivity (v379) — and it is Lean-formalised as FORM.SEAM.MMST.01: the collar's MMST hypotheses are kernel-proved, the MMST scaling-limit and Adamo–Moriwaki–Tanimoto OS-reconstruction theorems enter as named cited axioms, and the **#print axioms** check is clean. The *only* residual of that route that stays [O] is the abstract continuum existence of the scaling limit (v336) — its 128-spinor extension leg since certified at net level by the peer-reviewed crossed-product package ($h_s=16/16=1\in\mathbb{Z}$, the Longo–Rehren locality criterion; Böckenhauer; KLM $\mu=4/2^2=1$; AGT/AMT the independent second witness) with the realisation input reduced to invariant level and the parallel Lean route **seamResidualClosed'** (v469); so the MMST route is *closed modulo cited theorems*, not solved. QGEO.SYM.01 (the μ_4 deck acting geometrically) is its *corollary*: a conformal net's vacuum is rotation-invariant by axiom, so the deck follows with no extra premise (v335, Lean FORM.QGEO.BW.01). The nonperturbative quantum-gravity measure QG.AMB.01 is no longer carried as an open item: it is a [C] *redundancy* (v369), a certification object rather than missing dynamics, conditional on SEAM.EQUIV.01 and Bisognano–Wichmann (and TFPT is moreover rigorously gap-decoupled from the general Euclidean-QG conformal-factor problem, margin $1.648 > 0$, v76/v330). So the honest residual is the one unit v_{geo} plus the typed F_{transfer} interfaces, above the cited-theorem ceiling on the

seam and with QG.AMB.01 a [C] redundancy. Everything carries a claim ID resolving to a row of `verification/status_ledger.csv` (the single source of truth); **if the text and the ledger ever disagree, the ledger wins**. The historical labels ($U_{\text{wall}}, G_{\text{metric}}, F_{\text{frontier}}$) are retained only for ledger continuity — the live residual is $v_{\text{geo}} \oplus F_{\text{transfer}}$, with the seam G_{net} closed modulo cited theorems on its MMST route (parent [O]) and QG.AMB.01 a [C] redundancy.

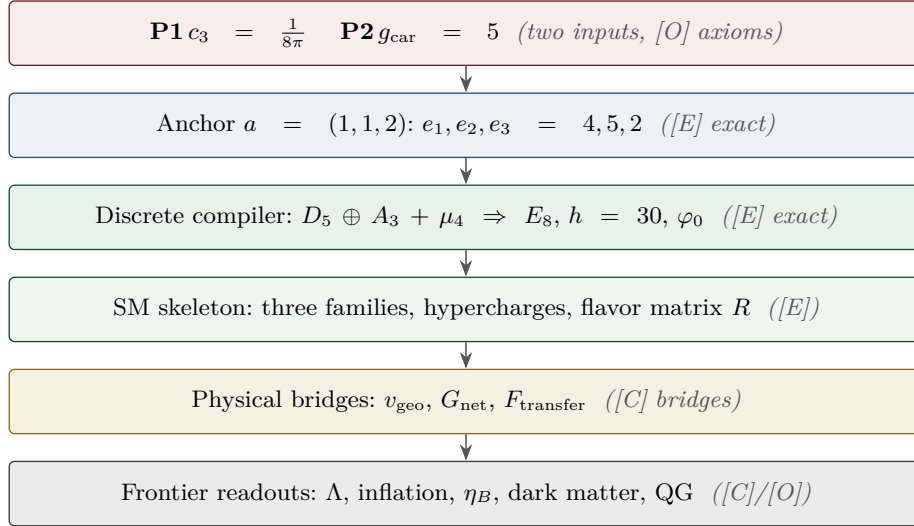
Marker key: [E] exact / machine-proven · [C] conditional (holds under named hypotheses) · [O] open / axiom · [X] falsifiable kill test. Per-claim fine type in `verification/status_ledger.csv`.

[E] exact / machine-proven

[C] conditional

[O] open / axiom

[X] kill test



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Reading the markers. Claims carry one of *four* reader-facing classes, so one can see at a glance what is proven and what is conditional: **[E]** *exact / machine-proven* — an exact identity (e.g. $240 = 16 \cdot 5 \cdot 3$), a Lie/lattice theorem (e.g. $D_5 \oplus A_3 + \mu_4 = E_8$), a Lean/script formalisation, or a reproduced numerical fixed point; **[C]** *conditional* — follows under explicitly named hypotheses (a physical bridge, readout or pending step); **[O]** *open / axiom* — a declared input or a genuine gap; **[X]** *kill test* — a falsifiable threshold. The finer per-claim type (Axiom / Formal / Lattice / Numerical / Identity / Physical) is kept in `verification/status_ledger.csv`, the single source of truth.

Physical — under hypotheses	RG masses, QG QG.AMB.01
Numerical — fit-free fixed point	$\alpha^{-1}, \Lambda, \theta_{12}$ EM.FP.01
Lattice — Lie / glue / root system	$E_8 = (D_5 \oplus A_3) + \mu_4$ E8.GLU.01
Formal — Lean / exact script	P2 algebra FORM.P2.02
Axiom — declared inputs	P1 c_3 , P2 g_{car} AX.P1.01

The *claim stack* (bottom = most certain/fewest, top = conditional). Each claim sits on exactly one level; the bottom two are inputs, the middle two are proved/reproduced, only the top is conditional. The single source of truth for which claim sits where is `verification/status_ledger.csv`.

No-free-pattern rule. To keep the structure from drowning in decorative coincidences, an identity enters the *main text* only if it (1) is a necessary step in a derivation, (2) kills an alternative, (3) is ablation-relevant, (4) links two previously independent modules, or (5) is experimentally tested. Everything else is explicitly demoted to an *audit fingerprint* **[E]** (clearly boxed as such) — so the load-bearing beams stay visible and the ornament never gets promoted to spine.

Admissible-invariant classes (the harder filter). Sharper still: a *load-bearing* integer may only come from one of seven typed sources — (i) a symmetric function $e_k(a)$ of the anchor $a = (1, 1, 2)$; (ii) a power sum $p_n(a)$ or difference $p_{n+1} - p_n$; (iii) a determinant, spectrum, Smith normal form or trace of (R, Q, K, L) ; (iv) an anchor quadratic form $u^\top M v$ with $u, v \in \{1, a\}$; (v) a Plücker coordinate of the anchor plane $\langle 1, a \rangle$; (vi) an E_8 Casimir degree or branching block; (vii) a pre-registered experimental observable. Anything else is an audit fingerprint or a frontier item, never spine. This is what converts TFPT from *pattern hunting* (“look, another number”) into a typed compiler: *fewer admissible kinds of explanation*, not more matches.

Reviewer path (read in this order; the rest is support):

1. the architecture: the two axioms $\{c_3, g_{\text{car}}\}$ and the two-engine picture (§1, the figures);
2. the E_8 glue $E_8 = (D_5 \oplus A_3) + \mu_4$ — document 1, Part II, machine-checked (`v1_e8_glue.py`);
3. the α^{-1} fixed point plus ablation (`v3_em_alpha.py`);
4. the **single status ledger** `verification/status_ledger.csv` — the source of truth for every claim’s grade, location, dependency and script;
5. the **open gates** as numbered research contracts (`tfpt_research_contracts`: the residual classes R1–R5 and their current reductions) and the honest frontier list (document 4).

Everything carries a claim ID (e.g. E8.GLU.01, EM.FP.01) that resolves to a row of the ledger. **If the text and the ledger ever disagree, the ledger wins.**

1 What this is about: the jump in construction principle

In plain words

What we found. TFPT reproduces dozens of real numbers of physics (particle masses, the fine-structure constant, dark-energy and inflation values) from a small set of inputs — and the

compiler closure says *why* the same handful of small integers $(2, 3, 5, 16, \dots)$ reappears in every sector: those numbers are not separate lucky hits. A single tiny “machine” — fed by just **two inputs** (a boundary number $\frac{1}{8\pi}$ and a five-slot carrier) — builds the exceptional symmetry E_8 , and E_8 is the unimodular “audit hull” that classifies the discrete Standard-Model readout: the constants, the flavor skeleton and the gravity/cosmology regime are then read off by projection and boundary dressing (not “printed” for free — where a scheme or analytic interface is needed, it is named).

Why this is simple. There are not many separate derivations that happen to share numbers — there is *one generator and a handful of corollaries*, and the number of independent structural assumptions is **two**.

How plausible it is. A theory becomes more believable when it *explains more from less*. Here the two inputs are even *over-determined*: the machine reproduces the very two numbers it started from (the dashed bootstrap loop in the architecture diagram, §2), so there is *no free dial left to tune*. Pushed to the end ([\[verification/v353_selfloop_capstone.py\]](#)), this means TFPT is best read not as a *linear* theory (axioms $\rightarrow$ theorems) but as a *closed self-consistent loop* whose outputs fix its own inputs ($g_{\text{car}}=5$ is the largest prime of the output $h(E_8)=30$; the 8 in c_3 is rank E_8), with a *unique* fixed point ([v6/v56](#)) and *zero* free adjustable dimensionless parameters. Even π is not a free dial: it is the fixed geometric constant of the boundary 2-sphere ($\oint_{S^2} K = 4\pi$), the one transcendental the continuous boundary contains. “Which is the axiom?” is the wrong question for a loop — every part is fixed by the whole; the one remaining structural question, whether the loop also closes in the *continuum* (the keystone [SEAM.EQUIV.01](#)), now carries two named routes (route split 2026-07-22, an ID restructuring with *no* status change in substance): its MMST route [SEAM.EQUIV.MMST.01](#) is *closed modulo cited theorems* — the lattice model and S_3 stack pin it at every computable level and it is Lean-formalised ([FORM.SEAM.MMST.01](#)); only the cited continuum-existence theorems stay [\[O\]](#) ([v367/v368](#), [v376–v379](#), [v336](#)), their extension leg since re-founded on peer-reviewed crossed-product theorems with the realisation input reduced to invariant level ([v469](#)) — while its twistor route [SEAM.EQUIV.TWISTOR.01](#) (the open Costello–Li construction, prepared by [CELEST.SEAM.01](#)) stays [\[O\]](#); the parent [SEAM.EQUIV.01](#) is closed if either route closes and, as an unconditional claim, stays [\[O\]](#).

Sharper still: one anchor $a = (1, 1, 2)$, and E_8 as a compiler hull ([\[E\]](#))

The two axioms are not even independent: they are the *elementary symmetric polynomials* of the single parabolic anchor $a = (1, 1, 2)$ (the exponents-at-infinity / splitting type $\mathcal{O}(-2) \oplus \mathcal{O}(-1)^2$):

$$e_1(a) = 4 = |\mu_4|, \quad e_2(a) = 5 = g_{\text{car}}, \quad e_3(a) = 2 = |\mathbb{Z}_2|, \quad c_3 = \frac{1}{2e_1(a)\pi} = \frac{1}{8\pi}.$$

Its *power sums* $p_n(a) = 1^n + 1^n + 2^n = 2 + 2^n$ generate the big Lie data directly: $p_1=4=|\mu_4|$, $p_2=6=|R^+(A_3)|$, $p_3=10=\mathcal{A}_\Lambda$, and

$$|R(E_8)| = p_1 p_2 p_3 = 240, \quad \dim E_8 = p_1 p_2 p_3 + (p_4 - p_3) = 248, \quad p_4 - p_3 = 8 = \text{rank } E_8,$$

with the binary ladder $p_{n+1} - p_n = 2^n$. So the inputs collapse from $\{c_3, g_{\text{car}}\}$ to $a = (1, 1, 2)$ plus π . [\[verification/v23_anchor_generator.py\]](#)

And a is itself *half-forced* ([\[E\]/\[C\]](#)): on $\mathbb{P}^1$ every bundle splits (Birkhoff–Grothendieck), so once $|\mu_4| = 4$, $N_{\text{fam}} = 3$, $\deg E = -4$ are set, the three positive anti-degrees are positive integers summing to 4, and $4 = 2 + 1 + 1$ is the *unique* partition into three positive parts — machine-checked with all its negative controls as the partition corollary ([\[verification/v491_p2_partition_corollary.py\]](#), [P2.PARTITION.01](#)): the unique multiset $\{1, 1, 2\}$ forces $e = (4, 5, 2)$, hence $g_{\text{car}} = e_2 = 5$, $|\mathbb{Z}_2| = e_3 = 2$, $N_{\text{fam}} = 3$ as *corollaries* (dropping positivity, the sum, the part count or integrality each destroys uniqueness — Mehta–Seshadri-rational weights give $e_2 = \frac{16}{3}$ or $\frac{44}{9} \neq 5$), sharpening [v53](#) which needs all three targets. The typing itself is now hardened

([verification/v499_p2_weights_deligne_bg.py], P2.TYPING.01): given the four marks, rank 3, the cusp class and unitarity (U), the Deligne canonical extension of the flavor connection has $\deg E = -4$ (residue traces) and Mehta–Seshadri stability forces $h^0(E) = 0$, so integrality (Birkhoff–Grothendieck), positivity and the sum 4 are *theorems* — the residual shrinks to the module identification and (U), both [C]; and that module-identification rest is now *one* residual with the QGEO modulus rest (the order-4 clock = the Coxeter/cusp-class carrier datum; [verification/v503_qgeo_emergence_light.py], QGEO.EMERGE.LIGHT.01, no marker moves). That common residual is itself now reduced to *one alignment bit* — the collar deck central in the mark- D_4 ; the clock’s *order* is fermionically forced, $U^2 = (-1)^F$ exactly ([verification/v506_seam_clock_rigidity.py], SEAM.CLOCK.RIGIDITY.01, markers unchanged); and the bit is no tautology — the deck’s *class* is derived (every mark-free collar deck is a half-period translation of the seam double), only its *position* stays the [C] input ([verification/v507_seam_bit_origin.py], SEAM.BIT.ORIGIN.01, markers unchanged); and that position half is now *topology* — the covering deck is free on the seam circle, the edge class is excluded, and the bit reduces to the square-modulus datum $\tau = i$ alone ([verification/v510_seam_bit_freedom.py], SEAM.BIT.FREEDOM.01, markers unchanged); and that modulus datum now carries an equivalent *discrete* form — flag transitivity of the four marks (marks *and* their two sides indistinguishable, $V_4 \rightarrow D_4$) $\iff \tau = i$, a 13-fold exact equivalence web (since 15-fold by v528 facets #14/#15) in which bare mark-transitivity is automatic for every configuration and no local jet sees the side bit ([verification/v512_seam_tau_flag.py], SEAM.TAU.FLAG.01, markers unchanged); free OS positivity is since documented as the *eighth* side-blind test on that scoreboard — the bit is not derivable from free RP/ Θ existence and remains genuine discrete input (v521, SEAM.BIT.RPBLIND.01, markers unchanged); the mark-decorated *state* class (twist/defect insertions — everything Wick-computable) is since documented as the *ninth*: the free-plus-twist class is exhausted (v525, SEAM.BIT.TWISTBLIND.01, markers unchanged); and the first genuinely interacting Fidkowski–Kitaev seam toy is the *tenth* side-blind test ($9 \rightarrow 10$), while Kill-Test 2 fires at toy level under a typed fence (v529, SEAM.INT.FKTOY.01, markers unchanged); the straddle filter it produced, since run as a *selector* on the interacting mark family, keeps exactly *one* member alive — reflection positivity dynamically selects $\delta = \pi/2$ with positive coupling, the same member that carries the twist-class order parameter: the first *positive* selection datum for the bit (v534, SEAM.STRADDLE.CONE.01, markers unchanged; toy-level evidence, not a derivation); the straddle law itself is since refined to the *odd-split law* — the Jaffe–Pedrocchi reflection-positivity condition, made decidable on the toy, predicted RP survival on center-straddled (2+2) cuts and direct measurement confirmed it: a straddled cut kills RP iff the split is odd (1+3) — while the quartet-avoiding cut family generates the full even seam algebra and carries a *positive* OS/GNS inner product at $g = 1$: the Kill-Test-2 counterweight is narrowed (an OS-viable cut geometry selected by the toy’s own clock), not removed ([verification/v972_seam_interaction_front.py], toy level, fence inherited, markers unchanged). The bit itself is now the *twist-class choice*, in principle interferometrically readable (v528, SEAM.BIT.TWISTCLASS.01; it remains formal input). Temperature joins geometry and anomaly as the *third leg* of c_3 (v526, SEAM.THERMAL.KMS.01, [C]-typed reading). The genuine remaining axiom is therefore not “why $a = (1, 1, 2)$ ” but “why the carrier $g_{\text{car}} = 5 / (|\mu_4|, N_{\text{fam}}) = (4, 3)$ ” — that interface (with c_3), i.e. the weight-*typing* postulate itself, is the [O] input layer (AX.P2.01 stays a declared axiom). The consolidated reduction state (2026-07-23): the compiler’s dimensionless inputs reduce to *four marks* (derived from P1-side topology), *one discrete symmetry-lift bit* — the twist-class choice (flag transitivity $\iff \tau = i$; equivalently the clock, the CM-fixed half-period, or the non-split extension class on the free seam circle) — and π — a reduction state, not an abolition of the axiom: AX.P2.01 remains declared, and the [C] identifications R1/R2 of v499 remain conditional.

Two readings, one source (no contradiction). P1 and P2 are the *operational compiler inputs*; their anchor provenance is $a = (1, 1, 2)$ plus π . The *single structural bedrock postulate* is the keystone SEAM.EQUIV.01, whose conformal-deck face QGEO.SYM.01 (the carrier μ_4 clock is the seam’s conformal deck, see `tfpt_research_contracts`) forces the μ_4 deck, hence $N_{\text{fam}} = 3$,

$\deg E = -4$ and the tripartition $4 = 2+1+1$, of which c_3 and g_{car} are the two elementary readouts. “Two inputs” (the working axioms) and “one postulate” (the geometric bedrock) are the same statement at two layers. Its geometric normal form and the mark-local $\Rightarrow \omega \circ \rho = \omega$ implication are now Lean-formalised (FORM.QGEO.02/FORM.QGEO.01); the postulate itself stays [O].

One source, four readings (the cleanest origin). The four-point seam divisor μ_4 on $\mathbb{P}^1$ generates the whole discrete skeleton by four canonical functors:

$$\underbrace{c_3 = \frac{1}{8\pi}}_{\text{thermal}} \quad \underbrace{\text{rank } H_1(\mathbb{P}^1 \setminus \mu_4) = 3 = N_{\text{fam}}}_{\text{cycles} \rightarrow A_3} \quad \underbrace{h^0(\mathbb{P}^1, \mathcal{O}(\mu_4)) = 5 = g_{\text{car}}}_{\text{functions} \rightarrow D_5}$$

$$\underbrace{(D_5)_1 \otimes (A_3)_1 \rtimes \mu_4 \cong (E_8)_1}_{\text{net}}$$

and the function side even generates D_5 itself ([verification/v197_rr_carrier_clifford_d5.py]): $\Lambda^{\text{even}}(\mathbb{C}^5) = \binom{5}{0} + \binom{5}{2} + \binom{5}{4} = 16 = \dim S^+$, the $\mathfrak{so}(10) = D_5$ half-spinor. So μ_4 is not merely glue: it is the *common source* of A_3 , D_5 , c_3 and E_8 ([verification/v189_riemann_roch_carrier.py]) — the arithmetic is exact [E], the physical reading of the carrier as the seam mode space stays [C].

What E_8 is (and is not). In TFPT E_8 is *not* an unbroken physical gauge group: it is the unimodular *audit / compiler hull* that classifies the admissible discrete charge and residue structures. The Standard Model is a *readout* after projection, not a direct E_8 gauge theory; the Lorentz signature appears only after projection; fermions are not “everything in the adjoint”. This is exactly why the known no-go results against literal E_8 world-formulas (Distler–Garibaldi; Coleman–Mandula) do *not* bite: they constrain E_8 as a spacetime gauge symmetry, which TFPT does not claim. The defensible claim is: *TFPT is the unique parabolic compilation of the anchor $a = (1, 1, 2)$ into the E_8 audit hull.*

In one line:

■ The anchor generates the syntax; the boundary generates the scale; E_8 checks the consistency.

i.e. the discrete content (carrier $D_5 \oplus A_3 + \mu_4$, the operators R, Q, K, L) flows from $a = (1, 1, 2)$; the continuous content ($c_3 = \frac{1}{8\pi}$, φ_0 , α^{-1} , the exponential scales) flows from π ; and E_8 is the unimodular *checksum container*, not the world group.

The anchor ratio triad ([verification/v119_review_validation_2.py]). The three elementary symmetric values, normalised by the family count, are the theory’s three recurring fractions [E]:

$$\frac{e_3}{p_0} = \frac{2}{3} \text{ (Koide branch / sheet ratio), } \quad \frac{e_1}{p_0} = \frac{4}{3} \text{ (seed gain), } \quad \frac{e_2}{p_0} = \frac{5}{3} \text{ (carrier branch)}$$

— the canonical flow’s critical points are exactly $(2, 5) = (e_3, e_2)$ with inflection $\frac{7}{2} = \frac{e_3+e_2}{2}$: the fractions $\frac{2}{3}, \frac{4}{3}, \frac{5}{3}$ are not scattered numbers but the three normalised anchor coefficients. Further micro-identities [E]: $\Omega_{\text{adm}} = 2p_1p_2 = 48$, $10b_1 = 1 + p_1p_3 = 41$, $\Delta_Y = e_2^2 = p_0^2 + 2 \text{rank } E_8 = 25$, $h(E_8) = e_3p_0e_2 = 30$, $\text{rank } E_8 = p_0 + e_2$.

$$a = (1, 1, 2) \quad [E]$$

elementary $e_k(a)$

$$\begin{aligned} e_1 &= 4 \rightarrow |\mu_4| \\ e_2 &= 5 \rightarrow g_{\text{car}} \\ e_3 &= 2 \rightarrow |\mathbb{Z}_2| \\ c_3 &= \frac{1}{2e_1\pi} = \frac{1}{8\pi} \end{aligned}$$

power sums $p_n = 2 + 2^n$

$$\begin{aligned} p_0, p_1, p_2, p_3 &= 3, 4, 6, 10 \\ p_1p_2p_3 &= 240 = |R(E_8)| \\ p_4 - p_3 &= 8 = \text{rank } E_8 \\ \Rightarrow \dim E_8 &= 248 \end{aligned}$$

derived motifs

$$\begin{aligned} &4, 5, 8, 16, 25, \\ &30, 41, 120, 240 \\ &\text{one anchor,} \\ &\text{many projections} \end{aligned}$$

The companion documents

The whole development is consolidated into **eight companion documents** (plus this introduction), organised in layers that build on one another; this introduction is the entry point and reading guide. Each document collects the material of its layer into self-contained parts:

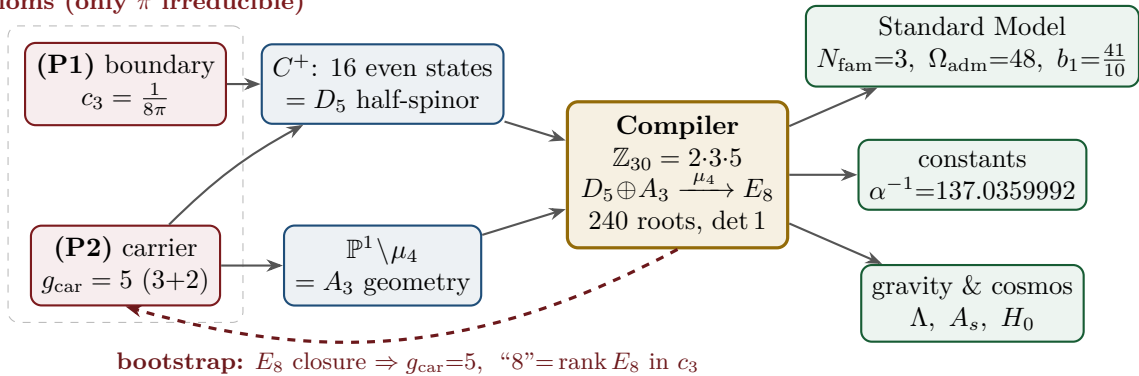
Document	What it contains (former notes now as parts)
tfpt_1_architecture_e8	Core. The two axioms $\{c_3, g_{\text{car}}\}$, the derivation map and the EM fixed point (Part I); the Coxeter–cyclotomic compiler $\mathbb{Z}_{30}=2\cdot3\cdot5$, the explicit $D_5 \oplus A_3 + \mu_4$ E_8 construction, the machine-checkable E_8 appendix and the group-level glue $(\text{Spin}(10) \times SU(4))/\Delta\mathbb{Z}_4$ (Part II).
tfpt_2_standard_model	Standard Model. The discrete Standard-Model <i>structure</i> (charges, families, flavor operators) is derived under the axioms; 4D existence, chiral measure, mirror gap, couplings and neutrino dynamics are open. The φ_0^{ret} -ladder formula (Part I); the flavor block from parabolic weights and the transport theorem, H2 as a spectral selector (Part II); the worked closures — explicit gap, APS–Fredholm, truncation/ n_s, r , Starobinsky M , derived θ_{12} , quark c , the H2 splitting type, Λ -typing (Part III).
tfpt_3_e8_audit_bootstrap	E_8 audit & bootstrap. The seven E_8 slices as an audit raster ($E_6 \times A_2$ reads the flavor matrix) (Part I); the old cascade $D=60-2n$ as the same even-integer spine (Part II); the Möbius bootstrap — $g_{\text{car}}=5$ and the “8” in c_3 as overdetermined fixed points, only π irreducible (Part III).
tfpt_4_frontier	Frontier. The honest status of η_B , m_p/m_e , Koide, dark matter and quantum gravity — the genuine handle, the precision, and what is <i>not</i> forced onto the ladder.
tfpt_5_redteam	Red Team. The adversarial audit of the five load-bearing reductions (Targets A–E): the declared attacks, what survives each, what each one reduces to, and the explicit kill tests.
tfpt_research_contracts	Research contracts. The open gates as numbered contracts with lemma chains and closing theorems: (U_{wall}) (now reduced to the selector triangle: $(d, n) \Rightarrow R$ columnwise, residue = <i>two</i> line pairings, the third integrality-forced) and $G_{\text{metric}}/G_{\text{net}}$ (the index-4 seam-net identification — one theorem, three doors, now realised at the finite Lie level).
tfpt_horizon_readouts (App. H)	Appendix H — horizon unit system (reframe, not new physics). One seam constant $c_3 = \frac{1}{8\pi}$ as the universal horizon thermal code: Hawking/de Sitter/Unruh, BH thermodynamics, Page, scrambling, Nariai bound, $v_{\text{GW}}=c$ — standard physics in seam units, two compiler fingerprints ($1920= W(D_5) $, $ \mu_4 =4$); plus the Nariai/anchor surface, the dual anchor and the resummed seam clock (v101–v138).
origin_theory	Origin Theory. Why no free <i>dimensionless compiler dial</i> remains beyond the anchor and π (the dimensionful v_{geo} and transfer physics stay typed): the $(g_{\text{car}}, N_{\text{fam}})$ skeleton, the triply-forced 8, the order-30 Coxeter cycle, one boundary transport for flavor and horizon, the gapped unique attractor; [E] core plus one honestly-typed [C] cyclic interpretation.

The five formerly “research-level” problems are now *closed, reduced or typed* inside the documents where they belong — the group-level closure $(\text{Spin}(10) \times SU(4))/\Delta\mathbb{Z}_4$ in document 1 (closed), and the H2 splitting type, the Starobinsky scalaron mass, the θ_{12} texture and the quark c in document 2 (the first two closed; the quark *ratios* now closed combinatorially (v49/v71), only the *absolute* scale a U_{point} anchor; θ_{12} the seam-misalignment residual). Eight companion files (plus this introduction), each result where it logically lives.

2 The architecture at a glance

The diagram below shows the whole pipeline: *two* inputs on the left, the discrete compiler in the middle, the physics on the right. Everything in between is a consequence.

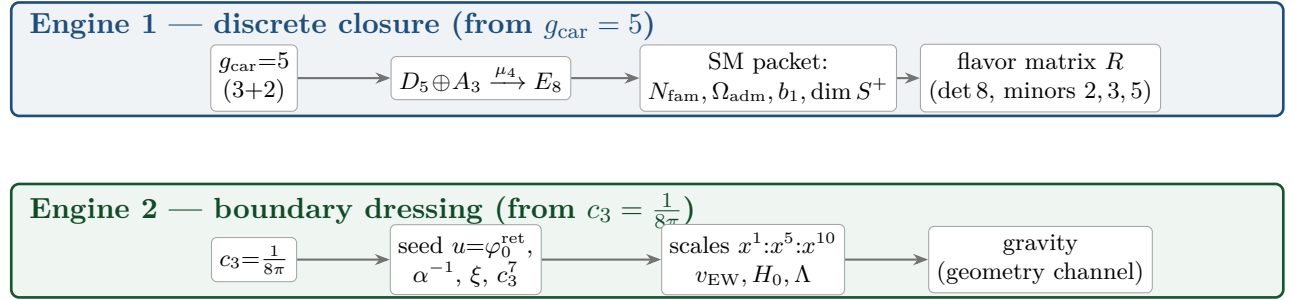
2 axioms (only π irreducible)



Key statement (the loop closes): previously D_5 , A_3 and E_8 sat *as given* Lie structures in the background. Now they are *intermediate products* of the two inputs — *and the red back-channel is the new part*: the E_8 closure feeds back and *fixes the inputs*. $g_{\text{car}} = 5$ is the unique

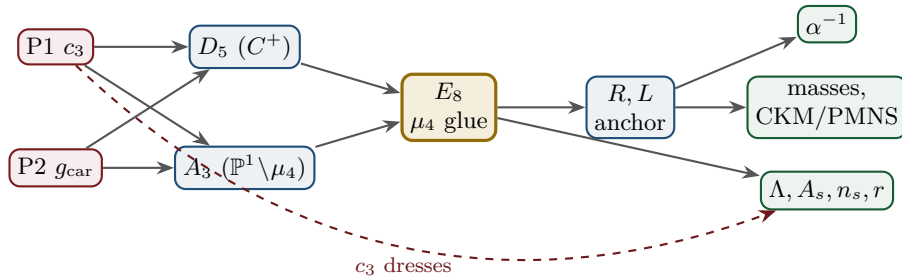
rank-fill/Coxeter/Pascal solution ($2^{g-1} = \binom{g}{0} + \binom{g}{1} + \binom{g}{2}$), and the integer 8 in $c_3 = \frac{1}{8\pi}$ is rank $E_8 = h(D_5) = \det R$. **Inputs and output form an overdetermined fixed point** — the structure does not “prove itself”; it has fewer degrees of freedom than independent consistency conditions. The only thing *not* produced by the loop is the continuous π (Möbius/Gauss–Bonnet), the lone irreducible primitive. So it is not a one-way arrow chain but a closed, overdetermined self-consistency loop.

The master story is two engines. Read from the two axioms, the whole theory factorises into exactly *two* engines — a *discrete* closure and a *boundary* dressing. Gravity is not a third block; it is the geometry channel of Engine 2.



3 The dependency DAG and the proof ledger

The whole theory is a directed acyclic graph: two axioms at the source, the compiler in the middle, the observables as sinks. The DAG makes the attack surface explicit — each arrow is a named theorem or a declared input, and each node fails in exactly one way.



Node	Definition	Inputs	St.	Output	Failure mode
P1	RP boundary kernel, $c_3=1/(8\pi)$	— (axiom)	[O]	c_3	no reflection-positive seam
P2	5-slot carrier $g_{\text{car}}=5$	— (axiom)	[O]	carrier 3+2	wrong family/charge lattice
D_5	C^+ even-Hamming = half-spinor 16	P2	[E]	$\dim S^+=16, Y$	group/matter mismatch
A_3	$\mathbb{P}^1 \setminus \mu_4$ four-puncture geom.	P1	[E]	$N_{\text{fam}}=3, \mathbb{Z}_6$	wrong multiplicity
E_8	μ_4 glue: $\text{disc}=\mathbb{Z}_4, q\text{-sum}=2$	D_5, A_3	[E]	240, 248	not even-unimodular
R, L	residue + winding matrix, anchor (1, 1, 2)	A_3	[E]	det 8, minors (2, 3, 5)	wrong D_6 branch
α^{-1}	root of $F_{U(1)}(\alpha)=0$	$c_3, M=41$	[E]	137.0359992	no/second root (excl.)
masses	φ_0^{ret} -ladder $\lambda_Y^L \Lambda$	R, L, c_3	[E]/[C]	9 masses, mixings	hierarchy mismatch
θ_{12}	TBM + seam $\varepsilon=c_3$	R, L	[E]/[C]	0.307	seam-misalign. lemma fails
Λ, A_s	seam det. / R^2 scalaron	c_3	[C]	Λ, A_s, n_s, r	ambient RP fails

Marker key: [E] exact / machine-proven · [C] conditional (holds under named hypotheses) · [O] open / axiom · [X] falsifiable kill test. Per-claim fine type in `verification/status_ledger.csv`.

Reading the table top-to-bottom is reading the theory: two red axioms in, everything else a consequence with exactly one failure mode each.

The ledger itself is versioned: each row of `verification/status_ledger.csv` carries a claim ID, its dependencies, its verification script, and `active/canonical_status/supersedes` fields, so claims that were later superseded (e.g. the early “flavor gate open” rows, now *ratios closed* via `FLAV.RIGID`) are marked inactive — the canonical status is the only one read as current.

The compact status formula: three honest layers

$$\underbrace{\text{compiler}}_{\text{closed}} \mid \underbrace{\text{admissible IR physics}}_{\text{conditionally closed (RP, gap)}} \mid \underbrace{\text{strict physical TOE}}_{\text{open}}$$

TFPT v5.4 closes the discrete compiler; the discrete Standard-Model *structure* (charges, families, flavor operators) is derived under the axioms, while 4D existence, chiral measure, mirror gap, couplings and neutrino dynamics remain open. It closes the EM fixed point, the admissible gapped IR sector and the $R + R^2$ spectral-action shadow. It does *not* yet certify a strict physical TOE. The remaining items have now collapsed sharply: the R -bridge amplitude normalisation U_{point} *reduces to* v_{geo} (Gate 1 closed, v75 — the same anchor as $1/G$), and the ambient metric measure is *holographically reduced* to a finite seam-boundary measure (Gate 2 tier B, v76) — which is in turn the rigorously-constructed $(E_8)_1$ lattice net (v77), so G_{metric} is imported into existing RCFT rigor rather than built anew. So the only genuine residuals are *one* dimensionful scale v_{geo} — the *dimensional-analysis floor* that no theory escapes (v78), shared by flavor and gravity — the boundary net identification (now *closed modulo cited theorems* on its MMST route `SEAM.EQUIV.MMST.01`, v367/v368, v376–v379, Lean `FORM.SEAM.MMST.01`; the parent `SEAM.EQUIV.01` stays [O]), and the named QFT/cosmology transfer interfaces (F_{frontier}).

Two points that are *not* in the residual (closed, but easy to mis-list as open). (i) *Parameter-freeness is a theorem under the named hypotheses:* the boundary transport is gapped ($\Delta = 6 \log \frac{3}{2} > 0$), so by Perron–Frobenius its iteration has a *unique* attracting fixed point — the constants are *selected*, not tuned ([E] for the attractor, [verification/v56_unique_attractor.py]; the *physical identification* of the transport operator stays [C]), reinforcing the static bootstrap web ($g_{\text{car}} = 5$ forced three ways *given* the E_8 closure rank — a consistency loop, see red team Target B — [verification/v6_bootstrap.py], [verification/v14_carrier_uniqueness.py]). (ii) *Newton’s constant is not an independent input:* fixing the physical Λ branch ($(8\pi)^2 \delta_{\text{top}} = \frac{3}{4\pi^2}$) pins $\bar{M}_{\text{Pl}}$ *relative to* Λ , so G_N is read out *after* the branch choice + *one* dimensionful induced-gravity anchor ([E]/[C], [verification/v60_lambda_metrology_branch.py]), not predicted from pure numbers. What stays irreducible is then just π , the discrete E_8 -closure fixed point (self-consistent, *not* a free axiom; the bootstrap of `tfpt_3`), and *one* dimensionful scale v_{geo} — and that single scale is shared by *both* the flavor sector ($U_{\text{point}} \rightarrow v_{\text{geo}}$, v75) and gravity ($1/G$, v68): the two [A] anchors are *one* (dimensional analysis; no metre from pure mathematics).

The hard reduction: the live residual as typed interfaces

After the compiler closure, the entire residual is the pair of accounting formulae (the compiler rest, and the strict-physical-TOE rest of the 2026-08-27/28 contract wave; `tfpt_research_contracts`):

$$\text{Rest} = v_{\text{geo}} \oplus G_{\text{net}} \oplus F_{\text{transfer}}$$

$$\begin{aligned} \text{Rest}_{\text{TOE}} = & \text{SeamContinuum} \oplus 4\text{DAction} \oplus \text{ChiralMeasure} \\ & \oplus \text{MirrorGap} \oplus \text{UnitaryDynamics} \oplus \text{IR/continuum} \\ & \oplus \text{BulkSeam} \oplus \text{QuantumGravity} \\ & \oplus \text{GeneratingFunctional} \oplus \text{InitialState} \end{aligned}$$

The first is the *compiler* rest — one dimensionful scale anchor, one metric-sector inclusion, and a set of deliberately typed QFT/cosmology interfaces. The second is the *strict-physical-TOE* rest:

every summand is a named **[O]** (or standing-rule) contract; nothing in Rest_{TOE} is claimed closed. The historical gate labels $(U_{\text{wall}})/(G_{\text{metric}})/(F_{\text{frontier}})$ are kept only for ledger continuity. In current terms: $(U_{\text{wall}}) \rightarrow v_{\text{geo}}$ — the flavor ratios are *closed* (Plücker/Readout Rigidity, v49/v71/v75), what remains is *one dimensionful unit*, not a flavor gap; $(G_{\text{metric}}) \rightarrow G_{\text{net}}$ — reduced to a single boundary-net theorem, “the seam–Calderón net is the index-4 μ_4 simple-current extension of the carrier net” (holomorphy then follows, v89/GATE.METRIC.06); since the QBL chain (v108–v113) the carrier choice rides on the same theorem: the certified scalar kernel exists iff it pairs the sheets (v110), the certified channel counts the code identically (v112), pair transport is minimally complete (v111), and the one quasi-free kernel — rank = c : 5 carrier block, 8 seam hull — is the defining datum of the free net the gate already posits (v113), so closing G_{net} also closes the carrier selection **[E]**; $(F_{\text{frontier}}) \rightarrow F_{\text{transfer}}$ — named QFT/cosmology transfer interfaces (Koide source→pole, η_B Boltzmann, axion relic, m_p/m_e), never compiler powers; the four are one typed functor with a four-axiom contract (CONTRACT.F.01, v213) and *one shape* — each is a gapped relaxation to a unique attractor (the main-branch discrete→dynamic motif), with F_{pole} at the seam rate $(2/3)^6$ and the other three external (v303). The metric-sector reduction lands on a *single named keystone*. The boundary inclusion G_{net} is the index-4 μ_4 simple-current extension $(D_5)_1 \otimes (A_3)_1 \rtimes \langle (1, 1) \rangle \cong (E_8)_1$ (Simple-Current Extension Theorem, v154, exact: index 4, $c=8$, $\mu=1 \Rightarrow$ holomorphic $\Rightarrow E_8$); net existence and full-cone reflection positivity are discharged to **[E]** (v175); and the **No-Unit Theorem** (v153/v725) makes v_{geo} a closed metrology structure — an $\mathbb{R}_+$ unit torsor; one dimensionful calibration is necessary by dimensional analysis ($U_{\text{point}} \sim v_{\text{geo}}$, $1/G \sim v_{\text{geo}}^2$, $m/\mu = e^{3/4}$ — one unit in three dimensions; display stays **[O]**, no physical **[E]**). The flavor selector and Q-geometry residues are *derived* (no discrete freedom left). The *one seam-side identification*, packaged as the single named theorem SEAM.EQUIV.01 — *the raw reflection-positive seam state is the holomorphic $(E_8)_1$ net at $\tau=i$* — is now *closed modulo cited theorems on its MMST route* (SEAM.EQUIV.MMST.01; the twistor route SEAM.EQUIV.TWISTOR.01 and the unconditional parent stay **[O]**): the explicit lattice model (v367/v368) and the S_3 stack ($c=8$, 248 currents/1 primary, torus GSD=1, RP; v376–v379) pin it at every computable level, Lean-formalised as FORM.SEAM.MMST.01, with only the cited MMST/OS continuum-existence theorems left **[O]** (v336); its conformal-deck premise QGEO.SYM.01 is its *downstream* definitional face (per v323; the residual is Lean-pinned to named cited steps, v308). The sprint-by-sprint reduction that produced it is recorded in the changelog and in `tfpt_research_contracts`, not replayed here. The status card:

Item	Status	Reading
parameter-freeness (self-consistency)	[E]	gapped transport $\Rightarrow$ <i>unique</i> Perron–Frobenius attractor (v56); bootstrap web $g_{\text{car}}=5$ forced (v6/v14)
Newton constant G_N	[E]/[C]	not <i>independent</i> : branch pins $\bar{M}_{\text{P1}}$ rel. to Λ (v60); readout after branch + one dim. anchor
ratio $c_u/c_d = \frac{55}{117}$	[E]	$g_{\text{car}} \ \text{Pl}_{1,a}(K) \ _1 / (N_{\text{fam}}^2 \Delta_Q)$; rigid on the derived stratum (v49/v71), no solve
flavor absolute scale	[E]/[O]	ratios <i>closed</i> (v49/v71); only the absolute scale remains = v_{geo} (Gate 1, v75), the same anchor as $1/G$
$R + R^2$ gravity	[E]/[C]	covariant $f(R)$ field equation closed in regime; heat-kernel grounded (G2)
Einstein eq. (covariant, local)	[E]/[C]	fixed-volume entanglement equilibrium $\Rightarrow$ <i>full</i> $G_{ab} + \Lambda g_{ab} = c_3^{-1} T_{ab}$ carrying no free dimensionless Newton coupling under the named QFT/entanglement premises [C] : $8\pi=1/c_3$ (v358, thermo=geo via $ \mu_4 = \mathbb{Z}_2 \chi=4$) and Λ from α (v60); Einstein tensor via Lovelock, conservation an output (v359); residual = equation-of-state status + v_{geo} , global measure (C7) now a [C] redundancy (v369)
physical QG sector	[E]/[C]	gap-decoupled admissible measure ($\Delta_{\text{eff}}=1.648>0$)

Item	Status	Reading
ambient QG measure	[C] (redundancy)	certification object, not missing dynamics (v369; conditional on SEAM.EQUIV.01+Bisognano–Wichmann): holographically reduced to a finite seam- <i>boundary</i> measure (v76); IR tier closed (decoupling); strict-TOE cert. = the simple-current extension $(D_5)_1 \otimes (A_3)_1 \rtimes \langle (1,1) \rangle \cong (E_8)_1$ (v154); the free-bulk premise (A) is itself a fixed-point theorem with the cone eliminated (cone gap = one-particle gap $(2/3)^6$) and factors into the A_2 net-existence + the keystone SEAM.EQUIV.01 (MMST route closed mod. cited; parent [O]) — zero new gates (v160–v165)
v_{geo} metrology unit	[O] (closed metrology)	No-Unit Theorem (v153/v725): CLOSED METROLOGY STRUCTURE ($\mathbb{R}_+$ unit torsor; one dimensional calibration necessary by dimensional analysis); $U_{\text{point}} \sim v_{\text{geo}}$, $1/G \sim v_{\text{geo}}^2$, m/μ a ratio — one unit, not a gap
Koide	[C]	$Q_{\text{src}} + \varphi_0/24$ source→pole: typed runnable solver with kill test (QED-excluded, v371)
axion DM	[C]	$f_a = M_{\text{scal}}/128$: finite- T spine-branch typed runnable solver (v373)
η_B	[C]	readout closed; integrated BDP leptogenesis Boltzmann ODE, typed runnable solver (v372)
m_p/m_e	[C]	cross-sector QCD/EW ratio: typed runnable solver with uncertainty budget (v374)
N_*	[C]	reheating input; scalaron-reheating point $N_*=51.4$ (v86); frozen band [50, 60]
$a = (1, 1, 2)$	[E]/[C]	forced by $4 = 2 + 1 + 1$, conditional on the carrier
carrier selection $g=5$ (QBL)	[E]/[C]	theorem chain v108–v113: sheet-odd kernel, self-counting channel, transport degree 2, one quasi-free kernel (rank = c); residue = the G_{net} premise itself — gate closes $\Rightarrow$ carrier [E]
selector establishment R4'	[E]/[C]	$(d, n) \Rightarrow R$ columnwise (v136); both normals <i>anchor data</i> — $n = (p_2, p_0, e_2)(a)$ in the cusp frame (v145/v149); residue = <i>one</i> assignment
sheet/parity (Q-geometry derived)	[E]/[C]	H^1 characters = $\text{Spec}(Q_+) = A_3$ exponents (v137); $\mathbb{Z}_3$ choice <i>derived</i> (v141); full Möbius D_4 matched parity by parity (v146); residue = the module identification, folded into SEAM.EQUIV.01
seam quantum clock R1	[E]/[C]	typed closed: resummed clock = entropy power law (v124–v133); VW edge match (v138); det-ratio in-family (v144); ring sum = Born ² Gaussian zero-mode integral, bend det'-clean (v147); residue = measure + reference
E_8 Lean	[E]	hardening, not a blocker (script-certified)

Marker key: [E] exact / machine-proven · [C] conditional (holds under named hypotheses) · [O] open / axiom · [X] falsifiable kill test. Per-claim fine type in `verification/status_ledger.csv`.

Card addendum (2026-08-28, dual rest): the status card remains the *compiler* accounting ($\text{Rest} = v_{\text{geo}} \oplus G_{\text{net}} \oplus F_{\text{transfer}}$). The strict-physical-TOE accounting Rest_{TOE} (ten named summands, all [O] or standing-rule) sits beside it and does *not* upgrade any marker — it names the 2026-08-27/28 contract wave (`tfpt_research_contracts`). Wave 3 (same day): the rank-8 ADE census of `[verification/v993_minimal_defect_selector.py]` lifts the architecture conditionality of v624 at lattice level (axioms AX.P1.01/AX.P2.01 typing UNCHANGED); three new contracts GAUGE.DETLINE.FIXPOINT.01, GRAV.SPIN2.EMERGENCE.01, FTRANSFER.SK.RH00.01 are registered [O]. Completeness wave (same day; suite 986 $\rightarrow$ 990, no marker upgrades): `[verification/v994_mmst_criteria_battery.py]`, `[verification/v995_kms_subnet_rigidity.py]`, `[verification/v996_gauge_grammar_kill.py]` and `[verification/v997_spin2_smg_witnesses.py]` execute the MMST 5/7 criteria,

finite KMS rigidity, the H0 grammar kill, and the quadratic spin-2 + SMG toy witnesses; C6 is the written-out proof document `articles/2026-08-28/psi_lambda_convergence_theorem_en.tex`. Review wave 4 (2026-08-29; suite 990 → 994, ledger 1166 → 1168; no marker upgrades): `[verification/v998_seam_modular_closure.py]`, `[verification/v999_weak_collision_hp.py]`, `[verification/v1000_spin2_sk_witnesses.py]` and `[verification/v1001_nu_pentagon_chain.py]` plus the master contract `TFPT.TOE.COMPLETE.01 [O]` (the named AND of eight gates, not a closure), the lattice-fundamental quasilocal-family amendment, the v_{geo} closed-metrology retype, and the ALPHA.QUILLEN relative-determinant note. Review wave 5 (2026-08-29; suite 994 → 996): unit choice for v_{geo} is closed; dimensionless hierarchies ($M_{\text{Pl}}/v_{\text{EW}}$, M_R/M_{scal} , $\Lambda_{\text{QCD}}/v_{\text{EW}}$, $T_{\text{reh}}/M_{\text{scal}}$) remain predictive obligations (CHIRAL4D.MIRROR.DET16.01 [C], FLAV.NU.TEXTURE.MECHANISM.01 [O], SEAM.MMST.TYPEIII.CHARGED.01 [O]). Review wave 6 (2026-08-30; suite 996 → 998): `[verification/v1004_milnor_frobenius_gray.py]` types the Milnor–Gray finite algebra (classical cite + new-in-corpus rank/Gray/CP [E]-finite; corpus identification SEAM.MILNOR.LOCALRING.01 stays [O]); `[verification/v1005_relative_pencil_bridges.py]` flags the relative pencil as circular (carrier 5 already in Q_2/C column sums; not a P2 selector); GRAV.WEINBERG.WITTEN.01 [O] is the binding spin-2 firewall. Review wave 7 (2026-08-30; suite 998 → 1002, ledger 1173 no new rows): `[verification/v1006_mmst_lemma_battery.py]` (five MMST lemmas in-house; residual TEL-B-EXTERNAL + ALG-EXH boxed; SEAM.MMST.TYPEIII.CHARGED.01 stays [O]); `[verification/v1007_det16_stability_battery.py]` (T1/T2 proved, T3 Michalakis–Zwolak cited-verified; 1/192 and BDL boxed; CHIRAL4D.MIRROR.DET16.01 stays [C]); `[verification/v1008_master_assembly_scaffold.py]` (2+1D scaffold-coherent; Decision / DETLINE unmoved); `[verification/v1009_rho0_minimizer.py]` (unique KMS compression; two typed review corrections; FTRANSFER.SK.RH00.01 stays [O]). Afternoon harvest (2026-08-30; suite 1002 → 1004, ledger 1173 no new rows): `[verification/v1010_simplicity_bridge_census.py]` (no smaller axiom core — the simplicity lives in the theorems; pencil rehabilitated as forced provenance; Milnor strong bridge obstructed $\mathbb{F}_2$ +upstairs; SEAM.MILNOR.LOCALRING.01 stays [O], AX.P2.01 stays an axiom); `[verification/v1011_3p1d_ladder_battery.py]` (3+1D ladder complete at scaffold; matching scale in the deconfined/weak regime; Decision / DETLINE unmoved). Evening TOE-gate wave (2026-08-30; suite 1004 → 1005, ledger 1173 no new rows): `[verification/v1012_toe_gate_witnesses.py]` (T5 IR witnesses + typed SPLIT; T8 ρ_0 selection vacuity; T6 κ six-fold NULL; T7 interacting TT; all four contracts stay [O]). Late-evening harvest (2026-08-30; suite 1005 → 1007, ledger 1173 no new rows): `[verification/v1013_thermodynamic_dynamics.py]` closes the mandatory-dynamics leg at Hamiltonian-class level (Lieb–Robinson + τ_t + gauge-invariant quasilocal algebra + state existence; Decision typing UNCHANGED); `[verification/v1014_bridge_refinements.py]` verifies the finite detline restriction isomorphism (orientation $2 \rightarrow 1$, residual A_0 anchor) and derives W-bridge P-anch while narrowing P-dem to one character-blind response map. Within this finite compiler/W-bridge lane, the remaining identification was routed through the external MMST/Quillen leg. This does not classify or close T3–T8. Monday-morning harvest (2026-08-31; suite 1007 → 1009, ledger 1173 no new rows): `[verification/v1015_axiom_core_closure.py]` derives the remaining W-bridge premise (character-blind P-dem response $r = (1, 1, 1)$; both premises now finite; axiom-core remainder 0 modulo externalized MMST; AX.P2.01 stays an axiom); `[verification/v1016_state_gap_batteries.py]` records the first viable non-entropic selector (R_4 seam-modular cap), the narrowed TEL-B increment target, the uniform CAR nuclearity lemma, and the DFP volume-uniform gap for finite-group DET chains. The old “remaining fundamental gaps” phrase is scope-corrected: only the finite compiler/W-bridge lane was reduced to MMST plus the 4D functional; a shared 3+1D parent and the independent T3–T8 mechanisms remained open. Directed-readout and Coxeter–Euler harvest (2026-09-02; suite 1010 → 1012, ledger 1174 → 1176): `[verification/v1018_e8_directed_readout.py]` promotes seven exact E_8 readout cells (E8.DIRECTED.READOUT.01 [E] Identity; C7 Gauss-code transform stays open, `rem:c7-audit`). `[verification/v1019_coxeter_euler_completion.py]` is the Coxeter–Euler completion (E8.COXETER.EULER.COMPLETION.01 [E] Identity plus Numerical Euler products at $X = 10^5$; class statement: the vanishing linear term is generic from $\text{Tr } C = -1$; Beurling-generic; fence: the

trace-free completion is zero-free and pole-free in $\text{Re } s > 1/2$; the splitting remains open). Round-4 TOE integration (2026-09-05; [verification/v1026_telb_round4_closure.py], [verification/v1027_signed_det_car_wall.py], [verification/v1028_gauss_d4_cap.py], [verification/v1029_local_tensor_constraints.py], [verification/v1030_alg2_sector_frame.py]): T2 has the relaxed uniform TEL-B theorem $\|R_N\|_{\text{HS}} < 2.995906 < 3$ for every even $N \geq 16$, including CF, DG and finite-grid aliases. The old ALG2 Vandermonde implication remains refuted; the new sector/frame bridge is conditional on microscopic generation and uniform joint-adjoint tails. T4 has exact DET-CAR excitations under the determinant-singlet premise and a signed $z = 1$ wall for fixed classical gauge backgrounds; its additive parent is explicitly changed, and it has no hard bare-mirror response gap or chiral dynamical-gauge continuum theorem. T6 has exact full Gauss counts (one site 3 mod 5, open cube 0 mod 5), but no neutrino mass texture. T7 has a two-mode local constraint target only after global zero-mode removal, not an emergent graviton. T8 has a symmetric internal D_4 cap with gap one, but symmetry permits a two-dimensional invariant space and selects no global ρ_0 . T1 retains only finite axiom-core/W-bridge support while unconditional provenance and the dimension selector remain open; T3 retains its Hamiltonian-class result; T5 retains finite IR witnesses and the v1020 spectator obstruction while prime completion, OS reconstruction, confinement and scattering remain open. These are scoped subgate certificates and obstructions, not a TOE closure. All T1–T8 markers stay unchanged, and the shared 3+1D parent remains absent.

Round-7 continuation (2026-09-05; 233/233 typed checks including the round-6 quantum prerequisite): [verification/v1031_quantum_tensor_curvature.py] and [verification/v1032_covariant_curvature.py] construct the zero-mean Weyl/Fock target and its positive local covariant free curvature field with helicities ± 2 . This is a free target theorem, not TFPT graviton emergence. [verification/v1033_charged_disorder.py] supplies charged corners with an additional $\mathbb{Z}_4$ flux register and the exact mismatch $h = 1/4 \neq h_\lambda = 1$. [verification/v1034_parent_mirror.py] proves the factorized onsite lower gap $1 + \sqrt{3}/2$, while refuting a proposed bare-hopping relative bound, not proving gap closure. [verification/v1035_matter_coupling.py] preserves the physical Fourier factors in linear Ward propagation for prescribed sources; dynamical quantum and universal nonlinear coupling remain open. Complete proofs are in the contracts supplement. All T1–T8 remain [O]; the common parent, microscopic MMST and global state are not supplied.

Card addendum (2026-07-22): the $a = (1, 1, 2)$ residual now carries the consolidated P2 reduction state — the position half of the alignment bit is topology (v510) and the modulus half is one discrete symmetry-lift bit — the twist-class choice (flag transitivity $\iff \tau = i$, v512/v528), so the dimensionless compiler inputs read *four marks + one discrete symmetry-lift bit (the twist-class choice, in principle interferometrically readable; flag transitivity $\iff \tau = i$) + π* (AX.P2.01 stays a declared axiom).

The former structural open core, the *single* named keystone SEAM.EQUIV.01 (the G_{net} inclusion: the raw RP seam = $(E_8)_1$ at $\tau=i$), is now *closed modulo cited theorems on its MMST route* (SEAM.EQUIV.MMST.01; the twistor route SEAM.EQUIV.TWISTOR.01 and the unconditional parent stay [O]): the explicit lattice model (v367/v368) and the S_3 stack ($c=8$, 248 currents/1 primary, torus GSD=1, RP; v376–v379) pin it at every computable level, it is Lean-formalised as FORM.SEAM.MMST.01, and only the cited MMST/OS continuum-existence theorems stay [O] (v336); its conformal-deck face QGEO.SYM.01 is a *corollary* (a conformal net’s vacuum is rotation-invariant by axiom, v323/[verification/v335_seam_equiv_unify.py]), not a second item. v_{geo} is an irreducible metrology unit and the frontier items are typed interfaces, not structural holes. G_{net} is heat-kernel grounded (G2: the spectral action gives $R + R^2$ structurally) and *gap-decoupled* (G5: $\Delta_{\text{eff}}=1.648>0$ isolates the closed admissible sector from the ambient), so the ambient measure QG.AMB.01 is no longer carried as an open structural item: it is a [C] *redundancy* (v369, conditional on SEAM.EQUIV.01+Bisognano–Wichmann), a certification object rather than missing dynamics — it does not affect any TFPT readout. Both are written up as numbered *research contracts* (lemma chains + closing theorem + machine-certifiability) in the companion `tfpt_research_contracts`, with priority on the v_{geo} scale anchor and the G_{net} /SEAM.EQUIV.01 inclusion theorem. [verification/v36_spectral_action_g2.py]

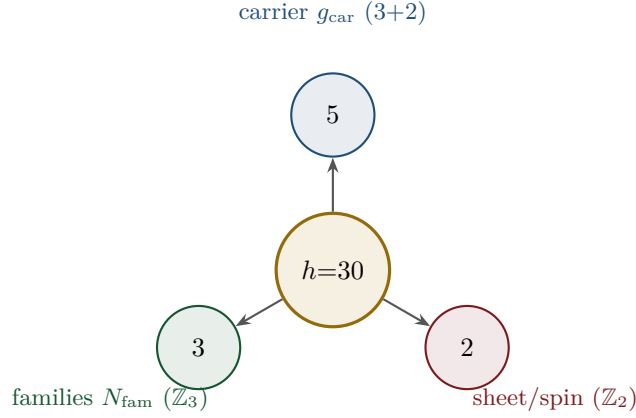
Sharper still: the structural residual is *one* condition. G_{metric} , the carrier P2 and the red-team Target A are not separate items: they are three provably-equivalent faces of the single condition “the seam carries no nontrivial abelian sector” — holomorphy (μ -index 1), a homology-sphere seam link (Γ perfect $\Leftrightarrow 2I$, [verification/v232_e8_kleinian_seam.py]), exactly one 1-dim irrep ([verification/v219_icosahedral_mckay.py]) — all of which force E_8 ($\#(\text{mark-1}) = |H_1| = 1$ only for E_8 ; holomorphic $c = 8 = g_{\text{car}} + N_{\text{fam}}$ gives the unique even unimodular rank-8 lattice). In abelian Chern–Simons language this is the single integer step holomorphic $\Leftrightarrow \det K = 1$, the extension tower $D_5 \oplus A_3(16) \rightarrow D_8(4) \rightarrow E_8(1)$ being anyon condensation (the Kitaev E_8 state); the one analytic step “the free RP seam condenses the order- $|\mu_4|$ Lagrangian glue” = the single named keystone SEAM.EQUIV.01 (with QGEO.SYM.01 its downstream conformal-deck face) is now *closed modulo cited theorems* on its MMST route SEAM.EQUIV.MMST.01 (v367/v368, v376–v379, Lean FORM.SEAM.MMST.01; cited continuum existence [O], v336; the parent SEAM.EQUIV.01 stays [O]). So beneath the gate *labels* there is, structurally, a single fundamental postulate. And the entire *emergent-QFT layer* collapses onto the *same* postulate (the *Modular Spectral Closure*, v261): the finite Dirac is a covariance induction of the seam KMS state (v258), the spectral-action cutoff *is* that KMS weight ($f_2/f_0 = 1$, v259), the seam, the carrier-16 and E_8 live on one Kummer/K3 surface (v260), so Dirac, cutoff, gauging, glue and orientability are all readouts of the one seam state — the boundary QFT is closed as a single relative object modulo the keystone SEAM.EQUIV.01 and adds *no new open item*, while the ambient quantum-gravity measure is a [C] redundancy (v369), not a separate structural gap. [verification/v234_seam_holomorphy_selection.py] [verification/v235_seam_chern_simons.py]

Reduction in one line

The number of *structural* assumptions is **two axioms**. Everything else ($N_{\text{fam}}, \Omega_{\text{adm}}, b_1, \alpha^{-1}$, the flavor matrix, the E_8 glue, the scale grammar) is a *consequence*. And even those two *tighten*: the bootstrap note shows $g_{\text{car}} = 5$ and the integer 8 in c_3 are *overdetermined* E_8 -closure fixed points (rank-fill, Coxeter-match, integer-glue/norm all give 5; $8 = h(D_5) = \text{rank } E_8 = \det R = \varphi(30)$), leaving *one* genuine continuous primitive: π from the Möbius boundary. A *fourth, deeper forcing* comes from the McKay correspondence: E_8 is the exceptional top of the tower of finite $SU(2)$ subgroups, so its branch data is the icosahedron and the three atoms (2, 3, 5) are its rotation-axis orders — the binary icosahedral group $2I$ (order 120 = $|R^+(E_8)|$) has irrep degrees equal to the affine- E_8 Kac marks, $\sum = 30 = h(E_8) = 2 \cdot 3 \cdot 5$ ([verification/v219_icosahedral_mckay.py]). So the *discrete* core has no freely tunable fundamental numbers — the bootstrap is *not creation from nothing* (two inputs remain), but an overdetermination of those inputs. (This concerns the discrete core only; dimensionful masses, the QG measure and frontier items remain typed-open.) [verification/v6_bootstrap.py] [verification/v14_carrier_uniqueness.py] [verification/v23_anchor_generator.py] [verification/v219_icosahedral_mckay.py]

4 The compiler: why $30 = 2 \cdot 3 \cdot 5$

The Coxeter number of E_8 is $h = 30 = 2 \cdot 3 \cdot 5$. Exactly these three prime factors are the three discrete atoms of the theory — that is the point of the compiler:



From this the compiler reads, among others:

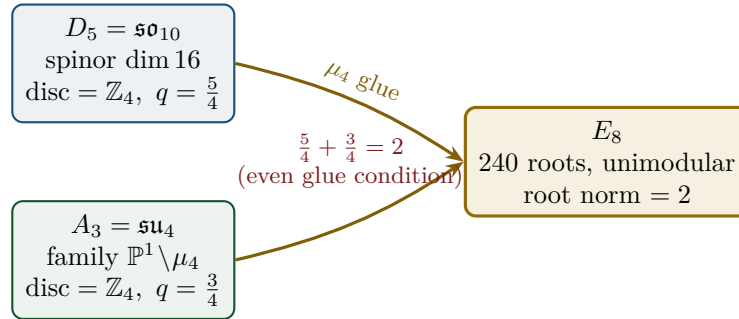
- $\dim S^+ = 1 + 10 + 5 = 16$ (one generation) as the even exterior algebra of the 5-slot carrier — the same Pascal row $\binom{5}{0}, \binom{5}{1}, \binom{5}{2} = 1, 5, 10$ appears in family, action ladder and the E_8 root count. [E]
- $|R(E_8)| = 16 \cdot 5 \cdot 3 = 240$ and $\dim E_8 = 240 + (5 + 3) = 248$. [E]
- the $\mathbb{Z}_{30}$ Coxeter element $\leftrightarrow$ the cyclotomic polynomial Φ_{30} ; the corner rotation $z \mapsto iz$ on $\mathbb{P}^1 \setminus \mu_4$ is the A_3 Coxeter element. [E]
- **why these three primes:** E_8 is the icosahedral top of the McKay tower ($2I$, order 120, irrep degrees = affine- E_8 marks summing to 30), so 2, 3, 5 are the icosahedron's rotation orders; and the E_8 exponents $(\mathbb{Z}/30)^\times$ carry an order-4 totative character $\langle 7 \rangle$ — the same μ_4 seam clock. [E] [verification/v219_icosahedral_mckay.py] [verification/v223_coxeter_totative_clock.py]
- **a network reading (computational substrate).** On the same McKay (2, 3, 5) graph the affine- E_8 marks are the *unique dynamical attractor* of a minimal local-averaging update $m \leftarrow (A+2I)/4 \cdot m$ (it converges from *any* positive start to (1, 2, 3, 4, 5, 6, 4, 2, 3)); the spherical tower terminates at E_8 and the cascade $E_8 \supset E_7 \supset E_6 \dots$ is nested-subgraph coarse-graining. So E_8 reads as the *universal attractor of a minimal (2, 3, 5) network* (a Wolfram-style computational-substrate picture) at the Coxeter-skeleton level. [C] A minimal hypergraph *rewrite* reproducing the *full* structure (lattice + recovery + readouts) stays open, and φ_0^{ret} is the analytic seed $\frac{4}{3}c_3 = 1/(6\pi)$, not an edge fraction. [O] [verification/v298_e8_network_attractor.py]
- **the bridge, hardened.** A local witness-based growth dynamics (a *diffusion-generated* witness + the local balance gate $Am \leq 2m$, Collatz–Wielandt = Smith's $\rho \leq 2$; the Perron eigenvector enters only as an audit) *reaches* E_8 as the last finite point ($E_6 \rightarrow E_7 \rightarrow E_8$, then stops at the affine boundary $\hat{E}_8$) — but *only* from a 3-arm (2, 3, $\cdot$) seed (the controls $\rho(A_n) = 2 \cos \frac{\pi}{n+1}$ and $\rho(D_n) = 2 \cos \frac{\pi}{2n-2}$ are < 2 for *all* n , so neither family ever reaches E_8). So P_2 is exactly the irreducible seed on which the rule reaches E_8 as the last finite point — a second network reading of the (2, 3, 5) hull, not a derivation of P_2 . [O] [verification/v299_hypergraph_0d_autonomous.py]
- **what a rewrite must inject.** Testing *which* load-bearing quantities are graph-spectral sharpens the open question: [E] the Kac marks are the Perron eigenvector ($Am=2m$) and the subleading eigenvalue is exactly $2 \cos(\pi/5)$ = the golden ratio (the 5-fold/icosahedral signature), but [E] the recovery rate $(2/3)^6$ is *not* any eigenvalue of the adjacency and φ_0^{ret} is not a rational edge fraction. The cusp weight $2/3 = |\mathbb{Z}_2|/N_{\text{fam}}$ is now *derived* from a minimal branching rule ([verification/v327_hypergraph_rewrite.py]); what remains non-graph-spectral for a *full*-structure rewrite at leading order is sharpened by [verification/v396_phi0_icosahedral.py] (tree-level $\varphi_0^{\text{tree}} = F/(4h\pi)$); the puncture $48c_3^4$ alone stays open. [O] [verification/v312_hypergraph_substrate.py]
- **one coupled local rule (carrier $\times$ family).** On a 9×3 labelled grid (affine- E_8 nodes $\times$ family channels) a *single* coupled micro-step — network lazy diffusion on each cusp column plus the

[[verification/v327_hypergraph_rewrite.py](#)] branching rule M on each node's family vector — has joint attractor marks $\otimes(w=0)$ and recovery rate $(2/3)^6$ after one clock hand ($2N_{\text{fam}}$ family steps); the [[verification/v324_hypergraph_fiber.py](#)] fiber product $T_{\text{net}} \otimes T_{\text{cusp}}$ emerges as the cusp-readout basis, and the [[verification/v299_hypergraph_0d_autonomous.py](#)] growth trajectory $E_6 \rightarrow E_7 \rightarrow E_8 \rightarrow \hat{E}_8$ is unchanged with the fiber attached. [E] [[verification/v395_hypergraph_coupled.py](#)]

- **the seed at leading order.** The tree-level retained seed $\varphi_0^{\text{tree}} = 1/(6\pi)$ is exactly $F/(4h\pi)$ on the icosahedral hypergraph ($F = 20$ triangular hyperedges, $h = 30$, $|\text{Aut}| = 120$): equivalently $(F/(g_{\text{car}}N_{\text{fam}}))c_3$, with $F/h = |\mathbb{Z}_2|/N_{\text{fam}} = 2/3$ the same survival ratio as [[verification/v327_hypergraph_rewrite.py](#)]; Gauss–Bonnet consistent with $c_3 = 1/(|\mathbb{Z}_2|4\pi)$. The puncture $48c_3^4$ remains analytic, not a graph fraction. [C] [[verification/v396_phi0_icosahedral.py](#)]

5 The μ_4 glue: how E_8 is really built

The decisive, now *proved* step: D_5 and A_3 have the *same* discriminant group $\mathbb{Z}_4$, and their discriminant-form norms are exactly two TFPT constants which add up to the E_8 root norm.



Glue theorem (proved)

$\text{disc}(D_5) = \text{disc}(A_3) = \mathbb{Z}_4$, glue index $|\mu_4| = 4$, and $q(D_5) + q(A_3) = \frac{5}{4} + \frac{3}{4} = 2 =$ the E_8 root norm. Hence $E_8 = (D_5 \oplus A_3) + \mu_4\text{-glue}$ is a *closed lattice-theoretic* construction — not a blind “positing of 248”. [E] [[verification/v1_e8_glue.py](#)]

6 How derivation now works: the derivation map

What can one concretely *compute* with $\{c_3, g_{\text{car}}\}$? The following map summarises what is now a consequence rather than an assumption.

Sector	How it now arises	Status
gauge group / families	carrier $3+2$, $\dim S^+ = 16$, $N_{\text{fam}} = 3$, $\Omega_{\text{adm}} = 48$	[E]
hypercharge	roots of the charge polynomial $bsY^2 + (s-b)Y - 1$	[E]
$U(1)$ index b_1	$b_1 = \frac{g_{\text{car}} 2^{g_{\text{car}}-2} + 1}{10} = \frac{41}{10}$	[E]
fine structure α^{-1}	unique root of $F_{U(1)}(\alpha) = 0$	[E]
flavor matrix	transport theorem (H1 proved, H2/H3 force the matrix)	[E]/[C]
electroweak scale	$v_{\text{EW}} \sim e^{-\alpha^{-1}/5}$ (carrier divides α^{-1} by 5)	[E]
cosmological constant	$\Lambda \sim e^{-2\alpha^{-1}}$ (density quotient; see typing note)	[E]/[C]
Hubble scale	$H_0 \sim \sqrt{\Lambda}$	[C]
inflation amplitude	$A_s = \frac{N_*^2}{24\pi^2} c_3^7$ in the R^2 branch	[C]
E_8	$D_5 \oplus A_3 + \mu_4\text{-glue}$	[E]

Marker key: **[E]** exact / machine-proven · **[C]** conditional (holds under named hypotheses) · **[O]** open / axiom · **[X]** falsifiable kill test. Per-claim fine type in *verification/status_ledger.csv*.

Notable: the scale grammar is *one* exponential engine. The same number $\alpha^{-1} \approx 137$ generates the electroweak scale (divided by 5 = carrier), the cosmological constant (times 2) and — via the square root — the Hubble scale. One constant becomes many orders of magnitude.

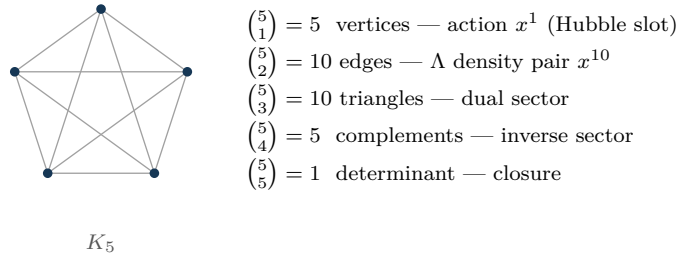
Typing note on Λ (a deliberate danger zone). “ Λ ” denotes *three* distinct objects that must not be conflated: (i) the seam-determinant exponent $e^{-2\alpha^{-1}}$ (an exact **[E]** readout), (ii) the dimensionless density quotient $\rho_\Lambda/\bar{M}_{\text{Pl}}^4$ (which carries a prefactor *branch*, hence **[C]**), and (iii) the observed curvature, to which (ii) is *anchored*, not predicted. The exponential is exact; the absolute dark-energy density remains a typed cosmology interface (full disambiguation in `tfpt_2_standard_model`).

Cosmology is the Pascal action grammar of the carrier

With $x = v_{\text{geo}}/(5\beta_{\text{rad}}^2\bar{M}_{\text{Pl}})$ the cosmological readouts are a *power tower* on the five-slot carrier graph K_5 :

$$\frac{H_0}{\bar{M}_{\text{Pl}}} = x^5 R_H, \quad \frac{\rho_\Lambda}{\bar{M}_{\text{Pl}}^4} = x^{10} R_\Lambda, \quad (1, 5, 10) = \binom{5}{0}, \binom{5}{1}, \binom{5}{2}$$

EW is the unit x^1 , Hubble is the product over the $\binom{5}{1} = 5$ vertices, Λ is the product over the $\binom{5}{2} = 10$ edges — the *same* Pascal triple that reads one generation, the action ladder and the E_8 root count $16 \cdot 5 \cdot 3 = 240$. “Hubble = slot product, Λ = pair product.” **[E]**



K_5 on the five carrier slots; the action powers x^1, x^5, x^{10} are its $\binom{5}{k}$ faces (mnemonic; the physical scale map stays **[C]**).

The entire fermion spectrum in one formula

Masses, Yukawa, CKM, PMNS and neutrinos all follow from *one* master formula with *one* seed:

$$\hat{m}_{f,j} = \frac{v_{\text{geo}}}{\sqrt{2}} \lambda_Y^{L_{f,j}} \Lambda_{f,j}, \quad \lambda_Y = \sqrt{\varphi_0^{\text{ret}}(1 - \varphi_0^{\text{ret}})}, \quad \varphi_0^{\text{ret}} = \frac{1}{6\pi} + \frac{3}{256\pi^4}.$$

The word-lengths $L_{f,j}$ are the *fixed residue matrix of the compiler*, whose characteristic polynomial $t^3 - 9t^2 + 10t - 8$ carries only compiler numbers ($\text{tr} = 9 = N_{\text{fam}}^2$, $\det = 8 = h(D_5)$, principal 2-minors 2,3,5 with product $30 = h(E_8)$). Through the φ_0^{ret} -ladder $\hat{m} = \frac{v_{\text{geo}}\pi}{\sqrt{2}}c(\varphi_0^{\text{ret}})^k$ all nine word-lengths are fixed and the *charged-lepton* amplitudes are closed; the *quark mass ratios* are closed too (integer Plücker readouts on the derived selector stratum, **v49/v71**), with only the *absolute* amplitude scale reducing to the single dimensionful anchor v_{geo} . **SM status:** the discrete packet, the dimensionless flavor skeleton, the charged-lepton source masses and the quark *ratios* are closed; the *absolute* quark scale and the full PMNS completion are reduced/conditional; $m_W, m_Z, m_H, \sin^2\theta_W, \alpha_s$ are RG scheme-layer (m_H rests on the closed UV quartic $\frac{1}{16\pi^2}$); and the solar angle is *realized* by a *TFPT texture* and reduced to the seam-misalignment lemma ($\sin^2\theta_{12} = \frac{1}{3} - \frac{\varphi_0^{\text{ret}}}{2}$; see below). (Full derivation: document 2, `tfpt_2_standard_model`.) [`verification/v18_quark_yukawa.py`] [`verification/v20_lepton_c_derivation.py`] [`verification/v46_grand_mass_volume.py`]

7 Physical, geometric, topological: why the architecture is plausible

The closure works on three levels at once: *physically*, α^{-1} is the fixed point of *one* equation and one generator drives many scales; *geometrically*, the C^+ spinor and the puncture geometry $\mathbb{P}^1 \setminus \mu_4$ produce D_5 and A_3 , glued to E_8 ; *topologically*, the common discriminant $\mathbb{Z}_4$ (the μ_4 winding) forces the glue and Φ_{30} /Coxeter drives the sectors — with exactly 2 axioms and the rest a consequence. **Why the compiled architecture is plausible.** It is (i) *parsimonious* (few independent assumptions $\Rightarrow$ low overfitting risk), (ii) *rigid* (the glue condition $5/4 + 3/4 = 2$ and the discriminant $\mathbb{Z}_4$ leave little freedom), and (iii) *checkable* (machine-checkable E_8 appendix, explicit fixed-point equation for α^{-1}). More explained from less — exactly the criterion that makes a theory more probable.

8 What role E_8 now plays exactly

E_8 is no longer the starting point but the *output format*:

- **Bookkeeping:** E_8 is the unimodular container in which carrier (D_5) and family (A_3) fit together consistently. Its numbers 240, 248 are carrier traces, not inputs.
- **Consistency test:** unimodularity ($\det 1$) is a hard condition; it closes only because the discriminant-form norms $5/4$ and $3/4$ (both already present in TFPT) add up to 2. E_8 thus tests the internal coherence of the two atoms.
- **Not an end in itself:** E_8 does not explain “everything”; it is the smallest even unimodular hull of the datum $D_5 \oplus A_3$. The physics sits in the *two inputs*, not in E_8 .

New — the secondary atlas. Beyond that, E_8 is an *audit container*: each maximal subalgebra projects a TFPT module. Document 3 (`tfpt_3_e8_audit_bootstrap`, Part I) shows the seven slices of 248 explicitly and labelled. The strongest new hit is that $E_6 \times A_2$ reads the flavor matrix:

$$248 = \|R\|_F^2 + \det R + 2(\mathbf{1}^\top R a) N_{\text{fam}} = \underbrace{78}_{\dim E_6} + \underbrace{8}_{\dim A_2} + 2 \cdot 27 \cdot 3,$$

with $\|R\|_F^2 = 78 = \dim E_6$, $\det R = 8 = \dim A_2 = h(D_5)$. The discipline rule is: *every load-bearing number must appear in at least one E_8 projection* — this makes the structure falsifiable rather than numerological. (Audit level; all identities machine-verified.)

9 What this means for the theory-of-everything question

The state of the five questions — closed, reduced or typed

1. **Flavor residual — ratios closed; only the absolute scale is the wall-selection.** Mehta–Seshadri supplies the equivalence-class framework (stable parabolic $\leftrightarrow$ unitary representation); the algebraic selector R , the Q spectrum and the splitting type are fixed (now *derived*: $\det R = 8$ lattice, $\text{Spec}(Q_+)$ from D_4 , v69/v70; since v136/v139 the dual pair (d, n) forces R *columnwise*, d is pure anchor data, and $\text{Spec}(Q_+) = (1, 2, 3)$ is the A_3 -exponent grading on the seam curve’s cohomology, v137), and the charged-lepton amplitudes are closed. The quark mass *ratios* ($c_u/c_d = \frac{55}{117}$ etc.) are then *constant* on this discrete selector stratum (Readout Rigidity, v49/v71) — integer Plücker readouts, no transcendental solve. Only the *absolute* amplitude scale reduces to the selected *polystable* point on the parabolic stability wall (U_{point} , an anchor; Research Contract 1). [E]/[O]
2. **Gravity — the classical covariant field equation carries no free dimensionless Newton coupling under the named QFT/entanglement premises [C].** The metric-sector *field equation* is supplied by the entanglement first law $\delta S = \delta \langle K \rangle$ at fixed *volume* (Jacobson 2015): equilibrium forces the *full* covariant Einstein equation $G_{ab} + \Lambda g_{ab} = c_3^{-1} T_{ab}$ with *both* coefficients fixed — $8\pi = 1/c_3$ (v358) and Λ from α , $\rho_\Lambda = (3/4\pi^2)e^{-2\alpha^{-1}}$ (v60) — the Einstein tensor (not Ricci) forced by Lovelock, so $\nabla^a T_{ab} = 0$ is an *output* (v359). The $R + R^2$ scalaron is the *action*/inflation layer (the next-order term of the same equilibrium route, v360), and v_{geo} is the theory’s single dimensionful input (v364). What remains is *not* the field equation but the equation-of-state status (Jacobson framing, not a from-action quantisation; an *external* candidate action — Bianconi’s entropic action, arXiv:2408.14391 — is quantified in v473 without changing this typing) and the one unit v_{geo} ; the ambient measure QG.AMB.01 is now a [C] redundancy (v369, conditional on SEAM.EQUIV.01 +Bisognano–Wichmann), not missing dynamics, and *perturbative* graviton unitarity is established — the Stelle ghost is a Seeley–DeWitt truncation artefact (v304), the spin-2 sector ghost-free via the entire KMS form factor (v370) with the truncation tower decoupling (v380). [E] (local field equation) / [C] (perturbative unitarity, ambient redundancy)
3. **Strong CP — decoupled.** $\theta_{\text{eff}} = 0$ follows from three structural facts (γ_5 -Hermiticity, polar structure, sheet involution) + reflection positivity — *without* a mass gap. [E] (given RP)
4. **Full dynamics — the admissible transfer model is closed, and the boundary QFT is now one relative object.** The mass gap is the *explicit* discrete gap $6 \log \frac{3}{2}$ of the C_6 transfer operator (eigenvalues $(k/3)^6$), which supports the OS reconstruction path on the admissible sector. On top of this the whole emergent-QFT round assembles the boundary theory into one relative object $\text{TFPT}_{\text{QFT}} = (\mathcal{A}_\Sigma, \omega_\Sigma, \Delta_\Sigma, \rho, A_F, H_F, D_F, J, \gamma, S_{\text{rel}})$ — the *Modular Spectral Closure*: the finite Dirac is a covariance induction of the seam KMS state (v258), the spectral-action cutoff *is* that KMS weight (v259), the seam/carrier/ E_8 live on one Kummer/K3 (v260), all certified together (v261) — closed modulo the single keystone SEAM.EQUIV.01 , whose MMST route $\text{SEAM.EQUIV.MMST.01}$ is *closed modulo cited theorems* (lattice + S_3 stack, Lean FORM.SEAM.MMST.01 ; v367/v368, v376–v379; the unconditional parent stays [O]). *What this does not fully close*: the full measured pole masses (the absolute scale v_{geo} + standard RG), the absolute QCD scales (m_p/m_e , now a typed [C] transfer, v374), the complete PMNS dynamics (the angles are typed; the full mass/CP dynamics stay [C]/[O]), and the real 4D interacting QFT — the continuum limit, whose cited existence theorems stay [O] — with the ambient measure a [C] redundancy (v369). [E] (transfer model + boundary relative object) / [C] (continuum modulo cited, transfers, ambient redundancy)
5. **Axioms P1/P2 — P2 machine-verified.** The Lean proof builds cleanly (3357 jobs, 0 sorry, only kernel axioms); the P2 algebra is a theorem, P1 a typed interface. They remain declared inputs. [E]/[O]

In other words: the theory has shrunk from “many open audit points” to “*standard steps* (cluster expansion, Fredholm, truncation bound) + two declared axioms”. The five questions are now *closed, reduced or typed* rather than open-ended — a qualitative jump in discipline, not a claim of completion. (*Details and proof chains: document 2, tfpt_2_standard_model, Part III.*)

The closure ledger: what is done, and what genuinely remains

A complete theory must close the discrete structure, the dimensionless constants, the mass spectrum, gravity, and the quantum measure. The current state, graded honestly:

TOE piece	Status	If not complete: what closes it
gauge group, N_{fam} , hypercharge, b_1	[E]	— complete
$E_8 = (D_5 \oplus A_3) + \mu_4$, group closure	[E]	— complete
bootstrap $(g, \mu) = (5, 4)$, “8” in c_3	[E]	— complete (reverse glue $\mu^2 - 5\mu + 4 = 0$)
fine structure α^{-1}	[E]	— existence+uniqueness proved ; value is a numerical fixed point (ledger EM.FP.01), Ward origin [C]
fermion masses (φ_0^{ret} -ladder)	[E]/[O]	leptons exact; quark <i>ratios</i> closed (Plücker, v49/v71); absolute scale = anchor
mixings $\theta_{13}, \theta_{23}, \theta_{12}$ (PMNS angles)	[E]/[C]	θ_{12} cond. derived; θ_{23} maximal; <i>full</i> PMNS dynamics (mass scale, CP magnitude) stay [C]/[O]
flavour matrix / H2	[E]	dictionary <i>exact</i> (hexagon = twisted family spectrum, addresses pinned, margins forced, v118–v122); R forced columnwise by (d, n) (v136/v139); pairing values = atom identities (v142/v145); residue = <i>one</i> lift map
seam quantum clock (R1)	[E]/[C]	typed closed: reduced edge-sector clock (v124–v133); external VW edge = $2 \times$ reduced budget, full 4d det = firewall (v138); det-ratio cancellation derived in-family (v144)
inflation A_s, n_s, r , scalaron M	[C]	scalaron $M = c_3^{7/2} \bar{M}_{\text{Pl}}$ exact; n_s, r are bands over $N_* \in [50, 60]$ (reheating point 51.4, v86)
boundary QFT (Modular Spectral Closure)	[E]/[C]	one relative object TFPT _{QFT} : D_F = covariance induction (v258), cutoff = KMS weight $f_2/f_0=1$ (v259), seam/carrier/ E_8 on one K3 (v260), certified (v261) — closed modulo SEAM.EQUIV.01, whose MMST route SEAM.EQUIV.MMST.01 is closed modulo cited theorems (v376–v379; parent [O])
perturbative 4D S-matrix (S_{pert})	[E]/[C]	Epstein–Glaser-constructible (v269): one-loop quartic (v271) + gauge $\beta = (41/10, -19/6, -7)$ (v273), $S_{\text{pert}} \xrightarrow{\text{LSZ}} S_{\text{phys}}$ with one-loop unitarity (optical theorem, v278); the spin-2 graviton sector is perturbatively unitary too — the Stelle ghost is a Seeley–DeWitt truncation artefact (v304/v370/v380)
<i>the actual TOE remainder — dimensionful units, typed transfers, and the cited-theorem ceiling on the seam</i>		
QFT measure (admissible sector)	[E]	closed: RP from cusp spectrum, OS reconstruction
full measured pole masses	[C]	ladder $\times v_{\text{geo}}$, dressed by standard RG (no new physics); v_{geo} over-determined (v274)
absolute QCD scales (m_p/m_e , Λ_{QCD})	[C]	typed runnable transfer with uncertainty budget (v374, contract FR.MPME.01); not a compiler number
full PMNS dynamics (mass scale, CP)	[C]/[O]	angles typed; CP strength $J_{\text{PMNS}} = -0.0297$ derived (v270); absolute ν -scale = one seesaw ratio (v272); four named post-hoc [O]/[C] candidates: third-gen ladder-base (v467), Δm^2 ratio = $ J $ (v468), carrier-normalised one-parameter seesaw (v481), scalaron-trace rung $M_R = 3c_3^{7/2} \bar{M}_{\text{Pl}}$ (v986) — record unchanged
(1) SEAM.EQUIV.01 — one named theorem (<i>raw seam</i> = $(E_8)_1$ at $\tau=i$)	[O]/[C]	route split 2026-07-22: closed if MMST or TWISTOR route closes. MMST route SEAM.EQUIV.MMST.01 closed modulo cited theorems: lattice model (v367/v368) + S_3 stack (v376–v379) pin it at every computable level, Lean FORM.SEAM.MMST.01; only residual [O] = the cited continuum existence (v336); extension leg certified (v469). Twistor route SEAM.EQUIV.TWISTOR.01 (Costello–Li, via CELEST.SEAM.01) [O] $\Rightarrow$ parent stays [O] as an unconditional claim
(2) QG.AMB.01 — ambient measure (<i>redundancy, not missing dynamics</i>)	[C]	discharged as a redundancy (v369; v379 RP $\rightarrow$ OS), conditional on SEAM.EQUIV.01+Bisognano–Wichmann: a certification object, gap-decoupled (margin $1.648 > 0$, v330/v335) so no readout depends on it; obstruction characterised (v332) + conditionally resolved by GHP+IDG (v334); Tier-B’s holomorphy bit (det $K=1$, v277) is absorbed into SEAM.EQUIV.01
analytic boundary origin of π ($c_3 = \frac{1}{8\pi}$)	[C]	hardened: $c_3 = 1/(\mathbb{Z}_2 \oint_{S^2} K) = 1/(8\pi)$ (Gauss–Bonnet); “8” = rank E_8 ; π stays the one primitive
$\eta_B, m_p/m_e$, Koide, dark matter	[C]	typed runnable transfer solvers with kill tests (v371–v374, observatory CI v375; see document 4)

Marker key: **[E]** exact / machine-proven · **[C]** conditional (holds under named hypotheses) · **[O]** open / axiom · **[X]** falsifiable kill test. Per-claim fine type in *verification/status_ledger.csv*.

The honest bottom line: the discrete core, the dimensionless constants, the *mass-hierarchy exponents* and the mixings are *closed*; the nine masses follow from one φ_0^{ret} -ladder (lepton rationals exact, quark $O(1)$ digits still a conditional finite evaluation). The *admissible-sector* QFT measure is closed (a finite gapped transfer system, RP from the cusp spectrum, OS-reconstructed), and on top of it the whole boundary QFT is now *one relative object* TFPT_{QFT} (the *Modular Spectral Closure*, v258–v261: D_F a covariance induction, the cutoff the seam KMS weight, seam/carrier/ E_8 on one Kummer/K3) — closed modulo the single keystone **SEAM.EQUIV.01**. *What that closure does not reach* is exactly the dimensionful/ambient remainder: the full measured pole masses (ladder $\times v_{\text{geo}}$ + standard RG, **[C]**), the absolute QCD scales (m_p/m_e , now a typed **[C]** transfer, v374), the complete PMNS dynamics (**[C]**/**[O]**), and the nonperturbative *ambient* measure **QG.AMB.01**, now itself a **[C]** redundancy (v369). (The metric-sector *field equation* carries no free dimensionless Newton coupling under the named QFT/entanglement premises **[C]** — the full covariant $G_{ab} + \Lambda g_{ab} = c_3^{-1} T_{ab}$ from fixed-volume entanglement equilibrium, v358/v359 — and the ambient *measure* is no longer an open structural item but a certification object, conditional on **SEAM.EQUIV.01**+Bisognano–Wichmann.) The *perturbative* 4D QFT is now built: the spectral-action S-matrix is Epstein–Glaser-constructible and LSZ-bridged to the physical asymptotic S-matrix with one-loop unitarity for the matter+gauge sector (v269–v278), and the spin-2 graviton sector is perturbatively unitary too — the R^2/Weyl^2 Stelle ghost is a Seeley–DeWitt *truncation artefact* (v304), ghost-free via the entire KMS form factor and the Barnes–Rivers decomposition (v370) with the truncation tower decoupling (v380); the whole bedrock reduces to one geometric postulate, *the raw seam is the flat $\tau=i$ pillowcase* (v276), with Tier-B’s holomorphy bit $\det K=1$ (v277) absorbed into **SEAM.EQUIV.01**. The former single open lemma, the named theorem **SEAM.EQUIV.01** — *the raw reflection-positive seam state is the holomorphic $(E_8)_1$ net at $\tau=i$* — is now *closed modulo cited theorems on its MMST route* **SEAM.EQUIV.MMST.01** (the twistor route **SEAM.EQUIV.TWISTOR.01** and the unconditional parent stay **[O]**). (The flat $\tau=i$ geometry and the E_8 holomorphy are *two faces of one object*: the $(E_8)_1$ character is $\chi_{E_8} = j^{1/3}$, so $\chi_{E_8}(i) = 1728^{1/3} = 12$ and $\tau=i$ is at once the order-4 CM point and the $(E_8)_1$ partition-function modulus, v282.) The explicit lattice model (v367/v368) and the S_3 stack ($c=8$, 248 currents/1 primary, torus GSD=1, RP; v376–v379) pin it at every computable level, and it is Lean-formalised as **FORM.SEAM.MMST.01** (collar hypotheses kernel-proved, the MMST scaling-limit and Adamo–Moriwaki–Tanimoto OS-reconstruction theorems as named cited axioms, clean **#print axioms**); the *only* residual that stays **[O]** is the abstract continuum existence of the scaling limit (v336) — its 128-spinor extension leg since re-founded on the peer-reviewed crossed-product package ($h_s=16/16=1 \in \mathbb{Z}$ is the Longo–Rehren locality criterion; KLM $\mu=4/2^2=1$; AGT/AMT the second witness), the realisation input reduced to invariants (R1’; computed $|C|=1$, $\nu=16$), Lean parallel route **seamResidualClosed’** (v469) — so it is *closed modulo a cited theorem*, not solved, Lean-pinned to exactly those named steps plus the derived Recovery gap $\Delta = 6 \ln(3/2) \approx 2.43 > 0$ (v308); the conformal-deck premise **QGE0.SYM.01** is its *downstream* definitional face (v323). This is by design the *one* irreducible structural input of the theory — the role the *constancy of c* plays in relativity. It is not a defect to be removed but the single, sharply-localised, falsifiable premise on which the whole boundary closure turns; with the lattice/ S_3 pinning and the Lean formalisation in place, “closing the theory” has reduced to invoking exactly the two cited continuum-existence theorems, not an open-ended search. The full sprint-by-sprint reduction that pinned **SEAM.EQUIV.01** is recorded in the changelog, not replayed here. The seam seed is *hardened*: $c_3 = 1/(|\mathbb{Z}_2| \oint_{S^2} K dA) = 1/(8\pi)$ is the one-sided Gauss–Bonnet normalisation of the seam sphere, with the discrete “8” equal to rank E_8 and only the Gauss–Bonnet π left as the single irreducible primitive. What remains for a full TOE is then the cited continuum-existence theorem on the seam and the one unit v_{geo} , plus the standard-RG dimensionful masses and the typed frontier transfers (the ambient QG measure being a **[C]** redundancy, v369). No load-bearing discrete parameter remains free, and π is the lone continuous primitive. *4D-QFT fork policy (frozen, v265)*: the canonical 4D reading is *boundary only* — a 4D-GUT is *not claimed by default* (E_8 is the audit hull; SM-only unification is killed,

v246); carrier-native Pati–Salam is a separately-typed, falsifiable UV branch (thresholds + proton decay). Not an open ambiguity, a decision tree.

10 TFPT in the light of algorithmic physics: Zuse–Schmidhuber–Wolfram

The “compiler” framing places TFPT in an older lineage — the idea that physics is, at bottom, the output of a short computation — and it is worth stating precisely what TFPT shares with that lineage and where it deliberately parts company, so the family resemblance is not mistaken for a claim the theory does not make. Three landmarks fix the coordinates. **Zuse** (*Rechnender Raum*, 1969) proposed that the universe is literally a (cellular-automaton) computation. **Schmidhuber** sharpened this into an *algorithmic* theory of everything (1997, 2000): the shortest program that outputs a universe is the natural prior — a physics reading of Kolmogorov complexity and Solomonoff induction — while his *Speed Prior* (2002) adds that a computed universe should be one that is *fast* to compute, and his low-complexity-art programme (1997) identifies beauty with compressibility. **Wolfram** (*A New Kind of Science*, 2002; the Physics Project) recasts the same instinct combinatorially: space–time as a hypergraph updated by simple rewrite rules.

Three shared instincts

1. **Minimal description length as the selection principle.** “No load-bearing free number, only π ” is, in these terms, a Kolmogorov-style compression statement — the plausibility discussion below already names it *Kolmogorov-like compression: many numbers from little* — and the grammar-internal null model of the next section turns it from rhetoric into a measured bound.
2. **Deterministic, resource-bounded generation.** The readouts fall out of a chain of exact identities in about a second, not a search over a model space — the same spirit as the Speed Prior’s preference for *fast*-computable worlds, though TFPT makes no claim to instantiate a speed prior.
3. **Compressibility as the aesthetic.** “Choosing E_8 is choosing the icosahedron” selects the maximally symmetric, shortest-to-describe object; the affine Kac marks (1, 2, 3, 4, 5, 6, 4, 2, 3) carry a fourfold identity (representation dimensions = network attractor = spectral certificate = local balance weight). This is Schmidhuber’s *beauty = compressibility*, realised on the Standard-Model alphabet rather than on pixels.

Three deliberate divergences

- (A) **One forced program, not an ensemble.** Schmidhuber’s shortest program computes *all* universes and privileges none; TFPT bets the opposite — an over-determined bootstrap fixed point that *forces* a single dimensionless skeleton ($g_{\text{car}}=5$ fixed three independent ways). TFPT is a candidate for *the* short program of our constants, not a measure over programs.
- (B) **The description language is algebraic.** TFPT’s compression is measured in a Lie/lattice/VOA language, not in Turing bit-strings; Kolmogorov complexity is language-dependent up to an additive constant, so the honest question — is the shortness real, or hidden in the E_8 machinery? — is exactly what the null model and the “forced three ways” bootstrap are built to answer. A Wolfram-style rewrite reading sharpens the same point rather than dissolving it: the (2, 3, 5) seed is the terminal of a minimal $T(2, 3, r)$ growth rule (Cartan determinants 3, 2, 1, 0, -1 for $E_6, E_7, E_8, \hat{E}_8, E_{10}$), so the rewrite picture *re-formulates* axiom P2 rather than removing it — both pictures bottom out on the same single irreducible seed.
- (C) **Falsifiability — the one thing TFPT adds.** As *physics*, the Zuse/Schmidhuber algorithmic TOE and Wolfram’s rule search are essentially unfalsifiable: no dated measurement can kill

them. TFPT freezes dated, kill-tested predictions (the registry `predictions_frozen.json`, the predictions section below) and so puts the computational-universe intuition at genuine empirical risk. That, not the compression rhetoric, is the load-bearing difference.

Status. This section is *positioning*, not a new result: it introduces no formula and moves no status marker. Its machine-checked hooks already live in the suite — the grammar-internal null-model bound and the icosahedral/McKay bedrock with its network attractor; the Wolfram-style rewrite correspondence is worked out separately in the repository’s hypergraph note.

11 Does this make the theory more probable?

Plausibility balance. *Pro:* (a) two inputs instead of many; (b) α^{-1} to 2.9×10^{-10} (CODATA-2022, 1.9σ) as a *fixed point*, not a fit; (c) E_8 constructed, not postulated; (d) one compiler generates several sectors $\Rightarrow$ fewer degrees of freedom, more predictive power.

Contra/open: what remains are only *standard steps* (cluster expansion in the thermodynamic limit, the Fredholm property, the truncation bound) and the two declared axioms P1/P2; on the SM side the dimensionful EW/QCD masses ($m_W, m_Z, m_H, \sin^2 \theta_W, \alpha_s$) sit on the RG scheme layer. The solar angle, previously the one open SM number, is now *conditionally derived* ($\frac{1}{3} - \frac{\varphi_0^{\text{ret}}}{2}$, modulo the seam-misalignment lemma). A final verdict “it maps reality” requires this short list plus the near-term experimental tests (below).

Net: the parsimony (Kolmogorov-like compression: many numbers from little) and the high precision of individual closures raise the a-posteriori plausibility substantially — without hiding the open points.

12 Predictions for running and upcoming experiments

Because *one* generator now sits behind the numbers, the theory makes a set of concrete, falsifiable statements that running or near-term experiments are actively testing. Each row gives the TFPT value, the *new* derivation behind it, the experiment, and an honest status.

Observable	TFPT value & derivation	Experiment (running / upcoming)	St.
solar $\sin^2 \theta_{12}$	prediction of record $\frac{1}{3} - \frac{\varphi_0^{\text{ret}}}{2} = 0.306747$; TBM + seam misalignment $\varepsilon = \frac{3}{4}\varphi_0^{\text{ret}} = c_3 + 36c_3^4$ (cond.)	JUNO : first 59.1 d run 0.3092 ± 0.0087 (compatible), precision phase pending	[E]/[C]
reactor $\sin^2 \theta_{13}$	$\varphi_0^{\text{ret}} e^{-5/6} = 0.0231$; seed $\times$ carrier-trace $e^{-\gamma}$, $\gamma = \frac{5}{6}$	Daya Bay / RENO / JUNO (PDG 0.0220)	[E]
atmospheric $\sin^2 \theta_{23}$	$\approx \frac{1}{2}$ ($\mu\tau$ -symmetric limit; octant not selected)	NOvA / T2K / DUNE (octant ambiguity; NuFIT 6.0 pre-JUNO baseline)	[C]
fine structure α^{-1}	137.0359992 as the unique root of $F_{U(1)}(\alpha)=0$ (no fit, no second branch)	CODATA-2022 (data through 2022) 137.035999177(21): dev. 2.9×10^{-10} (1.9σ of its uncertainty)	[E]
tensor ratio r	$r = \frac{12}{N_*^2} \in [0.0033, 0.0048]$ (frozen band, $N_* \in [50, 60]$); scalaron-reheating point 0.0045 ($N_*=51.4$, v86)	now $r < 0.036$ (BICEP/Keck BK18); CMB-S4 ($\sigma_r \leq 5 \times 10^{-4}$, obs. ~ 2033)	[C]
tilt n_s	$n_s = 1 - \frac{2}{N_*} \in [0.960, 0.967]$ (same band); scalaron-reheating point 0.9611 ($N_*=51.4$, v86)	Planck (0.9649 ± 0.0042); CMB-S4 sharpens	[C]
amplitude A_s	$\frac{N_*^2}{24\pi^2} c_3^7$; 2.0×10^{-9} at $N_*=55$ (the measured A_s prefers fast reheating, v86)	Planck (2.1×10^{-9})	[C]
neutron EDM	$\theta_{\text{eff}} = 0 \Rightarrow d_n$ essentially null (structure + RP)	PSI nEDM / SNS (running)	[E]
CP phase δ_{CKM}	$\delta = \frac{\pi}{3} + 3\lambda^2 = 68.65^\circ$ (frozen of record, v88); survives at $+0.98\sigma$ vs γ_{PDG}	LHCb / Belle II γ combination; decision at $\sigma_\gamma \leq 0.96^\circ$	[E]
cosmic birefringence β	$\beta = \frac{\varphi_0^{\text{ret}}}{4\pi} = 0.2424^\circ$ (seam readout)	ACT DR6 hint $0.215^\circ \pm 0.074^\circ$ (systematics not yet understood — not a validation target); Simons Obs. / LiteBIRD	[C]
$0\nu\beta\beta$ / ordering	Majorana branch; normal-ordering preference	LEGEND / nEXO , DUNE, KATRIN	[C]
flavor invariants	$\det R = h(D_5) = 8$, principal minors (2, 3, 5), $\chi_R = t^3 - 9t^2 + 10t - 8$ (exact)	any future CKM/PMNS global fit must satisfy these	[E]
H_0 vs. Λ	$v_{\text{EW}} \sim e^{-\alpha^{-1/5}}$, $\Lambda \sim e^{-2\alpha^{-1}}$, $H_0 \sim \sqrt{\Lambda}$: one engine	SH0ES / DESI / Planck (Hubble tension)	[C]

Marker key: [E] exact / machine-proven · [C] conditional (holds under named hypotheses) · [O] open / axiom · [X] falsifiable kill test. Per-claim fine type in verification/status_ledger.csv.

The two decisive near-term tests

(1) **JUNO** and θ_{12} . JUNO is *taking data since August 2025* and targets sub-percent $\sin^2 \theta_{12}$. TFPT commits to the single prediction of record $\frac{1}{3} - \frac{\varphi_0^{\text{ret}}}{2} = 0.306747$ (misalignment $\varepsilon = \frac{3}{4}\varphi_0^{\text{ret}} = c_3 + 36c_3^4$). The first 59.1-day JUNO run reports $\sin^2 \theta_{12} = 0.3092 \pm 0.0087$ — *compatible*, but the precision phase is still pending; this is a first compatibility check, not yet the decisive test. A converged central value away from ~ 0.307 at high significance falsifies the seam mechanism.

(2) r . The R^2 scalaron with M fixed by c_3^7 predicts a small $r = 12/N_*^2$: the frozen band $r \in [0.0033, 0.0048]$ over $N_* \in [50, 60]$, with the scalaron-reheating point $r = 0.0045$ ($N_*=51.4$, v86) — already below the current bound $r < 0.036$ (BICEP/Keck BK18) and within reach of CMB-S4 ($\sigma_r \leq 5 \times 10^{-4}$, first observations ~ 2033 –34). A detection of $r \gtrsim 0.01$ would be incompatible with the R^2 branch on which M_{Pl} and A_s rest.

Structural (non-experimental) checks. Independent of any apparatus, the machine-checkable E_8 appendix (all 240 roots, Gram matrices, discriminant groups) lets anyone verify that the two TFPT atoms really generate E_8 ; and the discipline rule “*every load-bearing number appears in at least one E_8 projection*” (atlas note) turns the number stock into a falsifiable raster rather than

numerology. The numerology charge is additionally *quantified* by an explicit null model: under the declared formula grammar the alignment density is anomalously high — a random theory of equal formula complexity essentially does not reproduce the scorecard. This is a *grammar-internal null-model bound*, not a Bayesian probability that TFPT is true; the explicit figure and its controls are stated in the verification appendix [E] [verification/v100_numerology_null_mc.py].

Freeze file: committed kill criteria

To prevent post-hoc rescue, the predictions above are frozen with explicit kill criteria in the machine-readable registry `verification/freeze_file.csv`. The decisive entries:

- **solar** $\sin^2 \theta_{12} = \frac{1}{3} - \frac{\varphi_0^{\text{ret}}}{2} \approx 0.3067$ — a JUNO central value clearly away from 0.307 kills the seam-misalignment mechanism;
- **tensor** $r \approx 0.0040$ — any robust $r \gtrsim 0.01$ kills the R^2 branch carrying M_{P1}, A_s ;
- **ordering** normal, small $m_{\beta\beta}$ — inverted ordering or large $m_{\beta\beta}$ kills the Majorana branch;
- **strong CP** $\theta_{\text{eff}} = 0$ — a solid nEDM signal above SM background falsifies the structural cancellation;
- $w = -1$ — a robust $w \neq -1$ kills the single-engine dark-energy readout.

The proton/electron ratio is explicitly *not* claimed as a compiler power (only fails if mis-asserted as one).

Blind-prediction registry (frozen 2026-06-09, machine-enforced). Beyond the kill criteria, the *values* themselves are now frozen: `verification/predictions_frozen.json` registers every dimensionless prediction of record at 25 significant digits *before* JUNO / CMB-S4 / LiteBIRD / DESI decide, and [verification/v84_frozen_registry.py] re-derives each decimal from the two axioms on every suite run (formula $\leftrightarrow$ value lock; covered by `manifest.sha256`; ledger `REG.FREEZE.01`). In particular the registry admits exactly *one* θ_{12} prediction of record (the seed $\frac{1}{3} - \frac{\varphi_0^{\text{ret}}}{2} = 0.306747$) — the seam and non-linear variants are typed as derived variants of the same texture and can never be silently promoted afterwards. r and n_s enter only as *bands* over the declared external $N_\star \in [50, 60]$, never as point predictions.

What likely follows next.

- the quark mass *ratios* are now closed combinatorially (integer Plücker readouts on the derived selector stratum, `v49/v69/v71`); the only residual is the *absolute* amplitude scale, an anchor (U_{point}) of the same nature as the one dimensionful scale — no new physics;
- further constants as carrier traces (analogous to $b_1 = 41/10$), since the compiler systematically produces traces over S^+ ;
- a sharper geometry $\leftrightarrow$ gravity bridge once the Hodge/ R^2 branch is lifted from [C] to [E].

Conclusion

TFPT's sectors form an impressive collection of closures sharing common numbers. The compiler closure explains *why* they are the same numbers: a small discrete generator $\mathbb{Z}_{30} = 2 \cdot 3 \cdot 5$ builds, from two inputs $\{c_3, g_{\text{car}}\}$ via $D_5 \oplus A_3 + \mu_4$, the E_8 container and outputs the Standard Model, the constants and the scale grammar from there. The theory thereby becomes *more parsimonious, more rigid and more checkable*. Precisely nameable gaps remain — one geometric flavor realisation, the conditional gravity/QFT closures, and two declared axioms — but the path to closure is now short and concrete.