

TFPT Verification Catalog

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Source registry edition

This reference volume lists the registered verification modules and their stated checks. It is generated from the script registry. A row or a passing finite check is not a proof of the complete physical theory. Claim status and scope remain governed by `verification/status_ledger.csv` and original sources.

The reading guide, research contracts and dated publication history are separate documents. See <https://www.fixpoint-theory.com/documentation> for the central source and evidence registry.

Script	What it machine-checks
v1_e8_glue.py	glue theorem $E_8=(D_5\oplus A_3)+\mu_4$: $\text{disc}=\mathbb{Z}_4$, $q(D_5)+q(A_3)=\frac{5}{4}+\frac{3}{4}=2$, $240=16\cdot 5\cdot 3$, $248=240+8$
v2_carrier_pascal.py	$g_{\text{car}}=5$ unique Pascal solution; $16=1+5+10$, $N_{\text{fam}}=3$, $\text{rank } E_8=8$, $\Omega_{\text{adm}}=48$, $b_1=\frac{41}{10}$
v3_em_alpha.py	EM closure: unique root of $F_{U(1)}(\alpha)=0$, $\alpha^{-1}=137.0359992168$, existence/uniqueness, inverse test, ablation
v4_flavor_matrix.py	residue matrix R : $\det=8$, minors $\{2, 3, 5\}$, $\chi_R=t^3-9t^2+10t-8$, SNF $\text{diag}(1, 1, 8)$, $\ R\ _F^2=78$, $\sum L=40$
v5_e8_cascade.py	cascade $D_n=60-2n$: endpoints, exponent rungs $\rightarrow 240$, IR tail 46080, variance 6552
v6_bootstrap.py	reverse glue $\mu^2-5\mu+4=0$; $g_{\text{car}}=5$ three ways; $8=\text{rank } E_8=h(D_5)=\varphi(30)$
v7_gravity_cosmo.py	scalaron exponent 7, $M_{\text{scal}}^2/\bar{M}_{\text{Pl}}^2=c_3^7$, A_s, n_s, r , Ω_b , $\sin^2 \theta_{12}$
v8_horizon.py	horizon code: $\frac{1}{2\pi}=4c_3$, $1920= W(D_5) $, S_{dS} , Page, $\beta_{\text{rad}}=0.2424^\circ$
v9_neutrino_texture.py	solar angle: explicit $\mu\tau$ Majorana texture $\rightarrow \sin^2 \theta_{12}=\frac{1}{3}-\frac{\varphi_0^{\text{ret}}}{2}$, $\theta_{23}=45^\circ$, $\theta_{13}=0$
v10_projection_involution.py	Q, Σ algebra: $K=R+Q\Sigma$, $L=R+Q(I+\Sigma)$; χ_Q, χ_K ; det ladder $3\cdot 4\cdot 8\cdot 20=1920= W(D_5) $; $a^\top K a=41$
v11_unique_KQ.py	K, Q are the <i>unique</i> nonneg-int matrices with their compiler budgets, spectrum and monotone rows (enumeration)
v12_mass_generation_polynomials.py	sector/generation polynomials of K and the anchor-block det ladder $(9, 10, 16, 40)$
v13_open_gates.py	gate closures: $M=41=10b_1=\sum L+N_\Phi$; $Q_+=A_3$ exponents, $Q_-^2=N_{\text{fam}}$
v14_carrier_uniqueness.py	$g_{\text{car}}=5$ unique ($N_{\text{fam}}\in\mathbb{Z}^+$, $\text{rank } E_8=8$); split $(3, 2)$ from $b+s=5$, $b^2+s^2=13$; $\text{Tr } Y=\text{Tr } Y^3=0$
v15_bootstrap_classification.py	$D_5\oplus A_3$ unique familyful cyclic-gluon of E_8 (16-spinor + 3 families), glue $\mathbb{Z}_4$
v16_solar_dual_anchor.py	$a^\top R^{-1}=a^\top L^{-1}=(-\frac{1}{2}, -\frac{1}{2}, 1)$; $\sin^2 \theta_{12}=\frac{1}{3}-\frac{\varphi_0^{\text{ret}}}{2}$; full PMNS
v17_hexagonal_resolvent.py	finite resolvent $D_y^{-1}=(\sum y^{5-m}\delta^m U_6^m)/(y^6-\delta^6)$ (quark c backbone)

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Script	What it machine-checks (<i>continued</i>)
v18_quark_yukawa.py	quark source ratios $\frac{m_u}{m_d}=0.470085, \frac{m_c}{m_s}=13.61, \frac{m_t}{m_b}=40.80$ exact; lepton $c=(\frac{16}{7}, \frac{4}{3}, \frac{7}{6})$; full hierarchy
v19_monodromy_moduli.py	exact pole $z_\star=\frac{794-7\sqrt{9961}}{2187}$ (3^7); D_4 $SU(3)$ monodromy constructible but D_4 -fixed locus positive-dim $\Rightarrow$ exact quark c reduce to (U)
v20_lepton_c_derivation.py	lepton c 's derived: $\delta=\frac{1}{2}$ resolvent $c= \mu_4 ^w/(\frac{5}{4}-\cos\frac{r\pi}{3}) \Rightarrow \frac{16}{7}, \frac{4}{3}$; product $\frac{2^{g_{\text{car}}}}{N_{\text{fam}}^2}=\frac{32}{9} \Rightarrow \frac{7}{6}$
v21_solar_product_quark.py	solar coeff $=q(A_3)=\frac{3}{4}$ (glue-norm, $q(D_5)+q(A_3)=2$), $\sin^2\theta_{12}=\frac{1}{3}-\frac{\varphi_0^{\text{ret}}}{2}$; product $\frac{2^{g_{\text{car}}}}{N_{\text{fam}}^2}$; quark law fails ($\frac{1}{7}$ vs 0.724)
v22_open_gates_audit.py	residual-gates audit contract: exact reduction of each open gate (A2,B3,B4,B5,B6,C7) machine-pinned (forced part vs. named residual)
v23_anchor_generator.py	anchor $a=(1, 1, 2)$: $e_k=(4, 5, 2)$, $c_3=\frac{1}{2e_1\pi}$; $p_n=2+2^n \Rightarrow 240, 248$, binary ladder; inputs $\rightarrow \{a, \pi\}$
v24_quark_ratio_closure.py	quark ratios $\frac{55}{117}, \frac{34}{47}, \frac{3}{26}$ from TFPT blocks; mass ratios match $< 0.03\%$; rational c gauge, Λ_q in $O(1)$
v25_frontier_conjectures.py	conjectures: Koide $Q_{\text{src}}+\frac{\varphi_0^{\text{ret}}}{24}\approx\frac{2}{3}$; axion $f_a=M_{\text{scal}}/128\rightarrow m_a\approx 23.8\mu\text{eV}$
v26_flavor_frontier_unification.py	the “11” is not uniquely forced ($\Rightarrow$ [C]); flavor frontier unifies to one (U) gate; cusp config on the parabolic stability wall
v27_wall_representative.py	explicit balanced wall rep W_{wall} (cols = perm(0, 1, 2), rows $w=(2, 1, 1)$, pardeg 0); selector $\det R=8$, $\text{Spec}(Q_+)=\{1, 2, 3\}$
v28_gravity_fR.py	$R+R^2$ closed: $f(R)$, $M=c_3^{7/2}\bar{M}_{\text{Pl}}$ scalaron, $N_\star=57\rightarrow n_s, r, A_s$; full metric measure open; $248c_3^2<6\log\frac{3}{2}$
v29_research_contract_certs.py	research-contract certificates: $C_U^{(1)}$ wall enumeration (1296 $\rightarrow$ 144 $\rightarrow$ 5 orbits; symmetry alone does not pick W_{wall}) and $G5$ gap-dominance $2\ V\ <\Delta$
v30_d4_character_variety.py	$C_U^{(2)}$: full D_4 -fixed $SU(3)$ character variety is positive-dimensional $\Rightarrow$ selector needs the $R(\rho)$ dictionary (H2; exact since v118–v122, residue = the $R4'$ selector establishment)
v31_R_dictionary.py	$R(\rho)$ characterized: case A alive (irreducible $\Rightarrow$ mixing); R integer but ρ -invariants continuous $\Rightarrow R(\rho)$ is the transcendental non-abelian-Hodge map (residual = Hitchin solve)
v32_rh_splitting.py	RH route: $\sum_k U^k A_0 U^{-k}=4\text{diag}(A_0)$ exact $\Rightarrow$ splitting $\mathcal{O}(-2)\oplus\mathcal{O}(-1)^2\Leftarrow\text{diag}(A_0)=(\frac{1}{2}, \frac{1}{4}, \frac{1}{4})$ (algebraic); $\prod M_k=I + R$ -bridge stay open (c_u/c_d not forced)
v33_explicit_flat_bundle.py	explicit valid (U_{wall}) flat bundle (RH solve): cusp + $\mathcal{O}(-2)\oplus\mathcal{O}(-1)^2 + \ M_\infty-I\ \sim 10^{-9}$ ($\prod M_k=I$) + irreducible (case A)
v34_h2_bridge_attempt.py	H2 bridge: explicit per-puncture M_k (cusp, $\prod M_k=I$); honest negative — natural extraction $\neq$ lepton amplitudes, the Γ^{min} dictionary is the remaining input (c_u/c_d not obtained)
v35_quark_qcd_boundary.py	the open gates are the discrete $\leftrightarrow$ continuous boundary: quark cross-ratio cleanness tracks generation/QCD sensitivity (compiler hands off to continuous physics)
v36_spectral_action_g2.py	G2: spectral action $\rightarrow R+R^2$ ($a_2\sim-R/3$, $a_4 _{R^2}\sim R^2/72$); $M^2/\bar{M}_{\text{Pl}}^2=6(4\pi)^2/f_0$, c_3^7 fixes f_0 ; gap-decoupling $\Delta_{\text{eff}}=1.648>0 \Rightarrow$ admissible IR closed under RP, ambient (G6) = strict-TOE completion target
v37_plucker_anchor.py	anchor-plane Plücker apparatus: $\ Pl(K)\ _1=11$, $\ Pl_R(K)\ _1=26$, $\sum Pl_R(L)=60$; pencil $\det(K+xQ)=3x^3+7x^2+6x+4$; $K_e-K_u=a$, $L_e-L_u=\text{Exp}(A_3)$; lepton ring $c_e c_\tau= \mathbb{Z}_2 c_\mu$; Koide $u\rightarrow\frac{53}{54}u$ ([C])
v38_uwall_killswitch.py	(U_{wall}) U2 kill-switch hardened: D_4 -cusp rep irreducible at all 400 sampled points (commutant=1), mixing ≥ 0.35 , reducible locus measure-zero $\Rightarrow$ case A generic, (U_{wall}) survives; amplitude dictionary still research-level

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Script	What it machine-checks (<i>continued</i>)
v39_uwall_selectors.py	(U_{wall}) selector side closed on the explicit point: splitting type = anchor $a=(1,1,2)$, $\text{pardeg}=0$; $\det R=8=n \cdot a$, $\text{Spec}(Q_+)=\{1,2,3\}=3\alpha+1$ read off the bundle; only the amplitudes c_u/c_d ($\Gamma^{\min}$ Hitchin) remain
v40_harmonic_metric.py	(U_{wall}) harmonic metric = FINITE linear algebra (polystable $\Rightarrow$ unitary $\Rightarrow \Phi=0$): unique invariant form $H>0$, unitarised $\widetilde{M}_k$ cusp-class with $ \widetilde{M}_k \in \{0, \frac{1}{2}, \frac{1}{\sqrt{2}}\}$; the feared Hitchin PDE collapses to unitarisation + combinatorial R
v41_leg_assignment.py	(U_{wall}) final leg test: amplitudes = $\delta=\frac{1}{2}$ resolvent (closed); $\Lambda_\mu>1$ rules out holonomy moduli; harmonic holonomy $ \text{diag} =(0, \frac{1}{2}, \frac{1}{2})$ supplies $\delta=\frac{1}{2}$ (suggestive); honest negative on literal c_u/c_d reproduction
v42_exterior_leg.py	(U_{wall}) Exterior Leg Lemma: u, d share $(r, w)=(1, 1)$ so any scalar leg gives $c_u/c_d \equiv 1$; the u/d split is the $\Lambda^2 F$ area $\text{Pl}_{1,a}(K)$, $\ \cdot\ _1=11$ generated $\Rightarrow \frac{5 \cdot 11}{9 \cdot 13} = \frac{55}{117}$ [E]; phys. identification [C]
v43_exterior_bridge.py	(U_{wall}) $\Lambda^2 F$ bridge: $\Lambda^2(\widetilde{M})=\widetilde{M}$ (exterior leg = $\bar{3}$) confirmed; continuous action $\neq$ integer $\text{Pl}(K) \Rightarrow$ bridge is the discrete H2 invariant ($\det R=8$, $\text{Spec}(Q_+)$ confirmed), not continuous
v44_carrier_exterior.py	(U_{wall}) Lie-level grounding: $16=\Lambda^{\text{even}}(5)=1+10+5$; $u^c \in \Lambda^2(5)$, $d^c \in \Lambda^4(5) \Rightarrow$ exterior degrees $(2, 4)$, $\text{sum}=6= R^+(A_3) $, $\text{diff}=2= \mathbb{Z}_2 $; the exterior leg is the carrier's own Λ^2 grading (no special math)
v45_family_exterior.py	(U_{wall}) the “11” is Pascal: $ \text{Pl}(K) =(1, 4, 6)=\{\Lambda^0, \Lambda^1, \Lambda^2\}(\mu_4)$; $\ \text{Pl}(K)\ _1=11=\sum_{k \leq 2} \binom{4}{k}=16-g_{\text{car}}$ (cumulative ext of μ_4 up to $\deg u^c=2$); $15=\dim \mathfrak{su}(4)=10+5=N_{\text{fam}} g_{\text{car}}$
v46_grand_mass_volume.py	absolute mass-scaling is [E], not a product rule: sector dets $(\varphi_0^{\text{ret}})^6, (\varphi_0^{\text{ret}})^9, (\varphi_0^{\text{ret}})^{10}$ (exponents $ R^+A_3 , N_{\text{fam}}^2, \mathcal{A}_\Lambda \Rightarrow \det M_{\text{SM}} \sim (\varphi_0^{\text{ret}})^{25}=(\varphi_0^{\text{ret}})^{g_{\text{car}}^2}$; Q -rows $(4, 5, 6)$ sum $15=\dim A_3$; $25+15=40=\sum L$
v47_selection_theorem.py	Boundary Carrier Selection (Thm A): $\mu_4 \rightarrow A_3, N_{\text{fam}}=3$; 16-spinor $\rightarrow D_5$; $q(D_5)+q(A_3)=2$, glue $4= \mu_4 $; only $D_5 \oplus A_3$ meets all four conditions ($D_8, E_7+A_1, E_6+A_2, A_4+A_4, A_8$ excluded) [E]/[C]
v48_em_ward.py	EM boundary Ward (Thm C): $F_{U(1)} = \text{Maxwell } \alpha^3 - \text{Calderón } 2c_3^3 \alpha^2 - \text{transport } 8b_1 c_3^6 \log \frac{1}{\varphi_{\text{seam}}}$; $8b_1 = \frac{4}{5} M = \frac{164}{5}$, $-\frac{5}{4} = q(D_5)$ [E]; Ward origin [C]
v49_readout_rigidity.py	Readout Rigidity (Thm U2): $c_u/c_d = \frac{55}{117}$ is constant on the discrete selector stratum $\mathcal{S}_{8,Q} \Rightarrow$ no point-uniqueness needed; $(U_{\text{wall}})=U_{\text{unitary}}+U_{\text{H2}}+U_{\Lambda^2}+U_{\text{point}}$, only U_{point} open
v50_q_geometry.py	Q geometry (Thm Q): $Q_+ = \text{diag}(3, 2, 1)$ -block $\chi=(t-1)(t-2)(t-3)$, $Q_- \chi=t(t^2-3)$; Q unique under rows $(4, 5, 6)$ /cols $(9, 5, 1)$ /spectra; geom. origin [C]
v51_boundary_half_step.py	glue norms $=(g_{\text{car}}, N_{\text{fam}})/ \mu_4 $: $q(D_5)=\frac{5}{4}$, $q(A_3)=\frac{3}{4}$; four ops forced $\rightarrow \{\text{sum}=2 \text{ root norm, diff}=\frac{1}{2}= \mathbb{Z}_2 / \mu_4 =\delta, \text{prod}=\frac{15}{16}, \text{ratio}=\frac{5}{3}\}$. So $\delta=\frac{1}{2}$ is the carrier-family count over the glue index, not chosen [E]
v52_pencil_endpoints.py	$K+xQ$ pencil endpoints: $P(-1)=2= \mathbb{Z}_2 $, $P(0)=4= \mu_4 $, $P(1)=20=\det L$, $P(2)=68=2p_5(a)$; $\det(K-Q)=2$, $\text{tr}=N_{\text{fam}}$ (audit ext. of v37) [E]
v53_compiler_core.py	Big picture: the whole integer skeleton from $(g_{\text{car}}, N_{\text{fam}})=(5, 3)$ — rank $E_8=8$, $ \mathbb{Z}_2 =2$, Pythagorean $\Delta_Y=g_{\text{car}}^2=25=N_{\text{fam}}^2+ \mathbb{Z}_2 \cdot \text{rank } E_8=9+16=\dim S^+$ (diff. of squares); anchor char-poly $(t-1)^2(t-2)$ unique [E]
v54_seam_horizon_keystones.py	The “8” in $c_3=\frac{1}{8\pi}$ overdetermined and gravitationally aligned $(2 \mu_4 =\text{rank } E_8=h(D_5)=\varphi(30)=8\pi \text{ Hawking/Einstein})$; one boundary transport operator (spec $\{1, (2/3)^6, (1/3)^6\}$, $\lambda_2=(2/3)^6$) governs both SM flavor gap and horizon Page recovery [E]
v55_coxeter_cycle.py	Computed E_8 Coxeter element: order exactly $30= \mathbb{Z}_2 N_{\text{fam}}g_{\text{car}}$, eigenphases = exponents = totatives of 30, so rank $E_8=8=\varphi(30)=$ live phases of the order-30 cycle; one α^{-1} sets EM, S_{dS} and Λ ($S_{dS}\rho_\Lambda=32\pi^4$) [E]

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Script	What it machine-checks (<i>continued</i>)
v56_unique_attractor.py	Gapped boundary transport ($\text{gap } 6 \log \frac{3}{2} > 0$) $\Rightarrow$ <i>unique</i> attracting fixed point, geometric rate $(2/3)^6$ (two starts $\rightarrow$ same direction); Coxeter in $ \mu_4 =4$ planes; entropy reset = rank-1 projector [E]
v57_horizon_crosslinks.py	Horizon cross-links: $c_3 = \frac{1}{8\pi}$ is the Einstein/Jacobson coefficient ($1/4 = 1/ \mu_4 $ entropy density); Hod QNM $\omega_R/T_H = \ln 3 = \ln N_{\text{fam}}$; Hawking power denom $1920 = W(D_5) $; one α^{-1} for EM/ S_{dS}/Λ /Hubble [E] (+ [C] identification)
v58_seam_horizon_chain.py	Seam-horizon chain (precise: seam = abstract normaliser, locally realised as a horizon): one-sided S^2 Gauss–Bonnet $c_3 = 1/(2 \cdot 4\pi) = \frac{1}{8\pi}$; KMS $4c_3\kappa$; $S_{BH} = M^2/2c_3$; RT in seam units. Seam–Horizon Theorem (area-law from the seam kernel) [O] open
v59_area_law_evidence.py	Area-law necessary condition met: a reflection-positive Gaussian (Calderón-type) kernel yields an area law (gapped block-EE saturates; gapless $\sim \frac{\epsilon}{3} \log L$), by the <i>same</i> gap that fixes the attractor; $8 = \mathbb{Z}_2 \mu_4 $. The c_3 coefficient stays [O] open
v60_lambda_metrology_branch.py	Λ branch selection: $(8\pi)^2 \delta_{\text{top}} = \frac{3}{4\pi^2}$, mis-scale $2c_3/\delta_{\text{top}} = \frac{64\pi^3}{3} = 661.47 \Rightarrow G_N$ pinned as output; 123 orders = $119.028 + 3.920$; ACT DR6 birefringence $0.215^\circ \pm 0.074^\circ$ vs 0.2424° (0.37σ) [E]
v61_cft_bridge.py	Boundary-CFT mirror: level-1 WZW central charges $c(E_8)=8$, $c(D_5)=5$, $c(A_3)=3 = (\text{rank } E_8, g_{\text{car}}, N_{\text{fam}})$; conformal embedding $c_{\text{coset}}=0$; $SU(3) \leftrightarrow SU(4)$ reconciliation $N_{\text{fam}} = \mu_4 - 1$, $4 \rightarrow 3+1$ (one geometry $\mathbb{P}^1 \setminus \mu_4$, two sides) [E]
v62_data_scorecard.py	TFPT vs 2024/25 data: α^{-1} , $\sin^2 \theta_{12}$, β_{rad} match; $\sin^2 \theta_{13}$ (2.0σ) and Starobinsky n_s vs DESI ($\sim 2\sigma$) mild tensions; θ_{23} open; $r \approx 0.004$ future falsifier [E]
v63_seam_engineering_index.py	Exact Seam-Engineering Index $\Xi = 2\ V\ /\Delta = \frac{31}{24\pi^2 \log(3/2)} \approx 0.323$ ($2\ V\ = \frac{31}{4\pi^2}$, $248 = \dim E_8$, $31 = 1 + h^\vee$), $\Delta_{\text{eff}} \approx 1.648$; four-class possibility taxonomy [E]/[O]
v64_causal_boundary_nogo.py	Causal Boundary Engineering <i>conditional no-go</i> : gapped transfer has no periodic orbit (discrete no-CTC); RP+OS+gap $\Rightarrow$ ANEC $\Rightarrow$ Topological Censorship $\Rightarrow$ no traversable shortcut; only ER=EPR bridge survives [E] (core)/[C] (chain)
v65_falsification_layer.py	Prediction layer with explicit failure thresholds: 3 core ($v_{\text{GW}}=c$, no 4th gen, seam=8), 4 observational ($\beta, r, n_s, \theta_{12}$), no-go + unitarity; $N_\star$ demoted to [C] input; none violated [E]
v66_e8_casimir_degrees.py	Organizing simplification: the compiler atoms <i>are</i> the E_8 Casimir degrees $\{2, 8, 12, 14, 18, 20, 24, 30\}$ ($2= \mathbb{Z}_2 $, $8=\text{rank}$, $14=\dim G_2$, $20=\det L$, $24= W(A_3) $, $30=h(E_8)$); $\sum = 128 = 2^7$ (dS prefactor), $\sum \exp = 120 = R^+(E_8) $ [E]
v67_area_law_coefficient.py	Central-theorem <i>structural closure</i> : Fursaev–Solodukhin $S = 4\pi k A$, $k = c_3/2 \Rightarrow S = 2\pi c_3 A = \frac{1}{4} A$ ($2\pi c_3 = \frac{1}{4}$); $c_3 = \frac{1}{8\pi}$ is the <i>unique</i> value with replica-coeff = BH $\frac{1}{4}$. Reduces to the one coeff $k = c_3/2$ (then <i>forced</i> , v73) [E]
v68_seeley_dewitt_residual.py	Residual <i>resolved as an anchor</i> : $a_2 = -\frac{d}{192\pi^2} R \Rightarrow$ the <i>absolute</i> $\frac{1}{16\pi G}$ is UV-sensitive ($\propto d\Lambda^2 f_2$), so the <i>scale</i> $1/G$ is the one dimensionful anchor (the dimensionless $k = c_3/2$ is forced, v73); cutoff-indep. R^2 /scalaron derived [E]
v69_d4_q_geometry.py	D_4 -equivariant Q-geometry (gate [C]/[E]): on $H_1(\mathbb{P}^1 \setminus \mu_4) = B_1 \oplus E$, $Q_+ = 3w + 1 = \text{diag}(1, 2, 3)$ (cusp weights on $\mu_4 = \mathbb{Z}_4$ eigenspaces), $Q_- = E$ -coupling $\sqrt{N_{\text{fam}}} \Rightarrow t(t^2 - 3)$; Σ -split $= D_4 = \mathbb{Z}_4 \rtimes \mathbb{Z}_2$ [E]
v70_q_integer_lift.py	Q integer-lift sharpened: $\mathbb{Z}_4$ puncture action R unimodular (eigenvalues $\{-1, i, -i\}$); $\det Q = 3 = N_{\text{fam}}$, SNF $\text{diag}(1, 1, 3) \Rightarrow$ residual = one lattice invariant $\det Q = N_{\text{fam}}$, not closable by D_4 alone [E]
v71_simple_r_bridge.py	<i>Simple</i> R-bridge (gate #3): selector stratum $\mathcal{S}_{8,Q}$ now fully derived ($\det R = 8 = \text{rank } E_8$ lattice + $\text{Spec}(Q_+) = \{1, 2, 3\}$ from v69) $\Rightarrow$ quark <i>ratios</i> are pure integer Plücker readouts ($\frac{55}{117}$, no monodromy, v49 rigidity); residual $U_{\text{point}} =$ absolute norm. = an anchor [E]/[O]
v72_q_det_from_cusp.py	$\det Q = N_{\text{fam}}$ derived from the cusp class: $\det Q = \text{coker } Q =$ cusp-class order = denominator of the weights $\{0, \frac{1}{3}, \frac{2}{3}\}$ (same data as $\text{Spec } Q_+$); $\text{coker } Q = \mathbb{Z}/N_{\text{fam}} =$ triality deck group $\Rightarrow$ integer-lift residual closed [E]

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Script	What it machine-checks (<i>continued</i>)
v73_k_c3_half.py	Central coefficient $k=c_3/2$ forced: $(1/2)$ variational $\times 1/(\mathbb{Z}_2 2\pi\chi(S^2))$ Gauss–Bonnet topology ($\chi(S^2)=2$), both cutoff-indep $\Rightarrow$ Fursaev–Solodukhin $S=A/4$; only the absolute 4D Newton scale stays the anchor (v68) [E]
v74_compiler_micro_lemmas.py	Spine quotient ladder $(\frac{2}{3}, \frac{3}{4}, \frac{4}{5}, \frac{5}{4}, \frac{4}{3}) =$ adjacent quotients of $(2, 3, 4, 5)$; pencil differences $(2, 16, 48) = (\mathbb{Z}_2 , \dim S^+, \Omega_{\text{adm}})$ sheet $\rightarrow$ 1gen $\rightarrow$ 3gens; anchor QF $a^\top K a - \mathbf{1}^\top K \mathbf{1} = 41 - 25 = 16 = \dim S^+$ (EM budget = mass vol + one gen); solar dual anchor $L=R+6\mathbf{1}e_1^\top$, $a^\top R^{-1}\mathbf{1}=0$ (Sherman–Morrison rank-one invariance) [E]
v75_upoint_to_vgeo.py	Gate 1 complete: $U_{\text{point}} \rightarrow v_{\text{geo}}$. Ratios closed (v49/v71) + lepton c exact (v20) + sector products = φ_0^{ret} -powers (v46); (ratios, product) $\Leftrightarrow$ (individuals) bijection $\Rightarrow$ absolute amplitudes fixed up to <i>one</i> scale v_{geo} = the same anchor as $1/G$ (v68); two $[A] \rightarrow$ one [E]/[O]
v76_gmetric_reduction.py	Gate 2: Tier A (IR) closed under RP+gap (Decoupling Thm: $\Delta_{\text{eff}} = 6 \log \frac{3}{2} - \frac{31}{4\pi^2} = 1.648 > 0$, $\ V\ \leq 248c_3^2 = \frac{31}{8\pi^2}$); Tier B (strict TOE) holographically reduced from bulk to a finite seam-boundary measure (conditional: RP+tightness $\Rightarrow$ closes) [E]/[C]
v77_e8_conformal_net.py	G6 route: the seam boundary measure = the $(E_8)_1$ lattice net (rigorous, holomorphic $c=8$); level-1 $c(E_8) = \frac{248}{31} = 8$, $c(D_5)=5$, $c(A_3)=3$, embedding $5+3=8$ (coset $c=0$); imports G_6 into RCFT/conformal-net rigor [E]/[C]
v78_vgeo_floor.py	v_{geo} floor: no pure number is dimensionful $\Rightarrow v_{\text{geo}}$ irreducible by logic; all scales are ratios $\times$ one $\bar{M}_{\text{Pl}}$; $S_{dS}\rho_\Lambda = 32\pi^4$ pins it from one measurement; theory at the minimum (one scale + π) [E]/[O]
v79_review_identities.py	Four validated review identities + one firewall: hypercharge Lucas–Binet $D_n = (3^n - (-2)^n)/5 = 1, 1, 7, 13, 55, 133$ (roots = carrier charges); Inverse Anchor Thm ($\mathbf{1}^\top M^{-1}\mathbf{1} = 1/\text{atom}$, $a^\top M^{-1}a = 1$ for R, K, L); MacWilliams $(1, 10, 5)$; $6Y^2 - Y - 1 = (2Y - 1)(3Y + 1)$. Rejects m_p/m_e , η_B near-formulas (firewall) [E]
v80_operator_pencil_geometry.py	Operator-pencil geometry: Anchor Singularity Thm $\det B_{K+xQ} = (N_{\text{fam}}x + \mathbb{Z}_2)(N_{\text{fam}}x + g_{\text{car}}) = (3x+2)(3x+5)$ ($\frac{2}{3}$ Koide/gap = anchor-plane singularity); buildup chain $(3, 10, 16, 20)$; type checker $\det B_{Q,K,R,L} = (9, 10, 16, 40)$; audit: differential spectrum, $F_4 \times G_2$ shadow $248 = 52 + 14 + 26 \cdot 7$ [E]/[C]
v81_singular_pencil_matrices.py	Double cover $y^2 = \det B_{K+xQ} = (3x+2)(3x+5)$: Koide $x = -\frac{2}{3}$ and carrier $x = -\frac{5}{3}$ are the two branch points (deck $2= \mathbb{Z}_2 $; disc $= 81 = N_{\text{fam}}^4$; separation $= 1$ transport period). Clearing matrices $C_{2/3} = 3K - 2Q$ ($D_5 \oplus A_3$ glue, $B = (5, 7)^\top (9, 11)$, $\sum = 240$), $C_{5/3} = 3K - 5Q$ (neutral, $\chi = (\lambda+2)(\lambda^2 + \lambda + 6)$); scalaron $7 =$ mixed anchor disc $/N_{\text{fam}}$ [E]
v82_koide_attractor_splitting.py	Koide attractor forced: the branch-divisor-preserving Möbius map fixing $q=2, 5$ is unique, multiplier $(2/3)^6 = \lambda_2$ of the established transfer operator $\Rightarrow F'(2) < 1$ attractor, $F'(5) > 1$ repeller; three postulates $\rightarrow$ one [C]. Splitting trichotomy disc $81/49/40$: the clean split is non-generic (anchor-first) [E]/[C]
v83_e8net_holomorphic_uniqueness.py	Holomorphy pins $(E_8)_1$: #primaries = det Cartan ($D_8:4$ vs $E_8:1$), and a holomorphic $c=8$ chiral CFT is the lattice theory of the <i>unique</i> even unimodular rank-8 lattice (Minkowski–Siegel mass $1/ W(E_8) $); carrier Pascal truncation $K = (g-1)/2 =$ half-spinor split [E]
v84_frozen_registry.py	Blind-prediction registry frozen 2026-06-09 (25 digits, machine-enforced lock formula $\leftrightarrow$ value): exactly <i>one</i> θ_{12} prediction of record; r , n_s as $N_\star$ bands; conditional entries carry their hypothesis by name [E]
v85_master_cover.py	Master-cover theorem: $\det B$ is $\text{GL}(2)$ -covariant on $\text{span}\{K, Q\} \Rightarrow$ exactly <i>one</i> double cover up to Möbius (disc $= N_{\text{fam}}^4 \det(G)^2$); the disc-81 family is its orbit ($-\frac{8}{3} = -\text{rank } E_8 / N_{\text{fam}} =$ carrier $-$ one period); μ_4 is <i>not</i> a 4:1 cover (ladder of double covers); branch trace fixes only the scalaron <i>scale</i> [E]

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Script	What it machine-checks (<i>continued</i>)
v86_nstar_reheating.py	$N_\star$ band $\rightarrow$ point [C]: $\Gamma=4M^3/48\pi\bar{M}^2=128$ GeV, $T_{\text{reh}}=9.6\times 10^9$ GeV, $N_\star(0.05/\text{Mpc})=51.4 \Rightarrow n_s=0.9611$, $r=0.0045$ (inside the frozen band); honest tensions: $n_s + 0.9\sigma$, A_s dichotomy (slow point $-11.4\sigma \Rightarrow$ near-instant reheating or exponent fails) [C]
v87_bulk_uniqueness_reduction.py	Red-team Target A residual (ii) conditionally closed: holomorphic $\Rightarrow$ Rep = Vect $\Rightarrow$ 2D bulk <i>unique</i> (LR/KLM/BKLR); machine contrast $SO(16)_1$ admits <i>six</i> modular invariants (incl. both E_8 pairings) $\Rightarrow$ Target A = one residual [E]/[C]/[O]
v88_cp_phase_audit.py	Target-D CP residual quantified: frozen $\delta=\pi/3+3\lambda^2$ survives at $+0.98\sigma$ vs γ_{PDG} ; the 0.07° -near alternative $\pi/3+2\lambda^2$ recorded as look-elsewhere trap, <i>not</i> adopted; decision at $\sigma_\gamma \leq 0.96^\circ$ [E]
v89_carrier_index_lemma.py	Carrier Index Lemma: KLM $\mu_A=[B:A]^2\mu_B \Rightarrow$ Jones index $[(E_8)_1:(D_5)_1 \times (A_3)_1]=4= \mu_4 $ (glue order <i>is</i> the index); μ -additivity $16/4^2=1 \Rightarrow$ holomorphy <i>follows</i> ; Gate A (H) $\Leftrightarrow$ (H') index-4 extension [E]
v90_conical_defect_chain.py	Fursaev–Solodukhin factor 4π <i>derived</i> (smoothed-cone Gauss–Bonnet, exactly smoothing-independent); replica $S=4\pi kA$, $k=c_3/2 \Rightarrow S=A/4 \Leftrightarrow c_3=\frac{1}{8\pi}$ (sympy-solved); residual isolated to “seam determinant $\Rightarrow$ EH form” [E]/[O]
v91_spine_tetrahedron.py	Spine tetrahedron $\{2,3,4,5\}$ = anchor + zeroth moment; edges/faces/volume = the integer grammar, volume $120= R^+(E_8) $; $240= \mu_4 E(K_4) E(K_5) $ with K_6 negative control; dual cuts typed tautological; sub-grammar incompleteness honest [E]
v92_glue_uniqueness.py	Glue uniqueness: of all 15 subgroups of the discriminant form exactly two Lagrangian glues (the two <i>chiralities</i> , swapped by either single spinor conjugation, fixed by the simultaneous one) and exactly one halfway extension = $SO(16)_1$; tower carrier $\rightarrow SO(16)_1 \rightarrow (E_8)_1$, nothing else [E]
v93_koide_relaxation_toy.py	Koide relaxation toy (P2 narrowed): basin lemma (every physical configuration in the attractor basin); exact rate $(2/3)^6$; source at $\rho=-\varphi_0^{\text{ret}}/24$ to 0.8% ([C]); honest negatives: flow time $t=2.84 \notin \mathbb{Z} \Rightarrow$ the missing object is a <i>continuous</i> generator [E]/[C]
v94_sheet_diamond.py	Sheet diamond: all four flavor operators on <i>one</i> surface $M(s,t)=R+Q \text{ diag}(s,t,t)$ (pencil = the cut $(1+x, x-1)$; diagonal-cut disc 153 negative control); winding line $\det B=2 \det$ for all s ; cofactor seam normal $(5, -9, 6)$; Plücker canonicalisation: 11 and 26 both live in K ; spine-quotient firewall <i>rejected</i> [E]
v95_centered_diamond.py	Centered cross: $Q=U+V$, $R/L=C\mp U$, $K/F=C\mp V$ (five objects $\rightarrow$ three); Spec $V=\{0,1,2\}=N_{\text{fam}}\cdot\text{cusp}$; $\det C=14$, $\sum C=31=2^{g_{\text{car}}}-1$; $\text{Pl}_R(C)=7(2,3,1) \parallel \text{Pl}_R(L)=10(2,3,1)$; G_2 reading audit-typed [E]
v96_branch_kernel_selection.py	Branch-kernel selection (P1 unblocked): rank-1 anchor blocks at the branch points have <i>integer</i> kernels (carrier kernel = 1); collapse lemma $\Rightarrow (-1, 1, 0)$: up = $-$ down, <i>lepton pairing</i> = 0 (leptons on the ramification); sector zero ladder (up $-\frac{3}{2}$ doubly, down 0 & $-\frac{9}{5}$); anchor-placement controls [E]
v97_sheet_conjugation_bridge.py	Sheet-conjugation bridge (P1 $\rightarrow$ one [C]): the anchor forces the cusp conjugation uniquely $\Rightarrow$ integer T_A , $\det=-1$; $a=e_2+e_3$ (conjugation-symmetric); one deck action on $\mathbb{R}^3/\text{span}\{\mathbf{1}, a\}$; $\langle T_A, \Sigma \rangle = D_4$; sheet-index lemma (intertwiner dets even, $\min 2= \mathbb{Z}_2 $); remaining [C]: Q_+ grading = A_3 discriminant grading [E]/[C]
v98_discriminant_dictionary.py	Dictionary <i>derived</i> (P1 closed modulo GATE.QGEO): $G=T_A\Sigma$ acts integrally on the cusp basis ($Ge_1=-e_1$, $Ge_3=e_2$, $Ge_2=-e_3 = B_1\oplus E$); cusp-0 line = self-conjugate $\mathbb{Z}_4$ -class-2 line; $T_A GT_A^{-1}=G^{-1}$ ($k \mapsto -k$); $q_{A_3}(1)=q_{A_3}(3)=\frac{3}{8}$, $q_{A_3}(2)=\frac{1}{2}$; reflection classes = glue-swap vs glue-fix parities $\Rightarrow$ P1 carries no separate [C]; residual = the one existing Q -geometry gate [E]

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Script	What it machine-checks (<i>continued</i>)
v99_koide_flow_time.py	Koide flow time: canonical generator $\dot{q}=(\Delta/N_{\text{fam}})(q-2)(q-5)=(\Delta/N_{\text{fam}})\det B(q)$, time-1 map = F [E]; non-integrality of $t=2.84$ is <i>data-fragile</i> (Q crosses $\frac{2}{3}$ at $+0.43\sigma(m_\tau)$, t passes every integer ≥ 3 within $+0.5\sigma$) [E]; conditional steps: $n=2$ excluded (-2.9σ), $n=3=N_{\text{fam}} \Rightarrow m_\tau=1776.9427\text{ MeV}$ ($+0.14\sigma$), decision at $\sigma(m_\tau)\sim 0.01\text{ MeV}$ [C]; $\ln(46080)$ scale reading destroyed by controls (firewall)
v100_numerology_null_mc.py	Numerology null test (look-elsewhere corrected): exact census of the full declared formula grammar over the 13 scored frozen-registry observables (conservative data windows) gives joint formula-fishing probability $\prod p_i = 10^{-25.8}$, robust to budget/window variation; $2\times 2\cdot 10^5$ Monte-Carlo pseudo-theories reach at most 5/13 hits vs. TFPT 13/13; power controls (seed perturbation, data shuffle) collapse the scorecard; all 94 500 $F_{U(1)}$ variants solved, exactly <i>one</i> hits CODATA $\Rightarrow$ total $\leq 10^{-30.7}$, <i>conditional on the declared grammar</i> [E]
v101_horizon_anchor.py	The maximal black hole is the anchor (SdS in seam units): Nariai cubic $t^3-3t+2=(t-1)^2(t+2)$, roots $(1, 1, -2) =$ traceless anchor; $S_{\text{Nariai}}/S_{\text{dS}}=\frac{2}{3}= \mathbb{Z}_2 /N_{\text{fam}}$ (per horizon $\frac{1}{3}$); interpolation $(x^2+1)/\Phi_3(x)$; three-sheet total $ \mathbb{Z}_2 S_{\text{dS}}$ conserved; $Q_{\text{geom}} \in [\frac{3}{8}, \frac{1}{2}] =$ the $SU(4)_1$ weights; mass-line cover $(1-3m)(1+3m)$, deck = horizon swap; $\tau_{BH}=128 g_{\text{car}} M^3/c_3$; six atom landings, zero free parameters [E]/[C] (bulk reading)
v102_seam_orientation.py	One orientation: the anchor is the <i>stationary repeller</i> in both sectors — flavor relaxation = gradient flow of a cubic potential with critical points = the branch points, curvatures $V''(2)=+\Delta$, $V''(5)=-\Delta$ (= the gap), inflection at scalaron/2, Lyapunov rate Δ constant; SdS entropy has Nariai as its <i>unique</i> stationary point, curvature $\frac{2}{9}= \mathbb{Z}_2 /N_{\text{fam}}^2$; evaporation = entropy ascent away from the anchor [E]; “one variational principle of the seam” stays a reading [C]
v103_trisection_normal_form.py	Trisection normal form (the canonical coordinate): SdS cubic $\Leftrightarrow \cos 3\theta=-3m$ (angle trisection; $\mathbb{Z}_3$ deck = triality); $m=\cos\psi/N_{\text{fam}}$ and $S_{\text{tot}}/S_{\text{dS}}=\frac{4}{3}-\frac{2}{3}\cos\frac{2\psi}{3}$ — <i>one</i> cosine of glue atoms; canonical curvature $(\frac{2}{3})^3=(\mathbb{Z}_2 /N_{\text{fam}})^{N_{\text{fam}}}$ (Koide constant to the family power); invariant slope $d\sigma/dm _N=-\frac{8}{9}=-\text{rank } E_8/N_{\text{fam}}^2$; bridge: flavor rate $(2/3)^{2N_{\text{fam}}}$ vs gravity curvature $(2/3)^{N_{\text{fam}}}$, missing = one <i>clock</i> [E]/[C]
v104_nariai_clock.py	The <i>classical</i> Nariai clock is the anchor (third appearance): static pin $\phi=\rho$ solves the dS_2 static-patch equation with $m^2=-2\Lambda=- \mathbb{Z}_2 \Lambda$ exactly (Ginsparg–Perry tower: one negative mode); in Hubble units $\chi_{\text{clock}}=(\lambda-1)(\lambda+2)$ = the anchor quadratic, eigenvalues $\{1, -2\}$; Nariai cubic = $(t-1) \cdot \chi_{\text{clock}}$; entropy-deviation rate $2H= \mathbb{Z}_2 H$; honest $(2/3)$ -test <i>negative</i> for the classical clock — the quantum clock is the one remaining [C] of the seam variational principle [E]/[C]
v105_residual_inventory.py	The residual inventory: <i>one constant</i> $(2/3= \mathbb{Z}_2 /N_{\text{fam}}$ exact in seven places across both sectors), <i>one anchor</i> (three dynamical appearances: configuration, Nariai roots, clock spectrum), <i>relocation theorem</i> (cosmological quantum clock suppressed by the Λ hierarchy, 121.5 orders $\approx 2\alpha^{-1}/\ln 10 \Rightarrow$ the clock must be the seam transfer operator — one [C] identification), and the <i>complete machine-pinned gap list</i> : exactly five structural objects + one scale + π ; a sixth gap would fail the script [E]/[C]
v106_review_validation.py	External-review validation: seed normal form $\varphi_0^{\text{ret}}=\frac{ \mu_4 }{N_{\text{fam}}}c_3+\Omega_{\text{adm}}c_3^{ \mu_4 }$ exact [E]; hypercharge moment $\text{Tr } X^2=120=5!$ computed from the charge table; factorial spine $5!= R^+(E_8) =\sum \text{exponents}$, $240=2\cdot 120$, $1920=2^4\cdot 5!$; degree-2 inventory (Pascal $K=2$ unique at $g=5$, glue norms sum 2, $c_3=\frac{1}{2}\times\frac{1}{4\pi}$, $\binom{5}{2}=10$); named [C] hypothesis <i>Quadratic Boundary Locality</i> ($\Rightarrow K=2$ forced; would upgrade the Pascal selection to [E]); audit $240=16\times 15$ non-unique [E]/[C]

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Script	What it machine-checks (<i>continued</i>)
v107_quantum_clock_target.py	Quantum-clock target made quantitative: the classical Ginsparg–Perry clock decays on $\{0, -1, -2\} = -\text{Spec}(V) = -N_{\text{fam}} \times \text{cusp}$ (the transfer operator’s own grading) [E]; exact target identity $(1/3)^6 = ((2/3)^6)^{\log_{3/2} 3}$ — required bend $\log_{9/4} 3 = 1.355$ per weight step; coupling landscape $\kappa = c/(24\pi) \cdot \Lambda/M_{\text{Pl}}^2$: 10^{-122} cosmological vs $1/(3\pi)$ at seam curvature (the only viable, borderline-nonperturbative regime) [E]; identification stays [C]
v108_pascal_ladder.py	Pascal Ladder Theorem: $2^{g-1} = \sum_{k \leq K} \binom{g}{k} \Leftrightarrow g=2K+1$ (odd- g midpoint identity + even- g straddle) $\Rightarrow$ carrier selection $g=5$ <i>exactly equivalent</i> to degree bound $K=2$ — the Target-B residual = the one QBL hypothesis; neighbour worlds: $K=1$ one-family, $K=3$ nine-family, $K=4$ inconsistent; only $K=2$ also satisfies $g+N_{\text{fam}}=8$ (v14 overdetermination) [E]/[C]
v109_sheet_pairing.py	Sheet-Pairing Lemma (QBL anchored): character-exact multisets from $(\pm \frac{1}{2})^5$ — no scalar within a sheet (zero-weight mult of $S^+ \otimes S^+ = 0$; odd g flips parity); $S^+ \otimes S^- = \Lambda^0 \oplus \Lambda^2 \oplus \Lambda^4$ exactly ($256=1+45+210$, zero-modes $(1, 5, 10)$ = the code); sheet-diagonal = odd forms ($2\Lambda^1 + 2\Lambda^3 + \Lambda^5$); tower tops at Λ^{2K} , $K=2 \Rightarrow$ the seam scalar kernel is necessarily a <i>sheet pairing</i> [E]/[C]
v110_calderon_sheet.py	Calderón-sheet selection theorem: a Calderón involution ε on $S^+ \oplus S^-$ certifies a scalar two-point datum <i>iff</i> it is sheet-odd; sheet-odd $\Rightarrow$ exactly $2= \mathbb{Z}_2 $ invariant kernels = the two Lagrangian glues; ladder genericity ($g=3, 5, 7$): sheet-oddness forces $K=(g-1)/2$, <i>not</i> $g=5$ (anti-overclaim); QBL residue split into <i>interface</i> (“ ε sheet-odd”, natural from the one-sided collar) + <i>analytic core</i> (slot-degrees ≤ 2) [E]/[C]
v111_quadratic_transport.py	Quadratic-Transport Theorem: in the integer Jordan–Wigner model linears are sheet-odd, the 45 quadratics (= $\mathfrak{so}(10)$, the Λ^2 term of $1+45+210$) sheet-even, generate the code from the vacuum <i>and</i> span the full $\text{End}(S^+)=256$ at word length 2 $\Rightarrow$ <i>transport degree exactly 2</i> (degree ≤ 1 generates nothing) — the transport half of the QBL core is a theorem; $g=3$ control: degree selected, not rank [E]/[C]
v112_selfcounting_channel.py	Self-Counting Channel: $w \mapsto (w, -w)$ is a bijection code states $\leftrightarrow$ neutral certified kernels, so #kernels = 2^{g-1} <i>exactly</i> ; graded by pair-degree the same set has sizes $\binom{g}{m} \Rightarrow$ the Pascal closure $2^{g-1} = \sum_{m \leq K} \binom{g}{m}$ is <i>two countings of one set</i> (an identity, not a requirement); Hodge fold $\binom{g}{2j} = \binom{g}{\min(2j, g-2j)}$; QBL residue = one input (“a single scalar 2-point kernel”), selection carried by rank-8+integrality [E]/[C]
v113_quasifree_kernel.py	One kernel is the whole net: carrier $(D_5)_1 \times (A_3)_1 = SO(10)_1 \times SO(6)_1 = 16$ free Majoranas, $c=5+3=8$ at every tower level (only the glue grows, index $2 \times 2 = 4 = \mu_4 $); Wick/Pfaffian exact (all $210+210$ higher correlators = Pfaffians of the one kernel); kernel = Calderón involution, rank $P=5=g_{\text{car}}$, seam level $8=\text{rank } E_8$ ($c = \text{rank of the kernel}$); vacuum unique $\Rightarrow$ QBL input = R2 premise: gate closes $\Rightarrow$ carrier choice closes [E]/[C]
v114_torsion_delta.py	Torsion normal form + $\delta = \frac{1}{2}$ theorem: flatness of the $(U_{\text{wall}}) \mathbb{Z}_4$ -family $\Leftrightarrow (MU)^4 = \mathbf{1}$ ($\mu_4 = \text{order of the twisted cusp generator}$); on the involutive branch ($T^2 = \mathbf{1}$) the cusp trace forces $\text{diag } M = (0, \frac{i}{2}, -\frac{i}{2})$ with $\text{spec } \{1, \omega, \omega^2\}$ automatic $\Rightarrow \delta = \frac{1}{2}$ exact and constant (v20’s hand value = torsion identity); census: $\{1, i, -i\}$ branch varies, v33 point in its $d_1=0$ slice; residue = bundle-side branch selection [E]/[C]
v115_anchor_residue.py	The anchor pins the residue: μ_4 -average = diagonal projection $\Rightarrow$ anchor splitting $\Leftrightarrow \text{diag } A_0 = a/ \mu_4 $; off-weights uniquely $(8, 0, 5)/144$ ($= (\text{rank } E_8, 0, g_{\text{car}})/(\mu_4 N_{\text{fam}})^2$, total $13=\Delta_Q$); <i>exact</i> residue A_0^* with $\chi = \lambda(\lambda - \frac{1}{3})(\lambda - \frac{2}{3})$ is the RH solution ($\ M_\infty - \mathbf{1}\ \sim 10^{-10}$); anchor forces $d_1=0 \Rightarrow$ harmonic diagonal anchor+torsion-forced [E]

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Script	What it machine-checks (<i>continued</i>)
v116_resonance_uniqueness.py	Resonance theorem (v115 [N]→[E], linear — no Gröbner): twisted μ_4 averages collapse to $B_1=4a_{12}E_{12}+4\bar{a}_{13}E_{31}$; anchor exponents $\text{diag}(2, 1, 1)$ give resonance gap 1 with obstruction $4\bar{a}_{13} \Rightarrow M_\infty=\mathbf{1} \Leftrightarrow a_{13}=0$; + $(8, 0, 5)/144$ + Diagonaleichung $\Rightarrow$ flat anchor locus = <i>one</i> gauge orbit = exact $A_0^* - U_{\text{wall}}$ bundle datum algebraically unique; sharpness control $\ M_\infty - \mathbf{1}\ \sim 8.5 a_{13} $ [E]
v117_monodromy_weyl_a3.py	The monodromy is $W(A_3)$: the unitarised holonomy of A_0^* is <i>exact</i> (entries in $\frac{1}{2}\mathbb{Z}[i]$), $\text{diag } \bar{M}_0=(0, -\frac{i}{2}, \frac{i}{2}) \Rightarrow d_1=0, \delta=\frac{1}{2}$ are matrix entries; $\langle U, \bar{M}_0 \rangle$ enumerated exactly: order 24, statistics $(1, 9, 8, 6)$, characters $(3, -1, 0, 1) = S_4=W(A_3)$ (standard $\otimes$ sign) — the flavor wall realises the A_3 glue factor as its Weyl group; ODE match 3.5×10^{-10} [E]
v118_hexagon_family_dictionary.py	First exact H2 piece: $\text{spec}(\bar{M}_0) \cup \text{spec}(-\bar{M}_0) = \mu_6$ (hexagon = family spectrum + sheet twist, $\mathbb{Z}_6=\mathbb{Z}_2 \times \mathbb{Z}_3$); $\det(\mathbf{1}-t\bar{M}_0)=1-t^3 \Rightarrow \det_{\mp}=(\frac{7}{8}, \frac{9}{8})$; lepton coefficients = resolvent determinants ($c_e= \mu_4 /(2\det_-)$, $c_\mu=N_{\text{fam}}/(2\det_+)$, $c_\tau= \mu_4 \det_-/N_{\text{fam}}$, product = $ \mu_4 /\det_+=\frac{32}{9}$); $\langle U, \bar{M}_0, -\mathbf{1} \rangle$ has order $48=\Omega_{\text{adm}}$; the address table stays open [E]/[C]
v119_review_validation_2.py	Second review validation: anchor ratio triad $(e_3, e_1, e_2)/p_0=(\frac{2}{3}, \frac{4}{3}, \frac{5}{3}) = (\text{Koide branch, seed gain, carrier branch; flow critical points } (2, 5)=(e_3, e_2))$; the 121 audit lemma $(\mathbf{1}+a)^T R(\mathbf{1}+a)=121=11^2=\ \text{Pl}(K)\ _1^2$ (orderings $\{105, 121, 135\}$, only canonical = 121; audit, not load-bearing); micro-identities $\Omega_{\text{adm}}=2p_1p_2$, $10b_1=1+p_1p_3$, $\Delta_Y=e_2^2=p_0^2+2\text{rank}$; flavor surface = $\sqrt{94}/\sqrt{95}$ (presentational) [E]
v120_address_table.py	Address table (frozen v18/v20 integers): lepton words $(8, 5, 3)=(\text{rank } E_8, g_{\text{car}}, N_{\text{fam}})$; addresses = divmod by the hexagon ($p_2=6$): $e \rightarrow (2, 1)$, $\mu \rightarrow (5, 0)$, $\tau \rightarrow (3, 0)$, $\sum r=p_3$; sheet parity: τ sits at the real twisted eigenvalue -1 (= the product-rule site); quark sums: up = p_3 , down = p_1+p_3 , all quarks = $24= W(A_3) $, all nine = $40=p_1p_3=a^T Ra$; top at the vacuum site $(0, 0)$; the assignment derivation stays open [E]/[C]
v121_address_pinning.py	Address pinning: $L=R+2U$ ($\sqrt{95}$) $\Rightarrow$ the word table = the residue operator R + the generation-1 winding, R column 1 = the anchor a ; margins = atoms (rows (e_1, rank, p_3) , columns $(e_1, \Delta_Q, g_{\text{car}})$); <i>census theorem</i> : among all hexagon matrices with atom margins (17 of them) exactly <i>one</i> has $\det=8$ — and it is R (also unique with SNF $(1, 1, 8)$; all 17 determinants distinct) $\Rightarrow$ the address table carries <i>zero</i> residual information; the H2 residue = the six atom margins [E]/[C]
v122_margin_theorem.py	Margin theorem: the <i>established</i> selectors — the D_4 annihilator $n=(5, -9, 6)$ with $n^T R=(8, 0, 0)$ ($\sqrt{94}$), $\det R=8$, $\det K=4$ (the v71 quartet) — pin R <i>uniquely</i> among hexagon matrices ($64 \rightarrow 12 \rightarrow 1$) $\Rightarrow$ the atom margins, the anchor column and all sum rules are <i>consequences</i> (their input status is revoked); bonus: $\det L=20$ holds automatically on the locus (the quartet is redundant); H2 introduces <i>no</i> new residual class [E]/[C]
v123_inventory_update.py	Residual inventory updated (post v110–v122): thirteen new ledger rows machine-pinned; R2 carries <i>three</i> loads (metric + carrier + QBL: one theorem, three doors); the table re-pins to <i>five</i> classes — R1 clock, R2 index-4 net, R3 EH, R4' selector establishment (replacing the <i>discharged</i> H2 dictionary), R5 Q realisation — + v_{geo}, π ; a sixth class fails the script [E]
v124_resummed_clock.py	Resummed clock (the R1 bend in closed form): transfer eigenvalues = exactly $(1-n/N_{\text{fam}})^{p_2} \Rightarrow \text{rate}(n)=-p_2 \ln(1-n/N_{\text{fam}})$ reproduces $\{0, \Delta, 6 \ln 3\}$, the bend $\log_{3/2} 3$ in one line; the linearisation carries slope $ \mathbb{Z}_2 =2$ relative to the classical GP clock $\{0, -1, -2\}$; the pole at $n=N_{\text{fam}}$ forces the three-level spectrum; the R1 target is now closed-form [E]/[C]
v125_glue_qsystem.py	Glue Q-system: $\mathbb{C}[\mathbb{Z}_4]$ satisfies all Longo Q-system axioms exactly (associativity, unit, Frobenius, specialness $mm^*= \mathbb{Z}_4 \mathbf{1} \Rightarrow \text{Jones index } 4= \mu_4 $ (the v89 value); locality = isotropy ($q(k(1, 1))=k^2 \in \mathbb{Z}$, v92); halfway sub-Q-system $\mathbb{C}[\mathbb{Z}_2] = \text{the } SO(16)_1 \text{ step, } 4=2 \times 2$; R2 sharpens from “find” to “identify” [E]/[C]

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Script	What it machine-checks (<i>continued</i>)
v126_clock_wall_bridge.py	Clock and wall share one spectrum: the resummation weights $n/N_{\text{fam}}=\{0, \frac{1}{3}, \frac{2}{3}\}$ = exactly spec A_0^* (the parabolic MS weights); $\lambda_n=(1-\alpha_n)^{p_2}$; checkpoint 1 passed <i>classically</i> ($p_2/N_{\text{fam}}=2= \mathbb{Z}_2 $ = the v104 entropy rate $2H$); $\det(\mathbf{1}-A_0^*)=\frac{2}{9}$ = the entropy curvature (v102); the quantum content of R1 is isolated in the geometric tail [E]/[C]
v127_ring_resummation.py	The clock is a log determinant: rate = $-p_2 \text{Tr} \ln(\mathbf{1}-\alpha P)$ — six identical ring (RPA) towers, <i>one per hexagon site</i> , coupling = the parabolic weight; the $k=1$ ring = the classical term, the $k=2$ ring = the first quantum correction; $\kappa_{\text{seam}}=\frac{1}{3\pi}=\alpha_1/\pi$ (audit); the wall = the RPA instability at $\alpha \rightarrow 1$; v107's "O(1) resummation" is thereby <i>typed</i> (ring/log-det), its derivation open [E]/[C]
v128_graded_hull.py	Graded hull + zero-mode multiplicity: the 240 E_8 roots explicit in $D_5 \oplus A_3$ + glue coordinates, coset decomposition $240=52+64+60+64$; the grading is exactly additive on <i>all</i> 6720 root-pair sums $\Rightarrow E_8$ is a $\mathbb{Z}_4$ -graded Lie algebra over the carrier (grading = glue = Q-system); ring multiplicity $6=2(2l+1) _{l=1}$ = the sheet-doubled GP zero modes [E]/[C]
v129_entropy_power_law.py	The clock is an entropy power law: $\lambda_n=(S_n/S_{dS})^{p_2}$ with the three Nariai entropy levels $S/S_{dS} \in \{1, \frac{2}{3}, \frac{1}{3}\}$ (v101); rate = $p_2 \ln(S_{dS}/S)$; triple identity $\alpha=n/N_{\text{fam}}$ = MS weight = entropy-deficit share $\Rightarrow$ the RPA coupling is nowhere free; orientation consistent (attractor = max entropy); R1 thermodynamic: $\Gamma \propto (S/S_{dS})^{p_2}$ (a Gibbons–Hawking power law, $h=N_{\text{fam}}$ audit) [E]/[C]
v130_born_square.py	Born square: amplitude $\sim (S/S_{dS})^{n_{\text{zero}}/2}=(S/S_{dS})^3$ (one $S^{1/2}$ per zero mode), probability = $ A ^2=(S/S_{dS})^6 \Rightarrow h=n_{\text{zero}}/2=3=N_{\text{fam}}$, $p_2=2h$ (the Born rule) — the v129 weight audit is <i>derived</i> ; the 3 = the dimension of the $l=1$ space = the number of proper conformal Killing vectors of S^2 ; the $\times 2$ = the horizon pair (the v101 deck); the R1 residue = the standard zero-mode measure [E]/[C]
v131_measure_is_area.py	The measure is the area: $\ Y_{1m}\ ^2=r^2=A/(4\pi)$ <i>exactly</i> (all three $l=1$ modes integrated) $\Rightarrow$ the per-mode Jacobian = the mode norm $\sim S^{1/2} \Rightarrow$ amplitude S^3 , Born S^6 — every exponent factor with a derivation origin; the 4π = the same Gauss–Bonnet primitive as in c_3 , cancelling in all ratios; the R1 residue = <i>one</i> det-ratio cancellation $\det'_n / \det'_{dS} = 1 + O(\text{deficit})$ [E]/[C] (<i>cancellation since derived within the SdS family, v144</i>)
v132_detratio_anomaly.py	Det-ratio anomaly = the Koide constant: $\zeta(0) _{\det'}$ of the GP sphere operator $-\Delta-2$ (the 3 zero modes removed) = $a_1-3=\frac{7}{3}-3=-\frac{2}{3}=- \mathbb{Z}_2 /N_{\text{fam}}$ exactly ($a_1=\frac{1}{N_{\text{fam}}}+ \mathbb{Z}_2 $; numerical continuation $\sim 10^{-7}$) — the eighth $2/3$ appearance, the first as a <i>spectral</i> anomaly; consequence $\det'(cL)=c^{\zeta(0)} \det'(L)$; the R1 residue = <i>one</i> $\zeta(0)$ budget statement (the 4d sum) [E]/[C]
v133_zeta_budget.py	The ζ budget, both routes exact (Euclidean Nariai = $S^2 \times S^2$): the reduced route gives $-\frac{2}{3}$ per sector, total $-\frac{4}{3}=-e_1/p_0$ (= minus the seed gain — two of the three triad values); the naive 4d route gives $a_2=\frac{161}{45}$, $\zeta(0)=-\frac{109}{45}$ (<i>no</i> atom; continuation $\sim 10^{-8}$); zero modes $3+3$ = the horizon pair $\Rightarrow$ the budget structurally favours the <i>reduced</i> seam reading; remainder = graviton/ghost shares (Volkov–Wipf class) [E]/[C]
v134_dual_anchor.py	Dual anchor lemma: $d:=a^\top R^{-1}=a^\top L^{-1}=(-\frac{1}{2}, -\frac{1}{2}, 1)$, $d \cdot \mathbf{1}=0$, $d \cdot a=1$, $(1, 1, -2)=-2d$ — the inverse flavor response <i>is</i> the Nariai root (v101); the invariance is exact via Sherman–Morrison ($\Leftrightarrow$ orthogonality to $R^{-1}\mathbf{1}=\frac{1}{4}(1, 1, -1)$); controls: $\mathbf{1}, e_1, n$ do <i>not</i> lie on the plane); (d, n) = the dual normal pair of the flavor boundary; a third purely <i>algebraic</i> leg of the flavor $\leftrightarrow$ horizon bridge [E]/[C]
v135_det_surface.py	Determinant surface: $\det M(s, t)=3s(t+1)(t+2)+t^2+5t+8$ — two s -independent iso-volume walls $t=-2 \Rightarrow 2= \mathbb{Z}_2 $, $t=-1 \Rightarrow 4= \mu_4 $ ($\det K=4$ is a <i>layer</i>); winding line $6s+8 \Rightarrow (8, 14, 20)$, $\det F=32=2^{g_{\text{car}}}$; $\det B(s, 0)=2 \det M(s, 0)$ exactly, B -wall only at $t=-2$; row-sum axes $C=(7, 11, 13)$, $U=(3, 3, 3)$, $V=(1, 2, 3)=\text{Spec}(Q_+)$; micro-identities $e_1^2+e_2^2=41=10b_1$, $p_1^2+p_2^2=52$ = the carrier coset root count (v128) [E]/[C]

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Script	What it machine-checks (<i>continued</i>)
v136_dual_normal_selector.py	Dual-normal selector: (d, n) pins R columnwise — $d \cdot c_j = a_j$, $n \cdot c_j = 8\delta_{1j}$, kernel = primitive $(6, 8, 7)$, census: each column unique (1 of 216) $\Rightarrow$ $R4'$ shrinks from 6^9 to three column problems; the A_0^* zero mode carries $\sigma = (2, -9, 5) = (\mathbb{Z}_2 , -N_{\text{fam}}^2, g_{\text{car}})$ ($\ v\ ^2 = \frac{16}{9}$, $16 = \dim S^+$; $\text{adj} = \frac{2}{9}P_v$ = the SdS curvature); $n \cdot \sigma = 121 = 11^2$; $W(A_3)$ orbit control: the naive lift $\sigma \rightarrow n$ fails — a genuine mechanism, not a group element [E]/[C]
v137_qplus_cohomology.py	The Q_+ grading is cohomology: $H^1(\mathbb{P} \setminus \mu_4) = \chi_1 \oplus \chi_2 \oplus \chi_3$ ($\omega_k = z^{k-1}dz/(z^4-1)$, character i^k , residues $\zeta^k/4$); degrees $(1, 2, 3) = \text{Spec}(Q_+) =$ the A_3 exponents ($h=4= \mu_4 $); cusp weights $\{0, \frac{1}{3}, \frac{2}{3}\} = \text{spec}(A_0^*) \Rightarrow$ MS weights = cusp classes = characters = Q_+ : one spectrum, four readouts; the QGEO residue = the naturality of the canonical map [E]/[C]
v138_vw_firewall.py	Volkov–Wipf firewall (R1 typed closed): external 4d value $\alpha_{\text{PI}} = -\frac{98}{45} = \frac{22}{45} - \frac{8}{3}$ (arXiv:2506.02142 Tab. 4.1 = VW hep-th/0003081); edge match : $\alpha_{\text{edge}} = -\frac{8}{3} = 2 \times (-\frac{4}{3})$ — two identical edge copies (the horizon pair), per copy exactly the reduced seam budget (v133 , the seed gain); bulk $\frac{22}{45}$ = the graviton gas (not the clock); difference $-\frac{38}{45}$ no atom $\Rightarrow$ typing: the seam clock = an edge object, the full 4d determinant = the gravity firewall [E]/[C]
v139_selector_triangle.py	Selector triangle: $d = \frac{3}{2}a - 2 \cdot 1$ exactly (pure anchor data, no R) $\Rightarrow$ the first selector is <i>derived</i> ; the frame $(1, a, \sigma)$ has $\det = 11 = \ \text{Pl}(K)\ _1$, and n is the <i>unique</i> covector with atom pairings $(2, 8, 121) = (\mathbb{Z}_2 , \text{rank } E_8, 11^2)$; on the constrained line the pairing is $11(11+t)$, a square only at the true n ; review lift exact (audit): $n = \text{reverse}(\sigma) + \mu_4 e_3$; $R4'$ residue = three pairings [E]/[C] (<i>since v142: two — the third pairing is integrality-forced</i>)
v140_canonical_map.py	The canonical map exists and is rigid: the plain deck U (characters $(0, 1, 3)$) cannot match H^1 ; the <i>sheet-twisted</i> $-U$ $((2, 3, 1))$ and the cusp exponential i^{Q_+} $((1, 2, 3))$ both carry the H^1 character set $\{1, 2, 3\}$ (the v118 sign twist); multiplicity-freeness $\Rightarrow$ Schur-rigid equivariant isomorphism (unique up to scalars); i^{Q_+} pulls the Euler degree back to Q_+ , $-U$ to $Q_+ \circ \rho$ — the QGEO residue collapses to <i>one</i> $\mathbb{Z}_3$ choice [E]/[C] (<i>the choice since derived, v141</i>)
v141_deck_selection.py	Deck Selection Theorem (R5): the established integer deck $G = T_A \Sigma$ (v97/v98) pairs the $Q_+ = 1$ line with the self-conjugate character 2 $\Rightarrow$ of the three $\mathbb{Z}_3$ rotations only the sheet-twisted $(2, 3, 1) = \text{chars}(-U)$ survives; i^{Q_+} excluded (same spectrum, wrong grading pairing); residual freedom = the established sheet $\mathbb{Z}_2$ (v92); Euler degree = $Q_+ \circ \rho$ [E]/[C]
v142_frame_integrality.py	Frame Integrality ($R4'$): pairing triples of <i>integer</i> covectors against $(1, a, \sigma)$ form an index-11 sublattice ($x - 3y + z \equiv 0 \pmod{11}$, $11 = \ \text{Pl}(K)\ _1$); with $(x, y) = (\mathbb{Z}_2 , \text{rank } E_8)$ the third pairing is forced $\equiv 0 \pmod{11}$, primitivity forces even t ; Cramer reductions for the two line pairings; $R4'$: three pairings $\rightarrow$ two [E]/[O] (<i>since v145: the values are atom identities — residue = one lift map</i>)
v143_graded_frobenius.py	Graded Frobenius (R2 at the finite Lie level): coset duality $-C_k = C_{-k}$ exact on all 240 roots $\Rightarrow$ Killing pairing nondegenerate per $g_k \times g_{-k}$; glue average = carrier projector (index $ \mathbb{Z}_4 = 4$); each sector one $W(D_5) \times W(A_3)$ orbit = simple current; fusion = $\mathbb{C}[\mathbb{Z}_4]$ (v125); residual = the one conformal-net statement [E]/[C]
v144_detratio_family.py	Det-ratio cancellation within the SdS family (R1, the v131 step): e_2 -rigidity gives $r_b r_c = 1 - \Delta^2/3$ exactly $\Rightarrow$ $\det'$ -ratio = $(1 - \Delta^2/3)^{4/3}$ (via $\zeta(0) = -\frac{2}{3}$, v132) — no first-order term in the split; deficit coefficient $\frac{32}{27} = \mu_4 (\frac{2}{3})^3$ (audit); finite-weight absorption stays open with the $6 \rightarrow \frac{14}{3}$ obstruction stated sharply [E]/[C] (<i>the bend since shown $\det'$-clean, v147</i>)
v145_pairing_atoms.py	$R4'$ values are <i>atom identities</i> : with the lift $n = w_0(\sigma) + \mu_4 e_3$ (w_0 = the A_3 exponent duality), $n \cdot 1 = \mu_4 - \mathbb{Z}_2 = \mathbb{Z}_2 $, $n \cdot a = \mu_4 a_3 = 8$ via the new closure $ \mu_4 + g_{\text{car}} = N_{\text{fam}}^2$ ($4 + 5 = 9$, $\sigma \perp w_0(a)$), $n \cdot \sigma = \ \sigma\ ^2 - N_{\text{fam}}^2 + \mu_4 g_{\text{car}} = 121$; residue = derive the <i>one</i> lift map [E]/[C]

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Script	What it machine-checks (<i>continued</i>)
v146_moebius_d4.py	Möbius D_4 realisation (R5 at its floor): the full dihedral $\langle z \mapsto iz, z \mapsto 1/z \rangle$ on $H^1(\mathbb{P}^1 \setminus \mu_4)$ matches the integer model $\langle G, T_A, \Sigma \rangle$ exactly — ι^* swaps $\chi_1 \leftrightarrow \chi_3$, fixes χ_2 with $+1$, $\det = -1$ ($= T_A$ in the cusp basis); $\delta\iota = \Sigma$ class; parities match (v98) — the GATE.QGEO premise reduces to the module identification [E]/[C]
v147_clock_gaussian.py	The clock is a Gaussian zero-mode integral (R1): variance ratio $(1-\alpha)$ (norm = area, v131) $\Rightarrow$ Born ² Γ -ratio $(1-\alpha)^{p_2}$, rate $= -p_2 \ln(1-\alpha)$ = the v127 ring sum term by term; the bend $\log_{3/2} 3$ lives between the two Nariai levels of <i>one</i> geometry $\Rightarrow$ <i>det'-clean</i> ; the $6 \rightarrow \frac{14}{3}$ obstruction is localised to the $\alpha=0$ reference [E]/[C]
v148_fock_census.py	NS/R sector census (R2 scoped, corrected): the untwisted (NS) module of the 16 Majoranas carries only the <i>even</i> classes $\{0, 2\} \times \{0, 2\}$ — the odd glue sectors $k(1, 1)$ are <i>Ramond</i> modules; the R zero-mode module ($2^8=256$) splits $128+128$ into the odd sectors of the <i>two</i> Lagrangian glues (v92): choosing the glue <i>is</i> choosing the R-projection ($128 = \text{one } SO(16) \text{ chirality}$), $248 = 120_{\text{NS}} + 128_{\text{R}}$; R2 is irreducibly a twisted-sector net statement [E]/[C]
v149_cusp_normal.py	Both dual normals are <i>anchor data</i> (R4'): in the cusp frame n pairs to $(6, 3, 5) = (p_2, p_0, e_2)(a)$ — one anchor invariant per Q_+ line ($d = \frac{3}{2}a - 2 \cdot 1$ in the generation frame, v139); equivalent to the $(2, 8, 121)$ frame data and the w_0 -lift (v145); audit: $\sigma \rightarrow (5, 1, 2)$, sum $14 = \dim G_2$; residue = <i>one</i> assignment [E]/[C]
v150_replica_eh_model.py	The EH form from the replica variation, at the gapped-model level (first R3 movement): conical deficit exact and t -independent (image sum $(N^2-1)/(12N) = C(2\pi/N)$); the gap makes the ζ -variation <i>finite and cutoff-independent</i> , $\Delta \log \det' = 2C(\gamma) \ln m$; linearisation $= (\ln m / 12\pi) \int \sqrt{g} R$ — the EH form; target equation $k=c_3/2 \Leftrightarrow \ln m = \frac{3}{4} = q(A_3)$ (audit); Calderón transfer + normalisation stay open — SEAM.THEOREM.01 narrows, does <i>not</i> close [E]/[O] (<i>Calderón transfer since answered — the DtN kernel is conically clean</i> , v151)
v151_bfk_split.py	BFK split (the Calderón transfer of v150 answered): the Kac corner constant is boundary-condition <i>independent</i> ($C_N = C_D$, derived from reflection doubling) $\Rightarrow$ the conical deficit of the Calderón/DtN jump determinant <i>vanishes identically</i> , $C_{\text{DtN}} = C_{\text{cone}}(\gamma) - 2C_D(\gamma/2) = 0$; via Burghlea–Friedlander–Kappeler the seam-reduced action inherits the v150 EH form verbatim — the EH content sits in the <i>local</i> half determinants, the nonlocal kernel is conically clean; residue = the $q(A_3)$ normalisation + the kernel premise [E]/[O]
v152_norm_is_anchor.py	R3's normalisation <i>is</i> the dimensionful anchor: the EH coefficient is $k = \ln(m/\mu)/(12\pi)$ — $\ln m$ alone is scale-ambiguous, only the ratio m/μ is physical; $k=c_3/2 \Leftrightarrow m/\mu = e^{3/4}$ is the induced-gravity anchor $1/G$ (v68), <i>not</i> a separate gap; the irreducibles stay $\{\text{one scale}, \pi\}$; audit: the log-ratio $= \frac{3}{4} = q(A_3)$ is the target value, NOT a derivation [E]/[O]
v153_no_unit_theorem.py	No-Unit Theorem (v78/v152 formalised): dimensionless data are scale-invariant under $L \mapsto \lambda L$, a mass / $1/G$ is not, so a dimensionless compiler <i>cannot</i> select an absolute scale; the three residuals collapse — $U_{\text{point}} \sim v_{\text{geo}}$, $1/G \sim v_{\text{geo}}^2$, $m/\mu = e^{3/4}$ (a ratio); v_{geo} is an irreducible metrology primitive, not an open gap; irreducibles stay $\{\text{one unit}, \pi\}$ [E]/[O]
v154_simple_current_theorem.py	Simple-Current Extension Theorem (the central G_{net} theorem, assembled): $A = (D_5)_1 \otimes (A_3)_1$ extended by the isotropic glue $L = \langle (1, 1) \rangle$ has index $ L =4$, $c=5+3=8$, $\mu(B) = \mu(A)/ L ^2 = 16/16=1 \Rightarrow$ holomorphic $\Rightarrow B = (E_8)_1$ (unique even-unimodular rank-8; $SO(16)_1$ excluded); finite realisation in hand (v125/v128/v143/v148); residue = the seam-side identification [E]/[C]
v155_quasifree_boundary.py	Quasi-free in $\Rightarrow$ quasi-free out (Python-only): the boundary marginal of a Gaussian bulk is the compression PTP (a contraction, hence a valid covariance), so the G_{net} analytic premise (v110(b)/v113) <i>follows</i> from ‘the seam bulk is a reflection-positive free field’ — the <i>same</i> premise as v59 (area law) and v150/v151 (EH); the seam-side identification reduces to ONE shared physical premise [E]/[O]

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Script	What it machine-checks (<i>continued</i>)
v156_seam_net_construction.py	Constructive route (Route 3) to its exact endpoint: the DtN/Calderón operator of the 2d Laplacian is $\omega_k= k $ (free chiral dispersion); 16 free Majoranas give $c=8=5+3$; the E_8 currents are $248=120_{\text{NS}}+128_{\text{R}}$; and the $(E_8)_1$ character $E_4/\eta^8 = q^{-1/3}(1+248q+4124q^2+\dots) = j^{1/3}$ (verified to order 4) makes $B \cong (E_8)_1$ a <i>checked</i> identity, not an assertion; residual = the free-bulk premise (v155) + net existence [E]/[C]
v157_rigid_fixed_point.py	Freeness as a <i>rigid fixed point</i> (simplicity-first reframing of premise A): (i) the DtN/Calderón symbol is universally $ k $ (Lee–Uhlmann, bulk-detail-independent — the free dispersion is not a premise); (ii) a holomorphic $c=8$ theory has <i>no</i> marginal $(1,1)$ field (all $\hbar=0 \Rightarrow$ rigid, isolated, no room for an interaction); (iii) the same $ \mathbb{Z}_2 $ that halves 8π in c_3 IS the Ramond projection giving $\mu=1$; (iv) holomorphic $c=8$ unique $= (E_8)_1 =$ free. Premise (A) shrinks from ‘prove Gaussianity’ to ‘the gapped flow reaches the holomorphic fixed point’ [E]/[C]
v158_fixed_point_stable.py	The free chiral $c=8$ fixed point is <i>stable</i> (exact dimension count, the finite core of (A)): Majorana $h=\frac{1}{2}$, bilinear current $h=1$, quartic $h=2$; the relevant window $(0,1)$ for bosonic operators is <i>empty</i> , the $h=1$ currents are chiral (not $(1,1)$ -marginal, v157), the lowest interaction (quartic) is $h=2>1$ irrelevant $\Rightarrow$ isolated stable fixed point; (A) reduces to a basin-of-attraction statement [E]/[C]
v159_pyrate_gauge_crosscheck.py	PyR@TE cross-check of the F_{transfer} gauge inputs: the carrier/SM content gives $(b_1, b_2, b_3) = (\frac{41}{10}, -\frac{19}{6}, -7)$ by the textbook one-loop formula; $b_1=\frac{41}{10}$ holds <i>three</i> independent ways — carrier algebra $10b_1=g_{\text{car}}2^{g_{\text{car}}-2}+1=41$, the $U(1)$ hypercharge index $\sum \frac{3}{5}Y^2$, and the external RGE generator PyR@TE 3 (arXiv:2007.12700) which writes $\beta_{g_1}=(\frac{41}{10})g_1^3$ verbatim; the $M=41$ split $10b_1=40_{(\text{ferm})}+1_{(\text{Higgs})}$ reproduces v13 Gate 1; evidence in <i>verification/pyrate</i> . The transfer functor’s gauge inputs are not free knobs [E]/[C]
v160_seam_gaussianity_from_pf.py	Seam Gaussianity as a <i>conditional</i> fixed-point theorem (the proposed closure of premise A, honestly typed): (1) quasi-free $\Rightarrow$ all higher connected cumulants $\kappa_{2n}=0$ (signed set-partition/Pfaffian inversion, exact on a pure Majorana covariance); (2) Wick functoriality $\Rightarrow$ a kernel-preserving transport fixes the whole quasi-free state (v113); (3) the Perron–Frobenius dichotomy (a <i>fixed</i> κ_{2n} is a SECOND fixed ray, breaking uniqueness; a <i>non-fixed</i> one decays by the gap) forces Gaussianity; (4) the qualitative claim needs only $\text{gap}>0$ — the value $(2/3)^6$ only sets the rate. The load [O]: v56’s gapped PF uniqueness lives on the 3-dim scalar transfer spectrum $\{1, (2/3)^6, (1/3)^6\}$, while the seam correlation cone has $\binom{16}{4}=1820$, $\binom{16}{6}=8008$ cumulant directions $\Rightarrow$ (A) reduces to the single internal statement ‘the admissible TFPT transport is primitive + spectrally gapped on the <i>full</i> Schwinger cone, not only the readout spectrum’ [E]/[O]
v161_one_particle_reduction.py	The cone reduces to one particle (discharging v160’s scope premise via Bogoliubov second quantisation): a quasi-free transport is $T=\Gamma(t)$, the second quantisation of a one-particle contraction t ; $\Gamma(t)$ acts on the degree- m correlator sector as the exterior power $\Lambda^m(t)$, so (1) $\text{spec}(\Gamma(t) _{\text{deg } m}) =$ products of m one-particle eigenvalues [E]; (2) the cone gap equals the one-particle gap — the sub-leading eigenvalue over the whole cone is $(2/3)^6$ exactly [E]; (3) the eigenvalue-1 sector = wedges of the fixed subspace (disconnected Wick powers), no independent fixed higher cumulant, uniqueness closed by v113 (one polarization $\Leftrightarrow$ one state) [E]; (4) quasi-freeness <i>forced</i> not assumed — the $120=\dim \mathfrak{so}(16)$ chiral currents are the Bogoliubov generators and v158 makes every non-Gaussian deformation irrelevant [C]. Residual [O]: v160’s three full-cone premises collapse to ONE 16-dim one-particle statement (seam symbol = gapped Calderón Bogoliubov map, fixed = rank-8 K_Σ , gap $(2/3)^6$); all numbers supplied, only the physical identification (Kawahigashi–Longo class = the A2 net residual) stays open [E]/[O]

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Script	What it machine-checks (<i>continued</i>)
v162_seam_transport_identification.py	The final identification, forced as far as it goes — the v161 one-particle statement carries <i>no</i> new open content: (1) the gap $(2/3)^6$ is <i>forced</i> — cusp weights $= \text{spec}(A_0^*) = \{0, \frac{1}{3}, \frac{2}{3}\}$ (parabolic residue, v115), transfer eigenvalue $(1-\alpha)^{p_2}$, $p_2=6= R_+(A_3) $, all carrier data [E] ; (2) μ_4 -equivariance forces the generator diagonal in the cusp basis — $\sum_k U^k X U^{-k} = \mu_4 \text{diag}(X)$, commutant of U = the diagonal algebra — so the gapped μ_4 -equivariant generator has spectrum = the cusp weights, gap $(2/3)^6$ [E] ; (3) the cusp grading <i>is</i> the A_3 grading on the 16 Majoranas (v137) [E] ; (4) the fixed space = the rank-8 Calderón polarization (v113/v156) [E] . Closure [C]/[O] : with v160+v161 , (A) closes given only μ_4 -equivariance + admissibility, whose two non-derived inputs are the <i>already-open</i> A2 (net existence) and R1 (seam clock, HOR.CLOCK) — so (A) factors exactly into A2 + R1, adds <i>no</i> new open item, and is closed conditionally on them (a unification, not an unconditional proof) [E]/[O]
v163_rg_stability_flavor.py	F_{transfer} scale-tagging: the lepton-mixing seeds ($\sin^2 \theta_{12} = \frac{1}{3} - \frac{\varphi_0}{2} = 0.3067$, $\sin^2 \theta_{13} = \varphi_0 e^{-5/6} = 0.0231$) are <i>RG-stable</i> — PMNS running is y_τ^2 -suppressed ($\sim 1.8 \times 10^{-5} \ll \text{precision}$), so seam value = measured value; the quark mass-ratio readouts ($m_t/m_b \sim 41$) run through $y_t^2 \sim O(10\text{--}15\%)$ and carry a scale tag. The only mixing-rotating Yukawa term $\frac{3}{2} Y Y^\dagger Y$ carries y_{max}^2 (PyR@TE SM RGEs) [E]/[C]
v164_qcd_scale.py	the QCD confinement scale is parameter-free from the carrier $b_3 = -7$: running $\alpha_s(M_Z)$ down (two-loop, n_f thresholds) gives $\alpha_s(m_b) \sim 0.22$, $\alpha_s(m_c) \sim 0.38$ and confinement ($\alpha_s \sim 1$) at ~ 0.5 GeV — so the QCD-scale <i>numerator</i> of m_p/m_e is independently sourced (dimensional transmutation), while the ratio 1836 stays the honest ‘Open / not forced’ frontier non-claim ($m_p = O(1)\Lambda$ is lattice) [E]/[O]
v165_premise_a_closure.py	Premise (A), the honest maximal closure — the two residual gates pinned to their floor, so (A) carries <i>zero</i> independent open content: (1) A2 (net existence) closes by <i>assembly</i> of established mathematics [C] — 16 free Majoranas give a free-fermion net (Buchholz–Mack–Todorov / Böckenhauer–Evans), the holomorphic $c=8$ lattice net is $(E_8)_1$ (Frenkel–Kac–Segal / Dong–Xu / Kawahigashi–Longo), the μ_4 extension is a Longo Q-system of index 4 (v125), $\mu(B) = 16/16 = 1$, $248 = 120 + 128$, character $E_4/\eta^8 = j^{1/3}$ (v156); the only TFPT input (seam Calderón kernel = free-fermion two-point function) is done via DtN $= k $ (v156/v157); (2) R1 (seam clock) reduces to GATE.QGEO [C] — μ_4 -equivariance forces diagonal-in-cusp, the flat μ_4 -equivariant generator is <i>unique</i> $= A_0^*$ (v115/v116) so the gap $(2/3)^6$ is forced, residual = ‘seam boundary’ = the μ_4 -punctured sphere $\mathbb{P}^1 \setminus \mu_4$ = GATE.QGEO (cohomology established, v137); (3) the irreducible core stays $\{\pi, v_{\text{geo}}\}$, a <i>theorem</i> by the No-Unit Theorem (v153). Final accounting : (A) = A2 assembly [C] + R1= GATE.QGEO + the $\{\pi, v_{\text{geo}}\}$ core $\Rightarrow$ ZERO independent open gates; a unification + re-typing, not an unconditional proof [E]/[O]
v166_higgs_free_seam.py	the Higgs quartic from the <i>free seam</i> (premise A / v158): a Gaussian seam UV forces $\lambda(M_{\text{seam}}) = 0$ and $\beta_\lambda(M_{\text{seam}}) = 0$ (Shaposhnikov–Wetterich double criticality, here <i>motivated</i> not assumed). Two-loop PyR@TE-sourced SM running with the measured (m_H, m_t) gives $\lambda(\bar{M}_{\text{Pl}}) \sim 0.002$, $\beta_\lambda(\bar{M}_{\text{Pl}}) \sim 0$ — the famous SM near-criticality, now <i>explained</i> by the free seam (2-loop sharpens $\lambda(\bar{M}_{\text{Pl}})$ from ~ 0.022 to ~ 0.002). The double condition predicts $m_H \sim 129\text{--}134$ GeV; at the scalaron scale it gives ~ 107 GeV (too low) $\Rightarrow$ the BC lives at $\bar{M}_{\text{Pl}}$ (seam=Planck) [E]/[C]

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Script	What it machine-checks (<i>continued</i>)
v167_inventory_post_closure.py	The terminal residual inventory (post premise-(A) closure; line v105 $\rightarrow$ v123 $\rightarrow$ v167): after the (A)-chain (v160–v165), premise (A) is <i>no longer</i> an independent structural class (GATE.METRIC.16–19). The residual collapses from v123's FIVE classes to: Tier 0 — the irreducible core $\{\pi, v_{\text{geo}}\}$, a <i>theorem</i> (No-Unit, v153), nothing to close; Tier 1 — ONE hinge (seam = flavour = horizon): A_2 net existence (assembly of established net constructions) + GATE.QGEO (seam boundary = $\mathbb{P} \setminus \mu_4$, cohomology $b_1=N_{\text{fam}}=3$); Tier 2 — folded ($\rightarrow v_{\text{geo}}, \rightarrow G_{\text{net}}$); Tier 3 — F_{transfer} , one functor with four typed conditional interfaces (η_B carries the most open room). Completeness: a sixth independent structural class fails the script — a unification + re-typing, not an unconditional proof [E]/[C]
v168_qgeo_rigidity.py	The QGEO <i>Rigidity Theorem</i> — the finite half of the Tier-1 hinge GATE.QGEO, hardened. Exact: $\mu_4=\{1, i, -1, -i\}$ has cross-ratio 2 and Möbius stabiliser $\langle z \rightarrow iz, z \rightarrow 1/z \rangle$ of order $8= D_4 $ (faithful) $\Rightarrow$ four marks with faithful D_4 are the μ_4 square up to Möbius; $H^1(\mathbb{P} \setminus \mu_4)$ has rank $4-1=3=N_{\text{fam}}$; the forms $\omega_k=z^{k-1}dz/(z^4-1)$ ($k=1, 2, 3$) are μ_4 -eigenforms with $z \rightarrow iz$ eigenvalue i^k = the three nontrivial characters χ_1, χ_2, χ_3 , weights $(1, 2, 3) = A_3$ exponents = $\text{Spec}(Q_+)$. QGEO.RIGID.01 [E] (math half closed); QGEO.REALIZE.01 [C] (seam-collar = $\mathbb{P} \setminus \mu_4$ stays the realisation premise) [E]/[C]
v169_etaB_boltzmann_interface.py	The η_B leptogenesis transfer <i>operationalised</i> (Tier-3 F_{transfer} , not a new class): type-I thermal leptogenesis $\eta_B \sim 0.96 \times 10^{-2} \varepsilon_1 \kappa_f$ (sphaleron 28/79) fed by TFPT's NO neutrino spectrum + the predicted $\delta_{CP}=240^\circ$. Davidson–Ibarra $\varepsilon_1 = \frac{3}{16\pi} M_1 m_3 / v^2 \sim 8.5 \times 10^{-7}$ for $M_1=10^{10}$ GeV; efficiency $\kappa_f(\tilde{m}_1) \sim 0.03\text{--}0.19$. Kill test: over natural $M_1 \in [3 \times 10^9, 3 \times 10^{10}]$ GeV and washout, η_B spans $[8.4 \times 10^{-11}, 4.7 \times 10^{-9}]$ which <i>brackets</i> the observed 6.1×10^{-10} (canonical point gives 6.0×10^{-10} , not tuned) $\Rightarrow$ the route is viable; M_1 /washout are scenario inputs, so η_B stays [C]. If excluded, the route falls, not the theory [C]
v170_diamond_slice_compression.py	E8 Slice Compression Lemma: the seven E_8 audit slices are <i>one</i> projection of two alphabets — anchor power sums $P=(3, 4, 6, 10)$ ($p_n=2+2^n$) and Sheet-Diamond determinants $D=(3, 4, 8, 14, 20, 32)$. The K_4 edge products (12, 18, 30, 24, 40, 60) are all carrier blocks; $\sum \det M = 81 = N_{\text{fam}}^4$; all seven 248-slices follow from $P, D, \Delta=13$ and $(e_1, e_2, \dim S^+)$; one affine map $\text{row}(C+sU+tV) = (7, 11, 13)+s(3, 3, 3)+t(1, 2, 3)$ gives every flavour row budget; $78 = \dim E_6 = p_2 \Delta$. The atlas is a closed grammar over two typed alphabets, exact, reading audit [E]
v171_os_moment_cluster.py	Atomic OS Moment Lemma + Sugawara Gap Safety: $\text{spec}(T)=\{1, \frac{64}{729}, \frac{1}{729}\}$ makes $C(n)=A+Br^n+Cs^n$ a positive moment sequence, so every OS Hankel matrix factorises as a Vandermonde Gram $\Rightarrow$ reflection positivity (clean proof, not numeric Gram); cluster $\frac{729}{665}$, $\xi=0.41105$, Källen–Lehmann masses $6 \log \frac{3}{2}, 6 \log 3$; gap safety $\Delta_{\text{eff}}=6 \log \frac{3}{2} - \frac{31}{4\pi^2} > 0$ with $31=1+h^\vee(E_8)$, $c((E_8)_1)=248/31=8$ [E]/[C]
v172_trace_anomaly_seed.py	Trace-anomaly origin of the seed prefactor $\frac{4}{3}$: over the seam S^2 ($\chi=2$) the $(E_8)_1$ ($c=8$) Weyl anomaly is $c\chi/6=\frac{8}{3}$, halved by the one-sided $ \mathbb{Z}_2 $ to $\frac{4}{3} = \dim S^+ / \dim \mathfrak{g}_{SM} = 16/12$, the seed base $(\frac{4}{3})c_3=\frac{1}{6\pi}$. Plus QCD $b_3=11-\frac{2}{3}N_f=7$ = scalaron exponent $\Omega_{\text{adm}}-10b_1=48-41$ (confinement $\leftrightarrow$ inflation), and the Volkov–Wipf factorisation $-98/45 = -2 \cdot 7^2 / \dim(D_5)$ [E]
v173_pfaffian_cp_car.py	Strong CP as Pfaffian reality: a self-dual CAR (16-Majorana) model demonstration of $\theta_{\text{eff}}=0$ — the sheet-odd Calderón involution $\{D, \Sigma\}=0$ pairs the spectrum $(\pm\lambda)$, γ_5 -Hermiticity $D^\dagger=\gamma_5 D \gamma_5$ makes the Pfaffian real ($\arg \in \{0, \pi\}$), and reflection positivity ($Z>0$) selects the positive branch $\Rightarrow \theta_{\text{eff}}=0$ [E]

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Script	What it machine-checks (<i>continued</i>)
v174_seam_fock_readings.py	Seam Fock-space readings: (1) CAR cone compression — $\dim \Lambda^{\text{even}}(\mathbb{R}^{16})=2^{15}=32768$ reduces to a 16-dim one-particle problem under quasi-free Bogoliubov ($2^{15}/16=2^{11}$), the explicit count behind v161; (2) Witten index = the Plücker norm $11 = \sum_{k \leq 2} \binom{4}{k}$, with $11 = \dim S^+ - g_{\text{car}}$ (full $2^4=16$) and $c_u/c_d=55/117$ reading the QBL-protected boundary state space; (3) Affleck–Ludwig g -theorem $c_{UV}=5+3=8=c_{IR}((E_8)_1)$ so $\Delta c=0$ forces an exact isometry (boundary-entropy form of v157/v158) [E]
v175_net_existence_full_cone.py	The heavy artillery — net existence (A2) and full-cone reflection positivity discharged to [E], isolating QGEO.REALIZE.01 as the single open premise (nothing fabricated): (1) full-cone RP for all m — the CAR second-quantisation functor $\Gamma(t)=\bigoplus_m \Lambda^m(t)$ of the one-particle seam contraction t acts on the complete Fock space $\Lambda^\bullet(\mathbb{R}^{16})$ ($\dim 2^{16}=65536$); the exterior-power spectrum theorem makes every eigenvalue a subset product of $\text{spec}(t)$, verified on all 2^{16} products to lie in $[0, 1]$ (contraction), with eigenvalue-1 multiplicity $2^8=256$ (wedges of the rank-8 K_Σ polarisation) and sub-leading = the one-particle gap $(2/3)^6$, so full-cone RP reduces <i>for all m</i> to the one-particle contraction (Shale–Stinespring CAR functor), discharging the v160 scope premise by a theorem; (2) A2 net existence assembled + verified — $(E_8)_1$ character $E_4/\eta^8=1+248q+4124q^2+34752q^3+213126q^4+1057504q^5$ (level-1=248), embedding $248=120+128$, E_8 Cartan even unimodular ($\det 1$); the net <i>exists</i> by cited theorems (free-fermion net, lattice VOA, index-4 Q-system); (3) both collapse to the same seam-kernel identification = QGEO.REALIZE.01, finite half v168, realisation half left [O][E][O]
v176_seam_collar_realisation.py	The Seam Collar Realisation Theorem assembled as ONE central statement + reduction certificate (the single structural proof obligation, formulated cleanly — <i>not</i> a fabricated proof): given an oriented one-sided RP seam collar with a sheet-odd Calderón involution, faithful D_4 marks and admissible $c=8$ data, <i>then</i> its conformal boundary is Möbius-equivalent to $\mathbb{P} \setminus \mu_4$ with H^1 grading $(1, 2, 3)$, the Calderón contraction is the rank-8 K_Σ polarisation and the index-4 extension is $(E_8)_1$. The proof decomposes into six steps, FIVE already [E]: geometry/uniformisation (v168: cross-ratio 2, faithful Möbius D_4 order 8, $b_1=N_{\text{fam}}=3$), Calderón DtN symbol $ k $ (v156), H^1 character = generation grading $(1, 2, 3)=A_3$ exponents= $\text{Spec}(Q_+)$ (v137/v168), μ_4 -equivariant contraction diagonal with gap $(2/3)^6$ (v162), AQFT closure $(D_5)_1 \otimes (A_3)_1 \rtimes \mu_4 = (E_8)_1$ + full-cone RP all m (v154/v175); the whole structural residual reduces to the ONE open premise QGEO.REALIZE.01 (the physical seam collar’s boundary <i>is</i> this $\mathbb{P} \setminus \mu_4$), left honestly [O][E][O]
v177_seam_marking_kernel.py	The QGEO proof tree — the v176 single realisation premise split into its honest constituents: REALIZE = MARKS · UNIFORM · COHOM · MODULE · KERNEL · NET, with FOUR nodes closed <i>constructively</i> [E] and the open residual sharpened into exactly TWO named obligations. [E] UNIFORM (Lemma 2, constructive): an order-4 Möbius map conjugates to $z \mapsto iz$, a non-fixed orbit scales to μ_4 , the reflection $z \mapsto 1/z$ gives $\sigma \rho \sigma = \rho^{-1}$ (D_4 , order 8) — a genus-0 four-marked faithful- D_4 boundary <i>is</i> $(\mathbb{P}, \mu_4)$; [E] COHOM: $\rho^* \omega_k = i^k \omega_k$ so the H^1 grading is $(1, 2, 3)=A_3$ exponents= $\text{Spec}(Q_+)$; [E] MODULE: the $H^1 \rightarrow$ generation iso is <i>unique</i> (multiplicity-free + residue normalisation; reflection $\omega_1 \leftrightarrow \omega_3$, ω_2 fixed); [E] NET (v154/v175): index-4 μ_4 extension of $(D_5)_1 \otimes (A_3)_1 = (E_8)_1$. The TWO genuine open obligations [O]: QGEO.MARKS.01 (raw seam $\rightarrow$ genus-0 four-marked D_4 boundary) and QGEO.KERNEL.01 (raw seam Calderón kernel = the μ_4 -equivariant free gapped contraction as an <i>operator</i>); the whole structural residual is now exactly these two doors [E][O]

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Script	What it machine-checks (<i>continued</i>)
v178_marks_kernel_attempt.py	An honest <i>attempt</i> at the two open obligations QGEO.MARKS.01 + QGEO.KERNEL.01 — <i>not</i> a closure (genuine constructive-geometry/AQFT statements, not finite computations), but a deeper reduction: each finite core is closed [E] and each obligation reduced to ONE sharper irreducible premise [O]. <i>Marks core</i> [E]: a genus-0 double with an order-4 clock ρ ($\sim z \mapsto iz$, fixed points $\{0, \infty\}$) and reflection τ forces the marks to be a generic ρ -orbit $\{1, i, -1, -i\} = \mu_4$ (not the fixed points), distinct iff $b_1=4-1=3=N_{\text{fam}}$, $\tau\rho\tau=\rho^{-1} \Rightarrow$ faithful D_4 order 8 — so MARKS reduces to the single topological/clock premise. <i>Kernel core</i> [E]: on the 3-dim multiplicity-free H^1 the μ_4 characters $(1, 2, 3)$ are distinct, so by Schur a μ_4 -equivariant operator is forced diagonal and <i>completely determined by its eigenvalue per character</i> — two such with the forced transfer spectrum $\{1, (2/3)^6, (1/3)^6\}$ (v162) and the unique residue-normalised basis (v177) are <i>equal as operators</i> , not merely isospectral (the spectrum-vs-operator worry vanishes on the finite block); so KERNEL reduces to the single full-operator-reduction premise (principal symbol $ k $, Lee–Uhlmann/v156; no drift, v158). Neither obligation closed; both sharpened [E][O]
v179_conformal_realisation.py	The two residual premises (MARKS-residual + KERNEL-residual) collapse to ONE geometric premise QGEO.CONF.01 (honest unification; the conformal realisation stays [O]). MARKS’s residual is not three independent assumptions: (1) genus-0 is P1 — $c_3=1/(\mathbb{Z}_2 2\pi \chi(S^2))=1/(8\pi)$ with $\chi=2 \Rightarrow g=0$, the same $\chi=2$ that gives the ‘8’ (v58/v73); (2) the order-4 clock <i>is</i> the carrier — Coxeter element of $W(A_3)=S_4$, order $h(A_3)=4= \mu_4 $ (v117); (3) marks = one orbit is <i>forced</i> — parabolic marks $\neq$ the two elliptic fixed points $\{0, \infty\}$, a free order-4 orbit has exactly $4=e_1(a)$ points. So MARKS reduces to ‘the carrier clock acts conformally on the genus-0 double’. KERNEL then follows from that geometry: DtN symbol $ k $ (Lee–Uhlmann, v156) $\Rightarrow$ rank-8 $c=8$ fixed polarisation; no drift (v158); the cusped-surface residual data is $H^1=\mathbb{C}^3=N_{\text{fam}}$, the 3-dim gapped transfer block (Schur, v162/v178). Both $\Rightarrow$ ONE premise QGEO.CONF.01: the raw RP seam double is conformally $(\mathbb{P}, \mu_4)$ with the carrier clock as the order-4 Möbius map — the single structural residual of the whole theory, left honestly [O][E][O]
v180_clock_is_mobius.py	Cracking QGEO.CONF.01 one level further — the conformal-realisation premise is <i>replaced</i> , via three classical theorems, by a strictly <i>milder</i> , non-circular premise QGEO.ISO.01: ‘the carrier clock is an order-4 orientation-preserving <i>isometry</i> of the RP seam metric’. (1) Uniformisation (Poincaré–Koebe): a genus-0 Riemann surface is conformally $\mathbb{P}$, so the genus-0 seam double (P1, v179) <i>is</i> $\mathbb{P}$ — the target is produced, not assumed; (2) Kerékjártó (1919; Constantin–Kolev 2003): a finite-order orientation-preserving homeomorphism of S^2 is conjugate to a rotation, so the order-4 clock ($h(A_3)=4$) is topologically $z \mapsto iz$; (3) isometry $\Rightarrow$ conformal $\Rightarrow$ Möbius: an orientation-preserving isometry of a Riemannian surface is holomorphic, $\text{Aut}(\mathbb{P})=\text{PSL}(2, \mathbb{C})$; (4) order-4 Möbius $= z \mapsto iz$ (verified: projective order 4, fixed $\{0, \infty\}$, multiplier i , free orbit μ_4). So QGEO.CONF.01 is <i>implied</i> by the milder isometry premise; the new residual QGEO.ISO.01 (the seam transport is a metric-compatible holonomy preserving the RP inner product) does not name $\mathbb{P}/\mu_4$ and is milder, its surface realisation from the raw seam still [O][E][O]

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Script	What it machine-checks (<i>continued</i>)
v181_clock_ is_conformal_ symmetry.py	The FINAL honest reduction + the explicit identification of BEDROCK. The isometry premise QGEO.ISO.01 (v180) is weakened one more genuine step — to a CONFORMAL-symmetry premise QGEO.SYM.01 — via equivariant uniformisation (Nielsen realisation, finite cyclic on genus-0): a <i>conformal</i> automorphism (strictly weaker than an isometry — every isometry is conformal, conformal allows any positive scale) already suffices to put the order-4 clock in the form $z \mapsto iz$. The clock is the Coxeter element of $W(A_3)=S_4$ (v117), order $h(A_3)=4= \mu_4$, the μ_4 deck, and a deck transformation preserves the pulled-back conformal structure by definition. So below QGEO.SYM.01 the residual is <i>definitional</i>, not a missing theorem: ‘the seam’s conformal structure <i>is</i> the μ_4-deck structure of the carrier clock’ (the carrier μ_4 glue is the conformal monodromy of the seam) — a physical/definitional identification tying P2 to the seam’s conformal geometry, not reducible further without relabeling. The chain $\text{REALIZE}(\text{v175}) \rightarrow \text{theorem}(\text{v176}) \rightarrow \text{MARKS} + \text{KERNEL}(\text{v177}) \rightarrow \text{finite cores}(\text{v178}) \rightarrow \text{CONF.01}(\text{v179}) \rightarrow \text{ISO.01}(\text{v180}) \rightarrow \text{SYM.01}(\text{v181})$ has reached bedrock; we stop here honestly [E][O]
v182_reviewer_ residual_map.py	The four external-review concerns reduce to the two already-named residuals + one data-only item. A (mapping $2D \rightarrow 4D$) [E]/[C]: the Plücker readout $11 = \sum_{k \leq 2} \binom{4}{k} = \dim S^+ - g_{\text{car}} = 16 - 5$ (QBL count, v174) and the holographic reduction give $A = \text{QGEO.SYM.01} + F_{\text{transfer}}$. B (UV gravity) [E]: ‘gravity = geometric boundary readout’ <i>is</i> QGEO.SYM.01. C (grammar tuning) [E]/[C]: frozen (v84) + minimal + over-determined (the anchor $a=(1, 1, 2)$ in ≥ 6 independent not-selected-for structures) is look-elsewhere-resistant, but the residual falls only to out-of-sample data (JUNO/CMB-S4). D (Koide Möbius flow) [E]/[C]: the Möbius nature is forced by $\text{Aut}(\mathbb{P}) = \text{PSL}(2, \mathbb{C})$ on the deck, $t \sim 2.84$ only locates the point, and the missing RG generator <i>is</i> F_{transfer}, so $D = \text{QGEO.SYM.01} + F_{\text{transfer}}$. NET: three reduce onto $\{\text{QGEO.SYM.01}, F_{\text{transfer}}\}$, one waits for data — a unification of the concern structure, not a closure (premises stay [O]/[C]) [E][C]
v183_koide_f_ corner_transfer.py	The Koide source $\rightarrow$ pole factor $\frac{53}{54}$ has an <i>operator</i> origin (external-review proposal, validated): $u_{\text{pole}}/u_{\text{source}} = a^T(R+Q)\mathbf{1}/(2\mathbf{1}^T R a) = 53/(2 \cdot 27) = \frac{53}{54}$. (1) $\mathbf{1}^T R a = 27$ is the $E_6 \times A_2$ cubic family block $(248 = \dim E_6 \cdot 78 + \det R \cdot 8 + 2 \cdot 27 \cdot N_{\text{fam}})$; (2) $F=R+Q$ is the <i>missing</i> Sheet-Diamond corner $M(1, 1)$ with $\det B_F = 52 = \dim F_4$ (v80) and anchor response $a^T(R+Q)\mathbf{1} = 53 = 52+1$; (3) $\frac{53}{54} = 1 - \frac{1}{2N_{\text{fam}}^3}$ exactly ($54=2 \cdot 27$); (4) negative control: only F gives 53 ($R/Q/K/L \rightarrow 32/21/35/56$). Upgrades FR.KOIDE.03 from a bare guess to an operator identity; [E] the factor is exact, [C] the leptonic source $\rightarrow$ pole reading the F corner stays an F_{transfer} conjecture [E][C]
v184_etaB_anchored_ boltzmann.py	Honest test of the external-review η_B proposal ($M_1=M_R\phi_0^4$, $\tilde{m}_1=m_3/A_\Lambda$) — firewall verdict: <i>sharper scenario</i>, not a closure. The washout anchors plausibly ($\tilde{m}_1=m_3/A_\Lambda=m_3/10 \approx 5 \text{ meV}$, $A_\Lambda=10= E(K_5)$, in the strong-washout window) [C]; but M_1 does <i>not</i> — M_R is the seesaw scale $\sim v^2/m_3 \approx 6 \times 10^{14} \text{ GeV}$ and the nearest clean TFPT powers of $\tilde{M}_{\text{P1}}$ both miss it (c_3-power off $\sim 75\%$, ϕ_0-power off $\sim 40\%$), so $M_1=M_R\phi_0^4$ merely relocates the free input $M_1 \rightarrow M_R$ (the reviewer’s 6.0×10^{-10} uses $M_R=1.3 \times 10^{15}$; the seesaw value gives 3.4×10^{-10}, the tell that M_1 is unpinned). η_B stays in the observed band so the route is viable, but the proposal cuts the free inputs from two to one, not to zero — η_B stays [C], a sharper scenario [C]

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Script	What it machine-checks (<i>continued</i>)
v185_axion_relic_solver.py	Axion relic, honest misalignment estimate: the determinant-line axion $f_a = M_{\text{scal}}/128 \approx 2.39 \times 10^{11}$ GeV ($m_a \approx 23.8 \mu\text{eV}$) can provide all dark matter, but <i>only</i> near the $\theta_i \approx 170^\circ$ hilltop where the relic is exponentially sensitive — so the axion DM branch stays a [C] scenario. The harmonic misalignment under-produces at this f_a (prefactor $\sim 0.026/\theta^2$, $\theta \sim O(1)$ gives $\sim 21\%$ of Ω_{DM} , need $\theta_{\text{eff}}^2 \sim 4.7$), so the hilltop anharmonic enhancement is required; near the hilltop it is exponentially sensitive, hence a scenario not a sharp prediction. $F_{\text{relic}}(f_a, \theta_i, N_{\text{DW}}) = ? \Omega_{\text{DM}}$ is a kill test for the <i>branch</i> , not the theory (no free singlet WIMP: $128 = (16, 4) + (16, 4)$) [C][O]
v187_ftransfer_laws.py	The F_{transfer} discipline guard (CI-style firewall): the four continuous-transfer frontier observables — Koide, η_B , the axion relic, $m_p/m_e + \Lambda_{\text{QCD}}$ — must <i>never</i> be typed as primitive [E] compiler predictions; each carries a [C]/[O] marker. The guard reads <code>status_ledger.csv</code> and enforces it (exact algebraic sub-parts — Koide 53/54 v183, $b_3 = -7$ v159 — may be [E], the physical prediction never is). Records the four interfaces $F_{\text{pole}}/F_{\text{Boltzmann}}/F_{\text{relic}}/F_{\text{QCD}}$ and that the raster rule + frozen registry + null model bind, so no future edit can quietly promote a pretty frontier number to a closed compiler output [E]
v188_frontier_wording_guard.py	The frontier-wording guard (a prose sentinel, no new physics): v187 protects the ledger <i>typing</i> , this guard protects the <i>prose</i> . It forbids stale sentences whose semantics an earlier round superseded — “leptogenesis interface ([E])” (v184 retyped Route B to [C]), “closed branch also fixes the leptogenesis inputs” (M_R is the seesaw scale, not a compiler power), “relic scale f_a, m_a open” (v185: the scales define the branch, the open item is the hilltop-sensitive relic abundance), “computed $Q = 0.664 \dots$ near, not exact” (v183 gave 53/54 an exact operator origin), “Suite now 187 modules” (the count is 187, highest ID v188; v186 skipped). Scans the 10 active documents; passes when none appear, so a frozen Zenodo release can never re-introduce half-true wording [E]
v189_riemann_roch_carrier.py	The Riemann–Roch carrier reading: $(g_{\text{car}}, N_{\text{fam}}) = (5, 3)$ are the two canonical invariants of <i>one</i> object, the four-point seam divisor $D = \mu_4$ on $\mathbb{P}^1$. [E] arithmetic: $h^0(\mathbb{P}^1, \mathcal{O}(\mu_4)) = \deg + 1 = 5$ (function side) and $\text{rank } H_1(\mathbb{P}^1 \setminus \mu_4) = \deg - 1 = 3$ (cycle side, already QGEO.COHO.M.01/v177); $g_{\text{car}} = 5 = \text{rank}(D_5)$ (the carrier is the $\mathfrak{so}(10)$ half-spinor, $\text{rank } D_5 + \text{rank } A_3 = 5 + 3 = 8$, v1), $N_{\text{fam}} = 3$. [C]: reading the carrier as the meromorphic seam-mode space $H^0(\mathbb{P}^1, \mathcal{O}(\mu_4))$ (less number, more geometry) is matched by $\text{rank}(D_5) = 5$, but the physical identification is conjectural and does <i>not</i> replace the over-determined $g_{\text{car}} = 5$ (Pascal/bootstrap/Lean) — a fourth, geometric reading [E][C]
v190_nariai_entropy_bound.py	The one-line Nariai entropy bound: the Schwarzschild–de Sitter entropy ratio $S_{\text{tot}}/S_{\text{dS}} = (x^2 + 1)/\Phi_3(x)$ ($x = r_b/r_c$; $\Phi_3 = x^2 + x + 1$ the $N_{\text{fam}} = 3$ cyclotomic, already in <code>tfpt_horizon_readouts</code>) satisfies $S_{\text{tot}} \geq \frac{2}{3} S_{\text{dS}}$ with equality exactly at the Nariai merge $x = 1$, via the perfect square $3(x^2 + 1) - 2\Phi_3(x) = (x - 1)^2 \geq 0$ — a variation-free proof of the entropy floor (global minimum on $x > 0$ is $2/3 = Z_2 /N_{\text{fam}}$) [E]
v191_universal_branch_line.py	The universal branch line, honestly typed [C] — an exact affine <i>relabeling</i> , not a theorem. The map $q = \frac{7}{2} + \frac{N_{\text{fam}}^2}{2} m$ carries the SdS branch points $m = \pm 1/N_{\text{fam}}$ onto the flavor branch points $\{2, 5\} = \{ Z_2 , g_{\text{car}}\}$ ($m = 0 \rightarrow 7/2$). The arithmetic is exact, but the map exists for <i>any</i> two pairs of points (two intervals are always affinely equivalent), so the slope $N_{\text{fam}}^2/2$ and midpoint $7/2$ are <i>determined</i> by the data, not forced predictions; a decoy pair $\{3, 4\}$ admits an equally exact map (negative control). The genuine shared content — the $2/3 = Z_2 /N_{\text{fam}}$ ramification of the mass $\leftrightarrow$ transport double cover — is already established. Recorded as a [C] alignment, never promoted to [E] [C]

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Script	What it machine-checks (<i>continued</i>)
v192_qgeo_energy_clock.py	The energy-conserving-clock reformulation, honestly typed: QGEO.ENERGY.01 ($\rho^* \Lambda_\Sigma \rho = \Lambda_\Sigma$ — the carrier clock preserves the Calderón/DtN energy form) <i>relocates</i> the bedrock QGEO.SYM.01 to a more checkable operator identity, but does <i>not</i> eliminate it. The downstream chain (conformality $\rightarrow$ Möbius $\rightarrow z \mapsto iz \rightarrow \mu_4 \rightarrow$ QGEO.SYM.01) already exists (v180/v181); the new upstream link (energy invariance $\Rightarrow$ conformality in 2D) is checkable on the DtN operator $\Lambda = k $. But ‘ ρ preserves Λ ’ is plausibly equivalent to ‘ ρ is the conformal deck’, so it is a sharper restatement, not a theorem, unless ρ is independently defined and the invariance independently proven (open). Bedrock stays [O]
v193_qgeo_energy_commutator.py	QGEO.ENERGY.02: the energy- <i>commutator</i> contract (the non-circular sharpening of v192): $[\rho, \Lambda_\Sigma] = 0$ on the rank-8 Calderón polarisation, ρ the carrier clock, Λ_Σ the DtN energy form of the <i>raw</i> RP seam. Three sub-claims: (1) [E] ρ is carrier-defined (Coxeter of $W(A_3)=S_4$, order $4= \mu_4 $, v117), not imported from the seam; (2) [O] the non-circularity hinge — Λ_Σ must be the <i>raw</i> RP-seam DtN, not the μ_4 normal form; (3) [E] $[\rho, \Lambda_\Sigma]=0$ forces the (1, 2, 3) grading on H^1 (QGEO.COHO.01). Exact [E] rider: the induced $k=(\ln m)/(12\pi)$ v150 reproduces $c_3/2$ iff $\ln m=q(A_3)=\frac{3}{4}$ (FAMILY), not $q(D_5)=\frac{5}{4}$ (carrier, off by $5/3$) — gravity is family-geometry-induced. Proof target [O]; if proven, QGEO.SYM.01 becomes an energy-rigidity theorem [O]
v194_raw_seam_dtn_rp.py	QGEO.DTN.01 — subclaim 2 of v193 (“the raw RP-seam DtN is RP-definable”) tackled: a <i>reduction</i> , not a closure. (1) [E] finite core: $\rho: z \mapsto iz$ on $H^1=\langle w_1, w_2, w_3 \rangle$, $w_k=z^{k-1}dz/(z^4-1)$, acts as $\rho^* w_k=i^k w_k$ (characters $i, -1, -i$ distinct), so $[\rho, \Lambda_\Sigma]=0$ on H^1 (v177). (2) [E] hinge met: the DtN/transfer operator is RP-canonical (Osterwalder–Schrader, v54) on a quasi-free seam state (v155), so Λ_Σ is RP-definable without assuming $\mathbb{P}^1 \setminus \mu_4$. (3) [O] residual relocates: full- L^2 commutation $\Leftrightarrow$ Bisognano–Wichmann geometric modular flow of the quasi-free seam state (must be intrinsic, else re-circulates). QGEO.SYM.01 reduces from a definitional postulate to intrinsic BW modular covariance — sharper, still [O], not closed [O]
v195_marks_lefschetz_character.py	QGEO.MARKS.02 — a Lefschetz/character derivation of the four seam marks (review path 2): instead of positing D_4 marks, they are <i>forced</i> to be a free μ_4 orbit. [E]: $\rho: z \mapsto iz$ (order 4) fixes only $\{0, \infty\}$; $H^1=\chi_1+\chi_2+\chi_3$ (the A_3 exponents (1, 2, 3), v177) has no trivial character $\Rightarrow$ no puncture at a fixed point; rank $H_1=n-1=3 \Rightarrow n=4 \Rightarrow$ exactly one free orbit $\Rightarrow$ marks $=\mu_4$ (cross-ratio 2); $\text{Tr}(\rho H^1)=i+i^2+i^3=-1$, $L(\rho)=1+1=2=\#\text{fixed}$. [O] residual relocates from “the seam is $\mathbb{P} \setminus \mu_4$ (geometric)” to “ H^1 carries the A_3 -exponent rep” — less circular [E][O]
v196_seam_energy_functional.py	QGEO.VARI.01 — the E_{fail} variational functional (review path 1), a numerically-testable sharpening of the v194/ENERGY.02 target: $E_{\text{fail}} = \ [\rho, \Lambda_\Sigma]\ _{HS}^2 + \ \rho^4 - 1\ ^2 + \ \Theta \rho \Theta - \rho^{-1}\ ^2$, with $E_{\text{fail}}=0 \Leftrightarrow$ the QGEO.SYM.01 conditions. [E] on the finite H^1 block ($\rho=\text{diag}(i, -1, -i)$, Λ diagonal, $\Theta=\text{conj}$) all three vanish $\Rightarrow E_{\text{fail}}=0$; [E] a μ_4 -breaking Λ or non-order-4 ρ gives $E_{\text{fail}}>0$ (μ_4 a true minimiser); [E] the zero locus is the seam-deck conditions; [O] the full-operator minimisation is the v194 Bisognano–Wichmann residual — a discretisable handle on the open bedrock, a target not a closure [E][O]
v197_rr_carrier_clifford_d5.py	ARCH.RRCAR.02 — hardening the Riemann–Roch carrier from g_{car} to D_5 itself (review point 7): the 5-dim carrier mode space $C_{\text{car}}:=H^0(\mathbb{P}^1, \mathcal{O}(\mu_4))$ generates the $\mathfrak{so}(10)=D_5$ half-spinor by its even Clifford algebra. [E] $\dim \Lambda^{\text{even}}(\mathbb{C}^5)=\binom{5}{0}+\binom{5}{2}+\binom{5}{4}=1+10+5=16=2^{g_{\text{car}}-1}=\dim S^+$; the $\mathfrak{so}(10)=D_5$ half-spinor $2^4=16=S^+=\Lambda^{\text{even}}(C_{\text{car}})$; closes the chain $\mu_4 \rightarrow g_{\text{car}} \rightarrow D_5$ from one four-point divisor (cycle side rank $H_1=3=N_{\text{fam}}(A_3)$; function side $h^0=5=g_{\text{car}}$; Clifford spinor $16=D_5$ half-spinor = carrier). [C] “carrier = Clifford spinor of the seam mode space” stays physical (as v189), does not change the over-determined $g_{\text{car}}=5$ [E][C]

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Script	What it machine-checks (<i>continued</i>)
v198_modular_commutator_reduction.py	QGE0.MODULAR.01 — cracking the bedrock to a state-invariance. The v194 residual ($[\rho, \Lambda_\Sigma]=0$ on full L^2 , framed as Bisognano–Wichmann with a circularity worry) is (a) made <i>exact</i> at the principal-symbol level and (b) reduced via Tomita–Takesaki to a clean state-invariance. [E] the DtN principal symbol $ k =\sqrt{-d^2}$ is $\text{diag}(n)$ and the clock $\rho:z\mapsto iz$ is $\text{diag}(i^n)$ in the Fourier basis — both diagonal $\Rightarrow [\rho, k]=0$ exactly on <i>all</i> of L^2 ; [E] Tomita–Takesaki: $[\rho, \Lambda_\Sigma]=0$ follows from $\omega\circ\rho=\omega$ (the modular Δ is intrinsic to (M, Ω) ; a state-preserving symmetry commutes with it), needing <i>no</i> conformal covariance — removes the BW circularity; [E] the finite H^1 block is already μ_4 -invariant (v177). [O] residual: the full raw seam state is μ_4 -invariant ($\omega\circ\rho=\omega$) $\Leftarrow$ the Gaussian bulk measure is deck-invariant = operational QGE0.SYM.01. Sharpest non-circular form; not a closure (a foundational symmetry cannot be derived from nothing) [E][O]
v199_seam_state_invariance.py	QGE0.STATE.01 (work package A) — attacking $\omega\circ\rho=\omega$ directly on the raw seam: a further localising reduction, not a closure. [E] setup non-circular (ρ = Coxeter of $W(A_3)=S_4$, $\rho^4=1$, an automorphism of the raw CAR algebra; both carrier-side, no seam geometry); [E] ground-state reduction $\omega\circ\rho=\omega \Leftrightarrow [\rho, H_1]=0$ ($C_\Sigma=\frac{1}{2}(1+\text{sgn } H_1)$); [E] character criterion: $[\rho, H_1]=0 \Leftrightarrow H_1$ block-diagonal in the four μ_4 -character classes $\{n=r \bmod 4\}$; principal symbol $ k =\text{diag}(n)$ passes automatically. [O] residual: the bounded sub-principal symbol has <i>no</i> off-character matrix elements — non-circular, sharply typed, holds on H^1 (v177); not a closure [E][O]
v200_seam_variational_scan.py	QGE0.VARI.02 (work package B) — the discretised variational test: v196 had $E_{\text{fail}}=0$ at the μ_4 config on the fixed block; here the clock angle is free and E_{fail} is minimised over it. [C] scanning $E_{\text{fail}}(\theta)=\ \rho(\theta)^4-1\ ^2+\text{faithfulness}$ over $\theta\in(0, \pi)$ gives the unique minimum at $\theta=\pi/2$ ($E_{\text{fail}}=0$: order-4 and three distinct characters $i, -1, -i$ = the $(1, 2, 3)$ grading); decoys $(0, \pi, \pi/3, 2\pi/3)$ all lose. So $\arg \min E_{\text{fail}}$ = the μ_4 normal form. [E] consistent with v196/v199/v198. [O] a numerical sign on the finite H^1 grading, not the full operator-valued minimisation (the v199 residual) [C][O]
v201_seam_subprincipal_marks.py	QGE0.SUBPRIN.01 — the v199 bedrock residual reduced one genuine step further: block-diagonality of the sub-principal symbol is <i>not</i> an independent postulate. [E] the seam DtN is $\Lambda= k +M_f$, M_f = multiplication by a curvature function $f(\theta)$ (standard Steklov sub-principal), so $\langle n M_f n'\rangle=f_{n-n'}$. [E] M_f is μ_4 -character-block-diagonal $\Leftrightarrow f$ has Fourier support only on modes $\equiv 0 \pmod{4}$ $\Leftrightarrow f$ is $\mathbb{Z}_4$ -invariant ($ k $ already commutes, v198). [E] a μ_4 -mark sum $f(\theta)=\sum_{j=0}^3 g(\theta-2\pi j/4)$ has $f_m=4g_m[m\equiv 0 \bmod 4]$ for <i>any</i> profile g — automatically $\mathbb{Z}_4$ -invariant, so (v195 marks= μ_4 orbit) <i>forces</i> the sub-principal symbol block-diagonal; negative controls: 3 marks ($\mathbb{Z}_3$) and 4 generic marks break it. [O] new residual: $\omega\circ\rho=\omega$ reduces to ‘the DtN sub-principal symbol is mark-local (seam flat away from the μ_4 marks = conformal deck v177)’, the narrowest, structurally-definitional form of QGE0.SYM.01 [E][O]

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Script	What it machine-checks (<i>continued</i>)
v202_rare_kaon.py	The rare kaon sector $K \rightarrow \pi \nu \bar{\nu}$ from the TFPT CKM point ([C] downstream flavor readout, <i>not</i> a compiler power). The kernel fixes the full CKM matrix ($s_{12}=\lambda_C$, $s_{23}=\varphi_0/(1+\lambda_C)= V_{cb}$, $s_{13}=\lambda_C^3/3$, $\delta=\pi/3+3\lambda_C^2=1.19823$ rad; v18/v88) with no flavor fit; feeding the exact point into the standard Brod–Gorbahn–Stamou short-distance formulas gives $\text{BR}(K^+ \rightarrow \pi^+ \nu \bar{\nu})=9.45 \times 10^{-11}$ and $\text{BR}(K_L \rightarrow \pi^0 \nu \bar{\nu})=3.33 \times 10^{-11}$. [E] CKM point + exact apex $(\bar{\rho}, \bar{\eta})=(0.1374, 0.3509)$, $\lambda_t=V_{ts}^* V_{td}$; [C] the branching ratios (<i>not</i> parameter-free — $X_t, P_c, \kappa_{\pm}$ are external EW/QCD input); [E] $\text{BR}(K^+) \text{BR}(K^+)=9.45 \times 10^{-11}$ lands ON the NA62 2016-2024 combination $(9.6^{+1.9}_{-1.8}) \times 10^{-11}$ (La Thuile 2026), $+0.08\sigma$ (the 2016-2022 obs $(13.0^{+3.3}_{-3.0}) \times 10^{-11}$ was $\sim 1.2\sigma$ above) — a strong consistency hit, but an F_{transfer} bridge, not a unique TFPT-vs-SM discriminator (SM $(8.6 \pm 0.4) \times 10^{-11}$ also inside the NA62 error); [E] Grossman–Nir ratio $0.352 \ll 4.3$; [X] dated kill test: a stable NA62 $\text{BR}(K^+)$ outside $[7, 12] \times 10^{-11}$, or a KOTO-II $\text{BR}(K_L)$ off the GN point, breaks the flavor bridge (core untouched) [C][X]
v203_eht_achromatic.py	The EHT achromatic polarization-rotation intercept β_{BH} around a horizon-scale black hole — the surviving core of the old UFE/BH notes (<i>not</i> the RN-type metric, superseded by Nariai/seam=horizon v101–v104/v190; only the polarization signature). [E] the coupling is a compiler number: $\beta_{\text{BH}}(r)=Q_e^{\text{eff}} Q_m^{\text{eff}}/(256\pi^4 r^2)=16c_3^4(Q_e Q_m/r^2)$, $16c_3^4=1/(256\pi^4)$ exactly. [E] α-kernel cross-link: $16c_3^4=\delta_{\text{top}}/3$, $\delta_{\text{top}}=48c_3^4=3/(256\pi^4)$ — the <i>same</i> top-form coefficient that fixes the α-kernel precision-zone correction (one row from $\beta_{\text{rad}}=\varphi_0/4\pi$). [C] TFPT fixes the $1/r^2$ profile, achromaticity, and sign-flip under $E \cdot B$ reversal; the amplitude $Q_e Q_m$ is an MHD/GR weight, not a compiler output. [X] dated kill test: the residual intercept must pass three nulls (frequency/achromatic, spatial $1/r^2$, sign-flip); a null-consistent residual after honest GRMHD subtraction falsifies the channel (core untouched) [E][C][X]
v204_muon_seam_g2.py	The muon anomalous magnetic moment $a_\mu=(g_\mu-2)/2$ as a seam vertex readout ([C] downstream, <i>not</i> a compiler power; archive integration of the old muon-$g-2$ note). The carrier fixes the second-order defect $\delta_2=B\gamma \delta_{\text{top}}^2=\frac{5}{4}\delta_{\text{top}}^2$ ($\delta_{\text{top}}=\Omega_{\text{adm}}c_3^4=48c_3^4=3/256\pi^4$, $\sqrt{2}/\sqrt{23}$; $B\gamma=\frac{3}{2}\cdot\frac{5}{6}=\frac{5}{4}$, v51); the seam-loop projection $a_\mu^{\text{seam}}=\delta_2/(2\pi)=45/(524288\pi^9) \approx 2.879 \times 10^{-9}$. [E] the value is an exact compiler number ($\delta_2=4! \text{Tr}_{S^+}(X^2)c_3^8$, $\text{Tr}=120=5!$); [C] the identification of $\delta_2/(2\pi)$ as a magnetic vertex ($1/2\pi=4c_3$) is a physical bridge; [E] 0.81σ vs dispersive $\Delta a_\mu=(2.49 \pm 0.48) \times 10^{-9}$; [C] HONEST: lattice/CMD-3 HVP shrinks it ($\sim 1.5 \times 10^{-9}$), the fixed value then $\sim 1.5\sigma$ high; [X] dated kill test: a converged Δa_μ outside $2.879 \times 10^{-9} \pm 0.5 \times 10^{-9}$ excludes the mechanism [E][C][X]
v205_xi_threequarter.py	$\xi=c_3/\varphi_{\text{tree}}=3/4$: an <i>independent</i> route to the gravitational $3/4$ (archive integration of the old Eliminating-K note). The torsion-compression ansatz $\kappa^2=\xi\varphi_0/c_3^2$ with the Einstein limit $\kappa^2=8\pi G$ fixes $\xi=8\pi c_3^2/\varphi_0=c_3/\varphi_0$ (since $8\pi c_3^2=c_3$), and at tree level $\varphi_{\text{tree}}=1/(6\pi)$ this is exactly $3/4$. [E] tree identity $\xi=c_3/\varphi_{\text{tree}}=3/4$; [E] Einstein-limit reduction $8\pi c_3^2=c_3 \Rightarrow G$ is an output; [E] over-determination $3/4=q(A_3)=N_{\text{fam}}/ \mu_4 =\ln(m/\mu)$ (v152 $k=c_3/2$) — the torsion-compression ξ and the gapped EH replica are two independent appearances of the same gravitational $3/4$; [E] with the retained seed $\xi=c_3/\varphi_0=0.748303$ (-0.226%); [C] the $\kappa^2=\xi\varphi_0/c_3^2$ ansatz is the bridge, the modern derivation is v152/v68, $1/G$ stays the one anchor (v60/v153) [E][C]

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Script	What it machine-checks (<i>continued</i>)
v206_h0_lambda_branch.py	The cosmological-constant Letter branch: the seam number $\delta_\Sigma = m_1 e^{-2\pi\alpha^{-1}/3}$ with the lowest block $m_1 = \Omega_{\text{adm}} = 48$, the Planck-convention split, and the quantitative $H_0 = 66.5\text{--}67.1$ (archive integration of the tfpt-31 CC note; sharpens the qualitative H_0 -vs- Λ row). [E] $\delta_\Sigma^{\text{lead}} = 48 e^{-2\pi \cdot 137.036/3} \approx 1.085 \times 10^{-123}$; [E] convention split $M_{\text{Pl}}^4/\bar{M}_{\text{Pl}}^4 = (8\pi)^2 = 631.65$ (unreduced vs reduced — must be displayed); [E] $\rho_\Lambda = M_{\text{Pl}}^4 \delta_\Sigma \approx 2.4 \times 10^{-47} \text{ GeV}^4$ (observed vacuum order); [E] 123-orders cross-link $ \log_{10} \delta_\Sigma \approx 122.96$, consistent with the v60 split 122.948; [C] under flatness closure $H_0^{\text{lead}} = 66.51$, $H_0^{\text{disc}} = 67.10$ — $1.6\text{--}0.5\sigma$ below Planck, $\sim 6\sigma$ below SH0ES: the Hubble tension is <i>not</i> relieved by raising the vacuum scale; H_0 uses imported $\Omega_b, \omega_{\text{DM}}$, a [C] readout [E][C]
v207_asymptotic_safety.py	Asymptotic Safety as a <i>second</i> , independent, [O] route to the metric sector (archive integration of the old Five-Problems note). The current theory closes QG via the discrete seam-net/AQFT programme (v175; open premise QGEO.REALIZE.01); this records a complementary continuum-FRG argument that a non-Gaussian UV fixed point exists from the same axioms — a plausibility cross-check, <i>not</i> load-bearing, does <i>not</i> close G_{metric} . [E] the axion coupling is fixed and small $y^2 = 16c_3^2 = 1/(4\pi^2) = 0.025330$ exactly ($g_{a\gamma\gamma} = -4c_3$ from the cubic); [E] existence by IVT: $\partial_t g/g = 2 + \eta_R$ is $+2 > 0$ as $g \rightarrow 0$ and < 0 at large g (torsion K^2 damping) $\Rightarrow$ a root $g_* > 0$; [E] $g_* = 2/a_1 > 0$ finite, Reuter-type $O(1)$, no new free input; [O] HONEST: a continuum-FRG ansatz the discrete-compiler theory did <i>not</i> adopt, primary stays the seam-net (v175) [E][O]
v208_bh_thermodynamics.py	Black-hole thermodynamics from the seam: the modular Hawking temperature and the scalaron-corrected Wald entropy (archive integration of the dropped tfpt-42 stationary-horizons section, re-typed through the current Tomita–Takesaki seam work v198/v199). [E] modular T_H : $\Delta^{it} = e^{-2\pi t K_H}$ (Bisognano–Wichmann) $\Rightarrow$ KMS at $\beta = 2\pi$ and $T_H = \kappa/(2\pi)$; the 2π is the seam unit $1/(4c_3)$ ($1/2\pi = 4c_3$, v58), reproducing $T_H = c_3/M$ (v57); seam $\leftrightarrow$ horizon identification [C]; [E] Wald entropy: with the induced $f(R) = R + R^2/(6M_s^2)$ ($M_s = c_3^{7/2} \bar{M}_{\text{Pl}}$, v28), $S_W = (f_R A)/(4G) = (A/4G)(1 + R_h/3M_s^2)$ — leading $A/4G$ is the c_3 area law ($1/4 = 1/ \mu_4 $), the correction an exact scalaron consequence; [E] SdS $T_H = (1/4\pi r_h)(1 - \Lambda r_h^2)$, $1/4\pi = 2c_3$; [E] area law $S_{BH} = M^2/(2c_3) = 4\pi M^2 = A/4G$ [E][C]
v209_bh_regular_core.py	The black hole as a seam fixed point (topological defect), <i>not</i> a singularity: the honest [O] synthesis of the old Five-Problems BH picture, with the superseded torsion/RN-vortex metric dropped (RN-type metric superseded by Nariai/seam=horizon v101–v104/v190; cf. v203). Built entirely from established suite atoms. [E] no singularity = seam fixed point: the gapped attractor multiplier $\lambda_2 = (2/3)^6 = 64/729$ with gap $\Delta = 6 \log(3/2) > 0$ (v56) — the core is a fixed point, $\rho \rightarrow \infty$ replaced by $\varphi \rightarrow \varphi_*$ [C]; [E] maximal BH = anchor: Nariai cubic $t^3 - 3t + 2 = (t-1)^2(t+2)$, roots $(1, 1, -2)$ = the traceless projection of $a = (1, 1, 2)$ (v101/v190); [E] information stays in the boundary field: Page recovery decays at $\lambda_2 = (2/3)^6$ per step (v54) [C]; [E] holographic remnant $S_{BH} = A/4G$, $1/4 = 1/ \mu_4 $ [C]; [O] HONEST: a qualitative structural synthesis (reuses v54/v56/v57/v101/v190), <i>not</i> load-bearing, <i>not</i> a metric [E][O]

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Script	What it machine-checks (<i>continued</i>)
v210_mark_local_dtn.py	A numerical <i>sharpening</i> of v201/QGEO.SUBPRIN.01 on <i>realistic</i> Steklov curvature profiles, carried to the quasi-free <i>state</i> level (the actual $\omega \circ \rho = \omega$, not just $[\rho, \Lambda] = 0$); <i>not</i> a closure of QGEO.SYM.01. A real von-Mises bump $g(\theta)$ at a puncture, summed over the four μ_4 marks $f(\theta) = \sum_{j=0}^3 g(\theta - j\pi/2)$, builds the Steklov DtN $\Lambda = D_\theta + M_f$. [E] every off-(mod 4) Fourier coefficient of the real f vanishes to $< 10^{-16}$ (exact 4-fold cancellation), although g has all modes. [C] $\ [\rho, \Lambda]\ < 10^{-15}$. [C] <i>state invariance</i> (new vs v201): the quasi-free covariance $C = \frac{1}{2}(1 + \text{sgn } H_1)$ satisfies $\rho C \rho^\dagger = C$ to $< 10^{-13}$ — the state, not just the operator, is clock-invariant. [C] negative controls (single off-centre bump, $\mathbb{Z}_3$ source, 4 generic marks) break both by $O(1)$; convergence stable for $N \in \{16, 32, 64\}$. [O] certifies ‘mark-local DtN $\Rightarrow \omega \circ \rho = \omega$ ’ for concrete profiles <i>and</i> at the state level; the premise that the physical seam <i>is</i> mark-local stays [O] — the narrowest definitional form of QGEO.SYM.01, not its closure [C][O]
v211_axion_spine_angle.py	Axion DM, the spine-angle branch $\theta_i = \pi N_{\text{fam}}/g_{\text{car}} = 3\pi/5$ (108°): an alternative, more robust misalignment angle than the determinant-line hilltop $\theta_i \approx 170^\circ$ (v185, which over-produces $\Omega_a h^2 \approx 0.66$). [E] rational motive $\theta_i = 3\pi/5$ exactly (spine quotient $3/5$, no fit); [E] the v185 finite-T solver ($\theta=1 \rightarrow 0.03$) reaches Ω_{DM} at $\theta \approx 106^\circ$, so 108° is on target (harmonic $0.03\theta^2 = 0.107$); [C] <i>robust</i> : 108° is 62° below the 170° hilltop (mild-anharmonic, not exponentially sensitive); [O] an alternative ansatz to $\theta_i = \pi(1 - \varphi_{\text{seam}}) \approx 170^\circ$ (mutually exclusive, the full solver decides, DM.AXION.SPINE.01); [X] kill test: $\Omega_a h^2$ outside $\sim [0.08, 0.16]$ demotes the branch [E][C][O][X]
v212_leptogenesis_decouple.py	Leptogenesis, the scalaron-decouple branch: both Boltzmann inputs share the decouple $A_\Lambda = 10 = E(K_5) $ — $M_1 = M_{\text{scal}} \varphi_0^2 / A_\Lambda \approx 8.65 \times 10^9$ GeV and $\tilde{m}_1 = m_3 / A_\Lambda \approx 5$ meV. A cleaner [C] route than v184’s $M_1 = M_R \varphi_0^4$ (which only relocated the free input to the un-pinned seesaw M_R). [E] shared decouple $A_\Lambda = 10$; [E] $M_1 = 8.65 \times 10^9$ GeV inside the thermal window $[3 \times 10^9, 3 \times 10^{10}]$ (v169); [E] $\tilde{m}_1 \approx 5$ meV, $K \approx 4.6$ strong washout; [E] Davidson–Ibarra $\varepsilon_1 \approx 8.5 \times 10^{-7}$, $\eta_B \approx 1.2 \times 10^{-9}$ brackets observed 6.1×10^{-10} ; [C] HONEST: M_1 uses only $\{M_{\text{scal}}, \varphi_0, A_\Lambda\}$ but the coupling mechanism is posited not derived; [X] kill test falls the route, not the theory (FR.ETAB.01 independent) [E][C][X]
v213_ftransfer_functor.py	The F_transfer <i>functor contract</i> (CONTRACT.F.01): the four frontier transfers are ONE typed functor $F_{\text{transfer}} = F_{\text{observable}} \circ F_{\text{threshold}} \circ F_{\text{RG}}$ with four structural axioms, each instance a discrete compiler kernel [E] composed with an external continuous solver [C]; consolidates v183 (F_{pole}), v212 ($F_{\text{Boltzmann}}$), v211 (F_{relic}), v164/FR.MPME (F_{QCD}), the structural complement of the v187 typing guard. [E] axiom 1 μ_4 -deck equivariance ($\lambda_2 = (2/3)^6 = 64/729$ the deck transfer eigenvalue); [E] axiom 2 Plücker preservation ($53 = a^T(R+Q)\mathbf{1}$, $\text{Pl}(F) = (1, 22, 30)$, $\ \text{Pl}(K)\ _1 = 11$); [E] axiom 3 positivity/stochasticity ($\text{spec } T = \{1, (2/3)^6, (1/3)^6\}$ positive, $\kappa_f \in (0, 1)$); [E] axiom 4 external modules explicit ($b_3 = -7$ a carrier output, $ b_3 = \Omega_{\text{adm}} - 10b_1 = 7$); [C] verdict: a typed functor, not a bag of open topics; an architectural consolidation guarded by v187, not a closure [E][C]

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Script	What it machine-checks (<i>continued</i>)
v214_seam_pillowcase.py	The <i>pillowcase</i> reduction of QGEO.SYM.01 (QGEO.PILLOW.01): the two separately-tracked open QGEO residuals — v180/QGEO.ISO.01 (the carrier clock is an order-4 isometry of the seam metric) and v201/QGEO.SUBPRIN.01 (the DtN sub-principal symbol is mark-local, the seam flat away from the μ_4 marks) — are ONE statement, ‘the seam carries the uniformising flat orbifold (pillowcase) metric’, and the order-4 clock is <i>derived</i> from cross-ratio 2 (v168), not assumed. [E] $\chi_{\text{orb}}(S^2(2, 2, 2, 2)) = 2 - 4(1 - \frac{1}{2}) = 0 \Rightarrow \text{flat}$ (Trojanov cone-metric uniformisation, unique up to scale; Gauss–Bonnet four deficits π sum to $4\pi = 2\pi\chi(S^2) \Rightarrow \int K_{\text{smooth}} = 0$, flat away from the marks). [E] NEW LINK: cross-ratio(μ_4)=2 (v168) $\Rightarrow j(\lambda) = 256(\lambda^2 - \lambda + 1)^3 / (\lambda^2(\lambda - 1)^2)$ with $j(2) = 1728$ (all six harmonic cross-ratios $\{2, -1, \frac{1}{2}\}$ give 1728) $\Rightarrow$ the square modulus, hence the order-4 clock, is a <i>consequence</i> of cross-ratio 2. [E] $j = 1728 \Leftrightarrow \tau = i$ (square torus) $\Leftrightarrow \text{CM by } \mathbb{Z}[i] \Leftrightarrow \text{Aut} = \mathbb{Z}/4$ ($j=0$ gives $\mathbb{Z}/6$; generic $\mathbb{Z}/2$). [E] explicit CM $(x, y) \mapsto (-x, iy)$ on $y^2 = x^3 - x$ has order $4 = z \mapsto iz$. [E] negative control $\lambda = 3 \Rightarrow j = 21952/9 \notin \{0, 1728\} \Rightarrow \text{Aut} = \mathbb{Z}/2$, no clock. [E] UNIFICATION: ‘seam = uniformising flat pillowcase metric’ implies both v201 mark-locality and v180 QGEO.ISO.01. [O] does <i>not</i> close QGEO.SYM.01 — the canonical constant-curvature-metric premise stays open, milder/more canonical; net existence + full-cone RP remain v175’s [E]
v215_seam_deck_killtest.py	The bedrock QGEO.SYM.01 ($\omega \circ \rho = \omega$) recast as a <i>falsifiable</i> kill-test (QGEO.KILL.01), not a proof-promise — a foundational symmetry cannot be derived from nothing (v181/v153), and Bisognano–Wichmann would presuppose the covariance it should produce. Non-circular reduction (v198/v199/v201): $\omega \circ \rho = \omega \Leftrightarrow [\rho, C] = 0$; the principal symbol k commutes exactly, so the residual is the sub-principal M_f with $[\rho, M_f] = 0 \Leftrightarrow f$ $\mathbb{Z}_4$-invariant; measure form = the raw Gaussian bulk form A is μ_4-deck-invariant. Four levers (carrier-side [E], seam-side [O]): K1 exactly 4 marks (order-4 clock free orbit $\mu_4 + b_1 = \# \text{marks} - 1 = 3 = N_{\text{fam}} \Rightarrow \# \text{marks} = 4 = \mu_4$); K2 square config (cross-ratio $2 \Rightarrow j = 1728$, $\text{Aut} = \mathbb{Z}/4$; order 4 selects $\mathbb{Z}/4$ not the $j=0$ $\mathbb{Z}/6$; generic $\Rightarrow \mathbb{Z}/2$); K3 mod-4 sub-principal support (μ_4-mark sum $\Rightarrow f_m = 0$ for $m \not\equiv 0 \pmod{4} \Rightarrow [\rho, M_f] = 0$); K4 transfer gap $(2/3)^6 = 64/729$ (cusp weights $\{0, \frac{1}{3}, \frac{2}{3}\}$). Freeze-bound (freeze_file.csv seam_deck_symmetry). [O] the decisive kill is <i>deferred</i> (QGEO.REALIZE.01): the raw $\mathbb{P} \setminus \mu_4$ collar DtN must yield 4 square marks <i>without</i> inputting them; carrier-side K1–K4 are green regression guards. A kill-test, not a closure
v216_marks_gauss_bonnet.py	The four seam marks <i>emerge</i> from Gauss–Bonnet (QGEO.MARKS.03), executing the K1 lever of the v215 kill-test. [E] mark count = 2χ: $\mathbb{Z}_2$ branch points (deficit π) on a flat sphere ($\chi=2$) give $n\pi = 2\pi\chi = 4\pi \Rightarrow n = 2\chi = 4 = \mu_4 = e_1(a) = N_{\text{fam}} + 1$ (the same $\chi=2$ as the 8 in $c_3 = 1/(8\pi)$). [E] the Euclidean sphere 2-orbifolds ($\chi_{\text{orb}}=0$) are exactly $(2, 3, 6), (2, 4, 4), (3, 3, 3), (2, 2, 2, 2)$. [E] all-order-2 (the $\mathbb{Z}_2$ sheet branch) $\Rightarrow$ uniquely $(2, 2, 2, 2)$; [E] $N_{\text{fam}} = 3$ (rank $H^1 = \# \text{marks} - 1$) $\Rightarrow$ uniquely $(2, 2, 2, 2)$, picking the 4-mark square over the 3-mark hexagonal $(3, 3, 3)$; [E] a free order-4 deck $\Rightarrow$ uniquely $(2, 2, 2, 2)$ — three independent selectors converge. [O] residual: the square modulus (cross-ratio $2 \Rightarrow j = 1728$, v214) needs the one order-4 carrier input. The mark count + equality are now derived; does <i>not</i> close QGEO.REALIZE.01

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Script	What it machine-checks (<i>continued</i>)
v217_marks_emergence_scan.py	The <i>numerical</i> emergence scan (QGEO.EMERGE.01, the sibling of v216 as v210 is to v201): with the number of marks n and their positions free, the 4-equally-spaced (square) configuration is the joint minimiser of {clock-invariance + 3-family cohomology + transfer gap $(2/3)^6$ } on the actual seam DtN/state. [C] $n=4$ equally-spaced $\Rightarrow \ \rho_4 C \rho_4^\dagger - C\ \sim 10^{-14}$ (clock-invariant state); [C] family count selects $n=4$ (scan $n \in \{2..8\}$, only $n-1=3=N_{\text{fam}}$; $n=3 \rightarrow 2$ families = hexagonal, excluded; $n=5 \rightarrow 4$); [C] gap: μ_4 -equivariant $\Rightarrow$ diagonal in the cusp basis (deck-average off-diagonal $\sim 10^{-16}$), cusp weights $\{0, \frac{1}{3}, \frac{2}{3}\} \Rightarrow$ transfer $(1-w)^6 = \{1, (2/3)^6, (1/3)^6\}$, gap $(2/3)^6 = 64/729$; [C] position scan: the square minimises the defect (square $\sim 10^{-14}$ vs off-square ~ 0.4); [C] negative controls $n=3, 5, 6$. [O] confirms the emergence on the real DtN (number scanned, positions free); selector = the 3-family/gap structure (carrier input); executes K1 numerically, does <i>not</i> close QGEO.REALIZE.01. Python-only
v218_diamond_axis_geometry.py	Diamond axis geometry: the Sheet Diamond (v94) is a discrete geometry with two axes around the centered cross (v95: C center, U winding, V sheet), F the transfer completion. Three exact [E] lemmas + honest audit/heuristic typing, no new numbers. [E] AXIS CURVATURE: $\det(C+xU)=14+6x$ linear (slope $6= R^+(A_3) $), $\det(C+yV)=14+14y+4y^2$ quadratic, 2nd difference $8=\text{rank } E_8$; $\det B(C+xU)=2 \det(C+xU)$, anchor-block sheet curvature $6= R^+(A_3) $. [E] PLÜCKER LADDER: $\text{Pl}(K)=(-1, 6, 4) \rightarrow \text{Pl}(C)=(0, 14, 14) \rightarrow \text{Pl}(F)=(1, 22, 30)$, steps $(1, 8, 10)=(N_\Phi, \text{rank } E_8, A_\Lambda)$ and $(1, 8, 16)=(N_\Phi, \text{rank } E_8, \dim S^+)$ (identity [E], transfer reading [C]). [E] SPECTRAL RAMIFICATION: $\text{Disc}(\chi)=q(r)^2 \text{Disc}(q)$ for Q, K, C, F ; squares $(1, 3, 4, 6)$, kernels $(13, 48, 65, 105)$ with $48=\Omega_{\text{adm}}$, $105=N_{\text{fam}}g_{\text{car}} \cdot 7$. [C] heuristic: F the transfer-completion corner, a search principle, not a hard filter; the G_2/F_4 pair-sum labels stay audit-only (cf. v94/v95) [E][C]
v219_icosahedral_mckay.py	McKay bedrock: <i>why</i> the atoms are $\{2, 3, 5\}$. E_8 is the exceptional <i>top</i> of the McKay tower of finite $SU(2)$ subgroups ($2T \rightarrow \hat{E}_6$, $2O \rightarrow \hat{E}_7$, $2I \rightarrow \hat{E}_8$). The McKay graph is built <i>from the group</i> : the 120 icosians close to the binary icosahedral $2I$ (element orders $\{1, 2, 3, 4, 5, 6, 10\}$, containing the $2, 3, 5$ axis orders), 9 conjugacy classes, Dixon irrep degrees $\{1, 2, 2, 3, 3, 4, 4, 5, 6\}$ (sum $30=h(E_8)$, sum of squares $120= R^+(E_8) $); the natural-rep McKay adjacency <i>is</i> the affine E_8 graph with Kac marks = the degrees. A backward certificate of the closed E_8 [E], the reading that it explains $(2, 3, 5)$ [C], the raw-seam origin [O]
v220_cp_hexagonal_modulus.py	CP lives in the <i>hexagonal</i> phase fiber, not the square seam deck (a geometric sharpening of red-team Target D). [E] the seam deck is the square modulus $j(i)=1728$, $\text{Aut}=\mathbb{Z}/4$ (the μ_4 clock); its exceptional partner is the hexagonal modulus $j(\rho)=0$, $\rho=e^{i\pi/3}$, $\text{Aut}=\mathbb{Z}/6$, CM by $\mathbb{Z}[\omega]$, $\arg \rho=\pi/3$. [E] the frozen leading CKM reading $\delta=\pi/3+3\lambda_C^2=68.654^\circ$ (v88) has leading term $\pi/3=\arg \rho$; the $ \mathbb{Z}_2 $ alternative $\pi/3+2\lambda_C^2$ is the frozen look-elsewhere trap. The deck stays $\mathbb{Z}/4$ (v215); CP is the $\mathbb{Z}/6$ fiber, the bridge [C][E][C]
v221_seam_qecc.py	The seam as a <i>finite recoverability</i> code (recovery rate $(2/3)^6=64/729$). [E] code dimension $\dim S^+=16=2^{g_{\text{car}}-1}$; the gapped transport T on the cusp-weight 3-space (deviations $(1, -1, 0)$ and the Nariai anchor $(1, 1, -2)$) is symmetric, doubly stochastic (CPTP), spectrum $\{1, (2/3)^6, (1/3)^6\}$; on the trace-zero subspace $\ T\delta\ \leq (2/3)^6 \ \delta\ $ hence $\ T^n \delta\ \leq (2/3)^{6n} \ \delta\ $ (a Knill–Laflamme-type bound); a free ratio breaks it. [C] the holographic/Petz reading (gated on the Seam–Horizon theorem) [E][C]
v222_cm_norm_duality.py	CM-norm duality: the two exceptional moduli give 41 and 7. [E] SQUARE (Gaussian $\mathbb{Z}[i]$, $j=1728$): $N(g_{\text{car}}+i \mu_4)=5^2+4^2=41=10b_1$ — the EM index <i>is</i> the Gaussian norm of the carrier-glue vector; $N(3+2i)=13=\Delta_Q$. [E] HEX (Eisenstein $\mathbb{Z}[\omega]$, $j=0$): $N(3+2\omega)=3^2-3\cdot 2+2^2=7=$ scalaron. The $(3, 2)=(\text{colour}, \text{weak})$ split generates $(5, 6, 7, 13)$ by sum / product / Eisenstein / Gauss norm; the rings are rigid (Eisenstein of $(5, 4)=21 \neq 41$). The architecture bridge square $\leftrightarrow$ EM, hex $\leftrightarrow$ scalaron is [C][E][C]

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Script	What it machine-checks (<i>continued</i>)
v223_coxeter_totative_clock.py	The μ_4 clock is the order-4 character of the E_8 Coxeter cycle. [E] $(\mathbb{Z}/30)^\times = \{1, 7, 11, 13, 17, 19, 23, 29\}$ = the E_8 exponents = live Coxeter phases; $\varphi(30)=8=\text{rank } E_8$, $30=2\cdot 3\cdot 5$. [E] $(\mathbb{Z}/30)^\times \cong \mathbb{Z}/4 \times \mathbb{Z}/2$ with order-4 generator 7 $(7^2=19, 7^4=1 \bmod 30)$: a literal μ_4 clock $\langle 7 \rangle = \{1, 7, 13, 19\}$ on the exponents; the conjugate pairs $m+(30-m)=30$ give $ \mu_4 =4$ invariant planes the clock permutes. Only E_8 has $\varphi(h)=\text{rank}$ and $h=2\cdot 3\cdot 5$; the seam-clock identification is [C][E][C]
v224_diamond_fttransfer_path.py	F_{transfer} as one path on the Sheet Diamond, not four external interfaces. [E] family $M(s, t) = R + Q \text{diag}(s, t, t)$: the corners $K=M(1, -1), C=M(1, 0), F=M(1, 1)$ lie on the sheet axis ($s=1$); the sheet axis is curved $\det M(1, t) = 4t^2 + 14t + 14$ (2nd diff $8=\text{rank } E_8$), the winding axis $\det M(s, 0) = 6s + 8$ flat (slope $6= R^+(A_3) $); Plücker steps $(1, 8, 10), (1, 8, 16)$. [C] F_{transfer} is the $K \rightarrow C \rightarrow F$ sheet geodesic, Koide source $\rightarrow$ pole its 1-D Möbius projection (v37/v183) [E][C]
v225_dual_normal_frame.py	The dual normal frame (d, n) : one boundary compass for flavor and horizon, with CP as orientation. [E] $d = a^\top R^{-1} = a^\top L^{-1} = (-\frac{1}{2}, -\frac{1}{2}, 1) = -\frac{1}{2}(1, 1, -2)$ (the Nariai/horizon normal; $d \cdot \mathbf{1} = 0, d \cdot a = 1$); $n = (5, -9, 6)$ with $n^\top R = (\det R, 0, 0) = (8, 0, 0)$, $n^\top L = (20, 0, 0)$ (the first-generation/torsion selector). [E] oriented volume $\det(\mathbf{1}, d, n) = 21 = N_{\text{fam}} \cdot 7$. [C] CP as orientation: $\text{Im } \det(\mathbf{1}, d, \rho n) = 21 \sin(\pi/3)$ for $\rho = e^{i\pi/3}$ — CP sits where the magnitude bijection (Target D) fails [E][C]
v227_degree_exponent_channel_split.py	$248=120+128$ as a magnitude/phase channel typing (replaces the over-strong S^- -dark-matter reading). [E] E_8 exponents sum $120= R^+(E_8) $ (<i>magnitude</i> channel); degrees $\{2, 8, 12, 14, 18, 20, 24, 30\}$ sum $128=2^{\text{rank}-1}=\text{rank} \cdot \dim S^+$ (<i>phase/glue</i> channel); $248=120+128=\text{adj}(D_8)+\text{spinor}(D_8)$; $\sum \deg - \sum \exp = \text{rank} = 8$. [C] ratios+products (Target D) live in the 120 channel, the un-covered CP phases in the 128 phase/glue channel; [O] a dark-sector reading of 128 stays Frontier [E][C][O]
v228_rr_index_gate.py	P2 as the mode space of a degree-4 seam divisor (a Riemann–Roch <i>index gate</i> ; bedrock language for P2, not a proof from nothing). [E] $\deg D = 4 = \mu_4 $ on $\mathbb{P}^1 \Rightarrow h^0(\mathcal{O}(D)) = 5 = g_{\text{car}}$ (Riemann–Roch, genus 0); $\text{rank } H_1(\mathbb{P}^1 \setminus 4) = 3 = N_{\text{fam}}$; $h^0 + \text{rank } H_1 = 8 = \text{rank } E_8$, $h^0 - \text{rank } H_1 = 2 = \mathbb{Z}_2 $; $\Lambda^{\text{even}}(\mathbb{C}^5) = 1 + 10 + 5 = 16 = \dim S^+$. The mode-space reading is [C], conditional on the raw seam producing the degree-4 divisor ([O], = QGEO.SYM.01) [E][C][O]
v229_lepton_frobenius_algebra.py	The charged leptons as an étale Frobenius algebra over the μ_6 resolvent. [E] exact coefficients $(c_e, c_\mu, c_\tau) = (\frac{16}{7}, \frac{4}{3}, \frac{7}{6})$, ring closure $c_e c_\tau = \frac{8}{3} = \mathbb{Z}_2 c_\mu$, product $\frac{32}{9} = 2g_{\text{car}} / N_{\text{fam}}^2$. [E] $A = \mathbb{Q}[t]/(m)$, $m = \prod(t-c)$: the trace-form Gram is nondegenerate ($\det = \text{disc}(m) \neq 0$, A étale) — a commutative Frobenius algebra; the C_6 shift has characteristic polynomial $t^6 - 1$ (spectrum $\mu_6 = \mu_3$ family $\times \mu_2$ sheet). [C] the PMNS extension via $\text{Aut}(A)$ and the hexagonal CM point [E][C]
v230_center_budget_norms.py	The Sheet-Diamond center budget $(7, 11, 13)$ is the three <i>local norms</i> of the theory. [E] $C = R + Q \text{diag}(1, 0, 0)$, row sums $(7, 11, 13)$: $7 = N_{\mathbb{Z}[\omega]}(3+2\omega)$ (Eisenstein/hex = scalaron), $13 = N_{\mathbb{Z}[i]}(3+2i)$ (Gauss/square = Δ_Q), $11 = \binom{4}{0} + \binom{4}{1} + \binom{4}{2} = 1+4+6$ (QBL boundary Fock count on the 4 μ_4 corners = $\dim S^+ - g_{\text{car}} = 16 - 5$). The two CM rings (v222) and the seam boundary count meet in one operator center; the reading is [C][E][C]

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Script	What it machine-checks (<i>continued</i>)
v231_cp_mu6_phases.py	Both CP phases are μ_6 powers of <i>one</i> hexagonal CM unit, split by the sheet — a structural reduction of red-team Target D (sharper than v220/v225). With $\rho=e^{i\pi/3}$ (the $j=0$ Eisenstein CM unit): [E] ρ is a primitive 6th root ($\rho^6=1$, $\rho^3=-1$ the $\mathbb{Z}_2$ sheet half-turn); [E] δ_{CKM} leading = $\arg(\rho^1)=\pi/3$ (quark), $\delta_{\text{PMNS}} = \arg(\rho^4)=4\pi/3$ (lepton, the <i>phase lattice</i>); [E] $\rho^4=-\rho \Rightarrow \delta_{\text{PMNS}}=\delta_{\text{CKM,lead}}+\pi=(\text{CM unit})\times(\mathbb{Z}_2 \text{ sheet})$ — the two CP phases are <i>one</i> hexagonal unit on the two sheets, not two independent inputs; [E] the C_6/μ_6 monodromy has charpoly t^6-1 (spectrum μ_6 carries ρ); [E] orientation $\text{Im det}(\mathbf{1}, d, \rho^1 n)=+21 \sin(\pi/3)$, $\text{Im det}(\mathbf{1}, d, \rho^4 n)=-21 \sin(\pi/3)$ (sheet-flipped Jarlskog, v225); [E] NEG μ_3 has no -1 (no sheet; $\mu_6=\mu_3$ family $\times \mu_2$ sheet). REDUCTION: 2 CP phase inputs $\rightarrow$ 1 hexagonal unit + the sheet; the physical CP derivation stays [C], the deck stays $\mathbb{Z}/4$ (v215) [E][C]
v232_e8_kleinian_seam.py	The seam as the E_8 <i>Kleinian singularity</i> — a canonical algebraic-geometric model for the open seam-realisation premise QGEO.REALIZE.01 (the du Val side of the McKay correspondence, v219). [E] the McKay graph of $2I$ is affine E_8 ; dropping the unique trivial-rep node (the single Kac mark 1) leaves the <i>finite</i> E_8 Dynkin on 8 nodes = the dual intersection graph of the eight exceptional $\mathbb{P}^1$'s of the minimal resolution of $\mathbb{C}^2/2I$ (trivalent node, arms 1, 2, 4). [E] eight exceptional $\mathbb{P}^1$'s = $\text{rank } E_8 = g_{\text{car}} + N_{\text{fam}} = \# \text{ nontrivial } 2I \text{ irreps}$ — a fourth reading of the 8 in $c_3=1/(8\pi)$. [E] the negated intersection form is the E_8 Cartan (even, $\det=1$, positive definite; each $\mathbb{P}^1$ a (-2) -curve). [E] one degree-1 irrep $\Rightarrow 2I$ perfect $\Rightarrow H_1(S^3/2I)=0$: the link is the Poincaré homology 3-sphere, $\pi_1=2I$ of order $120= R^+(E_8) $. [C] seam reading: the raw RP seam ($\mathbb{P}^1$ with marks) is canonically a du Val exceptional curve — a model for QGEO.REALIZE.01, not a P2 proof (presupposes E_8); bedrock [O][E][C][O]
v233_cp_triality_phase.py	The CP phase is the <i>universal</i> family/triality phase, only sheet-split — one step past v231 in $\mu_6=\mu_3$ (family/triality) $\times \mu_2$ (sheet). [E] $\mu_6=\mu_3 \times \mu_2$: the $\mathbb{Z}_3$ triality centre $\{1, \omega, \omega^2\}$ = the cusp weights $\{0, \frac{1}{3}, \frac{2}{3}\} \times 2\pi$, the sheet $\mu_2=\{1, -1\}$; $\rho=\omega^2 \cdot (-1)$. [E] SAME FAMILY CLASS: $\rho^4=\rho^1 \cdot \rho^3$ with $\rho^3 \in \mu_2$, so the quark (ρ^1) and lepton (ρ^4) CP phases have the <i>same</i> image in $\mu_6/\mu_2 \cong \mu_3$ and <i>opposite</i> sheet — the CP phase <i>is</i> the universal triality phase ω^2 (the $2/3$ cusp-weight $\mathbb{Z}_3$ centre), not a free power choice. [E] ω is the μ_3 factor of the order-30 $(2, 3, 5)$ Milnor/Coxeter monodromy that builds E_8 (v232). Reduces Target D from ‘one hexagonal unit + sheet’ (v231) to ‘the universal triality phase + sheet’; the physical CP derivation stays [C][E][C]
v234_seam_holomorphy_selection.py	The Seam-Holomorphy selection certificate: the entire structural residual is <i>one</i> condition with <i>three</i> equivalent faces, all forcing E_8 . The condition: <i>the seam carries no nontrivial abelian sector</i> . [E] (i) AQFT — the boundary net is holomorphic (μ -index 1); (ii) geometry — the seam link is a homology 3-sphere $\Leftrightarrow$ the binary group is perfect $\Leftrightarrow 2I$; (iii) rep theory — exactly one 1-dim irrep. [E] $\#(\text{mark-1 affine nodes}) = \Gamma^{\text{ab}} = H_1(S^3/\Gamma) = \#(1\text{-dim irreps})$: $A_n \rightarrow n+1$, $D_n \rightarrow 4$, $E_6 \rightarrow 3$, $E_7 \rightarrow 2$, $E_8 \rightarrow 1$ — only E_8 gives 1 ($2I$ the unique perfect $SU(2)$ subgroup, Poincaré the unique homology-sphere space form). [E] holomorphic $c=8=g_{\text{car}}+N_{\text{fam}} \Rightarrow$ the unique even unimodular rank-8 lattice = E_8 . [E] the three faces (v83/v154, v232, v219) are the SAME E_8 -selector, so Target A, G_{net} , the carrier P2 and the Kleinian seam are <i>one</i> gate. [O] the closing theorem (stated): RP+gap+chirality $\Rightarrow$ quasi-free bulk (v160) $\Rightarrow$ invertible bulk $\Rightarrow$ holomorphic boundary $\Rightarrow E_8$; the single residual analytic step is ‘free bulk $\Rightarrow$ holomorphic boundary’ [E][O]

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Script	What it machine-checks (<i>continued</i>)
v235_seam_chern_simons.py	The closing step in abelian Chern–Simons language: holomorphic $\Leftrightarrow \det K=1$ — a genuine reduction (not a closure) of GATE.HOLO.01 into standard anyon-condensation physics. [E] a free gapped bosonic 2+1d bulk = an even integer K -matrix with $\# \text{anyons} = \det K $, edge $c = \text{signature}(K)$, holomorphic $\Leftrightarrow \det K =1$. The TFPT extension tower (v92) is the condensation tower read by determinant: carrier $D_5 \oplus A_3$ ($\det 16$, 16 anyons) $\rightarrow SO(16)_1 = D_8$ ($\det 4$) $\rightarrow (E_8)_1$ ($\det 1$, holomorphic), all rank 8, $c = \text{sig}=8=g_{\text{car}}+N_{\text{fam}}$. [E] holomorphic $\Leftrightarrow \det 1 \Leftrightarrow E_8$ = the Kitaev E_8 quantum-Hall state. [E] condensation: a Lagrangian glue of order $\sqrt{16}= \mu_4 =4$ takes $\det 16 \rightarrow 1$ (a partial order-2 isotropic only $\rightarrow 4=D_8$). [E] NEG: D_8 is free+bosonic but has 4 anyons; an odd K is fermionic — $\det=1$ is the extra condition. [O] residual: ‘the free RP seam condenses the order- $ \mu_4 $ Lagrangian glue’ = the sheet/QGEO selection, now with holomorphy $\Leftrightarrow \det 1$ a theorem [E][O]
v236_brieskorn_capstone.py	The $(2, 3, 5)$ Brieskorn singularity $x^2+y^3+z^5$ is the <i>one</i> generator of the discrete skeleton — the capstone of the icosahedral round (v55/v219/v223/v232/v233); its exponents <i>are</i> the atoms $(\mathbb{Z}_2 , N_{\text{fam}}, g_{\text{car}})=(2, 3, 5)$. [E] Milnor number $\mu=(2-1)(3-1)(5-1)=1\cdot 2\cdot 4=8=\text{rank } E_8$ = the 8 in $c_3=1/(8\pi)$ (a fifth independent origin). [E] the Milnor monodromy eigenvalues are the eight primitive 30th roots $e^{2\pi i m/30}$, m the E_8 exponents (charpoly Φ_{30} , $\deg \varphi(30)=8=\mu$) — so it <i>is</i> the order-30 E_8 Coxeter element (v55). [E] both clocks: the monodromy group $\langle h \rangle = \mathbb{Z}/30 = \mathbb{Z}/2 \times \mathbb{Z}/3 \times \mathbb{Z}/5$ carries the μ_3 triality (CP, v233) as h^{10} ; the Galois group $(\mathbb{Z}/30)^\times = \mathbb{Z}/2 \times \mathbb{Z}/4$ carries the μ_4 clock ($\times 7$, v223). [E] Milnor lattice = E_8 , link = Poincaré sphere. [C] one singularity generates atoms + 8 + E_8 + order-30 + both clocks + seam; a unification, not a closure [E][C]
v237_seam_sre_closure.py	The closing step as a <i>physical</i> condition: no topological ground-state degeneracy $\Leftrightarrow \det K=1 \Leftrightarrow$ the seam bulk is short-range-entangled (SRE/invertible) — sharpening GATE.HOLO.02’s residual from definitional to falsifiable. [E] the K -matrix ground-state degeneracy on a genus- g surface is $ \det K ^g$ (carrier $\rightarrow 16$, $D_8 \rightarrow 4$, $E_8 \rightarrow 1$ on the torus), so ‘no degeneracy on any closed surface’ $\Leftrightarrow \det K=1$. [E] among rank-8 even positive-definite K ($c=8=g_{\text{car}}+N_{\text{fam}}$) only E_8 has $\det 1$ — the unique nontrivial bosonic SRE 2+1d phase (Kitaev E_8), edge holomorphic; D_8 /carrier are LRE. [E] a unique vacuum on the plane (RP+gap+cluster) is necessary but not sufficient (the plane cannot see $\det K$, the torus does), so the residual is ‘the seam unique-vacuum extends to the torus’ = SRE. [E] NEG: an LRE bulk (D_8) has 4-fold torus degeneracy + non-holomorphic boundary. [O] sharpened residual: ‘the free RP gapped seam is short-range-entangled (no topological order)’ = $\det K=1$ = the Kitaev E_8 phase — a yes/no statement, sharper than v235/QGEO.SYM.01; not a closure [E][O]
v238_modular_lindblad_dynamics.py	DYN.SEMIGROUP.01 — the static $\rightarrow$ dynamic flip: the seam’s modular flow (reversible) and its recovery channel as a Markov/Lindblad generator (irreversible), the dissipative gap = the OS mass gap. Companion to v196/v198 (modular) and v221/v64 (recovery), which state the structure <i>statically</i> ; this reads the same objects <i>dynamically</i> . [E] the modular flow $\sigma_t = e^{it\Lambda_\Sigma}$ is a unitary one-parameter group (Tomita–Takesaki) and the μ_4 clock is conserved $\Leftrightarrow [\rho, \Lambda_\Sigma] = 0$ (the v198 state-invariance), so the static commutator is the conservation law of modular time. [E] $L = \log T$ is a doubly-stochastic generator ($e^L = T$, $e^{L\tau} \rightarrow$ the democratic projector = the arrow of time, cf. v64). [E] keystone: the dissipative gap = $-\log((2/3)^6) = 6\log(3/2)$ = the OS mass gap Δ (v64) — the static recovery bound and the dynamical mass gap are one number, one exponentiated. [E] GKSL split (imaginary + $\text{real} \leq 0$ spectrum). [O] geometric modular flow on the full seam algebra (Connes–Rovelli thermal time = QGEO.SYM.01, v198) — a target, not a closure.

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Script	What it machine-checks (<i>continued</i>)
v239_kms_thermal_time.py	DYN.KMS.01 — KMS / thermal time: the modular flow of v238 makes the seam state a KMS (thermal) state at $\beta = 1$, and the geometric normalisation fixes the seam temperature via $2\pi = 1/(4c_3)$. [E] KMS at $\beta = 1$: $\omega(A\sigma_i(B)) = \omega(BA)$ ($\omega(X) = \text{Tr}(\rho X)$, $\rho = e^{-\Lambda_\Sigma}/Z$), so modular time (v238) is a thermal time (Connes–Rovelli); NEG $\beta \neq 1$ fails (Tomita–Takesaki pins $\beta = 1$). [E] the seam unit $\beta_{\text{phys}} = 2\pi = 1/(4c_3)$ (v58) makes the KMS temperature the horizon temperature $T_H = c_3/M$ (v57/v208). [E] one object with v238. [O] the geometric-boost identification = QGEO.SYM.01 — a target, not a closure.
v240_gns_os_reconstruction.py	DYN.GNS.01 — GNS / OS reconstruction (finite toy): the Hilbert space and a POSITIVE Hamiltonian are OUTPUTS of the seam data (M, ω) , not inputs. [E] GNS: $\langle A, B \rangle = \text{Tr}(\rho A^\dagger B)$ Hermitian positive-definite ($\rho > 0$), $\dim n^2$, identity cyclic+separating. [E] modular flow $\sigma_t(x) = \rho^{it} x \rho^{-it}$ is a state-preserving *-automorphism, generator $i[\log \rho, \cdot] = \Lambda_\Sigma$ (v238). [E] OS Hamiltonian $H_{\text{OS}} = -\log T$ (the v221 transfer) is POSITIVE — eigenvalues $\{0, 6\log(3/2), 6\log 3\} \geq 0$, gap = $6\log(3/2)$ = the v64 mass gap. [E] $H_{\text{OS}} = -L$: minus the v238 dissipative generator (recovery semigroup = Euclidean time). [O] the geometric/operator-level step = QGEO.SYM.01/BW + the standard OS theorem under RP/gap — a target, not a closure.
v241_dhr_sectors.py	DHR.SECTORS.01 — particles = DHR superselection sectors: the carrier discriminant/anyon content and the v235/v237 condensation tower as an abelian MTC. Carrier form (Lean-verified, FORM.GLUE.01): on $\mathbb{Z}_4 \times \mathbb{Z}_4$, $q(x, y) = (5x^2 + 3y^2)/8 \bmod 1$, $\theta(a) = e^{2\pi i q(a)}$. [E] 16 sectors = $\mathbb{Z}_4 \times \mathbb{Z}_4$ ($= \det K_{\text{carrier}} = \dim S^+$), fusion = abelian group law. [E] condensable $\Leftrightarrow \theta = 1 \Leftrightarrow \text{isotropic} \Leftrightarrow 5x^2 + 3y^2 \equiv 0 \bmod 8$ — the six elements $\{(0, 0), (1, 1), (1, 3), (2, 2), (3, 1), (3, 3)\}$. [E] tower = v235/v237: Lagrangian $\langle (1, 1) \rangle$ (order 4, self-dual) $\rightarrow 1$ sector = $(E_8)_1$; order-2 $\langle (2, 2) \rangle \rightarrow 4 = D_8$; carrier $16 \rightarrow D_8 \rightarrow E_8$. [E] NEG: a non-isotropic anyon $(1, 0)$ is confined. [C] sector $\leftrightarrow$ SM-multiplet map is the interpretation; the MTC is exact.
v242_spin_statistics_modular.py	DHR.MODULAR.01 — spin-statistics and the modular (S, T) data of the carrier MTC: statistics + the fusion ring recovered from modular data + the anyon central charge $c = 8$. Same MTC as v241 ($\mathbb{Z}_4 \times \mathbb{Z}_4$, $q = (5x^2 + 3y^2)/8$, $\theta = e^{2\pi i q}$). [E] spin-statistics: $T = \text{diag}(\theta_a) \rightarrow 6$ bosons ($\theta = 1$), 2 fermions ($\theta = -1$) = $\{(0, 2), (2, 0)\}$, 8 anyons. [E] modular $S_{ab} = (1/\sqrt{16})e^{-2\pi i B(a,b)}$ unitary, symmetric, $S^2 = C$ (charge conjugation), $S^4 = I$. [E] Verlinde $N_{ab}^c = \sum_x S_{ax} S_{bx} S_{cx}^* / S_{0x} = \delta(c, a+b)$ — fusion recovered from modular data. [E] Gauss–Milgram $(1/\sqrt{16}) \sum \theta_a = e^{2\pi i c/8}$ with $c = 8 = g_{\text{car}} + N_{\text{fam}}$ = the $(E_8)_1$ central charge (v156/v175). [C] the boson/fermion split is the kinematic skeleton; the sector $\leftrightarrow$ multiplet map is the interpretation.
v243_haag_ruelle_braiding.py	DHR.SMATRIX.01 — scattering: the Haag–Ruelle skeleton + the braiding S-matrix. The seam net has a mass gap (v64/v238) so Haag–Ruelle constructs asymptotic states; for the abelian anyon MTC (v241/v242) the 2-particle S-matrix is the monodromy $M(a, b) = \theta(a+b)/(\theta(a)\theta(b)) = e^{2\pi i B(a,b)}$. [E] mass gap $\Delta = 6\log(3/2) > 0 \rightarrow$ HR in/out states. [E] 2-particle S = monodromy: $ M = 1$, diagonal in conserved labels $\rightarrow$ no particle production, factorised (integrable) scattering. [E] Yang–Baxter: M is a bicharacter $\rightarrow$ multi-particle factorisation. [E] crossing+symmetry: $M(a, b) = M(b, a)$, $M(a, -b) = M(a, b)^*$. [E] holomorphic point: on the condensed $(E_8)_1$ (single sector) $M = 1$, trivial braiding ($\det 1/\text{SRE}$). [O] the 4d S-matrix / cross-sections are the open holographic uplift (Phase 3).

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Script	What it machine-checks (<i>continued</i>)
v244_spectral_action_contract.py	CONTRACT.QFT4D.01 — the 4d Lagrangian via Connes' spectral action: the honest contract for the Phase-3 gap (2d seam net $\rightarrow$ 4d physics). A single Dirac operator whose $\text{Tr } f(D/\Lambda)$ yields gravity AND matter. [E] carrier spinor = one generation: $SO(10)$ half-spinor = $\dim S^+ = 2^{g_{\text{car}}-1} = 16$ ($15 + \nu_R$), $N_{\text{fam}} = 3$. [E] SM gauge group inside the carrier: $SU(3) \times SU(2) \times U(1)$ ($\dim 12$) $\subset SU(5)$ (24) $\subset SO(10) = D_5$ (45); colour $SU(3) \subset A_3 = SU(4)$ (Pati-Salam); $\text{rank}(D_5) + \text{rank}(A_3) = 8 = \text{rank } E_8$. [E] one Dirac operator $\rightarrow$ gravity ($a_2 \sim R$, $a_4 \sim R^2$, $\sqrt{36}$) + matter ($a_4 \sim F^2$ Yang-Mills + $D\phi ^2$ Higgs, Gilkey). [X] hooks: $g_3 = g_2 = \sqrt{5/3} g_1$ + a Higgs-quartic relation. [O] CONTRACT.QFT4D.01: obligations (seam $\rightarrow$ Dirac D; finite geometry = carrier; spectral action reproduces SM couplings) $\rightarrow$ the 4d SM+gravity Lagrangian is an OUTPUT — the Phase-3 target, not closed.
v245_spectral_matter_content.py	QFT4D.MATTER.01 — the computable core of CONTRACT.QFT4D.01 (v244): the spectral-action / NCG matter content, discharging the rep-theory + tree-relation core to [E]. The carrier half-spinor is the $SO(10)$ 16. [E] 16 = one generation: $SO(10)$ 16 = $SU(5)(\mathbf{10} + \mathbf{5} + \mathbf{1})$; SM dims $6 + 3 + 1 + 2 + 3 + 1 = 16 = \dim S^+$, $N_{\text{fam}} = 3$ (15 Weyl fermions + ν_R). [E] electric charges $Q = T_3 + Y$ are exactly the SM values — hypercharges forced by the embedding. [E] anomaly-free: $\sum Y = 0$, $\sum Y^3 = 0$, $[SU(2)]^2 U(1) = 0$, $[SU(3)]^2 U(1) = 0$ (exact). [E] unification: $\sin^2 \theta_W = (\sum T_3^2) / (\sum Q^2) = 3/8$, i.e. $g_3 = g_2 = \sqrt{5/3} g_1$. [E] Higgs = the $(1, 2)_{1/2}$ inner fluctuation (one doublet). [O] residual: the seam $\rightarrow$ Dirac realisation + measured-coupling reproduction stay the open contract.
v246_unification_data_crosscheck.py	QFT4D.RGTEST.01 — the honest data cross-check for the spectral-action prediction (v244/v245): does $g_1 = g_2 = g_3$, $\sin^2 \theta_W = 3/8$ at Λ survive the <i>measured</i> SM couplings? Not in the plain SM. Inputs (PDG, GUT-normalised, M_Z): $\alpha_i^{-1} = (59.01, 29.59, 8.47)$, SM 1-loop $b = (41/10, -19/6, -7)$ (v159). [E] the prediction: $\alpha_1 = \alpha_2 = \alpha_3$, $\sin^2 \theta_W = 3/8$ at Λ. [X] tension: pairwise crossings spread ~ 4 decades ($\sim 10^{13} - 10^{17}$ GeV), residual spread at 2×10^{16} $\Delta \alpha^{-1} \sim 8.8$ — $g_1 = g_2 = g_3$ not realised by the plain SM. [X] $\sin^2 \theta_W$ 3/8 vs measured 0.23122. [X] 2-loop also misses (min spread ~ 3.2 at 1.7×10^{14} GeV). [O] no rescue: SM gauge content + no new states (the E_8 spine is arithmetic, not a threshold tower) $\Rightarrow$ no admissible thresholds; closing it needs new matter (vs 'no new state') or a non-GUT/boundary reading — tension like NCG-SM, likely falsified unless extended. A kill-test, [X]/[O], never [E]-as-success.
v247_e8_branching_no126.py	PS.E8BRANCH.01 — the E_8 audit hull forbids the 126 and supplies exactly $\{1, 10, 16, 45\}$ for $SO(10)$. Carrier $D_5 \oplus A_3 = SO(10) \times SU(4) \subset E_8$ (via $SO(16)$); 248 = $(45, 1) + (1, 15) + (10, 6) + (16, 4) + (\overline{16}, \bar{4}) = 248$. [E] ranks $5 + 3 = 8$; [E] dims = 248 ($SO(16)$: 120 adj + 128 spinor); [E] $SO(10)$ content $\{1, 10, 16, 45\}$, the 126 ABSENT $\Rightarrow 126_H$ algebraically forbidden, $10 + 16 + 45$ E_8-supplied not fitted; [E] caveat only one 45/one 15 $\rightarrow$ proton-marginal; [O] the field-content principle + NCG complement (v250).
v248_ps_algebra.py	PS.ALGEBRA.01 — the Pati-Salam NCG algebra $A_F = \mathbb{H}_L \oplus \mathbb{H}_R \oplus M_4(\mathbb{C})$ and its exact SM matching. [E] unimodular group $SU(2)_L \times SU(2)_R \times SU(4)_c$ (rank 5, $\dim 21$); [E] 16 = $(4, 2, 1) + (\bar{4}, 1, 2) = 8 + 8$; [E] $Y = T_{3R} + (B - L)/2$ gives the exact SM hypercharges and $Q = T_{3L} + Y$ the exact charges; [E] matching $\alpha_1^{-1} = \frac{3}{5} \alpha_{2R}^{-1} + \frac{2}{5} \alpha_4^{-1}$, $\sin^2 \theta_W = 3/8$. [O] A_F uniquely from seam+sheet+μ_4; [O] caveat $SU(4)_c \subset SO(10) = D_5$ is not the carrier $A_3 = SU(4)$ (family).
v249_ps_unification.py	PS.RGTEST.01 — carrier-native Pati-Salam/$SO(10)$ two-step unification kill-test + negative controls (suite check of experiments/gauge-unification). [E] matching + a valid 1-loop unification solution; [X] NEG SM-only fails (spread ~ 8.8 @ 2×10^{16}); [C] $M_{PS}/M_s = 1.0 - 1.7$ (1-loop; 2-loop $\sim 1.0 - 1.2$) — gauge unification meets the gravitational scalaron scale; [X] NEG 126 breaks the match ($b_{2R} > 0$; also E_8-forbidden v247); [X] NEG proton decay selects content (minimal $M_{GUT} \sim 2 \times 10^{15}$ excluded; $+(15, 1, 1)$ safer). [O] the gauging fork, exact κ, the one-45 marginality.

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Script	What it machine-checks (<i>continued</i>)
v250_dirac_triple_contract.py	CONTRACT.QFT4D.DIRAC.01 — the spectral-triple contract that would make ‘carrier gauged’ a theorem. Target (A, H, D, J, γ) almost-commutative, $A_F = \text{PS}$ (v248), $H_F = 3 \times 16$, D_F from $(R, L, \varphi_0, \text{Majorana})$. [E] $H_F = 3 \times 16 = 48$; [E] the Yukawas are already fixed (v18) so the open test is NCG consistency; [O] the 7 NCG axioms (first-order condition = the historic $SO(10)$ obstruction); [O] $\sigma = \text{scalaron hypothesis}$ (rescues first-order + ν_R Majorana; $M_{PS} = \kappa M_s$) — caveat $\sigma \leftrightarrow \nu_R \nu_R$ not automatic; [O] inner fluctuations $\rightarrow 10+16+45$ not 126. Reduces 4d QFT to one object + finite NCG checks.
v251_first_order_sigma.py	PS.DIRAC.01 — the first-order condition is violated <i>exactly</i> by the Majorana/ σ term (Chamseddine–Connes–van Suijlekom ‘beyond first order’ $\rightarrow$ Pati–Salam + σ), exhibited on a faithful lepton-block model; advances v250 from contract to mechanism. Honest correction: σ does NOT ‘rescue’ first order — one DROPS it and the inner fluctuations generate $\text{PS} + \sigma$. [E] order-zero; [E] real-even ($J^2=+1$, $\gamma^2=1$, $D\gamma=-\gamma D$, KO-6 signs); [E] first order HOLDS for the Yukawa block; [E] first order VIOLATED by $M \neq 0$, supported exactly on the $\nu_R \nu_R^c$ blocks (σ the unique violator). [C] $\sigma = \text{scalaron}$ (v249). [O] the full 96-dim SM/PS triple + spectral action (v250).
v252_full_finite_triple.py	PS.DIRAC.02 — the full 96-dim finite spectral triple $(A_F, H_F, D_F, J, \gamma)$ built explicitly with the NCG axioms verified; advances v250 from a 7-obligation contract to a concrete object discharging 5 to [E]. $H_F = \text{particle} \oplus \text{antiparticle}$ doubling of three $SO(10)$ 16 -plets (dim 96). [E] dim 96; D_F Hermitian+odd; reality $J^2=+1$, $JD=DJ$; grading $\gamma^2=1$, $[\gamma, a]=0$, $J\gamma=-\gamma J$; KO-dim 6; order-zero; first order HOLDS for the SM $\mathbb{C} \oplus \mathbb{H} \oplus M_3$ (incl. Majorana) and VIOLATED for Pati–Salam exactly by the Majorana on $\{\nu_R, e_R\}$ (CCvS beyond-first-order $\rightarrow \text{PS} + \sigma$); spectrum = fermion masses + seesaw $m_{\text{light}} = m_D^2/M_R$. [C] Poincaré duality (intersection form non-degenerate). [O] orientability + no-junk + spectral-action expansion.
v253_kappa_scalaron_ps.py	PS.KAPPA.01 — pinning κ in $M_{PS} = \kappa M_s$, discharging residual 6(b) of v249. $M_s = c_3^{7/2} \bar{M} \approx 3.06 \times 10^{13} \text{ GeV}$ (exact). [E] scalaron scale exact; [E] κ pinned by RG (scan PDG errors $\times$ the two E_8 -allowed contents) to a tight $O(1)$ interval ~ 1.3 (1-loop $[1.0, 1.7]$, 2-loop $[1.0, 1.2]$) — pinned, not free. [C] heat-kernel origin $\kappa = \sqrt{(f_2/f_0)} c_{PS}/c_{\text{grav}}$, a ratio of heat-kernel traces over the 96-dim H_F (v252) — Λ cancels, κ scale-free and $O(1)$. [X] the 126 -content drives κ out of the $O(1)$ window (content-selective). [O] the exact decimal needs the cutoff moments f_2/f_0 fixed.
v254_inner_fluctuations.py	PS.NCG.FLUCT.01 — the inner fluctuations $\Omega_D^1(A_F)$ of the finite Dirac operator computed explicitly (reuses the v252 triple); closes v250 #5 (Higgs content, not 126) + the no-junk obligation + the σ quantum numbers. [E] $\Omega_{D_F}^1$ purely chirality-odd $\rightarrow$ finite fluctuations are scalars; [E] no junk / no 126 : SM-algebra 1-forms sit exactly in the Higgs-doublet pattern (the single $(1, 2)_{1/2}$); [E] the σ (ν_R Majorana) direction is absent for the SM algebra but present for Pati–Salam — σ is the CCvS beyond-first-order scalar; [E] σ is an SM singlet $(1, 1, 0)$ with $B-L=2$; [C] $\sigma = \text{scalaron consistency}$.
v255_spectral_action_expansion.py	PS.SPECACT.01 — the spectral-action heat-kernel (Seeley–DeWitt) expansion $S = 2f_4\Lambda^4 a_0 + 2f_2\Lambda^2 a_2 + f_0 a_4$ over the finite triple; closes v252 #11 (spectral-action expansion) and makes $\kappa(f_2/f_0)$ explicit. [E] expansion structure (a_0 cosmological, a_2 Einstein–Hilbert+Higgs-mass, a_4 Yang–Mills+Weyl ² + R^2 +Higgs-quartic, $N=96$); [E] trace inputs $b/a^2 = 1/3$ (top-dominated, Chamseddine–Connes); [E] $\sin^2 \theta_W = 3/8$ (cross-check v245); [C] Higgs quartic $\lambda(\Lambda) \sim g^2 b/a^2 \rightarrow \sim 125 \text{ GeV}$ with σ ; [E] scalaron = R^2 spin-0 mode (gravitational $a_4 \sim f_0 N$); [C] $\kappa = \sqrt{(f_2/f_0)} c_{PS}/c_{\text{grav}}$ explicit; [O] exact decimal needs the cutoff moments fixed.

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Script	What it machine-checks (<i>continued</i>)
v256_orientability_ poincare.py	PS.NCG.ORIENT.01 — orientability and Poincaré duality treated honestly (no faked proof). KO-dim 6 forces the intersection form $\text{cap}(p, q) = \text{Tr}(\gamma \pi(p) J \pi(q) J^{-1})$ to be antisymmetric. [E] skew form forced by $J\gamma = -\gamma J + \text{order-zero} + \text{reality}$ (verified); [E] on the SM K-theory $\mathbb{Z}^3$ the skew form has rank 2, corank 1, null $\sim (1, 1, -1)$ — the structural obstruction; [E] orientability local condition $[\gamma_F, \pi(a)] = 0$, full orientability is a degree-4 cycle on $M \times F$; [C] the canonical hypercharge-faithful SM/PS triple satisfies both (van Suijlekom; CCM) — literature; [O] a self-contained machine proof needs the complete canonical bimodule.
v257_quasiorient_ modpd.py	PS.NCG.ORIENT.02 — the honest, literature-confirmed resolution of orientability + Poincaré duality, correcting the too-generous v256 typing. Published result (Cacic–Stephan arXiv:0902.2068; CCM07; SM-vacuum hep-th/0601192): the CCM SM finite triple (KO-6, $3\nu_R$) genuinely FAILS strict orientability and strict Poincaré duality, satisfying the weakened versions. [E] strict orientability fails ($\gamma \notin \text{span}\{\lambda(a)\rho(b)\}$); [E] quasi-orientability holds (left/right A -irrep boxes disjoint by chirality: $L = H$ doublet, $R = \mathbb{C}$ singlet $\Rightarrow L^{\text{LR}}(\text{even}, \text{odd}) = \{0\}$); [E] strict Poincaré fails (KO-6 skew form, corank 1, the equal- L/R -neutrino case); [C] modified Poincaré duality (CCM) / Stephan’s PD-restoring triple. A known model-class feature, not a TFPT defect — no faked closure.
v258_dirac_ covariance_ induction.py	PS.DIRAC.03 — D_F is the modular/covariance <i>induction</i> of the boundary seam state, not an independent posit; closes the ‘posited Yukawa vs derived operator’ gap of v250/v252 (Q2: Dirac as Kasparov product + covariance formula). Quasi-free/modular dictionary: a Gaussian state is fixed by its covariance C (contraction, $\text{spec} \subset (0, 1)$) with one-particle modular Hamiltonian $H = \log((1-C)C^{-1})$ (Araki; Casini–Huerta), inverse to the KMS occupation $C = (1+e^H)^{-1}$ ($\beta=1$, v239). [E] inversion identity $\log((1-C)C^{-1}) = H$ exactly (random Hermitian + a chirality-graded Yukawa block); [E] $C_F = (1+e^{D/\mu})^{-1}$ a positive contraction; [E] chirality-odd ($D_F^{\text{ind}}\gamma = -\gamma D_F^{\text{ind}}$); [E] unitarily equivalent to v252 (inducing C_F from the 9 Yukawas returns the same spectrum); [E] Majorana = off-diagonal covariance (seesaw $m_{\text{light}} = m_D^2/M_R$); [C] $C_F = P_F C_\Sigma P_F$, so D_F is the KK shadow $[D_\Sigma] \hat{\otimes}_{(E_8)_1} [\mathcal{K}_{\text{car}}]$ and the v18 Yukawas are the readout of C_Σ .
v259_modular_ cutoff_kappa.py	PS.SPECACT.02 — the spectral-action cutoff <i>is</i> the seam KMS weight, fixing $f_2/f_0=1$ exactly and reducing the last open scheme freedom (v253 #5, v255 #7) from a free function to a finite-triple trace ratio (Q4: the cutoff is modular, not chosen). By Tomita–Takesaki/BW the seam state is KMS at $\beta=1$ (v239) and $2\pi=1/(4c_3)$ (v58) fixes β , so the heat-kernel cutoff $f(u)=e^{-u}$ is <i>derived</i> . [E] KMS cutoff moments $f_0=f(0)=1$, $f_2=\int f=1$, $f_4=\int u f=1$, so $f_2/f_0=f_4/f_2=1$; [E] seam-fixed $\beta=1$ (no new parameter beyond c_3); [E] non-vacuous neg control: a Gaussian cutoff e^{-u^2} gives $f_2/f_0=\sqrt{\pi}/2 \neq 1$; [E] $\kappa=\sqrt{(f_2/f_0)c_{PS}/c_{\text{grav}}}=\sqrt{c_{PS}/c_{\text{grav}}}$, no cutoff function left; [C] the RG $\kappa\sim 1.3$ pins $c_{PS}/c_{\text{grav}}\sim 1.7$ ($O(1)$); the [O] free scheme becomes a [C] finite computation over the built triple; [C] the same logic fixes $\lambda(\Lambda)$.

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Script	What it machine-checks (<i>continued</i>)
v260_k3_kummer_unification.py	ARCH.K3.01 — one Kummer/K3 surface carries the <i>seam</i>, the <i>carrier-16</i> and the E_8 lattice as facets of one smooth object, the geometric unification of the v1 ‘glue $D_5 \oplus A_3 + \mu_4 \Rightarrow E_8$’ step (the K3/Kummer proposal). The seam square torus $\tau=i$ ($j=1728, v214$) under the elliptic involution $z \mapsto -z$ squares to the Kummer K3. [E] the E_8 Cartan is even, $\det=1$, positive-definite (the unique even unimodular pos-def rank-8 lattice); [E] the K3 lattice $L_{K3}=U^3 \oplus E_8(-1)^2$ has rank $22=b_2$, $\det=-1$ (unimodular), is even, signature $(3, 19)$, with $E_8(-1)^2$ an orthogonal summand; [E] seam = $T^2/(z \mapsto -z)$: $4= (\mathbb{Z}/2)^2$ fixed points, pillowcase $S^2(2, 2, 2, 2)$, orbifold Euler char 0 (the v214/v216 four marks); [E] carrier-16 = Kummer nodes $A[2] =2^4=16 \rightarrow 16$ exceptional $\mathbb{P}^1 = \dim S^+ = \Lambda^{\text{even}}(\mathbb{C}^5) = 16$ (v197), $16=4 \times 4$; [E] honesty: the 16 node classes span the rank-16 Kummer lattice, <i>not</i> literally $E_8(-1)^2$ (distinct sublattices of $H^2(K3)$); [C] two faces of E_8 in K3 (local du Val $\mathbb{C}^2/2I$, v232/v236; global H^2 summand); [C] unification (lattice [E], carrier$\leftrightarrow$node identification [C]).
v261_modular_spectral_closure.py	QFT.MSC.01 — the <i>Modular Spectral Closure</i>: the assembly/reduction certificate turning the whole QFT layer (v238–v260) into <i>one</i> relative object TFPT_{QFT} = $(\mathcal{A}_\Sigma, \omega_\Sigma, \Delta_\Sigma, \rho, A_F, H_F, D_F, J, \gamma, S_{\text{rel}})$ reduced to <i>one</i> open premise (like v176/v234, an assembly certificate, not new physics). [E] one index = marks = fixed points = glue order: Jones $[B:A]=4$ (v89) = $\mu_4 =4$ (v92) = seam marks $2\chi=4$ (v216) = pillowcase/Kummer fixed points $(\mathbb{Z}/2)^2 =4$ (v260); [E] one carrier-16: $\dim S^+ = \Lambda^{\text{even}}(\mathbb{C}^5) = \text{Kummer nodes } 2^4=16, H_F=2N_{\text{fam}} \cdot 16=96$; [E] one gap $\Delta = -\log((2/3)^6) = 6 \log(3/2) > 0$ = the OS mass gap (v240) = the recovery rate (v221) = the Lindblad gap (v238); [E] the three closures re-derived (Kasparov $\log((1-C)C^{-1})=H$, v258; KMS cutoff $f_2/f_0=1$, v259; K3 lattice signature $(3, 19)/\det -1/\text{even}$, v260); [E] relative-object manifest (10/10 component scripts present); [O] the single residual: the whole QFT layer reduces to QGEO.SYM.01 (seam realisation), the ambient QG measure QG.AMB.01 kept separate; [C] the master statement (Modular Spectral Universality) holds modulo QGEO.SYM.01 — the honest sense in which the QFT layer is complete.
v262_fqcd_mp_me.py	FR.MPME.02 — the F_{QCD} transfer pipeline for m_p/m_e, implemented as a real solver (the one F_{transfer} pipeline that was contract-only). <i>Not</i> a compiler power — a [C] standard-physics transfer reproduction. [E] $b_3 = -7 = -(11-2n_f/3)$ at $n_f=6$ (the only TFPT number in the run); [E] a two-loop $\alpha_s(M_Z)=0.1179$ run with thresholds gives $\alpha_s(2 \text{ GeV}) \sim 0.30$ (real ODE solve); [C] $\Lambda_{\text{MS}}^{(3)} \sim 0.33 \text{ GeV} \times$ the lattice bridge $C_p = m_p/\Lambda$ (external $O(1)$) over the closed m_e gives $m_p/m_e \sim 1824$ vs the measured 1836.15 within the $\sim 7\%$ external budget; [X] firewall: m_p/m_e is not an admissible compiler integer ($SU(9)$ absent from $D_5 \oplus A_3$). Advances FR.MPME.01 ([O]) to FR.MPME.02 ([C]).
v263_mnu_from_df.py	FLAV.PMNS.02 — the light neutrino matrix M_ν as the type-I seesaw of D_F, advancing the solar-angle texture (v9) from a posited matrix to a seesaw <i>object</i> built from D_F’s blocks. [E] $M_\nu = -m_D M_R^{-1} m_D^\top$ symmetric + seesaw-suppressed (the light masses an output of D_F); [E] a $\mu\tau$-symmetric (m_D, M_R) gives a $\mu\tau$-symmetric M_ν (the v9 texture is in the seesaw image); [C] diagonalising gives $\theta_{23}=45^\circ$ and $\sin^2 \theta_{12} = \frac{1}{3} - \frac{\varphi_0^{\text{ret}}}{2} = 0.30675$ under the seam misalignment; [O] $\theta_{13}=0$ in the leading texture (physical $\sin^2 \theta_{13} \sim \varphi_0^{\text{ret}} e^{-5/6}$ a separate readout), the CP magnitude $\delta_{\text{PMNS}}=240^\circ$ is the $\mu_6/\text{triality}$ phase (v231/v233), and M_R is the free seesaw scale. An operator advance, not a closure of full PMNS dynamics.

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Script	What it machine-checks (<i>continued</i>)
v264_raw_seam_ marklocal.py	QGEO.ENERGY.03 — the raw-seam $\Rightarrow$ mark-locality <i>reduction</i> (not a closure of QGEO.SYM.01). Composing v216+v201+v198 on the canonical pillowcase: [E] Gauss–Bonnet 4 cone points (deficit π each, sum $4\pi=2\pi\chi(S^2)$), curvature <i>only</i> at the 4 marks; [E] the curvature sourced at the μ_4 orbit $\{0, \pi/2, \pi, 3\pi/2\}$ has Fourier support <i>only</i> on $4\mathbb{Z}$ (FFT), so mark-locality is automatic for the pillowcase; [E] M_f then commutes with the clock $\rho=\text{diag}(i^n)$; [E] with $ k $ already commuting (v198), $[\rho, \Lambda]=0 \Rightarrow \omega \circ \rho = \omega$ on this metric; [O] the residual <i>is</i> the metric — the chain assumes the raw seam carries the uniformising flat pillowcase metric (=QGEO.SYM.01), the negative control (curvature off the μ_4 orbit) breaks it. A reduction/sharpening, not a closure.
v265_qft4d_fork_ freeze.py	QFT4D.FORK.01 — freeze the 4D-QFT fork as a <i>branch policy</i> (not an open ambiguity); writes <code>qft4d_fork_freeze.json</code> + a prose guard, no new physics. [C] A: boundary-only is the canonical 4D reading (no 4D-GUT claim by default); [X] SM-only 4D-GUT unification is killed (1-loop spread ~ 8.8 at 2×10^{16} , v246); [C]/[O] B: carrier-native Pati–Salam is a falsifiable UV branch (E_8 content $\{1, 10, 16, 45\}$ no 126 v247, $\sin^2 \theta_W = 3/8$ v248, $\kappa O(1)$ band v249/v253, threshold + proton kill test); [X] proton safety rule (no fake τ_p window); [E] wording guard (bare 4D over-claims absent, scoped policy phrases present). A frozen decision tree, not an open ambiguity.
v266_ps_threshold_ proton.py	PS.PROTON.02 — the explicit Pati–Salam threshold model + proton-decay window that DECIDES branch B of the v265 fork; writes <code>ps_threshold_proton.json</code> . Two-step PS solve + $d=6$ $\tau_p(p \rightarrow e^+ \pi^0)$: the carrier-native PS UV branch survives proton decay <i>only</i> with the E_8 -allowed $(15, 1, 1)$ [the single 45]. [E] explicit thresholds: minimal $16H \rightarrow M_{GUT} \sim 2.4 \times 10^{15}$, $+(15, 1, 1) \rightarrow M_{GUT} \sim 5.9 \times 10^{15}$; [X] minimal KILLED ($\tau_p \sim 4.4 \times 10^{33}$ yr < Super-K 2.4×10^{34} , even high-band); [C] $+(15, 1, 1)$ survives now ($\tau_p \sim 1.6 \times 10^{35}$ yr); [X] <i>Hyper-K decisive</i> (τ_p at the $\sim 1.4 \times 10^{35}$ yr reach) — a dated kill test within the decade; [O] marginal (only one 45 in the hull, v247) + $O(3)$ hadronic uncertainty. A (boundary-only) stays canonical.
v267_qgeo_rigidity_ minimal_axiom.py	QGEO.SYM.02 — the rigidity / minimal-axiom form of the bedrock QGEO.SYM.01: the ONE bare statement (the raw RP seam admits the carrier μ_4 clock as a conformal symmetry permuting its 4 marks, $= \omega \circ \rho = \omega$) <i>forces</i> everything downstream; it does <i>not</i> close the axiom. [E] an order-4 Möbius orbit $\{a, ia, -a, -ia\}$ has cross-ratio 2 (independent of a); [E] cross-ratio $2 \Leftrightarrow j=1728$ (only $\lambda \in \{-1, \frac{1}{2}, 2\}$) $\Leftrightarrow$ the order-4 CM automorphism $(x, y) \mapsto (-x, iy)$ on $y^2=x^3-x$; [E] downstream forced: square $\Rightarrow$ the unique flat pillowcase (Trojanov, v214) $\Rightarrow$ curvature at the 4 marks $\Rightarrow \mathbb{Z}_4$ -Fourier DtN (v201/v264) $\Rightarrow [\rho, \Lambda]=0 \Rightarrow \omega \circ \rho = \omega$ (v198); [E] neg controls (generic $j \neq 1728$, only $\mathbb{Z}_2$; hexagonal $j=0$ has $\mathbb{Z}_6$, order $6 \neq 4$); [C] arithmetic rigidity ($\{1, i, -1, -i\}$ over $\mathbb{Q}$, $j=1728$ CM by $\mathbb{Z}[i]$, Belyi/dessins); [O] the bare order-4 symmetry stays the one foundational postulate (like $c=\text{const}$). Closes the reduction (axiom $\Rightarrow$ everything), not the axiom.
v268_theta13_ carrier_trace.py	FLAV.TH13.01 — the reactor angle θ_{13} <i>exponent</i> is the carrier hypercharge trace. The value $\sin^2 \theta_{13} = \varphi_0^{\text{ret}} e^{-5/6} = 0.0231$ was already checked (v16); here the exponent origin is closed exactly: [E] $\gamma = \text{tr}_E Y^2 = 3(1/3)^2 + 2(1/2)^2 = 5/6$ over the 5-slot carrier hypercharge $Y = \text{diag}(-\frac{1}{3}, -\frac{1}{3}, -\frac{1}{3}, \frac{1}{2}, \frac{1}{2})$ (roots of $6Y^2 - Y - 1 = 0$), complement $1/6$ the neutrino ratio; [C] value 0.02311 vs PDG ~ 0.0222 ; [E] own channel — the $\mu\tau$ -breaking $\varepsilon = 3\varphi_0^{\text{ret}}/4$ induces only $\sim 1.6 \times 10^{-3} \ll 0.023$, so θ_{13} is a separate carrier-trace channel, not the seesaw $\mu\tau$ breaking (corrects the tempting ‘ θ_{13} from M_ν ’ route); [O] CP magnitude + absolute ν scale remain open.

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Script	What it machine-checks (<i>continued</i>)
v269_spert_paqft_skeleton.py	QFT4D.SPERT.01 — the perturbative 4D S-matrix (S_{pert}) as an Epstein–Glaser / pAQFT skeleton: the honest middle layer of the three-layer S-matrix (S_{top} 2d DHR braiding v243 / S_{pert} 4d EG of the spectral action / S_{phys} LSZ on the OS Wightman functions v240), <i>not</i> a nonperturbative closure. [E] three distinct layers (the 2d braiding $ M =1$ is statistics, not 4d cross-sections); [E] every spectral-action a_4 operator has mass dimension ≤ 4 in 4D (power-counting renormalizable); [E] a finite counterterm basis (7 marginal +3 relevant, no infinite tower); [C] Epstein–Glaser existence — a renormalizable interaction has an order-by-order $S(g)=T \exp(i \int g L_{\text{int}})$ by causal factorisation + finite local extension (no path integral, no UV divergences); [C] adiabatic limit/gap ($\Delta=6 \log(3/2)>0$) $\rightarrow S_{\text{phys}}$ via LSZ; [O] perturbative only — the ambient measure QG.AMB.01 stays open. A contract/skeleton, explicitly perturbative.
v270_pmns_jarlskog_assembly.py	FLAV.PMNS.03 — the complete complex PMNS matrix + the leptonic Jarlskog J_{PMNS} (the CP <i>strength</i>), assembled from the four TFPT channels ($\sin^2 \theta_{12}=\frac{1}{3}-\frac{\phi_0}{2}$, $\sin^2 \theta_{23}=\frac{1}{2}$, $\sin^2 \theta_{13}=\phi_0 e^{-5/6}$, $\delta=4\pi/3$) into one unitary object. [E] the three angle channels; [E] $U = R_{23}U_{13}(\delta)R_{12}$ is exactly unitary; [C] $J_{\text{PMNS}} = \Im(U_{e1}U_{\mu 2}U_{e2}^*U_{\mu 1}^*) = -0.02965$ (formula and full matrix agree), $J_{\text{max}} = 0.03424$ — a <i>derived</i> CP strength, the leptonic analogue of the CKM J (v88); [C] data: J_{max} vs NuFIT 0.0332 ($\sim 3\%$), J vs best fit -0.026 , the negative sign reproduced; [O] δ is the μ_6 /triality phase (assembled input, <i>not</i> from M_ν/D_F) and the absolute ν -mass scale (Σm_ν , M_R) stays open. Assembles the PMNS matrix + CP strength; does not derive δ from D_F nor fix the scale.
v271_eg_oneloop_quartic.py	QFT4D.SPERT.02 — a concrete Epstein–Glaser order-2 (one-loop) quartic renormalization, taking the v269 S_{pert} skeleton from <i>exists</i> to an actual EG number (no path integral). [E] $T_1=:L_{\text{int}}$: needs no extension, the first extension is T_2 ; [E] the massless propagator has scaling degree $\text{sd}=2$ in $d=4$, the one-loop bubble (two propagators) has $\text{sd}=4=d$ so the UV singular order $\omega=\text{sd}-d=0$; [E] $\omega=0 \Rightarrow$ exactly one logarithmic local counterterm ($C(\omega+d,d)=1$, renormalizable, no infinite tower); [E] the loop factor $\Omega_3/(2(2\pi)^4)=1/(16\pi^2)$ exactly — the same factor that normalises the spectral-action a_4 geometric quartic; [C] the ϕ^4 one-loop $\beta_\lambda=3\lambda^2/(16\pi^2)$ (symmetry factor 3 = the s, t, u channels), EG initial condition $\lambda_\Phi(\text{UV})=1/(16\pi^2)$; [O] order-2/one-loop only — the all-order EG construction and the nonperturbative measure QG.AMB.01 stay open. Turns the skeleton into a concrete one-loop number.
v272_nu_mass_scale.py	FLAV.NUSCALE.01 — the absolute neutrino-mass scale, typed honestly (it does <i>not</i> fabricate a Σm_ν number, which would contradict the v184 firewall). [E] the absolute scale reduces to <i>one</i> seesaw ratio $m_3 = (y_\nu v_{\text{EW}})^2/M_R$ — one irreducible UV input like v_{geo} (v153), while the ratios (m_2/m_3 , ordering, PMNS angles v270) are pinned; [C] the observed $m_3=0.050$ eV with the TFPT PS $\rightarrow$ GUT window $M_R \in [4.2 \times 10^{13}, 2.4 \times 10^{15}]$ GeV (v249) needs a third-generation Dirac Yukawa $y_\nu \in [0.26, 2.0]$ — $O(1)$, no tuning; [O] $M_R(y=1)=6.1 \times 10^{14}$ has $\log_{c_3}(M_R/M_{\text{Pl}})=2.57$ (non-integer), not a TFPT power, so the absolute value stays open; [C] the normal-ordering floor $\Sigma m_\nu=0.0586$ eV is consistent with cosmology ($< 0.072\text{--}0.12$ eV); [X] a cosmological $\Sigma < 0.0586$ eV excludes the normal-ordered $m_1 \sim 0$ spectrum. Closes the PMNS bookkeeping (the last [O] is one seesaw ratio), not the absolute number; sharpened by v481 (carrier normalisation $y_\nu=y_t$: one-parameter, window-bracketed candidate).

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Script	What it machine-checks (<i>continued</i>)
v273_eg_gauge_running.py	QFT4D.SPERT.03 — the gauge sector of the Epstein–Glaser one-loop (v271’s quartic mechanism applied to the gauge self-energy). [E] the one-loop gauge 2-point has scaling degree $sd=4=d$ so $\omega=0 \rightarrow$ one counterterm per coupling (same marginal mechanism + loop factor $1/(16\pi^2)$ as v271); [E] the one-loop b_i from the explicit carrier/SM content: $b_3=-7$, $b_2=-19/6$, $b_1=41/10$ (the same 41 as the carrier algebra, v159/CAR.SM.01); [C] physical RG directions $b_3<0$ (asymptotic freedom), $b_1>0$ (U(1) Landau); [O] the two-loop matrix (v159, PyR@TE) + all-order stay open. Shows the gauge running is an EG order-2 result. Exact b_i mirrored in Wolfram.
v274_scale_overdetermination.py	SCALE.OVERDET.01 — the single mass anchor is <i>over-determined</i> , and the absence of a derivable absolute scale is a <i>theorem</i> . [E] one anchor (No-Unit, v153): every dimensionful output = pure number $\times M_{P1}^d$ (ρ_Λ/M_{P1}^4 , $M_{scal}/M_{P1}=c_3^{7/2}$, the spectrum); [C] two independent routes to M_{P1} agree: gravity $(8\pi G)^{-1/2}=2.4353\times 10^{18}$ GeV and cosmology (invert $\rho_\Lambda/M_{P1}^4=(3/4\pi^2)e^{-2\alpha^{-1}}$ with $\rho_\Lambda^{1/4}=2.24$ meV) $=2.438\times 10^{18}$ GeV, to 0.11%; [E] the anchor is the gravitational unit (G), the one measured dimensionful input of all physics; [E] theorem not gap: the seam is a conformal $c=8$ CFT (v157/v158), scale-invariant by construction $\rightarrow$ no intrinsic scale; [O]/[E] scale-complete up to one over-determined anchor = maximal predictivity. Sharpens v153/v78.
v275_qgamb_roadmap.py	QGAMB.ROADMAP.01 — the obligation roadmap for QG.AMB.01 (the ambient nonperturbative QG measure), consolidated into one module (the open gate had no script). [E] Tier A gap decoupling: $\Delta_{\text{eff}}=6\log(3/2)-2.248c_3^2=1.648>0$ (v36/v76), so every low-energy readout is independent of the un-built measure — not a blocker; [E] Tier B: the bulk measure reduces to identifying the seam-Calderón boundary with the holomorphic $(E_8)_1$ net ($c=248/31=8$; v77/GATE.METRIC.03), reduced not closed (REDTEAM.A.01); [C] the perturbative layer is in hand (v269/v271/v273); [O] the nonperturbative ambient measure is <i>not</i> constructed — the one genuine structural frontier; [X] closes IFF the seam net $= (E_8)_1$ and the bulk reconstruction is proved. A roadmap, not a closure.
v276_qgeo_flat_closes_commutator.py	QGEO.SYM.03 — the flat $\tau=i$ pillowcase premise <i>closes</i> the modular-commutator chain to all orders, collapsing the bedrock QGEO.SYM.01 to <i>one</i> geometric postulate (it does <i>not</i> prove the premise). For a quasi-free seam state $QGEO.SYM.01 = (\omega \circ \rho = \omega) \Leftrightarrow [\rho, C]=0 \Leftrightarrow [\rho, H]=0$. [E] isometry $\Rightarrow$ commutator: if $H=f(\Delta_{\text{flat}})$ and the order-4 deck $\rho(z \rightarrow iz)$ is a flat- $\tau=i$ isometry then $[\rho, \Delta]=0 \Rightarrow [\rho, H]=0$ <i>exactly</i> (all orders), verified on the discretised square torus ($\rho^4=I$, $[\rho, \Delta]=0$, $[\rho, \sqrt{-\Delta}]=0$; generic non-isometry fails); [E] this upgrades v198 (principal symbol) + v201 (subprincipal) to the full H (flatness removes the curvature terms); [C] $\tau=i$ is forced by order-4 ($j=1728$; hexagonal $j=0$ is order-6, excluded; v214/v267); [O] QGEO.SYM.01 collapses to the single statement ‘the raw seam is the flat $\tau=i$ pillowcase quasi-free state’ — needs a human constructive-QFT proof or stays an honest axiom. Sharpest non-circular form.
v277_seam_calderon_e8_match.py	QGAMB.TIERB.01 — the seam-Calderón $\rightarrow (E_8)_1$ matching certificate, the concrete Tier-B step of QG.AMB.01 (v275): it computes the full $(E_8)_1$ matching target and pins the residual to <i>one</i> bit (it does <i>not</i> close it). [E] $c=8$ (Sugawara, $248/31=g_{\text{car}}+N_{\text{fam}}$), but $c=8$ alone does not pin the net; [E] the discriminator is holomorphy — $\det \text{Cartan}(E_8)=1$ (1 primary, holomorphic) vs the $c=8$ counterexample $\det \text{Cartan}(D_8=SO(16))=4$ (4 primaries, non-holomorphic), so the single discriminator is $ \det K =1$; [E] the $(E_8)_1$ character $E_4/\eta^8=j^{1/3}=q^{-1/3}(1+248q+\dots)$ has a single primary + exactly $248=\dim E_8$ weight-1 currents (240 roots); [E] equivalence chain holomorphic $\Leftrightarrow \det \text{Cartan} 1 \Leftrightarrow$ unique even unimodular rank-8 (v83) $\Leftrightarrow$ homology-sphere link $\Leftrightarrow \det K =1$ (v235); [C] seam-side match via v276 (flat $\tau=i$) + v260 (Kummer/K3); [O] residual = the single holomorphy bit — reduced to one bit, <i>not</i> closed.

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Script	What it machine-checks (<i>continued</i>)
v278_lszy_bridge_unity.py	QFT4D.SPERT.04 — the $S_{\text{pert}} \rightarrow S_{\text{phys}}$ LSZ bridge + one-loop unitarity: connects the EG perturbative S-matrix (v269/v271/v273) to the physical asymptotic S-matrix (S_{phys} = LSZ on the OS Wightman functions, v240). [E] LSZ bridge: S_{phys} = amputate+on-shell-residue of the connected time-ordered products, and the EG T-products of S_{pert} are those correlators (OS Wick-rotation, v240) $\Rightarrow S_{\text{pert}} \xrightarrow{\text{LSZ}} S_{\text{phys}}$; [C] the gap $\Delta=6\log(3/2)>0$ gives Haag–Ruelle asymptotic states so LSZ is valid; [E] <i>one-loop unitarity</i> (optical theorem): the bubble discontinuity $\text{Im } B(s)/\pi = x_+ - x_- = \sqrt{1 - 4m^2/s}$ <i>exactly</i> = the two-body phase space, so $2\text{Im } M = \sum \int d\Pi M ^2$ (cutting rule) holds $\Rightarrow$ matter+gauge unitary; [E] threshold: $\text{Im } B=0$ below $s=4m^2$, turning on at the physical two-particle threshold; [O] gravity caveat — the Stelle ghost makes the gravity perturbative S-matrix non-unitary $\rightarrow$ QG.AMB.01; [C] finite field-strength Z from the EG scheme.
v279_qgeo_obligation_lemma.py	QGE0.OBLIG.01 — the QGE0.SYM.01 bedrock written as <i>one</i> precise constructive-QFT lemma with a proof-tree completeness check (the formal obligation write-up; does <i>not</i> close it). Lemma: given the premise ‘the raw seam carries the flat $\tau=i$ pillowcase metric g_{flat} (Trojanov-unique, cone angles π), so $\Lambda_\Sigma = \sqrt{-\Delta_{\text{flat}}}$’, then $\omega_\Sigma \circ \rho = \omega_\Sigma \rightarrow$ mark-locality $\rightarrow E_8$. [E] the reduction DAG from ‘free RP seam’ has 8 closed nodes and <i>exactly one</i> open leaf (‘the raw seam state is the flat state’); [E] the geometric side is fixed (flat DtN diagonal, ρ commutes to all orders, Lean FORM.QGE0.04), so the obligation is state-identification not geometric ambiguity; [C] two proof routes (RP-state uniqueness on the flat orbifold, or Trojanov + OS); [E] the all-orders step is a Lean theorem (SeamDeckClosure.flat_all_orders_clock, standard axioms, no sorry); [O] one constructive-QFT statement closes QGE0.SYM.01.
v280_pillowcase_steklov.py	QGE0.STEKLOV.01 — a direct numerical experiment on the flat $\tau=i$ pillowcase orbifold (the seam geometry): the self-investigable test of the QGE0.SYM.01 obligation (does <i>not</i> prove the premise). [E] pillowcase = the Z_2-even sector of the flat torus, 4 cone points (2-torsion, deficit π each, sum $4\pi=2\pi \cdot 2$); [E] the order-4 deck $\rho(z \rightarrow iz)$ descends ($[\rho, Z_2]=[\rho, P_{\text{even}}]=0$) and permutes the 4 cone points as 2 fixed + 1 swapped pair; [E] the geometric chain is exact: $[\rho, \Delta]=0 \Rightarrow [\rho, H]=0 \Rightarrow [\rho, C]=0 \Rightarrow \omega \circ \rho = \omega$ (the v276/v279 all-orders closure on the real orbifold); [C] the Steklov DtN is positive self-adjoint, fixed by the flat metric (route-(i) evidence); [O] confirms the conclusion given flat geometry, the premise stays open.
v281_holomorphy_modular_data.py	QGAMB.MODULAR.01 — the modular-data / anyon-condensation layer of the QG.AMB.01 Tier-B holomorphy bit. [E] $\# \text{anyons} = \det \text{Gram} : E_8 \rightarrow 1$ (holomorphic), $D_8=SO(16) \rightarrow 4$, carrier $D_5 \oplus A_3 \rightarrow 16$; [E] the anyon-condensation tower $D_5 \oplus A_3 (16) \rightarrow D_8 (4) \rightarrow E_8 (1)$, each step condensing a Lagrangian Z_2 boson, the Kitaev E_8 endpoint (v92/v235); [E] Gauss–Milgram recovers $c=8$; [E] E_8 is the unique holomorphic $c=8$ ($\det 1$) — $SO(16)$ has the same c but 4 anyons, so holomorphy is THE discriminator (v277); [O] the open bit: does the seam-Calderón net condense to $\det K=1$? Reduced to one bit.
v282_e8_tau_i_unification.py	QGAMB.UNIFY.01 — the E_8-at-$\tau=i$ unification: the candidate <i>simplification</i> reducing the two open obligations to <i>one</i> object (the raw seam is the $(E_8)_1$ holomorphic CFT at $\tau=i$). $\chi_{E_8}(\tau)=\Theta_{E_8}/\eta^8=j^{1/3}$. [E] $\tau=i$ is the order-4 CM point ($j=1728$, the QGE0.SYM.01 flat geometry); [E] $\chi_{E_8}=j^{1/3}$ ($\chi^3=qj$ as q-series), so $\chi_{E_8}(i)=1728^{1/3}=12$ (the $(E_8)_1$ character at the SAME $\tau=i$, the QG.AMB.01 holomorphy); [E] one object, two faces; [C] obligation count $2 \rightarrow 1$: prove ‘the raw seam is $(E_8)_1$ at $\tau=i$’ and <i>both</i> follow; [O] the unified premise stays open but is now one object.

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Script	What it machine-checks (<i>continued</i>)
v283_live_killtest_scorecard.py	PRED.LIVE.01 — a live kill-test scorecard of the recent round’s computable predictions vs current data, each tagged with the decisive experiment. [C] PMNS angles $\sin^2 \theta_{12}=0.30675$ ($+0.31\sigma$), $\sin^2 \theta_{13}=0.02311$ ($+1.45\sigma$), θ_{23} maximal; [C] leptonic CP $J_{\text{PMNS}}=-0.0297$, $\delta=240^\circ$ vs $\sim 232(30)$; [X] Σm_ν NO floor 0.0586 eV (DESI/CMB-S4 decisive); [X] proton decay $\tau_p=1.55\times 10^{35}$ yr for $+(15, 1, 1)$ (Hyper-K decisive); [E] closed readouts α^{-1} , Ω_b , β ; all rows consistent $< 2\sigma$, two sharp near-term kill tests. A consolidation, not new physics.
v284_route_i_rp_uniqueness.py	QGEO.ROUTEI.01 — Route (i) (RP-state uniqueness) decomposed into a 6-lemma chain with every dischargeable lemma discharged and the one irreducible lemma isolated (does <i>not</i> prove the open premise). [E] 5/6 lemmas are existing [E]/[O] results — L1 RP→DtN (v194), L2 the four marks force the pillowcase class (v195/v216/v214), L3 the flat orbifold Steklov operator $= \sqrt{-\Delta_{\text{flat}}}$ (verified: flat-strip DtN(k)/ $k \rightarrow 1$, principal symbol $ \xi $ with no curvature term), L4 covariance $C = (1 + e^H)^{-1}$ from the DtN (v258), L5 μ_4 -invariance (v276/Lean/v280); [C] Troyanov reduction: 4 cone points of angle $\pi \Rightarrow \chi_{\text{orb}} = 0 \Rightarrow$ the unique constant-curvature representative is flat ($\tau=i$), so L_{open} reduces to ‘the raw seam is the constant-curvature geometric state’; [O] the one open lemma — the raw RP seam state is the constant-curvature/geometric state (the state-identification step).
v285_route_ii_seam_condensation.py	QGAMB.ROUTEII.01 — Route (ii) (seam-net condensation) decomposed into a 4-lemma chain, with the key result that its open lemma <i>coincides</i> with Route (i)’s (the v282 unification at the lemma level). [E] 3/4 lemmas discharged — M1 no abelian sector $\Leftrightarrow \det K =1 \Leftrightarrow$ holomorphic (v234/v235), M2 holomorphic $c=8 \Leftrightarrow (E_8)_1$ with the $SO(16)$ det-4 counterexample (v277/v281), M3 the condensation tower $16 \rightarrow 4 \rightarrow 1 =$ the unique μ_4 -Lagrangian glue (v92/v281/v235); [E] the discriminator det 1 vs det 4; [E] Routes (i) and (ii) share <i>one</i> open lemma — both say ‘the raw seam is the $(E_8)_1$ -at- $\tau=i$ object’ (v282), so proving either closes both; [O] the unified open lemma: construct a canonical equivalence between the raw seam KMS/DtN state and the holomorphic $(E_8)_1$ net at $\tau=i$. $M_{\text{open}} = \text{QGEO.SYM.01}$.
v286_seam_equivalence_contract.py	SEAM.EQUIV.01 — the Seam Equivalence contract: concentrates the whole open structure on <i>one</i> named arrow (does <i>not</i> prove it). Theorem: the raw RP seam state reconstructs canonically the holomorphic $(E_8)_1$ boundary net at the $\tau=i$ pillowcase. [E] four objects (RawRPSeam, FlatTauIPillowcaseDtN, HolomorphicE8Net, SREKitaevE8Phase); [E] six arrows — 2 closed (Route i v276/v280/v284, Route ii v281/v277/v235), 1 conditional (v282), 2 open premises (the same lemma, v284/v285), 1 Gral; [E] import firewall : no Route-i module imports any Route-ii module or vice versa, so the routes converge only through SEAM.EQUIV.01 (kills the ‘ E_8 into the geometry and back’ circularity); [E] exact-label taxonomy (Formal/Numerical/Conditional Exact, Open Selection); [O] the one open arrow ‘free Gaussian RP bulk $\Rightarrow$ holomorphic single-sector boundary’.
v287_free_rp_bulk_to_holomorphic_boundary.py	SEAM.EQUIV.A01 — Route A (AQFT) theorem-dependency checker for the open Gral arrow ‘free Gaussian RP bulk $\Rightarrow$ holomorphic single-sector boundary net’: types the 5-lemma chain and isolates the <i>one</i> missing standard theorem. [E] L1 RawRPSeam→OS→CAR/quasi-free boundary (v155/v160/v240/v175); [E] L2 gap+chirality $\Rightarrow$ gapped chiral bulk (v64/v156); [O] L3 invertible/SRE Gaussian bulk $\Rightarrow$ single-sector boundary (μ -index 1) — the one missing standard theorem (the AQFT form of $\det K=1$); [E] L4 $\mu=1+c=8 \Rightarrow$ holomorphic (v234); [E] L5 holomorphic $c=8 \Rightarrow (E_8)_1$ (v83/v277/v281). Verdict: 4/5 discharged, Route A reduces SEAM.EQUIV.01 to one cited theorem.

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Script	What it machine-checks (<i>continued</i>)
v288_full_l2_subprincipal_z4.py	SEAM.EQUIV.B01 — Route B (DtN): the full- L^2 lift of the sub-principal $\mathbb{Z}_4$ block-diagonality, proving (numerically, on the full Toeplitz operator) the ‘probably provable’ step and lifting v201/v284 from the finite block to L^2 . [E] character orthogonality: a mark-sourced curvature $f = \sum_{j<4} g(\theta - j\pi/2)$ has Fourier support only on $m \equiv 0 \pmod{4}$; [E] full- L^2 block-diagonality: $\Lambda = n + M_f$ commutes with $\rho = \text{diag}(i^n)$, $\ [\rho, \Lambda]\ \sim 2 \times 10^{-15}$ on $-50..50$; [E] negative control: a generic curvature gives $\ [\rho, \Lambda]\ = 4.44 > 0$; [E] Lean consistency (geom_sum_fourth_root + markLocal_blockDiagonal); [O] the sharper residual — why is the raw seam sub-principal term mark-local?
v289_marklocal_raw.py	MARKLOCAL.RAW.01 — decompose the one remaining Route-B residual (‘why is the raw seam sub-principal term mark-local?’) into a 5-lemma chain and isolate the single open analytic lemma. [C] L1 conic parametrix: conic Steklov DtN $= D_\theta + M_f + \text{cone sources}$ (b-calculus/Melrose, imported); [O] L2 Flat-Away — the one open analytic lemma: $\text{RP} + \text{gap} + 4 \text{ marks} \Rightarrow \text{curvature vanishes away from the marks}$ (the flat-pillowcase realisation); [E] L3 orbit-source: the 4 marks form one μ_4 orbit (v195/v216); [E] L4 Fourier-support: μ_4 -orbit curvature $\Rightarrow$ support only on $4\mathbb{Z}$ (v264/v288, with a non-orbit negative control); [E] L5 full-operator: $\Rightarrow [\rho, \Lambda]=0$ on full L^2 (v288). 4/5 discharged; Route B reduces to exactly L2.
v290_z4_smooth_curvature_adversary.py	SEAM.ADVERSARY.01 — the Route-B red-team that $\mathbb{Z}_4$ block-diagonality is <i>not</i> mark-locality. The strongest adversary, a smooth $\mathbb{Z}_4$ -symmetric off-mark curvature $f = \varepsilon \cos(4\theta)$: [E] it is $\mathbb{Z}_4$ -symmetric (Fourier support $\{\pm 4\} \subset 4\mathbb{Z}$) but <i>not</i> mark-local ($f(\pi/4) = -\varepsilon \neq 0$); [E] it <i>passes</i> the v288 commutator $\ [\rho, \Lambda]\ = 0$ (same as mark-local) — so $[\rho, \Lambda]=0$ is necessary but <i>not</i> sufficient; [E] but it shifts the DtN spectrum off the flat ladder ($\max \Delta\lambda = 0.155$) and the heat trace ($\Delta = 0.019$), so the KMS weight and $(E_8)_1$ character shift; [O] a genuine candidate modulus the commutator misses but the spectral data excludes — Flat-Away must use spectral/energy/heat input.
v291_flataway_contract.py	FLATAWAY.RP.01 — the Flat-Away lemma as its own named mini-theorem with three proof routes opened by v290. Lemma [O]: given RawRPSeam with gap, chirality and the four μ_4 marks, the smooth curvature density in the DtN sub-principal symbol vanishes away from the branch divisor. [E] <i>spectral-rigidity</i> : scanning $f = \varepsilon \cos(4\theta)$, the spectrum deviation from the flat ladder is 0 only at $\varepsilon=0$ — flat is the unique spectral match; [E] <i>heat-kernel</i> : the heat-trace deviation is 0 only at $\varepsilon=0$; [C] <i>RP-energy</i> : $\text{RP} + \text{gap}$ is a Dirichlet-energy minimisation in the Troyanov conformal class $\Rightarrow$ constant-curvature minimiser (Troyanov; cf. v284). [O] three independent routes to one lemma; closing any one closes Route B.
v292_flataway_heat_reduction.py	FLATAWAY.HEAT.01 — the Heat-Kernel route made precise: reduces Flat-Away to <i>one</i> named spectral invariant. [E] the heat-trace deviation $\Delta \text{Tr}(e^{-t\Lambda}) = c(t)\varepsilon^2 + O(\varepsilon^4)$ is a positive-definite quadratic form in the off-mark curvature ($c_k(t) > 0$ for every $\mathbb{Z}_4$ mode $4k$; positive on all combinations), so $\Delta \text{Tr} = 0 \Leftrightarrow f = 0$; leading invariant $\ f\ _{L^2}$ (Parseval). [O] reduction: Flat-Away $\Leftarrow$ ‘the seam fixes the a_2 heat coefficient to its flat value’ $\Rightarrow \int f^2 = 0 \Rightarrow f = 0$ off the marks — one external invariant.
v293_flataway_spectral_hessian.py	FLATAWAY.SPEC.01 — the Spectral-Rigidity route upgraded from one direction (v291) to the <i>full</i> smooth- $\mathbb{Z}_4$ space. [E] splitting mechanism: the degenerate flat Steklov level $ n $ is split by mode $4k$ at $ n =2k$ by $\pm\varepsilon/2$; [E] $S = \sum (\Delta\lambda)^2 \sim 0.50\varepsilon^2$; [E] the Hessian over modes $\{4, 8, 12\}$ has eigenvalues $\{0.497, 0.500, 0.503\} > 0$, so the flat seam is a <i>strict</i> isolated minimum over the whole $\mathbb{Z}_4$ space; [E] a non- $\mathbb{Z}_4$ mode breaks the commutator outright. [O] pinning the seam’s Steklov spectrum excludes every smooth $\mathbb{Z}_4$ deformation $\Rightarrow$ Flat-Away.

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Script	What it machine-checks (<i>continued</i>)
v294_flataway_rp_energy.py	FLATAWAY.ENERGY.01 — the RP-energy / Trojanov route: the flat pillowcase is the unique constant-curvature minimiser at the fixed mark divisor. [E] prescribed divisor + Gauss-Bonnet: S^2 with 4 cone angles π , $\sum(2\pi - \theta) = 4\pi = 2\pi\chi$; [C] Trojanov/Euclidean-cone uniqueness (Trojanov 1991) excludes smooth off-mark curvature; [E] strictly convex curvature energy $E[f] = \int f^2$, Hessian $2\pi I$ (PD) $\Rightarrow$ unique minimiser; [E] no zero-cost deformation. [O] premise: ‘RP+gap realises the energy-minimiser’, converging with v292/v293 on one selection principle; closing any one closes Route B.
v295_flataway_a2_exact.py	FLATAWAY.A2.01 — the <i>exact</i> analytic a_2 coefficient, upgrading the v292 positive-definiteness from numerical to a proof. [E] first variation vanishes: $\partial_\varepsilon \text{Tr } e^{-t\Lambda(\varepsilon)} _0 = -t\hat{f}(0) \sum e^{-t n } = 0$ (zero-mean off-mark curvature, Gauss-Bonnet); [E] convexity $\Rightarrow$ global minimum: $\phi(x) = e^{-tx}$ strictly convex $\Rightarrow \Lambda \mapsto \text{Tr } e^{-t\Lambda}$ convex (Klein/Peierls), so $\varepsilon=0$ is the global minimum and $\Delta \text{Tr} \geq 0$ for all ε , $= 0$ iff $f = 0$; [E] exact a_2 kernel via the divided difference of e^{-tx} (Duhamel), matched to numerics to rel.err $< 10^{-6}$; [E] degenerate-split closed form $2e^{-2kt}(\cosh(tg/2)-1) \geq 0$; [O] reduction now analytic: Flat-Away $\Leftarrow$ ‘the seam fixes a_2 ’. Lean-mirrored (FORM.FLATAWAY.01).
v296_flataway_a2_closed.py	FLATAWAY.A2.CLOSED.01 — the exact a_2 coefficient in <i>closed form</i> . [E] the operator tails telescope geometrically ($C_k + D_k e^{-4kt} = 4kt(1 - e^{-4kt})$), giving $W_k^{\text{tail}} = t(1 - e^{-4kt})/(8k(1 - e^{-t}))$; [E] a finite $(4k-1)$ -term middle (incl. the degenerate diagonal $\Phi(2k, 2k) = (t^2/2)e^{-2kt}$); [E] closed form $W_k(t) = \frac{t(1-e^{-4kt})}{8k(1-e^{-t})} + \frac{1}{2} \sum_{m=1}^{4k-1} \Phi(m, 4k-m)$ $(W_1(t) = t(2te^t + e^{3t} + 3e^{2t} + e^t - 1)e^{-3t}/8)$, reproducing v295 to machine precision; [E] manifestly positive; [E] small- t : $W_k = t/2 + O(t^3)$ (mode-independent leading $1/2$, the t^2 term cancels).
v297_route_a_literature_stack.py	SEAM.EQUIV.A.LIT.01 — Route A’s ‘one standard import’ as a precise citable theorem stack. [E] LIT-A invertible/SRE bulk $\Rightarrow$ trivial bulk topological order (Kitaev 2006; Freed–Hopkins 2021); [E] LIT-B bulk MTC = Drinfeld center, trivial center $\Rightarrow$ holomorphic boundary net (Müger 2003; Kawahigashi–Longo–Müger 2001); [E] LIT-C holomorphic $c=8$ net $\Rightarrow (E_8)_1$ (Conway–Sloane; Dong–Xu/Kawahigashi–Longo). [E] the three compose into ‘invertible bulk $\Rightarrow (E_8)_1$ ’, all legs established; [O] the one open hypothesis is the input of LIT-A, ‘the raw quasi-free seam bulk is invertible (SRE)’ = Route B’s Flat-Away. [E] non-circular with Route B (the v286 firewall holds).
v298_e8_network_attractor.py	<i>E8 as a network attractor</i> — a computational-substrate (Wolfram-program) reading of the $(2, 3, 5)$ /McKay hull, on the v219 bedrock; an honest audit, not a derivation. [E] the E_8 Kac marks $(1, 2, 3, 4, 5, 6, 4, 2, 3)$ are the <i>unique</i> attractor of the minimal lazy graph update $m \leftarrow (A + 2I)/4 \cdot m$ on the affine- $E_8/(2, 3, 5)$ McKay graph (converges from any positive start; $Am = 2m$, top eigenvalue 2). [E] the spherical McKay tower terminates at E_8 ($2T \rightarrow E_6$, $2O \rightarrow E_7$, $2I \rightarrow E_8$, $h = 30$); [E] the cascade is nested-subgraph coarse-graining ($240 \rightarrow 126 \rightarrow 72 \rightarrow 40 \rightarrow 20$). [C] Wolfram reading: E_8 as the universal attractor of a minimal $(2, 3, 5)$ network (Coxeter-skeleton level). [O] a minimal hypergraph <i>rewrite</i> whose attractor is the full TFPT structure stays open; $\varphi_0 = (4/3)c_3 = 1/(6\pi)$ is the analytic seed, not an edge fraction.

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Script	What it machine-checks (<i>continued</i>)
v299_hypergraph_0d_autonomous.py	The hypergraph/Wolfram bridge (hardened): the 3-arm $(2, 3, \cdot)$ branch type is the irreducible seed on which a local witness-based spectral growth <i>reaches</i> E_8 as the last finite point ($E_6 \rightarrow E_7 \rightarrow E_8$, then stops at the affine boundary $\hat{E}_8$) — <i>not</i> ‘P2 derived’. [E] icosahedron = 3-uniform hypergraph ($ \text{Aut} = 120 = I_h $; the McKay group is the $SU(2)$ binary lift $2I$, a different order-120 group); [E] the $1 \rightarrow 4$ subdivision rewrite is equivariant (120 symmetries at every scale); [E] the $2I$ fusion tensor is a weighted 3-uniform hypergraph whose 2-dim slice is the affine E_8 McKay graph; [E] Smith: $\rho \leq 2$ selects (affine) ADE; [E] Collatz–Wielandt: $\rho \leq 2 \Leftrightarrow$ a positive witness m with $Am \leq 2m$ (local); [E] the autonomous rule (diffusion witness + local gate $Am \leq 2m$) runs $E_6 \rightarrow E_7 \rightarrow E_8 \rightarrow \hat{E}_8$ under the $(2, 3, \cdot)$ seed; [E] A_n ($\rho = 2 \cos \frac{\pi}{n+1}$) and D_n ($\rho = 2 \cos \frac{\pi}{2n-2}$) controls are < 2 for all n , never reaching E_8 ; [O] the seed = P2. A second network reading of the $(2, 3, 5)/E_8$ core (v219/v298).
v300_flataway_rigid.py	FLATAWAY.RIGID.01 — the attack on Flat-Away. [E] the flat fingerprint: $\text{spec}(D_\theta)$ is the integer ladder, every level $n \geq 1$ of multiplicity exactly 2 (a discrete fingerprint, not a norm); [E] the resonant mode $4k$ splits level $2k$ by gap $= g_k$ (sympy 2×2 $[[2k, g/2], [g/2, 2k]] \Rightarrow 2k \pm g/2$), validated vs the full Toeplitz operator; [E] any $g_k \neq 0$ lifts the resonant degeneracy (mult $2 \rightarrow 1+1$) and changes the spectral multiset, so preserving the flat ladder <i>with</i> its mult-2 degeneracies forces every $g_k = 0 \Rightarrow f = 0$ — a discrete obstruction, strictly stronger than the v291/v293 ‘deviation grows’ scan; [E] with the v295 convexity, flat is isolated analytically <i>and</i> discretely; [C] the pin derived: the $(E_8)_1$ character $E_4/\eta^8 = q^{-1/3}(1 + 248q + \dots)$ has integer q -coefficients (248 at level 1; E_8 even unimodular $\Rightarrow$ integer weights), and by 2d Steklov conformal rigidity the integer ladder $\Leftrightarrow$ flat seam, so $(E_8)_1$ rationality $\Rightarrow f = 0$ (conditional on Route A); [O] Flat-Away carries <i>zero</i> new open content beyond Route A — the two SEAM.EQUIV.01 routes converge on one rationality fact.
v301_route_a_invertible.py	SEAM.EQUIV.A.INV.01 — discharge Route A’s last open hypothesis (‘the raw quasi-free seam bulk is invertible/SRE’) via the free-fermion classification; since v300 collapsed Route B into Route A, this is the last unconditional gap of SEAM.EQUIV.01. [E] carrier = 16 Majoranas, $c = 8$ ($g_{\text{car}} + N_{\text{fam}} = 5 + 3 = 8 = 16/2$, v148); [E] $SO(16)_1 \supset (E_8)_1$: $\dim \mathfrak{so}(16) = 120$ currents + 128 spinor = 248 = $\dim E_8$ (v154); [C] free-fermion invertibility (Kitaev): a gapped Gaussian/quasi-free 2+1D fermion phase (class D) is $\mathbb{Z}$ -classified by the chiral Majorana number and is <i>always</i> invertible (no intrinsic anyons; topological order needs interactions), so a gapped quasi-free bulk is invertible automatically; [E] the invariant $ \det K = \#\text{anyons}$ is 1 for E_8 (invertible) vs 4 for the gauged $D_8 = SO(16)$ (anyons), which free fermions cannot produce; [O] LIT-A’s ‘invertible bulk’ now follows from ‘gapped 16-Majorana quasi-free bulk’ (v148/v160+the gap), so the residual changes from a topological-order statement to the spectral input ‘is the quasi-free bulk gapped?’; [O] with v300 the whole open content of SEAM.EQUIV.01 reduces to the single spectral statement ‘the quasi-free seam bulk is gapped’.

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Script	What it machine-checks (<i>continued</i>)
v302_seam_gap.py	SEAM.EQUIV.GAP.01 — the last lever: after v300/v301 the whole open content of SEAM.EQUIV.01 was ‘the quasi-free seam bulk is gapped’; that gap is <i>not</i> a free input but the established Recovery gap of the seam transfer operator. [E] $\text{spec}(T) = \{1, (2/3)^6, (1/3)^6\}$ (v160/v162), a simple leading Perron eigenvalue 1; [E] the gap is derived: $\Delta = -\ln((2/3)^6) = 6 \ln(3/2) = 2N_{\text{fam}} \ln(3/2) \approx 2.4328 > 0$ (multiplicative gap $1 - (2/3)^6 = 665/729$; $6 = 2N_{\text{fam}}$, $(2/3)^6$ the μ_4-deck transfer eigenvalue forced by the carrier); [E] the positivity margin $\Delta - 31/(4\pi^2) = 1.6476 > 0$ (the v76 decoupling margin); [C] by Osterwalder–Schrader / quasi-free clustering a transfer gap $\Delta > 0$ is a mass gap of the reconstructed Hamiltonian; [O] so the last TFPT-internal input is the derived Recovery gap $6 \ln(3/2) > 0$, and SEAM.EQUIV.01’s residual is a composition of cited theorems (OS/clustering + Kitaev v301 + the v297 AQFT stack) over established TFPT facts — no undischarged TFPT-internal assumption remains, though it stays [O] (not machine-proved end-to-end).
v303_ftransfer_dynamics.py	FR.DYNAMICS.01 — the discrete→dynamic lens on F_transfer: the main-branch mechanism (a gapped, positivity-preserving relaxation to a <i>unique</i> attractor; the local-averaging update → the E_8 marks, gap $6 \ln(3/2)$) is the shared <i>shape</i> of all four instances. [E] F_pole (Koide) <i>is</i> the seam dynamics — the source→pole/branch relaxation is the Möbius map with fixed-point multiplier $F' = (2/3)^6 = \lambda_2$, the seam-clock subleading eigenvalue (v82/v54); $F' < 1 \Rightarrow$ a unique attractor at the seam rate; [C] F_Boltzmann (η_B) is a gapped positive contraction (washout $\kappa_f \in (0, 1)$, H-theorem; compiler fixes $A_\Lambda = 10$, rate thermal); [C] F_relic (axion) freezes at an adiabatic fixed point (seed $\theta_i = 3\pi/5$, rate cosmological); [E] F_QCD (m_p/m_e) is the 1-loop RG flow with the carrier $b_3 = -7$ (asymptotic freedom $\Rightarrow$ the Gaussian UV attractor, Λ_{QCD} generated). [O] Verdict: one shape underlies all four = the main-branch principle; F_pole has the seam rate exactly, the other three share only the shape (external rates), so F_transfer is the readout end of the one principle, not a bolt-on — simplicity is preserved by honest fencing (v187).
v304_idg_nonlocal_ghost.py	QGAMB.IDG.01 — the KMS spectral-action cutoff suggests a <i>nonlocal</i> (infinite-derivative) graviton form factor; under entire analyticity the Stelle ghost is a <i>truncation artefact</i> — a [C] narrowing of the red-team rt_F perturbative-gravity attack, <i>not</i> a closure of QG.AMB.01 (no new parameter: the cutoff is the v259 seam KMS weight). [E] the local four-derivative propagator $1/(p^2(p^2 + M^2)) = (1/M^2)[1/p^2 - 1/(p^2 + M^2)]$ has a healthy massless graviton (residue $+1/M^2$ at $p^2=0$) and a massive spin-2 mode with <i>negative</i> residue $-1/M^2$ at $p^2 = -M^2$ (the Stelle ghost, reproducing v278); [E] for an IDG operator $p^2 a(p^2)$ with $a(z) = e^{z/M^2}$ entire and nowhere zero, the dressed propagator $1/(p^2 a)$ keeps its <i>only</i> pole at $p^2=0$ — no ghost (Tomboulis 1997; Biswas–Mazumdar–Siegel 2006); [E] negative control: a polynomial truncation $a(z) = 1 + z/M^2$ (the $R+R^2$ order) has a real zero at $z = -M^2$ = the ghost pole, so ‘entire vs polynomial’ is the discriminator; [C] the cutoff is the $\beta=1$ seam KMS weight $f(u) = e^{-u}$ (v259), not a choice — truncating $\text{Tr} e^{-D^2/\Lambda^2}$ at a_4 is what makes the local $R+R^2$ and the ghost; [C] conditional narrowing: <i>if</i> the resummed form factor is entire (Biswas–Mazumdar–Siegel class) <i>then</i> the perturbative graviton is ghost-free and rt_F’s attack is a truncation artefact; [O] open: (i) the trace regulator f is not the kinetic form factor $a(\square)$ — entire analyticity of the resummation is unproven; (ii) a ghost-free <i>perturbative</i> graviton is not the nonperturbative ambient measure — QGAMB.IDG.01 stays [C]/[O], not a QG.AMB.01 closure.

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Script	What it machine-checks (<i>continued</i>)
v305_witness_independence.py	Witness-independence / generator-economy audit (structural anti-numerology firewall, companion to v100): every headline integer is a documented image of the single anchor $a=(1,1,2)$ ($e=(4,5,2)$, $p_n=2+2^n$; v23/v228), π the only transcendental primitive (ARCH.CORE.01) — 13 atoms / 2 free primitives = $6.5 \times$ compression made explicit (the recurring $2/3= \mathbb{Z}_2 /N_{\text{fam}}$ and $(2/3)^6$ are <i>one</i> ratio); E_8/g_{car} /anchor are overdetermined (≥ 3 structurally independent witnesses), the 5 pure-seed readouts single-witness (correlated, scored jointly by v100); α^{-1} 's '137' is foreign to the anchor family = an independent witness [E]
v306_seed_crossval.py	Leave-one-out cross-validation of the shared seed φ_0 : back-solving φ_0 independently from the five seed-grammar observables ($\sin^2 \theta_{12}$, $\sin^2 \theta_{13}$, β , Ω_b , λ_C) and error-weighted-averaging reproduces the axiom seed $\varphi_0=1/(6\pi)+48c_3^4=0.0531720$ to 0.04% (one real seed, not a per-observable fit); leave-one-out predicts every held-out observable within 3σ out of sample (most-tensioned = $\sin^2 \theta_{13}$, $\sim 2\sigma$); a data $\leftrightarrow$ formula shuffle explodes the χ^2 by $> 100 \times$ [E]
v307_data_watchdog.py	Data watchdog: the operational decision pipeline over the frozen registry (v84). Classifies all 20 entries (16 predictions + 2 assigned textures + 2 bands) PASS/WATCH/TENSION/KILL by live n_σ vs repo-documented current bests (CODATA 2022, NuFIT 6.0, ACT DR6, Planck 2018, PDG 2024, BK18); no decidable prediction in KILL (theory alive); watch items α^{-1} (1.9σ), s_{23} (1.8σ) and the most-tensioned core $\sin^2 \theta_{13}$ (2.0σ); the prediction-of-record $\sin^2 \theta_{12}=0.306747$ compatible (JUNO, the fastest falsifier); $r \in [0.0033, 0.0048]$ below the BK18 limit and the kill 0.01; $w=-1$ flagged the dark-energy watchdog (DESI) [E]
v308_seam_equiv_chain.py	TOE attack 1 — the SEAM.EQUIV.01 keystone as a composition certificate: the v297 stack as one well-typed chain $\text{gap}>0 \rightarrow \text{invertible} \rightarrow \text{holomorphic } c=8 \rightarrow (E_8)_1$ with exact discriminators $ \det \text{Cartan}(E_8) =1$ vs $ \det \text{Cartan}(D_8) =4$, carrier tower $4 \cdot 4=16 \rightarrow 4 \rightarrow 1$, $c=g_{\text{car}}+N_{\text{fam}}=8$; the input gap is the derived recovery gap $6 \ln(3/2)>0$. The only undischarged premise is the cited OS step — an assembly/reduction certificate (Lean target), NOT a closure [E][O]
v309_modular_bedrock.py	TOE attack 2 — the bedrock $\omega \circ \rho = \omega$ via an explicit modular Hamiltonian, non-circular: marks = 4 from Gauss–Bonnet (v216) + the order-4 clock from cross-ratio 2 (v214) $\Rightarrow \mu_4$ derived, not assumed; the quasi-free modular Hamiltonian $K = \log((1-C)/C)$ round-trips to the seam operator and $[\rho, K]=0 \Leftrightarrow \omega \circ \rho = \omega$ (a $\mathbb{Z}_2$ profile breaks it). Residual = Bisognano–Wichmann intrinsicality of the raw collar; NOT a closure of QGEO.SYM.01 [E][O]
v310_carrier_sm_anomaly.py	TOE attack 3 — the carrier half-spinor is one anomaly-free SM generation with the SM RG: $16=\Lambda^{\text{even}}(\mathbb{C}^5)=1+10+5 \rightarrow SU(5) \subset SO(10)$ as $10+5+1 = \text{one generation}$; gauge-anomaly-free ($\sum Y=0$, $\sum Y^3=0$, $[SU(2)]^2 U(1)=[SU(3)]^2 U(1)=0$, exact) and reproduces $(b_1, b_2, b_3)=(\frac{41}{10}, -\frac{19}{6}, -7)$; a fourth family shifts b_1 , so $N_{\text{fam}}=3$ pins the RG. Closes the spectrum/anomaly/ β sub-question; the full EG S -matrix + Yukawa stay open [E][C]
v311_gap_decoupled_measure.py	TOE attack 4 — the physical QG measure as a gap-decoupled, exponentially-clustering object: the transfer spectrum $\{1, (2/3)^6, (1/3)^6\}$ gives geometric clustering at rate $(2/3)^6$, correlation length $1/(6 \ln(3/2))$, finite susceptibility $729/665$; the v76 margin $6 \ln(3/2) - 31/(4\pi^2) \approx 1.648 > 0$ decouples the physical sector from the un-built ambient. Spectral-action $a_2=EH/a_4=R^2/72$ (v36) + KMS $\beta=1$ (v259); QG.AMB.01 stays [O] (gap-decoupled, inert) [E][O]

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Script	What it machine-checks (<i>continued</i>)
v312_hypergraph_substrate.py	TOE attack 5 — the hypergraph substrate sharpened: the affine- E_8 Kac marks are the Perron eigenvector ($A m=2m$) and the subleading eigenvalue is exactly $2 \cos(\pi/5) =$ the golden ratio (the 5-fold/icosahedral signature), but the recovery rate $(2/3)^6$ is <i>not</i> any eigenvalue and φ_0 is not a rational edge fraction; so a full-structure rewrite must inject exactly two non-graph-spectral data — the cusp weight $2/3 = \mathbb{Z}_2 /N_{\text{fam}}$ (gap $6 \ln(3/2)$) and the analytic seed φ_0 . The open question is precisely delimited, not closed [E][O]
v313_golden_atoms_spectral.py	The golden ratio is the $g_{\text{car}}=5$ signature: the $(2, 3, 5)$ atoms <i>are</i> the affine- E_8 network spectral angles (v312 follow-up, exact). [E] the charpoly factors $x(x^2-4)(x^2-1)(x^2-x-1)(x^2+x-1)$, the golden minimal polynomial x^2-x-1 divides it ($\phi=2 \cos(\pi/5)$ an exact eigenvalue); the non-trivial eigenvalues are $2 \cos(\pi/k)$ for $k \in \{2, 3, 5\} = \{ \mathbb{Z}_2 , N_{\text{fam}}, g_{\text{car}}\}$ (giving $0, 1, \phi, 1/\phi$), so the golden ratio is the $g_{\text{car}}=5$ (5-fold) signature — a new spectral witness for g_{car} (raises the v305 multiplicity). The $(2, 3, 5)$ spherical excess $1/2+1/3+1/5=31/30$ ties the v63/v76 margin numerator $31=2^{g_{\text{car}}}-1=248/8=1+h$ to the Coxeter 30 (a unification, not new evidence). [E] honest null: ϕ is structural, not a readout. [C] direction: ϕ is the E_8 -quasicrystal (Elser-Sloane) ratio, a candidate substrate [E][C]
v314_rate_translation.py	Do the discrete-kernel and dynamic rates translate? An exact number-field split. The affine- E_8 adjacency spectrum splits into the rational part $\{0, \pm 1, \pm 2\}$ in $\mathbb{Q}$ and the golden part $\{\pm \phi, \pm 1/\phi\}$ in $\mathbb{Q}(\sqrt{5})$; the dynamic transfer spectrum $\{1, (2/3)^6, (1/3)^6\}$ is entirely rational. [E] the family rates DO translate (the rational angles $2 \cos(\pi/2)=0= \mathbb{Z}_2 $, $2 \cos(\pi/3)=1=N_{\text{fam}}$ build the recovery rate $(2/3)^6 = (\mathbb{Z}_2 /N_{\text{fam}})^{2N_{\text{fam}}}$ in $\mathbb{Q}$), but the carrier 5-fold (golden, $\mathbb{Q}(\sqrt{5})$) has <i>no</i> rational dynamic image — a field obstruction, so it is static-only. The shared object is the order-30 Coxeter element ($30=g_{\text{car}}(2N_{\text{fam}})=5 \cdot 6$); the ϕ quasicrystal carries the carrier, not the cusp-weight family dynamics [E][C]
v315_coxeter_coupling.py	Couple or factorize? The order-30 Coxeter sectors couple as a cyclotomic field (v314 follow-up). [E] GROUP FACTORIZES: $\gcd(5, 6)=1 \Rightarrow \mathbb{Z}/30 = \mathbb{Z}/5 \times \mathbb{Z}/6$ (direct product, group-decoupled); [E] EXPONENTS FACTOR: E_8 exponents = totatives(30) = totatives(5) $\times$ totatives(6), $\phi(30)=4 \cdot 2=8 =$ rank E_8 ; [E] FIELD COUPLES: $[\mathbb{Q}(\zeta_{30}):\mathbb{Q}]=8 =$ rank E_8 , $\mathbb{Q}(\zeta_{30})$ is the compositum of the carrier $\mathbb{Q}(\zeta_5) (\ni \sqrt{5})$ and the family $\mathbb{Q}(\zeta_3)$; [E] GALOIS = $\mu_4 \times \mathbb{Z}_2$: $(\mathbb{Z}/30)^\times = (\mathbb{Z}/5)^\times \times (\mathbb{Z}/3)^\times = \mathbb{Z}/4 \times \mathbb{Z}/2$ (order 8, max order 4), $\mu_4=(\mathbb{Z}/5)^\times$ the carrier Galois (the seam clock = the carrier golden-field Galois), $\mathbb{Z}_2=(\mathbb{Z}/3)^\times$ the family Galois; [E] $\sqrt{5}=\phi+1/\phi$ = the Gauss sum in $\mathbb{Q}(\zeta_5)$. [C] $30=5 \cdot 6$ does not dynamically entangle — it couples as the cyclotomic compositum, the bridge is Galois not dynamical [E][C]
v316_galois_readout.py	Does the Galois $\mu_4 \times \mathbb{Z}_2$ (v315) organize the physical readouts? Yes — the CP phases. [E] the hexagonal CP unit $\rho=\zeta_6=\zeta_{30}^5$ is the order-6= $2N_{\text{fam}}$ FAMILY factor c^5 (the carrier is $\zeta_5=\zeta_{30}^6$); [C] $\delta_{\text{CKM,lead}}=\pi/3=\arg \zeta_6$, $\delta_{\text{PMNS}}=4\pi/3=\arg \zeta_6^4$ (power $4= \mu_4 $), $\zeta_6^4 = -\zeta_6$ the sheet flip ($\mu_6=\mu_3 \times \mu_2$); [E] the Galois $\mathbb{Z}_2=\text{Gal}(\mathbb{Q}(\zeta_6)/\mathbb{Q})=\{\zeta_6 \mapsto \zeta_6^5=\bar{\zeta}_6\}$ IS CP conjugation ($\delta \mapsto -\delta$); [E] the carrier factor ζ_5 (golden $\sqrt{5}$) carries no phase (static); [E] the magnitudes ($\sin^2 \theta_{12}=1/3-\varphi_0/2$, transcendental φ_0) are not cyclotomic. So the Galois bridge reaches phenomenology through the family factor (phases); the carrier is static; the magnitudes are the analytic seed [E][C]

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Script	What it machine-checks (<i>continued</i>)
v317_galois_family.py	Are the 3 generations a μ_3 /Galois orbit? Yes (μ_3), refined 1+2 by Galois (v316 follow-up). [E] the 3 cusp weights $\{0, 1/3, 2/3\}$ ($\text{Spec}(Q_+) = \{1, 2, 3\} = A_3$ exponents) map under $w \mapsto e^{2\pi i w}$ to the cube roots $\{1, \zeta_3, \zeta_3^2\}$; the cyclic family symmetry $w \mapsto w+1/3$ is a transitive μ_3 orbit (the family IS the cube-root orbit). [E] the transfer eigenvalues $(1-w)^6 = \{1, (2/3)^6, (1/3)^6\}$ attach to the weights (attractor = eigenvalue 1 at $w=0$). [E] the Galois $\mathbb{Z}_2$ ($\zeta_3 \mapsto \zeta_3^2$, = CP conjugation v316) fixes $w=0$ (rational) and swaps $w=1/3 \leftrightarrow 2/3 \Rightarrow$ orbit 1+2; so the Galois-FIXED generation is the recovery ATTRACTOR (the law), the Galois PAIR the decaying hierarchy. [C] the family structure is arithmetic; the mass magnitudes stay the analytic seed [E][C]
v318_arithmetic_capstone.py	The capstone: the SM structural sector is $\mathbb{Q}(\zeta_{30}) + \text{Galois } \mu_4 \times \mathbb{Z}_2$, and the complete input is $\{a, \pi, v_{\text{geo}}\}$ (synthesis of the v313–v317 arc). [E] the structural sector (3 generations, 2 CP phases, orbit/hierarchy) lives in $\mathbb{Q}(\zeta_{30})$: $[\mathbb{Q}(\zeta_{30}):\mathbb{Q}] = \varphi(30) = 8 = \text{rank } E_8$, $30 = \mathbb{Z}_2 N_{\text{fam}} g_{\text{car}} = h(E_8)$, Galois $(\mathbb{Z}/30)^\times = \mu_4 \times \mathbb{Z}_2$; [E] rigidity: forced by the anchor atoms $\{2, 3, 5\} = e(a)$; [E] magnitude reduction: $\varphi_0 = (4/3)c_3 + 48c_3^4$ is a pure function of π (no free parameters), so the magnitudes are $\{a, \pi\}$ -determined, not free; [E] free inventory: 0 dimensionless free parameters, π the unique transcendental, v_{geo} the one dimensional unit. [O] residual: the raw-seam realisation stays open (QGEO.SYM.01/SEAM.EQUIV.01) [E][O]
v319_translation_clock.py	The translation clock: the discrete $\leftrightarrow$ dynamic bridge is the order-30 Coxeter element, a clock with two coprime hands 5×6 , read law-inclusive (0..5) or live-only (1..5). [E] the only object holding both the static carrier ($\mathbb{Q}(\sqrt{5})$) and the dynamic family (rational) data is the order-30 Coxeter element (v314); $30 = h(E_8) = g_{\text{car}}(2N_{\text{fam}}) = 5 \cdot 6$, $\text{gcd}(5, 6) = 1 \Rightarrow \mathbb{Z}/30 = \mathbb{Z}/5 \times \mathbb{Z}/6$ (v315). [E] DYNAMIC HAND ($\mathbb{Z}/6 = 2N_{\text{fam}}$, ticks 0..5): recovery exponent exactly $6 = 2N_{\text{fam}}$, rate $(2/3)^6$; order-6 generator c^5 ($\zeta_6 = \zeta_{30}^5$). [E] LAW VS LIVE: the resummed clock rate(n) = $-p_2 \ln(1 - n/N_{\text{fam}})$ (v124) has rate(0) = 0 (the attractor/law) and live modes from $n=1$; the E_8 live phases (totatives of 30) start at 1, so 0, 1, 2, 3, 4, 5 is law-inclusive, 1, 2, 3, 4, 5 live-only. [E] STATIC HAND ($\mathbb{Z}/5 = g_{\text{car}}$, ticks 1..5): golden $\mathbb{Q}(\sqrt{5})$, field-obstructed (no rational dynamic image) — static-only. [E] one full turn = $\text{lcm}(5, 6) = 30 = h(E_8)$ (rank $E_8 = 8 = \varphi(30)$, $ \mu_4 =4$ planes, v55); the “it is one clock” reading is [C].
v320_galois_cp_relation.py	A NEW falsifiable prediction from the Galois structure: the two CP phases are locked, $\delta_{\text{PMNS}} = \delta_{\text{CKM}}^{\text{lead}} + \pi$. [E] both phases are powers of one hexagonal unit $\rho = \zeta_6$ (v316): $\delta_{\text{CKM}}^{\text{lead}} = \arg \rho = \pi/3$ (60°), $\delta_{\text{PMNS}} = \arg \rho^4 = 4\pi/3$ (240°), $\rho^4 = -\rho$, so $\delta_{\text{PMNS}} - \delta_{\text{CKM}}^{\text{lead}} = \pi$ exactly (the $\mathbb{Z}_2$ sheet flip) — the quark and lepton leading CP phases are NOT independent. [C] prediction of record $\delta_{\text{PMNS}}^{\text{lead}} = 240^\circ$ (upgrades the assigned texture to a Galois-forced relation to the measured quark phase); [C] currently within the broad NuFIT 6.0 range; [X] kill test: δ_{PMNS} robustly away from 240° ($> 3\sigma$; DUNE/Hyper-K/JUNO) falsifies the Galois-CP organization [E][C][X]
v321_killtest_board.py	The forward kill-test board: the decisive upcoming measurements, ranked (forward companion to v307). [E] each entry is locked to a freeze_file.csv kill row: #1 JUNO $\sin^2 \theta_{12} = 0.306747$ (fastest), #2 CMB-S4/LiteBIRD r (kill $r > 0.01$), #3 DESI/Euclid $w = -1$, #4 DUNE/Hyper-K $\delta_{\text{PMNS}} = 240^\circ$ (the new v320 Galois-CP relation), #5 DUNE/LEGEND/nEXO ordering + $m_{\beta\beta}$, #6 PSI n2EDM, #7 JUNO $\sin^2 \theta_{13}$ ($\sim 2\sigma$ now), #8 LiteBIRD β . A forward decision ledger complementing v307; no new physics [E]

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Script	What it machine-checks (<i>continued</i>)
v322_cp_lock_sharpened.py	The v320 CP-lock prediction sharpened into a quantitative kill test. [E] the leading CP phase sits on the six hexagonal nodes $\arg \rho^k = k \cdot 60^\circ$; $\delta_{\text{CKM}}^{\text{lead}} = 60^\circ$ (node 1), $\delta_{\text{PMNS}}^{\text{lead}} = 240^\circ$ (node 4). [E] the node selector is the deck order: $\delta_{\text{PMNS}}^{\text{lead}} = \mu_4 \delta_{\text{CKM}}^{\text{lead}} = 4(\pi/3) = 4\pi/3 = \delta_{\text{CKM}}^{\text{lead}} + \pi$ ($\rho^4 = -\rho$). [C] sub-leading budget: $\delta_{\text{CKM}}^{\text{full}} = \pi/3 + 3\lambda^2$ ($\sim 68.7^\circ$); the lepton sub-leading is a separate open holonomy term bounded by $\sim 3\lambda^2 \approx 8.7^\circ \Rightarrow$ band $240 \pm \sim 9^\circ$. [C] current tension: vs NuFIT 6.0 NO ($\delta_{CP} = 212_{-41}^{+26^\circ}$) the leading 240° sits at $+1.08\sigma$, band edge $\sim 231^\circ$ at $+0.74\sigma$. [X] kill: the nearest wrong node is 60° away $\gg$ budget; DUNE/Hyper-K ($\sim 5\text{--}15^\circ$) discriminate, $> 3\sigma$ outside kills the lock. [E] an anarchic δ_{CP} hits the band with $p \sim 5\%$ and node 4 1-in-6 [E][C][X]
v323_bw_geometric_modular.py	The keystone pushed one step: Bisognano–Wichmann makes the seam modular flow <i>geometric</i> , so the μ_4 deck invariance is not an independent axiom. [E] the clock $\rho = \text{diag}(i^n) = \exp(i(\pi/2)L)$ is a geometric rotation ($L = \text{diag}(n)$, $\rho^4 = I$, $\mu_4 \subset U(1)_{\text{rot}}$). [E] for a rotation-covariant $C = f(L)$ the modular Hamiltonian $K = \log((1 - C)/C) = g(L)$, so $[K, L] = 0$ (the modular flow commutes with all rotations) and $[\rho, K] = [\rho, C] = 0$ — the clock is a modular symmetry for free. [E] discriminator vs v309: a period-4 curvature preserves the clock but its modular flow is <i>not</i> geometric ($[K, L] \neq 0$); BW is strictly stronger. [C] linked bedrock: given the seam is the $(E_8)_1$ chiral net (v308), BW/Hislop–Longo make the vacuum modular flow geometric $\Rightarrow$ QGEO.SYM.01 ($\omega \circ \rho = \omega$) is downstream of SEAM.EQUIV.01 + a rotation-invariant vacuum. [O] residual: the raw collar vacuum is rotation-invariant (cleaner than v309, shared with v308) [E][C][O]
v324_hypergraph_fiber.py	The minimal hypergraph substrate that works: a $(2, 3, 5)$ -network <i>fibered</i> by a 3-fold cusp channel reproduces both the E_8 skeleton and the recovery gap (the constructive v312 follow-up). [E] network factor: $T_{\text{net}} = (A + 2I)/4$ fixes the Kac marks (eigenvalue $1 = E_8$ skeleton), subleading $(\varphi + 2)/4$ (golden); $(2/3)^6$ is <i>not</i> in its spectrum (the v312 negative). [E] cusp fiber: $T_{\text{cusp}} = \text{diag}((1 - w)^{2N_{\text{fam}}})$, $w \in \{0, 1/3, 2/3\}$ ($N_{\text{fam}} = 3$, v317), spectrum $\{1, (2/3)^6, (1/3)^6\}$. [E] the fibered substrate $T = T_{\text{net}} \otimes T_{\text{cusp}}$ has top eigenvalue 1 (eigenvector marks $\otimes$ ($w = 0$), skeleton $\times$ democratic cusp) <i>and</i> $(2/3)^6$ as a genuine eigenvalue (network attractor $\times$ cusp subleading). [E] honest injection: without the fiber ($T_{\text{net}} \otimes I_3$) there is no $(2/3)^6$ — the cusp datum is injected, not graph-spectral; substrate = network $\times$ cusp = the v315 split $30 = g_{\text{car}}(2N_{\text{fam}}) = 5 \cdot 6$. [E] minimality: the smallest fiber is the 3-node cusp ($= N_{\text{fam}}$) = order-30 (v319 clock). [C] a consistent fibered realization, not a derivation of $2/3$ from a pure rewrite [E][C]
v325_pillowcase_keystone.py	The seam keystone as ONE citable theorem: the raw seam state <i>is</i> the flat $\tau = i$ pillowcase state, with exactly one open lemma. IF (raw RP-collar seam state = flat $\tau = i$ pillowcase / rotation-invariant state) THEN 4 square marks + μ_4 deck + $\omega \circ \rho = \omega$ + holomorphic $c = 8 \Rightarrow (E_8)_1$, with the carrier recovery gap as input. [E] pieces all exact: $n = 2\chi(S^2) = 4$ (v216); cross-ratio $2 \Rightarrow j = 1728$ (v214/v267); flat orbifold $S^2(2, 2, 2, 2)$, $\chi_{\text{orb}} = 0$ (Trojanov); DtN sub-principal at $m \equiv 0 \pmod 4$ (v201/v280); $\det \text{Cartan}(E_8) = 1$ vs $D_8 = 4$ (v83/v143/v308); gap $6 \ln \frac{3}{2} > 0$ (v76/v302). [O] the one open lemma — the raw collar state IS the flat $\tau = i$ pillowcase / rotation-invariant state — is SHARED by both bedrock IDs (QGEO.SYM.01, SEAM.EQUIV.01; v323), machine-pinned in Lean (FORM.SEAMEQUIV.01 + FORM.QGEO.BW.01); an assembly/reduction certificate (like v176/v261), not a closure [E][O]

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Script	What it machine-checks (<i>continued</i>)
v326_ftransfer_suite.py	The F_{transfer} solver suite: the four transfer readouts as ONE runnable harness, each a gapped relaxation to a unique attractor (productises v303). [E] F_{pole} (Koide): Moebius contraction to $Q^*=2/3$ with multiplier $(2/3)^6$ = the seam-clock subleading eigenvalue, unique attractor at the SEAM rate. [C] $F_{\text{Boltzmann}}(\eta_B)$: washout contraction to the balance 6.1×10^{-11} , monotone (H-theorem), external thermal rate. [C] F_{relic} (axion): the comoving number $N=E/\omega$ is the adiabatic invariant, the relic freezes (seed $\theta_i=3\pi/5$), cosmological rate. [E] $F_{\text{QCD}}(m_p/m_e)$: 1-loop RG with carrier $b_0=7$ flows to the Gaussian UV fixed point, Λ_{QCD} generated. [C] F_{RareKaon} : $\text{BR}(K^+)=9.45 \times 10^{-11}$ on NA62 2016-2024 (v202). [O] only F_{pole} has the seam rate $(2/3)^6$; the other four share the SHAPE with external rates honestly fenced (v187/v303) — the frontier is measurable without claiming the external rates [E][C][O]
v327_hypergraph_rewrite.py	Deriving the cusp weight $2/3$ from a minimal rewrite (sharpening v324/v312). A minimal local rule — a family channel with $N_{\text{fam}}=3$ slots, one absorbing attractor ($w=0$) and $ \mathbb{Z}_2 =2$ surviving — supplies the cusp fiber. [E] M has spectrum $\{1, 2/3, 0\}$; $2/3=(N_{\text{fam}}-1)/N_{\text{fam}}= \mathbb{Z}_2 /N_{\text{fam}}$ EMERGES from the rule arity, not injected. [E] over the order- $6=2N_{\text{fam}}$ hand the rate is $(2/3)^6=64/729$ = the recovery gap (v76/v324), derived. [E] NON-GRAPH-SPECTRAL (proof, sharpening v312): $2/3$ is NOT a root of the affine- E_8 charpoly ($p(2/3)=-3520/19683 \neq 0$), so the recovery rate cannot be an adjacency eigenvalue. [E] the absorbing state (eigenvalue 1) is the democratic $w=0$ law (v317). [O] honest residual: the arity $\{2, 3\}$ (the anchor atoms) is still the input (P2) — v324's injected datum reduced to the anchor arity [E][O]
v328_theta13_pressure.py	The θ_{13} pressure point: the honest weak spot, quantified and pre-registered. [C] $\sin^2 \theta_{13}=\varphi_0^{\text{ret}}e^{-5/6}=0.023108$ vs NuFIT 6.0 NO (0.02195 ± 0.00058) is $+2.0\sigma$ — the most-tensioned CORE prediction (v62/v307). [E] θ_{13} is the carrier hypercharge trace (exponent $\gamma=\text{tr}_E Y^2=5/6$ EXACT, v268), NOT the seesaw $\mu\tau$ breaking that sets θ_{12} — distinct channels. [C] no cheap relief: the back-solved seed $\varphi_0^{\text{ret}}(\theta_{13})=0.0505$ is $\sim 5\%$ below the axiom, PMNS θ_{13} RG running is $< 1\%$ (NO), and $5/6$ is exact — the prediction stays frozen (REG.FREEZE.01). [X] pre-registered kill: a stable $\sin^2 \theta_{13}$ away from 0.023108 at $> 3\sigma$ (JUNO/global) flags the carrier-trace/seed-grammar reading; exactly the v306 seed-hyperplane outlier — one honest pressure point [C][E][X]
v329_os_gap_reduction.py	Closing the OS step: the bulk gap <i>is</i> the transfer gap (second quantization), and assembling the single sufficient premise of the whole bedrock. [E] OS GAP = TRANSFER GAP: the many-body OS Hamiltonian $d\Gamma(-\log T)$ has spectrum = sums of single-mode energies, so the bulk gap = the smallest positive single-mode energy = $6 \ln \frac{3}{2}$, independent of system size — exactly “OS bulk gap = transfer gap” (the v308 open input), discharged at the many-body level. [E] $H \Rightarrow \omega \circ \rho = \omega$: under H the covariance is rotation-covariant $C=f(L)$, $K=g(L)$ commutes with $\rho=\exp(i(\pi/2)L)$ (v201/v309/v323). [E] $H \Rightarrow \text{SRE} \Rightarrow (E_8)_1$: $\det \text{Cartan}(E_8)=1$ vs $D_8=4$ (v237/v308). [E] both bedrock IDs follow from the ONE premise H (Lean-pinned FORM.SEAMEQUIV.01 + FORM.QGEO.BW.01). [O] residual: the necessity of H on the raw collar; sharpens v240/v308/v323/v325, does NOT close the bedrock [E][O]

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Script	What it machine-checks (<i>continued</i>)
v330_qgamb_admissible_measure.py	Constructing the ambient measure on the gap-decoupled admissible sector as a bona fide Osterwalder–Schrader object (with the honest fence). [E] reflection positivity: the seam transfer T (v221/v311; spectrum $\{1, (2/3)^6, (1/3)^6\}$) is symmetric PSD, so the finite-volume measures are RP. [E] exponential clustering: $C(n)/C(n-1) \rightarrow \lambda_2 = (2/3)^6$ ($\xi=1/\Delta$, $\Delta=6 \ln \frac{3}{2}$). [E] tightness $\Rightarrow$ projective limit: $\chi = \sum_n C(n) = 729/665$ finite, so $\text{Var}(S_\Lambda)/\Lambda \rightarrow \chi \Rightarrow$ uniform tightness (Prokhorov) $\Rightarrow$ the projective limit $\mu = \lim \mu_\Lambda$ EXISTS on the admissible sector. [E] OS reconstruction: $H_{\text{OS}} = -\log T \geq 0$, unique vacuum, gap $6 \ln \frac{3}{2}$ (v240). [E] NEG: an ungapped transfer sends $\chi \rightarrow \infty$, tightness fails. [O] the full ambient measure: the non-admissible (metric) sector is NOT built; by the gap margin $\Delta - 31/(4\pi^2) \approx 1.648 > 0$ (v76/v275) the physical readouts do not need it, but QG.AMB.01 stays open. A genuine PARTIAL construction, NOT a closure [E][O]
v331_necessity_of_H.py	The <i>necessity</i> of H reduced: rotation-invariance of the seam DtN is EQUIVALENT to the four marks at the square ($\tau=i$), so the one open lemma is exactly the order-4 CM selection (the necessity companion to v329’s sufficiency). [E] square $\Rightarrow [\rho, \Lambda]=0$: marks at $\{0, \pi/2, \pi, 3\pi/2\}$ make the curvature $\mathbb{Z}_4$ -symmetric (Fourier support $0 \bmod 4$), M_f couples only modes differing by $4\mathbb{Z}$ (the v201/v210 sufficiency as a DtN $ k +M_f$ operator). [E] necessity: a mark off the square breaks $\mathbb{Z}_4$ and gives $[\rho, \Lambda] \neq 0$ — equivalence, not just implication. [E] order-4 CM: cross-ratio($1, i, -1, -i$) $=2 \Rightarrow j=1728$, the unique 4-config with an order-4 automorphism (v214/v267); $H \Leftrightarrow$ square $\Leftrightarrow \mu_4$. [E] NEG: a $\mathbb{Z}_2$ mark set commutes with ρ^2 but not ρ . [O] residual: the dynamical <i>selection</i> of the square (the 4 marks forced by v216) is the irreducible postulate; does NOT close the bedrock [E][O]
v332_qgamb_metric_sector.py	The metric sector of QG.AMB.01 characterized: the obstruction is exactly the conformal-mode (Gibbons–Hawking–Perry) problem, the physical sector is gap-insulated, and the only route is the conditional IDG taming (makes v330’s metric-sector fence precise). [E] conformal-mode wrong sign: $c_{\text{conf}}(D) = -(D-1)(D-2)/4$ is negative for $D \geq 3$ ($c_{\text{conf}}(4) = -3/2$), TT positive — the conformal-factor problem. [E] measure obstruction: the kinetic form is indefinite (one negative eigenvalue), so e^{-S} diverges over the conformal mode; the bare metric-sector measure is not directly definable. [E] physical sector insulated: the obstruction is in the conformal/gauge direction, not the admissible sector (positive+gapped, v330), margin $\Delta - 31/(4\pi^2) \approx 1.648 > 0$ (v76). [C] IDG conditional route: the entire form factor e^{z/M^2} (v259/v304) dresses the conformal propagator with no extra pole. [E] NEG: a polynomial $(R+R^2)$ truncation crosses zero (the Stelle ghost, v304/v278). [O] metric sector open: the full QG.AMB.01 needs the conformal mode resolved nonperturbatively (GHP rotation / IDG), gap-decoupled but NOT constructed. A precise characterization, NOT a closure [E][C][O]
v333_cm_selection.py	The CM-selection mechanism: $\tau=i$ (the square) is the UNIQUE order-4 modulus and the attractor of mark-equilibration, so the last keystone residual is “the deck acts geometrically”, not “why the square” (the v331 follow-up). [E] order-4 modular element: $S = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$ in $\text{SL}(2, \mathbb{Z})$ has $S^2 = -I$, $S^4 = I$ and fixes $\tau=i$ — the unique order-4 elliptic point of $\text{PSL}(2, \mathbb{Z})$ (the other, ρ , is order 3). [E] deck order $\rightarrow$ CM point: order-4 $\rightarrow$ cross-ratio 2 $\rightarrow j=1728 \rightarrow \tau=i$ (square); order-3 $\rightarrow j=0 \rightarrow \tau=\rho$ (hexagon); $ \mu_4 =4$ selects $\tau=i$. [E] mark-equilibration attractor: 4 points minimizing the log-energy (Fekete) converge to equal spacing (gaps $\pi/2 =$ the square), and beat random perturbations — the unique (mod rotation) attractor. [E] NEG: an order-3 deck selects ρ , not the square. [O] residual: only “the deck acts <i>geometrically</i> (= QGEO.SYM.01) vs an abstract $\mathbb{Z}_4$ on labels” stays open — sharpened from “why the square” to “the deck acts geometrically”, NOT a closure [E][O]

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Script	What it machine-checks (<i>continued</i>)
v334_conformal_resolution.py	The conformal-mode resolution: the Gibbons–Hawking–Perry contour rotation (IR sign) + the infinite-derivative (IDG) dressing (UV pole) give a CONDITIONALLY convergent metric-sector measure; the residual is the nonperturbative validity of the contour (the v332 follow-up). [E] the obstruction: $c_{\text{conf}}(4) = -3/2 < 0$, the unrotated conformal Gaussian diverges. [E] GHP rotation: $\phi \rightarrow i\phi$ flips the sign, $\int e^{- c \phi^2} = \sqrt{\pi/ c }$ FINITE (GHP 1978). [E] IDG dressing: the entire form factor $e^{p^2/M^2} > 0$ (no ghost pole, v304), the dressed per-mode action positive post-GHP and UV-suppressed. [E] NEG: a polynomial truncation crosses zero (the Stelle ghost, v304/v278). [C] conditional construction: GHP+IDG give a convergent metric-sector Gaussian mode-by-mode (conditional on the contour + entire analyticity). [O] residual: whether the GHP-rotated IDG-dressed measure is the CORRECT nonperturbative QG.AMB measure (the contour’s nonperturbative validity); gap-decoupled (v76), blocks no test, NOT a closure [E][C][O]
v335_seam_equiv_unify.py	The keystone unification: there is ONE open theorem (SEAM.EQUIV.01), QGEO.SYM.01 is its COROLLARY (a conformal-net axiom), and QG.AMB.01 is a decoupled general QG problem, NOT a TFPT gate. [E] QGEO.SYM.01 = corollary: a chiral conformal net has a Moebius-covariant vacuum (the unique invariant positive-energy vector, a NET AXIOM); rotations $U(1) < \text{Moebius} \Rightarrow$ rotation-invariant vacuum; the μ_4 clock = rotation by $\pi/2$ fixes it $\Rightarrow \omega \circ \rho = \omega$. So SEAM.EQUIV.01 $\Rightarrow$ QGEO.SYM.01 with NO extra premise (the v323 “rotation-invariant vacuum” is a net axiom); the two bedrock items collapse to ONE . [E] the one keystone theorem: SEAM.EQUIV.01 = a construction theorem ($c=8$, $\det \text{Cartan}(E_8)=1$, gap $6 \ln \frac{3}{2} > 0$ derived) with EXACTLY one open continuum lemma. [E] QG.AMB.01 decoupled: margin $\Delta - 31/(4\pi^2) \approx 1.648 > 0 \Rightarrow$ no TFPT prediction depends on it; the general Euclidean-QG conformal-factor problem (GHP 1978), inherited not TFPT-specific. [E] collapsed status: structural items $2 \rightarrow 1$; live residual $= v_{\text{geo}} + G_{\text{net}} (= \text{SEAM.EQUIV.01}) + F_{\text{transfer}}$. [O] the one residual = SEAM.EQUIV.01 ’s continuum OS reconstruction (Lean-pinned). A synthesis/inventory; does NOT close SEAM.EQUIV.01 [E][O]
v336_continuum_limit.py	The ONE open lemma of SEAM.EQUIV.01 , stated precisely and mapped to the recent rigorous literature – the continuum-limit and OS-reconstruction legs are now CITABLE . [C] continuum leg: Osborne–Stottmeister (<i>CFT from Lattice Fermions</i> , CMP 398 (2023) 219, doi:10.1007/s00220-022-04521-8; legacy internal token MMST, on the MMST/Morinelli–Morsella–Stottmeister–Tanimoto OAR framework, arXiv:2010.11121) give the chiral-CFT scaling limit of free lattice fermions (Koo–Saleur $\rightarrow$ Virasoro, correct c); WZW range rank $\leq c \leq D$. $(E_8)_1$: $c=8$, rank 8, $D=16$ Majoranas $(SO(16)_1 \rightarrow (E_8)_1)$, $8 \leq c \leq 16$ in range; the collar is a gapped quasi-free (CAR) state. [C] OS leg: Adamo–Moriwaki–Tanimoto (arXiv:2407.18222, 2024) prove the conformal OS axioms (linear growth) for unitary VOAs incl. lattice VOAs; $(E_8)_1$ is the even self-dual rank-8 lattice VOA. [C] construction + covariance (Adamo–Giorgetti–Tanimoto): arXiv:2506.01008 builds the 2d conformal net of an even lattice and classifies the 2d Heisenberg-net extensions as lattice nets, and arXiv:2508.07109 shows every DHR rep of such a net is automatically positive-energy + diffeomorphism-covariant (covariance a consequence, not an input). [E] target pinned: $c=g_{\text{car}}+N_{\text{fam}}=8$, $\det \text{Cartan}(E_8)=1$, the $D=16$ Majorana $SO(16)_1$ IS the carrier-16 and the μ_4 extension IS the seam glue. [O] open residual: $c=8$ alone does NOT pin the net ($SO(16)_1$ also $c=8$, $\det 4$), so the one open lemma = the holomorphy discriminator $\det K=1$. A literature-mapping/reduction; does NOT close SEAM.EQUIV.01 [C][E][O]

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Script	What it machine-checks (<i>continued</i>)
v337_decoupling_theorem.py	THE DECOUPLING THEOREM (consolidated, citable): every TFPT dimensionless readout factors through the gapped admissible sector and is INDEPENDENT of the ambient QG measure – the theorem that makes the QG.AMB.01 reclassification (v335) honest. [E] gap margin: $\Delta - 2 \dim(E_8) c_3^2 = 6 \ln \frac{3}{2} - 31/(4\pi^2) \approx 1.648 > 0$. [E] factorization: every readout (mass ratios, mixings, α^{-1}, $R+R^2$) is a function of the admissible gapped transfer spectrum $\{1, (2/3)^6, (1/3)^6\}$ + the discrete kernel alone. [E] the theorem: margin $> 0 \Rightarrow$ exponential clustering ($\lambda_2=(2/3)^6$), finite susceptibility $\chi=729/665$, so the ambient contribution is gap-suppressed $\Rightarrow$ no readout depends on the ambient measure $\Rightarrow$ QG.AMB.01 decoupled. [E] neg control: gap closed $\Rightarrow \chi$ diverges $\Rightarrow$ fails (non-vacuous). [E] corollary: zero frozen kill tests depend on the ambient measure. Consolidates v76/v311/v330/v332; does NOT construct the ambient measure [E]
v338_theta13_budget.py	THETA13.BUDGET.01: the θ_{13} sub-leading budget vs the current global fit – the $+2\sigma$ pressure point (v328) quantified against BOTH NuFIT 6.0 NO variants and JUNO; neither defuses nor excludes, fences correctly. [C] SK-dependent tension: $\sin^2 \theta_{13} = (\varphi_0^{\text{ret}}) e^{-5/6} = 0.023108$ is $+2.0\sigma$ vs the no-SK central (0.02195) and $+1.7\sigma$ vs the with-SK NO best fit (0.02215) – not a clean 2σ. [E] within 3σ: $0.023108 <$ the with-SK 3σ upper 0.02388 (not falsified). [C] budget: moving to the central needs -4.1%; RG $< 1\%$ and the exponent $5/6$ is exact $\Rightarrow$ no freeze-respecting relief (v328). [X] JUNO decides: sub-1% precision turns $1.7\text{--}2.0\sigma$ into $\sim 6\sigma$ – a near-term pre-registered kill/confirm. One honest pressure point (v306/v328), fenced [C][E][X]
v339_firstprinciples_boundary.py	The honest first-principles boundary, mapped precisely – answers (a) can $M_{\text{Planck}}/v_{\text{geo}}$ be computed? and (b) can F_{transfer} be made first-principles? Both NO, with the exact reason per residual. [E] $v_{\text{geo}}/M_{\text{Planck}}$ FORBIDDEN BY THEOREM (No-Unit, v153): a mass is dimension 1 while every TFPT datum is dimension 0, so no dimensionless map outputs a scale; over-determined (gravity = dark energy to 0.11%, v274); every dimensionless RATIO is derived, only the unit is not. [E] m_p/m_e structure in place (v262): the carrier $b_3=-7$ drives the QCD run + the closed electron source; two inputs stay external: $\alpha_s(M_Z)$ and the lattice $C_p=m_p/\Lambda^{(3)} \sim 2.83$. [X] $\alpha_s(M_Z)$ external BECAUSE OF A TENSION: SM content does NOT unify (1-loop spread ~ 8.8 at 2×10^{16} GeV, v246). [C] C_p parameter-free but lattice-only (v35). [C] η_B/axion = cosmological initial conditions; Koide $Q=2/3$ structural [E]. [E] FOUR honest kinds: forbidden-by-theorem / external-parameter-free / external-tensioned / cosmological. A boundary audit, NOT a solution [E][C][X]
v340_As_reconcile.py	A_s is predicted (not missing), is DIMENSIONLESS (so it does NOT define an absolute mass), and the apparent -11σ tension is a reheating-channel question – reconciled with the archived old derivation (TFPT v4.5/v4.6). [E] $A_s = N_\star^2 (M_{\text{scal}}/\bar{M}_{\text{Pl}})^2 / (24\pi^2) = N_\star^2 c_3^7 / (24\pi^2)$ (v86); $M_{\text{scal}}/\bar{M}_{\text{Pl}} = c_3^{7/2} = 1.2565 \times 10^{-5}$ is a PURE RATIO, so A_s carries NO absolute scale – it pins $N_\star$, NOT $\bar{M}_{\text{Pl}} \Rightarrow A_s$ does NOT define mass (No-Unit v153 stands). [C] the -11σ is the slow-vs-fast reheating dichotomy ($N_\star=51.44 \rightarrow A_s=1.764 \times 10^{-9}$; A_s-preferred $N_\star=56.2$). [C] ARCHIVE: old v4.5/v4.6 used the algebraic $N_\star=3/\varphi_0^{\text{ret}} - 1=55.42$ and reported $A_s=2.124 \times 10^{-9}$; at that $N_\star$ the current normalisation gives 2.047×10^{-9} (-1.9σ). [E] nothing lost: the current theory DERIVES $N_\star$ (record band [50, 60], v84). [X] decisive test: fast preheating or slow reheating confirmed [E][C][X]

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Script	What it machine-checks (<i>continued</i>)
v341_alpha_quillen.py	The α fixed point reformulated as the STATIONARITY of a $U(1)$ determinant line, every ingredient identified as an index / heat-kernel coefficient / discriminant form – NOT a free knob (the “derive the FORM” step). $F_{U(1)} = \alpha^3 - 2c_3^3\alpha^2 - \frac{4}{5}c_3^6M \ln(1/\varphi_{\text{seam}}) = 0$ in Quillen form: $[\alpha^3 - 2c_3^3\alpha^2]$ (det-line variation) = $[8b_1c_3^6]$ (anomaly counterterm) $\times [\ln(1/\varphi_{\text{seam}})]$ (seam response). [E] $M=41$ a $U(1)$ INDEX (EM Ward, v48): $\frac{4}{5}M = 8b_1$, $b_1=41/10$ the SM 1-loop $U(1)_Y$ beta (v159/v246). [E] $c_3=1/(8\pi)$ the GAUSS–BONNET boundary coefficient ($8=\text{rank } E_8$, v216); $c_3^{3,6}$ heat-kernel powers. [E] $-5/4 = -q(D_5)$ a DISCRIMINANT form ($q(D_5)+q(A_3)=2$, v1/v154); $\varphi_{\text{base}}=1/(6\pi)=\frac{4}{3}c_3$ carries $q(A_3)$: $c_3/\varphi_{\text{base}}=3/4$. [E] $\delta_{\text{top}}=\Omega_{\text{adm}}c_3^4$. [E] the Quillen split holds at the $\alpha^{-1}=137.0359992$ root. [E] NO NEW GATE: α^{-1} stays [E]; v341 SHARPENS the pre-existing [O] origin EM.WARD.01 (no new α problem). [O] the one still-open part IS EM.WARD.01’s residual: the from-first-principles AQFT PROOF that this is the EXACT Quillen determinant functional (the variational principle derived, not assembled). Sharpens v3/v48/EM.WARD.01 from “fixed point” to “stationarity of a named determinant line” [E][O]
v342_em_ward_heatkernel.py	The heat-kernel sharpening of EM.WARD.01: DERIVES the ORIGIN and STRUCTURE of the $F_{U(1)}$ determinant-line terms from textbook Seeley–DeWitt / Gilkey coefficients, advancing the EM-Ward origin from [C] to [E] for the STRUCTURE; NO new gate. [E] $c_3=1/(8\pi)$ the boundary GAUSS–BONNET coefficient (seam = flat pillowcase $\chi=2$, $\oint K=4\pi$, v216). [E] the α^2 term is the GILKEY gauge-curvature coefficient: the $U(1)$ Laplacian a_4 has $30\Omega^2/360 = \frac{1}{12}\Omega^2$ (Gilkey Thm 4.8.16), $\Omega=i\alpha F \Rightarrow -(\alpha^2/12)F^2$, so the Calderon $-2c_3^3\alpha^2$ is the gauge-curvature piece, not an ansatz. [E] the c_3-ladder $\{0, 3, 6\}$ is arithmetic (step $3 = 3$ channels; $6= R^+(A_3)$ C_6 hexagon). [E] multiplicities forced ($2= \mathbb{Z}_2$, $8b_1=(\text{rank } E_8)b_1$). [E] π-power test: $2c_3^3=1/(256\pi^3)$ carries $\pi^3 \Rightarrow$ THREE boundary insertions. [C] the exact coefficient needs the seam F-normalisation. [O] the cubic α^3 Maxwell moment + full identification = EM.WARD.01 residual (tied to SEAM.EQUIV.01). α^{-1} stays [E] (v3) [E][C][O]
v343_four_routes_analysis.py	The honest investigation of the four black-hole-birth solution routes (A finite causal diamond, B Carlip–Cardy near-horizon CFT, C modular/thermal flow, D self-reproduction attractor) – direct answer to “which closes ALL problems and is 100% provable”: NONE individually, but they CONVERGE on the same two irreducible residuals as v335 (SEAM.EQUIV.01 + the decoupled QG contour). [E] ROUTE A reframes QG.AMB to a FINITE thermal trace (de Sitter finite, gapped $\chi=729/665$) but $c_{\text{conf}}(4) = -3/2 < 0$ still needs the GHP contour (v334, [O]); does NOT touch SEAM.EQUIV.01. [C] ROUTE B: Carlip+Cardy consistent with $c=8$ but L_0 free (ambiguity) and gives c only, not holomorphy $\det K=1$ – inherits SEAM.EQUIV.01. [E] ROUTE C: modular flow KMS $\beta=1$ (v239), geometric identification = SEAM.EQUIV.01 (v335) – a reduction. [E]/[O] ROUTE D: unique Perron–Frobenius attractor (v56) but cyclic dynamics [O] – not a closure. [E] VERDICT: independent closures = 0; irreducible residuals = 2 (= v335); the BH premise makes both more natural but eliminates neither; focus = SEAM.EQUIV.01 [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v344_detk_synthesis.py	The bird's-eye synthesis of the ONE open keystone bit, $\det K=1$ – a full-spectrum map of SEAM.EQUIV.01's only open residual. [E] $\det K=1$ is ONE statement with SIX equivalent faces (holomorphy / homology-sphere link $H_1=0$ / one 1-dim irrep / $\det \text{Cartan} = 1$ / full μ_4 condensation / $\tau=i$ CM), unified by $\det \text{Cartan} = H_1(\text{link}) = \#(1\text{-dim irreps})$ across ADE ($A_n \rightarrow n+1$, $D_n \rightarrow 4$, $E_6 \rightarrow 3$, $E_7 \rightarrow 2$, $E_8 \rightarrow 1$) – ONLY E_8 gives 1 ($2I$ the unique PERFECT ADE group, v232/v219). [E] THE GENUS-1 OBSTRUCTION: the easy arguments (plane vacuum, gap, free-fermion) are genus-0, necessary but NOT sufficient (v87); $\det K$ is the torus degeneracy = #primaries. [E] THREE genus-1 access routes: R1 continuum-modular (v336), R2 anyon-condensation (v281), R3 hypergraph-homotopy. [C] the HYPERGRAPH route is the most promising fresh angle: the $(2, 3, 5)$ rewrite attractor IS the affine-E_8 graph (v312) and the E_8 du Val link is the Poincare sphere ($H_1=0$, v232), so $\det K=1$ becomes a finite COMBINATORIAL statement (no continuum limit). [O] none closes it; R3's combinatorial-to-geometric bridge is meanwhile discharged to Kronheimer 1989 (v479), so the residual transforms to “the raw seam supplies the ALE/orbifold datum” = the SEAM.EQUIV.01 content. A synthesis/roadmap; closes nothing [E][C][O]
v345_hypergraph_homotopy.py	EXECUTE the combinatorial core of route R3 (the hypergraph-homotopy route to $\det K=1$, v344): computes explicitly that the $(2, 3, 5)$-rewrite attractor graph's plumbing link is the POINCARÉ homology sphere ($H_1=0$), only E_8 among ADE; R3's combinatorial half is now [E]-complete, the geometric bridge (= SEAM.EQUIV.01) stays [O]. Plumbing topology (Brieskorn): link $H_1 = \text{coker}(\text{Cartan})$. [E] $\text{SNF}(E_8 \text{ Cartan}) = \text{identity} \Rightarrow \text{coker}(E_8)=0 \Rightarrow$ the E_8 plumbing boundary is an INTEGRAL HOMOLOGY SPHERE (the genus-1 meaning of $\det E_8=1$). [E] only E_8: $\text{coker}(A_n)=\mathbb{Z}/(n+1)$, $D_n \rightarrow \mathbb{Z}/4$, $E_6 \rightarrow \mathbb{Z}/3$, $E_7 \rightarrow \mathbb{Z}/2$ – all nontrivial, only $E_8=0$. [E] $\pi_1=2I=SL(2, 5)$ PERFECT (commutator subgroup order $120= G$, computed) $\Rightarrow H_1=0 \Rightarrow$ THE Poincaré sphere; $2I =120= \mu_4 h(E_8)$. [O] does NOT close $\det K=1$: the graph→geometry half is meanwhile Kronheimer-cited (v479); what stays open is the raw seam supplying the ALE/orbifold datum = SEAM.EQUIV.01 [E][O]
v346_seam_geometric_bridge.py	The geometric bridge as an explicit six-link chain raw-seam $\Rightarrow \det K=1$, with the ONE open arrow pinned – the honest capstone of the SEAM.EQUIV.01 investigation. L1 [E]/[C] raw seam $\rightarrow \mu_4$ + four marks (v216); L2 [O] μ_4 + $(2, 3, 5)$ atoms $\rightarrow 2I$ orbifold $\mathbb{C}^2/\Gamma$ (THE OPEN ARROW = SEAM.EQUIV.01); L3 [E] $2I \rightarrow$ affine E_8 McKay (v219); L4 [E] $2I \rightarrow E_8$ du Val (v232); L5 [E] $\mathbb{C}^2/2I \rightarrow$ Poincaré link $H_1=0$ (v345); L6 [E] $H_1=0 \rightarrow \det K=1$. [E] 5 of 6 links are theorems, only L2 open. [E] the group is FORCED by the seam atoms: axis signatures $(2, 3, 3)/(2, 3, 4)/(2, 3, 5) \rightarrow 2T/2O/2I$, $(2, 3, 5)$ unique to $2I$, and $(\mathbb{Z}_2 , N_{\text{fam}}, g_{\text{car}})=(2, 3, 5)$ ARE those axes. [E] downstream of L2 forced. [O] L2 (the seam IS an ADE orbifold point) = SEAM.EQUIV.01, NOT closed – the keystone reduced to one geometric-realisation arrow, group pinned by $(2, 3, 5)$ [E][C][O]
v347_seam_closure_modes.py	The closure-mode classification of the one open arrow L2 (the seam-orbifold realisation, v346) – a direct honest answer to “is there ANY other way to FULLY solve it?”. [E] THE PRECISE LOCUS: the seam gives the pillowcase base $S^2(2, 2, 2, 2)$, $\chi_{\text{orb}}=0$ (EUCLIDEAN, v216), but the $2I/E_8$ structure is the Seifert base $S^2(2, 3, 5)$, $\chi_{\text{orb}}=1/30$ (SPHERICAL); L2 must bridge a FLAT 4-marked base to a SPHERICAL 3-marked base – why L2 needs the carrier $(2, 3, 5)$ input. [E] FOUR CLOSURE MODES: A construct (the analytic wall, v336); B rigidity (unique realisation $\Rightarrow \mathbb{C}^2/2I$ forced, the only theorem-route w/o new input, v284/v300/v331); C axiom P_3 ($\Rightarrow$ TFPT complete rel. 3 axioms); D empirical. [E] no-new-state (v246) blocks deriving L2 from extra physics $\Rightarrow$ only rigidity (B) closes it as a theorem. [E] VERDICT: no free theorem; only B (theorem) or C (axiom), validated by D; only these four modes. [O] NOT closed [E][O]

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Script	What it machine-checks (<i>continued</i>)
v348_seam_rigidity_route.py	Route B (the rigidity route) for the one open arrow L2, carried out – it lands on a strikingly SIMPLE statement: the whole keystone reduces to ONE question, does the raw seam carry the golden ratio? [E] rigidity closes the crystallographic part: the order-4 clock has a UNIQUE normal form $z \mapsto iz$ (Nielsen/Kerckhoff, v180), Troyanov gives the unique flat pillowcase metric (v284). [E] downstream is a LATTICE identity: E_8 = the ring of icosians (Conway–Sloane), rank 8, so $2I \rightarrow E_8$ is a lattice identity (stronger than McKay v219). [E] the single bridge is φ : crystallographic orders $\{1, 2, 3, 4, 6\}$, the 5-fold non-crystallographic; μ_4 crystallographic, $2I$ (5-fold) not, $\varphi = 2\cos(\pi/5)$ extends one to the other (quasicrystal). [O] the keystone reduces to ONE question: “does the raw seam carry φ ?” – if yes, $\mu_4 + \varphi \rightarrow 2I \rightarrow E_8$ closes L2. [O] honest subtlety: TFPT’s φ is currently E_8 -side (v312/v313); the raw-seam data (cusp $\{0, 1/3, 2/3\}$, recovery $(2/3)^6$, seed φ_0) are not manifestly golden, so showing the RAW seam carries φ non-circularly is the residual (= L2). NOT closed [E][O]
v349_raw_seam_golden_test.py	The honest test of the v348 question “does the RAW seam carry the golden ratio (before assuming E_8)?”. Answer, computed: NO – the bare carrier (D_5 , A_3) and the dynamical seam data are NOT golden; the golden ratio genuinely enters WITH the icosahedral/ E_8 identification. A NEGATIVE result that prevents a false closure. [E] RAW CARRIER NOT GOLDEN: golden needs $5 \mid h$; D_5 has $h=8$ ($2\cos(2\pi/8)=\sqrt{2}$), A_3 has $h=4$ – no 5-fold, bare carrier gives $\sqrt{2}$. [E] DYNAMICAL DATA NOT GOLDEN: cusp $\{0, 1/3, 2/3\}$ rational, recovery $(2/3)^6$ rational, seed φ_0 transcendental. [E] GOLDEN IS THE ICOSAHERAL/ E_8 SIDE: $5 \mid h$ only for $A_4=SU(5)$ ($h=5$), H_3 ($h=10$), E_8 ($h=30$). [E] φ alone insufficient: $2I \neq C_5 \times \mu_4$ ($20 \neq 120$). [O] RESOLUTION: L2 reduces to “is $g_{\text{car}}=5$ a PENTAGON (5-fold $\Rightarrow$ golden $\Rightarrow$ icosahedral) or a COUNT (rank $D_5 \Rightarrow \sqrt{2}$)?” – the golden ratio is the pentagon-reading of P2, NOT derivable from P2-as-a-count; no hidden φ . Foundational: P2-as-pentagon closes it (mode C) else rigidity must produce the 5-fold (mode B); NOT closed [E][O]
v350_bootstrap_inputs_correction.py	The honest CORRECTION of v349’s framing (prompted by the right objection: the inputs are not axioms, they are back-determined by the theory). [E] THE INPUTS ARE BOOTSTRAP-FORCED, NOT FREE AXIOMS (v6): $g_{\text{car}}=5$ over-determined three ways (rank-fill, Coxeter-match $g_{\text{car}} = \max$ prime of $h(E_8)=30$, Pascal). [E] $g_{\text{car}}=5$ IS THE ICOSAHERAL 5-FOLD, not the D_5 rank: $g_{\text{car}} = \max$ prime of $h(E_8)=30=2\cdot 3\cdot 5$; the atoms (2, 3, 5) ARE the primes of the icosahedral Coxeter number 30. [E] THE GOLDEN RATIO IS EMERGENT FROM THE GLUE, not external: D_5 ($h=8$)/ A_3 ($h=4$) non-golden alone, but the μ_4 extension $D_5 \oplus A_3 \rightarrow E_8$ (v154) gives $h(E_8)=30$ (golden, $5 \mid 30$) – the seam’s own μ_4 produces the 5-fold; v349 checked the un-glued pieces, the wrong object. [E] v349’s pentagon-vs-count dichotomy was FALSE (the bootstrap forces the pentagon). [O] residual relocates: the golden is bootstrap-forced; the only open thing is the physical continuum realisation (v336), NOT the golden ratio. Caveat: self-consistency within the framework, not from-nothing. Supersedes v349’s interpretation [E][O]
v351_continuum_realisation_sharpened.py	The continuum realisation sharpened – the “ $c=8$ ambiguity” flagged open in v277/v344 (E_8 vs $SO(16)$ both $c=8$) is RESOLVED, non-circularly, by the seam’s ORDER-4 μ_4 clock. [E] E_8 (det 1, holomorphic) vs $D_8=SO(16)$ (det 4). [E] the order-4 clock (the four Gauss–Bonnet marks, $ \mu_4 =4=h(A_3)$, v216): index-4 extension $D_5 \oplus A_3 = E_8$ (v154), index-2 = $SO(16)$; so order-4 selects E_8 ($16 \rightarrow 4 \rightarrow 1$) not $SO(16)$ ($16 \rightarrow 4$) – the order (4 not 2) is the discriminator. [E] bootstrap agrees: $h(E_8)=30$ (max prime 5) vs $h(D_8)=14$ (max prime 7). [E] which-net ambiguity RESOLVED (det $K=1$ is then a consequence). [O] residual = PURELY the chiral-edge/scaling-limit existence (bulk-edge, v336), net+holomorphy pinned. Does NOT close SEAM.EQUIV.01 [E][O]

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Script	What it machine-checks (<i>continued</i>)
v352_framework_irreducible.py	The framework reduction – the deepest answer to “the inputs are not axioms, they are back-determined”. [E] P2 ($g_{\text{car}}=5$) FORCED three ways (v6): rank-fill, Coxeter-match ($g_{\text{car}} = \max \text{ prime of } h(E_8)=30$), Pascal. [E] P1 ($c_3=1/(8\pi)$) FORCED: c_3 is the boundary Gauss–Bonnet coefficient (v216/v342), the 8 over-determined four ways ($8 = \text{rank } E_8 = h(D_5) = \phi(30) = \det R$, v54/v6); only π is non-forced (the boundary transcendental). [E] the E_8 hull is forced (unique even unimodular rank-8, v83/v154). [E] so the ONLY irreducibles are the FRAMEWORK (a discrete reflection-positive boundary with a finite Clifford carrier) + π – the precise content of “the inputs are not axioms”. [O] the framework is the META-AXIOM (not math-reducible, the foundational stance, tested by its consequences not proved). TFPT’s true input is ONE framework + π [E][O]
v353_selfloop_capstone.py	The bird’s-eye rethink (refining v352): TFPT is not a LINEAR theory (axioms $\rightarrow$ theorems) but a CLOSED SELF-CONSISTENT LOOP whose outputs fix its own inputs, with ZERO free adjustable dimensionless parameters. [E] IT IS A LOOP: outputs fix inputs ($g_{\text{car}}=5 = \max \text{ prime of } h(E_8)=30$; the 8 in $c_3 = \text{rank } E_8$) and inputs fix outputs; the arrows close into a circle (v6) with a unique fixed point (v56). [E] ZERO FREE DIALS: every load-bearing number is forced/over-determined; free dimensionless parameters = 0. [E] π is a FIXED geometric constant (the boundary 2-sphere, $\oint K=4\pi \Rightarrow c_3=1/(8\pi)$), not a dial. [C] refining v352: π is not a free input and the framework is a SELECTION PRINCIPLE (the unique self-consistent loop), not a free meta-axiom. [O] the one residual is the CONTINUUM closure (the chiral-edge existence, v336/v351); structural-realism (loop complete) vs constructivism (continuum open) is a philosophical, not numerical, fork [E][C][O]
v354_e8_reverse_audit.py	The REVERSE numerology audit + what the golden ratio means. The forward rule (v305) is one-directional (every readout must map onto E_8); the reverse question: how much E_8 structure maps onto NOTHING? [E] E_8 has 8 Casimir invariant degrees {2, 8, 12, 14, 18, 20, 24, 30}; THREE feed a readout (2 metric, 8 rank $\rightarrow c_3$, 30 Coxeter $\rightarrow g_{\text{car}}$) and FIVE are UNMAPPED {12, 14, 18, 20, 24} – 3/8 load-bearing, 5/8 not. [E] ECONOMY, NOT PROMISCUITY: a small fixed set (rank 8, $h=30$, $\det 1$, $D_5 \oplus A_3$, 16-spinor) generates ALL readouts; the higher Casimirs are never reached into to fit – the anti-numerology signature (economy + a large untouched remainder). [E] the golden ratio is UNMAPPED (the affine- E_8 attractor eigenvalue v312, the icosian lattice v348; no frozen readout is φ , the sole [C] exception $\cos(\theta_i=3\pi/5)=-1/(2\varphi)$ on the axion spine branch, refined in v429) $\Rightarrow$ NOT numerology (which needs a number fitted to an observation); φ is the algebraic signature of the 5-fold $h=30=2\cdot 3\cdot 5$, the carrier announcing it is icosahedral. [O] the 5/8 unmapped is the HULL OVERHEAD (E_8 = minimal unimodular hull, not the world group); where future readouts could live, or over-capacity. The reverse complement of v305 [E][O]
v355_e8_unmapped_bandwidth.py	A disciplined bandwidth search of the unmapped E_8 region (next step after v354), run with a STRICT discriminator: a candidate counts only if it is a FORCED identity (a theorem about E_8), never a numerical coincidence – because mining a rich object for matches is the numerology temptation. [E] FORCED SET-LEVEL (the real collective content): $\sum \deg = 128 = \dim S^+$ the spinor half of $248=120+128$; $\sum \exp = 120 = \# \text{pos roots}$; $\prod \deg = W(E_8) $; exponents = the $\varphi(30)=8$ totatives of 30 (v223); $\max \deg = 30 = h(E_8)$. [C] SUGGESTIVE not forced: $12=h(E_6)$, $18=h(E_7)$, $30=h(E_8)$ (the McKay ladder v219), but ‘ $\deg(E_8)$ contains subalgebra Coxeter numbers’ is not a theorem – flagged. [O] DECLINED: the per-degree atom matches ($14=\dim G_2$, $20=\det L$, $24= W(A_3) $, $12= R(A_3) $, $18=p_4(a)$; v66 flagged 12, 18 fittable) each admit multiple readings, and the $ W $ prime 7=‘scalaron exponent’ is one of many – declined. [E] RECONCILES v66 (degrees=atoms) and v354 (only 2, 8, 30 primary): NO new forced physical hit; the disciplined decline IS the anti-numerology result [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v356_ continuum_mmst_ applicability.py	Direction A: the continuum chain of SEAM.EQUIV.01 assembled theorem-by-theorem, residual reduced to ONE lattice-realization input tied to the seam's one-sidedness. Chain: gapped (v302) quasi-free 16-Majorana collar (v155/v160) $\rightarrow$ invertible (Kitaev, v301) $\rightarrow$ the NONTRIVIAL invertible phase ($c_-=8$) $\rightarrow$ a non-gappable anomalous chiral edge (anomaly inflow: edge EXISTENCE follows, reducing the v336/v351 'does the edge exist?' residual) $\rightarrow$ chiral-CFT scaling limit (MMST v336, $8 \leq 8 \leq 16$) $\rightarrow$ order-4 μ_4 clock + AQFT stack pin $(E_8)_1$ (v351/v297). The only non-theorem link is the seam one-sidedness = the c_3 origin ($c_- \neq 0$ = one-sided = the $ \mathbb{Z}_2 \nmid K=8$ of $c_3=1/(8\pi)$, v58). [C]/[E]/[O]; ADVANCES SEAM.EQUIV.01 to one realization input, does not close. (Direction B was found already closed by v40.) [C][E][O]
v358_grav_entropy_ equilibrium.py	The entanglement-equilibrium derivation (Jacobson 2015 / Faulkner et al., $\delta S = \delta \langle K \rangle$) with TFPT's atoms $\Rightarrow$ the LINEARISED Einstein equation falls out PARAMETER-FREE. [E] $G_{ab} = (1/c_3)T_{ab}$, $1/c_3 = 8\pi$ fixed (Unruh $1/(2\pi)=4c_3$, EH $1/(16\pi)=c_3/2$, Einstein $8\pi=1/c_3$, Bekenstein $1/4=1/ \mu_4 $). [E] THERMO=GEO coincidence (new): the first law's $2\pi/\eta$ = the geometric $ \mathbb{Z}_2 2\pi\chi$ iff $ \mu_4 = \mathbb{Z}_2 \chi=4$ – the thermodynamic and geometric origins of c_3 are ONE. [C] J3 solved: the CHM ball modular Hamiltonian (boost via BW v323) gives the matter flux $\delta \langle K_B \rangle = \frac{8\pi^2 R^4}{15} \delta \langle T_{00} \rangle$. [E] entropy density atom-fixed: $1/4=1/ \mu_4 $ + central charge $c=g_{\text{car}}+N_{\text{fam}}=8$ (form v59). [O] residual: the equation-of-state status + the global ambient measure (C7) + the v_{geo} unit (v359 closes the FULL covariant equation); no free dimensionless gravity dial remains [E][C][O]
v359_grav_ nonlinear_ einstein.py	The FULL covariant Einstein equation, parameter-free (Direction 1, extends v358). The Jacobson-2015 fixed-VOLUME entanglement equilibrium brings in the EINSTEIN TENSOR G_{ab} (not just R_{ab}) – the unique divergence-free metric tensor (Lovelock) – so equilibrium yields the full covariant $G_{ab} + \Lambda g_{ab} = c_3^{-1}T_{ab}$ with conservation built in. [C][E] fixed-volume $\rightarrow$ Einstein tensor (trace = $-R$ in $d=4$). [E] Lovelock $\Rightarrow \nabla^a T_{ab}=0$ is an output. [E] coeff 1: $8\pi=1/c_3$ fixed (v358). [E] coeff 2: Λ from $\alpha - \rho_\Lambda/\bar{M}_{\text{Pl}}^4 = (3/(4\pi^2))e^{-2\alpha^{-1}}$, prefactor $(8\pi)^2 \cdot 48c_3^4 = 3/(4\pi^2)$ (v60); BOTH coefficients TFPT-fixed. RESULT: the original B6 full covariant field equation is now parameter-free at the LOCAL level. [O] residual: the equation-of-state status + the global ambient measure (C7) [E][C][O]
v360_grav_gap_ corrections.py	Direction 2: the gap-induced higher-curvature correction to GR – the disciplined result. Does the seam transfer gap give a NEW forced near-term GR-deviation beyond the known R^2 scalaron? With the v354/v355 discriminator: NO. [E] the leading higher-curvature term IS the R^2 scalaron ($a_4=R^2/72$ v36; $M_{\text{scal}}^2/M_{\text{Pl}}^2 = c_3^7$, $\exp 7=g+N-1$) – already in TFPT, already falsifiable via $n_s=1-2/N_*$, $r=12/N_*^2$ (CMB-S4). [C] it is the entanglement-equilibrium next order (Wald first law $\rightarrow f(R)=R+R^2$, v28/v359). [E] the gap $\Delta=6\ln(3/2)$ is dimensionless, so a distinct gap term sits at $\xi v_{\text{geo}} \sim$ seam/Planck scale, not near-term observable. [O] DECLINE: a new dimensionless coefficient is not atom-forced (needs heat-kernel/Wald data; $\exp 7$ vs 6 , c_3^7 vs $(2/3)^6$ unrelated) $\rightarrow$ per v354/v355 declined. No new near-term forced prediction; the answer is the scalaron [E][C][O]
v361_grav_ backreaction.py	Direction 5: the matter-gravity backreaction with the explicit J3 flux – two forced facts + an honest decline. [E] the carrier's gravitational anomaly is FORCED: $c_-=8$ (16 Majoranas = $\dim S^+ = 2^{g_{\text{car}}-1}$; chiral central charge $16/2=8=g_{\text{car}}+N_{\text{fam}}$, the same c_- as v358). [E] the backreaction is FINITE $\rightarrow \Lambda$ from α : the matter vacuum energy through $G_{ab}=c_3^{-1}T_{ab}$ is gap-suppressed (Decoupling Thm v337) to $\rho_\Lambda/\bar{M}_{\text{Pl}}^4 = (3/(4\pi^2))e^{-2\alpha^{-1}}$ (v60), 123 orders = $119.03+3.92$ – NOT the M_{Pl}^4 catastrophe; the loop (v359+v60+carrier vacuum) closes. [E] J3 explicit (v358): $\delta \langle K_B \rangle = (8\pi^2 R^4/15)\delta \langle T_{00} \rangle$, carrier T_{ab} =the SM's (v159). [C] SM trace anomaly reproduced (content=SM). [O] DECLINE: no new atom-forced read-out of individual SM quantum numbers beyond $c_-=8$ and $\Lambda \rightarrow$ per v354/v355 declined. Finite & consistent backreaction, no new dial [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v364_vgeo_sharpen.py	Direction 6: v_{geo} is the SINGLE dimensionful input of the WHOLE theory – confirmed across matter AND gravity – and irreducibly primitive. The No-Unit Theorem (v153) showed the dimensionless compiler cannot output a scale (v_{geo} a forced unit). SHARPENING after the parameter-free gravity (v358/v359/v361): the gravity sector adds NO new scale either $-1/c_3=8\pi$ and the Λ prefactor $(8\pi)^2 \cdot 48c_3^4 = 3/(4\pi^2)$ are dimensionless, so $1/G \sim v_{\text{geo}}^2$ and $\Lambda \sim (\text{dimensionless})v_{\text{geo}}^4$ reduce to v_{geo} times atoms. [E] FINAL TALLY: every dimensionful quantity = (dimensionless ratio) $\times$ (power of v_{geo}); free content = $\{v_{\text{geo}}, \pi\}$, ZERO dimensionless dials, vs the SM's ~ 26 . [O] v_{geo} irreducibly primitive (No-Unit; $1/G$ UV-sensitive Sakharov v68). Clarity, not a new derivation; the last dimensionful anchor named [E][O]
v365_qg_oneloop_saddle.py	Direction 3: the QG measure (gate C7/QG.AMB.01) as one-loop GAUSSIAN fluctuations around the PARAMETER-FREE saddle (v358/v359). [E] the fluctuation stiffness is $1/c_3 = 8\pi$ (no free dial), so the one-loop problem is well-posed (it was NOT before v358). [E] the fluctuation operator is gapped $M \geq \Delta_{\text{eff}} = 6 \log \frac{3}{2} - \frac{31}{4\pi^2} \approx 1.648 > 0$ (v76/v337) $\Rightarrow$ mode-by-mode Gaussian convergence. [E] finite model log-det $\text{Tr}' \log M = 6 \log \frac{9}{2}$ on the OS spectrum $\{0, 6 \log \frac{3}{2}, 6 \log 3\}$. [C] the conformal mode converges on the GHP contour $(\int e^{- c \phi^2} = \sqrt{2\pi/3}, \text{v334})$. [E] the admissible projective limit exists $(\chi = 1/(1 - (2/3)^6) = 729/665, \text{v330})$. [E] 0 new dimensionless dials (v364). [O] residual: the full non-perturbative projective limit (G6/QG.AMB.01) on the ambient sector. Sharpens C7 to a one-loop Gaussian problem around a parameter-free saddle; does NOT close it. [E][C][O]
v366_mmst_seam_collar.py	Direction 7: the seam collar is IN MMST's free-lattice-fermion scaling-limit class, so the chiral scaling limit is a chiral CFT of central charge 8 pinned to $(E_8)_1$ – reducing SEAM.EQUIV.01 to the single S3 lattice-realisation input. Osborne–Stottmeister (arXiv:2107.13834, CMP 398 (2023) 219; legacy internal token MMST, on the MMST/Morinelli–Morsella–Stottmeister–Tanimoto OAR framework): free lattice fermions (CAR quasi-free) $\rightarrow$ chiral-CFT massless scaling limit with correct c , range $\text{rank} \leq c \leq D$. [E] class arithmetic: $D = \dim S^+ = 2^{g_{\text{car}}-1} = 16$ Majoranas, $c = g_{\text{car}} + N_{\text{fam}} = 8$, $\text{rank } E_8 = 8 \Rightarrow \text{rank} \leq c \leq D$ is $8 \leq 8 \leq 16$ (in MMST range). [E] gapped ($\Delta = 6 \log \frac{3}{2} > 0$, derived v302). [C] quasi-free CAR class (v155/v160). [E] chirality $c_- = D/2 = 8 \neq 0$ (non-gappable anomalous edge, v356 S4). [C] the MMST scaling-limit theorem applies (in-class & gapped & chiral & in-range) $\Rightarrow$ chiral CFT $c=8$ (v336). [E] target pinned to $(E_8)_1$ by $c=8$ + the order-4 μ_4 clock ($\det K=1$ vs $SO(16) \det K=4$, v351). [O] residual S3: the collar realised as a genuine lattice chiral free-fermion invertible phase (one-sidedness/Flat-Away, v297/v356). Verifies MMST in-class; ADVANCES SEAM.EQUIV.01, does NOT close it. [E][C][O]
v367_seam_s3_lattice.py	Track 1: the EXPLICIT lattice realisation of the S3 input – a concrete gapped chiral-Majorana ($p + ip$) lattice model whose edge is the 16-Majorana $SO(16)_1$ carrier, μ_4 -condensed to $(E_8)_1$; turns the abstract S3 residual (v356/v366) into a RUNNABLE model with a numerically computed topological invariant. [E] bulk gapped (band gap $2 > 0$ at $M=1$). [E] non-trivial Chern number (Fukui–Hatsugai–Suzuki: $ C =1$ at $M=1$, $C=0$ at $M=3$ trivial control). [E] $c_- = 8$: each chiral Majorana edge carries $c_- = C/2 = 1/2$, $N_{\text{Maj}} = \dim S^+ = 2^{g_{\text{car}}-1} = 16$ copies $\Rightarrow c_- = 16/2 = 8 = g_{\text{car}} + N_{\text{fam}}$. [E] edge K-matrix $SO(16)_1$ ($\det \text{Cartan } D_8=4$) $\rightarrow (E_8)_1$ ($\det \text{Cartan } E_8=1$) by the order-4 μ_4 clock (v351/v369). [C] the μ_4 condensation $SO(16)_1 \rightarrow (E_8)_1$ (v154/v351). [O] residual: the continuum scaling-limit existence (MMST v336). Reduces S3 to a runnable lattice model; does NOT close SEAM.EQUIV.01. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v368_seam_s3_inflow.py	Track 1: the bulk-edge / anomaly-inflow leg (S4 of the v356 chain) made CONCRETE on the v367 lattice model – a finite STRIP of the gapped $p + ip$ model has a realised, non-gappable chiral edge, so edge EXISTENCE follows from the invertible bulk (anomaly inflow), NOT a separate assumption. [E] topo in-gap edge states ($M=1$ strip $\min_{k_x} E \sim 0$) vs trivial clean gap ($M=3$, neg control); [E] the near-zero state is edge-localised (weight within 4 sites of a boundary, edge $\gg$ bulk); [E] bulk-edge correspondence (edge branch count = bulk Chern $ C =1$) $\Rightarrow$ 16-Majorana edge, $c_- = 8$. [C] anomaly inflow: a $c_- \neq 0$ invertible bulk cannot have a gappable edge $\Rightarrow$ discharges the v336/v351 ‘does the edge exist?’ residual on the lattice. [O] residual: the continuum scaling limit (MMST v336). Establishes edge EXISTENCE on the lattice; does NOT close SEAM.EQUIV.01. [E][C][O]
v369_qgamb_redundancy.py	Track 2 (next-plan v2): the AMBIENT REDUNDANCY statement – the holographic route to Gravity-complete that SIDESTEPS building the general Euclidean QG measure (C7/QG.AMB.01). Instead of constructing the non-perturbative ambient measure (the conformal-factor swamp, v332/v334), assemble the established discriminators proving the ambient sector carries NO physical d.o.f. relative to the holomorphic boundary algebra, so QG.AMB.01 is a non-fundamental CERTIFICATION object (like a coordinate choice in GR), not missing dynamics. [E] HOLOMORPHIC $\Rightarrow$ DHR = Vec: #DHR primaries = $ \det \text{Cartan} = 1$ for E_8 (ONE primary = vacuum) vs 4 for $SO(16)/D_8$ – no nontrivial superselection charges $\Rightarrow$ no hidden boundary sector a bulk could carry invisibly. [E] NO TORUS GSD: ground-state degeneracy on $T^2 = \# \text{anyons} = \det K = 1$ for $E_8 \Rightarrow$ unique ground state $\Rightarrow$ no topologically protected invisible bulk d.o.f. (the genus-1 obstruction of v344). [E] FINITE PETZ RECOVERY: the deviation subspace contracts at $(2/3)^6 = 64/729 < 1$ (v221) $\Rightarrow$ Rec_Σ bounded. [E] GAP-DECOUPLING MARGIN: $\Delta_{\text{eff}} = 6 \log \frac{3}{2} - \frac{31}{4\pi^2} \approx 1.648 > 0$ (v76/v337) $\Rightarrow$ the ambient sector is energetically separated. [C] RECONSTRUCTION MAP: Bisognano–Wichmann gives the modular boost (v258/v309/v323) $\Rightarrow \text{Rec}_\Sigma : (\text{bulk}) \rightarrow \mathcal{A}_\Sigma^{\mu_4}$. [C] THE REDUNDANCY STATEMENT: under SEAM.EQUIV.01 + BW, $\mathcal{O}_{\text{phys}}^{\text{bulk}}/\text{Diff} \cong \mathcal{A}_\Sigma^{\mu_4} \Rightarrow$ QG.AMB.01 carries no extra physical d.o.f. [O] residual: the two consumed premises – SEAM.EQUIV.01 (the S3 lattice input, v366) + the BW intrinsicity of the raw collar (v329); provides the ALTERNATIVE (holographic) route, does NOT construct the measure. Gravity-complete = Boundary-complete + Ambient-redundancy [E][C][O]
v370_grav_spin2_unitarity.py	Track 2: the Barnes–Rivers spin decomposition of the graviton propagator – perturbative graviton unitarity SECTOR-BY-SECTOR (extends v304’s scalar pole algebra to the tensor spin structure + combines with v334’s spin-0 conformal mode). [E] projector completeness: $\text{tr } P_2 = (d-2)(d+1)/2$, $\text{tr } P_1 = d-1$, $\text{tr } P_{0s} = \text{tr } P_{0w} = 1$ sum to $d(d+1)/2$; the $d=4$ split is $5+3+1+1=10$. [E] EH structure: spin-2 coefficient +1, spin-0 scalar $-1/(d-2) = -1/2$. [E] the Stelle ghost is a SPIN-2 state (a local $1+p^2/M^2$ dressing puts the negative-residue pole at $p^2 = -M^2$). [E] the entire KMS form factor e^{p^2/M^2} (v304/v259) makes spin-2 ghost-free (only the $p^2=0$ pole). [C] the wrong-sign spin-0 conformal mode ($c_{\text{conf}}(4) = -3/2$, v332) is cured by the GHP contour (v334) – a different mechanism. [C] $\Rightarrow$ perturbative graviton unitarity sector-by-sector, conditional on v304’s entire-analyticity assumption. [O] perturbative-only + the open analyticity assumption; NOT the non-perturbative measure (QG.AMB.01). [O] decline: $\text{tr } P_2 = 5$ is dimension counting, NOT g_{car} (v354/v355). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v371_ftransfer_pole.py	Track 3 (F_{transfer}): the Koide source→pole transfer as a typed solver – promotes the experiments/ftransfer solve into the ledger with a kill test (does NOT re-prove 53/54 v183 or $Q^*=2/3$ v82/v101). [E] $Q_{\text{pole}}=\text{Koide(PDG poles)}=2/3$ to 3×10^{-6} , $Q_{\text{src}}(\varphi_0^{\text{ret}}\text{-ladder})=0.66446$ (0.33% below). [E] QED runs the wrong way: $dQ/d\epsilon > 0$ pushes Q ABOVE 2/3; the ϵ mapping $Q_{\text{pole}} \rightarrow Q_{\text{src}}$ is NEGATIVE while QED gives $\epsilon=+(3/2)(\alpha/\pi) > 0$ – wrong sign for any $\alpha \in [1/137, 1/128]$. [C] verdict: F_{pole} is NOT standard QED running; the transfer is the non-QED 53/54 operator / $(2/3)^6$ Moebius generator (v183/v82). Stays [C], plain running excluded as the kill. [E][C]
v372_ftransfer_boltzmann.py	Track 3 (F_{transfer}): η_B from the INTEGRATED Buchmueller–Di Bari–Pluemacher Boltzmann network at the TFPT-frozen heavy scale – promotes the experiments/ftransfer solve, replacing the v326 toy washout. Frozen $M_1=M_{\text{scal}}(\varphi_0^{\text{ret}})^2/A_\Lambda$ ($\sim 8.65\times 10^9$ GeV, v212), $\tilde{m}_1=m_3/A_\Lambda=5$ meV, $\delta_{CP}=4\pi/3$. [E] integrated efficiency $\kappa_f \sim 0.09$ (strong washout $K \sim 4.6$) agrees with the BDP fit to $\sim 25\%$. [C] $\eta_B(\text{ODE})\sim 6.5\times 10^{-10}$ at the frozen M_1 lands within a factor ~ 1.1 of the observed 6.1×10^{-10} , NO M_R dial. [X] kill: η_B outside [obs/3, 3 obs] for all seesaw-consistent M_R would drop the leptogenesis branch. Stays [C] (a transfer target). [E][C][X]
v373_ftransfer_relic.py	Track 3 (F_{transfer}): the axion relic from the FINITE-T misalignment ODE – promotes the experiments/ftransfer solve and DECIDES the two TFPT angle branches, replacing the v326 adiabatic toy. $f_a=M_{\text{scal}}/128 \sim 2.4\times 10^{11}$ GeV, $m_a \sim 23.8 \mu\text{eV}$, lattice $\chi(T)$ $n=8.16$. [E] candidate scales fixed by the determinant-line atoms ($128=2 \dim S^+ \mu_4 $). [C] the frozen SPINE angle $3\pi/5=108^\circ=\pi N_{\text{fam}}/g_{\text{car}}$ gives $\Omega_a h^2 \sim 0.12$ in $[0.08, 0.16]$ (lands on Ω_{DM} untuned) – the robust dominant-DM branch. [X] the HILLTOP 170° over-produces ($\sim 5.4\times$) – disfavoured. [X] kill: a finite-T solve robustly outside $[0.08, 0.16]$ for the spine across $\chi(T)/g_*$ drops the dominant axion-DM branch. Stays [C]/[X]. [E][C][X]
v374_ftransfer_qcd.py	Track 3 (F_{transfer}): the m_p/m_e transfer as a typed uncertainty-budget + kill test – the falsifiability companion to v262 (the precise 2-loop point), replacing the v326 toy (which hardcodes 1836.15). [E] $b_3 = -(11 - 2n_f/3) = -7$ ($n_f=6$ carrier). [C] two declared externals (v339): $\alpha_s(M_Z)=0.1179\pm 0.0009$ and $C_p=2.83\pm 0.15$, each $\sim 5.3\%$. [C] m_p/m_e central ~ 1824 (v262) with a propagated $\pm 7.5\%$ band [$\sim 1690, \sim 1960$] CONTAINING the observed 1836.15 – no free dial. [X] kill: a future lattice $C_p\pm 0.03$ + tighter α_s shrink the band to $\sim \pm 2\%$; a band then excluding 1836.15 drops the QCD-matching route ($b_3 = -7$ + the $SU(9)$ -integer firewall v262). Distinct from v262's point; stays [C]. [E][C][X]
v375_observatory_registry.py	Track 4: the prediction OBSERVATORY – a status-typed CI over the frozen prediction registry (freeze_file.csv) that makes the falsifiability surface machine-checkable (no new physics). [E] falsifiability complete: every registry row carries a non-empty kill criterion (no orphan claims). [E] headline values re-derive from $\{\varphi_0^{\text{ret}}\}$: $\sin^2 \theta_{12}=1/3-\varphi_0^{\text{ret}}/2$, $\sin^2 \theta_{13}=\varphi_0^{\text{ret}} e^{-5/6}$, $\beta_{\text{rad}}=\varphi_0^{\text{ret}}/(4\pi)$. [C] live scorecard: θ_{12} vs JUNO first run (0.3092 ± 0.0087) = 0.28σ (compatible); θ_{13} vs NuFIT 6.0 NO (0.02195 ± 0.00058) = 2.0σ (the flagged most-tensioned core prediction); β_{rad} vs ACT DR6 (0.215 ± 0.074) = 0.37σ (hint); $r=12/N_\star^2 \sim 0.004 < \text{BK18}$ (compatible). [E] registry integrity: the single machine-readable falsifiability surface. Tooling for the closed/open pieces. [E][C]
v376_seam_s3_centralcharge.py	S3 closure stack: the central charge $c=8$ extracted NUMERICALLY from the lattice via Calabrese–Cardy finite-size entanglement scaling of the critical free-fermion content (the quantitative core of the MMST scaling-limit claim, on OUR model). [E] one critical complex mode gives $c=1.0000$ (Peschel correlation-matrix EE); [E] the collar is 16 Majoranas = 8 complex modes (v367), c additive $\Rightarrow c=8=g_{\text{car}}+N_{\text{fam}}$; [E] chiral $c_-=8$ (Chern $ C =1$ per Majorana v367, non-gappable edge v368). [O] the specific net $(E_8)_1$ is v377/v378; the continuum existence is the cited MMST theorem (v336). Numerical $c=8$ from the lattice; does NOT close SEAM.EQUIV.01. [E][O]

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Script	What it machine-checks (<i>continued</i>)
v377_seam_s3_e8character.py	S3 closure stack: the chiral $c=8$ content is the SPECIFIC net $(E_8)_1$, via the exact affine character q -series + the μ_4 /GSO promotion. [E] $\chi = E_4/\eta^8 = q^{-1/3}(1+248q+4124q^2+\dots)$: leading $-c/24 = -1/3 \Rightarrow c=8$; level-1 $= 248 = \dim E_8$ (one primary). [E] the μ_4 /GSO promotion $SO(16)_1 \rightarrow (E_8)_1$: $248=240+8$, $240 = \dim S^+ g_{\text{car}} N_{\text{fam}} = 16 \cdot 5 \cdot 3$; $248=120+128 = \dim SO(16) + \text{spinor}$. [E] discriminator: $(E_8)_1$ has 1 primary/248 currents vs $SO(16)_1$ 4 primaries/120. [O] continuum existence (v336); the μ_4 projection = the seam one-sidedness (S3). Pins the target net; does NOT close SEAM.EQUIV.01. [E][O]
v378_seam_s3_modular.py	S3 closure stack: the GENUS-1 discriminator – torus ground-state degeneracy = 1 (holomorphic = $(E_8)_1$), the “hard part” v344 flagged (genus-0 unique vacuum is necessary not sufficient). [E] KLM condensation: $\mu(\text{carrier}) = \det C(D_5) \det C(A_3) = 4 \cdot 4 = 16$; the order-4 μ_4 glue ($ L =4$) $\Rightarrow \mu(E_8) = 16/16 = 1$ (torus GSD = 1); index-2 $\Rightarrow \mu(SO16) = 16/4 = 4$. [E] $ \det C(E_8) = 1$ vs $ \det C(D_8) = 4$. [E] the single $(E_8)_1$ character has modular T -eigenvalue $e^{-2\pi i/3}$ ($h=0, c=8$), 1-dim rep $\Rightarrow$ one character $\Rightarrow$ torus GSD = 1. [O] continuum existence (v336). Pins the net at genus-1; does NOT close SEAM.EQUIV.01. [E][O]
v379_seam_s3_rp.py	C7 / OS reconstruction: reflection positivity (the OS axiom) of the explicit gapped collar measure, verified numerically – the remaining constructive-QFT ingredient for the OS reconstruction. [E] the gapped $p+ip$ band gives $G(\tau) = \text{mean}_k e^{-\varepsilon_k \tau}$ with $\varepsilon_k \geq \text{gap}/2 \sim 1 > 0$ (v367) – a positive spectral measure; [E] the Hankel/reflection Gram matrix $M_{ij} = G(\tau_i + \tau_j)$ is PSD – OS reflection positivity holds; [E] neg control: a growing ghost mode makes it indefinite (non-vacuous). [C] RP + gap (v76/v337) + GNS (v240) + $c=8$ (v376) + $(E_8)_1$ (v377/v378) give the OS inputs; C7/QG.AMB.01 is then DISCHARGED by the redundancy theorem v369, not built. [O] the full constructive measure stays the cited step. [E][C][O]
v380_grav_kms_hessian.py	The KMS Entire Hessian – the Stelle ghost is EXACTLY the Seeley–DeWitt truncation, and resummation pushes it to infinity (upgrades v304/v370 from “assume entire” to a derived statement). [E] the seam KMS cutoff $f(u) = e^{-u}$ (v259) gives the dressed spin-2 propagator $e^{-p^2/M^2}/p^2 = 1/(p^2 a)$ with $a(u) = e^u$ entire & nowhere zero $\Rightarrow$ only the $p^2=0$ pole (no ghost). [E] each finite truncation carries the ghost: the $R+R^2$ order $T_1=1+u$ has the Stelle zero $u=-1$, the Weyl ² order $T_2=1+u+u^2/2$ the pair $-1 \pm i$; the entire a has none. [E] the ghost DECOUPLES: nearest zero of T_n grows monotonically with n (1, 1.41, $\dots$, 3.07 for $n=1..8$) $\rightarrow \infty$, so “entire” = “do not truncate”. [C] $\Rightarrow$ perturbative graviton unitarity. [O] the exact off-shell curved-space Hessian identification is the cited heat-kernel resummation; perturbative-only, not the non-perturbative measure. [E][C][O]
v381_qft4d_eg_allorder.py	The all-order Epstein–Glaser / BRST contract for the perturbative 4D S-matrix S_{pert} – the “all-order closing statement” for the 4D perturbative QFT leg. Types the standard causal-perturbation-theory closure for the TFPT finite interaction class; it does <i>not</i> build a path integral. [E] POWER-COUNTING: every gauge+matter vertex (Yang–Mills + Dirac–Yukawa + Higgs + ghost) is a mass-dimension-4 marginal operator $\Rightarrow$ the EG singular order $\omega \leq 4 \Rightarrow$ a FINITE counterterm space at every order. [E] BRST NILPOTENCY $s^2=0$ verified via the Jacobi identity for $su(2)$ (residual 0) and $su(3)$ (10^{-16}), the carrier weak+colour content. [E] the seam gap $\Delta = 6 \ln(3/2) > 0$ (v302) gives the IR-safe adiabatic limit $g \rightarrow 1$. [C] imported: T_n exists to all orders by causal factorisation (Epstein–Glaser 1973 / Brunetti–Fredenhagen). [C] imported: all-order BRST invariance (Piguet–Sorella / Kugo–Ojima) $\Rightarrow$ Slavnov–Taylor to all orders. [E] scope fence: matter+gauge ONLY – the R^2 /Weyl ² gravity sub-sector is v304/v370/v380, not a local EG vertex; S_{pert} is not the ambient measure QG.AMB.01 (v369). NET [C] (imported EG+BRST on the TFPT dim-4 class + gap), prerequisites [E]; extends v269/v271/v273/v278 from 1-loop to all-order [E][C]

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Script	What it machine-checks (<i>continued</i>)
v382_alpha_quillen_exact.py	Names the Quillen determinant-line VARIATION $\delta_\tau(\log \det_\zeta \Delta_{U(1)} + 8b_1c_3^6 \log \varphi_{\text{seam}}) = 0$ as a tracked target (review Point 10), elevating EM.WARD.01's residual to a citable [O]. [E] the Quillen split holds at the root $\alpha^3 - 2c_3^3\alpha^2 = 8b_1c_3^6 \ln(1/\varphi_{\text{seam}})$ at $\alpha^{-1}=137.0359992$ ($F_{U(1)}=0$ IS the stationarity of the $U(1)$ determinant line, v341). [E] every coefficient a named atom: $8b_1=\frac{4}{5}\cdot 41$ a $U(1)$ index, $c_3=1/(8\pi)$ Gauss–Bonnet ($c_3^{3,6}$ heat-kernel powers), $q(D_5)+q(A_3)=2$ discriminant forms (v341/v48/v216). [E] the value $\alpha^{-1}=137.0359992168$ stays closed (unique root + ablation, v3) – only “why this functional” is open. [O] THE TARGET: the from-first-principles AQFT/ ζ proof that $F_{U(1)}$ is the EXACT Quillen functional. [C] a FACE of SEAM.EQUIV.01 (v336): the seam $U(1)$ determinant line lives on the same holomorphic seam net, so once the net is $(E_8)_1$ its $U(1)$ sub-determinant is fixed – not a second independent gate, it names/tracks the pre-existing EM.WARD.01 residual (v341/v342). No new number (reuses v341, Wolfram-mirrored) [E][C][O]
v383_dynamics_universal.py	DYNAMICS.UNIVERSAL.01: the UNIVERSAL spectral-gap / Perron–Frobenius principle – every TFPT sector is the SAME object (a gapped operator with a UNIQUE leading attractor = the physics, a spectral gap = the reason there is no free parameter), extending v303 from F_{transfer} to the whole theory. [E] FLAVOR (computed): the cusp transfer spectrum $\{1, (2/3)^6, (1/3)^6\}$ has a simple Perron leading 1 and gap $6 \ln(3/2) > 0$ (v56/v82). [E] DISCRETE COMPILER (computed): the affine- E_8 adjacency has Perron eigenvalue 2 (Kac marks, v312/v313) and subleading $2 \cos(\pi/5) = \varphi$, gap $2 - \varphi = 1/\varphi^2 > 0$. [E] DECOUPLING MARGIN: $\Delta_{\text{eff}} = 6 \ln(3/2) - 31/(4\pi^2) \approx 1.648 > 0$ (v76/v337). [E] TWO NUMBER-FIELD FACETS (v314): golden $\varphi \in \mathbb{Q}(\sqrt{5})$ (carrier-5, static) and $(2/3)^6 \in \mathbb{Q}$ (family-3, dynamic) are the prime-5 and prime-3 facets of the order-30 Coxeter clock $30 = 2\cdot 3\cdot 5 = h(E_8)$ – a factorisation, not an equality. [C] the other sectors are the same structure: gravity (v358/v359), QG saddle (v365), the holomorphic $c=8$ RG fixed point (v157/v158), the all-order S-matrix (v381), recovery (v221), F_{transfer} (v303), $\tau=i$ (v333). [C] META-THEOREM: gapped $\Rightarrow$ unique attractor $\Rightarrow$ parameter-free, theory-wide – one spectral-gap statement wearing many hats. A synthesis, no new number [E][C]
v384_residual_certification.py	RESIDUAL.CERTIFICATION.01 (historical compiler scope; corrected 2026-09-05): the then-listed compiler residual is CERTIFICATION, not CONSTRUCTION – after v369/v381/v382 there is NO open TFPT physics MECHANISM left; every residual is an external CERTIFICATE of already-determined structure, of three kinds: (A) external math proof, (B) theorem-forbidden, (C) external physics. A ledger-CI audit. [E] LEDGER CI: every residual claim id is present (no orphan). [E] NO-UNIT (B): $c_3=1/(8\pi)$ and $g_{\text{car}}=5$ are mass-dimension 0, so by No-Unit (v153/v364) no dimensionless compiler outputs an absolute scale $\Rightarrow v_{\text{geo}}$ is forbidden by theorem, not a gap. [E] GAP-DECOUPLED (A): $\Delta_{\text{eff}} \approx 1.648 > 0$ (v76/v337) $\Rightarrow$ every readout is independent of the ambient measure (QG.AMB.01 a [C] redundancy, v369). [E] CLASSIFICATION COMPLETE: SEAM.EQUIV.01 (continuum existence = cited MMST/Adamo, v336) $\rightarrow$ A, ALPHA.QUILLEN.EXACT.01 (v382) $\rightarrow$ A, QG.AMB.01 (v369) $\rightarrow$ A, $v_{\text{geo}} \rightarrow$ B, F_{transfer} (v371–v374, firewall v187) $\rightarrow$ C; ZERO open internal mechanisms within that scoped compiler list. This audit does not classify the physical completeness gates T1–T8; those and a shared 3+1D parent remain open. [C] CONVERGENCE applies only to the historical compiler residual. An audit, no new number [E][C]

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Script	What it machine-checks (<i>continued</i>)
v385_uvbranch_killtest.py	UVBRANCH.KILLTEST.01: the optional carrier–Pati–Salam UV branch on the ALL-ORDER footing – a single citable kill-test surface with the proton-decay SAFETY hierarchy computed (not a fake τ_p window). A consolidation (does <i>not</i> re-run the RGE v246 nor re-derive the PS scale v249/v253). [E] carrier content = SM ($b = (41/10, -19/6, -7)$, v159/v246, no new states) and S_{pert} closes to all orders (v381) $\Rightarrow$ the SM-non-unification is all-order-robust. [X] plain-SM 4D-GUT killed ($\sin^2 \theta_W = 3/8$ vs 0.231; v246). [C] optional carrier-PS branch: $M_{PS} = \kappa M_{\text{scal}}$, $M_{\text{scal}} = c_3^{7/2} \bar{M}_{\text{Pl}} \approx 3.06 \times 10^{13}$ GeV, $\kappa \in [1.0, 1.2]$ (v253); content $\{1, 10, 16, 45\}$, no 126 (v247/v248); not the default (v265). [E] proton-decay SAFETY hierarchy: minimal PS gauge bosons are $SU(4)$ leptoquarks ($B-L$ -conserving $q \leftrightarrow l$, rare LFV $K_L \rightarrow \mu e$), <i>not</i> the $p \rightarrow e^+ \pi^0$ dim-6 operator (needs an $SO(10)/SU(5)$ diquark, absent); the binding bound $M_{PS} \gtrsim 10^6$ GeV is cleared by $M_{PS}/M_{\text{bound}} \sim 10^7 \gg 1$. [X] frozen kill tests (v265): κ leaving $O(1)$ / a forbidden rep / a new gauge-charged state / a rare-LFV signal below the bound; no fake τ_p . A consolidation, no new number [E][C][X]
v386_grav_amplitude.py	GRAV.AMPLITUDE.01: the entire-form-factor graviton-exchange AMPLITUDE is finite, UV-softened and tree-unitary – perturbative gravity as an explicit scattering problem, extending v304/v370/v380 from the propagator to the amplitude. The dressed spin-2 propagator $P = e^{-p^2/M^2}/p^2 = 1/(p^2 a)$, $a(u) = e^u$, $M = M_{\text{scal}}$. [E] one pole, ghost-free: a entire & nowhere zero (v380) $\Rightarrow$ only pole at $p^2 = 0$, residue $e^0 = 1 > 0$. [E] UV-softened: ratio e^{-u} at $u = 1, 5, 10, 20 = 0.37, 6.7 \times 10^{-3}, 4.5 \times 10^{-5}, 2.1 \times 10^{-9}$ (faster than any power). [E] low-energy = GR + a calculable $-p^2/M^2$ correction ($M = M_{\text{scal}} = c_3^{7/2} \bar{M}_{\text{Pl}}$, v253). [C] tree unitarity: a single positive-residue pole, no negative-norm states (v370/v380). [C] the amplitude $A = (\kappa^2/2)(T \cdot P_2 \cdot T') e^{-p^2/M^2}/p^2$ is GR at low energy, softened in the UV (perturbative-only; QG.AMB.01 a [C] redundancy v369). No new number [E][C]
v387_corrections_gap.py	CORRECTIONS.GAP.01: the practical harvest of v383 – the same spectral gap that makes each sector parameter-free ALSO sets the SIZE of its first correction ($\text{correction}_n \sim (\lambda_2/\lambda_1)^n$). [E] FLAVOR: $\lambda_2 = (2/3)^6 = 64/729 \Rightarrow$ first Koide correction ~ 0.088 (v56/v82). [E] RECOVERY: the same $(2/3)^6$ Petz rate (v221). [E] QG: capped by $\chi = 1/(1 - (2/3)^6) = 729/665$ (v337). [E] DISCRETE COMPILER: the update $(A + 2I)/4$ fixes the Kac marks ($\lambda_1 = 1$) and decays at the golden $(\varphi + 2)/4 \approx 0.905$ (carrier-5 facet, v303/v312). [E] the rates split into the $(2/3)^6$ family (family-3, in $\mathbb{Q}$) and the golden family (carrier-5, in $\mathbb{Q}(\sqrt{5})$) – the two facets of v314/v383. [C] the correction calculus: the gap does double duty (WHY no free parameter AND HOW BIG the first correction), so sub-leading magnitudes are organised, not free. No new number [E][C]
v388_corrections_budget.py	CORRECTIONS.BUDGET.01: the gap correction (v387) is a <i>typed</i> budget, NOT a uniform band on every prediction – the $(\lambda_2/\lambda_1)^n$ size is a property of the distance from a gapped operator’s leading eigenvector, so it is only defined where λ_2 exists. The prediction surface splits into four correction classes (already implied by v303). [E] SEAM-GAPPED: Koide (F_{pole} v303), recovery (v221), the QG bound (capped by $\chi = 729/665$, v337) carry $(2/3)^6$; the discrete compiler decays at the golden $(\varphi + 2)/4$ (v312). [E] KOIDE FIRST CORRECTION: F_{pole} is the ONE seam-gapped prediction, rate $(2/3)^6 \approx 0.0878$ (v371), source quotient 0.33% below $2/3$ – the rate is the suppression SCALE, not the residual. [E] EXACT-IDENTITY class ($\det R = 8$, $N_\Phi = 1$, $\theta_{\text{eff}} = 0$, $\sin^2 \theta_{13}$): no $\lambda_2 \Rightarrow$ correction 0 STRUCTURALLY (a band would contradict [E]). [E] EXTERNAL-RATE class ($\eta_B/\text{axion}/m_p, m_e$): the gapped shape with external rates (only F_{pole} has the seam rate, v303), firewalled (v187). [E] FIXED-POINT class: the texture is already explicit ($\theta_{12} \varepsilon = c_3 + 36c_3^4$). [C] a uniform band on all predictions is WRONG; the size is keyed to the mechanism class. A typing of v387, no new number [E][C]

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Script	What it machine-checks (<i>continued</i>)
v389_grav_loop_finiteness.py	GRAV.LOOP.FINITE.01: the entire-form-factor graviton is UV-finite at the <i>loop</i> level by power counting – the honest next step past v386 (tree), extending v304/v370/v380/v386 from the propagator to the superficial degree of divergence. Honest scope: the standard infinite-derivative/nonlocal-gravity finiteness statement, NOT a full proof of perturbative QG. [E] super-polynomial falloff $p^k e^{-p^2/M^2} \rightarrow 0$ for every k . [E] one dressed line turns a quadratic divergence into the finite $(M^2/2)e^{-p_0^2/M^2}$; the GR $\int p^3/p^2 dp$ diverges quadratically. [E] the superficial degree $\rightarrow -\infty$ at every loop order (dressed cutoff-ratio $\rightarrow 1$ vs GR $\rightarrow 4$). [E] the regulator is the SEAM scale $M = M_{\text{scal}} = c_3^{7/2} \bar{M}_{\text{Pl}}$ (v253/v259), not a dial. [C] loop UNITARITY of the nonlocal form factor (Lorentzian continuation / macro-causality) stays the honest open point – tree unitarity is v386; NOT claimed solved. No new number [E][C][O]
v390_prime2_facet.py	COXETER.PRIME2.01: the prime-2 facet of the order-30 Coxeter clock, completing v383. The clock $30 = 2 \cdot 3 \cdot 5 = h(E_8)$ had two named facets (golden $\varphi \in \mathbb{Q}(\sqrt{5})$, prime-5/carrier; $(2/3)^6 \in \mathbb{Q}$, prime-3/family); this names the prime-2 facet as the Gaussian field $\mathbb{Q}(i) - \tau = i$ and the order-4 $\mu_4 = \mathbb{Z}/4$ square seam deck (v282/v288/v333), structure already present. [E] $h(E_8) = 30$ factors into exactly three primes. [E] one quadratic facet field per prime, each ramified at its prime: disc $\mathbb{Q}(i) = -4$, disc $\mathbb{Q}(\sqrt{-3}) = -3$, disc $\mathbb{Q}(\sqrt{5}) = 5$; ramified primes $\{2, 3, 5\}$, product = 30. [E] prime-2 Gaussian facet: min. poly $x^2 + 1$, $\tau = i$, $j(i) = 1728 = 12^3$, $ \mu_4 = 4 = 2^2$ (the static seam-orientation facet). [E] prime-5 golden (v383): $2 \cos(\pi/5) = \varphi$ (pentagon). [E] prime-3 family (v383/v220): $(2/3)^6$ plus the Eisenstein ζ_3 (hexagonal CP $\pi/3$). [C] completion: each prime carries a facet (square/hexagon/pentagon = seam/CP/carrier), the prime set forced by $h(E_8)$. A synthesis, no new number [E][C]
v391_alpha_quillen_progress.py	ALPHA.QUILLEN.PROGRESS.01: an <i>honest attempt</i> at the external target ALPHA.QUILLEN.EXACT.01 (v382) – it REDUCES the open step to a sharper named sub-target via a solvable model but does NOT close it; ALPHA.QUILLEN.EXACT.01 stays [O] (external math, type A, v384). [E] solvable model $\det_\zeta(-\partial_\tau^2 + m^2)$ on a circle $= (2 \sinh(\beta m/2))^2$, m -variation $\beta \coth(\beta m/2) = 2/m + (\beta^2/6)m - (\beta^4/360)m^3 + \dots$ a closed heat-kernel/Laurent series (m^3 coeff $-1/360$ verified). [E] a ζ -det variation is structured heat-kernel data, so v382's $8b_1c_3^6$ counterterm (a Gauss–Bonnet heat-kernel power) is the right <i>kind</i> of object. [E] the v382 split re-verified at $\alpha^{-1} = 137.0359992$. [E] reduction: the open step reduces to the named sub-target “seam Seeley–DeWitt coefficient $= 8b_1c_3^6$ ”. [O] NOT CLOSED: the actual seam ζ -det proof stays open, SEAM.EQUIV.01 continuum existence (v336) the other external [O]; α^{-1} stays [E]. An attempt that reduces, does not close [E][O]
v392_seam_s3_scalinglimit.py	SEAM.S3.SCALINGLIMIT.01: an <i>honest attack</i> on the one open lemma of SEAM.EQUIV.01 (the continuum scaling-limit existence, v336) – it does NOT close it (the abstract existence is the cited MMST theorem); it STRENGTHENS the case with the existence-relevant observable v376 did not test: that the finite-size data <i>converge</i> . [E] the Calabrese–Cardy EE slope $c_1(L)$ at $L = 66 \dots 514$ is a monotone Cauchy-like sequence approaching 1 ($ c_1(L) - 1 $ strictly decreasing). [E] a $1/L$ Richardson fit gives $c_1(\infty) \approx 1.000$, so the 16-Majorana collar $c = 8c_1 \approx 8.00 = g_{\text{car}} + N_{\text{fam}}$ is reached <i>in</i> the limit. [E] the successive differences are strictly decreasing (numerical Cauchy, necessary for existence). [O] convergent data are evidence, not a proof of existence (MMST v336), and do not pin $(E_8)_1$ vs $SO(16)_1$ (holomorphy v377/v378). Strengthens the residual, does NOT close it [E][O]

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Script	What it machine-checks (<i>continued</i>)
v393_corrections_numeric.py	CORRECTIONS.NUMERIC.01: the typed correction budget (v388) turned into ACTUAL first-correction magnitudes – a computed theoretical-uncertainty surface, the short-term testable harvest of v388. [E] FIXED-POINT band $(\theta_{12}/\theta_{13}/\lambda_C/\beta_{\text{rad}}) =$ the explicit φ_0 puncture term $36c_3^4/c_3 = 9/(128\pi^3) \approx 0.227\%$ (exact; $= \theta_{12}$'s ε first-correction). [E] SEAM-GAPPED band (Koide/recovery) $= (2/3)^6 \approx 8.78\%$; the QG bound capped by $\chi - 1 = 64/665 \approx 9.62\%$ (v337). [E] EXACT-IDENTITY band $= 0$ structurally ($\det R = 8$, $N_\Phi = 1$, $\theta_{\text{eff}} = 0$). [E] EXTERNAL-RATE band $=$ external physics quoted ($m_p/m_e \pm 7.5\%$ v374; n_s/r $N_\star$ band; $\eta_B 1.07 \times$ v212), fenced v187. [C] each prediction gets “central value $\pm$ computed first correction”. A harvest of v388, no new number [E][C]
v394_coxeter_atoms.py	COXETER.ATOMS.01: the clockwork coherence – the three Coxeter primes ARE the three anchor atoms ARE the three number-field facets, and the prime-2 seam is the common dynamical factor. A bird's-eye [E] re-reading tying v390 (facets) to the anchor $a = (1, 1, 2)$ and v319 (5x6 clock); registers RES.COXETER.SYMMETRY.01 as a tracked [O]. [E] $a = (1, 1, 2)$: $e_3=2= Z_2 $, $p_0=3=N_{\text{fam}}$, $e_2=5=g_{\text{car}}$, product $30=h(E_8)$. [E] atoms = facet fields (v390): $2 \rightarrow \mathbb{Q}(i)$, $3 \rightarrow \mathbb{Q}(\sqrt{-3})$, $5 \rightarrow \mathbb{Q}(\sqrt{5})$, each ramified at its prime. [E] $\chi=729/665=3^6/(3^6-2^6)$, $(2/3)^6=2^6/3^6$, exponent $6=2N_{\text{fam}}$. [E] both dynamic rates carry prime-2: $2/3= Z_2 /N_{\text{fam}}$, $(\varphi+2)/4=(\varphi+2)/ \mu_4 $, $ \mu_4 =4=2^2$. [E] $30=5 \times 6=g_{\text{car}}(2N_{\text{fam}})$. [C] the seam is the universal dynamic engine. [O] RES.COXETER.SYMMETRY.01 registered, not closed [E][C][O]
v395_hypergraph_coupled.py	HYP.COUPLED.01: the coupled hypergraph rewrite – one local rule unifies v299/v327/v324 (carrier $\times$ family). [E] LOCAL COUPLED MICRO-RULE: state on 9 affine- E_8 nodes $\times$ 3 family slots; one micro-step = network lazy diffusion on each cusp column + v327 M on each node's family vector; steps commute, $T_{\text{micro}} = T_{\text{net}} \otimes M$. [E] JOINT ATTRACTOR: top eigenvalue 1 with eigenvector $\text{marks} \otimes e_0$; iteration from any positive start converges. [E] ONE HAND = RECOVERY: one network step + $2N_{\text{fam}}$ family micro-steps gives $(2/3)^6$ on $\text{marks} \otimes v_{\text{surv}}$. [E] v324 EMERGES: $T_{\text{full}} = T_{\text{net}} \otimes T_{\text{cusp}}$ shares the same invariants; T_{cusp} is the 6-hand readout in the Galois/cusp basis (v317). [E] GROWTH + FIBER: v299 $E_6 \rightarrow E_7 \rightarrow E_8 \rightarrow \hat{E}_8$ unchanged with M -fiber attached. [O] 3-arm seed $(P_2) + \varphi_0$ (v312) remain irreducible [E][O]
v396_phi0_icosahedral.py	HYP.PHI0.01: the φ_0 leading term from icosahedral combinatorics (sharpening v312/v395). [E] ICO COUNTS ANCHOR-FORCED: $V=12$, $E=30=h(E_8)$, $F=20=g_{\text{car}}(g_{\text{car}}-1)$, $ \text{Aut} =120=4h= 2I $. [E] LEADING TERM EXACT: $\varphi_0^{\text{ree}}=1/(6\pi)=(4/3)c_3=F/(4h\pi)=F/(\text{Aut} \pi)=(F/(g_{\text{car}}N_{\text{fam}}))c_3$. [E] $F/h= Z_2 /N_{\text{fam}}$; leading term $= (F/h)/(4\pi)=c_3(g_{\text{car}}-1)/N_{\text{fam}}$. [E] GAUSS-BONNET: icosahedron deficit sum 4π ; $c_3=1/(Z_2 4\pi)$ (v216/v342). [E] HONEST NEGATIVE: puncture $48c_3^4$ not a rational hypergraph fraction. [C] tree-level seed $= (\text{hyperedges})/(g_{\text{car}}N_{\text{fam}}) \times c_3$, not an independent injection; puncture [O]
v397_external_clock_probe.py	FR.CLOCK.PROBE.01: a <i>falsifiable</i> probe of how external the “external physics” really is – do the frontier scheme-numbers land on the $\{2, 3, 5\}$ clock (the anchor atoms, v394) or not? Strict No-Free-Pattern (v100): “on the clock” = an EXACT match, not a wide-band fit. [E] η_B decuple $A_\Lambda=10= Z_2 g_{\text{car}}$ ON CLOCK (v212). [E] Koide rate $(2/3)^6=(Z_2 /N_{\text{fam}})^6$ ON CLOCK (v303). [E] axion spine angle $3\pi/5=\pi N_{\text{fam}}/g_{\text{car}}$ ON CLOCK (v211). [E] proton $C_p \sim 2.83 \pm 0.15$ NOT discriminating ($2^{3/2}$, $17/6$, $14/5$ all fit the band) $\Rightarrow$ EXTERNAL (firewall v187/v374). [C] 3 of 4 land exactly on the clock; the irreducible external residue shrinks to the proton QCD number C_p – “external physics” was overstated. [E] anti-numerology: refuses to assign C_p a clock value [E][C]

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Script	What it machine-checks (<i>continued</i>)
v398_seam_state_rigidity.py	Seam State Rigidity Theorem (Paper A, the G_{net} closure contract): the scattered state-invariance reductions (v177/v198/v199/v308/v309/v335) as ONE named target. [E] RP-definability hinge (OS canonical transfer $T=e^{-H}$ from RP + reflection alone, v54, on a quasi-free state v155, no μ_4 normal form); [E] band-limited core $[\rho, k]=0$ and character-block-diagonal sub-principal symbol swept $N=4.64$ (beyond the 3-dim H^1); [E] holomorphy $\Rightarrow (E_8)_1$ ($c=8$, $ \det \text{Cartan} =1$ vs 4, index $4= \mu_4 $, gap $6 \log \frac{3}{2} > 0$). [O] the one residual: $[\rho, \Lambda_\Sigma]=0$ on the full L^2 (intrinsic Bisognano–Wichmann). A contract+evidence module, NOT a closure of SEAM.EQUIV.01 (continuum = cited MMST v336)
v399_gravity_complete.py	Gravity-complete = Boundary-complete + Ambient-redundancy (Paper B accounting): combines the parameter-free local equation (v358/v359) and the ambient redundancy (v369). [E] $G_{ab} + \Lambda g_{ab} = (1/c_3)T_{ab}$, $1/c_3=8\pi$ (four c_3 -roles), Λ prefactor $3/(4\pi^2)$; [E] redundancy discriminators ($ \det \text{Cartan} =1$ vs 4, torus GSD=1, Petz $(2/3)^6$, margin $1.648 > 0$); [E] $\mathcal{O}_{\text{phys}} \subset \mathcal{A}_\Sigma$ over five readout classes (Newton 8π , Λ , scalaron c_3^7 , horizon $1/ \mu_4 $, recovery $(2/3)^6$) – all boundary/seam/gap. [C] the verdict; [O] SEAM.EQUIV.01 + intrinsic BW (no new gate)
v400_grav_nonlocal_action.py	Nonlocal spectral-gravity action with the local $R+R^2$ as its IR projection (Paper C, consolidating v304/v370/v380/v386). [E] the entire form factor $a=e^u$ gives the dressed propagator $1/(p^2 a)$ ONE pole (residue 1, ghost-free); [E] every truncation carries a Stelle zero whose nearest-zero modulus grows monotonically (v380); [E] the IR order $a=1+u+u^2/2+\dots$ reproduces the spectral-action $R+R^2$ (v28/v36) with the atom-fixed scale $M_{\text{scal}}^2/\bar{M}_{\text{Pl}}^2=c_3^7$ ($7=g_{\text{car}}+N_{\text{fam}}-1$, v253). [O] the entire- a analyticity assumption + perturbative-only (not the ambient measure QG.AMB.01, a [C] redundancy v369)
v401_metrology_closure.py	Metrology closure of the final input set $\{a, \pi, v_{\text{geo}}\}$ (Paper D, consolidating v153/v274/v364/v384). [E] $a=(1, 1, 2) \rightarrow (e_1, e_2, e_3)=(4, 5, 2)=(\mu_4 , g_{\text{car}}, Z_2)$, $c_3=1/(2e_1\pi)=1/(8\pi)$, 0 dimensionless dials + 1 unit; [E] dimensional bookkeeping (No-Unit v153) mass/ $1G/\Lambda/U_{\text{point}}/(m/\mu)=\text{number} \times v_{\text{geo}}^{1,2,4,1,0}$; [E] gravity adds no unit (v364); [E] G -vs- Λ over-determination 0.11% (v274). [O] v_{geo} theorem-forbidden ($\text{TOE}_{\text{strict}}=\text{TOE}_{\text{dimensionless}}+[v_{\text{geo}}]$, v384 type B)
v402_ftransfer_suite.py	F_{transfer} functor suite (Paper E): the four frontier sectors as ONE functor $F_{\text{transfer}}=F_{\text{observable}} \circ F_{\text{threshold}} \circ F_{\text{RG}}$ (consolidating FR.POLE/BOLTZMANN/RELIC/QCD.SOLVE). [E] the composition law (each observable factors source $\rightarrow$ threshold $\rightarrow$ RG $\rightarrow$ observable); [E] exact atom sources (Q_{src} v93; $A_\Lambda=2g_{\text{car}}=10$, $\delta_{CP}=4\pi/3$ v9/v212; $f_a=M_{\text{scal}}/128$ v185; $b_3=-7$ v164/v262); [E] a committed kill test per sector. [C] the firewall: physical predictions stay [C]/[O], only the algebraic source is [E] (never re-pressed into the compiler, v187)
v403_facet_compositum.py	ARITH.HULL.01: the three number-field facets (v390) COMPOSE to $K = \mathbb{Q}(i, \sqrt{-3}, \sqrt{5})$, a degree-8 = rank E_8 abelian field – the arithmetic hull dual to the E_8 lattice hull. [E] the squarefree parts $-1, -3, 5$ are independent in $\mathbb{Q}^\times/(\mathbb{Q}^\times)^2$, so $[K : \mathbb{Q}] = 2^3 = 8 = \text{rank } E_8 = g_{\text{car}} + N_{\text{fam}}$, Galois group $(\mathbb{Z}/2)^3$ order 8; $2^{\omega(h(E_8))} = 2^3 = 8 = \text{rank } E_8$ is E_8 -special (the E_7 control $h=18$, $2^2=4 \neq 7$ fails). [E] exactly 7 quadratic subfields $\{-1, -3, 5, 3, -5, -15, 15\}$, split 4 imaginary = $ \mu_4 $ (CM/dynamic) + 3 real = N_{fam} (RM/static). [E] ramified only at $\{2, 3, 5\}$ = the atoms = the primes of $h(E_8)=30$. [C] K is the abelian $(\mathbb{Z}/2)^3$ arithmetic hull dual to E_8 ; the 7 quadratic subfields a candidate for the 7 E_8 audit slices [E][C]

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Script	What it machine-checks (<i>continued</i>)
v404_e8_char_cm_duality.py	E8.CMDUAL.01: the $(E_8)_1$ vacuum character $\chi_{E_8}=E_4/\eta^8=j^{1/3}$ at the two CM points – 12 at the seam ($\tau=i$), 0 at the family ($\tau=\omega$), extending v282. [E] $\chi_{E_8}^3=j$ (q-series). [E] SEAM $\tau=i$ ($\mathbb{Q}(i)$, order 4): cross-ratio $2 \Rightarrow j=1728 \Rightarrow \chi_{E_8}(i)=1728^{1/3}=12$ (E_8 present, v214/v282). [E] FAMILY $\tau=\omega$ ($\mathbb{Q}(\sqrt{-3})$, order 6): the equianharmonic λ ($\lambda^2-\lambda+1=0$) $\Rightarrow j=0 \Rightarrow \chi_{E_8}(\omega)=0$ (E_4 vanishes, v220/v267). [E] $\tau=i, \tau=\omega$ are the ONLY elliptic points of $\text{PSL}(2, \mathbb{Z})$, so the values are forced. [C] the seam/flavor rigidity duality: the seam is rigid where E_8 is present ($\chi=12$, SEAM.EQUIV.01 closes), the flavor/CP sector is the soft residual where E_8 degenerates ($\chi=0$); the dual-keystone candidate (flavor = the $j=0$ degeneration of $(E_8)_1$) [E][C]
v405_seam_equiv_omega.py	SEAM.EQUIV.02 – the dual keystone at $\tau=\omega$: the family/flavor sector as the order-3 Eisenstein/ A_2 face of E_8 , dual to the seam = $(E_8)_1$ at $\tau=i$ (v404). A named contract (genre of v286/v398), NOT a closure. [E] $\chi_{E_8}(\omega)=0$ (E_8 degenerates at the family CM point) vs $\chi_{E_8}(i)=12$. [E] A_2 is the $\tau=\omega$ Eisenstein lattice (Cartan $\det=3=N_{\text{fam}}$, $h=3=N_{\text{fam}}$, $\mu_6=\mu_3 \times \mu_2$). [E] R lives in $E_6 \times A_2$: $248=\ R\ _F^2 + \det R + 2(1^\top R a)N_{\text{fam}}=78+8+2 \cdot 27 \cdot 3$, $\ R\ _F^2=78=\dim E_6$, $\det R=8=\dim A_2=\text{rank } E_8$. [E] $\delta_{\text{PMNS}}=4\pi/3$ is the $\tau=\omega$ hexagonal CM phase ($\arg \zeta_6=\pi/3$, v220/v233). [E] the cusp weights $\{0, 1/3, 2/3\}$ are the order-3 deck = $N_{\text{fam}} = \det Q$ (v72), $\text{Spec}(Q_+)=(1, 2, 3)$ (v69/v137). [C] the family/flavor sector is the order-3 Eisenstein/ A_2 deck at $\tau=\omega$; the two keystones sit at the only two elliptic points of $\text{PSL}(2, \mathbb{Z})$. [O] residual = the canonical $\mathbb{Z}_3$ deck map (v140) + the v_{geo} -class scale (No-Unit v153) [E][C][O]
v406_pmns_phase_origin.py	FLAV.PMNS.CLOSE.01: the PMNS dynamics closed modulo the $\tau=\omega$ keystone (v405) – the CP-phase ORIGIN is the family CM point and the absolute scale is one v_{geo} -class unit, so PMNS has zero free flavor dials beyond v_{geo} . [E] the three angles ($\sin^2 \theta_{12}=\frac{1}{3}-\frac{\varphi_0^{\text{ret}}}{2}$, $\theta_{23}=45^\circ$, $\sin^2 \theta_{13}=\varphi_0^{\text{ret}} e^{-5/6}$; v9/v268) assemble to one unitary U_{PMNS} (v270). [C] CP-PHASE ORIGIN (advance over v270): $\delta_{\text{PMNS}}=4\pi/3$ is the $\tau=\omega$ hexagonal CM phase (v405/v220/v233), upgrading v270's [O] assembled input to a keystone consequence. [C] $J_{\text{PMNS}}=-0.0297$ derived. [E] the absolute scale = one seesaw ratio $m_3=(y_\nu v_{\text{EW}})^2/M_R$ = a v_{geo} -class UV input (v272/v153), NOT a flavor gap. [C] net: PMNS = angles + δ [keystone] + J [derived] + scale [v_{geo}], zero free flavor dials. [O] residual = the seesaw operator realisation (M_R not a clean $\bar{M}_{\text{Pl}}$ power, v272/v184; one-parameter carrier-normalised candidate v481) + the normal-ordering Σm_ν floor kill test [E][C][O]
v407_dn_pairings_omega.py	FLAV.SELECTOR.CLOSE.01: the $R4'$ residue folds into the $\tau=\omega$ keystone (v405) – the three (d, n) selector pairings ARE the $\tau=\omega$ family-slice atoms. [E] the frame $(\mathbf{1}, a, \sigma)$ is a $\mathbb{Z}^3$ basis with $\det=11=\ Pl(K)\ _1$, and $n=(5, -9, 6)$ is the unique covector with $n \cdot \mathbf{1}=2$, $n \cdot a=8$, $n \cdot \sigma=121=11^2 \Rightarrow (d, n) \Rightarrow R$ columnwise (v136/v139). [E] $n \cdot a=8=\text{rank } E_8=\dim A_2=\det R$ – the anchor-pairing is the A_2 ($\tau=\omega$) block dimension that reads R in $E_6 \times A_2$ (v405). [E] the pairings $\{2, 8, 121\}=\{ Z_2 , \text{rank } E_8=\dim A_2=\det R, \ Pl(K)\ _1^2\}$ are the $\tau=\omega$ family-slice atoms (the μ_2 sheet, the A_2 block, the Plucker frame). [E] the square selects the point (σ -pairing $11(11+t)$, a perfect square only at $t=0$). [C] deriving (d, n) ($R4'$) folds into SEAM.EQUIV.02 – $d=\frac{3}{2}a-21$ anchor-derived (v139), the pairings the slice atoms. [O] the lone flagged residue “why $11=\ Pl(K)\ _1$ ” [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v408_phi0_puncture_heatkernel.py	HYP.PHI0.PUNCTURE.01: name the φ_0 puncture term $\delta_{\text{top}}=48c_3^4$ as the order-4 local boundary heat-kernel (Seeley-DeWitt) contact term of the μ_4 puncture divisor – the analytic complement of the icosahedral tree term (v396, HYP.PHI0.01). [E] THE SPLIT IS EXACT: $\varphi_0=\varphi_0^{\text{tree}}+\delta_{\text{top}}=1/(6\pi)+48c_3^4$ (v396/ARCH.QUAD.01). [E] PUNCTURE COUNT = $\Omega_{\text{adm}}=N_{\text{fam}} \dim S^+=48$, order = $ \mu_4 =4$: $\delta_{\text{top}}=\Omega_{\text{adm}}c_3^{ \mu_4 }$. [E] CLOSED FORM $\delta_{\text{top}}=48c_3^4=3/(256\pi^4)$; $c_3=1/(Z_2 4\pi)$ Gauss-Bonnet (v216/v342) so c_3^4 is a fourth-order boundary heat-kernel power (cf. v391). [E] HONEST NEGATIVE: δ_{top} not a rational hypergraph fraction ($\delta_{\text{top}}/\varphi_0^{\text{tree}} < 1\%$). [O] THE TARGET: prove $\Omega_{\text{adm}}c_3^4$ IS the order-4 boundary Seeley-DeWitt contact term of the μ_4 puncture summed over the Ω_{adm} admissible states. [C] two engines, two terms; a FACE of the seam boundary analysis (the c_3 datum), not a new gate [E][C][O]
v409_coxeter_prime2_lemma.py	RES.COXETER.SYMMETRY.01 closed as a STRUCTURAL LEMMA: prime-2 is NECESSARY but NOT autonomous – no prime-2-only attractor exists (resolves the v394/COXETER.ATOMS.01 open question's falsifiable corollary). [E] SHEET INVOLUTION $\sigma=\text{diag}(1, -1, -1)$, $\sigma^2=I$, spectrum $\{+1, -1\}$ (parity). [E] SHEET PROJECTOR $P=(I+\sigma)/2=\text{diag}(1, 0, 0)$, $P^2=P$, spectrum $\{0, 1\}$ (projection). [E] NO CONTRACTION RATE: none of $\{-1, 0, 1\}$ lies in $(0, 1)$, whereas the genuine rates $2/3$ and $(1/3)^6$ do – prime-2 alone gives parity/projection, never a nonzero rate. [E] FACTOR NOT RATE: $2/3= Z_2 /N_{\text{fam}}$ needs prime-3, $(\varphi+2)/4=(\varphi+2)/ \mu_4 $ with $ \mu_4 =2^2$ needs the golden φ (prime-5). [E] $30=g_{\text{car}}(2N_{\text{fam}})$, carrier static, 2·3 dynamic. [C] prime-2 is the universal dynamical parity factor, necessary in every sheet-paired transport but not an autonomous attractor; dynamics begins after coupling to family-3 or carrier-5 ($\mu_4=2^2$ the Galois bridge) [E][C]
v410_sheet_generator_binary.py	The <i>sheet generator</i> $V=Q \text{diag}(0, 1, 1)$ (rank-2 sheet axis, v95/v218) is a binary internal compiler: $V^n=\begin{pmatrix} 0 & 2^{n-1} & 0 \\ 0 & 2^n & 0 \\ 0 & 2^{n+1}-2 & 1 \end{pmatrix}$ (induction), so $V^n \mathbf{1}=(2^{n-1}, 2^n, 2^{n+1}-1)=(1, 2, 3), (2, 4, 7), (4, 8, 15), (8, 16, 31)$; bilinears $\mathbf{1}^T V^n \mathbf{1}=7 \cdot 2^{n-1}-1$, $\mathbf{1}^T V^n a=7 \cdot 2^{n-1}$, $a^T V^n a=11 \cdot 2^{n-1}$, $a^T V^n \mathbf{1}=11 \cdot 2^{n-1}-2$ give $(6, 7, 9, 11)$ then $13=\Delta_Q$, $27=\mathbf{1}^T R a$, $55, 56=\dim \mathbf{56}_{E_7}$; the spine is FORCED by $\text{Spec}(V)=\{0, 1, 2\}$, the carrier (rank $E_8=8$, $\dim S^+=16$, $248/8=31$) and theta $(\sigma_3(2)=9=a^T V \mathbf{1}, \sigma_3(3)=28=\mathbf{1}^T V^3 a=\det(I+R), \sigma_3(5)=126)$ readings audit-typed [E][C]
v411_ud_ratio_vpower.py	The quark u/d ratio is a pure V -power readout: the established $c_u/c_d=g_{\text{car}}\ \text{Pl}(K)\ _1/(N_{\text{fam}}^2 \Delta_Q)=55/117$ (v94) re-expresses EXACTLY via the sheet generator (v410) as $\boxed{c_u/c_d = \frac{\mathbf{1}^T V^4 \mathbf{1}}{(a^T V \mathbf{1})(\mathbf{1}^T V^2 \mathbf{1})}} = \frac{55}{9 \cdot 13}$, with $55=\mathbf{1}^T V^4 \mathbf{1}$, $9=a^T V \mathbf{1}=N_{\text{fam}}^2$, $13=\mathbf{1}^T V^2 \mathbf{1}=\Delta_Q$; the same number as $5 \cdot 11/(9 \cdot 13)$, so the numerator repackages $g_{\text{car}} \cdot 11=55$. An exact <i>re-encoding</i> : the value and the u/d identification stay [C] (U _{wall} readout rigidity) [E][C]
v412_sheet_source_corner_J.py	The <i>sheet source corner J</i> : the determinant surface has two s -independent iso-volume walls (v135) $t=-1$ ($\det=4= \mu_4 $, carries K) and $t=-2$ ($\det=2= Z_2 $); the operator on the Z_2 wall, $J=M(1, -2)=C-2V=\begin{pmatrix} 4 & 1 & 0 \\ 5 & 1 & 1 \end{pmatrix}$, completes the sheet axis $J, K, C, F=M(1, -2..1)$. $\chi_J=\lambda^3-6\lambda^2+3\lambda-2 \Rightarrow (\text{tr}, e_2, \det)=(6, 3, 2)=(R^+(A_3) , N_{\text{fam}}, Z_2)$; $a^T J a=30=h(E_8)$, $\det(I+J)=12=\dim \mathfrak{g}_{\text{SM}}=\chi_{E_8}(i)$, $\det(2I+J)=40= R(D_5) $ (Lie readings audit-typed like the G_2/F_4 shadows of v95/v218) [E][C]
v413_sheet_characteristic_calculus.py	The sheet axis is a discrete <i>characteristic-difference calculator</i> : on $M_t=C+tV$ (v95/v218) the elementary-symmetric coefficients encode atoms as DIFFERENCE ORDERS – $e_1=3t+12$, $e_2=2t^2+15t+25$, $e_3=\det M_t=4t^2+14t+14$ give $\Delta e_1=3=N_{\text{fam}}$, $\Delta^2 e_2=4= \mu_4 $, $\Delta^2 e_3=8=\text{rank } E_8$ (the e_3 curvature cross-cited to v218/v224; the full (e_1, e_2, e_3) ladder is new); the anchor energy $a^T M_t a=52+11t$ (step $11=a^T V a$, v410) reads $30 \rightarrow 41 \rightarrow 52 \rightarrow 63=(h(E_8), 10b_1, \dim F_4, 7N_{\text{fam}}^2)$ [E][C]

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Script	What it machine-checks (<i>continued</i>)
v414_center_resolvent_portal.py	The center C is a <i>resolvent portal</i> $G_2 \rightarrow F_4 \rightarrow E_8$: $C=M(1,0)$ (v95) is the $t=0$ value of V ; $\text{tr } C=12=\dim \mathfrak{g}_{\text{SM}}=\chi_{E_8}(i)$, $\det C=14=\dim G_2$, $\sum C=31=2^{g_{\text{car}}}-1=248/8$; the shifted determinants climb $\det(C)=14=\dim G_2$, $\det(I+C)=52=\dim F_4$, $\det(2I+C)=120= R^+(E_8) $ – the shell ladder $G_2 \rightarrow F_4 \rightarrow E_8^+$ as $\det(C+kI)$, $k=0,1,2$ (the resolvent ladder is new; reading audit-typed) [E][C]
v415_gaussian_operator.py	The square CM-norm dictionary is <i>operator-realised</i> and the μ_4 deck is an intrinsic diamond object: the Gaussian arithmetic of v222/v230 lifted from numbers to OPERATORS via $J=[U,V]/3$, the complex structure born from the commutator of the binary V and ternary U compilers (v410/v95). [E] $J=\begin{pmatrix} -1 & 1 & 0 \\ -2 & 1 & 0 \\ -3 & 1 & 0 \end{pmatrix}$ is integer, $\text{Spec } J=\{i, -i, 0\}$, $J^2=-I$ on the rank-2 image, $J^3+J=0$ (a μ_4 quarter-turn); [E] $3I+2J$ has spectrum $\{3+2i, 3-2i, 3\}$ and $5I+4J$ has $\{5+4i, 5-4i, 5\}$, so $3+2i$ ($ \cdot ^2=13=\Delta_Q$) and $5+4i$ ($ \cdot ^2=41=10b_1$) are literal operator eigenvalues; [E] $(3I+2J)(3I-2J)$ has $\text{Spec}\{13, 13, 9\}$ and $(5I+4J)(5I-4J)$ has $\{41, 41, 25\}$ (kernel slot = real part ² : $9=N_{\text{fam}}^2$, $25=g_{\text{car}}^2$); [E] the intrinsic deck $D=-I+J-J^2$ is order 4 ($\text{Spec}\{i, -1, -i\}$, $\chi=(x+1)(x^2+1)$) with χ_2 line $\ker[U,V]=(0,0,1)=a-1$. [C] the geometric-deck identification sharpens (does not close) the v140 $\mathbb{Z}_3$ residue [E][C]
v416_atom_trichotomy.py	The atom trichotomy: $\{2, 3, 5\}$ are ramified/inert/split in the two exceptional CM rings, and each atom is the unique ramified prime of one quadratic facet of $K=\mathbb{Q}(i, \sqrt{-3}, \sqrt{5})$ (v403). [E] $\mathbb{Z}[i]$ (square/seam, $\tau=i$): $2= Z_2 $ ramifies ($2=-i(1+i)^2$), $3=N_{\text{fam}}$ inert (norm $9=N_{\text{fam}}^2$), $5=g_{\text{car}}$ splits $((2+i)(2-i))$ – the carrier rank factors on the seam; [E] $\mathbb{Z}[\omega]$ (hex/flavor, $\tau=\omega$): $3=N_{\text{fam}}$ ramifies ($N(1-\omega)=3$), 2 inert (norm 4), 5 inert (norm $25=g_{\text{car}}^2$); [E] the ramified prime of each ring IS its atom ($\mathbb{Z}[i]$ at 2= sheet/seam, $\mathbb{Z}[\omega]$ at 3= family/flavor); [E] the three facets $\mathbb{Q}(i)/\mathbb{Q}(\sqrt{-3})/\mathbb{Q}(\sqrt{5})$ (disc $-4, -3, 5$) ramify over one atom each, product $2\cdot 3\cdot 5=30=h(E_8)$; 2 imaginary (CM/dynamic) + 1 real (RM/static). [C] the seam/flavor/golden reading [E][C]
v417_eisenstein_cp_operator.py	The Eisenstein/CP operator (the hex dual of v415): the family rotation $P=(1\ 2\ 3)$ and the CP clock $W=-P^2$ put the $\tau=\omega$ flavor side on operators, unified with the seam into ONE order-30 clock. [E] $P^3=I$, $P^2+P+I=\text{ONES}$ (Eisenstein $\omega^2+\omega+1=0$ on the plane $\perp (1,1,1)$); [E] $(3I+2P)(3I+2P^2)=7I+6\text{ONES}$, $\text{Spec}\{7, 7, 25\}$ ($7=N_{\mathbb{Z}[\omega]}(3+2\omega)$ = scalaron on the ω -plane, $25=g_{\text{car}}^2$) – the dual of v415's $\{13, 13, 9\}$; [E] the CP clock $W=-P^2$ ($=\rho$, v233) has $W^2=P$, $W^3=-I$, $\text{Spec}\{-1, \zeta_6, \zeta_6^{-1}\}$, so $\delta_{\text{CKM,lead}}=\arg \zeta_6=\pi/3$ and $\delta_{\text{PMNS}}=\arg \zeta_6^4=4\pi/3$ ($W^4=P^2$); [E] all flavor clocks are powers of ζ_{30} ($\zeta_{30}^{15}=-1$, $\zeta_{30}^{10}=\omega$, $\zeta_{30}^6=\zeta_5$, $\zeta_{30}^5=\zeta_6$) while the seam $\mu_4=i$ is the Galois side $(\mathbb{Z}/30)^\times$ of order $\varphi(30)=8=\text{rank } E_8$. [C] the carrier μ_5 has no clean 3×3 operator (golden φ an output-side trace, v313/v349); honest negatives included [E][C]
v418_cyclotomic_norm_triple.py	The cyclotomic norm triple: the carrier split $(3,2)$ read in the three atom-rings gives $(7, 13, 55)=(\text{scalaron}, \Delta_Q, \text{quark numerator})$, and the missing carrier-5 clock of v417 is the 4×4 Φ_5 -companion C_5 . [E] C_5 has $\chi=x^4+x^3+x^2+x+1$, $C_5^5=I$, $\text{tr}=-1$; the golden ratio is its real-part data ($\zeta_5+\zeta_5^4=1/\varphi$, $\zeta_5^2+\zeta_5^3=-\varphi$; output-side v313/v349; $\dim 4$, not 3 – refines v417's gap); [E] $N_{\mathbb{Z}[\zeta_5]}(3+2\zeta_5)=\det(3I+2C_5)=55=5\cdot 11=g_{\text{car}}$ $\ \text{Pl}(K) \ _1=$ the quark numerator (v410/v411); [E] the triple $\det(3I+2\text{Comp}(\Phi_n))=(7, 13, 55)$ for $n=3, 4, 5$ over $\mathbb{Z}[\omega], \mathbb{Z}[i], \mathbb{Z}[\zeta_5]$ (atoms 3, 2, 5, v416); [E] NEG control: the anchor $(5,4)\rightarrow(21, 41, 461)$, with $21=N_\omega(5,4)$ and $41=10b_1$ named (v222) but the carrier ring 461 prime/un-named, so the carrier ring separates $(3,2)\rightarrow 55$ from $(5,4)\rightarrow 461$. [C] HONEST: $(3,2)$ is FORCED (v14) not unique – the clean splits are $\{(2,1)\rightarrow(3, 5, 11), (3,2)\rightarrow(7, 13, 55)\}$, a small ladder; the sharper reading: only $(3,2)$ spans three physics sectors (gravity/flavor/masses), the unique cross-sector seed [E][C]

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Script	What it machine-checks (<i>continued</i>)
v419_seam_galois_carrier.py	The seam μ_4 is the carrier's Galois group: a positive resolution of the v409/RES.COXETER.SYMMETRY.01 cyclic/Galois asymmetry. [E] $h(E_8)=30=2\cdot 3\cdot 5$ is squarefree, so $\mathbb{Z}/30$ has <i>no</i> order-4 element — the seam μ_4 cannot be a cyclic hand and is forced onto the Galois side; [E] $(\mathbb{Z}/30)^\times = (\mathbb{Z}/2)^\times \times (\mathbb{Z}/3)^\times \times (\mathbb{Z}/5)^\times = \mu_4 \times \mathbb{Z}_2$ (order $\varphi(30)=8=\text{rank } E_8$), where the μ_4 $(\mathbb{Z}/4)$ factor IS $(\mathbb{Z}/5)^\times$ (carrier 5) and the $\mathbb{Z}_2$ IS $(\mathbb{Z}/3)^\times$ (family/CP); [E] so the seam $\mu_4 = \text{Gal}(\mathbb{Q}(\zeta_5)) = (\mathbb{Z}/5)^\times$, the Frobenius $\zeta_5 \mapsto \zeta_5^2$, realised on the carrier clock C_5 (v418) by the explicit order-4 operator G with $GC_5G^{-1}=C_5^2$, $G^4=I$, $G^2C_5G^{-2}=C_5^{-1}$. [C] resolves v409 (the $2^2=4$ is the order of $(\mathbb{Z}/5)^\times$; “no contraction rate” because the seam is an automorphism, not a hand); $\mathbb{Q}(\zeta_{30})$ carries both E_8 invariants (cyclic $h=30$, Galois rank=8). Figure coxeter_galois [E][C]
v420_fpole_qed_running.py	F_pole external: the Koide source→pole transfer is a <i>one-loop electromagnetic</i> effect, not an algebraic step — the honest external-physics follow-up to v93 and the clock No-Go. [E] Koide Q is rescaling-invariant ($Q(cm)=Q(m)$), so flavor-<i>universal</i> running leaves it fixed and the source→pole shift is purely flavor-<i>split</i>; [C] the tree→pole gap $\frac{2}{3}-Q_{\text{src}}=0.00220$ is one-loop-EM-sized ($=\varphi_0^{\text{ret}}/24$ to 0.6%, $=\alpha/\pi$ to $\sim 5\%$), the PDG pole sits AT $\frac{2}{3}$ (the IR attractor); [C] a 1-loop QED per-lepton-log pole $\leftrightarrow \overline{\text{MS}}$ estimate shifts Koide by EM-loop order toward $\frac{2}{3}$ (the v82 IR-attractor direction); [O] the EXACT flow time $t\sim 2.84$ (v93) is scheme/scale-dependent external QED, only sized. [C] F_pole stays [C], firewalled (v187): the lens forces the RATE $(2/3)^6$, this external EM supplies the flow. Numerical (mpmath), Python-only [E][C][O]
v422_galois_net_bridge.py	The Galois$\leftrightarrow$Net bridge: the seam $\mu_4 = \text{Gal}(\mathbb{Q}(\zeta_5))$ is the SAME cyclic $\mathbb{Z}/4$ as the $(E_8)_1$ simple-current glue — not a mere order-4 coincidence — linking the Galois gearbox of v419 to G_{net}/SEAM.EQUIV.01. [E] $\text{disc}(A_3)=\text{disc}(D_5)=\mathbb{Z}/4$ (one Smith invariant factor 4 = cyclic, $\det=4$); D_n disc is $\mathbb{Z}/4$ for n ODD, $\mathbb{Z}_2 \times \mathbb{Z}_2$ for n EVEN, so the carrier D_5 (rank $5=g_{\text{car}}$, odd) is cyclic while the control D_8 (rank 8, even) is Klein; [E] $\text{Gal}(\mathbb{Q}(\zeta_5))=(\mathbb{Z}/5)^\times=\langle 2 \rangle$ is cyclic order 4 (only the carrier prime 5 gives order 4); [E] in $\text{disc}(D_5 \oplus A_3)=\mathbb{Z}_4 \times \mathbb{Z}_4$ ($16=\dim S^+$) the simple current $(1,1)$ is order 4 (cyclic) with Lagrangian quotient $16/4^2=1 \Rightarrow (E_8)_1$ (holomorphic, v89/v154). [E] NEG control: the Klein $\mathbb{Z}_2 \times \mathbb{Z}_2$ / order-2 halfway $\langle (2,2) \rangle$ gives $16/2^2=4= \text{disc}(D_8) =SO(16)$ ($\det=4$), NOT E_8 ($\det=1$) — cyclic $\mathbb{Z}/4 \rightarrow E_8$, Klein $\rightarrow D_8$. [C] the bridge: one cyclic $\mathbb{Z}/4$ threads the seam deck μ_4 (v419), $\text{Gal}(\mathbb{Q}(\zeta_5))$ and the $(E_8)_1$ glue (v1/v89/v154); cyclicity forced by 5, Klein excluded. [C] this is the four-fold μ_4 identity (deck/divisor = Galois = discriminant = simple-current); per v428 a <i>compression</i> (one object read four ways), not four independent witnesses [E][C]
v423_no_ambient_dependency.py	The <i>No-Ambient-Dependency</i> certificate: no frozen TFPT readout is <i>computed</i> from the ambient QG measure QG.AMB.01 — sharpening the v369/v384 prose redundancy into a machine-checked DAG+script fact, told honestly. [E] gap-decoupling margin $\Delta_{\text{eff}} = 6 \ln(3/2) - 31/(4\pi^2) \approx 1.648 > 0$ ($31=2^{g_{\text{car}}}-1$), susceptibility $\chi = 729/665$ finite (neg control gap $\rightarrow 0 \Rightarrow \chi \rightarrow \infty$). [E] QG.AMB.01 is a certification <i>sink</i>: every claim listing it as a dependency is a gravity-gate/QG row, none a frozen prediction. [E] it is not a value source — it has no producing script while each frozen readout is computed by a compiler script ($\alpha^{-1} \leftarrow \text{v3}$, $\theta_{12} \leftarrow \text{v9}$, $\theta_{13} \leftarrow \text{v268}$, cosmology $\leftarrow \text{v7}$). [E] the one transitive link is architectural: only θ_{13} references QG.AMB.01, via the 4D-QFT contract spine (PS.DIRAC→CONTRACT.QFT4D→QG.G2→GATE.METRIC), a coherence edge not a numerical input; α^{-1}/θ_{12}/cosmology have no route. [C] so QG.AMB.01 is gap-decoupled certification (v369 as a DAG/script fact); honestly this does NOT prove SEAM.EQUIV.01 — the readouts depend on the seam being $(E_8)_1$; QG.AMB.01 specifically is dead [E][C]

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Script	What it machine-checks (<i>continued</i>)
v424_seam_lto_rp_reduction.py	The (<i>LTO-RP</i>) reduction of the keystone: an honest MMST-style reduction of SEAM.EQUIV.01's one open lemma — the raw collar's intrinsic Bisognano–Wichmann property (the v308/v309 residual) — to the cited commuting-projector theorem of Naaijken–Penneys–Wallick (arXiv:2605.10693), with the central mapping <i>corrected</i> . [E] the μ_4 clock is a modular <i>symmetry</i> ($[\rho, K]=0$, v309/v199), not the flow — $\sigma^\psi=\rho$ is type-wrong (a one-parameter group versus a finite order-4 element). [E] NPW26's axiom (LTO-RP) means $u_\Theta=J$ (reflection = modular conjugation) = the intrinsic BW condition $\theta K \theta = -K$, <i>distinct</i> from $\omega \circ \rho = \omega$: a positive character-block-diagonal K satisfies $[\rho, K]=0$ yet never $\theta K \theta = -K$, so clock-invariance does <i>not</i> imply (LTO-RP). [O] make-or-break: NPW26 prove (LTO-RP) for <i>topologically ordered</i> models (Toric Code $ \det K =4$ via a trace; Levin–Wen anyonic), while the seam is invertible ($ \det \text{Cartan}(E_8) =1$, no anyons) and a $\beta=1$ KMS state (not a trace) — in neither proved bucket (neg control D_8 $ \det =4$). [C] so SEAM.EQUIV.01's BW residual reduces to NPW26 Theorem A modulo two open sub-steps (realise the seam as a $\mathbb{Z}_2$ -reflection commuting-projector LTO; extend (LTO-RP) to the invertible KMS case) — a reduction, not a closure; SEAM.EQUIV.01 stays [O] [E][C]
v425_dyn_transfer_universal.py	DYN.TRANSFER.UNIVERSAL.01 — the <i>single-flow reduction</i> of F_{transfer} : the four frontier transfers (F_{pole} , $F_{\text{Boltzmann}}$, F_{relic} , F_{QCD}) do not each need a separate external solver; their <i>dynamics</i> is the ONE native flow of the theory — the seam modular/recovery semigroup (v238/v240, gap $6 \ln(3/2)$) restricted to each sector. [E] recovery spectrum $\{1, (2/3)^6, (1/3)^6\}$, $H_{OS} = -\log T$ gap $6 \ln(3/2)$, $e^{-\Delta} = (2/3)^6$ exact; an explicit column-stochastic T makes $\log T$ a Markov generator. [E] F_{pole} is this flow: the v99 generator $\dot{q} = (\Delta/N_{\text{fam}})(q-2)(q-5)$ linearised at $q=2$ has rate $-\Delta$, time-1 contraction $(2/3)^6$. [E] $F_{\text{Boltzmann}}$ washout = that contraction, CP phase $4\pi/3$ native (v320). [E] F_{QCD} rate native ($b_3=-7$). [C] only the anchors (v_{geo} , C_p , M_R) external; F_{relic} 's cosmological IC θ_i the one wall. Extends v383 static→dynamic; a reduction, no new premise [E][C]
v426_seam_lto_rp_kms.py	SEAM.EQUIV.LTORP.KMS.01 — the <i>invertible</i> $\beta=1$ -KMS variant of (LTO-RP), the corner NPW26 leave open (they prove it for topologically-ordered models; the seam is invertible + $\beta=1$ KMS, not a trace). A constructive Tomita–Takesaki witness advancing v424 sub-step (ii); does <i>not</i> close SEAM.EQUIV.01. [E] build K reflection-odd/ μ_4 -even/gapped (gap $2k=6 \ln(3/2)$); $C=1/(1+e^K)$ the $\beta=1$ KMS covariance, $C/(1-C)=e^{-K}$ (genuine KMS, not trace). [E] $\Theta K \Theta^{-1} = -K$ ($u_\Theta=J$) AND $[\rho, K]=0$ both hold $\Rightarrow$ (LTO-RP) satisfied by direct Tomita–Takesaki. [E] $ \det \text{Cartan}(E_8) =1$ (invertible, no anyons) vs anyonic $ \det =4$; state not a trace ($\Delta=e^{-K} \neq I$) — neither NPW26 bucket. [E] neg controls: side-even reflection $\rightarrow +K$ (BW fails), off- μ_4 -block K breaks $[\rho, K]$. [C] (LTO-RP) reduces to $(\Theta K \Theta = -K) \wedge ([\rho, K]=0)$, constructively satisfiable; SEAM.EQUIV.01 stays [O] [E][C]
v427_overdet_witness_map.py	OVERDET.WITNESS.MAP.01 — the multiply-vs-compress <i>framework</i> for over-determination: witnesses from <i>disjoint</i> grammars multiply, projections of the <i>same</i> generator compress. The classification of the seven arithmetic witnesses is refined by v428 (they compress). [E] seven grammar readouts, each from its own syntax landing on the carrier skeleton: Gauss $N(3+2i)=13$, Eisenstein $N(3+2\omega)=7$, cyclotomy $N(3+2\zeta_5)=55$, Galois $ \mathbb{Z}/5 ^\times=4$, $ \det \text{Cartan}(E_8) =1$, Pascal $\binom{4}{0} + \binom{4}{1} + \binom{4}{2} = 11$ ($2^4=16 = \dim S^+$), Coxeter $h(E_8)=30=2 \cdot 3 \cdot 5$ with $\varphi(30)=8 = \text{rank } E_8$. [E] by v236 these are facets of ONE $(2, 3, 5)/E_8$ object, so syntactic distinctness is NOT independence — they compress, like the anchor $a=(1, 1, 2)$. [C] the genuine multiplicative strength is the multiply-forced inputs + foreign witnesses (v428); the map does not by itself establish physics [E][C]

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Script	What it machine-checks (<i>continued</i>)
v428_overdet_ reclass.py	OVERDET.WITNESS.RECLASS.01 — the honest correction of v427: applying its own multiply-vs-compress test to itself. [E] the $(2, 3, 5)$ Brieskorn singularity (v236) is the ONE generator — Milnor $\mu=(2-1)(3-1)(5-1)=8=\text{rank } E_8$, $30=2\cdot 3\cdot 5=h(E_8)$, $\varphi(30)=8$. [E] every one of v427's seven witnesses maps to a facet of that SAME object (primes 2, 3, 5 of 30, the clock 30, or E_8), so all seven collapse to ONE generator (distinct objects = 1) $\Rightarrow$ COMPRESSION, not seven multiplications. [E] what honestly multiplies is the input forced four independent ways — the “8” in $c_3=1/(8\pi)$ from rank E_8 , $h(D_5)=2(5-1)$, $\varphi(30)$ and the Milnor number — plus the foreign witness $\alpha^{-1}\approx 137$ (prime, not in the $(2, 3, 5)$ -skeleton). [C] refines and partly walks back v427; consistent with v236/v305/v313 [E][C]
v429_axion_ pentagon_phi.py	DM.AXION.PENTAGON.01 — the ‘unmapped’ icosahedral/golden E_8 structure surfaces in the ONE external cosmological input θ_i , answering “why does idle E_8 structure exist?” for the one case where it has a job. [E] because $N_{\text{fam}}=g_{\text{car}}-2$, the spine quotient $\theta_i=\pi N_{\text{fam}}/g_{\text{car}}=(g_{\text{car}}-2)\pi/g_{\text{car}}$ is EXACTLY the interior angle of the regular g_{car} -gon; for $g_{\text{car}}=5$ the PENTAGON, $\theta_i=3\pi/5=108^\circ$ (the carrier polygon, not a bare rational multiple of π). [E] its cosine is golden: $\cos(3\pi/5)=(1-\sqrt{5})/4=-1/(2\varphi)$, partner $2\cos(2\pi/5)=1/\varphi=\varphi-1$, $\varphi=2\cos(\pi/5)=(1+\sqrt{5})/2$. [E] the golden character is UNIQUE to $g_{\text{car}}=5$: among small n -gons only $n=5$ has an irrational interior-angle cosine ($n=3, 4, 6$ give $1/2, 0, -1/2$), so θ_i is golden BECAUSE the carrier is 5 (P2). [C] a re-reading bridging v354/v313 (the unmapped $g_{\text{car}}=5$ golden signature) to v211 ($\theta_i=3\pi/5$, the one external input): it REFINES v354 from “ φ in no readout” to “ φ touches only the [C] spine misalignment angle”, a geometric motive for the spine over the hilltop $\sim 170^\circ$; it does NOT upgrade DM.AXION.SPINE.01 (stays [C]) and closes no gate. [E][C]
v430_other_side_ reverse_audit.py	E8.OTHERSIDE.AUDIT.01: the ‘other side of the seam’ (the double-cover deck / conjugate sheet S^-) audited against E_8 's UNMAPPED Casimir degrees — the sheet/deck complement of v354/v355, answering “is the leftover where the second sheet lives?” with a disciplined NEGATIVE. [E] DECK = DEGREE-2: the one-sided cover contributes $ \mathbb{Z}_2 =2$ (the $1/2$ in $c_3=1/(2\cdot 4\pi)=1/(8\pi)$, v58/v216); $2=\min(E_8 \text{ degrees})$ = the metric, one of the matched primary readouts $\{2, 8, 30\}$ (v354), NOT one of the unmapped $\{12, 14, 18, 20, 24\}$. [E] TWO SHEETS = 128-SPINOR: $\dim S^+=\dim S^-=16$, the spinor block $128=\text{rank} \cdot \dim S^+=8\cdot 16=2^{\text{rank}-1}=\sum \text{deg}$, the spinor half of $248=120+128$; S^- the conjugate $(\overline{16}, \overline{4})$, $128=2\cdot 64$, not a spare singlet. [E] FORCED-DISJOINT: the sheet/deck integer set $\{2, 16, 32, 128\}$ has EMPTY intersection with $\{12, 14, 18, 20, 24\}$, its only degree-alphabet contact the matched 2. [O] DISCIPLINED DECLINE: each unmapped degree needs an UNFORCED coefficient from the sheet atoms and admits ≥ 2 readings (the v355 discriminator) — no forced sheet $\rightarrow$ unmapped-degree identity. [E] ‘ $S^-=\text{DM}$ ’ DOWNGRADED + WIMP NO-GO: v227 replaced the over-strong ‘ S^- is dark matter’; $128=(16, 4)+(\overline{16}, \overline{4})$ is the SAME matter spinor (no spare singlet), DM is the determinant-line axion (a phase). [O] the only live ‘other side’ question (the 128 phase/glue dark sector, v227) concerns MATCHED structure, not the unmapped degrees [E][O]

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Script	What it machine-checks (<i>continued</i>)
v431_e8_degree_ladder.py	E8.DEGREE.LADDER.01: the reverse-audit ‘unmapped’ E_8 Casimir degrees are NOT diffuse overhead but the forced two-family decomposition $\deg(E_8)=6\cdot\text{spine}\{2, 3, 4, 5\} \sqcup (\{2\} \cup \det\text{-ladder}\{8, 14, 20\})$ — the structural complement of v354/v355/v430. [E] TWO-FAMILY SPLIT FORCED BY $30=2\cdot3\cdot5$: the E_8 exponents are the $\varphi(30)=8$ totatives of $h=30=2N_{\text{fam}}g_{\text{car}}$ (coprime to $6 \Rightarrow \pm 1 \pmod 6$), so the degrees occupy ONLY the residue classes $\{0, 2\} \pmod 6$. [E] $6k$ family $\{12, 18, 24, 30\}/6=\{2, 3, 4, 5\}$ = the v91 spine $\{e_3, e_1, e_2, p_0\}(a=(1, 1, 2))$. [E] $6k+2$ family $\{2, 8, 14, 20\}$: $\{8, 14, 20\}=(\det R, \det C, \det L)=$ the winding line $\det M(s, 0)=6s+8$ of the flavor diamond (v135), $C=R+Q \text{ diag}(1, 0, 0)$. [E] ‘$18=6N_{\text{fam}}$’ is NOT a holdout (spine family, not on the det-ladder). [E] SPECIAL TO E_8 among the simply-laced exceptionals ($E_6/E_7/D_5$ fail the clean $\{0, 2\} \pmod 6$ split). [C] HONEST v355 LINE: the arithmetic decomposition is exact, but the FUNCTORIAL claim ‘$6k+2$ Casimir stratum = flavor sheet operators’ needs a representation-theoretic map ([C]); 12, 24 admit two canonical readings each, so this is a STRUCTURE theorem, not a forced functorial flavor map — it reclassifies v354 overhead to zero orphan degrees, closes no gate [E][C]
v432_overdet_floor.py	OVERDET.FLOOR.01: the UNCONDITIONAL improbability floor + the $L1 \leftrightarrow L2$ bridge — the defensible number that survives even if a skeptic REJECTS the declared formula grammar, complementing the conditional null model (v100) and the multiply-vs-compress framework (v427/v428). [E] DISJOINT PIECES (v428): compression removed (v427’s seven readouts are one $(2, 3, 5)/E_8$ object, NOT multiplied); what multiplies is the input ‘8’ forced FOUR ways $\{\text{rank } E_8, h(D_5)=2(g_{\text{car}}-1), \varphi(30), \text{Milnor}(2, 3, 5)\}$ plus the FOREIGN witness $\alpha^{-1} \sim 137$ (prime, outside $(2, 3, 5)$). [C] CONSERVATIVE FLOOR: multiplying ONLY across disjoint pieces (input over-determination $\times$ the α grammar census $1/94500$ (v100) $\times$ the φ_0^{ret}-seed cluster counted ONCE $\times$ one downstream witness) the floor stays $\leq 10^{-6}$ across a grid of generous assignments, nominal $\sim 10^{-10}$ — ‘extraordinary’ WITHOUT the declared grammar. [E] THE BRIDGE: the floor ($\sim 10^{-10}$) sits ~ 20 orders ABOVE the conditional $10^{-30.7}$ (v100); that gap = the evidential value of proving the FORMS forced, so L1 (ALPHA.QUILLEN.EXACT.01, v382) and L2 (this floor) are the SAME lever. [C] HONEST SCOPE: bounds ONLY “is it numerology?”, NOT the physics bridge (firewall v187); a conservative FLOOR, not a posterior [E][C]
v433_alpha_quillen_heatkernel.py	ALPHA.QUILLEN.PROGRESS.02: a <i>second honest step</i> on the external target ALPHA.QUILLEN.EXACT.01 (v382) – it GROUNDS and CONNECTS, it does NOT close it; ALPHA.QUILLEN.EXACT.01 stays [O] (external math, type A, v384), α^{-1} stays [E]. [E] a solvable 4D model (flat $\Delta = -\partial^2 + m^2$ on T^4) reaches the a_4 (t^0) conformal-anomaly order: $a_4 = Vm^4/(2(4\pi)^2)$ NON-ZERO – the order v391’s 1D circle toy (a_0, a_1 only) could not reach. [E] it is the order v342 grounds (Gilkey a_4 gauge-curvature $30/360 = 1/12$), unifying v391 (a ζ-det variation IS heat-kernel data) with v342 (the term IS the Gilkey a_4). [E] $(4\pi)^{-2} = 4c_3^2$ is c_3-built. [E] the v382 split re-verified at $\alpha^{-1} = 137.0359992$. [O] NOT CLOSED: the actual seam a_4 ($= 8b_1c_3^6$) and the cubic α^3 Chern moment stay open (v384); the exact seam F-normalisation stays [C] (v342). Grounds/connects, does not close [E][O]

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Script	What it machine-checks (<i>continued</i>)
v434_alpha_quillen_betafunction.py	ALPHA.QUILLEN.PROGRESS.03: a <i>third honest step</i> on ALPHA.QUILLEN.EXACT.01 (v382) – it settles the three residuals named after v433 and shows they are NOT three independent problems; the target stays [O], α^{-1} stays [E]. [E] b_1 IS THE U(1) a_4 HEAT-KERNEL COEFFICIENT (the $\beta=a_4$ theorem): from the carrier hypercharge content with spin weights ($\frac{2}{3}$ Weyl, $\frac{1}{3}$ complex scalar), $\sum \frac{2}{3}Y_f^2 + \frac{1}{3}Y_s^2 = 41/6$ (SM), $(3/5) \cdot \text{that} = 41/10 = b_1$ (GUT) – the b_1 in $8b_1c_3^6$ is the a_4 content coefficient, not a fitted multiplicity (same number as the β, v159/v246; same KIND as the α^2 Calderón a_4, v342). [E] $8b_1c_3^6 = b_1 \cdot (\text{rank } E_8) \cdot c_3^6$ (rank 8 = $\chi=2$ boundary, v216; c_3^6 six insertions, v342). [C] residual (1) “exact $a_4 = 8b_1c_3^6$” $\equiv$ residual (3) “seam F-normalisation” – ONE obligation. [E] residual (2) located: $a^3 - 2c_3^3a^2 = a^2(a - 2c_3^3)$, so a^3 is the first moment of the Chern density (a level, order c_3^0); origin stays [O]. [E] net reduction: the EM-Ward residual is $1[C]+1[O]$, not three. [O] NOT CLOSED; α^{-1} stays [E]. Python-only [E][C][O]
v435_alpha_quillen_chernlevel.py	ALPHA.QUILLEN.PROGRESS.04: a <i>fourth honest step</i> on ALPHA.QUILLEN.EXACT.01 (v382) – it attacks the SINGLE remaining [O] after v434 (residual (2), the cubic α^3 Chern level) and SHARPENS it, it does NOT close it; the target stays [O], α^{-1} stays [E]. [E] π-POWER / METRIC-INDEPENDENCE TEST: the three closure coefficients carry π-powers exactly $\{0, 3, 6\} = c_3$-orders ($k_0 = 1 \rightarrow \pi^0$; $-2c_3^3 = -1/(256\pi^3) \rightarrow \pi^3$; $-8b_1c_3^6 = -41/(327680\pi^6) \rightarrow \pi^6$), so the Maxwell a^3 is the UNIQUE π^0/c_3^0 (metric-INDEPENDENT) term – the signature of a topological level (a heat-kernel boundary coeff always carries the $(4\pi)^{-d/2}$ measure; a level carries none). The test partitions the closure into ONE topological level (a^3) + TWO heat-kernel boundary terms, confirming v342/v434’s “a^3 is a level, not a curvature integral” from a test. [C] conditional on the CS/η reading (EM1, v48), large-gauge invariance forces the level in $\mathbb{Z}$ and $k_0 = 1$ is the unit (minimal) level – an integer, not a free real. [O] NOT CLOSED: the EM1 CS-boundary derivation stays external (type A, v384); seam F-norm stays the one [C] (v434); α^{-1} stays [E]. [E][C][O]
v436_overdet_floor2.py	OVERDET.FLOOR.02: HARDENS OVERDET.FLOOR.01 (v432) — the “is it numerology?” floor does NOT rest on v432’s subjective chance assignments. [E] ASSUMPTION-MINIMAL FLOOR: the α cubic-class census (v100 layer D) is PURE COUNTING — of $N=94500$ complexity-matched $F_{U(1)}$ variants only ONE hits the 4×10^{-8} CODATA window (the TFPT instance, $\alpha^{-1}=137.0359992$), so $p_\alpha \leq 1/94500 = 1.06 \times 10^{-5} \sim 4.40\sigma$ with NO subjective probability, prior or multi-observable grammar. [E] MONOTONE CONCESSION LADDER: $-\log_{10} p$ full scorecard+$\alpha \sim 30.7 \rightarrow$ scorecard-only $\sim 25.8 \rightarrow \alpha$-census-only ~ 4.98 ($= 4.40\sigma$); the “not chance” verdict holds at the MOST adversarial rung. [E] INDEPENDENCE: strip ALL of v432’s subjective factors ($0.1^3 \times 0.012 \times 0.15 = 1.8 \times 10^{-6}$) and the floor is still 4.40σ — they only sharpen it. [C] HONEST 5σ GAP: 5σ ($p=5.7 \times 10^{-7}$) is crossed by the census times exactly ONE more independent factor ≤ 0.054 (the input-‘8’ four-fold over-determination or one foreign witness), stated openly. [C] FIREWALL: bounds numerology only, not the physics bridge (v187); Python-only, deliberately NOT Wolfram-mirrored (a counting bound, not an identity). [E][C]

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Script	What it machine-checks (<i>continued</i>)
v437_e8_degree_joint.py	E8.DEGREE.JOINT.01: a CONSOLIDATION of v6/v66/v355/v431 deriving more from the E_8 Casimir degrees WITHOUT crossing the v354/v355 anti-numerology line — no new per-degree coincidence, only a joint lock. [E] E_8 IS FIXED BY ITS DEGREE MULTISSET: from $\deg(E_8)=\{2, 8, 12, 14, 18, 20, 24, 30\}$ alone — $\text{rank}=\#\deg=8$, $h=\max=30$, $\#\text{pos roots}=\sum \exp=120$, $\#\text{roots}=240$, $\dim=248$, $W =\prod \deg=696,729,600$, $\sum \deg=128=2^7=\dim S^+$. [E] THE JOINT QUADRATIC: the two structural integers $(g_{\text{car}}, N_{\text{fam}})$ are the UNIQUE root pair of $x^2 - (\text{rank } E_8)x + (h/2) = x^2 - 8x + 15 = (x-3)(x-5)$ — $\text{sum}=\text{rank } E_8=8$ ($\text{rank-fill}, v6$), $\text{product}=h/2=15=g_{\text{car}}N_{\text{fam}}$ ($2g_{\text{car}}N_{\text{fam}}=h, v431$); $\{3, 5\}$ the unique factor pair of 15 summing to 8, so BOTH are forced together by two degree-invariants. [E] the three mapped degrees $\{2, 8, 30\} = \min/\text{rank}/\max$ (the canonical invariants); $g_{\text{car}}=5=\max$ prime of 30. [E] DISCIPLINE: no new per-degree mining; the five non-primary degrees keep their v431 homes. Exact integer/lattice, mirrored in wolfram. [E][C]
v438_seam_hsmi_borchers.py	SEAM.EQUIV.BW.HSMI.01: the half-sided modular inclusion (Borchers/Wiesbrock) as an INTRINSIC Bisognano–Wichmann route for face (ii) of SEAM.EQUIV.01 — geometric modular flow WITHOUT presupposing covariance. [E] STANDARD-PAIR ALGEBRA (ladder, exact): boost $K=\text{diag}(n)$ and translation P (raising shift) satisfy $[K, P]=P$ and the Borchers scaling $\Delta^{it}P\Delta^{-it}=e^{-t}P$ (the $ax+b/\text{Moebius}$ relation). [E] BW REFLECTION: $J(n \rightarrow -n)$ gives $J^2=I$, $JKJ=-K$ ($u_\Theta=J$) and $JPJ=P_-$ (the opposite-chirality translation), the standard-pair reflection $JU(s)J=U(-s)$. [E] POSITIVE ENERGY: in the unitary lowest-weight $sl(2, \mathbb{R})$ rep the line translation $P_{\text{line}}=L_0-(L_++L_-)/2$ is POSITIVE ($\min \text{eig} > 0$), the positive-energy generator the c_3 one-sided origin demands; the boost direction is the indefinite negative control. [C] SYNTHESIS: $P \geq 0 + [K, P]=P + J$ is a Longo STANDARD PAIR / +half-sided modular inclusion (Wiesbrock), so by Borchers the seam modular flow is geometric INTRINSICALLY (complementary to Adamo–Giorgetti–Tanimoto, arXiv:2508.07109); face (ii) becomes a STRUCTURE consequence, not a state condition. [C][O] assembling the finite algebra and the positive-energy rep into ONE continuum standard pair is the continuum existence (the same wall as MMST/NPW26, v336/v424); SEAM.EQUIV.01 stays [O]. Python-only (numpy/scipy). [E][C][O]
v439_seam_lieb_robinson.py	SEAM.EQUIV.CONTINUUM.LR.01: the Lieb–Robinson/Nachtergaele–Sims continuum-existence MOTOR for the gapped seam collar — grounds the BULK half of the cited MMST existence (v336) in the explicit v367 $p+ip$ model. [E] UNIFORM GAP: $\Delta(N)=\text{const} > 0$ across $N=20..160$ (the lattice image of the OS transfer gap $6 \log \frac{3}{2} > 0$, v302/v329). [E] EXPONENTIAL CLUSTERING: $\langle c_i^\dagger c_j \rangle \sim e^{-r/\xi}$ with ξ finite and STABLE across N (gapped $\Rightarrow$ Hastings–Koma decay), the N-independent locality. [E] LIEB–ROBINSON LIGHT CONE: the single-particle propagator $(e^{-iHt})_{ij}$ is confined to $i-j \lesssim v_{\text{LR}}t$ with finite v_{LR} ($\sim 2t$), exponentially small beyond the cone. [C] NACHTERGAELE–SIMS LIFT: uniform gap + finite LR velocity $\Rightarrow$ exponential clustering with N-independent ξ AND existence+uniqueness of the thermodynamic-limit ground state with a finite light cone — derived for OUR collar, not imported. [C][O] the bulk thermodynamic limit EXISTS by Lieb–Robinson; SEAM.EQUIV.01 stays [O], the open analytic step narrowed to the CHIRAL massless EDGE scaling limit (the $c=8$ $(E_8)_1$ CFT), distinct from the bulk limit. Python-only (numpy/scipy). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v440_seam_lto_rp_beta.py	SEAM.EQUIV.LTORP.BETA.01: the β -interpolation connecting the NPW26-PROVEN trace case ($\beta=0$) to the seam's $\beta=1$ KMS case along an obstruction-free homotopy — upgrading the single-point v426 witness for v424 sub-step (ii) to a PATH argument. [E] β -INDEPENDENT (LTO-RP) DATA: $\Theta K \Theta = -K$ ($u_\Theta = J$) and $[\rho, K]=0$ are conditions on K alone, β -independent. [E] THE KMS PATH: $C_\beta = 1/(1+e^{\beta K})$ has $\beta=0 \rightarrow C=\frac{1}{2}I$ (the NPW26 TRACE state), $\beta=1 \rightarrow$ the seam KMS state, $\beta \rightarrow \infty \rightarrow$ the ground-state projection; at every β $\Theta C_\beta \Theta = 1-C$ (reflection), $[\rho, C_\beta]=0$ (mu4), $0 \leq C_\beta \leq 1$ (valid covariance/RP). [E] NO OBSTRUCTION: $\beta \mapsto C_\beta$ is norm-continuous and stays in the (LTO-RP)-valid set — a continuous homotopy from the proven trace endpoint to the seam KMS point, no topological wall. [E] NEG CONTROLS: a reflection-EVEN K' breaks $\Theta C_\beta \Theta = 1-C$ for $\beta > 0$ (the trace endpoint is degenerate); an off-mu4-block K breaks $[\rho, C_\beta]$. [C][O] a PATH argument for v424 sub-step (ii), stronger than the single point of v426; SEAM.EQUIV.01 stays [O] (closedness of (LTO-RP) along the path in the continuum is the residual). Python-only (numpy/scipy). [E][C][O]
v441_seam_applicability_ledger.py	SEAM.EQUIV.APPLICABILITY.01: the applicability ledger — a hypothesis-by-hypothesis audit of the THREE external theorems the seam keystone cites (MMST scaling limit, NPW26 (LTO-RP), Adamo–Giorgetti–Tanimoto covariance), isolating the SINGLE imported analytic fact. [E] MMST HYPOTHESES: $D=16$ Majoranas ($= 2^{g_{\text{car}}-1}$), $c=8$ ($= g_{\text{car}} + N_{\text{fam}}$), rank $E_8=8$, range rank $\leq c \leq D$ reads $8 \leq 8 \leq 16$, gapped ($6 \log \frac{3}{2} > 0$), quasi-free CAR — all internal computed facts. [E] NPW26: (LTO-RP) $= u_\Theta = J$, gap, $\mathbb{Z}_2$ reflection, mu4 clock, $[\rho, K]=0$ internal (v424/v426/v440); the seam is invertible $ \det \text{Cartan } E_8 = 1 + \beta = 1$ KMS, OUTSIDE NPW26's topological/trace bucket ($ \det =4$) — a TEMPLATE, not a direct import. [E] ADAMO–GIORGETTI–TANIMOTO (arXiv:2508.07109): DHR reps of nets extending loop-group/Virasoro are AUTOMATICALLY positive-energy + diff-covariant; the seam net extends $(D_5)_1 \times (A_3)_1$ (v154), so covariance is a CONSEQUENCE — the v215 circularity is defused, covariance downgraded ASSUMPTION $\rightarrow$ [E]. [E] of 12 audited hypotheses, 11 are internal [E] and exactly 1 external — the continuum EXISTENCE of the chiral massless scaling limit (MMST/v336, Lean FORM.SEAM.MMST.01). [C][O] external dependence pinned to ONE analytic fact; SEAM.EQUIV.01 stays [O]. Python-only (a structural/arithmetic audit; the dets Wolfram-mirrored via v89/v281/v422). [E][C][O]
v442_seam_rigidity_uniform.py	SEAM.RIGIDITY.UNIFORM.01: the uniform-in- N hardening of the Seam State Rigidity Theorem (v398) — the band-limited rigidity is NOT a small- N artifact. [E] EXACT UNIFORM 4-SECTOR COMMUTATION: $\rho = \text{diag}(i^n)$ has EXACTLY 4 distinct eigenvalues $\{1, i, -1, -i\}$ for all N , and a genuinely character-block-diagonal K (random Hermitian within each $n \bmod 4$ class, not merely diagonal) has $[\rho, K]=0$ EXACTLY for $N=4..256$ (extends v398's $N \leq 64$). [E] UNIFORM GAP: $\Delta(N) = \text{const} > 0$ across $N=20..160$ (the Nachtergaele–Sims uniform gap, shared with v439). [E] N -INDEPENDENT RIGIDITY BOUND: a FIXED local clock-breaking perturbation (single off-mu4-block Hermitian entry) gives $\ [\rho, V]\ =2$ EXACTLY for all N — a uniform lower bound; any fixed-size clock-breaking is detected with N -independent strength. [E] NEG CONTROL: a clock-PRESERVING (same-sector) perturbation gives $\ [\rho, V']\ =0$; an order-2 clock has only 2 distinct eigenvalues — the ORDER of the clock (the four Gauss–Bonnet marks) is the discriminator, uniformly in N . [C][O] the band-limited rigidity of v398 is uniform in N ; SEAM.RIGIDITY.01/SEAM.EQUIV.01 stays [O]: that RP+gap+holomorphy FORCE Λ_Σ block-diagonal on the full L^2 (vs merely permit) is the cited rigidity/MMST step. Python-only (numpy). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v443_seam_e8_discriminator.py	SEAM.E8.DISCIMINATOR.01: the empirical/structural DISCRIMINATOR bundle (mode D of the v347 closure-mode classification) — concrete FALSIFIABLE kill tests separating the claimed seam $= (E_8)_1$ from the nearest $c=8$ rival $SO(16)_1=(D_8)_1$. [E][X] PRIMARY/GSD: $\det \text{Cartan}(E_8) =1$ (ONE primary, holomorphic) vs $\det \text{Cartan}(D_8) =4$ (FOUR primaries $1, v, s, c$); torus GSD $= \# \text{primaries} = 1$ vs 4 — a seam with $\text{GSD} > 1$ falsifies $(E_8)_1$. [E][X] CURRENT/THETA: level-1 current count $\dim E_8=248$ vs $\dim SO(16)=120$; the E_8 lattice theta has 240 norm-2 roots ($= 112$ integer $+128$ spinor, computed) vs D_8's 112 — current spectrum and lattice theta DIFFER. [E] $c=8$ IS NOT A DISCRIMINATOR: both have $c=8$ (the v277 ambiguity); only the order-4 μ_4 condensation $+ \det K=1$ (the genus-1 statement, v90) selects E_8. [E] NON-VACUITY: the discriminators all fire on the rival ($\det 4 \neq 1$, currents $120 \neq 248$, roots $112 \neq 240$). [X][C] mode D realised as concrete kill tests; SEAM.EQUIV.01 stays [O] (the discriminators distinguish the TARGET but do not PROVE the seam realises it). Python-only (numpy; the dets Wolfram-mirrored via v89/v281/v422). [E][C][O][X]
v444_seam_edge_scaling.py	SEAM.EQUIV.CONTINUUM.EDGE.01: the CHIRAL EDGE scaling-limit MOTOR — the edge half of the one SEAM.EQUIV.01 continuum residual, attacking exactly the step v439 left open. On the SAME explicit v367/v368 $p+ip$ collar it shows the lattice edge carries the kinematic AND conformal data of a chiral $c=\frac{1}{2}$ Majorana CFT, converging under refinement. [E] CHIRAL LINEAR EDGE DISPERSION: the in-gap branch is linear near its zero-crossing (top $v=0.983$, $R^2=0.9999$) and the two boundaries carry OPPOSITE velocities — one chiral Majorana per edge (relativistic, chiral kinematics). [E] ALGEBRAIC EDGE TWO-POINT: the equal-time edge correlator decays as $r^{-\eta}$ with $\eta=1.00$ (the chiral free-fermion CFT exponent) — a CRITICAL edge. [E] EXPONENTIAL BULK (neg control): the bulk-row correlator decays exponentially ($\xi \sim 1.1$) — only the edge is critical, so the power law is the edge CFT, not a geometric artefact. [E] TRIVIAL-PHASE NEG CONTROL: $M=3$ (no edge, v368) has an exponential edge-row — the algebraic decay is the topological edge, not the boundary geometry. [E] SCALING-COLLAPSE / CONVERGENCE: η is N-stable (1.001 ± 0.007) and the edge correlator profile is Cauchy-convergent under refinement (successive spread shrinks $0.028 \rightarrow 0.013$, $N_x=36..60$) — an existing scaling limit, the edge analogue of v439's bulk thermodynamic limit. [C] EDGE CENTRAL CHARGE: $\eta=1 \Leftrightarrow$ one chiral Majorana ($c=\frac{1}{2}$) per edge, so the $N_{\text{Maj}}=16$-copy carrier has a chiral $c_-=8$ edge CFT ($= (E_8)_1$, $c_-=g_{\text{car}}+N_{\text{fam}}$). [C][O] grounds the EDGE half of the cited MMST scaling limit (v336) the way v439 grounds the bulk; with both halves the one continuum residual is grounded and pinned to a single cited theorem; SEAM.EQUIV.01 stays [O] (the rigorous uniform-convergence theorem is not supplied). Python-only (numpy). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v445_seam_rigidity_forcing.py	SEAM.RIGIDITY.FORCING.01: the rigidity FORCING theorem — upgrades v442’s “block-diagonal PERMITS commuting” to “commuting with the order-4 clock FORCES block-diagonal”, isolating the single remaining physical premise. [E] FORCING (commute $\Leftrightarrow$ block-diagonal, EXACT): for $\rho = \text{diag}(i^n)$, $[\rho, K]=0$ iff $K_{ij}=0$ whenever $i \not\equiv j \pmod 4$ — verified ENTRYWISE, swept $N=4..128$ (the converse of v442). [E] EXACT COMMUTANT DIMENSION: $\dim\{K : [\rho, K]=0\} = \sum_s n_s^2$ (the four sector sizes), verified as the ad_ρ nullspace; a PROPER subspace of the N^2 algebra ($N=16$: $64 < 256$) — a genuine quantitative restriction. [E] OFF-BLOCK $\Leftrightarrow$ NON-COMMUTING: every off-block matrix unit E_{ij} has $\ [\rho, E_{ij}]\ = i^i - i^j \geq \sqrt{2} > 0$ — zero slack. [E] THE ORDER IS THE DISCRIMINATOR: the order-4 clock gives 4 sectors ($\dim \sum n_s^2(4)$), the order-2 clock $\text{diag}((-1)^n)$ a STRICTLY LARGER commutant ($N=16$: 64 vs 128) — the four Gauss–Bonnet marks (order $4= \mu_4 =h(A_3)$) force strictly more structure than two; only the index-4 extension is $(E_8)_1$ ($\det 1$; v281/v154/v351). [E] NONDEGENERACY: exactly 4 distinct eigenvalues $\{1, i, -1, -i\}$ for all $N \geq 4$. [C] SYNTHESIS (force, not permit): commuting with the order-4 μ_4 clock is EQUIVALENT to μ_4-block-diagonality (iff, exact, uniform in N), so RP-definability (v54/v398) + clock-invariance FORCE the block-diagonal Λ_Σ — v442’s “permit” upgraded to “force”. [C][O] the single residual is now precisely “transfer in commutant” (clock-invariance = QGEO.SYM.01, v323/v335); SEAM.RIGIDITY.01/SEAM.EQUIV.01 stays [O]. Python-only (numpy; the det facts Wolfram-mirrored via v89/v281/v422). [E][C][O]
v446_seam_clock_invariance.py	SEAM.RIGIDITY.CLOCKINV.01: DERIVING clock-invariance (“transfer in the commutant”) from RP-symmetry, closing v445’s single residual one notch further — the residual drops from an OPERATOR commutation to the STRUCTURAL μ_4-symmetry of the seam RP data. [E] OS RECONSTRUCTION INHERITS THE SYMMETRY: for a μ_4-invariant RP covariance $([\rho, C(t)]=0)$, the OS canonical transfer $\Lambda=C(1)C(0)^{-1}=e^{-h}$ (the transfer FIXED by RP+reflection, v54) has $[\rho, \Lambda]=0$ — swept $N=4..32$ over random block-diagonal h. [E] SHARPNESS / NEG CONTROL: a μ_4-BREAKING covariance gives $[\rho, \Lambda] \neq 0$ — iff-sharp, so the inheritance is non-vacuous. [E] CONTRACTION / OS-VALIDITY: Λ has spectrum in $(0, 1]$ (a positive contraction, the physical canonical transfer). [E] MODULAR (Tomita–Takesaki): the free modular Hamiltonian $K=\log((1-C)C^{-1})$ (the v258 formula) of the μ_4-invariant state has $[\rho, K]=0$ (the clock commutes with modular flow), the breaking control $[\rho, K] \neq 0$. [C] SYNTHESIS: $[\rho, \Lambda_\Sigma]=0$ is a CONSEQUENCE of μ_4-invariance of the seam RP data (the four Gauss–Bonnet marks, v216/v323) via the OS reconstruction (v54) + the modular fact (v258), NOT an extra assumption; with v445 (commute $\Leftrightarrow$ block-diagonal), RP-definability PLUS the marks FORCE the block-diagonal Λ_Σ. [C][O] the residual reduces from an operator commutation to “the seam RP data is μ_4-symmetric” (QGEO.SYM.01); the continuum Tomita–Takesaki implementation on the full L^2 is the cited backbone. SEAM.RIGIDITY.01/SEAM.EQUIV.01 stays [O]. Python-only (numpy/scipy). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v447_seam_edge_chern.py	SEAM.EQUIV.EDGE.CHERN.01: an INDEPENDENT (topological) reading of the edge $c_- = 8$, corroborating v444's correlator route via the bulk-edge correspondence on the same v367/v368 $p+ip$ collar. [E] INTEGER CHERN NUMBER: the $M=1$ collar lower band has Chern $C=+1$ (the Fukui-Hatsugai-Suzuki lattice link-variable method, an EXACT integer, no fit) — one chiral channel per copy. [E] TRIVIAL-PHASE NEG CONTROL: $M=3$ (v368) has $C=0$ (no chiral edge), and $M=-1$ gives $C=-1$ (opposite chirality, matching v444's opposite per-edge velocities). [E] BULK-EDGE CORRESPONDENCE: the open strip carries EXACTLY $C =1$ in-gap edge branch crossing zero per boundary in the $M=1$ phase, 0 in the trivial phase — the chiral edge channel count = C. [E] LI-HALDANE: the half-cut bulk ground state's single-particle entanglement spectrum has in-gap modes at $1/2$ in the topological phase and NONE in the trivial — the entanglement edge tracks the physical edge. [C] EDGE CENTRAL CHARGE: $c_- = N_{\text{Maj}} \cdot \frac{1}{2} \cdot C = 16 \cdot \frac{1}{2} \cdot 1 = 8 = g_{\text{car}} + N_{\text{fam}}$, from the Chern integer + bulk-edge correspondence — the SAME $c_- = 8$ as v444's correlator route, from a logically independent (topological) observable. [C][O] corroborates v444's edge $(E_8)_1$ reading; SEAM.EQUIV.01 stays [O] — the topology fixes c_- and the channel count but not the cited continuum existence theorem. Python-only (numpy). [E][C][O]
v448_seam_edge_fourpoint.py	SEAM.EQUIV.EDGE.FOURPOINT.01: pinning the ONE external MMST fact empirically — the edge FOUR-point function is quasi-free and conformally convergent, extending v444's two-point scaling limit to the next order. [E] QUASI-FREE / WICK (CAR hypothesis): the ground-state correlation matrix is an exact projector $G^2 = G$ ($\sim 10^{-13}$), so the state is quasi-free and all n-point functions are Wick/Pfaffian sums of the two-point — the MMST quasi-free CAR hypothesis (ledger entry 5) literally holds on the collar (structural: the BdG state is free). [E] FOUR-POINT CAUCHY CONVERGENCE: the edge four-point cross-ratio $Q = [G_{01}G_{23}]/[G_{02}G_{13}]$ at COMMENSURATE positions $(1, 2, 4, 7) \cdot (N_x/12)$ is Cauchy-convergent under refinement (successive spread shrinks, $N_x=36..60$) — the four-point converges, extending v444's two-point scaling-collapse. [E] CONFORMAL FOUR-POINT FORM: Q converges to the free-fermion CONFORMAL cross-ratio $\sin(5\pi/12)/\sin(\pi/12) = 2 + \sqrt{3} \approx 3.732$ (chord distance $d(r) = (N_x/\pi) \sin(\pi r/N_x)$) — the edge four-point has the chiral-CFT cross-ratio structure ($\eta=1$), not just the two-point. [E] BULK NEG CONTROL: the bulk-row four-point is orders of magnitude off the conformal value (exponential decay, gapped) — only the EDGE four-point is conformal. [C] the one external MMST fact (continuum existence of the chiral scaling limit) is now empirically supported at BOTH two-point (v444) and four-point order on our explicit collar; every measured n-point converges to its conformal limit. SEAM.EQUIV.01 stays [O] — the rigorous MMST uniform-convergence theorem (v336) is the cited backbone. Python-only (numpy). [E][C]

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Script	What it machine-checks (<i>continued</i>)
v449_seam_mmst_uniform.py	SEAM.EQUIV.MMST.UNIFORM.01: uniform-in-N control of the edge scaling limit — the empirical content of the cited MMST uniform-convergence theorem, strengthened, on the same v367/v368 $p+ip$ collar. [E] CROSS-RATIO A CONVERGES: the edge four-point $Q(1, 2, 4, 7)/12 \rightarrow \sin(5\pi/12)/\sin(\pi/12) = 2+\sqrt{3}$, the deviation shrinking monotonically under refinement ($N_x=36, 48, 60$). [E] CROSS-RATIO B (independent positions): $Q(1, 3, 5, 9)/12 \rightarrow$ its OWN conformal value 2 — a SECOND observable with a DIFFERENT limit, so the convergence is not a single tuned point. [E] UNIFORM $1/N$ RATE: $Q(N)-Q_\infty \cdot N \leq 4$ for BOTH cross-ratios and every $N_x \in \{36, 48, 60\}$ — one N-independent constant bounds the deviation across two independent observables, the empirical hallmark of uniform-in-N convergence. [E] BULK NEG CONTROL: the bulk-row cross-ratio is off-scale (gapped, exponential) — only the EDGE converges. [C][O] the MMST uniform-convergence HYPOTHESIS is empirically satisfied on the collar (two-point v444, four-point v448, and now multi-observable uniform rate); SEAM.EQUIV.01 stays [O] — the abstract continuum existence theorem (v336) is strengthened in evidence, not replaced by a proof. Python-only (numpy). [E][C]
v450_seam_edge_entanglement.py	SEAM.EQUIV.EDGE.ENTANGLEMENT.01: a THIRD independent reading of the edge $c_-=8$ — the Calabrese–Cardy entanglement scaling $c=1/2$ per Majorana (after v444 correlator, v447 topology). [E] CALABRESE–CARDY LAW: the block entanglement entropy of the critical XX (Dirac) chain fits $S=(c/3)\ln[(L/\pi)\sin(\pi\ell/L)]+\text{const}$ with $c_{\text{Dirac}}=1.000$ (flat log slope) — the universal scaling-limit signature. [E] c PER MAJORANA = $1/2$: $c_{\text{Dirac}}=1=2c_{\text{Maj}}$ (Dirac = two Majoranas), so $c_{\text{Maj}}=1/2$ — the chiral CFT of one $p+ip$ edge mode (v444). [E] GAPPED NEG CONTROL: a dimerised (gapped) chain has saturating, ℓ-independent entanglement ($c=0$) — the log growth is the CRITICAL edge CFT. [C] EDGE CENTRAL CHARGE: $c_-=N_{\text{Maj}} \cdot c_{\text{Maj}} = 16 \cdot \frac{1}{2} = 8 = g_{\text{car}} + N_{\text{fam}}$, from entanglement — the SAME $c_-=8$ as v444 (correlator) and v447 (topology), from a third independent observable. [C][O] three observables agree; SEAM.EQUIV.01 stays [O]. Python-only (numpy). [E][C]
v451_seam_edge_cardy_tower.py	SEAM.EQUIV.EDGE.CARDY.01: the Cardy finite-size conformal tower — the edge spectrum reproduces the EXACT Ising primary dimensions $\{1/16, 1/2\}$, on the critical Majorana ring (the v367/v368 edge universality class). [E] SPIN DIMENSION $h_\sigma=1/16$: the periodic(R)–antiperiodic(NS) ground-energy split gives $(E_0^R - E_0^{NS})L/(2\pi v)=0.06250$ ($v=2$), stable across $L=200, 400, 800$ — the Ising spin field. [E] ENERGY DIMENSION $h_\varepsilon=1/2$: the lowest NS pair excitation gives $2\varepsilon_{\min}L/(2\pi v)=0.50000$ — the Ising energy field. [E] CONFORMAL SCALING: both dimensions are L-INDEPENDENT (the gaps scale exactly as $1/L$) — a conformal (gapless) spectrum, not a gapped lattice. [C] ISING IDENTIFICATION: $\{c, h_\sigma, h_\varepsilon\}=\{1/2, 1/16, 1/2\}$ is the chiral Ising (free Majorana) CFT (the $c=1/2$ building block, v444/v450); with $N_{\text{Maj}}=16$ copies and bulk-edge (v447), $c_-=16 \cdot \frac{1}{2}=8=g_{\text{car}}+N_{\text{fam}}$. [C][O] the edge CFT is named by its central charge (v450) AND its operator content (this); SEAM.EQUIV.01 stays [O]. Python-only (numpy). [E][C]

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Script	What it machine-checks (<i>continued</i>)
v452_seam_e8_modular.py	SEAM.EQUIV.E8.MODULAR.01: the $(E_8)_1$ torus modular data — one primary, S-invariant, T-phase $e^{-2\pi i/3}$, the holomorphic $c=8$ signature (extends v156's q-expansion to the modular transformation data). [E] S-INVARIANCE: $\chi(-1/\tau)=\chi(\tau)$ for $\chi=E_4/\eta^8$ (weight 0, since E_4 wt 4 / η^8 wt 4), to $\sim 10^{-30}$ — ONE primary, the S-matrix is [1]. [E] T-PHASE: $\chi(\tau+1)/\chi(\tau)=e^{-2\pi i/3}=e^{-2\pi ic/24}$ ($c=8$), to $\sim 10^{-30}$ — the central charge appears in the modular T eigenvalue. [E] LEADING POWER $\Rightarrow c=8$: $\chi q^{1/3} \rightarrow 1$ so the leading power is $q^{-c/24}=q^{-1/3} \Rightarrow c=8=g_{\text{car}}+N_{\text{fam}}$. [E] HOLOMORPHIC CONSTRAINT: $c=8=0 \bmod 8$ — the minimal holomorphic (single-primary) chiral central charge, the even unimodular rank-8 lattice E_8. [C][O] the $(E_8)_1$ modular data (one primary, S-invariant, T-phase $e^{-2\pi i/3}$, $c=8$) is the torus signature of the seam net; with the edge readings (v444/v447/v450/v451) the $(E_8)_1$ identity is pinned on the torus AND the edge; SEAM.EQUIV.01 stays [O] — the cited continuum existence theorem (v336) is the residual. Wolfram-mirrored (tfpt_readouts_extension.wl). [E][C]
v453_seam_mu4_from_marks.py	SEAM.RIGIDITY.MU4FROMMARKS.01: deriving QGEO.SYM.01 (μ_4-symmetry of the seam RP data) from the four marks — the LAST structural premise of the rigidity chain folded into the existing realisation premise. [E] THE MARKS ARE μ_4: the four Gauss–Bonnet marks are exactly $\{1, i, -1, -i\} = \text{roots of } z^4-1$ (v168/v216/v323). [E] THE CLOCK PERMUTES THE MARKS: $z \mapsto iz$ is a 4-cycle of order 4 ($1 \rightarrow i \rightarrow -1 \rightarrow -i \rightarrow 1$), fixing the configuration setwise (the order-4 clock of v445). [E] MOEBIUS STABILISER: $z \mapsto iz$ preserves the marks' cross-ratio $\lambda=2$ (in the D_4 stabiliser, v168) — the symmetry is geometric. [E] THE FORM BASIS IS μ_4-GRADED: $\omega_k = z^{k-1} dz / (z^4-1) \rightarrow i^k \omega_k$ under $z \mapsto iz$ ($k=1, 2, 3 \rightarrow \{i, -1, -i\}$, the three nontrivial μ_4 characters; weights $(1, 2, 3)=A_3$ exponents = $\text{Spec}(Q_+)$) — the natural basis is μ_4-graded, so any geometric datum is μ_4-covariant. [C][O] QGEO.SYM.01 (“the seam RP data is μ_4-symmetric”) is a CONSEQUENCE of marks=μ_4 (this) + QGEO.REALIZE.01 (seam = the marked geometry, the EXISTING premise), NO new premise; the rigidity chain (this $\rightarrow$ v446 $\rightarrow$ v445) closes modulo realisation, SEAM.EQUIV.01 stays [O]. Wolfram-mirrored (tfpt_readouts_extension.wl). [E][C]
v454_seam_edge_virasoro.py	SEAM.EQUIV.EDGE.VIRASORO.01: the lattice realises the level-1 current algebra whose Sugawara central charge is EXACTLY 8 (G2 of the post-F next steps) — testing the cited MMST “Koo–Saleur lattice generators $\rightarrow$ continuum Virasoro with the correct c” fact on our own free-fermion edge. [E] CASIMIR c: the critical complex free-fermion ring $E_0(L)=e_\infty L - \pi v c / (6L)$ (Affleck–Cardy) fits $c_{\text{Dirac}}=1.000 \Rightarrow 1/2$ per Majorana (parameter-free, $L=64..1024$). [E] KAC–MOODY LEVEL: the lattice $U(1)$ current J_n has $\langle 0 J_n J_{-n} 0 \rangle = n$ EXACTLY ($n=1..8$) — the affine level-1 central extension closes; a gapped (dimerised) control gives a vanishing non-linear term. [E] SUGAWARA EXACT: $c = \dim G / (1+h^\vee) = 8$ for BOTH $SO(16)_1$ (120/15) and $(E_8)_1$ (248/31) — Wolfram-mirrored. [C] ASSEMBLY: 16 Majoranas $\times \frac{1}{2} = 8 =$ the level-1 Sugawara c; the edge IS a $c_- = 8$ level-1 current-algebra CFT. [C][O] the lattice Virasoro/current algebra with the correct central extension is realised on the explicit collar; SEAM.EQUIV.01 stays [O] (the continuum existence theorem v336 is the cited backbone). Mixed numerical (Casimir, Kac–Moody) + exact (Sugawara, Wolfram-mirrored). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v455_seam_bw_uniform.py	SEAM.EQUIV.BW.UNIFORM.01: a UNIFORM-IN-N Tomita–Takesaki tower for the intrinsic Bisognano–Wichmann condition $u_\Theta=J$ (G1 of the post-F next steps) — the inductive-limit companion to the single finite witness v426, advancing v424 sub-step (i). One-particle: $\Delta=e^{-K}$, conjugation J, reflection Θ; BW $\Leftrightarrow u_\Theta=J \Leftrightarrow \Theta K \Theta = -K$. [E] UNIFORM BW: the reflection-odd, μ_4-even, gapped collar of size $4m$ ($m=2..32$, $N=8..128$) has $\ \Theta K \Theta + K\ =0$ to machine precision at EVERY N — $u_\Theta=J$ uniform. [E] UNIFORM GAP: the gap of K is N-independent ($6 \log \frac{3}{2} = 2N_{\text{fam}} \log \frac{3}{2}$) so $\Delta=e^{-K}$ stays uniformly bounded away from 1 (a genuine KMS, not trace, state). [E] UNIFORM CLOCK SYMMETRY: $[\rho, K]=0$ exactly at every N. [E] N-INDEPENDENT NEG CONTROL: a side-even reflection gives $\ \Theta K \Theta + K\ =2\ K\$ (a fixed per-mode margin, growing with N) and an off-μ_4 K breaks $[\rho, K]$ at every N — the success is non-vacuous. [C][O] the inductive (continuum) limit inherits $u_\Theta=J$; SEAM.EQUIV.01 stays [O] (the rigorous continuum theorem NPW26/MMST v336 is the backbone). Python-only (numpy). [E][C][O]
v456_seam_chirality_from_c3.py	SEAM.S3.FROM-P1.01: the edge chirality ($c_- \neq 0$, the S3 topological phase) is FORCED by the one-sidedness that defines $c_3=1/(8\pi)$ (P1) (G6 of the post-F next steps) — so S3 is a CONSEQUENCE of axiom P1, not an independent input. [E] c_3's “8” IS THE ONE-SIDED COUNT: $8\pi= \mathbb{Z}_2 \int K = 2(2\pi\chi(S^2)) = 2 \cdot 4\pi$ ($\chi=2$), so $8= \mathbb{Z}_2 \cdot (\int K/\pi) = 2 \cdot 4$ (v73, Wolfram-mirrored). [E] REFLECTION REVERSES C: the explicit 2-band $p+ip$ Chern model has $C=+1$ and the orientation-reversed ($k_y \rightarrow -k_y$) model $C=-1$. [E] TWO-SIDED $\Rightarrow$ NON-CHIRAL: any GAPPED boundary carrying an orientation-reversing (reflection) symmetry must have $C=-C=0$ ($c_-=0$, gappable). [C] ONE-SIDED $\Rightarrow$ CHIRAL: the one-sided seam is precisely the $\mathbb{Z}_2$ quotient with NO reflection (the same $\mathbb{Z}_2$ that gives c_3 its 8π), so $C \neq 0$ is forced — S3 follows from P1. [C][O] magnitude $c_-=8=\text{rank } E_8=g_{\text{car}}+N_{\text{fam}}$ is the SAME integer as c_3's one-sided count; SEAM.EQUIV.01's continuum EXISTENCE (v336) stays [O]. Mixed exact (the $8= \mathbb{Z}_2 \int K/\pi$ arithmetic, Wolfram) + numerical (the reflection $C \rightarrow -C$ flip). [E][C][O]
v457_seam_character_killtest.py	SEAM.EQUIV.KILLTEST.01: an explicit $(E_8)_1$-vs-$SO(16)_1$ character/sector kill-test for the seam edge (G7 of the post-F next steps) — a FALSIFIABLE consistency test of the $(E_8)_1$ identification of SEAM.EQUIV.01. [E] $(E_8)_1$ CHARACTER TOWER: $\chi=E_4/\eta^8=q^{-1/3}(1+248q+4124q^2+34752q^3+\dots)$ — the exact conformal-tower degeneracies $(E_4 \cdot \prod (1-q^n))^{-8}$, Wolfram-mirrored). [E] CURRENT-COUNT DISCRIMINATOR: the weight-1 multiplicity is $248=\dim E_8=120(SO16)+128(\text{spinor})$, NOT the 120 of the free $SO(16)_1$. [E] SECTOR-COUNT DISCRIMINATOR: $(E_8)_1$ is INVERTIBLE $\det \text{Cartan } E_8 =1$ (one primary) vs $SO(16)_1=D_8$ $\det \text{Cartan } D_8 =4$ (four sectors). [X] KILL CRITERION: a measured weight-1 count of 120, OR a sector count of 4, OR a tower coefficient $\neq \{1, 248, 4124, \dots\}$ would FALSIFY $(E_8)_1$; current data give $248/1/\{1, 248, 4124\}$, so PASSED. [C][O] the $(E_8)_1$ identification survives the kill-test; SEAM.EQUIV.01's continuum EXISTENCE (v336) stays [O]. Exact (Wolfram-mirrored) + a numerical determinant cross-check. [E][C][O][X]

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Script	What it machine-checks (<i>continued</i>)
v458_seam_mmst_citation_audit.py	SEAM.EQUIV.MMST.AUDIT.01: the EXACT hypothesis-by-hypothesis citation audit of the seam scaling-limit theorem (Osborne–Stottmeister, CMP 398 (2023) 219; arXiv:2107.13834; legacy internal token MMST, on the MMST/Morinelli–Morsella–Stottmeister–Tanimoto OAR framework) against our collar (G3 of the post-F next steps, the “exakter Zitat-Abgleich”). [C] H1 ALGEBRA CLASS: a gapped quasi-free CAR 16-Majorana system = MMST’s lattice-fermion class (v155/v160/v302). [C] H2 MASSLESS POS-ENERGY LIMIT: the gapless chiral edge IS that massless scaling limit (v439/v444). [E] H3 PER-COPY ($c=1/2$): each of 16 chiral Majoranas is EXACTLY the proven Theorem A $c=1/2$ case. [C] H4 DECOUPLED ADDITIVITY: MMST’s limit decouples into Majoranas $\Rightarrow L_k = \sum_i L_k^{(i)}$ on the common core $\Rightarrow$ the free $c=8$ $SO(16)_1$ Virasoro follows ($16 \cdot \frac{1}{2} = 8$). [C] H5 WZW RANGE rank $\leq c \leq D$: $8 \leq 8 \leq 16$ IN range, the 120 $so(16)$ currents are bilinears — covered. [O] H6 RESIDUAL = THE 128-SPINOR EXTENSION: the index-4 $SO(16)_1 \rightarrow (E_8)_1$ adds 128 SPINOR currents ($248=120+128$), NOT bilinears — OUTSIDE MMST’s method (the $\det K$ 4$\rightarrow$1 holomorphy discriminator), handed to v459. [C][O] the audit CLOSES-by-citation the $c=8$ EXISTENCE and pins the open residual EXACTLY to the 128-spinor extension; SEAM.EQUIV.01 stays [O], its open part now this one holomorphic-extension statement. Python (sympy; a structural/arithmetic audit). [C][O]
v459_seam_lattice_voa_route.py	SEAM.EQUIV.LATTICEVOA.01: the SECOND, independent route to $(E_8)_1$ — the lattice-VOA / conformal-net $A_Q(E_8)$ construction supplies EXACTLY the 128-spinor extension MMST (v458) leaves open (G5 of the post-F next steps). Cited: Adamo–Giorgetti–Tanimoto, “Rational and non-rational 2d CFTs arising from lattices” (arXiv:2506.01008); OS for unitary lattice VOAs (Adamo–Moriwaki–Tanimoto, arXiv:2407.18222). [E] E_8 EVEN UNIMODULAR: $\det \text{Cartan}(E_8)=1$ and even $\Rightarrow A_{E_8}$ HOLOMORPHIC (one sector, the $\det K=1$ the residual demanded). [E] LATTICE CURRENTS $248=8+240$: 8 Cartan + 240 roots = the full $(E_8)_1$ weight-1 space, from the lattice (not bilinears). [E] THE 240 ROOTS SPLIT 112+128: 112 INTEGER (D_8) + 128 HALF-INTEGER; $8+112=120=so(16)$ and the 128 half-integer roots ARE the spinor ($248=120+128=8+240$) — the lattice route builds the 128-spinor explicitly. [C] AGT THEOREM: A_Q of an even lattice IS a 2d conformal net; the holomorphic $SO(16)_1 \rightarrow (E_8)_1$ extension is CONSTRUCTED, not assumed. [C][O] TWO complementary routes now cover $(E_8)_1$ (MMST fermions v458 + the lattice net A_{E_8}); the residual reduces to the single realization input “the collar’s scaling limit = A_{E_8}” (tied to P1 by v456). SEAM.EQUIV.01 stays [O]. Exact (E_8 even unimodular; $240=112+128$; $248=8+240=120+128$, Wolfram-mirrored) + structural literature mapping. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v460_seam_s3_lto.py	SEAM.S3.LT0.01: the EXPLICIT flat-band commuting-projector (local-topological-order) realisation of the S3 input — advancing v424 sub-step (i) (“realise the raw seam as a $\mathbb{Z}_2$-reflection commuting-projector LTO”) from abstract existence to an explicit gap-protected quasi-local projector net carrying the $\mathbb{Z}_2$ reflection and the μ_4 clock. [E] FLAT-BAND PARENT: the flattened Bloch $Q=h/ h$ of v367’s $p+ip$ collar has $Q^2=I$ (flat ± 1 bands) and $P=(I-Q)/2$ is an exact projector EQUAL to the occupied ground-state projector — a frustration-free commuting-projector parent with the same gapped ground state. [E] GAP-PROTECTED QUASI-LOCALITY: the gapped projector kernel $P(n, 0)$ decays rapidly ($\xi \approx 1.14$ at $M=1$, $\exp R^2=0.995$, $P(20, 0) < 10^{-6}$) and ξ GROWS as the gap closes (2.7 at gap 0.02); at the GAPLESS point the kernel decays as a clean power law $R ^{-2.1}$ ($R^2=0.999$, tail $\sim 2 \times 10^{-4}$) — locality needs the gap. [E] $\mathbb{Z}_2$ REFLECTION + μ_4 INHERITED: the flattened modular Hamiltonian $K_{\text{flat}} = \text{sign}(K)$ inherits $\Theta K_{\text{flat}} \Theta = -K_{\text{flat}}$ (BW, $u_\Theta = J$) and $[\rho, K_{\text{flat}}] = 0$ (μ_4) EXACTLY (sign is odd; ρ commutes with any $f(K)$). [E] NEG CONTROLS: a side-even reflection gives $2\ K_{\text{flat}}\ \neq 0$ (BW fails), an off-μ_4 K mixing opposite-sign marks breaks $[\rho, \text{sign}(K)] \neq 0$. [C][O] the chiral $c_- = 8 \neq 0$ (FHS Chern $C =1$) obstructs STRICT finite-range commuting-projector locality (Kapustin–Fidkowski, arXiv:1810.07756; $C \neq 0$ forbids exponentially-localised Wannier, Thouless), so the realisation is the quasi-local LTO net of NPW26 — the form sub-step (i) asks for. SEAM.EQUIV.01 stays [O] (the continuum theorem MMST v336 is the backbone). Python-only (numpy; the det/level discriminators Wolfram-mirrored via v89/v281/v422). [E][C][O]
v461_seam_strict_locality.py	SEAM.S3.LOCALITY.01: the Kapustin–Fidkowski/Thouless strict-locality OBSTRUCTION made explicit — sharpening v460’s verdict from a cited statement to an EXHIBITED topological obstruction on the same v367 $p+ip$ collar. [E] CHERN INTEGER: the FHS Chern is $C=+1$ (chiral $M=1$), 0 (trivial $M=3$), -1 (opposite mass) — the invertible-phase invariant. [E] WILSON-LOOP / WANNIER-CENTRE WINDING = CHERN: the hybrid Wannier centre $\theta(k_y)$ winds by $C =1$ (chiral) and 0 (trivial) over the BZ; exponentially-localised Wannier functions exist IFF the winding is 0 (Brouder–Panati et al., PRL 98 046402; Thouless), so the chiral collar has NONE. [E] OBSTRUCTION INTEGERS TIED: winding = $C =1 \neq 0$ and $c_- = 16/2 = 8 = g_{\text{car}} + N_{\text{fam}} = \text{rank } E_8 \neq 0$ (the same 8 as c_3’s one-sided count, v456). [E] NEG CONTROL: BOTH phases are gapped, yet only the trivial (winding 0) admits exp-localised Wannier and a strict finite-range commuting projector — it is the CHIRALITY, not the gap. [C][O] Kapustin–Fidkowski (arXiv:1810.07756): a strictly finite-range commuting projector would force winding 0, $C=0$; since $C=1 \neq 0$ NONE exists, so v424 sub-step (i)’s realisation is PROVABLY the quasi-local NPW26 LTO net (strict locality topologically forbidden, not a missing premise) — upgrading v460’s cited verdict. SEAM.EQUIV.01 stays [O] (continuum theorem MMST v336 the backbone). Python-only (numpy; the winding/Chern integers Lean-mirrored, SeamResidualAxiom.lean). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v462_seam_spinor_continuum.py	SEAM.EQUIV.SPINOR.01: the 128-spinor extension $SO(16)_1 \rightarrow (E_8)_1$ exhibited at CHARACTER level and as a finite-$L \rightarrow$ continuum convergence — the constructive companion of the v458 (MMST audit) / v459 (lattice-VOA) residual. [E] $(E_8)_1$ TOWER FROM $SO(16)_1$ SECTORS: the exact Jacobi/E_8 identity $\theta_2^8 + \theta_3^8 + \theta_4^8 = 2E_4$ gives $\chi_{(E_8)_1} = E_4/\eta^8 = \frac{1}{2}[(\theta_3/\eta)^8 + (\theta_4/\eta)^8] + \frac{1}{2}(\theta_2/\eta)^8 = \chi_o^{SO16} + \chi_s^{SO16}$ — the holomorphic $(E_8)_1$ character IS the $SO(16)_1$ vacuum + spinor sector sum. [E] THE 128 SPINOR WEIGHT-1 STATES FILL 120 $\rightarrow$ 248: χ_o gives weight-1 multiplicity 120, χ_s gives 128, summing to the exact $(E_8)_1$ tower $\{1, 248, 4124, 34752\}$ — the spinor currents ARE the $(E_8)_1$–$SO(16)_1$ deficit (248=120+128). [E] FINITE 16-MAJORANA FOCK: $C(16, 2)=120$ NS bilinear ($so(16)$) currents and $2^{16/2}=256$ Ramond ground states = 128 spinor + 128 cospinor — the spinor present already at finite N. [E] FINITE-$L \rightarrow$ CONTINUUM CONVERGENCE: the critical free-fermion ring Casimir $E_0(L) = e_\infty L - \pi v c / (6L)$ fits $c_{\text{Dirac}} \rightarrow 1$ ($c_- = 8$) and the lowest scaled NS gap $x_1 \rightarrow 1$ with $x_1 - 1 \sim 1/L^2$ ($L=64..1024$) — the lattice flows to the conformal tower. [C][O] the rigorous holomorphic extension ($\chi_o + \chi_s$ simple-current projection) is supplied by AGT/AMT (v459); SEAM.EQUIV.01's continuum existence (v336) stays [O]. Mixed exact (θ identity + tower + 120=$C(16, 2)$, 128=2^7, 248=120+128, Wolfram-mirrored) + numerical (the finite-L convergence, Python-only). [E][C][O]
v463_seam_c8_holomorphic_uniqueness.py	SEAM.EQUIV.UNIQ.01: the $c=8$ holomorphic-uniqueness pin — the positive lever that makes the IDENTIFICATION half of SEAM.EQUIV.01 classification-forced rather than assumed (B of the A+B round). [E] $c=8$ NOT UNIQUE AT LEVEL 1: $c = \dim \mathfrak{g} / (1 + h^\vee) = 8$ has THREE simple solutions — A_8 (dim 80), $D_8 = \mathfrak{so}(16)$ (dim 120), E_8 (dim 248); $c=8$ is necessary but NOT sufficient (the v457 $\det K=4$ $SO(16)$ rival is a real gleich-c competitor). [E] HOLOMORPHY FORCES $\dim V_1=248$: the only weight-0 form with leading $q^{-1/3}$ and integer coefficients is $j^{1/3} = E_4/\eta^8$, whose q^1 coefficient (the 1-dim candidate space, vacuum $a_0=1$) is 248 — forced, not chosen. [E] $\dim V_1=248 + \text{level-1 } c=8 \Rightarrow E_8$ UNIQUELY (248/(1+30)=8); the gleich-c rivals A_8 (80) and D_8 (120) are excluded. [E] the $(E_8)_1$ tower $\{1, 248, 4124, 34752, 213126\}$ are the E_4/η^8 coefficients, and $E_4/\eta^8 = j^{1/3}$ (numeric $< 10^{-25}$). [C] Dong–Mason/Schellekens: the holomorphic VOA at $c=8$ is UNIQUE = V_{E_8}, and the even unimodular rank-8 lattice is unique = E_8 (Mordell–Witt) — so “$c=8$ holomorphic limit = $(E_8)_1$” is classification-forced. With v458 (free part) + v459 (spinor extension) the continuum/identification HALF of SEAM.EQUIV.01 is [C] conditional on named audited theorems; the REALISATION R1 (v464) is the sole remaining input. SEAM.EQUIV.01 stays [O]. Exact (sympy/integer q-series + Lie-algebra scan; mpmath cross-check), Wolfram-mirrored. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v464_seam_ oneparticle_ rigidity.py	SEAM.EQUIV.ONEPARTICLE.01: the one-particle RIGIDITY + scaling limit attacking R1 — the REALISATION input of SEAM.EQUIV.01 (A of the A+B round). The seam is quasi-free (v113/v160/v161), so by Araki self-dual CAR the whole net is the second quantisation of its one-particle symbol P , and R1 collapses to a finite-per-mode statement about P . [C] ARAKI SELF-DUAL CAR: a gauge-invariant quasi-free state $\leftrightarrow$ its symbol P ($0 \leq P \leq 1$) bijectively (Araki 1971; Shale–Stinespring 1965), so a realisation is fully determined by P . [E] RIGIDITY: the gapped ground state is the UNIQUE quasi-free state with $P =$ projection onto $K < 0$ ($P^2 = P$, hermitian to $< 10^{-12}$), K fixed by gap + chirality + reflection (v426) — no second realisation. [E] ONE-PARTICLE SCALING LIMIT EXISTS: the real-space kernel is Cauchy on a fixed window ($\max P_{2N} - P_N \sim 1/N \rightarrow 0$), so P_∞ exists (Gaussianity is why a computation reaches it). [E] THE LIMIT IS $c=1$ DIRAC ($c_-=8$): entanglement $S(L) = (c/3) \ln L$ gives $c \rightarrow 1$ (per Majorana 1/2; Peschel/Calabrese–Cardy, ties v450), 16 copies $\rightarrow c_-=8$. [C] Shale–Stinespring: gauge-invariant $\Rightarrow$ no pairing block $\Rightarrow$ the Bogoliubov map is implementable, GNS reps quasi-equivalent. R1 is upgraded from a bald axiom to “the unique quasi-free realisation, one-particle limit exhibited, modulo the named Araki/Shale–Stinespring functor”; with v463 the SEAM.EQUIV.01 residual is now entirely certification (named cited functors), zero open internal mechanism — closed modulo cited theorems. SEAM.EQUIV.01 stays [O]. Python-only (numpy: idempotency, kernel Cauchy-convergence, entanglement c -fit). [E][C][O]
v465_seed_ crosssector_ joint.py	SEED.CROSSSECTOR.01: the cross-sector one-parameter seed test — the θ_{13} -independent, externally-runnable slice of v306. TFPT reads a CMB EB/TB birefringence angle β and a quark Cabibbo angle $\lambda_C = V_{us} $ (unrelated in the SM) as two readouts of the ONE axiom seed $\varphi_0 = 1/(6\pi) + 48c_3^4$. [E] plumbing: the axiom φ_0 reproduces the frozen λ_C , $\sin^2 \theta_{12}$, β to 10^{-9} . [E] CROSS-SECTOR (headline): back-solving φ_0 <i>independently</i> from β (CMB) and λ_C (quark) gives the <i>same</i> seed within $0.01\sigma_{\text{comb}}$ — a correlation only a shared-origin theory predicts. [E] one-parameter fit: the error-weighted mean of the three back-solved φ_0 reproduces the axiom to 0.06%; the joint χ^2 at the axiom (zero free parameters, 3 dof) is 0.007, $\chi^2/\text{dof} < 1$, combined pull 0.08σ . [E] θ_{13} EXCLUSION declared, not cherry-picked: adding $\sin^2 \theta_{13}$ raises χ^2 by ~ 4 (the documented $\sim 2\sigma$ pressure point, v328/v338), so this slice is <i>deliberately</i> θ_{13} -independent. [E] negative control: a data $\leftrightarrow$ formula shuffle explodes the cluster χ^2 by $> 5 \times 10^4$. A consistency / out-of-sample statistic (a subset of v306); φ_0 is FIXED by the axioms, so it upgrades <i>no</i> prediction. Python-only. [E]

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Script	What it machine-checks (<i>continued</i>)
v466_seed_leptonmass_channel.py	SEED.LEPTONMASS.01: a SIXTH, new-sector seed channel — the charged-lepton mass ratio $m_e/m_\mu = \frac{12}{7}\varphi_0^2$ points to the SAME axiom seed $\varphi_0 = 1/(6\pi) + 48c_3^4$, extending the empirical seed over-determination (v306/v465) from three measurement sectors to five. [E] plumbing: the axiom φ_0 reproduces the frozen $m_e/m_\mu = \frac{12}{7}\varphi_0^2 = 0.00484673$ to 10^{-9} . [E] NEW SECTOR (headline): back-solving φ_0 from the measured POLE ratio $m_e/m_\mu = 0.004836$ (PDG) gives $\varphi_0 = 0.053113$, only -0.11% from the axiom — a charged-lepton MASS reading (Penning-trap masses), a fourth measurement sector beyond {neutrino mixing, CMB, quark mixing}. [C] TRANSPORT CAVEAT: the formula is the SOURCE ratio, the datum the POLE ratio; the source→pole shift is the seam-gapped correction class (bound $(2/3)^6 = 8.78\%$, v393) but largely CANCELS for m_e/m_μ , so the 0.11% residual sits far inside the band — added as a CONSISTENT new sector, not a sharper pin. [E] EXTENDS THE OVER-DETERMINATION: the six-channel cluster (v306's five + this) has $\chi^2/\text{dof} < 1$ and the error-weighted mean stays at the axiom to $< 0.1\%$; with the corroborating heavy-quark m_t/m_b (-0.23%) it is a seven-channel, FIVE-sector agreement (neutrino mixing, CMB, quark mixing, lepton mass, quark mass). [E] negative control / power: a data↔formula shuffle explodes the cluster χ^2 by $> 100\times$; and not every mass ratio qualifies — $m_c/m_s = (34/47)/\varphi_0$ is scheme-ambiguous (FLAG 11–14), a WEAK channel deliberately not counted. [C] HONEST: theoretically still the ONE seed (v305 multiplicity 1) — an EMPIRICAL strengthening (a new measurement sector agrees), NOT theoretical independence; φ_0 is FIXED by the axioms, so it upgrades <i>no</i> prediction and closes <i>no</i> gate. Python-only. [E][C]
v467_thirdgen_mixing_pattern.py	FLAV.THIRDGEN.PATTERN.01: the three $\sim 2\sigma$ mixing tensions ($\theta_{13}, \theta_{23}, V_{cb}$) are ONE common $-\varphi_0^{\text{ret}}$ suppression ($-5.36\% \pm 1.67\%$, 3.2σ non-zero, -0.03σ from $-\varphi_0^{\text{ret}}$); the ladder-base forms $\lambda_C^2 e^{-5/6} / (1 - \varphi_0^{\text{ret}})/2 / \lambda_C^2 / (1 + \lambda_C)$ drop the joint χ^2 $10.4 \rightarrow 0.11$ with zero parameters; post-hoc candidate [O], frozen record unchanged, JUNO-era reactors + Belle II decide
v468_dm2_ratio_jarlskog.py	FLAV.DM2RATIO.01: $\Delta m_{21}^2 / \Delta m_{31}^2 = J_{\text{PMNS}} $ of the frozen matrix = 0.029653 vs measured $0.029805(792) \rightarrow -0.19\sigma$ — a parameter-free candidate relation for the previously unpredicted splitting ratio; the informal $m_2/m_3 \sim \pi\varphi_0^{\text{ret}}$ heuristic is now -2.44σ and retyped; NO floor $\Sigma m_\nu = 0.0588$ eV consistent; post-hoc [O], JUNO decides

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Script	What it machine-checks (<i>continued</i>)
v469_seam_ crossedproduct_ route.py	SEAM.EQUIV.CROSSEDPRODUCT.01: the net-level crossed-product certification of the 128-spinor extension + the $R1 \rightarrow R1'$ invariant-level reduction. [E] LR LOCALITY INTEGER (index-2): the $SO(16)_1$ spinor has $h_s = N/16 = 16/16 = 1 \in \mathbb{Z} \Rightarrow$ statistics phase +1 — the Longo–Rehren criterion HOLDS, so the $\mathbb{Z}_2$ simple-current crossed product $SO(16)_1 \rtimes \{1, s\}$ is a LOCAL index-2 extension (Longo–Rehren, Rev. Math. Phys. 7 (1995); the level-1 $so(N)$ net with DHR sectors from even-CAR: Böckenhauer, Rev. Math. Phys. 8 (1996); simple-current extensions: Böckenhauer–Evans, Comm. Math. Phys. 197 (1998)); KLM $\mu(B) = 4/2^2 = 1 \Rightarrow$ HOLOMORPHIC $\Rightarrow (E_8)_1$ by the v463 pin (E_4/η^8 $q^1 = 248$ re-verified). The 2024/2025-preprint leg (AGT/AMT, v459) is DEMOTED to an independent second witness — the extension certification now rests on 1995–2001 PEER-REVIEWED journals. [E] INDEX-4 PARALLEL: the μ_4 glue $J = (s, \Lambda_1)$ has $h(J^k) = \{1, 1, 1\}$ ALL integer ($\frac{5}{8} + \frac{3}{8} = 1$; $\frac{1}{2} + \frac{1}{2} = 1$) — the v125 isotropy $q(k, k) = k^2$ at net level; $\mu = 16/4^2 = 1$, the same endpoint. [E] $R1'$ INVARIANTS COMPUTED: per-copy FHS Chern $C(M=1) = 1$ vs $C(M=3) = 0$, $\nu = 16 \times C = 16$, $c_- = \nu/2 = 8 = g_{\text{car}} + N_{\text{fam}}$; $\nu \bmod 16 = 0$ is EXACTLY Kitaev’s class-D phase whose edge admits a purely bosonic description = the $(E_8)_1$ level-1 state (Ann. Phys. 321 (2006), sixteen-fold way). [E] THE CHAIN COMPOSES: T1 (phase classification: Kitaev + c_- invariance, Kapustin–Spodyneiko PRB 101 (2020) / Kim et al. PRL 129 (2022)) $\rightarrow$ T2 (MMST CMP 397 (2023) + Böckenhauer 1996) $\rightarrow$ T3 (LR/BE + KLM CMP 219 (2001)) $\rightarrow$ T4 (Dong–Mason + v463) with matching in/out slots (v297 typing). [C] $R1 \rightarrow R1'$: collar_realizes (model-level fiat) replaceable by collar_invariants — {quasi-free [C] (v155/v160), gap [E] (v302), class D, $c_- = 8$ [E] (v456, from P1)}; quasi-freeness stays the ONE [C] hypothesis; Lean mirror FORM.SEAM.RESIDUAL.01. [O] NOT CLOSED: the cited theorems stay cited (certification, not re-proof); SEAM.EQUIV.01 stays [O]. Mixed exact (weights/μ/tower, Wolfram-mirrored) + numerical (FHS Chern, Python-only). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v470_alpha_inflow_level.py	ALPHA.QUILLEN.INFLOW.01: the α^3 level = the COMPUTED bulk Chern invariant + the seam F-normalisation = the affine embedding index $k_Y=5/3$. [E] TARGET RE-VERIFIED: $\alpha^{-1}=137.0359992168$ unique root; the Quillen split $a^3-2c_3^3a^2=8b_1c_3^6\ln(1/\varphi_{\text{seam}})$ at the root to $<10^{-35}$ (v341/v382). [E] THE INVARIANT COMPUTED: FHS Chern $C(M=1)=1$, $C(M=3)=0$ — the same integers as v367/v461, here read as the quantised $U(1)$ response of the collar phase. [C] $k_0= C =1$ UNDER THE EM1 READING: the a^3 coefficient EQUALS the computed bulk invariant of the SAME model that realises S3 — “why exactly 1” is answered by computation + the cited inflow identification (TKNN PRL 49 (1982) / Avron–Seiler–Simon PRL 51 (1983) quantisation; Callan–Harvey Nucl. Phys. B250 (1985) inflow; APS 1975 / Alvarez-Gaumé–Della Pietra–Moore 1985 / Witten Rev. Mod. Phys. 88 (2016) $\eta=\text{CS}$ part of $\delta\log\det$; Quillen 1985 / Bismut–Freed CMP 106 (1986) determinant-line integrality) — REPLACING v435’s minimality assumption. [E] $k_Y=5/3$ EXACT: $\text{tr}_5(Y^2)/\text{tr}(T_3^2)=(5/6)/(1/2)=5/3$ (Ginsparg, Phys. Lett. B197 (1987)); $(3/5)\times\frac{41}{6}=\frac{41}{10}=b_1$ — the “GUT 3/5” IS the inverse embedding index, not an imported convention; carrier decomposition $\frac{41}{6}=\frac{20}{3}$ (fermions, 3×16-content) $+\frac{1}{6}$ (Higgs doublet). [C] F-NORMALISATION RETYPED: once the seam net is $(E_8)_1$ level 1 (SEAM.EQUIV.01), the $U(1)_Y$ normalisation $\langle J(z)J(w)\rangle=k/(z-w)^2$ is FIXED by k_Y — level-1 current-algebra rigidity, no continuous dial; the v434 [C] has ZERO independent content (a face of SEAM.EQUIV.01, per the v382 typing). [E] UNIFICATION: ONE invertible phase, TWO quantised responses — $c_-=16\times\frac{1}{2}\times C =8=g_{\text{car}}+N_{\text{fam}}$ (gravitational, feeds SEAM.EQUIV.01/S3, v456) and $C=1$ ($U(1)$, feeds EM1) — “the one theorem and the one number” are two faces of the SAME phase; closing R1’ (v469) feeds both. [O] NOT CLOSED: the bridge lemma “$\delta\log\det_c(\text{seam})$ = the inflow response” stays the named cited step; the EM1 reading stays [C]; ALPHA.QUILLEN.EXACT.01 stays [O]; α^{-1} stays [E] regardless. Mixed exact (k_Y/b_1 identities, Wolfram-mirrored) + numerical (root/split mpmath, FHS Chern, Python-only). [E][C][O]
v471_seam_horizon_replica.py	SEAM.EHMODEL.04: the Seam–Horizon replica chain exercised NUMERICALLY on a discretized seam collar — the kernel-identification premise of SEAM.THEOREM.01 (the residual isolated by v150/v151/v152) discharged at the FINITE/MODEL level for the seam’s own kernel, with REAL replica sheets. [E] REPLICA$\Rightarrow$EH FORM on a real operator: $dG/d\ln m = 2C(\gamma)$ on deficit cones $\gamma/2\pi = \frac{1}{4}, \frac{1}{2}, \frac{3}{4}$ (0.01–0.05%) AND replica sheets $n=2$ (0.8%), $n=3$ (1.5%). [E] COEFFICIENT CUTOFF-INDEPENDENT (0.5% drift) while the ζ-scale μ_{lat} drifts with the discretization = the v152 anchor exhibited on data; NO canonical $\ln(m/\mu)=\frac{3}{4}$ emerges (recorded honestly). [E] BFK SPLIT MEASURED ON THE KERNEL: Schur identity exact ($\sim 10^{-16}$); the Calderón/Schur factor’s deficit slope is a PURE CUT-EDGE law $E(1-q)$ with tip term 0 (power check: the same law fails on the full determinant); the halves carry the whole tip = $2C_{\text{cone}}$ via Kac doubling (exact). [E] THE SEAM’S OWN SPECTRUM: the v302 transfer masses $m_2=6\ln\frac{3}{2}$, $m_3=6\ln 3$ sit ON the calibrated EH line ($\leq 0.05\%$); the Perron/attractor mode ($m=0$) is IR-DIVERGENT (runs exactly as $-2C\ln(\text{IR})$) — the recovery gap $\Delta = 6\ln\frac{3}{2}$ makes the induced-gravity coefficient finite: the same gap that makes the attractor unique makes $1/G$ finite. [O] HONEST SCOPE: finite/discretized level; SEAM.THEOREM.01 stays open — the residual retypes to the CONTINUUM scaling limit (MMST class, = the single residual of SEAM.EQUIV.01, v336) + the v152 anchor. Numerical (sparse lattice determinants), Python-only by nature. [E][O]

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Script	What it machine-checks (<i>continued</i>)
v472_quillen_ detline_moduli.py	ALPHA.QUILLEN.DETLINE.01: the DETERMINANT LINE over the $U(1)$-twist moduli of the collar model carries curvature = the inflow level — the finite Quillen/Dai–Freed shadow of the v470 bridge lemma, COMPUTED. [E] BLOCH LEVEL RE-VERIFIED: BZ Chern $C(M=1)=1$, $C(M=3)=0$, $C(M=-1)=-1$ (the v470/v367 integers). [E] THE QUILLEN OBJECT COMPUTED: the same collar $h(k)$ in real space on an $L \times L$ torus with TWISTED boundary conditions — the twist torus (θ_x, θ_y) IS the moduli space of flat $U(1)$ connections — and the Fukui–Hatsugai–Suzuki curvature of the determinant line of the occupied one-particle frame (the free-fermion ground state) over that torus = 1 exactly (10^{-9}) at $M=1$, for $L=4$ AND $L=6$ (size-independent, as an integer must be). [E] CONTROLS: trivial collar $M=3 \rightarrow 0$; orientation flip $M=-1 \rightarrow -1$. [E] TWO TORI, ONE LEVEL: the twist-moduli integer equals the Bloch-BZ integer for all three M — the Niu–Thouless–Wu identification (PRB 31 (1985)), exhibited on the collar model that realises S3 (v460/v461). [E] SECTION GLOBALLY DEFINED: the Fermi gap (= 2.0) stays open over the WHOLE twist torus — the Dai–Freed section has no zero, the holonomy reading is globally valid. [C] THE READING: det-line holonomy over the $U(1)$ moduli = inflow level $k_0= C =1$ — the v470 bridge lemma “$\delta \log \det_\zeta(\text{seam}) = \text{the inflow response}$” holds VERBATIM at the finite/model level, where $\log \det$ of the occupied frame replaces $\log \det_\zeta$ (Quillen 1985; Bismut–Freed CMP 106 (1986); Dai–Freed JMP 35 (1994); FHS JPSJ 74 (2005)). [O] NOT CLOSED: the abstract-seam ζ-determinant identification (the continuum leg, = the SEAM.EQUIV.01 face); ALPHA.QUILLEN.EXACT.01 stays [O]; α^{-1} stays [E] regardless. Structurally the same manoeuvre as v471 for SEAM.THEOREM.01’s replica side. Numerical (dense eigh + FHS twist grid), Python-only by nature. [E][C][O]
v473_entropic_ action_bridge.py	GRAV.ENTROPIC.ACTION.01: the entropic-action bridge — Bianconi’s <i>Gravity from entropy</i> (Phys. Rev. D 111, 066001 (2025); arXiv:2408.14391) quantified as an EXTERNAL CANDIDATE for the local volume action behind TFPT’s parameter-free Einstein equation (v358/v359, honestly typed “equation of state, not a from-action quantisation” [O]). Her $S_B = -\text{Tr}_F \ln(\tilde{G}\tilde{g}^{-1})$ is the quantum relative entropy between the spacetime metric and the matter-induced metric (Araki-related, $\Delta^{1/2} = \tilde{G}\tilde{g}^{-1}$), a local covariant action whose variation gives Einstein + emergent nonnegative Λ at low coupling — the missing variational layer IF the bridge holds. [E] CARRIER HODGE COUNT: her $\Omega^{0,1,2}$ fiber on the FIVE-SLOT carrier $\mathbb{C}^5$ (not 4d spacetime, where it is $1+4+6=11$) counts $1+5+10=16=2^{g_{\text{car}}-1} = \dim S_{D_5}^+$, Hodge-folded onto $\Lambda^{\text{even}}\mathbb{C}^5$ (vector-space identity ONLY). [E] COEFFICIENT MATCH (the one quantitative pin): her weak-coupling $\mathcal{L} = 3\beta R - \alpha\mathcal{L}_m$ matched to $1/(16\pi G) = c_3/(2G)$ fixes her free constant EXACTLY, $\beta_B' = c_3/6 = 1/(48\pi)$; the $6 = 3 \text{ blocks} \times 2 = p_2 = R^+(A_3)$ (structural echo, not a proof). [E] ENTROPY POTENTIAL: $\Lambda_{\mathcal{G}} = \frac{1}{2\beta} \text{Tr}(\mathcal{G} - I - \ln \mathcal{G}) \geq 0$, quadratic at the fixed point $\Rightarrow$ with $\varepsilon_\star = e^{-\alpha^{-1}}Q$ the closed v60 branch $(3/4\pi^2)e^{-2\alpha^{-1}}$ is reproduced with the EXACT target $\text{Tr } Q^2 = 32c_3^4 = 1/(128\pi^4) = \frac{2}{3} \delta_{\text{top}}$ ([C] until Q is constructed). [E] FRULLANI: $-\ln A = \int_0^\infty \frac{dt}{t} (e^{-tA} - e^{-t})$ — her log action is an all-scale heat-kernel action, the right genre against $S_{\text{rel},\chi}$ (KMS cutoff). [E] R^2 KILL TEST: raw $(c_3/6)^2$ vs Starobinsky $1/(12c_3^7)$ ($M_{\text{scal}}^2 = c_3^7 \bar{M}_{\text{Pl}}^2$, v36) — EXACT gap $3(8\pi)^9 \approx 1.2 \times 10^{13}$ (13 orders): a direct identification of the raw entropic action with the TFPT R^2 sector is FALSE without a mechanism (light $\mathcal{G}$-trace mode generating c_3^{-9}, or KMS-spectral renormalisation) — pre-registered. [C] COMPRESSION CONJECTURE: $P_\Sigma(\tilde{G}\tilde{g}^{-1})P_\Sigma = \Delta_\Sigma^{1/2} + \text{the operator-level Hodge items (Clifford, Dirac, leaf involution, Calderón polarisation) stay open; Lorentzian positivity NOT automatic — TFPT’s OS route is the sturdier construction. [O] NOTHING CLOSES: v359’s equation-of-state status stays [O]; zero TFPT knobs added. Mixed exact (sympy, Wolfram-mirrored) + one quadrature (mpmath). [E][C][O]$

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Script	What it machine-checks (<i>continued</i>)
v474_entropic_hodge_carrier.py	GRAV.ENTROPIC.HODGE.01: the OPERATOR level of the entropic-action bridge (work packages 1 + 4-algebra of v473). [E] CAR⇒CLIFFORD: the ten Γ's from $(a_k^\dagger, a_k)$ on the carrier Fock space $\Lambda^\bullet \mathbb{C}^5$ ($\dim 2^{g_{\text{car}}}=32$) satisfy $\{\Gamma_a, \Gamma_b\}=2\delta_{ab}$ exactly (all 100 pairs, integer matrices) — the $\mathfrak{so}(10)=D_5$ Clifford algebra acts on the carrier exterior algebra. [E] $S^+=\Lambda^{\text{even}}$ AS D_5-MODULE: the 45 bilinears $[\Gamma_a, \Gamma_b]/4$ commute with $\gamma=(-1)^N$, span exactly $45=\dim \mathfrak{so}(10)$ and leak NOTHING from the 16-dim even subspace — the half-spinor IS the even exterior algebra WITH its spinor structure (operator level of v2/v44/v197). [E] HODGE-DIRAC SYMBOL: $c(\xi)=a^\dagger(\xi)-a(\xi)$ satisfies $c(\xi)^2=- \xi ^2 \text{Id}$ for SYMBOLIC ξ — Bianconi's $D=d+\delta$ is Clifford multiplication at symbol level. [E] THE FOLD IS $5\rightarrow\bar{5}$: the traceless $\mathfrak{u}(5)$ weights of Λ^4 are the NEGATIVES of those of Λ^1, so the Hodge fold $\star: \Lambda^1\cong\Lambda^4$ conjugates the vector block — her fiber $1+5+10$ becomes the GUT half-spinor $16=1+\bar{5}+10$ (the SM carrier decomposition), not a mere dimension match. [E] HONEST OBSTRUCTION: $\Omega^{\leq 2}$ is NOT Clifford-invariant ($c(\xi)$ maps Λ^2 into Λ^3); only Λ^{even} is (even algebra) — the bridge must go through the fold, never through degree truncation (constraint on AP2). [E] Q-TARGET ENUMERATION (the v473 conjecture DECIDED): $\text{Tr } Q^2=d k^2 c_3^4=32c_3^4$ with INTEGER k has exactly the supports $(d,k)=(2,4), (8,2), (32,1) = \{ \mathbb{Z}_2 , g_{\text{car}}+N_{\text{fam}}=\text{rank } E_8, 2^{g_{\text{car}}}=\dim \Lambda^\bullet\}$ — minimal uniform solution $q=c_3^2=1/(64\pi^2)$ per Fock mode; the two-form block $d=10$ (the “pair sector” conjecture) and the fiber $d=16$ need irrational multipliers $\sqrt{16/5}, \sqrt{2} \Rightarrow$ KILLED in uniform form; bonus identity $\text{Tr } Q^2/\delta_{\text{top}}=32/48=2/3=\dim \Lambda^\bullet/\Omega_{\text{adm}}$. [C] the physical choice among the three admissible supports; [O] AP2 compression + R^2 mechanism stay open, no marker moves. Mixed exact: integer Fock matrices (numpy, exact in double) + symbolic sympy (weights/enumeration Wolfram-mirrored). [E][C][O]
v475_entropic_scalaron_gate.py	GRAV.ENTROPIC.SCALARON.01: the R^2 kill test of the entropic-action bridge EXECUTED (work package 5 of v473) + the explicit Lorentzian-positivity witness. [E] MAX-SYMMETRIC EIGENVALUES (her Appendix-B flattening verified): $\tilde{R}\tilde{g}^{-1}$ has eigenvalues EXACTLY $\{R; R/4 \times 4; R/6 \times 6\}$ on a general diagonal 4d metric, incl. the 6×6 two-form flattening. [E] EXACT VACUUM $f(R)$: $\mathcal{L}_B(R)=-[\ln(1-\beta R)+4\ln(1-\beta R/4)+6\ln(1-\beta R/6)]=3\beta R+\frac{17}{24}\beta^2 R^2+O(R^3)$ — the 3 re-derives her Eq. (45) (= the v473 pin), $\frac{17}{24}=\frac{1}{2}(1+\frac{1}{4}+\frac{1}{6})$ is the EXACT tensorial R^2 factor. [E] RAW SCALARON TRANS-PLANCKIAN: with $\beta'=c_3/6$ both routes (Starobinsky matching AND $f'/(3f'')$) give $m_{\text{raw}}^2=\frac{4608\pi^2}{17}M_{\text{Pl}}^2$, $m_{\text{raw}}\approx 51.7 M_{\text{Pl}}\approx 1.3\times 10^{20}$ GeV — HEAVY, not light (TFPT: $c_3^{7/2}M_{\text{Pl}}=3.06\times 10^{13}$ GeV); required enhancement EXACTLY $m_{\text{raw}}^2/m_{\text{TFPT}}^2=\frac{72}{17}(8\pi)^9\approx 1.69\times 10^{13}$ in mass² — v473's interpretation 2 (the TFPT scalaron as the light $\mathcal{G}$-trace mode) is KILLED in naive form. [E] DOMAIN: first log pole at $R=1/\beta=384\pi^2 M_{\text{Pl}}^2$ (trans-Planckian) — the raw action is well-defined at all sub-Planckian curvatures; the obstruction is the MASS, not the domain. [E] LORENTZIAN WITNESS: a timelike gradient gives Gg^{-1} eigenvalue $1-\alpha v^2\leq 0$ for $v^2\geq 1/\alpha$ ($\ln$ undefined); spacelike/Euclidean positive for all v — the v473 [C] caveat exhibited, the OS/reflection-positive route sturdier. [C] VERDICT: interpretation 1 survives (the entropic action covers the Einstein + Λ level), 2 is dead naive, 3 (KMS-spectral renormalisation) is the ONLY surviving R^2 route. [O] unchanged: AP2 compression + the R^2 gate; no marker moves. Exact (sympy, Wolfram-mirrored). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v476_entropic_compression_toy.py	GRAV.ENTROPIC.COMPRESS.01: the AP2 compression conjecture of the entropic-action bridge (v473) made WELL-POSED on an exactly solvable model. Numerical facts on a staggered-mass chain: the ground-state covariance is a PROJECTION (pure bulk, thermal boundary — the seam situation); the compression $C_A=PCP$ has spectrum strictly inside $(0,1)$ with finite Peschel $K=\ln((1-C_A)/C_A)$ and $S>0$ (v155 in the bridge context). ORDER OBSTRUCTION (the reading DECIDED): on the pure bulk $f(x)=x/(1-x)$ is SINGULAR on $\text{spec}(C)=\{0,1\}$ — the literal operator-side reading $Pf(C)P$ of the v473 conjecture is ILL-POSED while $f(PCP)$ is finite: the compression identity can only be read STATE-SIDE (build Δ_Σ from the COMPRESSED relative metric), matching Bianconi's own local-metric construction — AP2 retyped, not weakened. [E] BLOCK ALGEBRA (symbolic): $[C^2]_{AA}-(C_{AA})^2=BB^t$ and $[C^3]_{AA}-(C_{AA})^3=ABB^t+BB^tA+BDB^t$ — first order in the cross block vanishes identically, so for ANY analytic f the two readings agree to SECOND order: the modular (entanglement) content lives exactly in that quadratic correction. GAP CONTROL at the bounded (covariance) level: the bulk identity $f(C_T)=e^{-h/T}$ holds to 10^{-11} relative; the mismatch obeys the quadratic law $d \leq x^2$ and falls with the gap in the gapped regime, the decoupled cut agrees EXACTLY — the two readings converge in the gap-dominated regime, where TFPT operates ($\Delta_{\text{eff}}>0$, v76/v337). [C] the retyped conjecture; [O] AP2 stays open (the continuum seam statement); no marker moves. Numerical (numpy lattice + one symbolic block identity), Python-only by nature. [C][O]
v477_entropic_scaleflow.py	GRAV.ENTROPIC.SCALEFLOW.01: the scale-flow representation of the entropic action — v475's surviving interpretation 3 typed PRECISELY: the $(72/17)(8\pi)^9$ gap collapses to ONE moment condition on the scale weight, satisfied by the SAME KMS moment TFPT already fixes (v36: $f_0=6(4\pi)^2/c_3^7$); zero new dials, nothing closes. [E] SCALE-FLOW IDENTITY: $-\ln a = \int_0^\infty \frac{dt}{t}(e^{-ta}-e^{-t})$ (symbolic) $= 2 \int_0^\infty \frac{dx}{x}(e^{-a/x^2}-e^{-1/x^2})$ ($t=1/\chi^2$, 10^{-20} quadrature) — Bianconi's log action IS the FLAT scale-integral of relative heat-kernel actions; TFPT's $S_{\text{rel},\chi}$ evaluates ONE KMS scale with a weight f: the bridge is a choice of SCALE MEASURE. [E] MOMENT DICTIONARY: a weight $w(t) dt/t$ gives $3\beta R \mu_1 + \frac{17}{24}\beta^2 R^2 \mu_2$ ($\mu_1 = \int w e^{-t} dt$, $\mu_2 = \int w t e^{-t} dt$); the flat weight has $\mu_1=\mu_2=1$ = the v475 raw coefficients — the raw action is the unit-moment point of a moment family. [E] THE ONE MOMENT CONDITION: with the weight-dressed EH pin $\beta' \mu_1=c_3/6$ the scalaron is $m^2=\frac{4608\pi^2}{17}\frac{\mu_1^2}{\mu_2}M_{\text{P}1}^2$; demanding $m^2=c_3^7 M_{\text{P}1}^2$ forces EXACTLY $\mu_2/\mu_1^2=\frac{72}{17}(8\pi)^9$ — the v475 kill-test number IS a moment ratio; and the closure identity $\frac{4608\pi^2/17}{(72/17)(8\pi)^9}=c_3^7$ holds IDENTICALLY: the 13 orders are a scale-measure datum, not a bridge mismatch. [E] v36-CONSISTENCY: $f_0=6(4\pi)^2/c_3^7 \Leftrightarrow M^2/M_{\text{P}1}^2=c_3^7$ — the same mass from both parametrisations, ZERO new dials. [C] a CONSISTENCY statement, not a derivation (the KMS weight is TFPT input; the entropic action supplies the Einstein + Λ level and the scale-flow FORM, TFPT supplies the measure); negative side-record: the exact lattice-BW commutator attempt for AP2 (Peschel–Eisler simple forms) did NOT hold on the half-filled open chain (kept out of the suite, logged). [O] unchanged: the R^2 gate and v359's typing. Exact (sympy + one quadrature, Wolfram-mirrored). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v478_entropic_continuum_legs.py	GRAV.ENTROPIC.LEGS.01: first computable steps on the TWO remaining legs of the entropic-action bridge (v473–v477). LEG A (AP2 continuum): the compressed critical interval has $S(L)=(c/3)\ln L+k$ with $c_{\text{est}}=1.00089/1.00038/1.00021$ (monotone $\rightarrow$ the Dirac $c=1=2\times\frac{1}{2}$, the v450 reading; gapped control $\sim 6\times 10^{-8}$, area law); the Peschel modular Hamiltonian $K=\ln((1-C_A)/C_A)$ organises on the CHM weight $\beta(x)=x(L-x)/L$ (corr 0.87$\rightarrow$0.99, plateau drift shrinking; constants deliberately NOT asserted — the lattice EH is only asymptotically local); even-range bands vanish identically (particle-hole, $\sim 10^{-36}$), odd tail 1.8% parabola-enveloped — the state-side Δ_Σ (v476’s forced reading) FLOWS TO the CHM/BW geometric form that TFPT’s Einstein derivation consumes (v323/v358): the bridge’s modular side and TFPT’s gravity side MEET in the continuum limit. LEG B (the measure): [E] single-scale corollary — $d\mu=\delta(t-t_0)dt$ gives $\mu_2/\mu_1^2=e^{t_0}$ exactly, so the v477 condition forces $t_0=\ln\frac{72}{17}+9\ln(8\pi)=30.461$ — ONE dimensionless KMS time, exact closed form; DECLINED: $t_0\neq h(E_8)=30$ (difference 0.461; the near-miss is rejected per the v354/v355 no-free-pattern rule); deriving the measure from the entropic structure stays OPEN. [C] the meeting point; [O] both legs, no marker moves. High-precision numerical (mpmath, 50 digits) + one exact corollary, Python-only by nature. [C][O]
v479_kronheimer_quiver_bridge.py	SEAM.KRONHEIMER.01: the R3 “combinatorial-to-geometric bridge” of the $\det K=1$ keystone (v344 — “the rewrite attractor graph IS the du Val singularity”) is an ESTABLISHED THEOREM: Kronheimer’s ALE hyper-Kähler quotient construction + Torelli classification (J. Diff. Geom. 29 (1989) 665 and 685), with ALL finite input data already compiler outputs. [E] MARKS = NULL = PERRON: $C_{\text{aff}}\delta=0$ and $A\delta=2\delta$ on the affine-E_8 McKay graph; multiset $\{1, 2, 2, 3, 3, 4, 4, 5, 6\}$ = the $2I$ irrep dimensions = the v312 rewrite-attractor Perron vector. [E] DIMENSION COUNT: $\dim_{\mathbb{R}} M - 4\dim_{\mathbb{R}} G = 4(\sum_{\text{edges}} d_i d_j - \sum d_i^2 + 1) = 4$ — the hyper-Kähler quotient of the marks quiver is 4-real-dimensional (the $\mathbb{C}^2/\Gamma$ geometry); $\sum_{\text{edges}} d_i d_j = \sum d_i^2 = 120$ forced by the null-vector identity. [E] GAUGE DATUM: $\sum \delta_i^2 = 120 = 2I = \mu_4 h(E_8)$, $h(E_8)=30= \mathbb{Z}_2 N_{\text{fam}}g_{\text{car}}$. [E] RESOLUTION: $8=\text{rank } E_8$ exceptional spheres with intersection form $-\text{Cartan}(E_8)$, $\det=1$ and SNF = identity (the Poincaré-sphere link = the $\det K=1$ face, v232/v344); deformation space $\mathfrak{h} \otimes \mathbb{R}^3$, $\dim 3 \cdot 8 = 24$. [C] the theorems are CITED, not re-proved (the same import class as NPW26/MMST/AGT, v424/v336/v459). [O] the residual premise TRANSFORMS, it does not vanish: “the raw seam supplies ALE hyper-Kähler data asymptotic to the $(2, 3, 5)$ cone” = the SAME single arrow as SEAM.EQUIV.01 (v346 L2); no gate closes. Exact (sympy; Wolfram mirror added, counted with the verified 2026-07-21 engine run). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v480_multilocal_ four_interval.py	QGEO.MULTILOCAL.01: the four μ_4 marks make the seam circle a FOUR-INTERVAL free-fermion geometry — the class whose multi-interval modular theory is EXACTLY KNOWN (Casini–Huerta mixing term; Longo–Xu multi-interval subfactors; Rehren–Tedesco multilocal fermions; KLM: holomorphic $\Leftrightarrow$ trivial multi-interval inclusion, $\mu=1$ — the SAME one bit as $\det K=1$). On the exactly solvable antiperiodic critical ring ($N=256$, $Q=64$, $\ell=48$): [E] BINARY CLOCK: the quarter-turn clock is a signed permutation with $\rho^4 = -1$ EXACTLY — the fermionic μ_4 clock is the order-8 double-cover lift (the same $\mathbb{Z}_2$-lift pattern as $2I$ over I). [E] EXACT SECTOR DECOUPLING: the primitive-8th-root character projectors resolve the identity and commute with the reduced covariance at 10^{-15} (the Rehren–Tedesco diagonal 4-fold-cover isomorphism at covariance level). [E] COVER/TWIST: each sector kernel is the SINGLE-interval quarter-ring kernel with boundary twist λ_k; the union of sector spectra = the full 4-interval spectrum at 10^{-14}. [E] CLOCK INVARIANCE MANIFEST: $\rho C \rho^{-1} = C$ at $10^{-14} \Rightarrow [\rho, K]=0$ by functional calculus — $\omega \circ \rho = \omega$ HOLDS at the 4-interval state level; NEGATIVE CONTROL: displacing ONE interval by one site re-couples the sectors at 10^{-2}. CONJUGATE-POINT MIXING (numerical): every cross-interval row of K peaks on $s'-s \leq 2$ at both sizes — the lattice shadow of the Casini–Huerta mixing term. [C] the continuum multi-interval theory is CITED; [O] the raw-seam premise (QGEO.SYM.01/SEAM.EQUIV.01) stays OPEN — mechanism exhibited, not closed. Numerical (numpy), Python-only by nature. [E][C][O]
v481_seesaw_ carrier_ladder.py	FLAV.NUSCALE.02: the absolute neutrino-mass scale under the CARRIER Yukawa normalisation $y_\nu = y_t$ — FLAV.NUSCALE.01's two-parameter (y_ν, M_R) trade-off collapses to ONE parameter and the required M_R lands INSIDE the compiler's own PS window; the nearby integer c_3-rung is explicitly DECLINED at 1-loop (v354/v355). CANDIDATE class (genre v467/v468); the frozen record (v84) is untouched and NO gate closes. CARRIER NORMALISATION (conjectured premise; named premise): one $SO(10)$ 16 per family + minimal Yukawa sector (10_H / PS (1, 2, 2)) $\Rightarrow y_\nu = y_t$ at the matching scale — the trade-off collapses to M_R alone. INVERSION INSIDE THE WINDOW (numerical): the observed $m_3=0.0503$ eV demands $M_R=9.3 \times 10^{13}$ GeV, INSIDE $[M_{PS}, M_{GUT}] = [4.2 \times 10^{13}, 2.4 \times 10^{15}]$ (v249), at $\log_{c_3}(\bar{M}_{P1}/M_R) = 3.15$ ($y_\nu=1$ gives the structureless 2.58 — the old FLAV.NUSCALE.01 number). [X] INTEGER-RUNG HONESTY GATE: $M_R = c_3^3 \bar{M}_{P1} = 1.53 \times 10^{14}$ GeV predicts $m_3 = 0.030$ eV (40% low at 1-loop; ADKLR κ run-down factor 0.794) — NEAR the rung (3.15 vs 3), NOT ON: the ladder pin is DECLINED; the decision computation is NAMED (2-loop SM + explicit PS threshold matching). FALSIFIABLE BAND (numerical): over the PS window m_3 spans $[0.002, 0.115]$ eV bracketing the observation; the M_{PS} end ($\Sigma \sim 0.124$ eV) is already in tension with DESI ~ 0.072 — cosmology cuts the window from below; the NO floor $\Sigma m_\nu = 0.059$ eV stays the falsifiable edge (v272). [C] / [O] candidate class; the absolute scale stays formally open. Numerical (explicit 1-loop RG: gauge/y_t/λ up, ADKLR Weinberg-operator down), Python-only by nature. [C][O]

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Script	What it machine-checks (<i>continued</i>)
v482_seesaw_rung_ decision.py	FLAV.NUSCALE.03: the decision computation NAMED by v481, EXECUTED in bracketed (assumption-robust) form — the integer rung $M_R = c_3^3 \bar{M}_{Pl}$ is EXCLUDED as an unstructured exact pin, conditional on the carrier premise $y_\nu = y_t$. THE GAP: central $m_3(\text{rung}) = 0.0301$ eV vs observed 0.0503 — rescue factor $\times 1.670$ (+67%, 0.154 c_3 -rungs). BRACKETED EXCLUSION: with $m_t(\overline{\text{MS}}) \pm 3$ GeV ($> 3\sigma$), $\alpha_3^{-1} \mp 0.10$ ($> 3\sigma$), a $\pm 10\%$ band on the ADKLR κ run-down and the PS-leg Yukawa beta scaled $\times [0.5, 1.5]$, the largest single shift is $\times 1.10$ and the ALL-favourable combination reaches only $\times 1.165$ — far below $\times 1.670$: the v481 1-loop miss is NOT an RG artifact. [C] NAMED ESCAPE, RECORDED AND DECLINED: only a third-generation Majorana STRUCTURE factor $r \sim 1.67$ revives the rung; post-hoc $r_{\text{needed}} = 1.6696$ sits 0.18% from $g_{\text{car}}/N_{\text{fam}} = 5/3$ — no mechanism forces a 3/5 Clebsch on $M_{R,3}$ today, so this is a named coincidence with a named missing mechanism (PS Majorana-sector Clebsch), DECLINED per v354/v355 (the $t_0 \sim 30$ pattern of v478). [O] the v481 one-parameter window candidate (NO floor $\Sigma m_\nu = 0.059$ eV) never used the integer rung and STANDS; frozen record untouched; nothing closes. Numerical (explicit 1-loop RG + bracketed envelopes), Python-only by nature. [C][O][X]
v483_pillowcase_ exact_traces.py	HYP.PHIO.GEOM.01: the GEOMETRIC side of the φ_0^{ret} puncture target (HYP.PHIO.PUNCTURE.01/v408) is EXACT — every twisted/orbifold heat trace of the flat $\tau = i$ pillowcase is a t -INDEPENDENT RATIONAL, so the π^{-4} in $d_{\text{top}} = 48c_3^4$ cannot come from flat orbifold geometry at ANY order. [E] TWISTED TRACES EXACTLY 1: $\text{Tr}(\gamma e^{t\Delta}) = 1$ for $\gamma = \sigma(z \mapsto -z)$, $\rho(z \mapsto iz)$, ρ^3 at every tested $t \in [0.05, 3]$ (position-space Gaussian image sums / erf closed forms + 2d quadrature, residual $< 10^{-9}$; mode-space proof: only $n=0$ is γ -diagonal) — t -independent, no asymptotic tail. [E] ATIYAH–BOTT MATCH: $1 = 4 \times \frac{1}{4}$ ($\det(1-d\sigma) = 4 = \mu_4 $) and $1 = 2 \times \frac{1}{2}$ ($\det(1-d\rho) = 2 = \mathbb{Z}_2 $). [E] PILLOWCASE DATA EXACT: orbifold heat trace $= \frac{1}{2} \text{Tr}_{T^2} + \frac{1}{2}$ (contact term EXACTLY $\frac{1}{2} = 4 \times \frac{1}{8}$ per mark, all t); clock-equivariant trace exactly 1 (all t). [E]/[O] THE REDUCTION: the analytic content of $d_{\text{top}} = 48c_3^4 = \frac{3}{256\pi^4}$ must sit in the per-insertion COUPLING normalisation — $4 = \mu_4 $ insertions of weight c_3 give c_3^4 , multiplicity $\Omega_{\text{adm}} = 48$; the bare $1/(2\pi)$ -propagator 4-cycle differs by the exact RATIONAL $\frac{3}{16}$; the ONE remaining [O] is the rule “per-mark weight = c_3 ” (seam zeta/Green normalisation, the same residual class as EM.WARD.02). The target narrows from “derive the term” to “derive the weight”; HYP.PHIO.PUNCTURE.01 stays open; no gate closes. Numerical verification of exact statements + sympy exact arithmetic; Python-only by nature. [E][O]

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Script	What it machine-checks (<i>continued</i>)
v484_seam_contact_unit.py	SEAM.CONTACT.UNIT.01: the shared “c_3 per boundary insertion” rule of the two open analytic targets (ALPHA.QUILLEN.EXACT.01 ladder $\{0, 3, 6\}$; HYP.PHIO.PUNCTURE.01 per-mark weight c_3) is ONE identity and NOT a new unknown: it is the KMS seam unit $2\pi = 1/(4c_3)$ with $\frac{1}{4} = 1/ \mu_4$ (v239) — one bare boundary propagator ORBIT-AVERAGED over the four marks. [E] UNIT CHAIN: $\frac{1}{2\pi} = 4c_3 = \mu_4 c_3 = \mathbb{Z}_2 \chi(S^2)c_3$. [E] MECHANISM DERIVED ON THE SEAM CIRCLE: $G(d) = -\frac{1}{\pi} \ln 2 \sin(d/2)$ (polylog identity, 40 digits) takes INTEGER multiples of $c_3 \ln 2$ at the μ_4 separations — $G(\pi/2) = -4c_3 \ln 2$, $G(\pi) = -8c_3 \ln 2$, so $G_{\text{marks}} = -4c_3 \ln 2 \cdot \text{circ}(0, 1, 2, 1)$ with $\text{spec} = \{4, -2, 0, -2\}$; the μ_4-invariant (orbit-averaged) insertion carries $(GV) _{\text{marks}} = -(c_3 \ln 2) C$ EXACTLY, so the log-det contact expansion is exactly graded in c_3 per insertion with integer cycle combinatorics $\text{Tr}(C^k) = 4^k + 2(-2)^k$. [E] SUITE-WIDE GRAMMAR: the $F_{U(1)}$ ladder $\{0, 3, 6\}$ (v3); φ_0^{ret} ladder $\{1, 4\}$ (v37); the Λ prefactor $\frac{3}{4\pi^2} = (8\pi)^2 d_{\text{top}} = 48c_3^2$ (v60) — the SAME multiplicity $\Omega_{\text{adm}}=48$ as the puncture, at TWO insertions; the $g-2$ seam loop divides by the same $2\pi = 1/(4c_3)$. [C]/[O] THE MERGE: the two tracked [O] targets collapse into ONE named analytic step — the diagonal (self-energy) zeta-renormalisation at the marks + the state-multiplicity matching ($48 = \Omega_{\text{adm}}$, $41 = 10b_1$); the finite cycle sector is proven. Anti-numerology: the integers are forced by the square configuration; no target coefficient is claimed. Exact (sympy + 40-digit mpmath polylog); Python-only by nature. [E][C][O]
v485_contact_diagonal_closed.py	SEAM.CONTACT.UNIT.02: the DIAGONAL channel of the merged analytic target (v484) settled at the computable level — the merged residual COLLAPSES ONTO THE KEYSTONE. [E] DIAGONAL ZERO AT THE KMS SCALE: the renormalised coincident-point Green function on circumference ℓ is $G_{\text{reg}}(0; \ell) = \frac{1}{\pi} \ln(\ell/2\pi)$ exactly — it VANISHES iff $\ell = 2\pi = 1/(4c_3)$, the v239 KMS seam circumference: the seam scale is the unique zero-self-energy scheme point. [E] THE LOG IS THE SCALE CHANNEL: rescaling gives $\frac{1}{\pi} \ln \kappa$ and nothing else — matching the functional structure ($F_{U(1)}$ carries exactly ONE log term, the transport $8b_1 c_3^6 \ln(1/\varphi_{\text{seam}})$; the φ_0^{ret} split is log-free); [C] reading: log = diagonal/scale channel, log-free = contact data at the KMS point. [E] CLOSED-FORM RESUMMATION (BFK route, v151 class): the finite-rank mark determinant resums exactly, $\det(I - uC) = (1 - 4u)(1 + 2u)^2$ with $u = \varepsilon c_3 \ln 2$ — all orders; the linear term is ABSENT precisely because the diagonal vanishes ($\text{Tr } C = 0$); the series matches v484’s $\text{Tr}(C^k) = 4^k + 2(-2)^k$. [E] WEIGHT DICHOTOMY: the SAME $48 = 3 \times 16$ admissible states carry BOTH multiplicities — flat count $48 = \Omega_{\text{adm}}$ (the φ_0^{ret} puncture) vs $Y^2/\text{loop}/\text{GUT-weighted } 41 = 10b_1 = 40 + 1$ ($\text{Tr}_{16} Y^2 = \frac{10}{3}$ exact, $\nu^c = 0$; Ginsparg $(3/5)(41/6) = 41/10$, v470) — one state set, two response weights. [C]/[O] CONSEQUENCE: with v484 EVERY finite/computable piece of the merged ALPHA.QUILLEN + PHIO.PUNCTURE target is proven; the single remaining [O] is the identification of the abstract seam ζ-det with this glued mark determinant — a face of SEAM.EQUIV.01, exactly the v382 typing, now substantiated computationally. No gate closes. Exact (sympy + 30-digit mpmath + exact charge sums); Python-only by nature. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v486_transfer_full_rule.py	HYP.REWRITE.02: the FULL physical transfer spectrum $\{1, (2/3)^6, (1/3)^6\}$ (v54/v221) from ONE forced local rule — the lazy $\mathbb{Z}_2$-pair walk; the $(1/3)^6$ mode, previously generator-less, gets its local-rule origin (sharpens v327, whose uniform rule produces $\{1, \frac{2}{3}, 0\}$ and can never generate the third mode). [E] UNIQUENESS: for $M(s, h) = \begin{pmatrix} 1 & 0 & 0 \\ 0 & s & h \\ 0 & h & s \end{pmatrix}$ (one absorbing family channel + SYMMETRIC $\mathbb{Z}_2$ pair) the survival spectrum is $\{s+h, s-h\}$; demanding the physical pair $\{\frac{2}{3}, \frac{1}{3}\}$ forces UNIQUELY (stay, hop, leak) $= (\frac{1}{2}, \frac{1}{6}, \frac{1}{3}) = (1/ \mathbb{Z}_2 , 1/(\mathbb{Z}_2 N_{\text{fam}}), 1/N_{\text{fam}})$ — atom form recorded (honest direction: spectrum $\rightarrow$ rates). [E] SIX-HAND GENERATION: over the order-6 $= 2N_{\text{fam}} = R^+(A_3)$ hand, $\text{eig}(B^6) = \{\frac{64}{729}, \frac{1}{729}\}$ exactly; decay gaps $6 \ln \frac{3}{2}$ (the recovery gap, v76) and $6 \ln 3$ (the subdominant gap, now generator-full). [E] SUPERSESSION: the uniform rule's zero mode persists under every power — no iterate reaches $(1/3)^6$; its λ_2 arity story ($\frac{2}{3} = \mathbb{Z}_2 /N_{\text{fam}}$) is unchanged. [E] sub-stochastic, symmetric (detailed balance), absorbing democratic attractor unchanged (v317). [O] the arity $\{2, 3\}$ stays the anchor input; the lazy-vs-uniform split is SELECTED by the physical spectrum, not yet first-principles-derived (named candidate: stay $= 1/ \mathbb{Z}_2$ as the sheet-symmetric choice of the $\mathbb{Z}_2$ involution). Exact (sympy); mirrorable, deferred to the next verified engine run. [E][O]
v487_transfer_clock_rungs.py	HYP.REWRITE.03: the lazy split $(\frac{1}{2}, \frac{1}{6})$ is FORCED by the resummed clock — the v486 [O] 'split selection' closes onto v124 structure; sharpens HYP.REWRITE.02, no gate closes. [E] RUNG READING: the lazy rule's one-step spectrum is EXACTLY the complete clock ladder below the wall, $\text{eig}(M) = \{1 - n/3 : n = 0, 1, 2\} = \{1, \frac{2}{3}, \frac{1}{3}\}$; v327's uniform rule puts its second pair mode ON the wall ($0 = 1 - 3/3$) — the degeneracy re-read as 'odd channel collapsed to the wall'. [E] DECK PARITY = RUNG INDEX: $[B, \sigma] = 0$; the σ-even pair mode carries rung $n = 1$ (survival $\frac{2}{3}$), the σ-odd mode rung $n = 2$ (survival $\frac{1}{3}$) — each clock step flips the deck parity; the structural home of the v486 parity assignment (ω_1 even-channel, ω_2 odd-channel). [E] FORCING: faithful ladder (no rung missing, no physical mode on the wall — definitional for a full-spectrum generator) + $\mathbb{Z}_2$ equivariance + rates ≥ 0 force UNIQUELY both the split $(\frac{1}{2}, \frac{1}{6})$ AND the assignment even $\rightarrow$ rung 1, odd $\rightarrow$ rung 2 (the swap needs $h = -\frac{1}{6} < 0$); the 'sheet-symmetric choice' candidate is superseded by this proof. [E] BEND COROLLARY: $\omega_1/\omega_2 = \text{rate}(2)/\text{rate}(1) = \log_{3/2} 3$ — the parity-comb tone ratio IS the v107/v124 bend of the pulsar-clock search. [O] the channel count $3 = N_{\text{fam}}$ is forced by the clock wall; the ladder stays an exact identity on frozen spectra (semiclassical derivation R1 open); the arity $\{2, 3\}$ stays the anchor input. Exact (sympy); mirrorable, deferred to the next verified engine run. [E][O]

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Script	What it machine-checks (<i>continued</i>)
v488_majorana_clebsch_door.py	FLAV.NUSCALE.04: the 3/5 CLEBSCH DOOR of the seesaw rung, ENUMERATED AND CLOSED — v482's named escape (a third-generation Majorana factor $r \approx 1.6696$, 0.18% from $g_{\text{car}}/N_{\text{fam}} = 5/3$) is decided NEGATIVE at the group-theory level; the v481 window candidate stands as the honest endpoint. [E] NO RENORMALISABLE CHANNEL: $\text{sym}^2(\mathbf{16}) = 136 = \mathbf{10} + \mathbf{126}$; the $\overline{\mathbf{126}}$ is NOT in the E_8 hull $\{1, 10, 16, 45\}$ (v247) — M_R only via the $d=5$ operator $(\mathbf{16}_F \overline{\mathbf{16}}_H)^2/\Lambda$ with the E_8-allowed $\mathbf{16}_H$. [E] CHANNEL LIST: $\mathbf{16} \times \overline{\mathbf{16}} = \mathbf{1} + \mathbf{45} + \mathbf{210}$; the hull admits singlet + $\mathbf{45}$ insertions ($\mathbf{210}$ absent). [E] CHARGE TABLE: $Y = T_{3R} + (B-L)/2$ on all 16 states, $\text{Tr}_{16} Y^2 = \frac{10}{3}$ (v485); $(B-L, T_{3R}, Y)(\nu^c) = (+1, -\frac{1}{2}, 0)$. [E] THE $\{2, 3\}$-SMOOTH THEOREM: every nonzero ν^c channel weight $\{1, \frac{1}{4}, 1, -\frac{1}{2}, \frac{3}{8}\}$ is $\{2, 3\}$-smooth and the multiplicative closure of $\{2, 3\}$-smooth rationals never contains $\frac{5}{3}$; the UNIQUE natural 5 of the embedding, $k_Y = \text{Tr} Y^2 / \text{Tr} T_{3L}^2 = \frac{5}{3}$ (Ginsparg, v470), is a full-multiplet trace whose direction has $Y(\nu^c) = 0$ EXACTLY — structurally decoupled from the Majorana operator. [E] GENERATION-BLINDNESS: the Clebsch is a family-space scalar; $\text{diag}(1, 1, \frac{3}{5})$ cannot arise from group theory. [O] compiler-flavor inventory typed and declined: exact $\frac{3}{5}$'s only in wrong slots (K lepton gen2/gen1; $R + L$ lepton gen3/gen2), no degenerate-base shape, no M_R link (v354/v355). Exact (Fraction/sympy); mirrorable, deferred to the next verified engine run. [E][O]
v489_seam_modular_commutator.py	SEAM.CCC.01: the chiral central charge $c_- = 8$ measured DIRECTLY from the bulk ground state of the v367 seam lattice model, via the Kim–Shehab–Kim modular commutator $J(A, B, C) = i \text{Tr}(\rho_{ABC}[K_{AB}, K_{BC}]) = (\pi/3) c_-$ on a 120° pie tripartition (PRL 128 (2022)) — the FIRST ground-state witness for premise (i) of SEAM.EQUIV.01 ($c_- = 8$) INDEPENDENT of both the Chern route (v367 FHS curvature) and the counting route (v378 KLM/det-Cartan): J is read off the entanglement data of the exact BdG ground state alone (Peschel covariance, $W = -2 \text{artanh } \Gamma$). [E] GROUND-STATE PURITY: $\text{eig}(i\Gamma) = \pm 1$ to 6×10^{-15}. [E] PER-LAYER $c_- = \frac{1}{2}$: $c_- = 0.499998$ at $L=32, R=12$ (0.499793 at $L=16 \rightarrow 0.500000$ at $L=48$, dev -1.8×10^{-7}). [E] CONTROLS: trivial $M=3 \rightarrow 0.000000$; orientation flip $M=-1 \rightarrow -0.499986$. [E] LAYER ADDITIVITY EXACT (1.4×10^{-14}): J additive over decoupled layers, so the carrier value is $16 \times$ the per-layer value. [E] 16-LAYER CARRIER $c_- = 8 = g_{\text{car}} + N_{\text{fam}}$: direct 16-layer run 7.9967 ($L=16$, tol 10^{-2}; $L=24$ gives 7.999781), additivity route 8.0000 (tol 10^{-3}). [E] CLIP INVARIANCE: $\varepsilon = 10^{-8}$ vs 10^{-12} moves c_- by 5×10^{-8}. [O] HONEST FENCE: pins $c_- = 8$ on the LATTICE ground state (third independent witness); does NOT close SEAM.EQUIV.01 — the continuum scaling limit (MMST v336) stays [O], the μ_4 condensation $SO(16)_1 \rightarrow (E_8)_1$ stays the cited KLM step (v378). Numerical (numpy), Python-only by nature. [E][O]

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Script	What it machine-checks (<i>continued</i>)
v490_seam_parity_census.py	SEAM.MU.01: the T^2 spin-structure fermion-parity census for the v367 seam lattice model — the lattice ground-state witness of “$\mu_{\text{pre}}=4$ before condensation” (step 1 of the v378 KLM chain) + the 16-fold-way bridge $\theta_v=1$ with the MEASURED $\nu=2c_-=16$ (v489). Ground-state parity per boundary-condition sector (AA, AP, PA, PP), determined TWICE: Read–Green TRIM product AND real-space Majorana Pfaffian sign (Schur), relative to the trivial $M=3$ phase. [E] REAL-SPACE = BLOCH SANITY: twisted spectra match to 9×10^{-15}. [E] PER-LAYER CENSUS (+, +, +, -): TRIM $\equiv$ Pfaffian in every sector — 3 even sectors, the $\nu=1$ Ising signature. [E] 16 LAYERS $\Rightarrow \mu_{\text{pre}}=4$: parity¹⁶=+ in ALL four sectors $\Rightarrow$ gauged torus $\text{GSD}=4=\mu(SO(16)_1)= \det \text{Cartan}(D_8)$. [E] 16-FOLD-WAY BRIDGE: $\theta_v=e^{2\pi i\nu/16}=1$ EXACTLY at $\nu=2c_-=16$ (vortex bosonic, condensable); rivals $\nu=1, 2, 8$ excluded (not holomorphically condensable). [E] NON-DISCRIMINATOR FENCE: the fermionic Kitaev–Preskill TEE is identically zero — $\gamma_f=0.000001$ ($M=1$) and 0.000000 ($M=3$) — an invertible fermionic phase has no TEE, so γ_f does NOT discriminate $(E_8)_1$ vs $SO(16)_1$ (both live only after gauging). [C] the KLM step $\mu_{\text{post}}=4/2^2=1$ stays cited (the condensed model is interacting); the numerics pin only $\{c_-=8, \mu_{\text{pre}}=4, \theta_v=1\}$ — the premise package of the condensation. [O] the continuum limit (MMST v336); SEAM.EQUIV.01 stays [O]. Python (numpy + scipy Schur + sympy exact θ_v). [E][C][O]
v491_p2_partition_corollary.py	P2.PARTITION.01: $g_{\text{car}}=5$ as a COROLLARY of the four marks — the partition sharpening of v53 (sympy exact, no floats). THE LEMMA: a multiset of exactly 3 POSITIVE INTEGERS summing to 4 is unique — $\{1, 1, 2\}$ — so $e=(e_1, e_2, e_3)=(4, 5, 2)$ and $g_{\text{car}}=e_2=5$, $\mathbb{Z}_2 =e_3=2$, $N_{\text{fam}}=e_2-e_3=3$ are COROLLARIES, not inputs; consistency closes as a fixed point $((2^4-1)/5=3=\text{rank } H^1=\#\text{marks}-1)$. NEGATIVE CONTROLS (every assumption load-bearing): drop positivity $\rightarrow 4$ solutions, e_2 ambiguous $\{0, 3, 4, 5\}$; sum 3 $\rightarrow e_2=3$; sum 5 $\rightarrow$ not unique; 2/4 parts $\rightarrow e_2 \in \{3, 4\}/\{6\}$; Mehta–Seshadri RATIONAL weights $\rightarrow e_2=\frac{16}{3}$ resp. $\frac{44}{9} \neq 5$ (integrality comes from the Birkhoff–Grothendieck SPLITTING-TYPE typing, not from MS weights). [E] v53 SHARPENING: v53 needs all three targets (4, 5, 2); the partition needs only $e_1=4$ — same unique $\{1, 1, 2\}$. [E] SUM RULE: $4 \times \frac{N-1}{2}=4$ iff $N=3$; the v115 route $a _1= \mu_4 \text{tr}(A_0)=4$. INDEPENDENCE CHAIN: $\#\text{marks}=4$ from v216 (P1-side, no g_{car} input); rank $H^1=3$ pure topology (v137/v228); $a _1=4$ g_{car}-free (par-deg-0/(U), v115). [C] HONEST RESIDUAL: P2 is NOT made axiom-free — the weight-TYPING postulate remains (integrality = splitting exponents; positivity = $h^0=0$, correlate v137 check 1; sum rule “given (U)”); AX.P2.01 stays a declared axiom; the N_{fam} direction reversal vs tfpt_constants is typed as an over-determination check, never double-counted. Exact (sympy); Wolfram-mirrored. [E][C]

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Script	What it machine-checks (<i>continued</i>)
v492_celestial_z4_orbifold.py	CELEST.WP1.01: WP1 of the celestial-holographic research contract CELEST.SEAM.01 — the E_8 μ_4-glue grading (v128) IS the flat $\mathbb{Z}_4$ monodromy of the glue-equivariant celestial chiral algebra on the A_3 ALE space $\mathbb{C}^2/\mathbb{Z}_4$ (Bittleston–Homans–Sharma, arXiv:2305.09451, the $\mathbb{Z}_2$/Eguchi–Hanson case; Kronheimer–Nakajima flat connection at infinity). Sympy exact. [E] INNER GRADING: $h=(2, 2, 2, 2, 2; 0^4)$ reads the glue class mod 4 on all 240 roots $\Rightarrow$ glue $= \text{Ad}(\exp(2\pi i h/4))$, an order-4 torus element $=$ flat $\mathbb{Z}_4$ monodromy; the A_3-side detector $h'=(0^5; 1, 1, 1, -3)$ reads the SAME class $=$ the diagonal $(1, 1)$ of the discriminant group $\mathbb{Z}_4 \times \mathbb{Z}_4$ (the v92/v125 Lagrangian glue); $\mathbb{Z}_2$ halfway $120 = \dim SO(16)$, $128 = \text{spinor}$. [E] $\mathbb{C}^2/\mathbb{Z}_4$ IS the A_3 singularity $XY=Z^4$ (Molien table exact; Hilbert series $(1+t^4)/((1-t^2)(1-t^4))$; conjugation symmetry $N[d][1]=N[d][3]$). [E] EQUIVARIANT SECTOR CLOSES: $D[d]=60(d+1)$ even / $64(d+1)$ odd — uniform per parity ONLY because $\dim \mathfrak{g}_j=(60, 64, 60, 64)$; zero modes $(d=0) = \mathfrak{g}_0 = \text{carrier } D_5 \oplus A_3 + \text{Cartan} = 60$; density $62/248=1/4=1/ \mathbb{Z}_4$; $\text{EH}/\mathbb{Z}_2$ halfway towers $120/128$. [E] CHARACTER: $\Theta_{E_8} = \sum_j \Theta_{C_j}$; shell $1 = (52, 64, 60, 64)$ from the LATTICE; the 4 sector characters Θ_{C_j}/η^8 sum exactly to $\chi_{(E_8)_1} = 1 + 248q + 4124q^2 + 34752q^3$ (v377); sector weights $h_{D_5}=(0, \frac{5}{8}, \frac{1}{2}, \frac{5}{8})$, $h_{A_3}=(0, \frac{3}{8}, \frac{1}{2}, \frac{3}{8})$ = the v92/v125 discriminant form $(5x^2+3y^2)/8 \bmod 1$; glue diagonal $h=(0, 1, 1, 1)$ INTEGER = v125 isotropy = local extension to $(E_8)_1$. [E] CRITICAL CORRECTION: the A_3 deck $\text{diag}(i, i^{-1})$ acts on the celestial sphere as $z \mapsto -z$ (projective order 2, the sheet flip), NOT as the order-4 clock $z \mapsto iz$; the clock is the $U(2)$ phase $\text{diag}(i, 1)$ (order 4, fixed $\{0, \infty\}$, free μ_4 orbit — all v180 properties; normalises the deck, $\det=i$ rotates the holomorphic symplectic form by the μ_4 generator); exact spin bridge $(\text{spin clock})^2 = \text{deck}$, spin group $\mathbb{Z}_8$, $8=2 \mu_4$ (the $c_3=1/(8\pi)$ winding integer). [E] clock-invariant A_3 deformation = the 1-parameter family $XY=Z^4+a_0$; its 4 branch points are ONE μ_4 orbit with cross-ratio 2 (v179 clock orbit; v168/v214 pillowcase $j=1728$). [E] NEGATIVE CONTROLS: false spatial action $\text{diag}(i, i)$ killed three ways ($\det=-1 \notin SL(2, \mathbb{C})$; Poisson closure fails 14/14; grades unsymmetric); false glue breaks additivity on 3112/6720 root pairs; rigidity: only $\text{Aut}(\mathbb{Z}_4)$ relabelings additive. [C] VERDICT B: match under the ONE named identification $\text{clock}^2=\text{deck}$ on the sphere (sheet-$\mathbb{Z}_2$ spin bookkeeping). [O] structural arithmetic ONLY — no celestial duality constructed; CELEST.SEAM.01 (WP2–WP5) stays a research contract; SEAM.EQUIV.01 stays [O], untouched. Exact (sympy). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v493_celestial_ wp2_clock_ deformation.py	CELEST.WP2.01: WP2 of the celestial-holographic research contract CELEST.SEAM.01 — the clock-invariant deformation $XY=Z^4+a_0$ of the A_3 seam orbifold: geometry, periods/monodromy, deformed algebra (Bittleston–Homans–Sharma $\mathbb{Z}_2 \rightarrow \mathbb{Z}_4$ transfer, arXiv:2305.09451). Sympy exact. [E] GEOMETRY: $P(iZ)=P(Z)$ forces $a_3=a_2=a_1=0$ SHARPLY (two-sided: $\prod_k (Z - i^k w) = Z^4 - w^4$); smooth iff $a_0 \neq 0$ (disc = $256 a_0^3$); branch points $Z^4 = -a_0 =$ ONE free μ_4 orbit in every fibre; cross-ratio $2 / j = 1728$ for ALL a_0 (binary-quartic invariants $I=12a_0$, $J=0$ identically) $\Rightarrow a_0$ is a PURE SCALE, the $\tau=i$ pillowcase (v168/v214) is FROZEN — no shape modulus. [E] PERIODS: $\Pi=t(i-1)(1, i, i^2)$, all 3 vanishing spheres carry the SAME volume $\sqrt{2}t$ (lockstep); the clock on H_2 is a COXETER element of $W(A_3)$ (char x^3+x^2+x+1, eigenvalues $\{i, -1, -i\}$ = the A_3 exponents 1, 2, 3; $h(A_3)=4= \mu_4 =N_{\text{fam}}+1$); NO invariant cycle ($\det(A-1)=-4$); the surviving direction is the weight-1 χ_1-Fourier diagonal $(1, i, i^2)$, NOT the naive invariant diagonal; the clock IS the Picard–Lefschetz monodromy of the family ($a_0 \rightarrow e^{2\pi i} a_0$ gives the 4-cycle); versal weights $(a_3, a_2, a_1, a_0) = (1, 2, 3, 0)$ = the REGULAR μ_4 representation, invariant line = a_0 alone. [E] ALGEBRA ($\mathbb{Z}_2 \rightarrow \mathbb{Z}_4$): mode dictionary $\{w[m, n] : m \equiv n \pmod{4}\} \leftrightarrow \{X^p Y^q Z^r : r \leq 3\}$; bracket $\{f, g\} = -4 \text{Nambu}(XY - Z^4 - a_0)$ anchored at the $a_0=0$ orbifold w-sector $(\{X, Y\}=16Z^3, \{Y, Z\}=-4Y, \{Z, X\}=-4X)$, Jacobi + Casimir exact, uniform clock-degree -1; S-algebra corrections exactly LINEAR in a_0 at the $\mathbb{Z}_4$ wrap $r+r' \geq 4$, grade-conserving (NO sector leak $\Rightarrow$ the v492 equivariant SDYM(E_8) sector deforms consistently); $a_0 \leftrightarrow$ the BHS c^2 slot (weight 0); matrix factorisations (McKay modules) deform along every 1+3 and 2+2 orbit splitting; the clock fixes exactly the antipodal 2+2 sector (the EH/$\mathbb{Z}_2$ middle node, $4=2 \times 2$). [E] NEGATIVE CONTROLS: $a_1 Z \Rightarrow j=0$ (hexagonal CM point); pure $a_2 Z^2$ stays SINGULAR (A_1 node); $a_2 \neq 0 \Rightarrow j=1556068/81 \neq 1728$ (exact instance, two routes agree); grading leak explicit ($Z^2 \cdot Z^2$ picks up grades $\{0, 1, 2\}$). [C] three NAMED identifications (verdict B, not A): $-4 \text{Nambu} = \text{THE } k=4 \text{ CCA bracket}$ (BHS prove $k=2$); period = root difference (A-series residue normalisation); the seam-scale reading of a_0 presupposes the WP1 bridge clock²=deck ($\mathbb{Z}_8$, $8=2 \mu_4$). [C] v216 PRECISION (typed, NO marker move): given the order-4 clock, the clock-invariant deformation freezes the $(2, 2, 2, 2)$ modulus to the square AUTOMATICALLY — a relocation of the same order-4 input (the clock IS the carrier input), not a new derivation; v216 stays [O]. [O] full deformed twisted-sector OPEs, the $W(\mu)$-type scaling limit for $k=4$, the spacetime splitting-function check, WP3–WP5; SEAM.EQUIV.01 stays [O], untouched. Exact (sympy). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v494_cosmo_running_mu_record.py	COSMO.RUNNING.01/COSMO.MUDIST.01: the two 2026-07-20 prediction-of-record rows promoted to the suite — the SAME Starobinsky branch as n_s, r, A_s (v7/v28/v86) read one derivative deeper and one observable further. [E] LO IDENTITIES (sympy exact): $\alpha_s = dn_s/d \ln k = -2/N_*^2 = -r/6$, $\beta_s = -4/N_*^3$ (NOT $-8/N_*^3$); LO band $N_* \in [50, 60]$: $[-8.0, -5.6] \times 10^{-4}$. [E] EXACT SLOW ROLL (third-order Lyth–Riotto + finite-difference cross-check $< 1\%$): $\alpha_s(51.4) = -7.09 \times 10^{-4}$, $\beta_s(51.4) = -2.70 \times 10^{-5}$; exact band edges $-7.48/ -5.23 \times 10^{-4}$. [C] DATA: Planck 2018 (-0.0045 ± 0.0067) $\rightarrow +0.57\sigma$; record leg P-ACT-LB ($+0.0062 \pm 0.0052$) $\rightarrow -1.33\sigma$ (watch channel: positive central value); β_s run+runrun $\rightarrow -0.77\sigma$. KILL: robust $\alpha_s < -5 \times 10^{-3}$ or $> +3 \times 10^{-3}$ at $\geq 5\sigma$; any robust POSITIVE running kills the plateau branch. [C] μ-DISTORTION (Chluba window, +21% calibrated on the ΛCDM anchor): sharp branch $N_* = 51.4$ ($A_s = 1.76 \times 10^{-9}$) $\mu = 1.6 \times 10^{-8}$; profiled record $N_* = 56.1$ $\mu = 1.94 \times 10^{-8}$; band $1.5\text{--}2.3 \times 10^{-8}$; branch split $\Delta\mu = 3.0 \times 10^{-9}$ (ratio 1.23) $\Rightarrow \geq 3\sigma$ A_s/N_* branch decision at $\sigma(\mu) = 10^{-9}$ (Voyage-2050 class); the PIXIE baseline 9×10^{-8} does NOT reach ($0.18 \times$ limit). KILL: robust $\mu < 0.9 \times 10^{-8}$ or $> 4 \times 10^{-8}$. [E] COMB BLINDNESS (honest S15): the frozen log-comb ($\omega = 2.5827$, $\varepsilon = 0.0173$) is structurally invisible in the μ window — $F(\omega) = 0.033$, $\delta\mu = 7.4 \times 10^{-12} = 0.007\sigma$ even at Voyage-2050. [O] FENCES: N_* stays an external reheating input (GATE.NSTAR.01); the frozen band $[50, 60]$ stays the surface of record. Python (sympy exact LO + numpy SR/quadrature), Python-only by nature. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v495_celestial_wp3_ gs_alignment.py	CELEST.WP3.01: WP3 of the celestial-holographic research contract CELEST.SEAM.01 — the Green–Schwarz axion coefficient λ_g of celestial/twistorial SDYM (Costello, arXiv:2111.08879) against the TFPT seam constant $c_3=1/(8\pi)$; the pre-registered “alignment test only”. Exact (Fraction/sympy, no floats). [E] OKUBO IDENTITY DERIVED, NOT QUOTED: $\sum_{\alpha} \langle \alpha, x \rangle^4 = \frac{5}{2(\dim \mathfrak{g}+2)} (\sum_{\alpha} \langle \alpha, x \rangle^2)^2$ as an exact POLYNOMIAL identity for ALL 8 algebras on Costello’s list ($\mathfrak{sl}_2, \mathfrak{sl}_3, \mathfrak{g}_2, \mathfrak{so}_8, \mathfrak{f}_4, \mathfrak{e}_6, \mathfrak{e}_7, \mathfrak{e}_8$; $\mathfrak{e}_6/\mathfrak{e}_7$ carved out of the v492 E_8 root set) — “no independent quartic Casimir”; NEGATIVE CONTROL: $\mathfrak{sl}_4$ (which HAS one) fails the proportionality (5/32 vs 3/32) — the list is sharp. [E] Killing $\sum_{\alpha} \langle \alpha, x \rangle^2 = 2h^{\vee} \langle x, x \rangle$ exact; Deligne dimension formula $\dim \mathfrak{g} = 2(5h^{\vee}-6)(h^{\vee}+1)/(h^{\vee}+6)$; closed form $\tilde{\lambda}^2 = 10h^{\vee 2}/(\dim +2) = h^{\vee}+6$ EXACTLY (8, 9, 10, 12, 15, 18, 24, 36) — fixes Costello–Paquette eq. (1.5); Dynkin indices $i_R = (1, 1, 2, 2, 6, 6, 12, 60)$ from explicit weight systems; E_8: $\tilde{\lambda}=6$, $\lambda_{\text{fund}}=1/10$ EXACT; cross-checks $\mathfrak{sl}_2=8$, $\mathfrak{sl}_3=9$; SO8 SLIP FLAGGED: Costello’s own weight content gives $\lambda^2(\mathfrak{so}_8)=3$ (Okubo-consistent 12/4), the printed 3/2 is a factor-2 slip. [E] ALIGNMENT: $\kappa = \lambda_g/(8\pi\sqrt{3}) \Rightarrow (\kappa/c_3)^2 = \lambda^2/3 = 12 = \mu_4 N_{\text{fam}}$ (unit-trace) resp. 1/300 (adjoint-trace), both EXACT anchor rationals; κ/c_3 ITSELF is IRRATIONAL ($2\sqrt{3}$ resp. $1/(10\sqrt{3})$) — the pre-registered “$\lambda/\sqrt{3}$ rational?” reading FAILS, only the SQUARED alignment holds; anchor decomposition $h^{\vee}=30= \mathbb{Z}_2 N_{\text{fam}}g_{\text{car}}$ (all three atoms once), $\varphi(30)=8=\text{rank}$, $\dim +2=250=2 \cdot 5^3$, $\tilde{\lambda}=6= \mathbb{Z}_2 N_{\text{fam}}$, $\lambda_{\text{fund}}=1/(\mathbb{Z}_2 g_{\text{car}})$. [E] LOOK-ELSEWHERE (the HARD FENCE — alignment $\neq$ selection): the alignment test AS SUCH passes 8/8 (ZERO selective power), $\{2, 3, 5\}$-smoothness 8/8, $\tilde{\lambda}$-integrality 2/8 (shared with $\mathfrak{sl}_3$), $\varphi(h^{\vee})=\text{rank}$ 4/8; the ONLY $\mathfrak{e}_8$-selective single test is $g_{\text{car}}=5 \mid h^{\vee}$ (1/8); the isolating conjunction was assembled POST HOC — it quantifies where $\mathfrak{e}_8$ sits, it is NOT a preregistered discriminator. [E] KILL-TEST K3 does NOT fire (exact alignment EXISTS) but its scope is DEMOTED: the c_3-connection survives as convention-level compatibility + genuine λ-arithmetic, NOT as $\mathfrak{e}_8$-selective evidence. [C] TYPED: the 8π is the 2π convention of the anomaly polynomial (Costello’s A.0.10 constant descended to spacetime), the $\sqrt{3}$ the box diagram’s $\sqrt{48} = 4\sqrt{3}$ — WP3 is an alignment yes/no ONLY, it can never derive c_3 from celestial data (contract wording, honoured). [O] WP5 (constructive holography) and SEAM.EQUIV.01 stay [O], untouched. Verdict B. Exact (Fraction + sympy). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v496_celestial_ wp4_character_ shadow.py	CELEST.WP4.01: WP4 of the celestial-holographic research contract CELEST.SEAM.01 — the $(E_8)_1$ character E_4/η^8 against the glue-equivariant $E_8[\mathbb{C}^2]$ S-algebra: the contract’s “type mismatch, head-on”. Exact integer/Fraction/sympy, no floats. [E] BASE: v492 replication $(240 = 52+64+60+64, \text{dims with Cartan } (60, 64, 60, 64))$; equivariant tower $D[d] = 60(d+1)$ even / $64(d+1)$ odd; cumulative generator count QUADRATIC — $\sum_{d \leq s} D[d] = 31s^2 + 92s + 60$ (even) with leading $31 = k + h^\vee$ (the Sugawara denominator, an arithmetic note); [C] CP Table 1 (arXiv:2201.02595): $J[m, n]$ carries 2d spin $1 - (m+n)/2$, UNBOUNDED BELOW along the tower $\Rightarrow$ no rational VOA (L_0 bounded below) contains the towers as graded pieces. [E] HILBERT SERIES: $\chi_{\text{sp}}(t) = (60+128t+60t^2)/(1-t^2)^2$ (palindromic numerator, value 248 at $t=1$); ALL μ_4 collapses $w \in \{1, -1, i, -i\}$ and the $SU(2)_+$ primary slice $(60+64t)/(1-t^2)$ fail to start $(1, 248, \dots)$ — the “row sum” route fails at the first coefficient. [E] CHARACTER SIDE: $\chi_{(E_8)_1} = E_4/\eta^8 = (1, 248, 4124, 34752, 213126, 1057504, 4530744)$ exact through q^6 (machinery cross-check $qj = E_4^3/\eta^{24} = (1, 744, 196884, 21493760)$); theta split (shell $1 = (52, 64, 60, 64)$), sector currents $(60, 64, 60, 64)$, glue-diagonal $h = (0, 1, 1, 1)$ INTEGER (v125 isotropy = locality); Sugawara $c = 248/31 = 8 = 2 \mu_4 = g_{\text{car}} + N_{\text{fam}}$. [E] BRIDGES: zero-mode slice $D[0]=60=$ the C_0-sector current count EXACTLY; the single-line jet slice z_1^d cycles $(60, 64, 60, 64)$ sector by sector; BOUNDARY/PERIOD LIMIT: one full μ_4 period of loop energies carries $\dim \mathfrak{g}_{n \bmod 4} = (64, 60, 64, 60)$, sum = 248 EXACTLY — the single-particle level of the $248q$ stage; 248 is NOT a jet-tower dimension ($d \leq 100$) — only the period collapse produces it; BUT the loop Fock at integer level 1 counts $897266 \gg 248$: the rational truncation is NOT in the jet/loop algebra. [E] MISMATCH LOCALISED THREE WAYS: (a) GRADING (spin unbounded below; 248 no tower dimension); (b) GROWTH: jet Fock $f = (1, 128, 8436, \dots)$ vs $\chi = (1, 248, 4124, \dots)$ TWO-SIDED ($f_1 < \chi_1$ undercount, $f_2 > \chi_2$ overcount), f_n/χ_n strictly increasing $n = 1..12$; Meinardus poles $s=2$ vs $s=1 \Rightarrow$ growth exponents $n^{2/3}$ vs $n^{1/2}$, asymptotically DISJOINT; (c) TRUNCATION: the level-2 null ideal deletes EXACTLY $27000 = 30^3 = (h^\vee)^3$ ($\text{Sym}^2(248) = 1+3875+27000$ [[C] standard]; the character keeps $4124 = 1+248+3875$) — NO analogue in the jet algebra (level 1 agrees: $248 = 248$). [E] KILL-TEST K4, three-way: (i) exact realisation NO; (ii) boundary-limit realisation PARTIAL YES — current stratum, period sum 248, integer glue weights and theta split hold exactly; the missing piece is precisely the rational truncation, which must come from a scaling/compactification limit — the SAME structure as the MMST scaling-limit route of SEAM.EQUIV.01 (v336/v449: the rational net exists in the LIMIT of the lattice collar, not in the pre-limit algebra); (iii) the hard mismatch is exactly located; K4 does NOT degrade the contract to “E_8 admissible” (the sector arithmetic holds exactly). [C] VERDICT B(ii): the $(E_8)_1$ character is a BOUNDARY/LIMIT SHADOW of the equivariant S-algebra, not a conformal block of it in the bulk grading — WP4 sharpens into a statement of SEAM.EQUIV.01 type. [O] the constructive boundary limit itself (which limit, which topology, convergence) stays OPEN and belongs to WP5/SEAM.EQUIV.01; SEAM.EQUIV.01 stays [O], untouched. Exact (integer/Fraction/sympy). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v497_celestial_ wp5a_null_ideal.py	CELEST.WP5A.01: WP5a of the celestial-holographic research contract CELEST.SEAM.01 — “the null ideal from the limit”, the first constructive milestone of WP5 (the v496 boundary-limit shadow made precise). Exact integer/Fraction arithmetic, no floats. [E] BASE: v492/v496 replication (glue dims (60, 64, 60, 64), equivariant tower $D[d]$, $\chi_{(E_8)_1} = E_4/\eta^8$ exact through q^6, μ_4 period sum 248). [E] STABILISATION THEOREM: a one-parameter family χ_w of graded Fock characters on the CHIRAL jet generators (loop energy m, radial number r; $E_w = m + wr$ in quarter units $u = q^{1/4}$; $w=2$ IS the chiral jet grading (generator counts 64, 120, 128, 180, 192, 240, 256, 300 per degree); the u^n coefficient of χ_w equals the quarter-moded loop Fock for ALL $w \geq n+1$ and is STRICTLY larger for every $w \leq n$ ($n \leq 8$, $w \leq 10$): the boundary reading is the precise coefficientwise limit $\varepsilon = 1/w \rightarrow 0$ with explicit threshold $w = n+1$ — a limit of a series, not a slice; convention clarified: 897266 is the quarter-moded loop Fock at $u^4 = \text{INTEGER level 1}$ (v496). [E] NULL IDEAL DERIVED, NOT CITED: Freudenthal multiplicities (unit-tested on the adjoint) + Weyl dimension formula + generic character peeling in the standard E_8 frame DERIVE $\text{Sym}^2(248) = V(2\theta) \oplus V(\omega) \oplus V(0) = 27000 + 3875 + 1$ (peeling residual exactly zero; independent Weyl-orbit cross-check); $27000 = 30^3 = (h^\vee)^3$ exactly; $C_2 = (124, 96, 0)$, Dynkin indices 6750/750; level-1 integrability $\langle 2\theta, \theta^\vee \rangle = 4$, $\langle \omega, \theta^\vee \rangle = 2 \Rightarrow$ the only level-1 primary is the vacuum ([C] Kac, used through its counting consequence); level-2 quotient $31124 - 27000 = 4124 = 1 + 248 + 3875$ EXACTLY. [E] TWO ROUTES, ONE NUMBER: the μ_4 theta-split sector characters summed at $q^2 = (1036, 1024, 1040, 1024)$ give the SAME 4124 — the independent lattice route hits the Fock quotient exactly; at q^3: $34752 = \chi_3$. [E] NEGATIVE CONTROLS: $SO(16)_1$ through the SAME pipeline — $\text{Sym}^2(120) = 5304 + 1820 + 135 + 1$ derived (FOUR components vs E_8’s three), $5304 \neq 14^3 = 2744$ (the $h^\vee{}^3$ identity is NOT generic), quotient $7380 - 5304 = 2076 = \Theta_{D_8}/\eta^8$ at q^2 (the pipeline validated on a second algebra), block weights $(0, \frac{1}{2}, 1, 1)$ do NOT fuse into one local character (four-block theory) vs E_8’s integer $(0, 1, 1, 1)$; false periodisation: only $P = 4 = \mu_4$ gives 248 ($P=1: 64$, $P=2: 124$, $P=8: 496$); swapped glue breaks the zero-mode anchor ($64 \neq 60$). [C] named identifications: “radial decoupling = MMST collar thickness $\rightarrow 0$” (the v336/v449 lattice-collar route has the same two-step shape), not a computed isomorphism; the Kac singular vector only via its counting consequence. [O] HONEST LIMIT: the limit does NOT generate the truncation — the singular vector as an OPERATOR in the limit net stays open (WP5b); the GNS limit state (kernel $\supseteq$ ideal) and local normality / Haag duality of the limit net stay open (WP5c/WP5d); the celestial route now has the SAME two-step shape as MMST (limit + maximal ideal), with the ideal quantitatively fixed; SEAM.EQUIV.01 stays [O], untouched. Exact (integer + Fraction). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v498_celestial_ wp5b_singular_ vector.py	CELEST.WP5B.01: WP5b of the celestial-holographic research contract CELEST.SEAM.01 — “the singular vector as an operator”, the second constructive milestone of WP5 (v497 fixed the ideal’s size and location; WP5b constructs the deleting object). Exact integer/Fraction arithmetic, no floats, deterministic. [E] CONSTRUCTION: $s\rangle = (E_{-1}^\theta)^2 0\rangle$, θ the highest root, weight 2θ (the top of the 27000), level 2 = 8 quarter units = q^2 (an INTEGER level); the Chevalley/Frenkel–Kac basis is MACHINE-built (bimultiplicative 2-cocycle, asymmetry on all 57600 pairs; the $[e_\alpha, e_{-\alpha}]$ sign FORCED by Jacobi, $\text{SGN} = -1$; κ DERIVED from invariance, $\kappa(\theta^\vee, \theta^\vee) = 2$; Jacobi exact on all 57600 $\mathfrak{sl}_2$-slice triples + 6000 seeded + all 496 θ-adjacent; all $N_{\alpha\beta} = \pm 1$). [E] SINGULARITY: $J_1^a s\rangle = 0$ for ALL 248 basis elements (0 violations); case tally 190 (first bracket) / 57 (second) / 1 ($a = F^\theta$ via the central-term cancellation — the ONLY case that sees the level k); plus $J_2^a s\rangle = 0$ (248), $E_0^a s\rangle = 0$ (120 positive roots), Shapovalov norm 0 at $k=1$ (4 at $k=2$); the affine PBW engine unit-tested on all 61504 basis pairs. [E] LEVEL DIAL: the F_1^θ coefficient is $2(1-k) - 2$ at $k=0$, 0 EXACTLY at $k=1$, -2 at $k=2$: without the central extension the deletion object does NOT exist. [E] μ_4 DATA: θ-grading dims $(1, 56, 134, 56, 1)$, $\mathfrak{g}_0 = \mathfrak{e}_7 \oplus \mathfrak{u}(1)$; the h-adapted chamber machine-built (Cartan det 1, E_8 Dynkin diagram, branch lengths $[1, 2, 4]$); $\langle \theta, h \rangle = 5 \Rightarrow j(\theta) = 1$, height $29 = h^\vee - 1$; $s\rangle$ in class 2 (sheet-EVEN, consistent with WP5a); clock phase $i^2 = -1$; cross-table θ-grading $\times$ glue class consistent (rows $(1, 56, 126, 56, 1)$, columns $(52, 64, 60, 64)$); the deleting θ-$\mathfrak{sl}_2$ crosses the sheet-ODD classes $(1, 3)$, its square is sheet-even. [E] LEVEL-2 MATCH: $\text{mult}(2\theta) = 1$ in the level-2 Fock $\Rightarrow U(\mathfrak{g}) s\rangle$ is THE 27000; the direct $\mathfrak{g}_0$-orbit BFS reproduces the Freudenthal multiplicities of $V(2\theta)$ EXACTLY through depth 4; quotient $31124 - 27000 = 4124$; lattice reading $(2\theta, 2\theta)/2 = 4 > 2 \Rightarrow$ no momentum-2θ state at q^2 in $E_4/\eta^8 - s\rangle$ IS the kernel generator of Fock $\rightarrow E_4/\eta^8$. [E] NEGATIVE CONTROLS: $E_{-1}^\theta 0\rangle$ NOT singular (one witness $F^\theta, \rightarrow -k 0\rangle$) — the 248-current state that must REMAIN ($\chi_1 = 248$); 4 generic level-2 states non-singular (14–33 witnesses); k-dial: at $k=2$ the CUBE is singular (the $(E^\theta)^{k+1}$ mechanism = generic Kac level mechanics); $D_8/SO(16)_1$: the singular vector exists there TOO (level-1 generic) but the $h = \frac{1}{2}$ blocks do not fuse (3 comark-1 weights, $\dim V(2\theta_{D_8}) = 5304 \neq 14^3$) vs E_8 (comarks ≥ 2, vacuum the ONLY level-1 primary, glue weights $(0, 1, 1, 1)$ integer) — the ONE-BLOCK closure is the E_8/μ_4-specific part, honestly separated from the generic singular-vector mechanics. [C] Weyl complete reducibility beyond BFS depth 4; the Kac mechanics beyond level 2; the per-period quarter dictionary (v496). [O] HONEST LIMIT: in the twisted quarter-SLOT moding of the χ_w limit Fock two sector-C_1 modes never sum to 8 quarters (minimum $6 = q^{3/2}$) — the per-PERIOD dictionary (v496), not the per-slot identification, carries $s\rangle$ to q^2; exactly the precise WP5c question (GNS limit state, kernel $\supseteq$ ideal); WP5c-e stay [O]; SEAM.EQUIV.01 stays [O], untouched. Exact (integer + Fraction). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v499_p2_weights_ deligne_bg.py	P2.TYPING.01: the P2 weight-typing postulate HARDENED (the v491 check-9 residual) — the anchor $a=(1,1,2)$ typed as the Birkhoff–Grothendieck splitting exponents of the DELIGNE CANONICAL EXTENSION E of the flavor connection; sympy exact, no floats. Given the [E] anchors (4 marks v216, rank 3 v137, cusp class + irreducibility v117, (U)): $\deg E = -4$ AS A THEOREM (cusp class $\Rightarrow$ canonical residue exponents $\{0, \frac{1}{3}, \frac{2}{3}\}$, the unique lift in $[0,1]$; trace 1 per mark $\times$ 4 marks; par-deg 0; ∞ APPARENT, monodromy product = 1 exactly); POSITIVITY AS A THEOREM (irreducibility EXACT: $\langle U, M_0 \rangle = 24 = S_4$, $\sum_g \chi ^2 = 24$; with (U) $\Rightarrow$ Mehta–Seshadri stability $\Rightarrow h^0(E) = 0$, all 324 section-saturation cases; BG dictionary $h^0 = 0 \Leftrightarrow a_i \geq 1$); INTEGRALITY = Birkhoff–Grothendieck, automatic once E is typed as a bundle. UNIQUENESS + SELECTOR: $\{1,1,2\}$ unique (v491); the Schur–Horn permutohedron of $4 \cdot \text{spec}(A_0)$ has integer points exactly $\{(2,2,0), (2,1,1)\}$ (the two options of the “Global computation” theorem) and $h^0 = 0$ kills $\{0,2,2\}$ (an $\mathcal{O}(0)$ summand has $h^0 = 1$) — the “balanced” selection is now TYPED as stability/positivity. THE h^1 DISCREPANCY, REAL + RESOLVED: $h^1(\mathcal{O}(-2) \oplus \mathcal{O}(-1)^2) = 1 \neq 3$ — the naive “generations = $H^1(E)$” typing is FALSE (forcing it demands $\deg -6$ and loses uniqueness: $\{1,1,4\}, \{1,2,3\}, \{2,2,2\}, e_2$ never 5); the correct TWO-OBJECT typing: $L = \mathcal{O}(-D)$, $D = \mu_4$, carries the generations ($h^1(L) = 3 = N_{\text{fam}} \cong H^0(\Omega^1(\log D))$, the v137 basis), while E carries them as its FIBER (rank 3) with the anchor as splitting type. BISWAS EXPLICIT (independent convergence witness): the weight denominator is $3 = N_{\text{fam}}$, so the Biswas cover is the $\mathbb{Z}_3$ cusp cover $y^3 = (z-1)(z-i)(z+1)^2(z+i)^2$, genus 2 (NOT the pillowcase double $w^2 = z^4 - 1$, genus 1, $j=1728$ — the deck side); $p_* \mathcal{O}_Y = \mathcal{O} \oplus \mathcal{O}(-2)^2$ (χ cross-check $-1 = -1$); the regular-representation model bundle lands on $\{0,2,2\}$ = the UNSTABLE Schur–Horn companion ($h^0 = 1$): integrality AND the sum rule COME OUT of the correspondence, and stability (irreducibility, v117) is the selector. NEGATIVE CONTROLS: drop positivity $\rightarrow 4$ resp. 31 solutions; $\deg -3/-5$ breaks; n-mark scan: $\{1, \dots, 1, 2\}$ unique for EVERY $n \geq 3$ but $e_2 = (n-2)(n+1)/2 = 5$ ONLY at $n=4$ — the VALUE, not the uniqueness, is the $n=4$ content; MS-rational exponents $e_2 = \frac{16}{3}, \frac{44}{9}$. [C] RESIDUALS: R1 the module identification “generation space = this H^1 with this connection” [C] (QGEO.SYM territory, stays [O]); R2 unitarity (U) [C] (v33/v40); R3 the analytic-monodromy identification (fine type Numerical, v117 check 4). P2 stays an axiom (AX.P2.01 declared, no marker moves); NON-CIRCULAR: neither v23’s splitting-type input nor v115’s $\text{diag}(A_0) = a/4$ input is used. Sharpens v491. Exact (sympy); Wolfram-mirrored. [E][C]

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Script	What it machine-checks (<i>continued</i>)
v500_celestial_ wp5c_gns_limit_ state.py	CELEST.WP5C.01: WP5c of the celestial-holographic research contract CELEST.SEAM.01 — “the GNS limit state”, the third constructive milestone of WP5 (v497 made the boundary limit precise, v498 built the deleting operator; WP5c constructs the STATE whose GNS kernel contains the ideal). Exact integer/Fraction arithmetic, no floats, deterministic. [E] CONSTRUCTION: the quasi-free family ω_w — loop sector ($r=0$) = the affine $k=1$ vacuum n-point functions via the MACHINE-determined compact anti-involution $\theta(e_\alpha)=-e_{-\alpha}$, $\theta(h)=h$ (the UNIQUE sign that is an anti-automorphism on ALL 61504 basis pairs; contravariance $\langle J_{-1}^x u, v \rangle = \langle u, J_1^{\theta x} v \rangle$ exact); radial sector ($r \geq 1$) = oscillator pairings x^{wr} (the exact Gibbs regulator $e^{-\beta E_w}$, kept x-adic). [E] CONVERGENCE, SHARP: $\omega_w = \omega_\infty \bmod x^{N+1}$ for ALL $w \geq N+1$ ($N=8$) and NOT yet at $w=N$ (the $r=1$ modes sit at order N) — the WP5a threshold $w = n+1$ holds IDENTICALLY at the state level; positivity of every ω_w checked. [E] THE KERNEL (core, fully machine): the FULL exact level-2 Gram — 31124 monomials in 9361 weight blocks (dim profile 164:1, 37:240, 7:2160, 1:6960), every block exact: level-1 rank 248 POSITIVE DEFINITE (Cartan block = the E_8 Cartan matrix, det 1); level-2 rank 4124, kernel 27000, every block PSD; rank per Weyl orbit (norm 8/6/4/2/0) = (0, 0, 1, 8, 44); kernel = $V(2\theta)$ WEIGHT BY WEIGHT (Freudenthal cross-check on all 9361 weights); highest-weight norms (3844, 49, 2, 0) at $(0, \omega, \theta, 2\theta)$; direct ideal checks $F_i s\rangle$, $F_j F_i s\rangle$ norm 0. [E] μ_4-EQUIVARIANCE: $\omega_w \circ \text{clock} = \omega_w$ for ALL w; the clock unitary DESCENDS to $\text{GNS}(\omega_\infty)$; level-2 GNS rank split by clock class $= (1036, 1024, 1040, 1024) = \Theta_{C_j}/\eta^8$ at q^2 (the two-routes identity at the STATE level); level-1 split (60, 64, 60, 64). RESOLUTION OF WP5b S4.10: $s\rangle$ IS the ZERO VECTOR of $\text{GNS}(\omega_\infty)$ — the twisted two-C_1-mode floor (6 quarters $= q^{3/2}$) concerns only pre-limit objects (GNS has no state there: $6 \bmod 4 \neq 0$). [E] NEGATIVE CONTROLS: $k=2$ ($\langle s s \rangle = +4$, dominant blocks FULL rank — NO ideal in the kernel); $k=0$ (level-1 Gram $\equiv 0$ — no 248 layer without the central extension); $D_8/SO(16)_1$ (level-2 rank 2076 = 7380 – 5304, kernel $= V(2\theta_{D_8})$ PSD weight by weight, but $h = (0, \frac{1}{2}, 1, 1)$: the vacuum GNS is 1 of 4 blocks — ONE-BLOCK completeness stays E_8/μ_4-specific); wrong family $E'_w = mw+r$ (level-1 limit rank 0: the 248 layer ERASED, u^4 content $710955 \neq 248$); no damping ($897266 \neq 248$); CCR OBSTRUCTION: at a FIXED radial pairing $c > 0$ positivity forces $\omega(bb^*) \geq c$ — NO w-uniform damping state exists: the family formulation is NECESSARY and the family EXISTS $\Rightarrow$ the preregistered KILL is probed and NOT triggered. [C] the quasi-free/Gaussian extension to the full $*$-algebra; Kac positivity beyond level 2 (levels ≤ 2 machine-checked); the module identification in the component route. [O] local normality of ω_∞, the net structure / Haag duality (WP5d), Costello–Li (WP5e), the operator-algebraic closure beyond the graded/x-adic topology; SEAM.EQUIV.01 stays [O], untouched. VERDICT: SUCCESS on the preregistered criterion (dim GNS level-2 = 4124 exactly). Exact (integer + Fraction). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v501_celestial_ wp5d_two_interval_ index.py	CELEST.WP5D.01: WP5d-α of the celestial-holographic research contract CELEST.SEAM.01 — “the two-interval index from the lattice” (the local-net question, alpha stage). The roadmap discriminator: $(E_8)_1 \Rightarrow \mu=1$ (Haag-dual two-interval net, ONE sector); $SO(16)_1 \Rightarrow \mu=4$; preregistered KILL = “the two-interval μ-offset does NOT vanish after the condensation”. numpy/scipy Gaussian machinery + exact Fractions. [E] SETUP (machine identities): critical Majorana ring (v450 style, NS closure, $c=\frac{1}{2}$ per layer), 16 layers = the seam carrier $c_-=8=g_{\text{car}}+N_{\text{fam}}$ (v489); Peschel-exact; three prescriptions — fermionic ρ, orbifold sector sum $\{1, P_A, P_B, P_{AB}\}$, dual algebra $\{1, P_{AB}\}$; superselection $[\rho, P_{AB}]=0$ machine-exact; EVERY Gaussian formula validated against exact diagonalisation ($\leq 1.5 \times 10^{-15}$). [E] FERMIONIC MI EXTENSIVE (the $\mu=1$ reference; lattice witness): $I(x) = -(c/3) \ln(1-x)$ with c fitted 0.5000; $\max F(x) = 5.97 \times 10^{-5}$ at $N=512$, F falling monotonically to 1.3×10^{-6} at $N=1024$ — Casini–Huerta extensivity on the lattice. [E] THE μ-OFFSET (core): Rényi-2 exactly $\Delta_2 = -\ln[(1+R)/2]$; the 16-layer seam carrier saturates $\ln 2$ to MACHINE PRECISION ($\Delta_2 - \ln 2 = 1.1 \times 10^{-15}$ at $N=512$; $R \sim N^{-0.500}$); index reading $[F : F_{\text{even}}] = e^{\Delta_\infty} = 2.000000 \Rightarrow \mu_{\text{gauged}} = e^{2\Delta_\infty} = 4.000000 =$ the v490 parity census (TWO independent lattice witnesses); gauging every layer separately costs $16 \ln 2$ — the offset measures $\ln[\text{index of the subnet}]$, not a universal blob. [E] HAAG-DUALITY INDICATOR: fermionic $S(E)=S(E')$ to 8.2×10^{-12} (graded-duality proxy); the orbifold BREAKS complementarity ($D(E) - D(E') = 0.427$ at $a=64$ — the direct duality-failure witness); the complementary-pair sum is exchange-symmetric and $\leq \ln 4 = \ln \mu(SO(16)_1)$ with $\max 1.2637$ at the self-dual $x=\frac{1}{2}$ and $\rightarrow \ln 2$ at the squeezed ends: the $\ln 4$ KLM budget is a DOUBLE-LIMIT statement, NOT a fixed-x identity (the first naive fixed-x check was WRONG and was replaced — honestly typed). [E] CONDENSATION ARITHMETIC, LATTICE-ANCHORED: $\det \text{Cartan}(D_5) \cdot \det \text{Cartan}(A_3) = 4 \cdot 4 = 16 = \mu(\text{carrier})$; KLM/Longo–Rehren quotients $\mu/ L ^2$: $16/4^2 = 1$ (one-step μ_4 glue) and $16/2^2 = 4 \rightarrow 4/2^2 = 1$ (via $SO(16)_1$), both routes EXACT; Σd_i^2 cross-checks (Ising 4, $SO(16)_1$ 4, $(E_8)_1$ 1); $\theta_v = e^{2\pi i \nu/16} = 1$ EXACTLY at $\nu = 2c_- = 16$, rivals $\nu = 1, 2, 8$ give $\theta_v \neq 1$. The anchored chain: $\mu = 1$ (graded, MEASURED) $\rightarrow 4$ (gauged, MEASURED + v490 census) $\rightarrow 1$ (arithmetic, [C]: the condensed net is interacting — the v490 fence). [E] NEGATIVE CONTROLS: $\nu=1$ single Majorana (offset non-trivial, $\Delta_2 = 0.6364$ at $N=2048$ rising, and $\theta_v = e^{i\pi/8} \neq 1$: NOT removable — the kill discriminator has teeth); trivial dimerised phase (everything $\leq 10^{-7}$); wrong sector sum $\{1, P_{AB}\}$ (offset EXACTLY 0 instead of $\ln 2$). [C] the continuum dictionary “offset = $\ln$ index” (KLM two-interval index; Longo–Xu; Casini–Huerta–Magan–Pontello entropic order parameters) + the $\theta_v=1$ condensation step itself. [O] continuum Haag duality, local normality, split/strong additivity of the quotient net (WP5d-β, running as exploration), Costello–Li (WP5e); SEAM.EQUIV.01 stays [O], untouched. VERDICT: the $\mu=1$ indicator chain PASSES; the preregistered KILL is NOT triggered. Python (numpy + scipy + Fractions). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v502_celestial_ wp5e_prefactor_ level.py	CELEST.WP5E.ALPHA.01: WP5e-α of the celestial-holographic research contract CELEST.SEAM.01 — “prefactor and level bookkeeping”, the CFT-side anchor stage of WP5e (the BCOV/Costello–Li twistor uplift: boundary partition function $= E_4/\eta^8$ including the $q^{-1/3}$ prefactor; preregistered kill: the anomaly inflow demands a level $\neq 1$). Exact sympy/Fraction. [E] PART A — the $q^{-1/3}$ prefactor is exact μ_4 vacuum-energy bookkeeping; Hurwitz-ζ derivation ($\zeta(-1, \theta) = -B_2(\theta)/2$; $E_b(\theta) = -\frac{1}{24} + \theta(1 - \theta)/4$ exactly); the clock is INNER ($h = (2, 2, 2, 2, 2; 0^4)$ and the A_3 detector $h' = (0^5; 1, 1, 1, -3)$ both read the class mod 4 on all 240 roots; $(h, h) = 20$, $(h', h') = 12$, sum 32) $\Rightarrow$ twist distribution $\theta = 0^8$ in ALL four sectors — a SHIFT orbifold (lattice cosets, integer-moded oscillators), <i>not</i> a rotation orbifold; $E_{\text{osc}} = -\frac{1}{3} = -c/24$ sector-independent ($c = 8 = \text{rank} = 248/31$); sector ground exponents $-\frac{1}{3} + (0, 1, 1, 1)$. [E] discriminant form = Casimir energy, TWO routes: spectral flow $j^2(h, h)/32$ ($5j^2/8, 3j^2/8$, sum $j^2 \equiv 0 \pmod{1}$ = the isotropy/Lagrangian condition) and <i>exactly</i> via free fermions ($D_5 = 10$ Majorana, $A_3 = D_3 = 6$, glue diagonal $= 16 = 2^{g_{\text{car}}-1}$, the WP5d seam carrier; R–NS shift $n/16$: $\frac{5}{8}, \frac{3}{8}, 1$); the ROTATION reading fails (the geometric A_3 deck gives $\frac{3}{16} \neq \frac{3}{8}$: the v492 “clock $\neq$ deck” lesson at the Casimir level). [E] character: $\sum_j \Theta_{C_j} = E_4$ and the four sector characters (leading coefficients $(1, 64, 60, 64)$, currents $(60, 64, 60, 64)$) sum exactly to $E_4/\eta^8 = q^{-1/3}(1, 248, 4124, 34752)$. [E] PART B — $k = 1$ forced THREE independent ways: (i) the CURRENT condition $h(J) = k = 1$ (the $\mathbb{Z}_4$ extension closes onto the E_8 adjoint $60+64+60+64 = 248$ only at spin 1); HONEST SHARPENING: glue-h integrality $h(J^j; k) = k(0, 1, 1, 1)$ holds for ALL $k = 1..8$ — the originally conjectured integrality route fixes <i>nothing</i>, the three other dials carry; (ii) conformal embedding $47k^2 + 219k - 266 = 47(k-1)(k+266/47) = 0$ resp. D_8-in-E_8: $128k(1-k) = 0$; (iii) central charge $248k/(k+30) = 8 \Leftrightarrow 240(k-1) = 0$ (= the prefactor itself); plus the v498 singular-vector dial ($\ (E_{-1}^\theta)^m 0\ ^2 = m! k(k-1) \cdots (k-m+1)$, singular vector exactly at grade $k+1$; $k = 1$ deletes $V(2\theta)$: $31124 - 27000 = 4124$). [E] negative controls: $D_8/SO(16)_1$ (same rank, same $c = 8$, SAME $q^{-1/3}$ prefactor, but $h = (0, \frac{1}{2}, 1, 1)$: the discriminator is glue-h integrality, not the prefactor; $\Theta_{D_8} + \Theta_s = E_4$); $\mathbb{Z}_2$ rotation ($E = +\frac{1}{6}$, $h = \frac{1}{2}$: no μ_4-shift sector there); μ_4 rotation (sector-dependent $(-\frac{1}{3}, \frac{1}{24}, \frac{1}{6}, \frac{1}{24})$: the common prefactor breaks); wrong $k \in \{2, 3, 4\}$ fails all five dials coherently (residuals $360/814/1362$; $\langle s s \rangle = 4/12/24$; level-2 dim stays $31124 \neq 4124$). [C] Kac generation of the maximal submodule by the grade-$(k+1)$ singular vector for $k \geq 3$ ($k = 1, 2$ machine-anchored by WP5b/WP5c). [O] the BCOV/Costello–Li twistor inflow itself (Costello’s one-loop axion $\lambda_g/(8\pi\sqrt{3})$ on $\mathbb{P}^1$, the Costello–Paquette–Sharma level-from-flux mechanism) stays open — v502 anchors the CFT side of WP5e only (α stage); the kill branch (“inflow demands a level $\neq 1$”) is not triggered on the CFT side but its twistor side is untested; WP5e stays [O]; SEAM.EQUIV.01 untouched, no marker moves. Exact (sympy + Fraction). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v503_qgeo_ emergence_light.py	QGEO.EMERGE.LIGHT.01: the v215 <i>deferred emergence test</i> (lever 7) executed in its first honest LIGHT version, plus the residual-convergence result QGEO-R1 $\equiv$ P2-R1 (analysis/kill-test class; NO marker moves — QGEO.REALIZE.01 stays [C]/[O]). NO DYNAMICAL SELECTION (ζ-log-det via the Dedekind-η formula, mpmath 40 digits): $\log F = \log(\tau_2 \eta ^4)$ is exactly S-invariant, so $t = 1$ is automatically critical on the rectangular family $\tau = it$; there a strict local maximum ($g''(1) = -1.298$) but a <i>minimum</i> in the τ_1-direction ($h''(0) = +0.298$): $\tau = i$ is a SADDLE of the full moduli space; critical points = the CM points ($E_2^*(i) = E_2^*(\rho) = 0$ to 40 digits); the <i>global</i> det' winner at fixed area is the HEXAGONAL torus ($\log F(\rho) = -1.03352 > \log F(i) = -1.05469$; Osgood–Phillips–Sarnak 1988) — free-field dynamics alone does <i>not</i> select $\tau = i$; criticality at the square is Palais symmetric criticality (the independent heat trace is equally critical). SHARP RIGIDITY (v280 lattice DtN): the mod-4 off-character indicator (the v215-K3 lever as a <i>modulus function</i>) has an isolated zero (8×10^{-15}) exactly at $\tau = i$, strictly monotone in both directions (min 8.4×10^{-2} away); $R^2 = \mathbb{Z}_2$ exactly as permutation matrices (the v492 $\mathbb{Z}_8$ bridge on the lattice); $j(it) \geq 1728$ with equality only at $t = 1$, $j(\rho) = 0$. [E] the $\mathbb{Z}_2$ chain is MODULUS-BLIND: 4 fixed points and $[\mathbb{Z}_2, \Delta_t] = 0$ on <i>every</i> torus (v216 confirmed without mark input); pillowcase det' = $\frac{1}{2}$ torus det' exactly ($\pm$-pair structure), so all τ conclusions transfer verbatim; marks/mark-locality/deck² exist on <i>every</i> pillowcase (v264/v280), only the order-4 clock distinguishes $\tau = i$; $\text{Aut}(E_\rho) = \mathbb{Z}_6$ (element orders 1, 2, 3, 6) contains <i>no</i> order-4 element — dynamics and clock are logically independent selectors; GIVEN the clock, $P(iZ) = P(Z)$ forces $a_3 = a_2 = a_1 = 0$ and $j = 1728$ identically (v493): the modulus is not a second input. [C]/[O] RESIDUAL CONVERGENCE (the core finding): the order-4 element on H^1 is a Coxeter element of $W(A_3)$ (char poly $\lambda^3 + \lambda^2 + \lambda + 1$, order $h(A_3) = 4 = \mu_4 = N_{\text{fam}} + 1$) — exactly the P2 cusp-class/carrier datum of the P2 hardening (v499 R1) $\Rightarrow$ QGEO-R1 $\equiv$ P2-R1: ONE common residual, “why does the raw seam carry the order-4 clock”, not two scattered ones; chain: marks derived (v216 [E]), square derived <i>given</i> the clock (v493 [E]), clock = carrier input [C], rest = the dynamical realisation of the clock [O]; route classification (v347 analogue): B-rigidity in the sharpened form “RP seam data $\Rightarrow$ order-4 clock” is the live route — free dynamics alone does not deliver the clock (the hexagonal finding). Lever update (documented here, v215 itself unchanged): lever 7 lifted from “deferred, not executable” to “light version executed: rigidity, not dynamical selection”. Python (mpmath + numpy/scipy + sympy). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v504_celestial_ wp5d_klm_ completeness.py	CELEST.WP5DB.01: WP5d-β of the celestial-holographic research contract CELEST.SEAM.01 — “split + strong additivity from the lattice”, the two remaining Kawahigashi–Longo–Müger legs of complete rationality (the μ-index is v501), witnessed for the orbifold prescription on the critical Majorana seam edge; the $U(1)$/Dirac subnet is the preregistered negative control (the current net, where strong additivity fails in the continuum). [E] STRONG ADDITIVITY, EXACT: shared boundary Majorana $\Rightarrow$ Even(A) $\vee$ Even(B) = Even($A \cup B$) EXACTLY (GF2 spans full 64/64 up to 1024/1024; matrix rank 32/32); DISJOINT: exactly HALF (rank 16/32, index 2 — the missing odd $\otimes$ odd sector is the v501 $\ln 2$ bit, localised at the split point); the neutral $U(1)$ algebras do NOT generate the union even with the shared site (gaps 2/10/52, growing). [E] ENTROPIC WITNESS [N]: the fermionic touching MI carries the pure UV point-gap law $((c/3) \ln 2$ increments, dev 1.2×10^{-6} — no discriminator); the honest discriminator is BOUNDED vs DIVERGENT: the $\mathbb{Z}_2$/orbifold deficit stays $< \ln 2$ with $(\ln 2 - \Delta_2) \sim N^{-p}$, $p = 0.2444$ vs $2\Delta_\mu = \frac{1}{4}$ (Ising disorder dimension; “defect $\rightarrow 0$” would be FALSE at the sharp split — bounded $\Leftrightarrow$ finite index, Longo–Xu), while the $U(1)$ control BURSTS $\ln 2$ from $L = 128$ and grows as $\frac{1}{2} \ln \text{Var } Q_A$ (Klich–Levitov 0.10134 vs $1/\pi^2$): infinite index. [E] SPLIT/NUCLEARITY [N]: coupling σ_k fall at the elliptic-nome rate $\pi K(1-x)/K(x)$ to 1.3–2.0%; $\sigma_1 \sim x^{0.5044}$; trace norm summable; ORBIFOLD INHERITANCE EXACT: P_A flips $C \rightarrow -C$ (σ_k identical, 8.3×10^{-17}), the even-bilinear Gram is the compound $\Lambda^2 C$ ($\{\sigma_a \sigma_b\}$, 2.8×10^{-14}) — Longo heredity [C]. [E] PIMSNER–POPA: $E(a) - a/2 = PaP/2$ IDENTICALLY $\Rightarrow$ $\lambda = \frac{1}{2} = 1/[F : F_{\text{even}}]$; integer attainment (16384 + 2048 monomial sweeps, 0 violations; pencil min $\lambda = 0.5000000000$); $\lambda_{E_4} = \frac{1}{4} = 1/\mu$ exactly; INDEX CONSISTENCY, two routes: $e^{\Delta_\infty} = 2.0000000000 = 1/\lambda_{\text{PP}}$ and $e^{2\Delta_\infty} = 4 = \mu$; $U(1)$: $\lambda = 1/(m+1) \rightarrow 0$. [E] CONTROLS + HONESTY: dimerised phase trivial (3.6×10^{-15}); wrong prescription $\{1, P_{AB}\}$ deficit EXACTLY 0; finite-size honesty (14.9% below $\ln 2$ at $N = 4096$ — witness, not proof). [C] the KLM dictionary (Longo–Xu; Longo heredity; CHMP). [O] the continuum theorem “finite-group orbifolds of completely rational nets are completely rational” is XU’S THEOREM — CITED, NOT CLAIMED; the seam quotient net and the condensed $(E_8)_1$ net stay WP5e/Costello–Li; SEAM.EQUIV.01 stays [O]. VERDICT: with v501, all THREE KLM ingredients witnessed on the lattice. Python (numpy + scipy); exact parts Wolfram-mirrored. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v505_celestial_ wp5e_beta_ equivariant_ ledger.py	CELEST.WP5E.BETA.01: WP5e-β of the celestial-holographic research contract CELEST.SEAM.01 — “the equivariant anomaly ledger on twistor space”, the twistor-side milestone of WP5e (the BCOV/Costello–Li uplift; preregistered kill: the anomaly inflow demands a level $\neq 1$); WP5e-α (v502) anchored the CFT side. The Atiyah–Bott/Lefschetz fixed-point skeleton of the one-loop box anomaly (Costello; Bittleston–Sharma–Skinner) evaluated exactly on $\mathbb{C}^2/\mathbb{Z}_4$ with the E_8 μ_4-glue monodromy. Exact sympy/Fraction. [E] AB ledger: denominators $\det(1 - g_j^{-1}) = (2, 4, 2)$; $\sum_j 1/\det_j = 5/4 = (\mathbb{Z}_4 ^2 - 1)/12$ (Dedekind); equivariant characters $\mathrm{tr}_{g_j}(\mathrm{Ad} E_8) = (248, 0, -8, 0)$ by two routes; invariant average $60 =$ the $D_5 + A_3$ carrier; Frobenius 61568; $\mathrm{tr}_{g_2} = -8 = 120 - 128$. [E] Okubo per sector (honest sharpening): the invariant sector is exactly Okubo-quadratic ($Q^{(0)} = 36\langle x, x \rangle^2$, $36 = \tilde{\lambda}_{e_8}^2$ — v495 re-derived through the glue grading); the twisted sectors do NOT reduce ($T_5: (-8, 32, -8)$, $T_3: (48, -64, 48)$); the AB-weighted sum cancels the D_5 quartic exactly and leaves the RIGID residual $32T_3$; the only quartic-free weighting is the uniform $\mathbb{Z}_4$ projector; the graded GS exchange is exactly rank-obstructed in sectors 1, 2, 3; heterotic identities exact ($\mathrm{Tr}_{120}, \mathrm{Tr}_{128}, \mathrm{Tr}_{E_8} = 9(\mathrm{tr}^2)^2$). [E] index bridge (centrepiece): $f(m) = \frac{1}{4} \sum_j (i^{jm} - 1)/\det_j = (0, -\frac{3}{8}, -\frac{1}{2}, -\frac{3}{8}) = \mathrm{ch}_2(T_m) = -(C^{-1})_{mm}/2$ EXACTLY — fixed-point ledger = McKay/Kronheimer intersection ledger; glue ch_2 defect -78 by both routes (classes $(-24, -30, -24)$; $-30 = -h^\vee$, a [C] coincidence); $\sum_m h_{A_3}(m) = 5/4 = \sum_j 1/\det_j$; Killing sums $(320, 320, 240, 320)$, total $1200 = 2h^\vee(h, h)$. [E] $k = 1$ geometric: lattice current count = 240 at $k = 1$, exactly 0 at $k = 2, 3, 4$; embedding residual $47k^2 + 219k - 266 = (0, 360, 814, 1362)$; $h(J; k) = k$ integer for all k — integrality alone fixes nothing (honest, as v502); one scale $\Rightarrow$ one level (v493 periods). [E] E3 REFUTED (prominent): $a_0 \in O(8)$ fills the GRAVITON slot $O(2)$, not the BSS axion slot $O(-2)$ ($X = -2 \neq +2 = Y$; mismatch $4 = \mu_4$, a [C] coincidence) — “the theory brings its GS axion as a_0” is refuted; instead the three $H^2(\mathrm{ALE})$ classes carry exactly the Coxeter eigencharacters $\{i, -1, -i\}$ = the three twisted slots (bijection); slot count $1 + 3 = 4 = \mu_4$ soft. [E] negative controls: $\mathrm{diag}(i, i)$ breaks four ways ($\sum 1/\det = \frac{1}{4}$, ω-weight -1, 5 generators); $SO(16)$ glue: characters $(120, 0, +120, 0)$, defect $-30 \neq -78$, bulk Okubo fails (independent quartic Casimir); $k = 2$: count 0, prefactor $-31/48 \neq -\frac{1}{3}$. [C] dictionaries $(\mathrm{CS}(\rho) \bmod 1 = \text{discriminant weight}; 32 = (h, h) + (h', h'); -30 = -h^\vee; \Omega\text{-contraction})$. [O] the global BCOV/Kodaira–Spencer quantisation on $\mathbb{PT}/\mathbb{Z}_4$, the $O(-2)$ bulk-axion construction, CPS level-from-flux, the pairing of the $32T_3$ residual with the three sphere axions. Verdict B; the kill branch does NOT fire on the equivariant skeleton; SEAM.EQUIV.01 untouched, no marker moves. Exact (sympy + Fraction). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v506_seam_clock_rigidity.py	SEAM.CLOCK.RIGIDITY.01: clock rigidity, Route B of the v503 classification — two exact theorems reducing the order-4 clock input to ONE alignment bit (Part A Moebius + Part B Fock in one module; QGEO.REALIZE.01 stays [C]/[O], no marker moves). Exact sympy + exact Cl(16) Fractions. [E] THEOREM A (Moebius): the collar deck $z \mapsto -z$ has in $\text{PGL}_2(\mathbb{C})$ exactly TWO square roots ($z \mapsto \pm iz$), both automatically of order 4 (complete case analysis: $\text{tr} \neq 0 \Rightarrow$ diagonal $\Rightarrow a/d = \pm i$; $\text{tr} = 0$ impossible) — “order 4” is no longer an input; a marks-preserving root exists $\iff$ the deck is the CENTRAL involution of the mark-D_4 (center = {id, deck}, exactly 2 order-4 elements = the clocks) $\Rightarrow$ then marks = one μ_4 orbit, cross-ratio class $\{2, \frac{1}{2}, -1\}$, $j = 1728$, $\tau = i$, free 4-cycle, deck = clock², only the scale free; COUNTEREXAMPLE: $\{\pm 1, \pm(3+2\sqrt{2})\}$ is deck-free AND harmonic with full D_4, but the deck is non-central (edge involution) $\Rightarrow 0$ roots — harmonicity alone is NOT sufficient; the RP filter selects nothing ($\text{Aut}(\mathbb{Z}_4)$ ambiguity irreducible, consistent with v492). [E] B3/B4: free orbit $\Rightarrow n \mid 4$; mark transitivity $\Rightarrow n = 4$; faithfulness kills $n \geq 5$; $n = 3$ fixes a mark; $n = 6$ dies at cusp degree 3 (v117); the deck is modulus-blind (v503 B5 exact); controls: $n = 8$ impossible; hexagonal A_4 (0 order-4 elements, squares only $\{1, 3\}$); generic V_4 (exponent 2); stabiliser trichotomy $V_4/D_4/A_4$ with order-4 counts (0, 2, 0). [E] THEOREM B (Fock, the core result): the unique S^2 spin structure gives NS on every circle (established P1 datum); one-particle $D^2 = -1$ (charpoly $(\lambda^2+1)^8$), quarter-shift $C^2 = D$, $C^8 = 1$ (charpoly $(\lambda^4+1)^4$); Fock: $\tilde{U} = \prod_j (1 - \gamma_j \gamma_{j+8})$, $\tilde{U}^2 = 256 \gamma_1 \cdots \gamma_{16} \Rightarrow U^2 = (-1)^F$ EXACTLY, and $(cU)^2 = c^2(-1)^F$ is never 1 (center of Cl(16) = scalars) — the $\mathbb{Z}_4$ lift is FORCED (nonsplit extension); $\mathbb{Z}_8$ tower: $V^2 \propto \tilde{U}$, $V^4 \propto (-1)^F$, projective order $8 = 2 \mu_4$ — fermionically explained; R control $U_R^2 = +1$ (split — the forcing rests on NS = established geometry); 16-fold way $\theta_v = 1$ at $\nu = 16$; the forcing already holds at 8 sites. [C] THE ONE REST: “the collar deck is the central involution of the mark-D_4” ($\iff$ square-root existence on the mark data) — ONE alignment bit; the fermionic $\mathbb{Z}_4$ forces the ORDER, not the spatial alignment. No overclaim. Exact (sympy + Cl(16) Fractions). [E][C]

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Script	What it machine-checks (<i>continued</i>)
v507_seam_bit_origin.py	SEAM.BIT.ORIGIN.01: the tautology attack on the v506 alignment bit, executed and refuted — where do the marks AND the deck come from, and does their common origin force the central alignment? (Part A torus origin + Part B fermion dichotomy in one module; NO marker moves — the bit stays [C], SEAM.CLOCK.RIGIDITY.01 and QGEO.REALIZE.01 text-precised only.) Exact sympy + exact Cl(16) Fractions. [E] ORIGIN THEOREM: the 4 marks are the fixed points of the hyperelliptic involution $w \mapsto -w$ on $\mathbb{C}/(\mathbb{Z} + \tau\mathbb{Z}) =$ the four half-periods $\Lambda/2\Lambda$; a translation t_c descends to the base sphere iff $2c \in \Lambda$ — exactly the THREE half-period translations (control $c = 1/3$ fails); the descended maps are the EXPLICIT rational involutions $\sigma_i(x) = e_i + (e_i - e_j)(e_i - e_k)/(x - e_i)$ with the exact curve-lift identity $\prod(\sigma_i - e_l) = \psi_i^2 \prod(x - e_l)$, ψ_i RATIONAL; $\{\text{id}, \sigma_1, \sigma_2, \sigma_3\} =$ Klein V_4; CONVERSELY, in ALL three stabiliser types the freely-acting involutions are EXACTLY the three σ_c (generic V_4 (4, 3, 3), harmonic D_4 (8, 5, 3), hexagonal A_4 (12, 3, 3)) $\Rightarrow$ EVERY mark-free collar deck (v216) IS a half-period translation — the CLASS of the deck is forced, its POSITION is not. [E] CORE SOLVE (symbolic λ): σ_c admits a marks-preserving PGL_2 square root $\iff \lambda \in \{-1\}(\sigma_1), \{2\}(\sigma_2), \{\frac{1}{2}\}(\sigma_3)$ — per half-period exactly ONE solution; intrinsically: the two deck pairs separate each other HARMONICALLY (pair cross-ratio = -1); union over $c =$ the harmonic orbit $\{-1, 2, \frac{1}{2}\} \iff j = 1728 \iff \tau = i$; generic modulus: V_4 abelian, ALL σ_c central and yet clockless (“central alone is empty” — the bit is the CONJUNCTION D_4 AND central); at $\tau = i$ the stabiliser jumps to D_4 with σ_1 central (2 roots = the clock pair) and σ_2/σ_3 edge-type (0 roots); the v506 seam deck $z \mapsto -z$ lands on the central $\sigma_1 = -1/x$ under ALL 8 mark bijections; CM DICTIONARY: mult-by-i fixes exactly ONE nonzero half-period $c^* = (1 + \tau)/2$ (mult-by-ρ 3-cycles all three); the clock lift needs the CM unit i ($\psi = 2i/(x + 1)^2$, $t^2 + 1$ irreducible over $\mathbb{Q}$) while half-period decks lift RATIONALLY: the clock root exists only WITH CM by $\mathbb{Z}[i] \iff \tau = i$. [E] EQUIVALENCE TETRAD + CIRCULARITY AUDIT: clock exists $\iff (\tau = i$ AND deck = the CM-fixed half-period) $\iff (\text{Stab} = D_4$ AND deck central) $\iff$ deck pairs harmonic $\iff$ the NS Fock lift is NONSPLIT; the v493 converse independently re-verified — two converses of ONE equivalence, no circularity. [E] FERMION DICHOTOMY (the new physical face): central arrangement (shift by 8): $\tilde{U}^2 = 256 \gamma_1 \cdots \gamma_{16} \Rightarrow U^2 = (-1)^F$, nonsplit $\mathbb{Z}_4$, 2 roots in the 32-element dihedral lift (the $\mathbb{Z}_8$ tower); edge arrangement (reflection $j \mapsto 4 - j$, fixed sites = non-marks = the silver $\{0, \infty\}$): the implementer EXISTS but $\tilde{U}_e^2 = +2^7 \cdot \mathbf{1} \Rightarrow U^2 = +1$, the extension SPLITS, 0 roots, no $\mathbb{Z}_8$; one-particle $(\lambda^2 + 1)^8$ vs $(\lambda^2 - 1)^8$; census: all 28 shift-invariant 4-sets cross, all 21 reflection-invariant do not; robust at 8 sites — the bit IS a physical extension class (Fidkowski–Kitaev-type), distinguished but not derived. [E] SILVER PLACEMENT: $\{\pm 1, \pm(3 + 2\sqrt{2})\} =$ “$\tau = i$ with deck = a non-CM-fixed half-period translation” (all 8 bijections $\rightarrow \sigma_2/\sigma_3$, never σ_1) — in-family witness against the tautology. [C] THE REST: the one alignment bit remains a carrier datum; no tautology — the origin forces the CLASS of the deck, not its POSITION. Exact (sympy + Cl(16) Fractions). [E][C]

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Script	What it machine-checks (<i>continued</i>)
v508_celestial_ wp5e_gamma_ pairing.py	CELEST.WP5E.GAMMA.01: WP5e-γ of the celestial-holographic research contract CELEST.SEAM.01 — “the sphere-axion pairing check”, an honest rigid NEGATIVE result: can the three twisted sphere axions η_m (Coxeter eigencharacters $\{i, -1, -i\}$ on $H^2(\text{ALE})$, v505 S5.8) cancel the rigid $32 T_3$ residual of the Atiyah–Bott ledger ($A_{\text{fix}} = 9P_1 - 30P_2 - 15P_3 + 32T_3$, v505) by Green–Schwarz-type EXCHANGE with sector-compatible quadratic vertices? NO, with certificate. Exact sympy/Fraction. [E] VERTEX-SPACE THEOREM: the $W(D_5) \times W(A_3)$-invariant quadratics on the 8-dim glue Cartan are EXACTLY $\text{span}\{s_5, s_3\}$ (dim 2, bidegree dims (1, 0, 1)), the quartics EXACTLY $\text{span}\{P_1, P_2, P_3, T_5, T_3\}$ (dim 5, bidegree dims (2, 0, 1, 0, 2)) — Weyl nullspace arithmetic over all bidegrees, basis COMPLETE; PRODUCT THEOREM (the master kill): $(as_5 + bs_3)(cs_5 + ds_3) = acP_1 + (ad + bc)P_2 + bdP_3$ identically — zero T_5/T_3 content, so EVERY exchange image (any axion count, any selection rule, any couplings) is annihilated by Φ_{T_3}, while $\Phi_{T_3}(A_{\text{fix}}) = 32 \neq 0$. [E] SELECTION ENUMERATION: the strict two-index reading COLLAPSES ($C_{j,j'} \neq 0$ only for $j' = -j$, so the rule forces $m = 0$ — the sphere axions have NO invariant bilinear Cartan vertex at all); twist insertion: $\eta_1 \leftrightarrow K^{(3)}$, $\eta_2 \leftrightarrow K^{(2)}$, $\eta_3 \leftrightarrow K^{(1)}$, $\eta_0 \leftrightarrow K^{(0)}$; channels $E_{13} = (16, -96, 144, 0, 0)$, $E_{22} = (16, 32, 16, 0, 0)$, $E_{00} = 225 E_{22}$; SIDE DISCOVERY: $K^{(0)} = -15 K^{(2)}$ (the even-sector quadratics are PARALLEL). [E] UNSOLVABILITY WITH CERTIFICATE (the core result): exchange matrix 5×2, rank 2, kernel 0; $\text{rank}([M A_{\text{fix}}]) = 3$; annihilator certificate $(\Phi_{T_5}, \Phi_{T_3}, \Phi_P)(A_{\text{fix}}) = (0, 32, 72)$ with $A_{\text{fix}} = (9, -30, -15, 0, 32)$ — two independent obstructions ($32 T_3$ structural, rule-independent + $\Phi_P = 72$ rule-driven via the $K^{(0)} \parallel K^{(2)}$ collapse); $\ker M = 0$ forces the unique non-disturbing coupling $c = 0$: the sphere axions are RIGIDLY SILENT in the exchange ansatz; $\Phi_P(Q^{(0)}) = 0$ (the v505 sector-0 mechanism undisturbed); relaxed control: dropping charge conservation reaches the P-block ($\det = -64$) but $T_5 = T_3 = 0$ persists. [E] NATURALNESS RESOLUTION: ch_2-natural $(9/64, 1/4)$ and AB-weight $(1/2, 1/4)$ couplings both carry certificate $(0, 0)$ vs required $(32, 72)$ — the failure is scale- and coupling-INDEPENDENT (no “unnatural factor”: the ansatz space misses the target identically). [E] NEGATIVE CONTROLS: invariant axion only = v505 replication + sharpening; flipped rule $m+j-j'$: the Φ_{T_3} kill is flip-invariant, Φ_P is rule-dependent; $SO(16)$: odd classes EMPTY and the AB sum $(15, -18, -15, -4, 40)$ does not even cancel T_5 (E_8 doubly special); D_8: $16 T_8 + 12 s_8^2$, no T_3 structure — the question cannot even be posed. [C] number fences: $32 = (h, h) + (h', h') = 20 + 12$; $72 = 2\tilde{\lambda}_{e_8}^2$. [O] SHARPENED FENCE: the exchange sub-branch is DEAD; the $32 T_3$ residual MUST be carried by twisted BCOV contact terms — binary criterion WP5e-δ_1: the one-loop coefficient on $\mathbb{C}^2/\mathbb{Z}_4$ must come out exactly $(9, -30, -15, 0, 32)$, COMPUTED, not fitted; named escape WP5e-δ_2: the full-tensor ledger (the collapse is Cartan-restricted); slot bijection (v505 S5.8) untouched; the preregistered level-kill still does NOT fire; SEAM.EQUIV.01 stays [O], no marker moves. Exact (sympy + Fraction). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v509_celestial_ wp5e_eps2_level_ from_flux.py	CELEST.WP5E.EPS2.01: WP5e-ε_2 of the celestial-holographic research contract CELEST.SEAM.01 — “the CPS level-from-flux dial”, executed (verdict B): derive the boundary level $k = 1$ from flux quantisation on the lockstep spheres, following the Costello–Paquette–Sharma (CPS) Burns-holography mechanism (PRL 130, 061602; arXiv:2306.00940). Exact sympy/Fraction, no floats. [E] CPS SKELETON REPLICATED EXACTLY: the S^3 period $\int \Omega_N = (2\pi i)^2 N$ (pullback density $-\sin 2\theta$, their eq. 3.33); the exceptional-sphere Kähler flux $\int_{\mathbb{P}^1} \omega = 2\pi N$; the boundary level magnitude $2N$ via the symplectic-boson double contraction ($N = 1, 2, 3$), Dynkin normalisation $T(\text{vector}) = 1$ — “level = flux quantum $\times$ Dynkin index”. [E] PAIRING MATRIX PINNED, NOT POSTULATED: the v505 ch₂ ledger + integrality + unimodularity + effectivity pin $P_{mi} = c_1(T_m) \cdot [\Sigma_i] = \delta_{mi}$ by COMPLETE enumeration (row candidates 8/6/8; 48 unimodular solutions of $PC^{-1}P^T = C^{-1}$; with $P \geq 0$ exactly 2 = {identity, A_3 diagram flip}); glue FLUXES $F_i = (64, 60, 64) = \dim \mathfrak{g}_i$, total 188 = 248 – 60, flip-invariant; flux per charged root current uniformly ONE quantum. [E] LEVEL FORMULA, honest: “level = total open-string flux” is KILLED by the lockstep test itself ($k_i = (64, 60, 64)$ unequal = the FLAVOUR multiplicity); what works: $k = \text{flux per adjoint current} = F_i / \dim \mathfrak{g}_i = (1, 1, 1)$, anchored by the lattice current count (240, 0, 0, 0) for $k = 1..4$ and the embedding index $j(D_5 \subset E_8) = j(A_3 \subset E_8) = 1$ ($60 = 2h^\vee$). ORD-4-VS-LEVEL-1 RESOLVED: the clock order counts FRACTIONAL flux sectors — $\mu = \det(D_5) \det(A_3) = 16 = \text{ord}^2$, the μ_4 glue diagonal isotropic + Lagrangian, KLM $16 \rightarrow 16/4^2 = 1$ (zero residual fractional flux); NEW DIAL: $\#\text{primaries}((E_8)_k) = (1, 3, 5, 10, 15, 27)$ for $k = 1..6$ from the affine marks — exactly ONE sector iff $k = 1$. [E] LOCKSTEP THEOREM (the lifting of v505 “one scale $\Rightarrow$ one level” to a THEOREM): clock invariance forces $a_3 = a_2 = a_1 = 0$, one μ_4 orbit of branch points, $\Pi_j = \sqrt{2}t$ EQUAL on all three spheres, monodromy = the pure phase i, $\det(A - 1) = -4$: no invariant flux vector — $k_1 = k_2 = k_3$ IS A THEOREM; NEGATIVE PROBE (new falsifier): the clock-forbidden family $Z^4 - Z$ (disc -27, branch points $\{0, 1, \omega, \omega^2\}$ not a μ_4 orbit): 0/24 orderings lockstep; HONEST LIMIT: uniform flux doubling keeps the lockstep — EQUALITY, not the value (1 from the current/sector counters and the minimal quantum $N = 1$). [E] NEGATIVE CONTROLS: $k = 2$ (count 0, residual 360, prefactor $-31/48$, $\#\text{prim}$ 3 — the lockstep dial honestly does NOT fire); $SO(16)$ (fluxes (0, 60, 0): spheres flux-dark, condensation stops at $4 = \det \text{Cartan}(D_8)$); A_2 ($\mu = 12$ not a perfect square: NO Lagrangian glue, Coxeter $3 \neq 4$). [C] the CPS dictionary itself on $\mathbb{P}T/\mathbb{Z}_4$ (their geometry is the $\mathbb{C}^2$ blow-up with ONE (-1)-sphere and $\mathfrak{so}(8)$ at negative level — not the A_3 ALE). [O] the type-I B-model backreaction on $\mathbb{P}T/\mathbb{Z}_4$ (the A_3 Ω_N) — the same fence as v502/v505; SEAM.EQUIV.01 untouched; no marker moves. Exact (sympy + Fraction). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v510_seam_bit_freedom.py	SEAM.BIT.FREEDOM.01: the freedom attack on the v506/v507 alignment bit — the POSITION half of the bit is topology (Part A dihedral/Fock + Part B Moebius/RP in one module; NO marker moves — the modulus datum stays [C]). Exact sympy + exact Cl(16) Fractions, no floats. [E] DIHEDRAL THEOREM: on the N-site seam circle the free involution is UNIQUE = the antipode ($N = 16$: 17 involutions in D_{16}, exactly 1 free = shift 8; all 16 reflections have exactly 2 circle fixed points; robustness $N = 8, 12$); the census is COMPLETE: $\text{Aut}(C_{16}) = D_{16}$ exactly (brute force over all $8!$ permutations at $N = 8$, propagation at $N = 16$); $N = 9$ control: ZERO free involutions (even carrier count, consistent with $16 = 2^{g_{\text{car}}-1}$); QUOTIENT TOPOLOGY (the P1 tie): circle/antipode = CIRCLE ($\chi = 0$, closed), circle/reflection = INTERVAL ($\chi = 1$, two corners) — the $6\pi = 2\pi + 2\pi + 2\pi$ Gauss–Bonnet budget counts three CLOSED circles, so “the deck is free on the seam circle” IS the established P1 datum “the seam is a closed circle”, not a new premise. [E] NONSPLIT $\iff$ FREE (complete census, exact Cl(16)): ALL 17 involutions implemented — the free one’s NS lift squares to $256 \gamma_1 \cdots \gamma_{16} = (-1)^F$ (nonsplit, 2 roots = the $\mathbb{Z}_8$ clock tower); ALL 16 reflections have $U^2 = \text{SCALAR}$ (2^7 site-, 2^8 edge-axis; split, 0 roots); chain: free $\Rightarrow$ shift 8 $\Rightarrow$ crossing (all 28 invariant 4-sets) $\Rightarrow$ central class $\Rightarrow$ the edge/silver arrangement is EXCLUDED; Klein control (covering decks are free regardless of the gluing); branch control: the pillowcase involution has exactly 4 fixed points = the marks and restricts to a REFLECTION on invariant circles — the edge class IS the BRANCHED involution’s restriction: silver mistakes the mark-creating branch $\mathbb{Z}_2$ for the seam deck. [E] REAL-STRUCTURE CLASSIFICATION: the deck-commuting antiholomorphic involutions of $\mathbb{P}^1$ are EXACTLY two families — $\mu\bar{z}$, $\mu = 1$ (fix LINE through the deck poles $\{0, \infty\}$: deck NOT free) and $\mu/\bar{z}$, $\mu > 0$ (fix circle $z = \sqrt{\mu}$ avoiding the poles: deck FREE; $\mu < 0$: empty); per configuration the mark-fixing real structure is UNIQUE; table: $\mu_4 \rightarrow$ equatorial $1/\bar{z}$, FREE (v506 A-S2.9); silver $\{\pm 1, \pm(3+2\sqrt{2})\} \rightarrow$ real axis THROUGH the poles, NOT free; generic-unit $\{\pm 1, \pm(3+4i)/5\} \rightarrow$ equatorial, free WITHOUT harmonicity; hexagonal $\rightarrow$ NO mark-fixing real structure (marks not concyclic: RP-incompatible, consistent v503); one-sidedness TYPES the $\mathbb{Z}_2$ as the free antipode (quotient $\mathbb{RP}^2 = \text{the } \mathbb{Z}_2$ of $c_3 = 1/(\mathbb{Z}_2 2\pi\chi)$, v456). [E] HARMONIC + FREE $\Rightarrow \mu_4$ EXACTLY: the deck-pair cross-ratio $(1-b)^2/(1+b)^2 = -1$ solves exactly to $b = \pm i$ — the silver family (harmonic AND edge) is EMPTY on free circles, harmonicity becomes SUFFICIENT. [E] HONEST COUNTERWITNESSES: “nonsplit $\Rightarrow$ clock” is FALSE — discrete $\{0, 1, 8, 9\}$ and continuous $\{\pm 1, \pm(3+4i)/5\}$ (free, central, $j = 148176/25 \neq 1728$, no clock): the Fock dichotomy measures the CLASS, not the modulus. PREMISE TYPING: (P-i) deck = Moebius covering deck $\Rightarrow$ free [standard topology; origin_theory/v456]; (P-ii) marks on the Θ-fix circle = existing REALIZE [C] content — no new input. [C] THE REDUCED REST (verbatim): the alignment bit reduces from “harmonic AND central” to the square-modulus datum $\tau = i$ alone; the position half is topology (edge class excluded), the modulus half stays the one carrier input. Exact (sympy + Cl(16) Fractions). [E][C]

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Script	What it machine-checks (<i>continued</i>)
v511_celestial_ wp5e_delta2_tensor_ ledger.py	CELEST.WP5E.DELTA2.01: WP5e-δ_2 of the celestial-holographic research contract CELEST.SEAM.01 — “the full-tensor ledger”, the named escape route of the v508 exchange no-go, executed (intermediate verdict, exact): does the FULL adjoint tensor structure of $\mathfrak{e}_8$ (non-Cartan external legs, higher-arity vertices) open a sphere-axion channel to the rigid $32 T_3$ residual ($A_{\text{fix}} = (9, -30, -15, 0, 32)$, v505)? The collapse is CONFIRMED full-tensorially, but one cubic door opens. Exact Kostant/Weyl weight arithmetic + sympy/Fraction. [E] STRUCTURE: $\mathfrak{g}_0 = \mathfrak{d}_5 \oplus \mathfrak{a}_3$ is SEMISIMPLE with NO $\mathfrak{u}(1)$ factor (class-0 roots $40 + 12$, root span rank 8); the twisted sectors factorise multiplicity-free into minuscule Weyl orbits $\mathfrak{g}_1 = (16_s, 4)$, $\mathfrak{g}_2 = (10, 6)$, $\mathfrak{g}_3 = (\mathfrak{g}_1)^*$, each irreducible $(64, 60, 64)$; INNERNESS THEOREM: $h = (2, 2, 2, 2, 2; 0^4)$ lies in the Cartan OF $\mathfrak{g}_0$, so every $\mathfrak{g}_0$-invariant tensor carries total sector charge 0 mod 4 — the v508 collapse is a full-tensor statement AND holds across arities (all 15 non-neutral sector triples: $\text{Hom} = 0$). [E] HOM TABLES: bilinear $\dim \text{Hom}_{\mathfrak{g}_0}(\mathfrak{g}_j \otimes \mathfrak{g}_{j'})$ nonzero ONLY at $j' = -j$ (dims $2/1/1/1$, Killing blocks); trilinear neutral multisets $\{0, 0, 0\}: 3$ ($= 1 \text{ sym} + 2 \text{ antisym}$), $\{0, 1, 3\}: 2$, $\{0, 2, 2\}: 2$, $\{1, 1, 2\}: 1$, $\{2, 3, 3\}: 1$ — ALL cross-sector trilinears are pure brackets (antisymmetric in the repeated legs); the ONLY totally symmetric survivor on all of $\mathfrak{e}_8$ is the $\mathfrak{su}(4)$ d-symbol ($\mathfrak{so}(10)$ has no cubic Casimir: $\text{Inv}(S^3 45) = 0$ protects T_5). [E] THE NEW CHANNEL: the quartic projection of the d-symbol exchange is $Q_{dd} = (0, 0, -\frac{1}{240}, 0, \frac{1}{60}) = \frac{1}{60}(T_3 - P_3/4)$, computed by TWO independent routes (Killing-propagator contraction with $2h^\vee = 60$ verified from the roots; hand route $x^2 - (\text{tr } x^2/4)\mathbf{1} ^2/60$); $\Phi_{T_3}(Q_{dd}) = \frac{1}{60} \neq 0$ — the v508 master kill does NOT extend to cubic vertices; brackets, tadpoles and mixed $d \times f$ die exactly; no T_5 analogue. [E] NEW CERTIFICATE: $M = [E_{13}, E_{22}, E_{00}, Q_{dd}]$ has rank 3, augmented rank 4 — the charge reading remains OBSTRUCTED with the WEAKER certificate $\{\Phi_{T_5}, \psi = \Phi_P - \Phi_{T_3}/4\}$, $\psi(A_{\text{fix}}) = 72 - 8 = 64$; the RELAXED reading becomes EXACTLY solvable: $A_{\text{fix}} = -u + 8v + 2w + 1920 Q_{dd}$ (residual 0). [C] number fences: $64 = \dim \mathfrak{g}_1 = 2^6$; $1920 = W(D_5) = 2^7 \cdot 3 \cdot 5 = 8 \cdot 240$. [O] the arity ≥ 4 ledger; the physical justification of the cubic GS term ($c_d = 1920$); ch_2-naturalness for CUBIC vertices UNDECIDED; the burden on δ_1 is SHARPENED to the $\psi = 64$ slice or the selection-rule relaxation. [E] NEGATIVE CONTROLS: Killing control = v508 replication; $SO(16)/D_8$: bilinears $(1, 0, 1)$, trilinears $(1, 0, 1, 0)$, $\text{Inv}(S^3 \text{adj}_{D_8}) = 0$ — no symmetric cubic, no odd sectors, no A_3 block (E_8/μ_4 doubly special); false $\mathfrak{g}_0 = \mathfrak{d}_5 \oplus \mathfrak{a}_2 \oplus \mathfrak{u}(1)$: $(5, 2, 2) \neq (2, 1, 1)$ and $\text{Inv}(S^3 \mathfrak{g}_0) = 6 \neq 1$; false sector content kills every pairing. SEAM.EQUIV.01 stays [O]; NO marker moves. Exact (sympy + Fraction). [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v512_seam_tau_flag.py	SEAM.TAU.FLAG.01: the flag-transitivity equivalence web — the $\tau = i$ attack executed on the free RP seam circle: which ESTABLISHED seam datum excludes the free-but-non-harmonic configurations? (Test family $M(\delta) = \{\pm 1, \pm e^{i\delta}\}$, $\delta \in (0, \pi/2]$; NO marker moves — the bit stays [C], QGEO.REALIZE.01 and P2.TYPING.01/AX.P2.01 text-precised only.) Exact sympy + mpmath 30 digits. [E] FALSIFICATION OF BARE TRANSITIVITY: on the free RP circle $V_4 = \{z, -z, b/z, -b/z\}$ acts SIMPLY TRANSITIVELY on the four marks for EVERY δ (pair-exchanging inversions; complete census: deck-commuting Möbius maps = diagonal/antidiagonal) — the expectation “transitivity $\Leftarrow$ v216 local equality selects $\tau = i$” is REFUTED; hardening: ALL undirected per-mark data (arc-pair multiset $\{\delta, \pi - \delta\}$, distance multiset, cone germ) are identical for every δ — no local jet sees the bit. [E] THE SHARP SELECTOR: FLAG transitivity (marks AND their two sides indistinguishable) $\iff \delta = \pi/2 \iff \tau = i \iff$ the clock — stabiliser jump $1 \rightarrow 2$, flag/arc orbits $2 \rightarrow 1$, order-4 rotation ($b^2 = -1$ solveset $\{\pi/2\}$), mark mirror $z \mapsto 1/z \iff \cos \delta = 0$. [E] 12-FOLD EQUIVALENCE WEB (each link exact): clock rotation, D_4, mark mirror, flag transitivity, three spectral degeneracies (odd-doublet split $= (2/\pi) \ln \cot(\delta/2)$, zero only at $\pi/2$ — counterwitness exactly $(2/\pi) \ln 2$; arc-Laplacian degeneracy $4/\pi$; the v215-K3 indicator in CLOSED FORM $(2\sqrt{2}/\pi) \ln \tan(\delta/2)$ — the v503 lattice curve analytically), ρ-twist existence $((m^2 - n^2)(t - 1/t) = 0 \iff t = 1$; Atiyah–Bott rationality is δ-BLIND — $\text{Tr}(\sigma e^{t\Delta}) = 1$ for ALL δ, $j_{cw} = 148176/25$ rational non-CM: rationality does NOT select), 4-cycle implementability (H4 rigidity: V_4 with element orders $\{1, 2, 2, 2\}$ cannot induce the cusp 4-cycle; centraliser scalar, U^2 nonscalar $\Rightarrow$ no projective involution — projective order exactly 4, $\mathbb{Z}_8$-shadow consistent v510), harmonic, $j = 1728$. [E] NEGATIVE CONTROLS: hexagonal (not concyclic, fails the PRECONDITIONS); silver (harmonic but topologically dead — position/modulus halves independent, consistent v510); 3 marks (impossible on the free circle: 0 invariant 3-subsets vs 28 invariant 4-subsets; bare $n = 3$ transitivity already forces equal spacing — “4 counts”: the deck-pairing makes bare transitivity free of charge). [C] THE REST (verbatim): the last input reduces from a continuous modulus to ONE discrete symmetry-lift bit ($V_4 \rightarrow D_4$: side-indistinguishability of the four equally-decorated marks); v216 local equality does NOT deliver it (no local jet can see the side bit); its negation is now concretely measurable (odd-split $(2/\pi) \ln \cot(\delta/2) \neq 0$). Scoreboard: the counterwitness passes all 7 established unsided tests, fails all 9 clock-equivalent ones. Exact (sympy + mpmath). [E][C]

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Script	What it machine-checks (<i>continued</i>)
v513_celestial_ dterm_ nonderivation.py	CELEST.DTERM.NONDERIV.01: the c_d negative certificate — can geometry derive $c_d = 1920$? An anti-numerology certificate in the v508 style (honest rigid NEGATIVE result): the v511 [C] fence “$1920 = W(D_5)$” stress-tested via four candidate routes with a PRE-DECLARED look-elsewhere ledger. Exact sympy/Fraction, no floats. [E] CONVENTION TABLE: $c_d \in \{1920, 120, 256, 32, 69120\}$ across five normalisations — only 1 of 5 hits $W(D_5)$; the convention-STABLE content is the factorisation $c_d = \Phi_{T_3}(A_{\text{fix}}) \times 2h^\vee(E_8) = 32 \times 60$, both factors [E] (Killing propagator 60 from $\sum_\alpha \langle \alpha, e \rangle^2 = 120$ over the actual roots; T_3-slot fixing via $\det(\text{P-block}) = -64 \neq 0$). [E] K1 DEAD: the charge-legal flux pairings $(1, 3)/(2, 2)$ give 2048/1800 — they BRACKET 1920 and both MISS; the only flux hit $64 \cdot 60/2$ is the FORBIDDEN $(1, 2)$ pairing (charge 3 mod 4, killed by the v511 innerness theorem). LOOK-ELSEWHERE LEDGER: 924 expressions from 21 [E] numbers, 11 hits on 1920; control targets $1800 \rightarrow 8$, $2048 \rightarrow 5$, $2016 \rightarrow 0$. [E] K2: quantisation delivers only lattices ($60\mathbb{Z}$: 1920 = the 32nd multiple, no minimality; strict ch_3-unit couplings $2160\mathbb{Z}$ EXCLUDE 1920); the cubic quantum is lattice-dependent (6 on coroots, $3/8$ on weights); the residual integer 32 has 12 signed factorisations. [E] K3 PROVENANCE CLASH (the death blow): cubic indices $A_m = (0, 16, 0, -16)$, twisted sum $\sum_m i^m A_m = 32i$ NUMERICALLY = $\Phi_{T_3}(A_{\text{fix}})$ — BUT the quartic class decomposition $(10, -4, 30, -4)$ is dominated by classes $0/2$ while the cubic 32 is built $16 + 16$ from classes $1/3$: same number, disjoint mechanism = coincidence exposed; the Weyl side is WRONG (the d-channel is an A_3-side object, $W(A_3) = 24$; D_5 has no cubic invariant, $\text{Inv}(S^3 45) = 0$; $W(E_8) / W(A_8) = 1920$ a second accidental 1920). [E] K4 NEGATIVE CONTROLS: $SO(16)/D_8$ fails every candidate formula consistently; $k = 2$ flux doubling scales the flux formula $\times 4$ (7680); false $\mathfrak{g}_0 = \mathfrak{d}_5 \oplus \mathfrak{a}_2 \oplus \mathfrak{u}(1)$ has SIX symmetric cubics; $\mathfrak{so}(10)$ sanity ($\text{Tr } X^3 = 0$). VERDICT: NUMEROLOGY as a derivation claim — the v511 [C] fence stays a fence, now typed look-elsewhere-loaded; the honest [E] core is $c_d = 32 \times 60$; the physical generation of the 32 stays [O]. Exact (sympy/Fraction); no marker moves. [E]

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Script	What it machine-checks (<i>continued</i>)
v514_celestial_ wp5e_eps1_axion_ slot.py	CELEST.WP5E.EPS1.01: WP5e-ε_1 of the celestial-holographic research contract CELEST.SEAM.01 — “the $O(-2)$ bulk-axion slot”, executed (verdict B): build the $s = 0$ tower field explicitly, pin $\tilde{\lambda} = 6$ as a residue with explicit factor bookkeeping on $\mathbb{PT}/\mathbb{Z}_4$, and take the first honest back-reaction step (Gibbons–Hawking A_3). Exact sympy/Fraction, no floats. [E] EQUIVARIANT $O(-2)$ SLOT: pushforward ledger $\pi_* O(-2)$ on $\mathbb{PT}' = \text{Tot}(O(1) \oplus O(1) \rightarrow \mathbb{P}^1)$: per spacetime degree d exactly $(d+1)^2 = \text{nullspaces of the wave operator}$ (1, 4, 9, 16, 25, 36 for $d = 0..5$); the v492 action on the fibre coordinates $(\mu_1, \mu_2) \mapsto (i\mu_1, i^{-1}\mu_2)$, incidence forces column weights $(+1, +1, -1, -1)$; the equivariant bookkeeping closes block by block (all $d \leq 6$, all 4 characters); character series $P_0 = 1 + 3t^2 + 15t^4 + 21t^6 + 45t^8 + \dots$, $P_1 = P_3 = 2t + 8t^3 + 18t^5 + \dots$, $P_2 = 6t^2 + 10t^4 + 28t^6 + \dots$; the $d = 0$ slot has multiplicity (1, 0, 0, 0) — the bulk axion survives the projection; Molien invariant ring $= (1 - t^8)/((1 - t^4)^2(1 - t^2))$ — $Z \in O(2)$, $X, Y \in O(4)$, relation degree 8 = the a_0 weight (v492/v493 bridge); E3 bijection sharpened: twisted characters $\{i, -1, -i\}$ with minimal content $(2t, 6t^2, 2t)$ and no degree-0 mode = the Coxeter eigenvalues on $H^2(\text{ALE})$, $\det(A - 1) = -4$; graviton control: the $O(+2)$ slot starts invariant only at fibre degree 4 with multiplicity $3 = \{X, Z^2, Y\}$ (the cohomological form of v505 $X = -2 \neq +2 = Y$). [E] $\tilde{\lambda} = 6$ TRIPLY PINNED: (1) Okubo: $\text{Tr}_{\text{adj}} X^4 = 36\langle x, x \rangle^2 = (6\langle x, x \rangle)^2$ on the 240 glue roots, $36 = h^\vee + 6$, $\tilde{\lambda} = 6 = \mathbb{Z}_2 N_{\text{fam}}$; (2) measure cancellation: $\mu = 1/4$ enters three times (vertex² μ^2, propagator $1/\mu$, anomaly μ) and cancels exactly — $\tilde{\lambda}_{\text{eff}}^2 = 36$ for arbitrary μ; wrong bookings quantified and excluded: anomaly-only $\Rightarrow \tilde{\lambda} = 3$, missing propagator renormalisation $\Rightarrow \tilde{\lambda} = 12$; (3) flux: minimal CPS quantum $N = 1$, a single exchange channel exactly at $k = 1$ (#primaries), $(\kappa/c_3)^2 = 36/3 = 12$ exact. [E] GH/A_3 BACK-REACTION STEP: invariant 4-centre configurations = exactly 2 branches (axis⁴ or one free μ_4 orbit); free orbit $\Rightarrow \prod_p (Z - i^p z_0) = Z^4 - z_0^4 \Rightarrow XY = Z^4 + a_0$ with $a_0 = -z_0^4$ (the v493 family re-derived from the geometry); monodromy $a_0 \rightarrow e^{2\pi i} a_0 = \text{one clock step}$; the GH point of charge k is exactly $\mathbb{R}^4/\mathbb{Z}_k$ ($k = 4 \Rightarrow \text{seam boundary } S^3/\mathbb{Z}_4$); periods $\int \omega = 4\pi(x_q - x_p)$, free orbit: $\Pi_j = 4\pi t_0(i - 1)(1, i, i^2)$, Π_j equal (lockstep, counter-check of v509); the Coxeter clock from the geometry ($A^4 = 1$, $\det(A - 1) = -4$, $\Pi \cdot A = i\Pi$); the CPS “$N \log$” analogue = source charge $4 = \mu_4$ (flux -4π per centre); honest sharpening: for the Ricci-flat ALE the asymptotic log coefficient is exactly 0 (EH: $uK' = \sqrt{u^2 + a^4}$, $\det g = 1$) — the log lives at the exceptional locus; Burns contrast ($K = u + N \log u \Rightarrow \det g \neq 1$, only scalar-flat); bonus: multipole selection rule $m \equiv 0 \pmod 4$, first symmetry-breaking multipole $(4, \pm 4)$ carries $-a_0$ with amplitude $(35/16) \sin^4 \theta$. [E] NEGATIVE CONTROLS: $\mathfrak{so}_8$ ($\tilde{\lambda}^2 = 12$ irrational; perfect squares in the Deligne series only $\{9, 36\} = \{\mathfrak{sl}_3, \mathfrak{e}_8\}$); $\text{diag}(i, i)$ (Veronese, 5 generators, no hypersurface, the bijection collapses); $k = 2$ (three channels; honest: $\tilde{\lambda}^2 = 36$ is k-independent, the kill is the closure dial). [C] conditional on Costello’s flat-$\mathbb{PT}$ matching $\lambda_g^2 E = A$. [O] the quantised BCOV one-loop coefficient on $\mathbb{PT}/\mathbb{Z}_4$; the twisted channels $(32 T_3)$ are not covered by the bulk axion — M1–M3 preregistered verbatim: M1 the $A_3 \Omega_N$ on $\mathbb{PT}/\mathbb{Z}_4$ (success: $(2\pi i)^2$ periods with lockstep phases; kill: unequal fluxes $\Rightarrow$ the v509 dial dies); M2 the twisted KS measure (success: bulk 36 + sphere axions cancel $32 T_3$; kill: a leftover T_3); M3 the a_0 uplift of the $(4, \pm 4)$ multipole (success: log correction $\propto 4 = \mu_4$; kill: decoupling from the centre count). No marker moves anywhere.

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Script	What it machine-checks (<i>continued</i>)
v515_celestial_ wp5e_m1_omega_n.py	CELEST.WP5E.M1.01: milestone M1 of the celestial-holographic research contract CELEST.SEAM.01 (WP5e back-reaction programme) — “the $A_3 \Omega_N$”, executed (SUCCESS on the preregistered v514 S8.1 criterion): the back-reacted holomorphic 3-form Ω_N on the twistor uplift of the deformed A_3 ALE, with exact periods. Exact sympy, no floats. [E] RESIDUE FORM DERIVED: on $F = XY - P(Z)$ all three ambient representatives satisfy $dF \wedge \omega_2 = -dX \wedge dY \wedge dZ$ and pull back to $\omega_2 = dX \wedge dZ / X$ (Poincaré residue, derived not assumed); cover pullback at $a_0 = 0$: $\omega_2 = 4 dz_1 \wedge dz_2 = \mu_4 \times (\text{flat form})$ — the residue normalisation carries the source charge 4; clock $\text{diag}(i, 1)$: $\omega_2 \rightarrow i \omega_2$ (v492 replicated); weight ledger $4+4+2-8=2$, $\Omega \in O(4) = -\deg K_{\text{PT}}$; EH anchor $2 = \mathbb{Z}_2$; wrong-weight control $Z \in O(4)$ breaks three ways ($4 \neq 2$, $6 \neq 4$, $5 \neq 3$). [E] THE TWISTOR FAMILY CLOSED: from the four $O(2)$ centre sections $q_p(\lambda) = i^p t_0 - i^{-p} t_0 \lambda^2$ the family is exactly $XY = Z^4 + 4t_0^2 \lambda^2 Z^2 - t_0^4 (1 - \lambda^4)^2$ ($e_1 = e_3 = 0$ identically; $\lambda = 0$ gives exactly the v493 clock family; $a_2 \in O(4)$ opens only off-seam, $a_2(0) = a_2(\infty) = 0$); clock lift $\gamma : (Z, \lambda) \mapsto (iZ, -i\lambda)$, $\gamma^4 = 1$, $\Omega \rightarrow +\Omega$ (CY-compatible). [E] Ω_N CLOSED + QUANTISED PERIODS: $\Omega_N = \Omega_0 + \sum_p N_p K_p$ with CPS/Bochner–Martinelli kernels on the centre twistor lines; $dK = 0$ away from the source, scale degree 0; period table: boundary $S^3/\mathbb{Z}_4$ at the orbifold point $(2\pi i)^2 \times 1$ (minimal invariant charge $4 = \mu_4$ — the lens fundamental domain forces $N \in 4\mathbb{Z}$), deformed phase $(2\pi i)^2 \times 4$, linking S^3 uniformly $(2\pi i)^2 \times N$, per-sphere flux vector $(2\pi i)^2 \times N(1, 1, 1)$ (forced uniform twice over: clock orbit + K_4 connectivity), seam-fibre phase vector $2\pi i t_0(i-1)(1, i, i^2)$; the undeformed Ω_0 carries zero quantised 3-flux (all flux sourced); $(2\pi i)^2 = (\text{fibre residue}) \times (\text{transverse residue})$ (density $-\sin 2\theta$). [E] CLOCK COVARIANCE: $\Pi_{j+1}(-i\lambda) = i \Pi_j(\lambda)$ for all λ; the 12 collision nodes sit exactly on the 8 eighth roots of unity ($8 = 2 \mu_4$, the $\mathbb{Z}_8$ seam bridge), clock orbits $4+4+4$, honest conifold points (Hessian $\det 512t_0^6$, quadric rank 4). [E] KILL PROBE (honest): the forbidden family $Z^4 - Z$: 0/24 orderings lockstep (vs 8/24), λ-support 12 twelfth roots $\neq \mathbb{Z}_8$, no antipodal pairing — but the $(2\pi i)^2$ quantisation holds there too: integrality alone is not the discriminator, the discriminator is the lockstep phase structure + the clock forcing of equal fluxes; the v509 dial survives. [E] ANCHORS + CONTROLS: EH/$\mathbb{Z}_2$ (2 nodes, charge $2 = \mathbb{Z}_2$ forced); CPS original (full S^3: every integer N allowed); $\text{diag}(i, i)$: $\Omega_0 \rightarrow -\Omega_0$ (collapse at step zero) while K stays invariant; fractional charges $N = 1, 2, 3$ excluded. [C] global kernel patching (Green function), Hitchin small resolution, CPS brane dictionary. [O] M2 (twisted KS measure), M3 (a_0 uplift), the quantised BCOV coefficient; SEAM.EQUIV.TWISTOR.01 untouched (preparation, not construction). No marker moves.

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Script	What it machine-checks (<i>continued</i>)
v516_celestial_ wp5e_m2_twisted_ks_ measure.py	CELEST.WP5E.M2.01: milestone M2 of the celestial-holographic research contract CELEST.SEAM.01 (WP5e back-reaction programme) — “the twisted Kodaira–Spencer measure”, executed (SUCCESS on the preregistered v514 S8.2 criterion, on the DECLARED completion measure — verdict B): the one-loop box coefficient per sector on $\mathbb{PT}/\mathbb{Z}_4$ under the completion contact term $\text{contact}_j = (Q^{(0)} - Q^{(j)})/\det_j$. Exact sympy/Fraction, no floats. [E] THE COMPLETION-WEIGHT IDENTITY (the centrepiece): per glue class the contact weights are $w_m = \sum_j (1 - i^{jm})/\det_j = (0, \frac{3}{2}, 2, \frac{3}{2}) = 4h_m = \mu_4 h_m = -4\text{ch}_2(T_m)$ EXACTLY ($h_m = m(4 - m)/8$ the v502 sector Casimir energies, $\text{ch}_2(T_m)$ the McKay/Kronheimer charges, v505 S4.3 index bridge): the three sphere axions pair through their OWN ch_2 charges — an exact identity, NO free scale, no fit. [E] PARAMETER-FREE LOCKS: $T_5 = 0$ for ANY scale c (the ch_2 pattern alone kills T_5); ratio $h_2 : h_1 = 4 : 3 =$ the δ_1-forced leading ratio (REPRODUCED, not fitted); the T_3 budget fixes $c = 4 = \mu_4$ uniquely. [E] THE CONTACT TERM: channel form $\sum_j (Q^{(0)} - Q^{(j)})/\det_j =$ class form $\sum_m 4h_m Q_m = (36, 120, 60, 0, -32)$ EXACTLY (one object, two bases); the contacts carry nonzero T_5/T_3 per channel (genuine contact, not exchange — the v508 product theorem replicated). [E] SUCCESS TABLE: $\text{skeleton}_j + \text{contact}_j = Q^{(0)}/\det_j = 36\langle x, x \rangle^2/\det_j$ — a PERFECT Okubo square ($T_5 = T_3 = 0$, $\tilde{\lambda}^2 = 36$) in EVERY twisted channel; total $A_{\text{fix}} + \text{contact} = 45\langle x, x \rangle^2 = \frac{5}{4} \times 36\langle x, x \rangle^2 = \text{Dedekind} \times \text{Okubo} =$ the UNIQUE quartic-free weighting (v505 S3.8 rigidity); both v508 certificates killed ($\Phi_{T_3} : 32 \rightarrow 0$, $\Phi_P : 72 \rightarrow 0$); the v511 slice $\psi = 64$ SUPPLIED EXACTLY — no cubic d-channel needed (c_d free = 0); remainder inside the exchange span ($45\langle x, x \rangle^2 = \frac{45}{16}E_{22} = \frac{1}{80}E_{00}$), the bulk axion cancels every channel with the SAME $\tilde{\lambda}^2 = 36$; the v514 measure chain stays μ-blind. [E] NEGATIVE CONTROLS: $c \in \{1, 2, 3, 5\}$ leaves $T_3 = (24, 16, 8, -8)$; the $h_1 \leftrightarrow h_2$ shuffle breaks $T_5 = -14$ AND $T_3 = 36$; $SO(16)$: $T_5 = 20 / T_3 = -40$ remain — the KILL fires there (Okubo failure inherited, E_8 doubly special); $\text{diag}(i, i)$ degenerates to the $\mathbb{Z}_2$ target and breaks the conjugation pairing + the index bridge; the $\mathbb{Z}_2/\text{Eguchi–Hanson}$ anchor PASSES ($9\langle x, x \rangle^2 = \frac{1}{4} \times 36$, scale $2 = \mathbb{Z}_2$). [E] MULTIPLIER NOTE (cross-reference to δ_{1d}): the contact weights are real rationals with no multiplier system of their own; the δ_{1c} residual phases = the SQUARES of the A_3 discriminant T-phases, orders $(1, 4, 1, 4)$. [C] THE COMPLETION READING (the fence): the loop of twisted states carries the UNPHASED sector trace with the same zero-mode normalisation — declared, supported by the δ_1 modular-completion finding, NOT derived from the BCOV integral. [O] the BCOV-integral derivation ($\delta_{1b}/\delta_{1c}/\delta_{1d}$ territory); SEAM.EQUIV.TWISTOR.01 untouched. VERDICT: SUCCESS wording met on the declared measure; the KILL does NOT fire; no marker moves. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v517_celestial_ wp5e_m3_a0_ uplift.py	CELEST.WP5E.M3.01: milestone M3 of the celestial-holographic research contract CELEST.SEAM.01 (WP5e back-reaction programme) — “the a_0 uplift”, executed (SUCCESS on the preregistered v514 S8.3 criterion): the $(4, \pm 4)$ GH multipole uplifted to the twistor-potential kernel $\chi = \log P_4$ (the log of the v515 family polynomial) with the induced Kähler-potential correction. Exact symplectic, no floats. [E] KERNEL BRIDGE: the $O(2)$ section is a NULL coordinate — $\Delta_{3d} G(\eta_p) = 0$ identically for an ARBITRARY kernel G (the uplift is well-typed); RESIDUE IDENTITY $\partial_x[\text{transform}(\log \eta_p)] = 1/r_p$ EXACTLY (residue $1/(2r)$): the GH potential $V = \sum_p 1/r_p$ IS the x-derivative of the contour transform of χ; flux -4π per centre, source charge $4 = \mu_4$ (the V-ledger matched). [E] FOUR COUPLED CENTRE-COUNT SCALES: (1) asymptotic kernel log $\chi = 4 \log \eta + a_2/\eta^2 + (a_0 - a_2^2/2)/\eta^4 + \dots$ — LOG COEFFICIENT $4 = \mu_4$ = centre count (the CPS “$N \log$” analogue at kernel level); at the clock-fixed seam fibre $\zeta = 0$ the a_2 slot closes and the first correction is EXACTLY a_0/η^4 = the $(4, \pm 4)$ multipole; exact m-grading ($m = \pm 4$ pieces PURE a_0, $m = 0$ piece φ_0-free); NO $\log \times$ power terms (the v514 honest zero preserved); (2) the GLT tower $\sum_p \eta_p \log \eta_p = 4\eta \log \eta + p_4/(12\eta^3) + \dots$ with $p_n = 0$ unless $n \equiv 0 \pmod 4$ and $p_{4k} = 4(-a_0)^k$; (3) the exceptional-locus log $\chi(0) = \log a_0 = 4 \log t_0 + i(4\varphi_0 + \pi)$, modulus response 1 at the locus vs power-law at infinity (v514 S6.3 uplifted); (4) periods: $d \log \Pi_j / d \log a_0 = 1/4 = 1/ \mu_4$ uniform, integrated monodromy $e^{2\pi i/4} = i =$ ONE Coxeter clock step (v493 reproduced from perturbation theory); node λ-support a_0-RIGID (the $\mathbb{Z}_8$ seam bridge), K_4 discriminants $\sim t_0^2 \neq 0$ (the forced flux vector persists), BM kernel modulus-free with $\int K = (2\pi i)^2$. [E] NEGATIVE CONTROLS: $(4, 0)$ clock-invariant (φ_0-free in V AND kernel: breaks nothing); $\mathbb{Z}_2/\text{EH}$ analogue: EVERY dial reads $2 = \mathbb{Z}_2$ ($(2, \pm 2)$ amplitude $\frac{3}{2} \sin^2 \theta$, kernel log 2, exceptional log $2 \log t_0$, response $\frac{1}{2}$, monodromy -1); $k = 3, 5$ orbits: coefficient k, slot $O(6)/O(10) \neq O(8)$ — the observable MOVES with the centre count; forbidden family $Z^4 - Z$: $p_3 = 3 \neq 0$ (selection rule broken), $e_4 = 0$ (no a_0-log) — fails BOTH dials. [C] the GLT dictionary ($\eta_p \log \eta_p$ = the GH Kähler-potential kernel; Lindström–Roček / Ivanov–Roček). [O] the full nonlinear Kähler potential of the resolved A_3 ALE; SEAM.EQUIV.TWISTOR.01 untouched. VERDICT: SUCCESS (log correction $\propto 4 = \mu_4$, coupled to the centre count on four scales); the KILL (decoupling) does NOT fire; no marker moves. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v518_celestial_ wp5e_delta1_ derived_kill.py	CELEST.WP5E.DELTA1.01: the δ_1 chain ($\delta_{1b} + \delta_{1c} + \delta_{1d}$) of the celestial-holographic research contract CELEST.SEAM.01 DECIDED — “the derived chiral measure kills the δ_1 route”, an honest, decided NEGATIVE result (v508 style): does the Harvey–Moore/BCOV fundamental-domain integral on $\mathbb{PT}/\mathbb{Z}_4$, evaluated under a measure DERIVED from blockwise $SL(2, \mathbb{Z})$ covariance (solved for, not declared, not scanned), deliver $-A_{\text{fix}} = -(9, -30, -15, 0, 32)$ or the $\psi = 64$ slice? NO — every member of the derived family fails all three preregistered testers. [E] THE 16-COMPONENT WEIL COMPLETION (δ_{1c}): discriminant module $\mathbb{Z}_4 \times \mathbb{Z}_4$ with $q = (5x^2 + 3y^2)/8$; Gauss sums $2\zeta_8^5 \times 2\zeta_8^3 = 4 = \sqrt{16}$ (signature 0 mod 8 = rank E_8); S symmetric + unitary, $S^2 = C$, $(ST)^3 = S^2$, $S^4 = 1$, $T^8 = 1$ EXACTLY in $\mathbb{Q}(\zeta_8)$; $S = S_{D_5} \otimes S_{A_3}$; the diagonal H and anti-diagonal H' are the two invariant Lagrangians (both counts = E_4: two E_8 gluings); $P_H S P_H = \frac{1}{4}J$ with $3/4$ of every S-image weight on the 12 shifted classes; the 16-vector theta S-covariance CLOSES: the δ_{1b} E1.5 residual $2.91 = O(1)$ drops to $\sim 10^{-39}$. [E] THE OBSTRUCTION IS A FINITE μ_4 CHARACTER, IDENTIFIED (δ_{1d}): gauge blocks $M = G[a, b] \eta^{-8}$ have constant transport (t_p, s_p) (28+ digits) recognised as exact $1/960$-grid phases; the T-fixed pairs $(0, b)$ carry $t = e(-1/2) = -1$ EXACTLY; loops land in $\Gamma_1(4)$ resp. $\Gamma_0(2)^\pm$, joint holonomy eigenspaces dim $8/16$ resp. $6/16$, every eigen-phase of order ≤ 4; KOBOUNDARY TEST: the relation defects c_{S^4}, $c_{(ST)^3 S^{-2}}$, $c_{[S^2, T]}$ are $(1, 1, 1)$ EXACTLY on all 15 pairs — a CHARACTER of the stabilisers, NOT a genuine 2-cocycle on $SL(2, \mathbb{Z})$; on $\Gamma_1(4)$: $\lambda(\gamma) = i^{2B+C/4}$. [E] THE CANCELLATION IS THE TWISTED FIBRE BLOCK $f_1 f_3$, NOT THE THREE SPHERE AXIONS: exact identity $G[a, b] = f_1 f_3$ (30+ digits); the T-fix mechanism is one line of exact phase arithmetic: $(-1) \times e(-1/6) = e(1/3) = \chi_4(T)$ at every T-fixed node; CANCELLATION TABLE (exact, minimal residual order over $\eta^m \times \chi_k$): none $\rightarrow 4$, $f_1 f_2 f_3$ (the three sphere axions) $\rightarrow 4$, $f_2 \rightarrow 6$, $f_1 f_3 \rightarrow 1$ (hol AND anti), wrong weights $\rightarrow 4$; strict solutions exactly χ_4 (dims $(3, 3)$) and χ_{10} (dims $(1, 1)$) at η^0, certified on the dressed functions (10^{-15}, NO residual multiplier). [E] THE DECISION — ALL THREE TESTERS FAIL: under both derived solutions the integral fails $T_5(V) = 0$ (fractions $0.5 / 0.83$), fails $W_2 : W_{13} = 4 : 3$ ($W_{13} = 0$), fails $V = -A_{\text{fix}} N$ (spreads $1.05 / 1.47$) and the $\psi = -64N$ slice; the honest (N_1, N_2) rebalance: χ_4 reaches $T_5 = 0$ only at $\psi > 0$, χ_{10} only at $N_2/N_1 = -4 < 0$ (outside the orbifold projector) — no branch fires in the positive cone. [E] NEGATIVE CONTROLS: $\mathbb{Z}_2$/Eguchi–Hanson (gauge-only residual order 2 — the μ_4 defect is $\mathbb{Z}_4$-specific — and the SAME fibre dressing cancels it to 1); $SO(16)/D_8$ (only even sectors, all axion b-characters in μ_2: the order-4 supply structurally absent); wrong form $(x^2 + y^2)/4$ ($G ^2 = 64 \neq 16$, its S-rule fails at $O(1)$); wrong signature ($S^2 = C$ breaks exactly). [C] the $f_1 f_3 = \text{KS-weight identification}$ (deck weights $(1, 3) =$ the twistor fibre weights $(+1, -1 \bmod 4)$ forced by the v514 incidence ledger — exact match, NOT a complete BCOV derivation) + the kernel-family convention + the discrete χ_k choice (both evaluated, both fail). TENSION, stated honestly (the mandatory fence): the DECLARED completion reading (v516/M2) delivers the $\psi = 64$ slice and cancels $32 T_3$; the DERIVED chiral measure (this module) fails all three testers — both are exact; the sharp open question is which of the two is the true BCOV measure (the declared reading is supported by the δ_1 modular-completion finding but not derived; the derived measure rests on the $f_1 f_3$ identification). Neither result is hidden behind the other. [O] the BCOV-integral derivation on $\mathbb{PT}/\mathbb{Z}_4$ that decides between the two measures — the single open item of the δ_1 strand; the twisted-contact route of v508 S6.2 is DECIDED NEGATIVE under the derived measure. NO marker moves anywhere. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v519_woit_theta_rp_free.py	WOIT.THETA.FREE.01: the WOIT-α milestone of the OS twistor bridge WOIT.OS.TWISTOR.01 — “the real structure exists, and free reflection positivity picks the SAME family” (Part W = the anti-linear Θ: classification, exact relations, kill test 1 on the free/equivariant level; Part R = reflection positivity of the free 16-Majorana NS seam system under the pinned Θ; NO marker moves — WOIT.OS.TWISTOR.01 stays [O]: kill test 1 is discharged on the FREE level only and stays formally live on the interacting algebra). Exact symplectic + exact $\text{Cl}(16)$ Fractions; the RP definiteness certificates are 40-digit spectra of exact Hermitian matrices. [E] THETA CLASSIFICATION COMPLETE: exactly TWO families of anti-linear structures on $\mathbb{C}^2$ normalise the clock $\rho = \text{diag}(i, 1)$ — family D ($z \mapsto \mu\bar{z}$, $\mu = 1$): $\Theta\rho\Theta = \rho^{-1}$ EXACTLY, $\Theta^2 = +1$ (−1 IMPOSSIBLE: $MM = \text{diag}(\mu ^2, 1)$ — Kramers-free), inverts the deck, fixed set = the great circle through the deck poles; family A ($z \mapsto \mu/\bar{z}$): centralises the clock projectively (NEVER inverts), $\Theta^2 = \pm 1$ per μ, fixed set $z = 1$ resp. empty. ROLE SEPARATION: family A DEFINES the euclidean section (Woit’s ρ_{tw} side: $\rho_{\text{tw}}^2 = -1$, no real points — replicated exactly on $\mathbb{C}^4$), family D REFLECTS it (the OS conjugation; σ_{std} = the standard conjugation with real points $\mathbb{RP}^3$). [E] MARK PINNING: $z \mapsto \mu\bar{z}$ preserves the μ_4 marks iff $\mu \in \mu_4$ — a 4-element μ_4-TORSOR (2 mark axes + 2 silver-midpoint axes); clock conjugation $\rho\Theta_\mu\rho^{-1} = \Theta_{-\mu} \Rightarrow 2$ clock orbits. [E] SPIN/FOCK: the $\mathbb{Z}_8$ plane has no phase leaks ($\zeta_8^k = \zeta_8^{-k}$); exact $\text{Cl}(16)$: $\Theta_{\text{Fock}} = U_r \circ K$ with $\Theta_{\text{Fock}}^2 = 2^7 > 0$ (normalised +1), inverts the clock tower ($V \mapsto 4096 V^{-1}$, exact scalar) and normalises the deck; KRAMERS DICHOTOMY: the deck-induced candidate $\Theta_t = \tilde{U} \circ K$ has $\Theta_t^2 = 256 \gamma_1 \cdots \gamma_{16} = (-1)^F$ — the v510 split/nonsplit dichotomy IS the $\Theta^2 = +1$ vs $(-1)^F$ dichotomy; the deck does NOT furnish Θ, the seam-circle REFLECTION does. [E] KILL TEST 1 (free level): does NOT fire — Θ exists with $\Theta^2 = +1$ AND $\Theta\rho\Theta = \rho^{-1}$ and satisfies all three side conditions simultaneously (marks, deck normalisation, spin/Fock). [E] FREE RP: the chiral NS vacuum $C(d) = (2/N)/\sin(\pi d/N)$ has $C^2 = -1$ exact; preconditions exact ($RCR^T = -C$, $SCS^T = C$, $RSR^{-1} = S^{-1}$; the deck FAILS anti-invariance); BOND CUT: one-particle Gram $(8, 0, 0)$ PD (min eigenvalue 1.888×10^{-3} at 40 digits), even $\deg \leq 2$ sector $(29, 0, 0)$ PD, $N = 8$ complete half-sided algebra PD (even + odd each $(8, 0, 0)$) — free RP with NO degree truncation; the twist $\eta = +i$ is FORCED ($\eta = 1$ non-Hermitian); CONTROLS: the site cut fails exactly ($\det = 0$, inertia $(3, 3, 1)$); continuum control: the Cauchy–Stieltjes factorisation is strictly PD — a lattice-PLACEMENT artifact: RP selects the site placement relative to the marks); the clock-CENTRALISING family-A structure fails RP structurally $((4, 4, 0))$ — RP and $\Theta\rho\Theta = \rho^{-1}$ select the SAME family; bonus: the anti-chiral state flips the odd sector to $(0, 8, 0)$ ND (the free shadow of kill test 3). [C]/[O] NOT shown: the interacting algebra $\mathcal{A}_{\text{hol}}$ (kill test 1 stays live there), gauge-fixed RP (kill test 2), the OS reconstruction, chirality without mirrors (kill tests 3/6 — only the free odd-sector shadow), μ_4 incidence (kill test 7); WOIT-β/γ roadmap: (β_1) Θ on the gauge-invariant subalgebra + gauge-fixed RP on the equivariant $\text{SDYM}(E_8)$ sector; (β_2) the OS quotient of the free system explicit; (β_3) the $\mathbb{PT} \leftrightarrow \mathbb{PT}^*$ duality vs σ_{std} typed; (γ) the chirality theorem + the mark incidence. Two contract PRECISIONS (prose, no marker): (i) “Θ induced by the seam reflection” means the seam-circle REFLECTION, not the deck (the deck furnishes the $(-1)^F$ Kramers class — the v510 bridge); (ii) the marks sit RP-side on the BOND MIDPOINTS of the 16-Majorana circle. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v520_celestial_ wp5e_measure_ decision.py	CELEST.WP5E.MEASURE.01: the WP5e BCOV measure question DECIDED at probe level ($\delta_{1e} + \delta_{1f}$ consolidated, v518 style) — “single-valuedness is derived, the completion reading wins”: which of the two exact, contradictory measures on $\mathbb{P}T/\mathbb{Z}_4$ is the true BCOV measure, (A) the DECLARED completion reading (v516) or (B) the DERIVED chiral measure (v518)? ERFOLG-A on the decision layer. [E] INVARIANT SUBSPACE: $\dim_{\mathbb{Q}}\{v : \rho(T)v = v, \rho(S)v = v\} = 8 = 4 \times 2$ in the dressed 16-component Weil system, EVERY kernel vector in the $\mathbb{Q}(\zeta_8)$-span of $\{e_H, e_{H'}\}$ (the two Lagrangian gluings, both $\theta = E_4$, level-1 quartic $= Q^{(0)}$ = the unphased trace); strict trivial-character solutions at $(m, k) = (0, 0)$: ZERO for every dressing (11 combinations). [E] SOURCE 1 (F-LEMMA): the only strict chiral families χ_4 (dims (3, 3)) and χ_{10} (dims (1, 1)) carry nontrivial T-characters exactly; pointwise covariance of the canonical column member certified (3.9×10^{-16}, $G \geq 59.6$); EXACT change of variables $\Rightarrow$ fundamental-domain independence forces $\int = 0$ for EVERY chiral integrand — the v518 route was never a well-defined nonvanishing moduli integral (kill SHARPENED). [E] SOURCE 2 (QUILLEN PAIRING): $t\bar{t} - 1 < 8.3 \times 10^{-40}$ on all 15 pairs/both generators; $\chi_4 ^2 = 1$ exact vs one-sided $\chi_4^2 = e(2/3) \neq 1$ (T-fixed: $640 \not\equiv 0 \pmod{960}$, 15/15 defective); the doubled 256-dim hol $\times$ antihol Weil system closes STRICTLY at trivial character and physical weight (nullspaces $(28, 17) \geq 11$), contains the unphased diagonal ($\sim 2 \times 10^{-15}$) AND the physical columns $w_b \otimes \bar{w}_b$ (σ $4.9 \times 10^{-16}/8.3 \times 10^{-16}$); negative control hol $\otimes$ hol: EMPTY nullspace (0, 0). [E] CONSISTENCY CLOSURE: the forced unphased numerator in the v518 scaffold reproduces $\sum_m V \propto (1, 2, 1, 0, 0) = \langle x, x \rangle^2$ exactly on every level $n \leq 8$; J-weighted spreads $\sim 5 \times 10^{-41}$, $T_5/T_3 \sim 7 \times 10^{-42}$, zero negative cells; $\psi(\text{skeleton}) = +0.2302 = -\psi(\text{contact})$, the J-weighted mirror image of $\psi(A_{\text{fix}}) = +64/\psi(\text{contact}) = -64$; linearity 4.6×10^{-41} — the circle to v516 is CLOSED. [E] D3 $\mathbb{Z}_2/\text{EH}$ ANCHOR: only the declared reading hits ($9\langle x, x \rangle^2 = (1/4) \times 36$, $\psi = -8$, scale tooth $c = 1/2 = \mathbb{Z}_2 h^{A_1}$); all three derived instantiations fail (spreads 1.12/0.895/0.516, ψ sign wrong). [E] D1 COLUMN CANONICALISATION: the physical AB column $\sum_m i^{bm} e_{(m,m)}$ is EXACTLY contained in the χ_4 family (σ $1.8 \times 10^{-16}/1.7 \times 10^{-16}$, one scalar per orbit — canonicalises the (N_1, N_2) freedom); the canonical member still fails all testers. [E] NEGATIVE CONTROLS: $SO(16)/D_8$ ($T_5 = 20/T_3 = -40$ exact, μ_2-only), wrong form ($\text{Gauss} ^2 = 64$), wrong weight (dev 0.78), shuffle ($T_5 = -14/T_3 = 36$), planted family detected (1.5×10^{-16}), hol $\otimes$ hol empty. [C] TYPED PREMISES (the mandatory fence): TP-1 (F-independent moduli integral), TP-2 (nonvanishing — must source $\psi = 64$), TP-3 (v518 kernel convention), TP-4 (Quillen structure of BCOV F_1). [O] the constructive BCOV derivation of the w_m normalisation itself. VERDICT: ERFOLG-A per the preregistered criteria (both sources independent, the consistency closure carries); the [O] question “which is the true BCOV measure” is DECIDED at probe level in favour of (A) under TP-1..TP-4. SEAM.EQUIV.TWISTOR.01 stays Open; NO marker moves. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v521_seam_bit_rp_blind.py	SEAM.BIT.RPBLIND.01: the RP/Θ attack on the alignment bit DECIDED — “free OS positivity does NOT see δ”, an honest, decided NEGATIVE result (v508 style): does free reflection positivity (v519) or anti-linear Θ existence break for $\delta \neq \pi/2$ on the deformed mark family $M(\delta) = \{\pm 1, \pm e^{i\delta}\}$, which would derive the v512 alignment bit from OS positivity? NO — the free RP/Θ battery is the EIGHTH side-blind test on the v512 scoreboard ($7 \rightarrow 8$); the bit remains genuine discrete input. [E] CENSUS (exact solvesets, symbolic δ): for every δ exactly the two mark-SWAPPING reflections $\Theta_{\pm e^{i\delta}}$ exist (axes $\delta/2, \delta/2 + \pi/2$; all 20 cut/mark incidence solvesets EMPTY); mark-FIXING reflections exist exactly at $\delta = \pi/2$ (solveset $\cos \delta = 0$, lost immediately at $\pi/2 - \varepsilon$); the v510/v512 counterwitness $\{\pm 1, \pm(3+4i)/5\}$ carries the swap pair exactly. [E] RP IS δ-BLIND: bond-cut Gram inertias $(8, 0, 0)$ PD for all tested δ, spectra IDENTICAL to 40 digits (deviation 0.0) — the ENTIRE free-RP spectral datum carries ZERO δ information; the $N = 16$ odd-m failure (site axes, $(3, 3, 1)$, $\det = 0$) is a lattice-PLACEMENT artifact: at $N = 32$ ALL $m = 1..7$ ($\delta = m\pi/8$) have mark-compatible BOND axes with PD inertia $(16, 0, 0)$; continuum: the OS kernel in axis-adapted coordinates is EXACTLY $1/\sin((s+t)/2)$, the axis position drops out identically (Cauchy–Stieltjes PD); the counterwitness PASSES free RP (6-point Gram $(6, 0, 0)$). [E] Θ EXISTENCE δ-BLIND: $\Theta^2 = +1$, deck normalisation and Fock implementability ($U^2 = +2^7/2^8 > 0$, exact $\text{Cl}(16)$) for every δ; the ONLY δ-sensitive v519 clause ($\Theta\rho\Theta = \rho^{-1}$) is for $\delta \neq \pi/2$ not violated but NOT FORMULABLE (a mark-compatible order-4 rotation exists iff $\delta = \pi/2$) — it PRESUPPOSES the bit; same for the clock-tower clause. [E] the battery has teeth at every δ: family A/antipode fails RP structurally (zero diagonal, $(4, 4, 0)$ indefinite), chirality-η pinning persists $((0, 8, 0)$ ND) — RP separates the two real-structure FAMILIES, never the SIDES. [E] precondition controls: hexagonal (marks not concyclic, no seam circle), silver (deck not free), lifting audit (B = index relabelling, δ-blind by construction; B' fails the $\pi/2$ negative control — discarded). [C] FACE #13 of the v512 equivalence web: the group generated by the admissible OS reflections is V_4 for every $\delta < \pi/2$ and closes to D_4 exactly at $\delta = \pi/2$ ($\Theta_i \circ \Theta_1 = \text{the clock}$) — $12 \rightarrow 13$ faces, a typed REFORMULATION of the bit, not a derivation. [O] honest gap: marks decorating the STATE (defect/twist insertions, interacting $\mathcal{A}_{\text{hol}} = \text{exactly v519's}$ [O] scope — there, and only there, could positivity still see the bit. VERDICT: KILL exactly as preregistered; the alignment bit is NOT derivable from OS positivity and remains genuine discrete input; no marker moves. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v522_woit_beta1_ gso_gauge.py	WOIT.BETA1.GS0.01: the WOIT-β_1 milestone of the OS twistor bridge WOIT.OS.TWISTOR.01 executed — “the clock is time-like, GSO is the gauge datum” (typed result: verdict UNDECIDED per the frozen preregistration, mechanism identified exactly, gauge-fixed RP established under the corrected GSO typing). [E] HERMITICITY WITNESS: the μ_4 clock average violates Hermiticity EXACTLY (the one-step insertion $T_1 = \langle \theta(e_a), \alpha_S(e_b) \rangle$ has entry $-i/(8 \sin(5\pi/16))$ where the conjugate transpose demands $+i/(8 \sin(5\pi/16))$); the pairing is complex-SYMMETRIC (745 entries matching, 96 anti-matching, 0 violations) — “OS-symmetric” is strictly weaker than Hermitian: “positivity after gauge fixing” is not well-posed for the clock reading. [E] TIME-LIKE TYPING: ALL 16 dihedral reflection axes of the NS seam circle invert the clock lift ($RSR^{-1} = S^{-1}$), NONE commutes — the μ_4 clock IS Woit’s euclidean rotation (the time translation itself); the gaugeable (θ-compatible) part of the $\mathbb{Z}_8$ tower is EXACTLY its 2-torsion $\{1, (-1)^F\}$ (Hermiticity census over all powers; $\alpha^4 =$ the full wrap = the 2π rotation of the seam = fermion parity, lattice spin-statistics). [E] POSITIVE PART — GSO-FIXED RP HOLDS EXACTLY: $N = 16$ even $\deg \leq 2$ parity-projected bond-cut Gram (29, 0, 0) PD (min eigenvalue 1.78×10^{-6} at 40 digits); $N = 8$ complete half algebra: the projected Gram kills all odd rows/columns exactly, even block (8, 0, 0) PD (3.35×10^{-3}), no degree truncation; the site-cut defect SURVIVES gauge fixing ((7, 9, 6)) — the RP bond placement is gauge-invariant information; family A keeps failing ((17, 12, 0) indefinite vs family D’s (29, 0, 0)); Kramers: $\Theta_t^2 = \text{id}$ on $\mathcal{A}^G$, Θ_{Fock} restricts with $\Theta^2 = +1$; Ramond control: the wrap +1 “true $\mathbb{Z}_4$” lift fails state invariance — the $\text{NS}/\mathbb{Z}_8$ tower is forced. [E] KILL-TEST BOOKKEEPING: kill test (1) stays discharged also gauge-invariantly (RP separates the families on the invariant sector); kill test (2)’s free shadow does NOT fire (no legitimate Hermitian gauge-fixed form has a negative direction); both stay formally live on the interacting algebra $\mathcal{A}_{\text{hol}}$. [E] WRONG-PROJECTION CONTROLS: invariant-dimension chain parity $120 >$ deck $64 >$ clock 32 strict, but Hermiticity singles out PARITY alone (deck and clock averages non-Hermitian): the finer “gauge” projections are structurally ill-posed pre-quotient. TRANSPARENCY: the first frozen run scored 6/13 and the preregistered $\deg$-2 invariant dimension 30 was a combinatorial error (correct census: $28 + 4 = 32$) — documented in full; verdict by the frozen [C-3] logic (Hermiticity failure $\Rightarrow$ UNDECIDED). [C] CONTRACT PRECISION (iii), prose only: “gauge-invariant subalgebra” at the free level means the GSO/fermion-parity $\mathbb{Z}_2$ — the only θ-compatible part of the μ_4 tower (the free-fermion shadow of the E_8 glue: $(E_8)_1 =$ even NS of $SO(16)_1 + \text{R spinor}$); the clock is the euclidean rotation itself (timelike), its equivariant statement moves to β_2 (OS quotient first, then the clock as reconstructed transfer operator). [O] β_1 proper stays open via β_2; WOIT.OS.TWISTOR.01 stays [O]; no marker moves. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v523_celestial_ wp5e_wm_derived.py	CELEST.WP5E.WM.01: the constructive derivation of the w_m normalisation — “$1/\det_j$ is the Atiyah–Bott / zeta-determinant fixed-point factor, COMPUTED from three independent sources”, closing the residual [O] of v516/v520 at the fibre-zero-mode level (verdict ERFOLG per the frozen preregistration). [E] ATIYAH–BOTT (route i): the equivariant mode ledger of the fibre $\mathbb{C}^2$ equals the closed form $1/((1 - q i^j)(1 - q i^{-j}))$ exactly in $\mathbb{Q}(i)$ for all $n \leq 120$; REGULAR at $q = 1$ with Abel value $(1/2, 1/4, 1/2) = 1/\det_j$, $\det_j = \det(1 - g^j) = (2, 4, 2)$; $(C, 2)$ Cesaro convergence in exact arithmetic; the fixed-point factor splits off EXACTLY at every truncation level $d \in \{7, 12, 25\}$, for the phased (skeleton) AND the v520-forced unphased (completion) trace alike — the Abel-limit contact$_j = (Q^{(0)} - Q^{(j)})/\det_j$ is the v516 contact vector COMPUTED, not declared. [E] ZETA/QUILLEN (routes ii/iii): $\det_\zeta$ of the g^j-twisted circle Laplacian $= 4 \sin^2(\pi j/4) = \det_j$ EXACTLY (Lerch + reflection formula symbolically; Hurwitz certificates $\sim 10^{-41}$); Quillen split $\det \Delta = \det_j^2$, $\det \bar{\partial} = \det_j$, with the real positive holomorphic section UNIQUE via the $SU(2)$ conjugation pairing; the $\delta_{1f} f_1 f_3$ block at the $(0, b)$ nodes carries the exact constant term $1/\det_b$ (deviations $\leq 5.2 \times 10^{-28}$). [E] CONSISTENCY CHAIN: the derived weight reproduces the v516 chain number by number — $w_m = (0, \frac{3}{2}, 2, \frac{3}{2}) = 4h_m = \mu_4 h_m = -4 \text{ch}_2(T_m)$; $T_5 = 0$ at every scale; $h_2 : h_1 = 4 : 3$; the T_3 budget $32 - 8c$ forces $c = 4 = \mu_4$ uniquely; per-sector Okubo squares $(18, 9, 18)\langle x, x \rangle^2$; total $45\langle x, x \rangle^2 = \frac{5}{4} \times 36\langle x, x \rangle^2$; $\Phi_{T_3} : 32 \rightarrow 0$, $\Phi_P : 72 \rightarrow 0$; $\psi(A_{\text{fix}}) = +64$, $\psi(\text{contact}) = -64$. [E] NEGATIVE CONTROLS: $1/\det^2$ gives $w' = (0, 5/8, 1, 5/8)$ with leftovers $(2, 12)$ and a Quillen contradiction; $1/ 1 - i^j$ gives $w''_1 = 1 + \sqrt{2} \notin \mathbb{Q}$; the $\mathbb{Z}_2$/Eguchi–Hanson anchor PASSES with the same derivation ($\det = 4$, $w = 1/2 = \mathbb{Z}_2 h^{A_1}$, $9\langle x, x \rangle^2 = \frac{1}{4} \times 36$, $c = 2 = \mathbb{Z}_2$); the $SO(16)/D_8$ KILL fires; $\text{diag}(i, i)$ breaks the zeta = AB identity itself; $k = 3, 5$: $w_m = m(k - m)/2 = k h_m$ — the weights wander correctly with the centre count, only $k = 4$ carries the E_8-glue chain. [C] TYPED PREMISES (the mandatory fence): TP-REG (Abel/Cesaro/zeta regularisation IS the definition of the equivariant character), TP-Q (Quillen structure of BCOV $F_1 = \text{v520 TP-4}$), TP-NUM (unphased numerator = the v520 ERFOLG-A decision layer), TP-CH (the insertion channel $(0, j)$ computes the box-channel weight). [O] the GLOBAL BCOV integral on $\mathbb{P}^1/\mathbb{Z}_4$ beyond the fibre zero-mode factor; the resolved-ALE route (v514/v517) not built; SEAM.EQUIV.TWISTOR.01 untouched. NO marker moves. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v524_woit_beta2_os_quotient.py	WOIT.BETA2.OS.01: the WOIT-β_2 milestone of the OS twistor bridge WOIT.OS.TWISTOR.01 executed — “the OS quotient of the free system made explicit” (verdict SUCCESS per the frozen preregistration, [C]-typed per contract precision (iii)). [E] $\mathcal{H}_{\text{phys}}$ EXPLICIT: $N = 16$ ($\deg \leq 2$): the 37×37 bond-cut OS Gram is exactly Hermitian, parity-block-diagonal, inertia $(37, 0, 0)$ PD (min eigenvalue 1.7801×10^{-6} at 40 digits), null space $\{0\}$, $\dim 37 = 29 \oplus 8$; $N = 8$ (complete half algebra): $(16, 0, 0)$ PD (min 3.3471×10^{-3}), $\dim 16 = 8 \oplus 8 = 4^2$ — compact euclidean time reconstructs a THERMAL (KMS) representation; exact certificate $\sin^2(3\pi/8) - \sin(\pi/8)\sin(5\pi/8) = 1/2$. [E] TRANSFER SEMIGROUP (Klein–Landau): τ_k exactly Hermitian on all domains ($k = 1..7$, dims $29, 22, 16, 11, 7, 4, 2$), chain identities exact, vacuum fixed; the positivity pattern IS the site/bond dichotomy: even k PSD via the exact square identity $T(2j) = A_j^* A_j$ ($(22, 0, 0)/(11, 0, 0)/(4, 0, 0)$), odd k indefinite ($(10, 12, 7)/(5, 6, 5)/(2, 2, 3)$) — the one-step transfer is NOT positive (the free chirality datum, kill-test-3 shadow sharpened), its even powers ARE. [E] THE CLOCK = $T^{N/4}$: $N = 16$: τ_4 PD $(11, 0, 0)$ (min 6.6821×10^{-5}), compressed spectrum $[0.0194517, 1.64144]$, vacuum eigenvalue exactly 1; $N = 8$: spectrum EXACTLY $\{1, \sqrt{2} - 1\} = \{1, 1/\delta_S\}$ in both parity sectors — the silver axes of the v519 μ_4 torsor return as the clock-transfer eigenvalue; spectral projections $\sim 10^{-40}$; the reconstructed rotation group $U(s) = e^{isH}$ is unitary with the group law. [E] v522 RESOLUTION: the census $(745, 96, 0)$ reproduced; EVERY anti-matching entry is a wrap overlap, every overlap-free entry matches — the pre-quotient non-Hermiticity is EXACTLY the domain/wrap artifact; on the quotient the clock has spectral calculus. Pre-registered KMS deviation: NO contraction on the compact circle (edge modes $C(1)/C(3) = 1 + \sqrt{2} = \delta_S$ exactly, $\det(G - \tau_4) < 0$). [E] GSO/Θ: the grading survives; the perpendicular torsor mirror descends anti-unitarily ($\eta_\perp \in \{\pm i\}$), $\Theta_{\text{phys}}^2 = +1$ on every sector (Kramers-free), $\theta_{\text{cut}} \circ \theta_\perp = \alpha_{N/2}$ exactly. [E] CONTROLS: site cut indefinite ($(3, 3, 1)/(2, 2, 4)$) — the contract kill branch fires there; family A $(4, 4, 0)$; anti-chiral $(8, 8, 0)$ no quotient; wrong direction non-Hermitian (mismatches all wrap-overlap). KILL-TEST BOOKKEEPING: (1), (2) strengthened, (3) shadow sharpened, none fires; (4)–(7) untouched; all seven stay live on $\mathcal{A}_{\text{hol}}$. [C] FENCE: “the clock acting unitarily” is operationalised per contract precision (iii) as the reconstructed transfer/rotation structure. TRANSPARENCY: run 1 scored 18/20 (a sympy simplify failure on a TRUE $\pi/16$ product formula, fixed by a Laurent-polynomial certificate; no criterion changed). [O] β_3 is the next milestone; WOIT.OS.TWISTOR.01 stays [O]; no marker moves. [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v525_seam_bit_twist_blind.py	SEAM.BIT.TWISTBLIND.01: the twist-state attack on the alignment bit DECIDED — “mark-decorated states do not see δ”, an honest, decided NEGATIVE result (v508 style): the NINTH side-blind test on the v512 scoreboard ($8 \rightarrow 9$); the free-plus-twist class (everything Wick-computable) is EXHAUSTED. [E] ALL LIFTINGS WELL-DEFINED AND BLIND: (a) σ-gauge arc decoration ($\mathbb{Z}_2$): $\sigma \circ r = \sigma$ on the swap axes makes the twisted Gram a diagonal unitary congruence DMD — spectra IDENTICAL to untwisted (dev 0.0); (b) Kadanoff–Ceva 4-twist insertion $\omega(D \cdot)/\omega(D)$: well-defined on $N = 32$ ($\omega(D)$ real nonzero; the $N = 16$ odd-m degeneration is the $C(\text{even}) = 0$ checkerboard artifact); the RP SPECTRA depend on δ for the first time in the program (pairwise up to 1.05), but the INERTIA is (16, 0, 0) PD with the SAME $\eta = +i$ for every m — the decoration sees δ, positivity does not; (c) the μ_4 twist at $\beta = \pi/2$ is pure plane gauge; (c') genuine Bogoliubov defect $\beta = \pi/4$: Θ-compatibility selects exactly 2 of 16 sign patterns (NS-wrap forced), the winner genuinely non-monomial — still PD, spectra identical. STRUCTURE THEOREM (empirical, mechanism exact): EVERY Θ-compatible quasi-free mark decoration is RP-spectrally INVISIBLE (the defect planes never straddle a cut bond; orthogonal congruence). [E] SUB-RESULTS: the defect energy $E_{\text{def}} = 1.2752872$ for EVERY m (spread 4×10^{-40}) — δ-blind; the 4-twist Casimir $\ln \omega(D)$ measures δ ($-0.890 \dots -1.348$) but is exactly mirror-symmetric under $m \leftrightarrow 8 - m$ — a family gauge, never a side selector; Kramers $\langle \Gamma \rangle_{\text{tw}} = +1$ for every m. [E] TWO BIT-PRESUPPOSING $\pi/2$ STRUCTURES (the harvest): the η flip $+i \rightarrow -i$ on the mark-fixing axes ($\sigma \circ r = -\sigma$, odd sector exactly negated); the twist frustration of the mark-fixing mirror ((4, 4, 0) indefinite for both η — the lattice shadow of the Ising twist field’s mirror-oddness) — both formulable ONLY on the fixing axes existing iff $\delta = \pi/2$: they PRESUPPOSE the bit (v512 facet class), no selector. [E] NEGATIVE CONTROLS: the twist-free limit = v519/v521 exactly; the site cut keeps failing in every decorated state; the v512 counterwitness is arc-equivalent at $N = 16$ to the blind member $\pi/4$ — no state-level selector can exclude it; a single twist has $\omega(D) = 0$ identically (twists exist only in mark pairs); the deck-paired FOUR-twist decoration is the minimal well-defined one. [O] the door narrows to a genuinely INTERACTING $\mathcal{A}_{\text{hol}}$ whose OS data are NOT Pfaffian-reducible to the chiral vacuum — beyond every Wick-computable class. VERDICT: KILL exactly as preregistered; the alignment bit remains genuine discrete input; no marker moves. [E][C][O]
v526_seam_thermal_kms_nariai_bridge.py	SEAM.THERMAL.KMS.01: the thermal seam — KMS of the reconstructed free OS quotient CLOSED onto the Nariai/BH temperature chain (the THIRD LEG of c_3). Verdict SUCCESS. [E] β MEASURED = N at both levels ($N = 8$: $\omega = \text{arcsinh}(2^{-3/4})$, $\kappa = q^{-8}$ exact; $N = 16$: pairing exponent $(N/2) + 1 = 9$); $T_{\text{seam}} = 1/N$ per clock step, $\beta_{\text{angle}} = 2\pi$ EXACT = $1/(4c_3)$, $T_{\text{seam}} = 4c_3$ = Bisognano–Wichmann/Hawking normalisation (v208); modular Hamiltonian closed ($\nu_1 = \cos(\pi/24)$, $\nu_2 = \cos(7\pi/24)$; Tomita KMS-$\beta = 1$ on all 256 pairs); c_3 third leg class-1 selected; entropy $S(8/16/32) = 0.52187/0.63510/0.75006$, $\Delta S/\ln 2 \rightarrow 1/6$, horizon fractions do NOT transfer; [C] silver = $C(3)/C(1)$ thermal kernel ratio; non-compact $\Rightarrow T = 0$. NO marker moves. [E][C]
v527_seam_clock_silver_spectrum.py	SEAM.CLOCK.SILVER.01: the silver clock eigenvalue EXPLAINED and DEMYSTIFIED (double verdict). STRUCTURE = SUCCESS: $\{1, \sqrt{2} - 1\}$ closed via diagonal Hankel pencil at $N = 8$, $\tan(\pi/8) = C(3)/C(1)$, doubling = exact second quantisation, carrier = silver-midpoint axes, gap = $\text{arcsinh}(1) = \text{gd}^{-1}(\pi/4)$; N-scaling = pure $N = 8/16$ lattice datum. CONNECTION = KILL: preregistered 11466-candidate census over 16 frozen numbers: 0 hits above null; placebos comparable. Cross-link v526: $\sqrt{2} - 1$ = thermal kernel ratio. NO marker moves. [E]

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Script	What it machine-checks (<i>continued</i>)
v528_seam_bit_twist_class_definition.py	SEAM.BIT.TWISTCLASS.01: the alignment bit as an exact measurable TWIST-CLASS choice (the physical definition). Verdict SUCCESS. [E] Facets #14 (η -flip $\Leftrightarrow \delta = \pi/2$) and #15 (twist-frustration $\Leftrightarrow \delta = \pi/2$) both directions exact (cardinality lemma $ A_+ = A_- \Rightarrow m = 4$; g -class census 224 axes: flip class exactly at $\{15, 31\}$); order parameter $O = 1/2$ at $m = 4$ else 0; unification #14=#15=flag-transitivity = ONE $\mathbb{Z}_2$ invariant (v512 web 13 $\rightarrow$ 15); Kramers = POSITION half (derived), twist class = MODULUS half (the input). [C] measurement sketch (interferometric in principle); the bit remains formal input. NO marker moves. [E][C]
v529_seam_interacting_toy_fk.py	SEAM.INT.FKTOY.01: the minimal interacting Fidkowski–Kitaev seam toy — the FIRST firing Kill-Test-2 shadow (triple-verdicted). F1 = KILL: Θ exists so Kill-Test 1 does NOT fire; Kill-Test 2 FIRES at toy level — RP breaks for every $g > 0$ (inertia ladder $(37, 0, 0) \rightarrow (29, 8, 0)$); STRADDLE LAW (24/24). F2 = KILL: the TENTH side-blind test ($9 \rightarrow 10$) — Θ_{15} maps $H(m) \rightarrow H(8-m)$ EXACTLY. F3 = ERFOLG: grading + $\mathbb{Z}_8$ tower + FK anchor + constructive OS quotient at $\pi/2$. [C] fence: one toy / one interaction class — narrows the Woit route, does NOT close it; WOIT.OS.TWISTOR.01 stays Open. NO marker moves. [E][C][O]
v530_center_quotient_compiler.py	center quotient compiler: $Cv=v$, $\mathbb{Z}^3/\mathbb{Z}v$ quotient = $(\begin{smallmatrix} 8 & 2 \\ 5 & 3 \end{smallmatrix})$ (atoms); row sums (7, 11, 13) self-code; CP code (1, 7, 11, 13); $\det(C+kI)=(k+1)\det(A+kI)$
v531_coxeter_tensor_stage_a.py	Stage A tensor clock: $T_{30}=\text{Comp}(\Phi_5)\otimes\text{Comp}(\Phi_6)$, order 30, $\chi=\Phi_{30}$; traces $c_{30}(k)=c_5(k)c_6(k)$; atom readout (2, 4, 8)
v532_e8_degree_modular_checksum.py	dual-degree checksum: (60, 192, 240, 252): sum 744=3·248, prod $ W(E_8) $, gcd 12; $j=q^{-1}+744+\dots$; D_{16} control 1488=3·496; primes < 30 fingerprint [audit]
v533_ftransfer_disc7_norm.py	sheet transfer as a disc = -7 norm line: $D(t)=N(\alpha_t)$, $\alpha_{t+1}=\alpha_t+2$, norms (2, 4, 14, 32) on $J \rightarrow K \rightarrow C \rightarrow F$
v534_seam_straddle_cone.py	SEAM.STRADDLE.CONE.01: the RP cone on the interacting FK quartets — the FIRST DYNAMICAL SELECTION of the alignment bit (double-verdicted). V1 = KILL: the literal leading-order cone is EMPTY everywhere (the linear pencil cannot carry the selection). V2 = ERFOLG — THE SELECTION LAW: reflection positivity holds for EXACTLY ONE member $\times$ sign of the equivariant FK family — $\delta = \pi/2$ with positive coupling, PD (37, 0, 0) on all four cuts incl. the straddled clock axes 7/15 for $g \in \{1/32..8\}$, minimum eigenvalue LIFTED off the RP boundary; asymmetric members die. Exact geometry: $\pi/2$ is the unique symmetric-straddle member (quartet partition, reflection-closed straddles, sign +1). [C] fence: one toy / one interaction class — NO marker moves

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Script	What it machine-checks (<i>continued</i>)
v561_cp_channel_identities.py	CP channel/invariant identities (T177): the hexagonal channel identity — on the CM unit $\rho = e^{i\pi/3}$ the E_8 split $248 = 120 + 128$ has an exact fiber realisation, $\sum_k \rho^{d_k} = 4\rho$ (arg = $\pi/3$ exactly, sheet-EVEN because all degrees are even) and $\sum_k \rho^{m_k} = 4$ (arg = 0 exactly, sheet-ODD because all exponents are odd) — the phase-channel angle is sheet-blind; $\arg(\prod c) = 0$ exactly on both TFPT magnitude sectors and the μ_3 branch group is the kernel because its order divides $N_{\text{fam}} = 3$ (the REDTEAM.D.01 residual is a <i>fiber</i> datum, not a magnitude datum); Tier-1 invariance is EMPTY by the blindness theorem (both kernels commute with conjugation, so every $\pi/3$ -carrier is κ -odd); the frame removal — $\text{Im det}(\mathbf{1}, d, \rho n) = 21 \sin(\pi/3)$ is homogeneous of degree +1 in the frame normalisation (frame data), while $\text{Im}(\rho \det)/\det = \text{Im } \rho = \sin(\pi/3)$ exactly (the invariant core is the fiber datum, the sign a declared orientation); and the two inequivalent Tier-2 characters $(-1, +1)$ vs $(-1, -1)$ carrying the same $\pi/3$ (the DEGENERATE verdict as algebra, neither frame-coupled), anchored by Jarlskog 1985 ($J = 3.327 \times 10^{-5} = \text{v88}$, passing rephasing/CP-oddness, failing only the $\pi/3$ -carrier test) — four ledger readings narrowed, no marker moves, no CP derivation claimed; R1/R2 typed OPEN [E]
v564_cp_fiber_pin.py	The frame door of the CP mirror, decided (T178): the Euler factorisation — the fiber acts by a scalar on the n -row, so $P(\rho n) = \rho^m P(n)$ for fully generic homogeneous blocks and every scale-free functional is $\sum_k A_k \text{Im}(\rho^k)$ with real degree-0 frame ratios A_k ; the natural (metric-free) class is FIBER-ONLY by theorem (the bracket enumeration on $\{\mathbf{1}, d, n\}$ has one generator: six permutations = $\pm\Delta$, the other 21 vanish identically in a generic n ; Weyl 1946 FFT the cited class boundary) — T177's R1 obstruction is now a theorem; the metric door is NON-CANONICAL ($\Delta/\langle d, n \rangle$, $\Delta/\langle \mathbf{1}, n \rangle$ at $(-1, -1, +1)$ vs $\Delta^2/\langle n, n \rangle$ at $(-1, -1, -1)$; the continuum $q_t = t n_1^2 + n_2^2 + n_3^2$ gives values $441 \sin(\pi/3)/(25t + 117)$ — no canonical frame factor, anti-numerology wired as a check); the SINGLE-SINE LEMMA — $\{ \text{Im } \rho_n^k \}$ has one nonzero element iff $n \in \{1, 2, 3, 4, 6\}$ (crystallographic, $\varphi(n) \leq 2$), by $\sin(4\pi/n) - \sin(2\pi/n) = 2 \sin(\pi/n) \cos(3\pi/n)$: the two compiler clocks μ_4 ($j = 1728$) and μ_6 ($j = 0$) are the two maximal single-sine fibers, so T177's DEGENERATE verdict was FORCED; and the ANCHOR SELECTION — Jarlskog carries the full tuple $(-1, -1, -1)$ (certified at 40 dps), matching the sheet-odd orientation class and not the sheet-even channel class: the unique anchor-matching canonical carrier is the fiber-pure $\text{Im } \rho = \sin(\pi/3)$ — R1 decided, R2 selected conditional on the anchor, no marker moves [E]
v565_woit_beta3_pt_duality.py	The WOIT- β_3 milestone executed: the $\mathbb{P}\mathbb{T} \leftrightarrow \mathbb{P}\mathbb{T}^*$ duality typed against σ_{std} — clock compatibility forces the two-block Hermitian class ($16 \rightarrow 8$ parameters); the ρ_{tw} pairing splits it into an EUCLIDEAN branch (σ_{std} 's home; seam norm $a(z ^2 + 1)$, no OS cut ever) and a MINKOWSKI branch whose null locus meets the seam line EXACTLY in the seam circle (the OS cut forced) with total signature $(2, 2)$ by the mirror theorem ($\Phi_1 = -\bar{\Phi}_i$, charpoly mirrored) — Woit's Minkowski signature a theorem, not an input; the kill branch is EMPTY BY ALGEBRA (every compatible duality inverts clock and deck — family D; family A would need $\rho_4^2 = \text{scalar}$); every seam-preserving Minkowski member induces the SAME conjugation $z \rightarrow -\bar{z}$ ($\mu = -1$, fixed points $\pm i$), perpendicular to σ_{std} 's $z \rightarrow +\bar{z}$, and under the declared RP-side placement it IS $\theta_\perp$ — the v524 Θ_{phys} carrier (regressions re-verified: Gram PD, anti-unitary, $\Theta^2 = +1$ per sector, time reversal, torsor closure onto the deck); verdict SUCCESS, the contract stays [O], γ is next [E][C][O]

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Script	What it machine-checks (<i>continued</i>)
v566_parabolic_anchor_selfcode.py	The parabolic anchor self-code: the sheet-diamond directions $U = Q \operatorname{diag}(1, 0, 0)$, $V = Q \operatorname{diag}(0, 1, 1)$ generate the FULL 2 1 parabolic algebra $\mathcal{A}$ (dim 7, word determinant -81 , multiplicatively closed); the anchor $a = (1, 1, 2)$ is the spectrum of $H = I + V(V - I)/2$ and $\chi_H = x^3 - 4x^2 + 5x - 2$ carries the DOUBLE code $(4, 5, 2) = (\mu_4 , g_{\text{car}}, \mathbb{Z}_2) = (\text{flag}, \text{Levi}, \text{radical})$; the uniqueness theorem $(x - m)(x^2 - mx + 1)$ forces $m = 2$ — $a = (1, 1, 2)$ is the only anchor this family can code; the saturated integral order has index $[P_{\mathbb{Z}} : \mathbb{Z}\langle U, V \rangle] = 3^4 = 81$ = the v218 determinant-staircase sum (cokernel $(\mathbb{Z}/3)^4$; mark-local mechanism [O]); the basic algebra is the A_2 path algebra with $\dim \operatorname{Ext}^1 = 1$ (two module classes: the alignment bit gains a canonical carrier, selection stays with RP); $p_n(a) = 1 + \operatorname{tr}(V^n)$ (AnchorLadder re-encoded, 240 and rank 8 as trace readouts); the CR = 4/3 preregistered test for CONTRACT.F.01 ; the Lorentz/pencil form of the Paper-II rank-3 classification — NO P2 reduction (the 'No Carrier Reconstruction' audit is the named [O] door) [E][C][O]
v567_carrier_free_q_reconstruction.py	The No-Carrier-Reconstruction audit (Stage A): with the v11 carrier budgets FORBIDDEN (rows (4, 5, 6), columns (9, 5, 1), χ_Q with its 5), the carrier-free inputs — sheet involution, winding normalisation $Q(I + \Sigma) = 2N_{\text{fam}}W$, A_3 exponent spectrum $\{1, 2, 3\}$, monodromy budget $Q_-^2 = N_{\text{fam}}P$, integrality, the seam-line demand — admit exactly $52 \rightarrow 28$ (parabolic) reconstructions, and ALL 28 code the SAME anchor ($\chi_{H'} = x^3 - 4x^2 + 5x - 2$, spectrum $(1, 1, 2) = a$): the anchor self-code is carrier-free ; the single family invariant (saturation index $N_{\text{fam}}^4 = 81$) then pins Q to a TWO-element residual family ($q_{32} \in \{2 = \mathbb{Z}_2 , 0\}$, difference $2E_{32}$) on which every classical carrier-free certificate coincides — the one separating certificate is the forbidden column budget (9, 5, 1): one binary sheet-coupling choice remains (typed resonance with the split/nonsplit alignment bit). Winding ablation $28 \rightarrow 1376$; bound-stable; verdict RECONSTRUCTS-TO-FAMILY; the audit relocates to GATE.QGEO.01 and the binary selector — no P2 reduction, markers untouched [E][C][O]
v568_bit_selector_ladder.py	The reconstruction bit located and given its canonical witness: the two 81-twins generate DIFFERENT integral orders (equal index, different lattices — the bit is integrally visible); the dominant mode of the sheet direction is $v(c) = (1, 2, 2c)$ identically, and the LADDER SELF-CONSISTENCY — the dominant mode reproduces its own eigenvalue as the geometric ladder $(2^0, 2^1, 2^2) = (1, 2, 4)$ — selects $c = 2$ (the compiler Q) UNIQUELY on all 28 members of the carrier-free class, with the witness anchored in prior structure (AnchorLadder steps 2^n , $2 = \mathbb{Z}_2 $, the trace code); the split geometry sits at $q_{32} = 1$ and is EXCLUDED (algebra dim 5; the A_2 Ext arrow is nonzero on the whole class — the bit toggles WHICH nonsplit order, not split/nonsplit); Priority-2 candidates: the μ_4 -grading fails, the $\mathbb{F}_3[V]$ -action is computed — charpoly $x(x - 1)^2(x + 1) \bmod 3$, NOT the regular μ_4 pattern; the 81 stays a fingerprint — the physical selection stays open (the RP-selection slot), no P2 reduction, markers untouched [E][C][O]
v571_cr_discrete_corners.py	The preregistered cross-ratio check, discrete half executed: the corners $J, K, C, F = M(1, t)$ ($t = -2..1$, dets (2, 4, 14, 32)) read (26, 35, 44, 53) under the declared Koide functional $\ell(M) = a^T M \mathbf{1}$ — CR = 4/3 exactly, and $y_F = 53$ is Möbius-forced by the three upstream corners (fit-free); ℓ is affine on the path (step $9 = N_{\text{fam}}^2$; every linear functional passes — stated honestly); negative controls: determinants 28/25, dominant eigenvalue 1.3222; the continuous solver states stay open per CONTRACT.F.01 [E][C]

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Script	What it machine-checks (<i>continued</i>)
v572_rp_bit_form.py	The RP form on the 81-twins: spectrally blind (identical inertia for every declared state; never PSD — no kinematic positivity selection, honest negative) but integrally ANCHOR-VISIBLE — the Smith towers of the anchor-state Gram separate the twins in one slot (18 vs 2, a factor $9 = N_{\text{fam}}^2$; ladder state identical, anonymous states blind); trace discriminant -81^2 on both; blindness robust under the compiler V -flow, but the anchor-Hamiltonian GIBBS PENCIL separates: the compiler twin is Gibbs-critical at $s^* = (8 - 4\sqrt{19})/15$ (det constant 81^2), the alt never — a rank-drop marker whose critical mode is the seam-row, sheet-flow-fixed direction (the A_2 -Ext carrier); the positivity selection stays open [E]
v574_stageb_winding.py	Stage B, first narrowing: the involution TYPE is forced (rank theorem — a 2-dim-positive involution cannot carry the binary trace code), (E) bounds $N \leq 3$, the ladder self-consistency selects one member per N , and $\text{sat} = N^4$ holds ONLY at $N = 3$ ($32 \neq 1$, $512 \neq 16$, $81 = 3^4$): the double self-consistency pins $(N, Q) = (3, \text{compiler } Q)$ — $N_{\text{fam}} = 3$ relocates from declared to consistency-forced; spectrum ablation: the surviving family is exactly $\{1, 2, N\}$ with the compiler shape — the self-consistency forces the sheet block, (E) contributes $N = 3$; redundancy: (M) and (L) fall relative to the self-code demands (class 1274, compiler Q still unique) — the maximal ablation drops (E) too — winding column + integrality + self-code pin the compiler alone; declared: involution existence, the winding UNIFORMITY (without it a four-column family survives, exactly one uniform — the compiler), $N_{\text{fam}} = 3$ (E8-glue); GATE.QGEO.01 narrowed by five items, not closed, no P2 reduction [E][C]
v575_cr_continuous_uniflow.py	The continuous half of the cross-ratio check, executed: the native exports $\{(2/3)^6, (2/3)^6, 1, -7\}$ are forced degenerate by the single-flow theorem (v425), and a repeated quadruple gives $\text{CR} \in \{0, 1, \infty\}$ in every assignment — never $4/3$: the continuous half closes onto the single-flow reduction; the anchors stay [O] walls, the discrete half (v571) carries the content [E][C]
v578_native_jets.py	The jet contract executed natively: the seam flow has $\{q, t\} = -\Delta^2/2$ exactly (Moebius in its own clock $u = e^{\Delta t}$), the 1-loop QCD flow has Schwarzian 0 in its own RG time — no shared wall-time jet invariant; each instance projective in its own clock, the obstruction is the clock; external anchor-level jets remain the future test [E][C]
v584_ext_source_response.py	The interacting follow-up of v572: rank-one Ext-source coupling on the Gibbs pencil separates the 81-twins directionally inside the unit coupling box — exact rational flip thresholds whose numerators are the v572 pencil factors; positive coupling $J \leq 15/16 < 1$ heals exactly the compiler twin, the alt twin is rigid; the response pole sits on the golden polynomial $s^2 - s - 1$; a response-level selection, not a positivity theorem [E][C]
v590_involution_existence.py	The sheet-involution existence of GATE.QGEO.01: the integral V -commuting involutions are exactly the spectral sign group $(\mathbb{Z}/2)^3$ on both twins (rigidity); the v574 type theorem, seam reversal and zero-mode fixing single out S_0 uniquely with exact Σ -signature — existence is unconditional; the two demands' continuum derivation stays the named open [E][C]
v597_mu4_cover_model.py	Strategy I/II first step: the μ_3 -cover $y^3 = x^4 - 1$ carries four compiler fingerprints — rank-3 Eisenstein module, projective D_4 via the deck ($r^4 = \omega$), cusp-class group $(\mathbb{Z}/3)^4$ of order 81, and the unique invariant hermitian form of Lorentz signature (1, 2) matching Chevalley–Weil and Paper II; the Q/V dictionary stays the named open [E][C]
v598_cover_dictionary.py	The cover dictionary, round 2: three compiler objects located exactly — $U \sim G_2$, $Q_- \sim G_1 - G_3$ (the sheet coupling as the diamond-diagonal Gram difference), the binary ladder $\sim 1 + G_1 + G_3$; opposite-twist products nilpotent; the grading half absent from 7296 scanned canonical combinations (kill not triggered; the real structure is the named suspect) [E][C]

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Script	What it machine-checks (<i>continued</i>)
v599_real_structure.py	The real structure on the μ_3 -cover: the anti-holomorphic D_4 reflection constructed exactly (R unique up to scale, $R^2 = +1$, four twist intertwinings); the grading functor closes the three v598 dictionary gaps at char level (V , H with the anchor spectrum $(1, 1, 2)$, Q_+); the Γ -decomposition carries 5, 9, 27; the joint embedding stays open (quantified negative); the invariant form has $\det J = 8$ and Lorentz signature $(1, 2)$ [E] [C]
v600_joint_embedding.py	The joint embedding: the compiler pair (U, V) realized on the μ_3 -cover as a Γ -even degree-2 pair — $\mathbb{Z}[\omega]$ -integral, seven-word rank 7, simultaneous conjugation to the compiler pair solved exactly, integer restrictions on the saturated $\text{Fix}(R)$ lattice, and saturation index $81 = 3^4$ with the exact v566 divisor pattern $(1, 1, 1, 3, 3, 3, 3)$; canonicity typed open [E] [C]
v601_equivariant_dual.py	The canonical equivariant realization: the J-adapted cusp projectors rotate exactly under D_4 ; the pair family $U_k = 3GJ_k$, $V_k = 1 + GJ_{k-1} - GJ_kGJ_{k+1}$ is $\mathbb{Z}[\omega]$ -integral, compiler-exact and equivariant by construction (mark choice = winding choice); it realizes the DUAL parabolic exactly (conjugate to the transposed pair; the direct intertwiner is singular), and the v590 Klein four-group lives integrally on the curve; the Weil-twisted RP comparison stays open [E] [C]
v602_duality_forms.py	The duality-and-forms round: the J-adjoint exchanges the two parabolic types inside one equivariant structure; the dictionary completes in the J-projector language (the corpus anchor formula $H = 1 + V(V - 1)/2$ holds verbatim); Weil positivity holds exactly (JC positive definite, the Riemann bilinear relations on the ω -sheet); the canonical bilinear form $B = M^\dagger J$ is symmetric with $\det B = 8$; the corpus-transpose and mark-local questions typed open; Lean certificate FORM.QGEO.04 [E] [C]
v603_seam_marks.py	The seam-and-marks round: the seam line is a REAL line of the cover (unique common eigenline, R-fixed, S_0 -reversed — the v590 seam-reversal demand geometric); the infinity cusp separates in the unreduced Burau module; the first per-mark $\mathbb{Z}/3$ witness lands (E_1 , class order 3 in the word-order cokernel); the corpus-transpose translator negatives quantified [E] [C]
v604_equivariant_order.py	The equivariant order and the infinity bridge: R IS an anti-isometry ($M^\dagger JM = J^T$ exact; correction of a diary side remark), J restricts to the integer form J_{fix} with $\det = 72$; the four mark frames generate a FULL order of index $27 = 3^3$ in $M_3(\mathbb{Z}[\omega])$; the 3-torsion localizes at infinity ($\text{coker}(1 - T_\infty) = \mathbb{Z}^2 \oplus (\mathbb{Z}/3)^3$, finite cusps torsion-free): 81 at the marks, 27 at infinity; translator negatives extended (the $\bar{\omega}$ -sheet named) [E] [C]
v605_translator.py	The translator round: the corpus RP anti-automorphism IS the J-adjoint twisted by an explicit inner element c ($\varphi(A) = cAc^{-1}$ exact, intertwiner space 1-dim, $14c$ integral over $\mathbb{Z}[\omega]$); the seam is a NONZERO pure 3-torsion class at infinity (torsion coords $(2, 2, 0)$); the 81 survives frame-joining as the saturation defect (chain indices $3^5, 3^4$); the J_{fix} duality certified with a Lean addendum [E] [C]
v606_mode_separation.py	The mode-separation round: all three V -eigenlines lift to PURE 3-torsion classes at infinity with PAIRWISE DISTINCT classes (the selection carrier the real structure could not provide; the canonical '+1' rule stays open); and the cubic field of the translator element has discriminant $-783 = -3^3 \cdot 29$, Galois S_3 — no cyclotomic identity for c (honest negative) [E] [C]
v607_selection_rule.py	The selection rule: the infinity torsion is a genuine $\mathbb{F}_3$ space, the deck rotation acts with char $(x + 1)(x^2 + 1) \bmod 3$ ($x^2 + 1$ irreducible) — EXACTLY ONE projective eigenline, and it IS the top mode; the three modes carry mutually exclusive canonical labels (seam = R -real, top = deck-eigen, zero = unlabeled) and S_0 flips exactly the labeled pair: both v590 demands expressed through cover structure [E] [C]

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Script	What it machine-checks (<i>continued</i>)
v608_gamma_free_slice.py	The free gamma slice: mirror modes are STRICTLY OS-negative (the anti-chiral odd sector is negative definite – no mirror survives reconstruction, kill test 3 cannot fire at the free level); the chiral generation is multiplicity-free (clock spectrum $\{1, \sqrt{2} - 1\}$); and the mark transport exists (τ_2 is the mark-A→B transport, PD) – kill test 7 does not fire at the free level; the gamma milestone stays open on $\mathcal{A}_{\text{hol}}$ [E][C]
v609_translator_factorization.py	The translator factorization: the mirror intertwiner d ($dA = \Gamma(A)d$) is UNIQUE, unimodular, $\mathbb{Z}[\omega]$ -integral and Γ -involutive ($\Gamma(d)d = 1$); the v605 element factorizes exactly, $c = \lambda K_1 d$ with $K_1 = J^{-1} \overline{F}_2^T M^{-1}$ — $\theta_{\text{corpus}} = J \text{adj} \circ \text{inner}(K_1) \circ \text{inner}(d)$: the geometric identity of c is closed [E][C]
v610_curve_landscape.py	The curve landscape: the Jacobian splits (differential characters of orders (12, 12, 6)) into a $\mathbb{Q}(\zeta_{12})$ -CM abelian surface — the field of deck AND marks — times the $\mathbb{Q}(\omega)$ -CM elliptic curve $E: y^3 = u^2 - 1$; point counts confirm the splitting ($a_p(C) = a_p(E)$ for all tested $p \not\equiv 1 \pmod{12}$); the integer-spectrum census honestly relativizes single-char hits (the anchor class is the most frequent nontrivial family; the compiler's distinction is the joint structure) [E][C]
v611_periods.py	The periods round: the five basic period integrals are EXACT Beta values with all Gamma denominators on the ζ_{12} grid; the μ_4 rotation acts on periods with the exact characters i^{k+1} ; $\Omega_E = B(1/3, 1/6)/2$ exactly (the classical ω -CM period); the cross-factor ratio admits no low-degree integer relation (PSLQ) — the two CM factors are period-independent, as the v610 splitting demands [E][C]
v612_polarization_frame.py	The polarization frame: r has three simple eigenvalues $\zeta_{12} \cdot \{1, -1, -i\}$; in the rotation eigenbasis J becomes exactly diagonal with signature (1, 2), and THE UNIQUE POSITIVE (Hodge) DIRECTION IS THE PRIMITIVE ζ_{12} EIGENSPACE — the analytic Hodge structure and the finite rotation agree on where positivity lives; the canonical period normalization (Beta weights) is the named next step [E][C]
v613_canonical_periods.py	The canonical period normalization – the analytic bridge closes: the quarter rotation acts DECK-FREE on the four branch segments (12 wrap factors exactly 1); THE EXACT DICTIONARY $r = \text{deck} \circ \text{rotation}$: $\text{char}(r) = \text{char}(\omega M)$ exactly, explaining $r^4 = \omega$ structurally; the period rows (hol dx/y^2 , hol $x dx/y^2$, antihol $\overline{dx}/y$) realize the rotation eigenframe; the Hodge weights are explicit Gamma monomials (complex Beta formula, $h_1 = (3\sqrt{3}/16\pi)\Gamma(1/3)^2\Gamma(1/6)^2$); and $J = -h$ PER CHARACTER: the compiler polarization is minus the analytic Hodge form — Riemann–Hodge positivity realized [E][C]
v614_transport_deck.py	The Gauss–Manin transport round – THE DECK STEP IS THE BOUNDARY MONODROMY: transporting the segment cycles along the rigid quarter-rotation loop, the discriminant $\lambda(\tau) = e^{2\pi i \tau}$ winds once and the periods factorize exactly; at $\tau = 1$ the deck factor is $\omega = t^4$ on every sheet (the exponent $4 = \mu_4 $ forced by the puncture count); the canonical transport matrix is EXACTLY ωM — the v613 dictionary $r \sim \omega M$ is CANONICAL, and $(\omega M)^4 = \omega$ re-derives $r^4 = \omega$ [E][C]
v615_gamma_toy_interacting.py	The interacting gamma slice at toy level: the gamma battery executed ON the RP-surviving interaction (the alignment bit, v534) – THE INTERACTING MIRROR FLIP: at the forced twist the mirror state's odd sector is STRICTLY NEGATIVE DEFINITE on every cut and every coupling (kill test (3) cannot fire on the surviving class – v608 upgraded from $g = 0$ to the full grid); the mark transport exists interacting (kill test (7) does not fire); the odd transfer spectrum stays multiplicity-free; the dead member has no RP home: bit selection and chirality data CO-LOCATE [E][C]

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Script	What it machine-checks (<i>continued</i>)
v616_su2_internal_kinematic.py	The internal $SU(2)$, kinematic separation at twistor level: Woit's Euclidean structure IS the internal j -direction ($\rho_{\text{tw}} = \text{right-}j$ verbatim); the internal $\mathfrak{su}(2)$ preserves every twistor fiber, commutes exactly with the spacetime quaternion action and intersects it in $\{0\}$ — kill test (6)'s KINEMATIC branch does not fire; THE CLOCK FACTORIZES as left- u right- u exactly ($u = e^{i\pi/4}$: spacetime half-quarter $\times$ internal half-quarter), the ALE deck is purely spacetime-side, and the complex choice breaks the internal $SU(2)$ to $U(1)$ with the v519 mark torsor as its μ_4 [E][C]
v617_seam_cover_forcing.py	The seam forcing round — THE CONFORMAL SEAM AXIOMS FORCE THE μ_3 -COVER: $\mathbb{Z}_4$ -Möbius rigidity (every $\mathbb{Z}_4$ -cyclic configuration is Möbius-equivalent to μ_4 ; harmonic cross-ratio orbit $\{2, 1/2, -1\}$), the weight census forces UNIFORM weights $j \in \{1, 2\}$ (the conjugate sheet pair), $j = 1$ gives $y^3 = x^4 - 1$ exactly with genus 3, and the seam reflections match the cover's real structure (the v599 $(k, 5-k)$ pattern, the two v519 cut points); the bedrock residue narrows to the cyclic-3 choice and the physical $\leftrightarrow$ conformal seam identification [E][C]
v620_cyclic_n_census.py	The cyclic- N census — the seam admits EXACTLY $N \in \{3, 5\}$ as primitive-Lorentz orders (full infinity ramification iff $\gcd(N, 4) = 1$; Chevalley–Weil signatures; $N = 6$ reduces to $N = 3$), and the compiler's machine-checked integral constants ($\det_{\mathbb{Z}}(1 - \text{deck}) = 27 = 3^3$, saturation $81 = 3^4$) pin $N = 3$ UNIQUELY: the v617 bedrock residue (i) is now conditional on $N_{\text{fam}} = 3$ (E_8 -anchored) [E][C]
v621_interacting_semigroup.py	The interacting Klein–Landau semigroup — at $g = 0$ the v524 pattern reproduces exactly at $N = 16$; at $g > 0$ exact Hermiticity survives PRECISELY on the μ_4 -commensurate steps $\{4, 6, 7\}$ and the clock step stays a positive transfer $((11, 0, 0))$ over the whole grid: the interaction breaks translation invariance to the quartet stabilizer exactly, and the reconstructed rotation group of the interacting toy is the CLOCK tower, not the full circle [E][C]
v622_seam_identification.py	The seam identification round — THE PHYSICAL SEAM IS THE CONFORMAL SEAM: the v519 kernel is EXACTLY the discrete NS chiral mode sum (including the even-distance zeros — the flat band IS the NS spectrum; Ramond must-fail), the mark-bond midpoints sit exactly at μ_4 , the group dictionary is exact (clock = $z \mapsto iz$, cuts = diameters), and the straddle law is literal geometry (straddled = axis through marks); the remaining residue is the covering-level identification [E][C]
v623_covered_seam.py	The covered seam round — the lattice skeleton of the covering-level identification: the lifted seam is ONE 48-site NS circle for uniform weights (the alternating pair DISCONNECTS it — a new independent kill), the lifted clock has EXACT ORDER 12 with $L^4 = \text{deck}$ ($r^4 = \omega$ as lattice combinatorics), the v622 kernel identity generalizes to $N = 48$, and the deck-character mode grid is the 12-grid with the untwisted sector equal to the base seam verbatim and the twisted pair carrying ω on bilinears [E][C]
v624_external_lattice_audit.py	The external-review lattice audit: THE FOUR-MARK CLOSURE (three independent selectors force $d = 4$ under the $D_{d+1} \oplus A_{d-1}$ glue architecture — disc-group census, the norm equation $(d+1)/4 + (d-1)/d = 2$, the Pythagorean $(3, 4, 5)$ selector; the two-input presentation reduces to ONE boundary degree plus π , conditional on the architecture); THE ANCHOR BYTECODE ($\chi = (t-1)^2(t-2)$, two-state recursion, $240 + 8 = 248$); and THE LORENTZ CONGRUENCE ($P^T J_{\text{det}} P = J_{\text{fix}}$ exactly, index 6) — the prime-front determinant form and the cover polarization lattice are the SAME rational quadratic form; the review's B -test is retyped as ill-posed (B complex symmetric) [E][C]

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Script	What it machine-checks (<i>continued</i>)
v626_e8_code.py	The E8 code round – E8 IS an error-correcting code: Construction A on the self-dual extended Hamming code $[8, 4, 4]$ yields the even unimodular rank-8 lattice (= E8, by uniqueness) with shells 240/2160 matching the v625 theta identity; every single-bit error is exhaustively correctable; the compiler ties ($8 = \text{rank}$, $4 = d = \mu_4 $, $16 = \text{half-spinor}$, $14 = 2 \times 7$) are typed observations.
v628_orbifold_casimir.py	The orbifold Casimir round – the covered seam’s three deck-mode classes carry EXACTLY the $\mathbb{Z}_3$ -twist Casimir data: exact closed form $E_0(\nu, N) = -\cos(\pi(2\nu - 1)/2N)/(2\sin(\pi/2N))$, finite-size coefficient exactly $\pi(6\nu^2 - 6\nu + 1)/12$, sector table $(1/72, -1/24, 1/72)$, degenerate twisted pair, ratio $-1/3$, twist gap $1/18$.
v629_root_incidence.py	The root incidence census – the naive 48×5 incidence to the E8 roots is KILLED (orbit census $19 \times 12 + 3 \times 4$ for the compiler-canonical order-12 element, not 20 free ζ_{12} orbits), and the positive residue is sharp: the μ_4 clock alone acts freely with EXACTLY 60 orbits ($60 = D_{\text{start}}$), and the family 3-cycle fixes exactly 12 roots (the lifted marks).
v632_ftransfer_pgl2.py	The F_{transfer} PGL ₂ round – the v533 preregistration executed in its literal group form: the four external transfer solvers share ONE Moebius action on the disc -7 norm line where they act at all (the Koide reading is the parabolic step $+9 = N_{\text{fam}}^2$, exactly intertwined with the base translation T ; g_{QCD} explicitly conjugate to T in the $1/\alpha$ coordinate; $g_{\text{Boltzmann}} = g_{\text{pole}}$ by the single-flow theorem; relic degenerate); the kill criterion ‘four incompatible arithmetic actions’ is NOT met; five must-fail controls have teeth.
v633_orbit60_quotient.py	The μ_4 -quotient round – the quotient of the 240 E8 roots by the free μ_4 clock IS the hermitian-unimodular $\mathbb{Z}[i]$ -E8 with the 60-hyperplane system of ST31 (hermitian-unimodular basis among the reps, σ census $19 \times 3 + 3$ on the lines, line group of order $11520 = 46080/4$; ST32 killed by its 40-hyperplane count); the $60 \rightarrow 6$ cascade route on the quotient is KILLED (Gram rank 4, regular graphs, no canonical pair rule) – a typed negative.
v634_st31_structure.py	The ST31 structure round – G_{31} is the FULL unitary stabilizer of the μ_4 -quotient structure (exact count 46080), the degrees $(8, 12, 20, 24)$ are unique via Molien, the compiler data embeds canonically ($\sigma = c^4$, $J = c^9$, $\langle c \rangle = Z_{12}$), and the computed structure is $G_{31} = (Z_4 \circ 2^{1+4}).\text{Sp}_4(2)$ – while the numerology $ G_{31} = W(D_5) \times W(A_3) $ carries NO structure (not isomorphic, not a (semi)direct product, and $W(D_5)$ does not even embed: minimal faithful dimension $5 > 4$); HONEST: the v629 compiler clock is NOT the Springer-regular 12-element (census $19 \times 12 + 3 \times 4$, $ C(c) = 72$).
v638_code_semantics.py	The code-semantics rounds (kill + stage 2) – the unique compiler-equivariant Hamming placement C^* IS Reed–Muller RM(1, 3) on AG(3, 2) and carries an exact dictionary: information bits one per μ_4 pair (3 families cycled + 1 anchor fixed; the unique minimal Z_6 -orbit of information sets), syndrome = in-pair bit + pair pointer with the σ 3-cycle (anchor = sum of families), decode = projection verbatim on the single-error class (3840/3840, exact arithmetic) – and all of it dies for every non-equivariant placement (only 2/30 carry the structure).
v639_twist_ope.py	The twist-field/OPE round – the interacting slice of the $\mathbb{Z}_3$ orbifold statement holds at the abelian vertex level on the seam double: $h_\sigma = 1/36$ from three exact routes (conventions reconciled), lattice two-point exponent $2\Delta = 2/9$ at 0.06%, crossing exactly symmetry-protected on the lattice, closed four-point form $[w(1-w)]^{-2\Delta}$ at $< 0.1\%$, OPE $c_1 = 2/9$ model-bound at 0.19% (model-free $\pm 15\%$ band typed open); reflection positivity validated in the real $\mathbb{Z}_2$ class and honestly OPEN for the complex $\mathbb{Z}_3$ pairing (parafermionic Klein twist); GATE.QGEO does not move.

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Script	What it machine-checks (<i>continued</i>)
v645_klein_rp.py	Parafermionic Klein-twist reflection positivity – the $\mathbb{Z}_3$ twist sector IS reflection positive on the seam-double lattice under the Klein pairing (mirror COMPOSED WITH charge conjugation, ω^{kq} zero-mode phases, $\eta = (1, 1)$ UNIQUE among 36 scanned pairs), resolving the named open item of QGEO.TWISTOPE.01 at the lattice OS level: every charged Klein block is exactly real symmetric AND PSD (worst 2.9×10^{-12}), N -stable 48..384, both diameter axes, including the FULL mixed OS Gram over $\{1, \sigma_1, \sigma_2, \text{dipoles}\}$ with no sector projection; the naive pairing keeps its N -stable violation (-4.5×10^{-3} , must-fail); continuum OS reconstruction and modularity stay typed open; GATE.QGEO does not move.
v646_rm13_reverse.py	The RM(1,3) reverse reading – are compiler numbers CODE operations? An honestly TWO-PART answer: the σ -fixed syndromes carry the anchor decomposition EXACTLY (coset-leader weights $(0, 1, 1, 2)$, norm-square sum 6, anchor = family sum $P_3 = P_0 + P_1 + P_2$ – the SELECTION is equivariance-specific, while the $(1, 1, 2)$ /norm-6 weights are generic for any $[8, 4, 4]$ placement), but the bytecode sequence $p_n = 2 + 2^n$ has NO code reading (0/11 natural families; 18/27/81 without any hit – the bingo is buried); the kill control fires selectively (the naive placement loses q -universality and the σ action but keeps the generic sector weights, all pure-code invariants, and even the σ -fixed-root count 12 – honestly retyped).
v647_st31_degree24.py	The ST31 degree-24/-20 round – the μ_4 center is a POWER of both regular clocks ($w^6 = \pm J$ for the regular 24-element with $\chi_w = x^4 + ix^2 - 1$ exact, all four eigenvalues primitive ζ_{24} ; $u^5 = \pm J$ central for the regular 20-element), and the clock question $c = w^2$ is KILLED by a PARITY THEOREM: the 12-cycles of any square come in pairs from 24-cycles, and census(c) = $19 \times 12 + 3 \times 4$ has ODD counts – impossible even in S_{240} (proof-grade); u^4 acts freely with census $\{5:48\}$, $48 = 240/5$ exactly, lines $\{5:12\}$; the equality $48 = \text{seam sites}$ stays a typed OBSERVATION.
v649_discipline_audit.py	The discipline audit – the suite parses ITSELF and certifies its process discipline as frozen minimum bars: 214 ledger rows document kills / honest negatives / retypes, 1469 must-fail/kill/scramble occurrences across 233 of 643 modules, 47 contract rows (29 naming kill criteria; executed chains FTR.PGL2 v533 $\rightarrow$ v632 and the W1 chain $\rightarrow$ v643 verified), deterministic replay 12/12 on the declared sample v55..v648 (two fresh runs, identical up to timing lines), five classical anchors recomputed against the literature (Jacobi r_4 , Construction A $\rightarrow$ 240 minimal vectors, the Shephard–Todd G31 degrees, the Suzuki archimedean constants to 25+ digits, the completed-zeta functional equation), and 54 committed Lean proof modules; the honest limit: process discipline, not physics truth – the open gates stay open (278 class-O rows).
v650_orbifold_modular.py	The modular data of the $\mathbb{Z}_3$ orbifold of the seam on the lattice: all nine twisted-sector partition functions $Z[g, h]$ match $ \theta[g/3, h/3]/\eta ^2$ at $< 1\%$, the modular S-covariance is MEASURED with a clean common N^{-4} rate (the N^{-2} lattice artifact is itself S-covariant and cancels in the S-relation), T is the exact discrete Dehn twist $(g, h) \rightarrow (g, g+h) \times (-1)^F$ at machine precision, the twisted characters carry $h_\sigma = 1/36$ with the parafermionic $1/6$ gap, and $\text{deck}^3 = (-1)^F$ closes exactly as $\mathbb{Z}_6$ trace arithmetic including the cover factorization; chiral phases, continuum T-phases and continuum OS stay typed open; GATE.QGEO does not move.

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Script	What it machine-checks (<i>continued</i>)
v651_orbifold_ assembly.py	The full $\mathbb{Z}_3$ -orbifold assembly of the seam: $H^2(\mathbb{Z}_3, U(1)) = 0$ by machine enumeration (27 cocycles, all symmetric – NO discrete torsion), and of six assembly candidates the survivors of {integer spectrum, unique vacuum, S measured clean, T exact} are exactly $\{B, C3\}$ – the naive $\mathbb{Z}_3$ dies by an exact T violation 3.5×10^{-3} (= its charge-3 content), C1 by S stalling, C2 has no vacuum, A' additionally by the wrong first twisted exponent; the seam data then discriminate B from C3 (B keeps every measured $c = 0$ sector ground and the Klein phase $\eta = (1, 1)$): THE SEAM ASSEMBLY IS B, the $\mathbb{Z}_6$ deck quotient with uniform charge-0 projection (data-backed, v652 hardens it structurally); the chiral phase $e^{-2\pi i \bar{a}b}$ is measured; GATE.QGEO does not move.
v652_orbifold_ arf.py	Arf/GSO hardening of the B-vs-C3 discriminator: the 6^6 classification of all sector-character wirings leaves exactly $\{B, C3\}$, the single-Fock-space pin forces B, and the μ_6 defect ladder measures the C3-excised states DIRECTLY – ladder exponents $2\Delta = (1/18, 2/9, 1/2)$ at $< 8 \times 10^{-4}$, exact charge-resolved minima $(0, 1, 4, 9, 4, 1)/36$; C3's odd-sector predictions 85/18 and 81/18 exceed the measurements by factors 85.0 and 9.0 (the defect string is exactly charge-neutral: C3 excises states that exist on the lattice seam with positive Klein norm); the earlier 2/9 read alone is B-vs-C3-blind (both coincide exactly on the even sectors) – the new τ datum: OPE exponent 1/18; the bond-defect premise passes to v653; GATE.QGEO does not move.
v653_bond_ defect.py	The bond-defect premise becomes a LATTICE THEOREM: twist sector = deck boundary condition = bond defect, canonically and exactly (unitary equivalence $A_r = \sqrt{3} R P_r$ on all modes, exact in $\mathbb{Q}(\zeta_6)$, at 16/48 and 48/144), with $D_{\text{can}} = L^4$ and $D_{\text{can}}^3 = -1$ as operator identities (the quarter clock fixes the canonical section lift); the defect position is pure gauge (symbolic telescoping theorem in all 16 free bond phases) with the gauge class pinned by the mark geometry (sheet reduction = one uniform twist unit per mark; cocycle support = the mark set); the exclusion census is complete – the base chain has NO other $\mathbb{Z}_3$, traces/holonomy/v628-Casimir kill everything outside, including the HONEST isospectral NN chain (it exists at 7.8×10^{-16} : purely spectral data cannot exclude it, but it is no $\mathbb{Z}_3$ -twist realization and the measured string data discriminate it); continuum CFT and the seam identification stay typed; GATE.QGEO does not move.
v654_st31_ degree8.py	The ST31 degree-8 round plus the unified $d/4$ theorem: every Springer-regular d -clock of G_{31} satisfies $x^{d/4} = \pm i \text{Id}$, a GENERATOR of μ_4 , never ± 1 (one formula from the exponent systematics: all exponents of G_{31} are 3 mod 4); the CONVERSE is exact at $d \in \{8, 20, 24\}$, and the unique exception at $d = 12$ is the COMPILER-CLOCK class (1280 extra elements = the class of c and its Galois twin; $\chi_c = (x - i)^2(x^2 + ix - 1)$ is half the regular-12 Springer block, all eigenvalues satisfy $\lambda^3 = -i$ – exactly why $c^3 = J^3$ is central: the compiler-clock classes are the ONLY non-regular clocks in all of G_{31} whose $d/4$ -th power generates the center); the order-8 landscape is complete (10560 elements, 480 regular = 2 Galois classes, $\chi = (x^2 + i)^2$ exact) with the honest kill: “free $\Rightarrow$ regular” is FALSE (4320 free order-8 elements noncentral; already at order 4); degrees = free orders divisible by 4 above 4; no marker moves.

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Script	What it machine-checks (<i>continued</i>)
v664_look_elsewhere.py	The look-elsewhere audit – the bingo budget of the typed [C] numeric coincidences, quantified: $N = 42$ structure slots, $K = 19$ hits, the 6 killed readings entering as 0-hit trials; the family-corrected global $p = 5.08 \times 10^{-3}$ in the most conservative of three null models (the ensemble survives the honest correction), with the empirical control that only 0.2%/0.3% of 2000 size-matched pseudo-target lists reach the real hit count / the real p – but NO single observation is significant on its own: suggestive (0.01..0.1) only $60 = D_{\text{start}}$, $12 = \text{marks}$, the G31 degrees, $48 = \Omega_{\text{adm}}$; unremarkable ($p > 0.1$): $6 = p_2(a)$ ($p = 0.169$) and the CODESEM number battery ($p = 0.593$ – the v646 finding quantified); 14/16 FORCED (their value is the theorem, not the number); the re-typings are executed as dated ledger notes (EXTREV.LATTICE.01, E8.CODESEM.01, E8.CODE.01); seed 20260802, 100k MC, exact Poisson-binomial tails.
v679_orbifold_continuum_os.py	The first continuum-OS slice of the seam orbifold B: correlator convergence with UNDERSTOOD rates – all six σ -channel observables share the uniform raw rate $0.659 =$ the predicted Fisher–Hartwig $2/3$ branch, the τ -channel contrast measures 1.298 vs $4/3$ (the channel law $\rho = 2(1 - \beta)^2 - 2\beta^2$: rates understood, not fitted); after removing the ONE known FH term the extrapolated limits hit the CFT values at $< 0.05\%$; RP SURVIVES THE LIMIT: $\lambda_{\min}$ extrapolations bounded away from zero (σ 1.36×10^{-3} , margin $7\times$; τ 2.80×10^{-4} , margin $358\times$; mixed OS Gram 1.34×10^{-3} , margin $31\times$; must-fail $\eta = -1$ flips); the cluster property holds in space AND Euclidean time ($2\Delta = 0.222220$ vs $2/9$ at 8×10^{-6} , cylinder/cosh forms pointwise, time gap = the ε level at 0.99933); the continuum characters $1/36, 1/9, 5/18, 4/9$ extrapolate at 10^{-12} with the measured N^{-2} rate; typed honestly: OS axioms E0/E2/E3/E4 are MEASURED at the convergence level, E1 only discretely exact; the formal-limit remainder is named (uniform bounds, the GNS limit Hilbert space, operator convergence, R sectors, the B assembly) – GATE.QGEO does NOT move.
v689_gaussian_code_bridge.py	The Gaussian code bridge (review contract E8.GAUSSIAN.CODE.01) – $E_8(\mathbb{Z}[i])/(1+i) \cong \mathbb{F}_2^4$ EXACTLY (Smith normal form; standard model: $ \det = 256 = 2^8$, SNF $[1^4, 2^4]$ – presentation-independent): the $240 = 15 \times 16$ census (the zero class PROVABLY empty, each class = 4 of the 60 G31 lines), $\sigma = c^4$ acts on the quotient as the $\text{RM}(1,3)$ family permutation (3-cycle $F_1 \rightarrow F_2 \rightarrow F_3 +$ fixed anchor, exactly the v638 info-bit action), residual gauge = the order-18 centralizer in $GL(4, \mathbb{F}_2)$, coordinate block = the $F_1 + F_2 + F_3$ label. All must-fail controls fire: the naive placement keeps the census but loses the σ semantics (off-lattice witness); a non- πJ placement has no $\mathbb{Z}[i]$ -module; $\mathbb{Z}[i]^4$ trivializes (16 vectors, 11 classes empty); exact integer/Fraction arithmetic; no marker move.
v690_quartic_half.py	The quartic invariant restriction (review contract E8.QUARTIC.HALF.01) – is G31 the holomorphic μ_4 shadow of the E8 compiler? ALIVE, with the honest split: the vanishing half $\{2, 14, 18, 30\}$ is TRUE but TRIVIAL (μ_4 orbit factor, proven symbolically: $W(J\alpha) = -iW(\alpha) \Rightarrow$ every J -orbit contributes $t^d(1 + (-i)^d + (-1)^d + i^d) = 0$ for $d \not\equiv 0 \pmod{4}$ – holds for 6, 10, 22, 26 too). THE SUBSTANCE: $F_8 , F_{12} , F_{20} , F_{24} $ are G31-invariant (60/60 mirrors exact), ALGEBRAICALLY INDEPENDENT (exact Jacobian $\neq 0$), degrees Molien-unique with product $46080 = G31 \Rightarrow$ by Chevalley [cited] BASIC INVARIANTS: the holomorphic restriction of the $W(E_8)$ ring generates the FULL G31 ring. The Jacobian carries the 60 mirror lines (degree $60 = \sum(d_i - 1)$, point-verified 60/60; full factorization = cited theorem, named residual); controls: $J' = RJR^T$ breaks the informative half, the root-preserving J'' keeps everything (the theorem is about the $W(E_8)$ -conjugacy class); no floats; no marker move.

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Script	What it machine-checks (<i>continued</i>)
v700_orbit60_census.py	The ORBIT60 census – the 60 μ_4 -lines of E8 as a combinatorial object: quotient graph, σ /clock/Coxeter dynamics on the ORBIT SPACE, and a STRICT park test for the cascade $60 \rightarrow 6$. All five routes adjudicated: (i) degree rules DEAD (all quotient graphs regular); (ii) σ structure DEAD (orbit sizes $\{3, 1\}$, no 2-blocks); (iii) THE INVOLUTION WITNESS DOES NOT EXIST: the full involution census of the line group LG (order 11520; 375 involutions, 21 classes) shows NO element of cycle type $2^{27}1^6$ (fixed-line census $\{0:120, 4:180, 12:15, 16:60\}$); (iv) W(E8) Coxeter does not descend; (v) the MUST-FAIL numerology control fires: rule-free lexicographic pair removal reproduces $60 - 2n$ in exactly 27 steps, $> 10^{70}$ equally ‘successful’ sequences – the counting carries no structure. A5 one-liner: order-5 elements exist (2304) but no visible natural A5 action ($\langle \sigma, \text{order-5} \rangle$ has order 960); PARKED per the review protocol; deterministic.
v705_chain_deck_sector.py	Original v705 D1 physical NS circle: 48-site antiperiodic shift, order-12 clock, projective deck cube -1 and three 16-mode deck sectors.
v715_qgeo_car_continuum.py	QGEO-CAR – the quasi-free CAR route to the formal orbifold continuum limit (GATE.QGEO), first slice. QGEO-CAR-RATES-SUMMABLE: all 6+1 deck/twist channels are Schatten/shadow-norm Cauchy on ε -separated configurations (N up to 3072/6144) with geometrically summable rates; the FH renormalization is FIT-FREE LATTICE-DERIVED (Barnes G, 8.8×10^{-7}); the RP cone does not degenerate along the ladder; all four kill criteria are clear. The named remainder: the majorant lemma (L1)–(L3) with constants + the classical proof route – named, not claimed: GATE.QGEO does NOT move.
v722_phys_ramified_ns_r.py	PHYS moonshot slice (T_2 / G_{net}) – is the Ramond projection $(1 + i)$ -adic? RAMIFIED-SEES-NSR: $(1 + i)L$ lies in the even/NS sublattice ($\mathbb{Z}$ -basis proof), the 240 roots fall into 15×16 classes with PURE parity (7 NS + 8 R), parity is a homomorphism $\mathbb{F}_2^4 \rightarrow \mathbb{F}_2$ – the NS/R grading IS the parity character of $E_8(\mathbb{Z}[i])/(1 + i) = \mathbb{F}_2^4$; the first exact witness for the groupoid reading of G_{net} (the ONE ramified edge of the tower is the Gaussian prime $(1 + i)$); controls fire: the $\mathbb{Z}[i]^4$ census is NOT 15×16 , scrambled labels break purity.
v723_phys_modular_clock.py	PHYS moonshot slice ($T_3 / F_{transfer}$) – can thermal time replace the external clock contract? The conjugacy-class KILL test. STT-KILLED + INTERNAL-PAIR-CONFIRMED: the F_{QCD} 1-loop clock map is PARABOLIC and not diagonalizable (single Jordan block), and exp of a real-diagonalizable generator is diagonalizable (symbolic lemma) – no constant-rescaled modular flow produces the QCD clock; the pole multiplier is EXACTLY $(2/3)^6 = 64/729$ (hyperbolic, dimensionless $\Rightarrow$ internal); typed consequence: the external clock contract is CONFIRMED and sharpened to the anchor census {one unit (v_{geo} -class), one angle θ_i , one lattice $O(1)$ } – T3’s clock wall == T1’s unit wall, counted once.
v724_phys_t3b_modular_flows.py	T3-B – conditioned modular flows from ONE internal mother state, the second thermal-time KILL. T3B-DEAD: with target-free graph projectors, ONE global KMS scale $\Delta = 6 \log(3/2)$ and the Connes cocycle composition exact to 1.7×10^{-15} along J–K–C–F, all four conditioned flows come out LOXODROMIC/COMPLEX – the frozen v578/v632 solver classes (hyperbolic / parabolic / degenerate) do NOT arise from conditioned modular flows of one internal mother state; the probe honestly refuses the NEEDS-LINDBLAD escape (the v238 GKSL variant is also all-loxodromic); with v723 BOTH thermal-time routes are closed: the external clock contract stands.

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Script	What it machine-checks (<i>continued</i>)
v725_phys_vgeo_torsor_audit.py	T1 CLOSURE – the calibration/scale-torsor audit of the v_{geo} interface. TORSOR CLOSURE: the v_{geo} interface is structurally CLOSED as an $\mathbb{R}_+$ scale torsor – (1) complete export table $O_i = r_i v_{geo}^{d_i}$, (2) dimension matrix rank 1 (conditional [A] on the flavor block, named), (3) all consistency conditions λ -homogeneous (the machine form of the No-Unit theorem v153), (4) two-anchor leave-one-out compatible (G vs ρ_Λ : 0.11%), (5) the calibration theorem stated in torsor language; FENCE: structure closure, NO scale derivation (impossible per No-Unit); moonshot NAMED, not executed: $H_{EW} = \ln(\bar{M}/v_{EW}) = 37.1776$.
v726_phys_car_pp_index.py	PHYS T2 main slice – Pimsner-Popa / Watatani index 4 on the CAR ladder, with the μ_4 action DERIVED and the Ramond zero-mode test. T2-SLICE-GO: the optimal PP constant is EXACTLY 1/4 (explicit rank-one minimizer + pinching theorem) and the Watatani index EXACTLY 4 via an explicit quasi-basis ($\sum vv^* = 4 \cdot 1$, weights FORCED – uniform weights break scalarness, the $\mathbb{Z}_2$ average gives index 2); μ_4 is NOT inserted but derived from the clock $L = S^{N/12}$ (order 4 forced by the NS spin structure); the Ramond sector degenerates undressed (index 2) and the v679 Klein dressing restores index 4 STATE-PRESERVINGLY ($[\rho, U'] = 0$); the $(1+i)$ dictionary to v722 closes; the GNET.RAMIFIED.01 contract candidate is printed.
v736_orbit_packet.py	The Gaussian ORBIT PACKET lemma. ORBIT-PACKET-EXACT: Burnside $7 = (15 + 3 + 3)/3$; the canonical 5×48 partition (fixed block + 4 moved blocks of 12 Gaussian lines each, label-free canonical – packets = $1 + 4 = 5 = g_{car}$, $240 = g_{car} \times 48$); anchor $(1, 1, 2)$ from the fixed-syndrome leader weights $(0, 1, 1, 2)$, leader pair e_6/e_7 = the v638 anchor pair; q normal form $240 = 16 \cdot 15$, $248 = 240 + 8$; circularity fence: P1/P2 come back as EXACT-INTERNAL-RECONSTRUCTION (reconstruction, NOT derivation); σ -class specificity: the 160 free order-3 elements of G_{31} give Burnside 5, not 7; companion Lean module OrbitPacket.lean (34 theorems, kernel-checked).
v737_seam48_intertwiner.py	The seam-48 intertwiner test – the sharpest structural kill of the review morning. SEAM48-DEAD: the 48×5 incidence matrix is NOT identically 1 (entry distribution 0:96 / 1:64 / 2:64 / 3:16), representative-independent (0 of 2304 order-5 elements of G_{31}) and the must-fail control fires (0 of 25 random operators); valuable residues: the 4 moved blocks carry the v623 character table EXACTLY, the fixed block deviates exactly by the 12 lifted marks; the 5-period lemma $u^5 = \pm J$ holds exactly; $240 = 48 \cdot 5$ remains a factorization WITHOUT coordinatization.
v745_qgeo_car_l1_sector_lemma.py	The (L1) sector lemma of the CAR continuum majorant. L1-SECTOR-PROVEN-MODULO-ELEMENTARY: $\ K_{2N}^{(q)} - K_N^{(q)}\ _{S_1(\Lambda_\varepsilon)} \leq B_q(\varepsilon)/N$ for all 6 undressed sectors on the fixed grid, proof-near – the occupied-arc mode sums are EXACT geometric sums (exact summation replaces Euler–Maclaurin), the entire $1/N$ structure is the sublattice embedding offset, the leading term is the exact matrix $(iu/2MN) f'_q(s)$ (ratio $\rightarrow 1$ at 6×10^{-4}), $\gamma = 2$ is DERIVED, 39744 + 108 inequalities at 0 violations, $r_1 = 1$ sharp; status typed PROVEN-MODULO-ELEMENTARY with explicit constants; named residues: (a) grid-sup [elementary], (b) L2 uniform FH/RH [hard-technical], (c) L3 uniformity [medium]; GATE.QGEO does not move.
v746_phys_gnet_local_functor.py	The G_{net} local net functor. GNET-LOCAL-FUNCTOR-ALIVE: the net axioms are EXACT (isotony, graded locality, clock covariance on the quotient circle); the Watatani index of the local fixed-point inclusion is LOCALLY EXACTLY 4 for every interval $\ell \geq 2$ – the $[D, A]$ index statement is interval-local, not merely global; Ramond = half-line/bond defect (solitonic; local footprint, leakage $\sqrt{2/N}$); 4 must-fail controls fire; missing continuum theorems NAMED, not claimed (GNS limit net, index continuity Pimsner–Popa/Longo, Longo Q-system identification to GATE.METRIC.11, twisted DHR/Longo–Roberts sectors, Haag duality/split).

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Script	What it machine-checks (<i>continued</i>)
v752_projective_hamming_incidence.py	The projective Hamming incidence lemma on $V = L/(1+i)L$ – the symplectic $\mathbb{F}_2^4$ of the unimodular hermitian E8 lattice, and the v737 resolution. PROJ-HAMMING-EXACT: $h = H/4$ is $\mathbb{Z}[i]$ -valued with hermitian Gram determinant 1 ($\mathbb{Z}[i]$ -UNIMODULAR); $\bar{h}$ alternating (doubly-even), nondegenerate $\Rightarrow (V, \bar{h})$ symplectic with explicit Darboux basis; $ H_y = 7$, pair intersections 3; $BB^T = 4I + 3J$ EXACT, characteristic polynomial $(x-7)(x-2)^9(x+2)^5$ – the multiplicities $(1, 9, 5)$ are the SYMPLECTIC signature; $K^2 = (4/49)I + (45/49)\Pi_0$ exactly (K itself honestly not psd); NS/R $\chi = \bar{h}(\cdot, y_0)$ for the UNIQUE σ -fixed point $y_0 = \text{FSUM}$ (the anchor bit), $112 + 128 = 240$, $+8$ Cartan: $248 = 120 + 128$; THE v737 RESOLUTION: the distribution 0:96/1:64/2:64/3:16 derived exactly ($16\times$ the 3×5 label table) AND the 5×48 coordinatization exists via exactly ONE $\bar{u}$ -invariant spread (kill explained, not revised); two honest corrections to the review derivation documented; companion Lean module ProjectiveHamming.lean (32 theorems).
v757_fano_disc7_bridge.py	The preregistered Fano $\rightarrow$ discriminant(-7) bridge – the three-cycle half is real, the parity half dies arithmetically. FANO-DISC7-DECORATIVE (break exactly at condition 2): the NS/R parity bit has NO arithmetic carrier in $\mathcal{O}_{-7} - 2$ SPLITS in $\mathbb{Q}(\sqrt{-7})$ ($-7 \equiv 1 \pmod{8}$, $\mathcal{O} \otimes \mathbb{Z}_2 = \mathbb{Z}_2 \times \mathbb{Z}_2$), every 2-adic ideal quotient has 2-rank $\leq 2 < 3$ (complete census of all norm-8/16 ideals): the code $\mathbb{F}_2$ -structures are arithmetically UNREALIZABLE; the REAL half (COND1, exact): equivariant lifts exist for both canonical difference-set Fano models, the canonical order-3 action is $x \rightarrow 2x$ (the difference-set multiplier, 2 = the transfer step), every lift sends the unique $\bar{\sigma}$ fixed point to 0 = $\text{red}(\alpha_0)$ = the C corner (norm 14 = $\dim G_2$); the seven-correlation permanently typed DECORATIVE; controls fire; the one [FAIL] = the preregistered COND2 break.
v774_arf_spinor_compiler.py	The Arf/spinor compiler on $V = L/(1+i)L = \mathbb{F}_2^4$ (Priority 1 of the Arf programme). ARF-SPINOR-EXACT: the parity lift $\iota: V \cong C_{\text{even}}(5)$ carries $\beta = \bar{h}$ EXACTLY in all 256 cells (crosslink 1); brute force over all 2^{16} functions: exactly 16 quadratic refinements; Arf census 6 + 10 with $ Sp(4, 2) = 720$ and a faithful+surjective S_6 action; the frozen selector picks a UNIQUE q^* (census $4 \rightarrow 2 \rightarrow 1$) and the weight form IS q^* (offset 0); $\text{Stab}(q^*) \cong S_5$ gives $16 = 1 + \bar{5} + 10$ on refinements AND words; the K_6 duad model is an equivariant bijection onto $E(K_6)$; $B = I + A_{KG(6,2)}$ in all 225 cells with the exact ovoid eigenvector; all 6 isotropic spreads have signature $(1, 2)$; the hypercharge table $X = (-2, -2, -2, 3, 3)$ reproduces the v310/v14 dictionary; moments $(16, 0, 120, 0)$ with the chain 40/41/240/248; Pati–Salam $8 + 8$ with $B-L = 1 - 2n_c/3$; χ_{NSR} = the anchor bit. $A_3^{\text{Fam}} \neq A_3^{\text{PS}}$ naming discipline; the code $\rightarrow$ matter reading FENCED (killed by v775). Lean companion ArfSpinorCompiler.lean (23 kernel theorems).
v775_gaussian_class_d5_purity.py	THE FIRED PHYSICAL KILL of the Arf compiler programme. ROOTCLASS-MIXED: no $D_5 \oplus A_3 / SU(5)$ convention makes even one full set of 15 Gaussian classes pure per the frozen code $\rightarrow$ matter table – the embedding-INDEPENDENT counting bound (every embedding has exactly 128 spinor-side roots, $240 > 128$) forces ≥ 7 adjoint-side classes ALWAYS; the exhaustive scan (56 splits $\times$ 240 assignments $\times$ 2 chiralities) finds ZERO passing conventions; all 8 spinor classes mix 8 distinct 16-weight pairs. BINDING FENCE: the code $\rightarrow$ matter reading must NOT enter any main claim (incl. the 'empty mailbox = right-handed neutrino' reading); the Arf mathematics of v774 is untouched. All three controls fire.

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Script	What it machine-checks (<i>continued</i>)
v776_boundary_hamming_uniqueness.py	Boundary code uniqueness. BOUNDARY-CODE-UNIQUE: the non-circular chain boundary $\rightarrow$ code $\rightarrow E_8 \rightarrow \mathbb{F}_2^4 \rightarrow 5$ slots closes with $g_{\text{car}} = 5$ as OUTPUT – census 135 $\rightarrow 30 \rightarrow 14 \rightarrow 2 \rightarrow 1$ rebuilt without Hamming/ E_8 input; the flag datum is ONE deck-invariant $\mathbb{Z}_2$ (the product of the four side orientations; all three predeclared formalizations agree); the boundary gauge group (order 12) makes the flagless twofold pure gauge; Construction A $\rightarrow E_8$ exact (240/2160 theta, Cartan det = 1, arms 1-2-4); q^* unique; packets 1 + 4. Honest residuals R1 (doubly-even self-dual universe premise – circularity relocated and shrunk, not removed), R2 (deck placement semantic; wrong-deck control does not fire, typed), R3 (anchor naming). NO P2-removal claim; the open contract form registered as ARF.BOUNDARY.CODE.01 [O].
v777_ftransfer_clock_jets.py	FTRANSFER.CLOCKS.01 EXECUTED + the fibered refinement of CONTRACT.F.01, ONE module from two probes. NO-COMMON-CONNECTION + FTRANSFER-FIBERED-CARRIES: the preregistered K1 kill fires EXACTLY as the frozen prior expected (prereg YAML byte-verified; both data tables SHA-frozen BEFORE the first run); all four dictionaries construction-valid (Koide scheme check $571\times$, washout drift 1.15×10^{-4} , QCD overlay 0.83%, relic slope 0.0602); the kill is sympy-exact $\{-\Delta^2/2, -\Delta^2/2, 0\}$ – a pass would need exactly the forbidden non-affine Möbius clock. The discrete layer coincides EXACTLY (cross-ratio 4/3 symbolic, deck unit $ \Delta\sigma = 1$, unit parabolic class – the v632 lattice-explicit half); the obstruction is the CONSTANT seam cocycle with values exactly $\{0, \pm\Delta^2/2\}$; classification = the predeclared thermal-vs-RG marker; relic degenerate unclassified; controls incl. the Möbius transplant fire; the first-run float64 artifact disclosed, bar untouched. The jet route of CONTRACT.F.01 closes at the physical-clock level; next named step: derive the coset assignment from KMS/modular clock typing.
v778_qgeo_gridsup_logsum.py	Remainder (a) of the (L1) majorant lemma FULLY closed in the corrected $(1 + \ln M)$ form, ONE module from two probes. GRIDSUP-SPLIT-CLOSED-LOG-LAW + FOURIER-LOGSUM-CLOSED: the v745 residue (a) splits four ways – (a1) the continuum entrywise supremum CLOSED ($\sim 1.26\text{e6}$ census inequalities, 0 violations), (a2) the configuration- S_1 closure with explicit $B_{\text{conf}}(\varepsilon)$ (packing $+\zeta(2)/\zeta(3)$), (a3) the refinement remainder with $\text{RHO}(\varepsilon)$ via exact csc^3 integrals, (a4) the leading part honestly LOG-divergent – the literal v715 clause ‘one $B(\varepsilon)$ for ALL grid refinements’ is FALSE at $r_1 = 1$ and repaired to $(1 + \ln M)$; the surviving inequality CERTIFIED at theorem level via the exact twisted-circulant diagonalisation + two exact summation-by-parts: $\ F\ _1 \leq c_0 + (J/4) \ln(M+3)$, a fortiori $(J/\pi) \ln M$; 162-case census to $M = 6144$, zero violations; repaired (L1) clause verified on all 252 transfer cases; Araki summability explicit. Honest: the measured slope is J/π^2 – valid, not sharp. Residues (b)/(c) open; GATE.QGEO does not move.
v779_gnet_gns_arf.py	The G_{net} continuum strand, ONE module from two probes. GNS-PRECURSORS-COHERENT + GNET-ARF-NO-CORRESPONDENCE: the Haar scaling isometry intertwines exactly ($\leq 2.2 \times 10^{-16}$); the commuting index-4 expectation squares are exact; the canonical state is Cauchy with geometric contraction $\sim 1/4$ per doubling; the index census is machine-exact at every level with zero degradation; the twisted Haag-duality defect is 0 with $\dim B'/\dim A' = 4$ = the Watatani index; 10-section continuum-paper skeleton. The exact dim law $d_c(\ell) = 4^{\ell-1} + 2^{\ell-1} \cos(\pi c/2)$ makes the $\mathbb{C}[\mathbb{Z}_4]$ quasi-basis obstruction exactly $2^{-\ell}$ (explains the $\ell = 1$ anomaly); explicit 185-element quasi-basis at $\ell = 2$; uniform sector-resolved split bounds. THE HONEST NEGATIVE: the $16 = 1+5+10$ counting echo is exact but non-geometric (rank 3 vs 4, $GL(4, 2)$ census 0/20160); K_{matter} does not govern tower transport; the two fours stay in their registers. All five controls fire.

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Script	What it machine-checks (<i>continued</i>)
v781_one_object_clock_census.py	The $d = 4$ forcing census + the 60-line clock kill, ONE module from two probes. ONE-OBJECT-PARTIAL + CLOCK-FIBER-DEAD (21/21 + 23/23): the TFPT glue pattern admits an even unimodular DIAGONAL glue of $A_{d-1} \oplus D_{d+1}$ iff $d = 4$ (census $d = 2..12$, exact fractions; at $d = 4$ exactly the two v92 Lagrangians $k \mapsto k, k \mapsto 3k$; explicit E_8 certificate with 240 norm-2 vectors; $d = 9$ dies at isotropy; both relaxation controls fire) — corollaries $g_{\text{car}} = d+1 = 5$, $N_{\text{fam}} = d-1 = 3$, rank $2d = 8$, index $4 = d = \mu_4 $; honesty gate: $c_3 = 1/(2\pi d) _{d=4} = 1/(8\pi)$ is a corpus-legitimate REWRITING, NOT a new derivation of P1. The clock kill: the fiber-product action $\mathbb{Z}_{12} \times_{\mathbb{Z}_6} \mathbb{Z}_{30}$ on the 60 Gaussian lines is dead at three levels (full line-compatible group order 23040, max element order 12 — orders 15/30/60 absent for every realization; the fiber product is cyclic $\mathbb{Z}_{60}$, exact SNF); all controls fire.
v782_e8_transition_bus.py	The transition-bus structure theorem. TRANSITION-BUS-TORSOR (35/35): the 240 roots are 15 disjoint coordinate 8-frames over $V = L/(1+i)L$; on $L/2L$ the 120 root pairs are exactly the 120 $q = 1$ points of the plus-type quadratic space and each class fiber is a canonical TORSOR under $v^\perp$ (affine $\mathbb{F}_2^3$, no distinguished origin); the deck J acts as translation by v ; the obstruction census is proof-grade: NO deck-equivariant root-level labeling $R(E_8) = V \times (V \setminus 0)$ exists; the frozen symplectic predicate reproduces all 57600 ordered inner products incl. the sign law and the h -refinement; spread layer $240 = 5 \times 3 \times 16$ with the q^* selector; the A_{15} comparison quantified (a strict bus WITH a canonical start state; E_8 provably has none; cross-class non-orthogonality exactly doubled). Controls fire.
v783_two_qubit_clifford.py	The two-qubit stabilizer identification of the compiler carrier. CLIFFORD-PARTIAL(H4) (32/32): under the single predeclared chart U the 60 Gaussian E_8 lines ARE the 60 pure two-qubit stabilizer rays, entry-exactly over $\mathbb{Z}[i]$ (60/60; support census $4 + 24 + 32$); $UG_{31}U^{-1}$ is an index-2 subgroup of the two-qubit Clifford matrix group ($ C_2 = 92160 = 2 \times 46080$, coset $\zeta_8 G_{31}$); $46080 = 4 \times 16 \times 720 = \mu_4 \times \text{Pauli}_{16} \times Sp(4, 2)$ with the 15 classes = the 15 Pauli contexts ($W(3, 2) = GQ(2, 2)$) and the 6 spreads = the MUB pentads; H4 fails as predeclared: the index bit is the Galois $\sqrt{2}$ /Hadamard bit, NOT $J \leftrightarrow -J$; all controls fire. Stabilizer-formalism mathematics about the carrier; ROOTCLASS-MIXED (v775) unaffected.
v784_curve_code_2torsion.py	The curve/code 2-torsion decider. CURVE-CODE-PARTIAL (33/33): the frozen CM-model route through $y^3 = x^4 - 1$ (every generator period certified as an integral $\mathcal{O} = \mathbb{Z}[\zeta_{12}]$ recognition, dps 120, HNF index 1; $A[2] = \mathcal{O}/2\mathcal{O}$ exact; $\tau = \zeta^4$ DERIVED as the only order-3 class; minimal ODD τ -invariant polarization type (1, 3), no principal form in the τ -invariant cone; q_Θ the unique τ -fixed refinement); the correspondence DIES at two exact layers — (1) τ acts freely (cycle type [3, 3], syntheme side) vs $\bar{\sigma}$ fixing a 2-plane ([3, 1, 1, 1], duad side), exchanged only by the OUTER S_6 automorphism, census 0; (2) q_Θ EVEN (Arf 0, 1+6+9) vs q^* ODD (Arf 1, 1+5+10), census 0; joint census 0 with positive control 6. All controls fire.
v792_ftransfer_kms_coset.py	The coset assignment of the fibered clock functor is a THEOREM from KMS/modular typing. KMS-COSET-THEOREM (18/18): $S = -(\ln \lambda)^2/2$ with λ the time-1 PGL_2 holonomy multiplier per clock e-fold; the classifier uses NO Schwarzian and NO derivatives (non-circularity gated on its own source): functional-identity holonomy witness + PGL_2 class + detailed-balance multiplier cross-ratio (the discrete KMS signature); Lemmas A/B/C sympy-exact; BLIND protocol: $F_{\text{pole}}/F_{\text{Boltzmann}}$ modular with $ \ln \lambda = \Delta = 6 \log(3/2)$, F_{QCD} autonomous (parabolic), F_{relic} degenerate; unblinding EXACT (predicted cosets = transported Schwarzians, sympy zero); controls: fake KMS caught, affine invariance, the v578 Moebius clock as the positive case — the fiber classification of the CONTRACT.F.01 refinement is derived, not case-inspected.

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Script	What it machine-checks (<i>continued</i>)
v796_duad_syntheme_bridge.py	The canonical OUTER bridge between the code duad side and the curve syntheme side. BRIDGE-CANONICAL (24/24): the Sylvester duality β : code odd forms $\rightarrow$ curve spreads with $\beta\sigma = \tau\beta$ and $\beta(q^*) = S^*$ (the UNIQUE $\langle\tau, \rho\rangle$ -fixed spread) exists and is unique up to the order-6 code joint stabilizer (census $18 + 18 \rightarrow 6 + 6$, ONE orbit incl. the τ/τ^2 swap by an inner code symmetry); the outer witness exact ($[3, 1, 1, 1] \leftrightarrow [3, 3]$ uniformly); q_Θ pulls back CONSTANTLY to q_{even}^* with $q^* = q_{\text{even}}^* + h(\cdot, A)$ — the anchor shift resolves the v784 Arf mismatch canonically; $5/10$ and $3+2$ transport exactly onto the S^* -line geometry; $t_A \mapsto \rho = J$ on every bridge; χ_{NSR} an honest exact TWO-variant torsor (pinned by the v752 NS/R parity). Controls: inner censuses $0/0$, odd-Arf pullback 0 , scrambled σ 0 . The v784 INNER identification stays dead; no matter semantics.
v798_seam_clifford_modular_s.py	The missing Clifford bit as the metaplectic lift of modular S at $\tau = i$. MODULAR-S-PARTIAL (27/27): COSET POSITIVE — the per-binary-factor Hadamard $K_1 = H \otimes I$ IS the Weil lift of S at $\tau = i$ and lands exactly in the missing coset $\zeta_8 G_{31}$ (exact relations $S^2 = I$, $T^2 = \text{Pauli parity}$, $(TK)^3 = \zeta_8 I$); the TOTAL Fourier $H \otimes H$ lies INSIDE G_{31} with metaplectic anomaly $(T_3 K_3)^3 = iI = J$ — the deck IS the anomaly of the total modular lift (R2 placed); $\zeta_8 = (1+J)/\sqrt{2}$ the real half-deck swapping the seam pair $\{L, \zeta_8 L\}$; F_4 typed out; OS reflection gate exact ($\tau = i$ fixed). THE STRICT UNIQUENESS CENSUS IS EMPTY ($0/46080$): no Θ -real metaplectic involution in the coset fixes q^* — the Arf defect is unavoidable; retyped census: 32 survivors = ONE G_{31} -conjugacy class; R3 NAMED, not fixed: the σ -orbit defects are exactly $\{A + F_\Sigma + F_i\}$ with XOR = the anchor A itself. Controls fire.
v799_seam_code_typeii.py	Type II FORCED from three physical seam axioms — the direct attack on residual R1 of ARF.BOUNDARY.CODE.01. TYPEII-FORCED (19/19): exhaustively over ALL 308,993 subspaces of $\mathbb{F}_2^8$ (dim 0..4, Gaussian binomials; dim > 4 by rank-nullity): mutual locality of the Construction-A vertex words $\iff$ self-orthogonal (135 at dim 4; the lift-shift braiding identity exhaustive); integer conformal spin $\iff$ doubly even (30); holomorphy/index one ($ \text{disc} = 1$, exact Fraction Gram determinants) $\iff$ self-dual — the survivor set is EXACTLY the 30 $\hat{e}_8$ copies; no boundary-legal non-Type-II code exists; every non-self-dual doubly-even code has a fractional-weight discriminant sector ($[8, 3]$ witness with exact coset thetas, $\theta_{L^*} \neq 2\theta_L$). R1 $\rightarrow$ R1' = A1 mutual locality + A2 integer spin + A3 holomorphy/index one; imported lattice-VOA/theta ingredients cited and machine-verified in every instance used. Controls fire. NO P2 marker move.
v800_e8_torsor_fourier.py	The projective Fourier modes of the 15 Gaussian torsors — carrier purity at CHARACTER level with the mutually-unbiased cap. TORSOR-FOURIER-PARTIAL (30/30): 120 canonical projective rays (phase law exact on 960 origin shifts), orthogonal basis (Gram = $16I$); deck J and all 16 Paulis diagonal by characters, G_{31} monomial through $Sp(4, 2)$ (kernel $64 = \mu_4 \times \text{Pauli}_{16}$; orbits $15 + 45 + 60$). THE CARRIER BLOCK: the 8 R-fibers' 64 rays = $(1+5+10) \boxtimes (1+3)$ under $W(D_5) \times W(A_3)$ (Clebsch charpoly $(x-5)(x-1)^{10}(x+3)^5$ exact; S_4 -natural tetrad with σ = family 3-cycle + anchor) — the carrier Pascal at CHARACTER level, impossible at point level (v775); P3 fails as predeclared: the weight and character bases are MUTUALLY UNBIASED ($ \langle \text{pair} \text{mode} \rangle ^2 = 1/8$ exactly) — ROOTCLASS-MIXED intact; the 45 deck-even modes ARE the 45 (context, Pauli) incidences under the certified chart. Controls fire.

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Script	What it machine-checks (<i>continued</i>)
v802_gnet_martingale.py	The martingale route to the G_{net} GNS limit — finite hypotheses MEASURED, all met. MARTINGALE-HYPOTHESES-MET (15/15): the filtration is EXACT (Haar isometry with support coherence, leak 0; Watatani quasi-basis 185/3041 at $l = 2/3$ with $\sum vv^* = 4 \cdot 1$; ONE index-4 expectation for the whole tower); the state defects are SUMMABLE at measured rate ~ 0.25 per doubling — one power better than the 2^{-l} dim-law envelope (reported, not forced); the unique limit follows by telescoping and is verified on every rung; the split/normality precursors are uniform (determinant witness $D \geq 0.985$, stabilizing at 0.9928). Steps 5–7 (GNS, local normality, split + μ_4 simple-current extension) typed NOT executed. QGEO note: the open majorant residues (b)/(c) are bypassed for limit EXISTENCE and relocated into the typed normality step — a reallocation, not a proof. Controls fire (decimation converges to the WRONG degenerate limit — the coherent bond is load-bearing).
v803_e8_jetcode_affine_nsr.py	The jet-code normal form of the Gaussian E8 compiler + the NS/R bit as an affine 8-point geometry. JETCODE-EXACT + AFFINE-NSR-EXACT (18/18 + 15/15): $\mathbb{Z}[i]/(2) \cong \mathbb{F}_2[\epsilon]/(\epsilon^2)$ with $\epsilon = 1 + i$ (2 RAMIFIES; unique iso, the split ring $\mathbb{F}_2 \times \mathbb{F}_2$ fails all 24 bijections); $W = L/2L$ is FREE of rank 4 over the dual numbers (explicit $\mathbb{Z}[i]$ -basis by Hermite reduction, covolume-certified); $0 \rightarrow \epsilon W \rightarrow W \rightarrow V \rightarrow 0$ is an exact SELF-extension with $\ker \epsilon = \text{im } \epsilon$; the deck IS the jet unit $J = 1 + \epsilon$, re-deriving the v782 torsor on all 240 roots; ZERO μ_4 -equivariant splittings among all 65536 linear sections — the no-origin obstruction IS non-splitness; the 120 root pairs = the $q = 1$ unit shell ($240 = 15 \times 8 \times 2$). PART 2: $V \setminus \{0\} = 7$ NS + an affine 8-point torsor carrying 112 D_8 + 128 spinor roots ($248 = (112+8)+128$); $\text{Stab}(\chi_{\text{NSR}}) = \text{AGL}(3, 2)$ of order 1344 = $\text{Aut}(H_8)$ with the SAME natural 8-point action; affine functions reconstruct $RM(1, 3) = H_8$ with exactly 1344 equivalences. Typed internal reconstruction — no P2 removal; no matter semantics (ROOTCLASS-MIXED).
v805_e8_syndrome_algebra.py	The honest kill — E8 is NOT an error-correction hull in the sharpest sense. SYNDROME-DEAD (13/13, the kill fires as preregistered): the μ_4 -linear-lift realization family reaches max rank 222/256 over ALL FOUR frozen phase conventions (sympy-exact over $\mathbb{Q}(i)$); the $\pm r$ proportionality obstruction is STRUCTURAL for the whole diagonal-phase family ($c(-r) = -c(r)$; collision witness printed), and both post-hoc escape directions score WORSE (nonlinear 215, ζ_8 -linear 160) — the death is robust. SURVIVES: the syndrome-table counting $16 + 240 = 256$, the neutral sector (the 16 v112 kernels ARE the diagonal MASA; same-class products A_0 -valued with μ_4 coefficients EXACTLY), the fine groupoid law (associative 0/3375) and the $W(3, 2)$ commutation skeleton; NO scalar V-cocycle (0/210). Successor criterion named: root-individual operator data. Controls fire.
v807_lorentz_nullselector.py	Original v807 S1 RR/Serre and null-spinor algebra: $d(4-d)$, $d=4$ rank one, conditional on stated functor assignment; E8.ONEOBJECT.01 addendum.
v808_petersen_sixthroot.py	The K5 edge machine + the bit-exact sixth-root decider. PETERSEN-RADIAL-EXACT + SIXTHROOT-SPECTRAL-ONLY (19/19 + 16/16): $X = (-2, -2, -2, 3, 3)$ unique primitive traceless block-constant; the $E(K_5)$ charge census $\{-4: 3, +1: 6, +6: 1\} =$ the $SU(5)$ decuple against the certified v774 table; Petersen $SRG(10, 3, 0, 1)$ certified ($ \text{Aut} = 120$ census = S_5); distance shells (1, 3, 6) CHARGE-PURE; the flavor hexagon = the distance-2 shell [E neu]; equitable quotient with hypercharge eigenvector $(6, -4, 1) \rightarrow -2$; $\text{spec}(P^6) = \{1, 64/729, 1/729\} =$ the deployed transport spectrum EXACTLY (v54/v56/v124); the 10-dim multiplicity prediction ($\times 5 = g_{\text{car}}$ fast, $\times 4 = \mu_4 $ slow) typed [H neu]. PART 2: $B = \frac{1}{18}[[13, 1, 4], [1, 13, 4], [4, 4, 10]]$ (every entry a compiler number) is the UNIQUE symmetric doubly stochastic PSD sixth root in the corpus basis; B^6 carries the deployed spectrum exactly but is bit-equal to NO deployed matrix ($GL(3, \mathbb{Q})$ -conjugate to v486's M^6 and the cusp-diagonal form) — the corpus freezes the SPECTRUM, not the basis.

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Script	What it machine-checks (<i>continued</i>)
v809_curve_code_ doily.py	The certified outer bridge as an incidence-operator statement with a spectral payoff. DOILY-EXACT (21/21): $NN^T = B + 2I$ ENTRYWISE (N = the K_6 doily incidence, 15 duads $\times$ 15 syntheses; B = the certified v752/v774 symplectic incidence); spec = $\{9, 4^9, 0^5\}$ exact; the singular values of $N/3$ are $\{1, 2/3, 0\}$: the RECOVERY BASE RATE $2/3$ (v221) as the unique nontrivial singular value of the canonical duad-to-synthese incidence — the $(2/3)^6$ identification typed [H neu], pending the six-step composition; Petersen edges = syntheses 15/15 at the q^* point; EVERY census bridge factors EXACTLY as $N_{\text{code}} = P_{\Delta}^T N_{\text{curve}}^T P_{\Gamma}$ — a DUALITY, not an isomorphism (the inner route stays dead, 0/720); the Arf switch set T_6 = the six within-block duads; $N/3$ doubly stochastic, typed classical, not CPTP.
v810_cutcode_ moment.py	The Arf split as the cut classification of K_5 + the one-line master moment with the frozen 210 decision. CUTCODE-EXACT + MOMENT-INCIDENCE-PARTIAL (17/17 + 16/16): the cut map δ is injective-isometric on all 256 cells (kernel = the repetition code); the Arf split $16 = 1 + 5 + 10$ IS the cut classification $(0 5) + (1 4) + (2 3)$ [E neu]; the Clebsch 40 edges grade $5 + 20 + 15$ over the Arf shells with forbidden blocks EMPTY and within-10 = Petersen (isomorphism census 120); the 240 roots / 60 μ_4 -lines grade $80 + 160 / 20 + 40$ — Arf/cut grading, NOT matter. PART 2: the symbolic identity $\sum_{i < j} (x_i + x_j)^2 - 3 \sum x^2 = (\sum x)^2$ yields $\text{Tr}_{S^+} X^2 = 4 X ^2 = 4h(E_8) = 120$ in one line; charpoly $(t+2)^3(t-3)^2$ exact, 72 audit-only; the 210 = $\binom{10}{4}$ map DECORATIVE — equivariant bijections killed by the fixed-point obstruction (exhaustive); the partial $80 \rightarrow 5 \times 16$ miss-slot map and the Newton tie survive as audit.
v812_flavor_graph_ filtration.py	The flavor-matrix filtration $Q \rightarrow K \rightarrow L$ as an incidence-compiler fingerprint. FILTRATION-FINGERPRINT-ONLY (16/16): the row budgets are EXACT, order-exact counts of the $K_{3,2}/\text{prism}/K_5/H_8$ incidence chain — Q (4, 5, 6), K (6, 9, 10) (line graph $\cong$ triangular prism $\cong C_6(2, 3)$), L (10, 14, 16) — with the level-wise additivity $(4, 5, 6) + (6, 9, 10) = (10, 14, 16)$ mirroring the deployed $L = K + Q$; but NO entry-level reconstruction: none of the frozen structural candidates (25/20/47 per level, entry-exact, 6 column permutations) reproduces any deployed matrix; the exhaustive false-positive rates 0.748%/0.035%/0.005% make the misses INFORMATIVE. Typed: an audit fingerprint at budget level, not an entry-level incidence construction.
v813_p1_index_ kms.py	The closed normalization identity $c_3 = 1/(I_{\text{Jones}} \cdot \beta_{\text{angle}}) = 1/(8\pi)$, its convention audit, and the sharpened P1 contract. P1-IDENTITY-CLOSED (13/13): $I\beta c_3 = 4 \cdot 2\pi \cdot 1/(8\pi) = 1$ EXACT (formal Fraction $\times \pi^k$ arithmetic); dependency audit: the index $I = 4 = \mu_4 $ is an INDEPENDENT c_3 -free theorem (zero occurrences in all four sources, gated by file scan); $\beta = 2\pi$ independently MEASURED (v526, wrong β excluded; the v519 radian pin is the one shared convention and cancels); c_3 STAYS the P1 axiom the identity EXPLAINS; the finite evenness precursor measured: $w_1 = w_3 = 1/4$ exactly at every level, symmetric zero-sum offset $\pm 2^{-(l+1)}$ (the no-anomaly shape); the sea state does NOT equidistribute (dev 0.188) — the bridge must normalize the MODULAR RESPONSE; contract registered [O] with the one open bridge and the kill criterion; controls: index $2 \rightarrow 1/(4\pi)$, booked elsewhere by the corpus.

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Script	What it machine-checks (<i>continued</i>)
v814_k5_sixstep_transport.py	The six-step composition and the canonical 10-dim transport proposal. SIXSTEP-CLOCK-ONLY + TRANSPORT10-PROPOSED (23/23): the rate $(2/3)^6$ arises canonically on three spatial routes (doily alternation, hexagon compression, hexagon circulation), each blocked by a typed obstruction (no unit mode / norm obstruction, bipartite sign $-2/3$, wrong space) — the deployed six is the CLOCK exponent (v124 $\lambda_n = (1 - n/3)^6$, v486 hand, fixed eigenbasis); sixth-power blindness [E neu]: only per-step data distinguish walk from clock; dated correction on the v808 row: $T_{v221} = B^6$ BIT-EXACT, so SIXTHROOT upgrades to BITEACT-vs-v221; the canonical proposal $T_{10} = P_{10}^6$ in the Λ^2 basis passes all gates (spectrum $\{1, (1/3)^6 \times 5, (2/3)^6 \times 4\}$, equitable v774 quotient $= (Q_{\text{Pet}}/3)^6$ bit-exact) — a promotion-ready proposal, no deploy claim.
v817_positive_descent_master.py	Abstract positive-descent theorem and G_net finite hypothesis checks; the prime packet instance is maintained by Prime Front.
v832_anchor_flavor_checksum.py	The anchor affine normal form and the flavor bidirectional checksum: $p_n(a) = 2 + 2^n$ obeys $p_{n+1} = 2p_n - 2$ identically; $T(x) = 2x - 2$ has the unique fixed point $2 = \mathbb{Z}_2 $ and the T -orbit of 4 is the compiler quintet (4, 6, 10, 18, 34) — the whole budget (240, 248, 30, 40, 48, 41) from ONE recursion. Part B: $Ra = (4, 10, 13)$, $R^T a = (6, 18, 8)$ — the same anchor decodes both sides; of 12 sibling candidates exactly ONE passes, and the anchor contraction $(Ra)_2 = 10 = p_3$ kills both siblings. ANCHOR-AFFINE-EXACT + FLAVOR-BIDIR-CHECKSUM (selective), 18/18 + 15/15 exact.
v833_gaussian_ramification_ladder.py	The $(1 + i)$ ramification ladder: the four documented roles of the ramified Gaussian prime $\pi_2 = 1 + i$ are ONE machine-checked object — (i) norm doubling $(1 + J)^T(1 + J) = 2I_8$ with the empty zero class (0/240, $240 = 15 \times 16$); (ii) the 4-bit address $L/(1 + i)L \cong \mathbb{F}_2^4$ with the deck acting trivially; (iii) the non-split jet $\mathbb{Z}[i]/(2) \cong \mathbb{F}_2[\varepsilon]/(\varepsilon^2)$, deck $= 1 + \varepsilon$, exactly 0 of 65536 sections deck-equivariant; (iv) the metaplectic lift $\zeta_8 = (1 + i)/\sqrt{2}$ with $(SH)^3 = \zeta_8 I$, the exact Clifford census $ C_2/\mu_8 = 11520$ and the RM-CSS phase bit $\chi(H \otimes I) = 1$. RAMIFICATION-LADDER-EXACT, 33/33 exact.
v834_pg32_flag_completion.py	The PG(3,2) flag normal form for the 105 + 35 vacuum completion: $\binom{4}{2}_2 = 35$, $140 = 35 + 105$ affine 2-flats, $105 = 35 \times 3$ point-line flags $\cong$ point pairs; the RM layer rebuilt ([15, 10, 4] enumerator exact, Grams $22I + 6J / 6I + J / 28I + 7J$); the vacuum coordinate is ORIGIN RESTORATION. The incidence kill typed as a split: $105 = 45 + 60$ is the $\text{Sp}(4, 2)$ -orbit decomposition on both sides; on the 60 non-isotropic rungs the symplectic polarity gives a canonical incidence-preserving dictionary; on the 45 doily rungs the obstruction is typed $((t + U) \cap U \text{ empty for } 45/45, \text{ flag Gram } 18I + 3J \neq 22I + 6J) - \text{'105 checks} = 105 \text{ flags'}$ is exact as a deck-equivariant bijection, NOT an incidence isomorphism. PG32-FLAGS-EXACT + INCIDENCE-SPLIT, 26/26 exact.
v844_message_doily_rank.py	The E8 addressing formula and the Doily–Pascal rank theorem, two exact corpus compressions: $M_n = 15 \cdot 2^n = (15, 30, 60, 120, 240)$ certified against the rebuilt objects with one NAMED structure per rung ($h(E_8) = 30$ derived from the rebuilt root system itself: highest root height 29, marks $\{2, 2, 3, 3, 4, 4, 5, 6\}$; 60 Gaussian lines; $120 = R^+ $; $240 = 15 \times 16$ census; coda $248 = 15 \cdot 16 + 8$; wrong anchor/multiplier controls fire); and $NN^T = B + 2I$ entrywise for the Cremona–Richmond duad–syntheme incidence under the K6 duad bijection, so $\text{charpoly}(NN^T) = (x - 9)(x - 4)^9 x^5$ exactly: rank $N = 10 = A_\Lambda$, $\dim \ker N = 5 = g_{\text{car}}$ (the six ovoid indicators SPAN the kernel), multiplicity $9 = N_{\text{fam}}^2$, top value $3 = N_{\text{fam}}$, recovery $2/3 = (N_{\text{fam}} - 1)/N_{\text{fam}}$, six-step $(2/3)^6 = 64/729$ exact — the P2 integers are the singular-value data of the doily incidence; NO $(1/3)^6$ doily mode (v814 typed, no upgrade). MESSAGE-LADDER-EXACT + DOILY-PASCAL-RANK-EXACT, 23/23 + 16/16.

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Script	What it machine-checks (<i>continued</i>)
v845_cfin_normal_form.py	The finite compiler normal form $C_{\text{fin}} = (V, \hbar, q^*, \sigma, \iota)$ assembled as ONE object read off the Gaussian quotient: the unique selector-picked refinement (16 refinements, Arf 6 + 10), the order-3 family cycle, the parity lift onto $C_{\text{even}}(5)$ with $\beta \equiv \hbar$ and $q_{\text{wt}} \equiv q^*$; derived counting $16 = 1 + 5 + 10$ with $ \text{Sp}(4, 2) = 720$ and $\text{Stab}(q^*) = 120$ faithful S_5 , the Pascal reading $(1, 10, 5) = (\binom{5}{0}, \binom{5}{2}, \binom{5}{4})$, the ovoid projective reading, and the budget $240 = 16 \cdot 15$, $30 = 2 \cdot 15 = h(E_8)$, $248 = 16 \cdot 15 + 8$ against the actual lattice census. Built-in negative: the exact 128-spinor counting bound (≥ 7 of 15 classes always adjoint-side; the concrete census saturates $8 + 7$ with zero mixed classes) and the weight-level kill re-verify v775 ROOTCLASS-MIXED, not overturned. P2 ($g_{\text{car}} = 5 = \text{the } \iota \text{ slot count}$) narrowed to the v799 residual R1' ($[C]$), NOT eliminated. NORMAL-FORM-ASSEMBLED, 28/28 (SPEC v2 declared).
v849_cfin_unique_cofinal_lean.py	CFIN.UNIQUE.01: finite compiler uniqueness, one orbit and C6 automorphisms; cofinal Weil mirror moved to Prime Front.
v852_arf_vacuum_ovoid.py	The Arf-vacuum syndrome theorem and the integral five-mode decoder: the Arf bit $a(t + U) = \hbar(u, v)$ on ALL 140 affine flats (position-independent); the two-bit syndrome table $(s_{\text{vac}}, s_{\text{Arf}})$ splits them EXACTLY into 15/20/45/60; the LOCAL Hecke theorem at all 15 points ($12 + 16 = 28 = \sigma_3(3)$, $12 - 16 = -4 = a_3$, isotropic directions $\leftrightarrow$ points of $x^\perp / \langle x \rangle$); the code pencil $[15, 11, 3] \supset \{[15, 10, 4], 2 \times [15, 10, 3]\} \supset [15, 9, 4]$ with the canonicity lemma (all 16 refinements induce ONE Arf functional on H) and the vacuum bit as the RM(2, 4) parity bit; the doily kernel gains the integral inverse $N^+ = N^T/4 - J/36$ (four Penrose axioms exact in $\mathbb{Q}$; $\text{SNF}(N) = \text{diag}(1^{10}, 0^5)$ torsion-free with a $\det \pm 1$ minor exhibited), the projector $P_5 = I/2 - B/4 + J/12$ ($\text{tr} = 5 = g_{\text{car}}$), the exact closed-form decoder $\hat{m} = (I - P_5)m$, the S_6 standard representation (11/11 classes), and the three-ring correspondence ($\mathbb{R}$ ovoid span / $\mathbb{Z}$ torsion-free / $\mathbb{F}_2$ code $A_q = [15, 5, 6]$ via $v_a \bmod 2 = q_a$). ARF-VACUUM-SYNDROME-EXACT + OVOID-DECODER-EXACT, 24/24 + 23/23 exact; NO RH claim.
v853_bent_css_mangoldt.py	ARF.BENT.CSS.01: exact bent phase and CSS code identities; Mangoldt incidence experiment moved to Prime Front.
v857_simplex_fourier_winding.py	The E8 audits I: the Gaussian census IS a Fourier law ($\hat{r} = (240, -16^{15})$); the uniform-nonzero channel $P = (J - I)/15$ with spectrum $\{1, (-1/15)^{15}\}$ and two-step contraction $1/225$, exact in Fractions), the packet numerator EQUALS the code Walsh transform at every level ≤ 16 (Eisenstein normal form $15 \Theta_{D8} = 7 \Theta_L + 8 \Theta_0$), and $mh_2(n) = -1/15$ for EVERY odd $n \leq 16500$ (integer identity; all 1911 odd primes covered) – v817's per-prime measurement is the prime restriction of a CHARACTER THEOREM of the code, typed honestly SPECTRAL-only (the gradings do not refine each other); the tfpt_2 winding line collapses to ONE adjugate quadratic $q_{\text{wind}} = e_1^T \text{adj}(tI - R) \mathbf{1} = t^2 - g_{\text{car}} t + Z_2 $ with the triple lock $s = 6$ (trace/det/Coxeter each alone; $\{6\} = \{ R^+(A_3) \}$), $\Delta(6) = 39200 = 2 \cdot 140^2$ (NOT a collision point; the sole $2 \times \text{square}$ hit) and the reality threshold $s^* \approx 2.825$ (the unique Δ -root in $(2, 3)$; deployed ≈ 2.83).
v858_g31_clock_alphabet.py	The compiler clock alphabet as a NORMAL FORM of G_{31} : $\text{Deg}(G_{31})/4 = \{2, 3, 5, 6\} = \{ Z_2 , N_{\text{fam}}, g_{\text{car}}, R^+(A_3) \}$ with $\text{gcd} = 4 = \mu_4 $, $\text{lcm} = 120 = R^+(E_8) $, $\text{lcm}/\text{gcd} = 30 = h(E_8)$ and the audit identity $16 \times 15 = 240 = R(E_8) $ REALIZED on the roots (the 60 reflections = the 60 Gaussian lines, 4 per class); (8, 12, 20, 24) the UNIQUE integer quadruple with product 46080 and sum 64; the 607-group rank-4 kill scan: G_{31} the SOLE full-battery passer (weak-triple impostors and raw-sum-64 coincidences typed by name; the honesty line kept: degree-only audits cannot see the reducible torus); the $W(D_5) \times W(A_3)$ fence re-killed by COMPUTED centers 4 vs 1 (v634 cited for the structural refutation).

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Script	What it machine-checks (<i>continued</i>)
v874_feedback_decoder_lean.py	TWO EXACT COMPILER THEOREMS: the integral basis $P = [2 \cdot \mathbf{1} \mid e_3 \mid Re_3]$ ($\det -4$, SNF $(1, 2, 2)$) conjugates the whole winding line to the gain-plus-companion form $[[s+4, 0, 3], [0, 0, -2], [4, 1, 5]]$ exactly (symbolic in s), so $\chi_{R_s} = (t - s - \mu_4) q_{\text{wind}} - 12t$ with $12 = N_{\text{fam}} \mu_4 = \dim g_{\text{SM}}$ and the honest typing $\mathbb{Z}^3/P\mathbb{Z}^3 = \mathbb{Z}_2^2$ (cardinality 4, NOT μ_4); and the winding quadratic decodes the clock alphabet, $q(\{2, 3, 5, 6\}) = (-4, -4, 2, 8)$, $D(y) = (y+4)^2(y-2)(y-8)$ with budget coefficients $(2, 48, 32, 256)$, and $ \mu_4 q(Z_2)/ R(E_8) = -1/15$ EXACTLY the Walsh message eigenvalue – an audit theorem, not a functor. Lean mirror: FlavorFeedback.lean, 11 theorems, standard axioms.
v875_shell_global_lean.py	THE GLOBAL SHELL THEOREM: the $-1/15$ census law upgraded from the finite census ($n \leq 16500$) to a proof for ALL shells – $\text{Sp}(4, 2)$ transitivity (60 transvections, identical to the shell-module action) + $(1+i)$ doubling + $\Theta_L = 240\sigma_3$ give $\Theta_u(n)/\Theta_L(n) = -1/15$ at every ODD n exactly; a non-transitive control breaks the law (transitivity load-bearing), the even-shell formula differs correctly ($7/135$ at $n = 2$). Lean skeleton GaussianShells.lean: the consequence chain kernel-checked from the named ShellSystem hypotheses (7 theorems, exact integer identities, no division); the census range retained as the exact ward.
v878_ledger_integrity.py	THE STATUS-LEDGER INTEGRITY GUARD: round 36 found and fixed the first primary-key violation (claim_id FORM.QGEO.03 double-booked 2026-06-15/2026-06-18; the SeamDeckClosure row renamed FORM.QGEO.04 with a dated QA note, all references updated); the guard enforces the 10-column schema, global claim-id uniqueness (the fix pinned), existing supersession targets with an ACYCLIC supersession graph, unique active supersession targets modulo the frozen remove-only allowlist of the two legitimate 2026-06 joint closures, and the dependencies cross-reference census frozen remove-only (13 SCCs / 265 ids; acyclicity enforced as NO NEW CYCLES).
v880_finite_anchor_theorems.py	the four finite anchor theorems: the census-free normal form $q^*(x) = \sum_{i < j} x_i x_j + \sum_i x_i = \binom{ x +1}{2} \bmod 2$ (weight-only; the selector forced on the linear part); the EXCLUSIVE anchor classification of $PG(3, 2)$ lines (all 15 doily lines carry $\{2, 1, 1\} = a$, per-line Vieta $(4, 5, 2)$ with $e_2 = g_{\text{car}}$, $e_3 = \mathbb{Z}_2 $; 10 secants carry the WRONG anchor $(1, 2, 2)$, 10 external lines $(1, 1, 1)$); the doily as the multiplication table $\Lambda^2 E \times \Lambda^2 E \rightarrow \Lambda^4 E$ (wedge nonzero EXACTLY on doily lines); one-step quadratic exhaustion FORCES $g = 5$ ([E] theorem; the Calderón premise stays [O]).
v888_finite_pfaffian_signature.py	the complete finite Pfaffian/ K_6 signature: Specht channel scalars $(1, 0, 2/3)$ exact; the 15 doily lines ARE the 15 Plücker monomials of $Gr(2, 5)$ with perfect sign match; the $(16, 6, 2, 10)$ Hadamard anchor; the $S_6 \rightarrow S_5$ vacuum selection; THE FLAVOR HEXAGON IS THE $\text{Aut}(C_{\text{fin}})$ ORBIT ($g^2 = \sigma$ exact, $(2/3)^6 =$ the recovery value); the K_6 motif theorem ($35 = 15$ matchings + 20 triangles); the fermionic Pfaffian signs GAUGE-MATCHED via the canonical character $\chi(i) = (-1)^{i+1}$; the self-hosting counting theorem $\binom{g+1}{2} = g!!$ forces $g = 5$ uniquely (nontrivially) with $N_{\text{fam}} = 3$; the mod-30 clock is CLOCK-DISTINGUISHED.
v896_wick_block_functor.py	the Wick functor arc of the finite compiler: the six roles exist in the deployed seam (sector law, q^* grading, C_6 intertwining exact) but the vacuum kernel is channel-diagonal; the PROVED scalar obstruction (the C_6 2-cycle $\{4, 5\}$ forces a duad zero); the block resolution (BLOCKFUNCTOR-CONSTRUCTED: 15/15 blocks and Wick monomials with the canonical sign law) and the decisive fact SEAM-DIAGONAL – the value level awaits a physical mixing mechanism; the [O] premise is unmoved.

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Script	What it machine-checks (<i>continued</i>)
v898_kms_schur_mining.py	the channel-mixing state the block Wick functor awaits: the C_6 -covariant mixing KMS state EXISTS ($u = 1$, $t = 1/8$, $\beta = 1$; all 15 blocks at the floor, grading $5/5 + 10/10$, canonical Pf4 signs; $\beta = 2$ robust); EXACT (sympy): Schur elimination of the boundary GENERATES all 10 carrier duads from the bare diagonal state – on both fronts the real correlation lives in the ELIMINATED boundary; the frozen 15-signature table is the registered prediction; RP-THETA-OPEN named; the [O] premise is unmoved.
v903_seam_rp_exclusion.py	the seam RP/modular exclusion and the two dead readings: strict RP forces $t = 0$ under BOTH spatial reflections (odd-sector Gram eigenvalues exactly $\pm a_J $: OS positivity $\iff$ the v898 mixing floor falls – mutually exclusive on this family); $u \geq t$ forced; the 2π -KMS locus is the point ($t=0, \beta=2\pi$); the complete twisted-OS census is exclusionary (0/6); the dilation route splits (marginal witness ON the cone boundary, Schur compression carrying the full Pfaffian mixing with $t^2 \cdot 3m/(1 - m^2) = 1/200$ exactly; the strict collar route obstructed by an exact linear $2t$ law); $t_{\text{gap}} = 0.230949$ theorem-shaped (Pf = $-(t-1)(3t^2-1)(9t^3+21t^2-t-1)$ exactly, Sturm uniqueness on $(0, 1/4]$, kernel dimension exactly 2; no root is $1/8$); the two dead readings booked as first-class negatives: ' $t = 1/8$ is a compiler value' is a DECORATION (PIN-ABSENT), ' $N_{\text{fam}} = 3$ as minimal mediation rank' is REFUTED (rank 1 suffices; deployed rank exactly 2; purity = dimension bookkeeping); the v898 [O] premise is unmoved.
v908_seam_equilibrium_wiring.py	the seam equilibrium wiring (the physics closure of the round-60 questions): strict 2-cycle RP is IMPOSSIBLE on the whole C_6 -covariant class (the seat law reduces exactly to $M_1 = \text{diag}(a_J, -a_J)$, interior EMPTY – the marginal witness is neither a limit of covariant strict equilibria nor isolated); the only escape is the covariance-breaking X coordinate at exact linear price 2ε , with the floor exchange $\text{Pf}_4(\varepsilon) = (\varepsilon - \frac{1}{200})(\varepsilon + \frac{1}{200})$ exactly – the canonical sign gate IS the negative effective RP margin; the strict-collar obstruction is a two-seat linear law with kernel $\{J, Z\}$, the deployed wiring is PURE-I (maximally obstructed), and equilibrium witnesses V_J/V_Z carry the full $1/200$ mixing at ZERO entropy production – NO NESS NEEDED (stationary $\Rightarrow \sigma \equiv 0$ exactly; drive buys no RP); the registered next contract – is PURE-I compiler-forced? (SEAM.STATE.WIRING.SELECTOR.01) – is CLOSED in v911: deployment choice, not a compiler theorem; the v898/v903 [O] premise unmoved.
v911_wiring_freedom.py	the wiring freedom theorem (closes the v908-registered contract SEAM.STATE.WIRING.SELECTOR.01): the exact Groebner census determines EXACTLY ONE admissible 3-dim wiring component mod rule gauge (the rotation cell C_{rot}); Z/X wirings are excluded gauge-invariantly by orientation propagation; pure-I is an INTERIOR point, connected to the pure-J ray by the integer gauge element $(\oplus_5 J_2) \oplus I_6$ – PURE-I IS A DEPLOYMENT REPRESENTATIVE, not a compiler theorem; THETA-CONVENTIONAL: no compiler-side demand distinguishes the θ_S sheet-swap frame in the 9-dim rule-gauge algebra (five demand classes silent-on-angle), and the deployed parent PASSES strict collar RP exactly in the integer-conjugated frame – the round-58/59 obstruction is FRAME-RELATIVE; RP-FRAME-COVARIANT: the strict-collar RP Grams transform exactly covariantly under the rule gauge, the pure-I exclusion is a frame statement (option 2), NOT a wiring no-go, while the Z/X exclusion IS orbit-invariant; the canonical sentence is frozen and 'pure-I is compiler-forced' is FORBIDDEN; the v898/v903 [O] premise stays [O]; zero RH content.

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Script	What it machine-checks (<i>continued</i>)
v957_ccc_crossover_kinematics.py	CCC.SEAM.KINEMATICS.01 (rounds DL–DLV, 2026-08-24): THE CCC CROSSOVER KINEMATICS DICTIONARY (28 + 29 + 18 + 21 + 14 + 7 gates, six probes embedded byte-exact). (1) Penrose’s reciprocal gauge $\Omega \tau(\Omega) = -1$ is the element $\tau = \rho^2 \sigma$ of the PROVEN μ_4 stabiliser D_4 (τ reverses the clock = the $\mathbb{Z}_2$ sheet parity; the crossover circle carries all four marks). (2) The clock alone leaves exactly ONE conformal modulus on the 2D seam and the reciprocal $\mathbb{Z}_2$ kills it (Liouville-exact; $so(3, 1)$ commutants 2/0). (3) The Stinespring dilation of the v221 transport is explicit: $V^\dagger V = 1$, $\ T^n - P_\star\ = (2/3)^{6n}$ EXACT, global overlap invariant – entropy reset = reduced channel, no information destroyed. (4) The kinematic 2D→3D→4D uplift: stereographic(Hopf) = z_1/z_2 EXACT, crossover $X = S^3/\mathbb{Z}_4$ = the lens boundary of the corpus A_3 ALE (deck free; marks = four linked fibre circles in the two sheet orbits, Gauss linking 1; $so(4, 1)$ deck-commutant = 4 Killing / 0 boosts – Yamabe rigidity with NO extra condition, global via the Obata family); the 4D bridge is the cone with the inversion as conformal aeon swap; the Lorentz shadow $(1/\cos^2 T)(-dT^2 + g_{S^3})$ is Einstein $R_{ab} = 3g_{ab}$ with a spacelike S^3 crossover and $\hat{\Omega}\hat{\Omega} = -1$. (5) KMS closure: detailed balance exact, $\text{spec}(-\ln T) = \{0, 6 \ln(3/2), 6 \ln 3\}$, $T = e^{-H_{\text{mod}}}$, $\beta_{\text{angle}} = 2\pi = 1/(4c_3) = \text{Gibbons–Hawking on the fibre}$. (6) Holonomy: pole strings carry the full μ_4, every seam string carries EXACTLY the 2-torsion -1 = the v522 GSO/fermion-parity wrap (typed [C]). (7) Selector necessity: $M(\delta)$ admissible reflections close to D_4 iff $\delta = \pi/2$; Majorana operator level: clock axes Θ-real ONLY at $k = 4$ – the UNIQUENESS half of the v534 selector DERIVED (survival + sign cited). (8) The frozen Gate-6 kernel: causal top-hat disc $\theta_{\text{max}} \approx 1.16^\circ$, rates $\ln(729/64)/\ln 729$, κ derived from v526 (declared band, contrast $\leq 3.3 \times 10^{-4}$) – feeds the preregistered search <code>ccc-crossover-disc</code> (no data touched). The cyclic/CCC reading stays [C]; WOIT.OS.TWISTOR.01 stays [O].
v971_markov_embedding_generator.py	DYN.MARKOV.EMBED.01 (finite kernel half [E]; external-review round 2026-08-27, ‘three meanings of dynamics’): $Q = \log T$ of the v221 seam transfer kernel is an EXACT classical Markov generator – sympy-exact spectral log with $e^Q = T$, row sums symbolically zero, off-diagonals exactly $\{\ln(9/8), 2 \ln 3, 2 \ln 3\} = \{0.117783, 2.197225, 2.197225\} > 0$, diagonals $-\ln(81/8), -\ln(81/8), -4 \ln 3$; uniformization certificate $Q + (4 \ln 3)I \geq 0$ entrywise $\Rightarrow e^{tQ}$ positivity-preserving doubly stochastic for ALL $t \geq 0$ (T embeddable, every root $T^{1/n}$ stochastic); $\text{spec}(Q) = -\text{spec}(H_{\text{mod}}) = \{0, -6 \ln(3/2), -6 \ln 3\}$ (gap = Δ), detailed balance w.r.t. the uniform state. NEGATIVE control: second eigenvalue $-1/10$ gives $\det = -1/200 < 0$ – provably NOT embeddable (embeddability is not generic; the RP/OS spectral positivity is the enabling fact). FIREWALL: closes relaxation→semigroup (a)→(b) at the finite kernel level ONLY; the local, size-consistent unitary dilation (b)→(c) is the separate open contract DYN.UNITARY.DILATION.01; the shared F_ transfer relaxation shape is a universal CONTRACTION CLASS, not one physical clock (v723/v724/v777).

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Script	What it machine-checks (<i>continued</i>)
v972_seam_interaction_front.py	SEAM.INT.ODDSPLIT.01 [E] + SEAM.INT.OSAVOID.01 [E] + SEAM.STATE.RPMIXING.01 [E] (+ updates to SEAM.INT.FKTOY.01 / WOIT.OS.TWISTOR.01 / SEAM.STATE.DERIVATION.01; three exploration rounds of 2026-08-27 consolidated, the probes embedded byte-exact with pinned source SHA-256 and executed verbatim, 20/20 + 18/18 + 25/25, verdicts CLASS_EMPTY_ON_BASIS + OS_VIABLE_ON_AVOIDING + RP_ADMITS_MIXING): THE SEAM INTERACTION FRONT – (1) the Jaffe–Pedrocchi sufficient condition for Majorana reflection positivity (arXiv:1406.1384; Wei–Li–Xiang arXiv:1601.01994) made DECIDABLE on the v529 FK toy: the crossing matrix B is UNIQUE (left-monomial pairs biject onto crossing monomials), so ‘B Hermitian AND $-B$ PSD’ is a finite check; the free FK Hamiltonian certified on all 8 bond cuts ($\eta = -i$ forced); the confusion matrix vs measured RP PERFECT over 35 cells (23/12/0/0); the μ_4-covariant quartic space (dim 464) EMPTY on the basis, the support-level exclusion pinning the full 1820-dim space – THE DISCOVERY: the v529 straddle law REFINES to the ODD-SPLIT LAW (JP predicted RP survival on CENTER-straddled cuts, $m = 4$ model, axes 7/15, 2+2 mirror split; measurement confirmed (37, 0, 0) at $g = 0.5/1/2$; the v529 anchor ladder reproduced exactly). (2) the quartet-AVOIDING cut family of the clock-invariant $m = 4$ member generates the FULL even algebra (rank 15, dim $32768 = 2^{15}$; single-cut members $m = 2/6$ typed deficit exactly 1) and carries a POSITIVE OS/GNS structure at $g = 1$ (min $+4.43 \times 10^{-5}$, GNS 37/37, distances monotone) while the straddled control genuinely fails (-6.94×10^{-2}); the μ_4 clock maps the avoiding pair $\{3, 11\}$ onto itself exactly – the kill-test-2 counterweight NARROWED, not removed. (3) the v903 exclusivity is RAY- and REFLECTION-relative, not slice-wide: on the full 33-dim C_6-covariant mixing slice θ_{abT} sees exactly ONE coordinate (a_J, kernel value $-1/(1+c^2) = -0.8240271368$ at $c = \tanh(1/2)$), 32/33 invisible $\Rightarrow$ a 32-dim MARGINAL RP hyperplane $\{a_J = 0\}$; the θ_S defect map has rank 16 $\Rightarrow$ a 17-dim first-order-neutral subspace with STRICT finite-s witnesses ($\lambda_{\min} = 0.1558$ at $s = 1/8$); the v903 anchor reproduced ($a_J = +0.04068013$). Module-own exact S0 (sympy/GF(2), no probe imports): the JP decidability lemma on a 4-Majorana toy (9 pairwise-distinct crossing masks $\Rightarrow$ unique B; the wrong-sign toy fails), the odd-split arithmetic (centered $\Leftrightarrow$ 2+2 exact on $\mathbb{Z}_{16}$; the odd 1+3 block forces $b = 0$ – the obstruction; the flipped-sign-law mutant caught), the GF(2) generation bookkeeping (pair rank 15, $2^{15} = 32768$; within-halves rank 14 – deficit exactly 1), the window arithmetic (33 = 24 + 9, 32 + 1, 33 – 16 = 17; kernel value $\equiv -\cosh^2(1/2)/\cosh(1)$ symbolically) plus 4 verdict bars with tipping mutants. HONEST: no marker moves; SEAM.EQUIV.01 stays [O]; the v529 fence (one toy, one interaction class, [C] flat-band parent) inherited by all three results; JP sufficient-only; the S1 census sector-truncated. NO RH claim.

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Script	What it machine-checks (<i>continued</i>)
v973_seam_route_narrowing.py	SEAM.EQUIV.MMST.01 [O update] + SEAM.EQUIV.TWISTOR.01 [O update] + SEAM.EQUIV.SKELETON.01 [E, NEW] + SEAM.EQUIV.01 [O update] (seam adjudication wave, 2026-08-27): THE SEAM ROUTE NARROWING (19/19 + 20/20 + 19/19, three probes embedded byte-exact with pinned SPEC SHAs, plus the module-own exact section S0). (1) MMST COVERAGE CARVED: the cited Osborne–Stottmeister theorem (CMP 398 (2023) 219, arXiv:2107.13834) COVERS the bilinear half of the seam target – $\mathfrak{so}(16)_1$ fermion-bilinear WZW currents converge STRONGLY on the finite-particle core (Thm 5.1 + Cauchy–Schwarz Eq. 229 incl. Majorana algebras), Virasoro/Koo–Saleur (Thms A/4.11/4.16), correlators (Thms B/C), polynomial errors $\text{Error}^2 \leq C 2^{-2\delta N}$, $\delta \in [0, 2]$ – and does NOT cover four NAMED items: N1 the μ_4/GSO extension $SO(16)_1 \rightarrow (E_8)_1$ as a NET statement (the 128 spinor currents are not bilinears), N2 the twist/spin-field sector, N3 the one-sided chiral edge net of a 2+1D bulk, N4 the holomorphy selector $\det K = 1$ vs 4; NEW MEASUREMENT: the collar edge-correlator rate $p = 3.48$ (Richardson 3.1–4.2, preregistered band $[0.5, 4.0]$), error $6.3 \times 10^{-2} \rightarrow 2.7 \times 10^{-6}$ over $N_x = 16..256$, the $M = 3$ control does NOT converge (min rel dev 0.836); exact-integer coverage gates ($248 = 120 + 128$, $240 = 112 + 128$, $\det \text{Cartan } 4 \rightarrow 1$, index $2 \times 2 = 4 = \mu_4$). (2) TWISTOR MEASURE RIGIDITY: on the computable v508/v515 sector the 18-parameter deformation of the declared measure data has executed-constraint ranks $9/8/2/2$, joint 13, 4 gauge directions $\Rightarrow$ the moduli kernel is EXACTLY 1 = the uniform sector-weight shift $dv = (1, 1, 1, 1)$, mapping to the untwisted Okubo square $Q^{(0)} = 36(1, 2, 1, 0, 0)$, annihilated by every executed certificate functional BY CONSTRUCTION; ablation ledger $(1, 3, 1, 2, 3, 10)$; the $W_2 : W_{13}$ tester honestly NOT-TRANSCRIBABLE. (3) OS SKELETON SHARED: all FIVE WOIT kill-test main invariants (α: forced $\eta = +i$, $\Theta^2 = +1$, bond RP; β_1: GSO 2-torsion; β_2: OS quotient + KMS $\lambda_{\max} > 1$; β_3: perp descent; γ: mirror flip, multiplicity-free, mark incidence) hold VERBATIM on the p+ip collar edge; ALL divergences control-typed to ONE mechanism (the twistor lattice’s exact chiral checkerboard $C(\text{even}) = 0$ vs the collar’s $K(\text{even})$ up to 0.1736 – confirming v519-R4 from the second route); the top edge realizes the anti-chiral state EXACTLY (7.5×10^{-16}); the $M = 3$ collar loses the skeleton first at GAMMA.MARK.INCIDENT. Module-own S0 exact: root census + Cartan determinants + index arithmetic; the uniqueness linear algebra in exact rationals (ranks $(9, 8, 2, 2) \rightarrow 13 \rightarrow$ kernel 1, ablation ledger exact, the dropped-C4 mutant opens the kernel to 3 – CAUGHT); the skeleton mechanisms exact (bipartite $SHS = -H \Rightarrow$ odd functions vanish on even distances; $PHP = -H$ on a strip $\Rightarrow K_{\text{top}} = -K_{\text{bot}}$); verdict bars with tipping mutants (a fake COVERAGE_FULL is REFUSED by the nonempty N1–N4 gate; hash mutation CAUGHT). HONEST: the coverage gates are executable transcriptions of a literature adjudication; the rate SUPERCONVERGES ($p > \delta_{\max} = 2$) vs the cited upper bound (band calibration-informed); the sector uniqueness is NOT a BCOV derivation; skeleton fidelity typed per test. NO marker moves: MMST and TWISTOR stay [O], the parent stays [O]; the only new row is SEAM.EQUIV.SKELETON.01 [E].

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Script	What it machine-checks (<i>continued</i>)
v974_alpha_faces_computed.py	ALPHA.QUILLEN.EXACT.01 [O update] + SEAM.CONTACT.UNIT.01/.02 + EM.WARD.01 / ALPHA.QUILLEN.INFLOW.01 + ALPHA.QUILLEN.FACES.01 [E, NEW] (seam/alpha promotion wave 2026-08-27): both named faces of the alpha target now carry computed witnesses — three probes embedded byte-exact, sha256-pinned and executed verbatim (21/21) MATCH_MODULO_LOCAL_FACTOR + 20/20 PUMP_QUANTIZED_MATCHES_CHERN + 18/18 CHAIN_SHADOW_OK), plus the module-own exact section S0 (sympy/Fraction/mpmath, no probe imports). (1) The BFK face EXECUTED: the Burghlea–Friedlander–Kappeler gluing constant is exactly 2^{-N} (derived symbolically $N = 1.4$, general interval lengths); massless reassembly $\det'_\zeta(\Delta_{S^1}) = l^2 = 2^{-N} \prod (2a_j) (l/N) \det'(R_0)$; at the KMS scale $l = 2\pi = 1/(4c_3)$: $R_0 = 16c_3 \text{ circ}(2, -1, 0, -1)$, $\det' R_0 = 2^{16}c_3^3$, glued product $(2\pi)^2$; $R(m) = (G_m _{\text{marks}})^{-1}$ exactly; vs the v484 mark matrix NO global proportionality (kernels in swapped μ_4 channels: gauge zero mode vs sign rep) but channel-wise EXACT (same μ_4 Fourier eigenbasis, spec multisets $\{0, 2, 2, 4\}$, doublet ratio $4/\ln 2$ with c_3 cancelling, $\text{Tr } B^k = 4^k + 2 \cdot 2^k$ mirroring $\text{Tr } C^k = 4^k + 2(-2)^k$); the v485 scale channel reproduced exactly via the KMS unit. (2) EM1 COMPUTED: pumped charge == edge spectral flow == Streda == Chern == 1 per flux quantum on the v367 collar (conjugation mutant flips all four readings simultaneously; wrong-band projector breaks quantization). (3) The finite Quillen identity TWO-SIDED: Berry integral == Poincaré–Lelong divisor integral == +1 over the twist torus, difference an exact form (3.3×10^{-16}), transition winding == Chern; typed conditional on the quasi-free rigidity premise (measured, not proven — SEAM.STATE.RPMIXING.01). S0 re-derives everything independently: the BFK closed forms from ζ_R values, the alpha anchor at 50 digits ($8b_1 = 164/5$ exact, unique root, $\alpha^{-1} = 137.03599921684071$, split residual 6.4×10^{-58}), the inflow bookkeeping ($c_- = 8 = g_{\text{car}} + N_{\text{fam}}$, $k_Y = 5/3$, $(1/k_Y) 41/6 = 41/10 = b_1$), a probe-free coarse FHS Chern certificate. Mutants: hash mutation caught by the sha256 pin; the wrong KMS unit ($2\pi \rightarrow 4\pi$) breaks the scale identity by exactly $-2\ln 2$; the b_1 mutant caught. NO marker moves — the target stays [O]: remaining content = {rigidity premise} + {channel-swap question} + {continuum Bismut–Freed identification}; α^{-1} stays [E] regardless.
v975_dimension_selector_4d.py	DIMENSION.SELECTOR.4D.01 [C, NEW] (master-route wave 2026-08-27): the CONDITIONAL 4D dimension selector, 16/16 sympy-exact. Under the named TFPT-compatible axiom set A1 ($d > 2$: propagating local gauge fields), A2 (dimensionless Yang–Mills coupling), A3 (real self-dual/anti-self-dual 2-form sectors: the Euclidean Hodge star an involutive endomorphism of 2-forms), A4 (chiral Weyl representations: even d), the dimension $d = 4$ is UNIQUE and MINIMAL on the exact scan window $d = 2..12$ — and the selector is OVERDETERMINED: A2 alone = $\{4\}$ ($[g_{\text{YM}}] = (4 - d)/2$ forced symbolically, unique zero 4) and A3 alone = $\{4\}$ (the explicit 6×6 star on $\Lambda^2(\mathbb{R}^4)$, $*^2 = I$, eigenvalues ± 1 at multiplicities 3/3), while A1 & A4 alone give $\{4, 6, 8, 10, 12\}$ — chirality does NOT select 4 by itself (honest ablation ledger). Weyl chirality certified by exact Clifford algebras $d = 2..7$ (even d: γ_* anticommutes, $\gamma_*^2 = I$, traceless; odd d: the product is CENTRAL and scalar). Signature typed honestly: Lorentzian $*^2 = -1$ on 2-forms — the real split is a EUCLIDEAN/OS-side statement. Mutants caught ($[g] = (6 - d)/2$ selects $\{6\}$; the ‘A4 alone’ overclaim refused). FIREWALL: μ_4 and g_{car} enter NOWHERE — ‘$\mu_4 \Rightarrow 4D$’ stays forbidden (DIMENSION.UPLIFT.FIREWALL.01); axiom provenance from $\{c_3, g_{\text{car}}\}$ is the OPEN half (the kill criterion in the ledger row); no 4D construction contract is advanced.

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Script	What it machine-checks (<i>continued</i>)
v976_seam_lift_ birkhoff.py	TRANSFER.HIDDEN.CIRCULATION.01 [E, executed half] + the EB no-go for DYN.UNITARY.DILATION.01 (external-review round 2026-08-27): the Birkhoff fibre of the seam single step B is EXACTLY a line, its hidden parameter is the sign character, and the deployed Kraus dilation is entanglement breaking — $B = \frac{1}{2}I + \frac{1}{18}P_{12} + \frac{2}{9}P_{13} + \frac{2}{9}P_{23}$ bit-exact ($B^6 =$ the v221 kernel), the decomposition map has a 1-dim kernel ($I + C_{123} + C_{132} = P_{12} + P_{13} + P_{23} = J$), complete family w_t with $t \in [0, 1/18]$; $\widehat{w}_t(\text{sgn}) = 6t$, populations exactly t-free, no fibre member chiral ($w(C_{123}) = w(C_{132})$ forced). DISCRIMINATOR: one-step coherence dynamics = the weighted left regular S_3 representation, spectrum $\{1, 6t, 2/3 \times 2, 1/3 \times 2\}$ exactly; the triangle loop current is an exact eigen-observable $\Psi_t(A) = 6t A$ (population-blind: one step + one current readout measures t, no ancilla; tomography rank 6). CONTRAST QUBIT: $\text{spec}(\text{Choi}^{T_2}) = \{-3t/2, 1/6 + 3t/2, 1/3 + 3t/2, 1/2 - 3t/2\}$ symbolically; CRITICALITY $\lambda_{\min} = (1 - \lambda_2 - \lambda_3 - 6t)/4$ with $2/3 + 1/3 = 1$ EXACTLY ($t = 0$ precisely on the EB boundary; mutated spectra miss by $\mp 1/12$ — not generic); the squared channel is PPT on the whole range (endpoint minima $1/9, 1/12 \Rightarrow$ qubit EB index 1 ($t = 0$) / 2 ($t > 0$)) [PPT $\Leftrightarrow$ EB in 2×2 + Lami-Giovannetti, literature-typed]. FULL LEVEL: $\lambda_{\min}(\text{Choi}(\Psi_t^n)^{T_2}) = -(1/3)(2/3)^n$, t-INDEPENDENT (exact for $n \in \{1, 2, 6\}$, float $n = 1..8$) — never EB at 3 levels. THE NO-GO: the deployed Kraus dilation $K_{ij} = \sqrt{T_{ij}} i\rangle\langle j$ is measure-and-prepare $\Rightarrow$ entanglement breaking [HSR] $\Rightarrow$ quantum capacity 0; $C_0(T) = 0$ exactly; it is NOT in the Birkhoff fibre. BINARY MESSAGE: $p^* = (1/2, 1/2, 0)$ is KKT-exactly optimal for BOTH T and B ($C(T) = 0.0083580191$ bit, $C(B) = 0.4890415237$ bit, ratio 1.71%). [C] observation: the weights $(9, 1, 4, 4)/18 = \text{squares}/18 =$ the v652 defect-ladder values $g^2/18$ (multiplicity matches only at $g = 2$; the forcing functor is the OPEN contract TRANSFER.DEFECT.BIRKHOFF.01). FIREWALL: finite matrix algebra + literature-typed channel theory; the fibre-point selection stays [O].

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Script	What it machine-checks (<i>continued</i>)
v977_transfer_unistochastic_wilson.py	TRANSFER.COHERENT.WILSON.01 [E, executed half] (external-review round 2026-08-27, companion of v976): B is UNISTOCHASTIC — an exact $SU(3)$ lift carrying the 5-12-13 Wilson code, the center bridge and a classically invisible orientation bit — angles forced by B ($\sin^2 \theta_{13} = 2/9$, $\sin^2 \theta_{12} = 1/14$, $\sin^2 \theta_{23} = 2/7$), $\cos \delta = -4/\sqrt{65}$ unique, $e^{i\delta} = (-4 \pm 7i)/\sqrt{65}$, lift set = $\{U, U^*\}$ up to rephasing; $U^\dagger U = I$, $\det U = 1$, $U_{ij} ^2 = B_{ij}$ entrywise exact [coherification iff unistochastic, literature]. $J = \text{Im}(\text{plaquette}) = 1/27$ EXACT; Re of every plaquette fixed by B (unitarity) $\Rightarrow$ the full rephasing-invariant Wilson data is classical up to the $\mathbb{Z}_2$ ORIENTATION BIT $\text{sgn } J$ (U^* lifts the same B with $J = -1/27$; observable = the plaquette interference readout). THE CODE: $Q_{12;12} = (-5 + 12i)/324$, normalized $(-5 + 12i)/13$ with $5^2 + 12^2 = 13^2$ (atoms $5 = g_{\text{car}}$, $12 = \dim \mathfrak{g}_{\text{SM}}$, $13 = \Delta_Q = N(3 + 2i)$); all nine plaquettes close on four Gaussian phase types with norms exclusively $\{10, 13, 130, 169\} = \{2 \cdot 5, 13, 2 \cdot 5 \cdot 13, 13^2\}$; every $\text{Im} = \pm 1/27$; the four fundamental plaquettes generate all nine exactly. CENTER BRIDGE: $\text{disc } \chi_A = 65 = \det(A - I)^2 + (\det A/2)^2 = 4^2 + 7^2$ for the v530 atom matrix $A = [[8, 2], [5, 3]]$; $e^{i\delta} = (-\det(A - I) \pm i \det A/2)/\sqrt{\text{disc}}$ EXACTLY equals the transport phase; $-4 + 7i = (1 + 2i)(2 + 3i)$ (the v738 tower primes, norms 5 and 13); the v530 siblings A_K/A_Q FAIL the square-sum identity (the bridge selects A). POWER LAW: $J_n^2 = (1 - b)^2(1 + 2b - 3a^2)/108$, every B^n unistochastic (U_6 built, $U_6 ^2 = T$ exact); $J_6 = 0.0951088904 = 0.9884006 J_{\text{max}}$; the uniform limit lifts to the Fourier matrix F_3 at J_{max} exactly; J_n RATIONAL ONLY at $n = 1$ ($3(1 + 2b - 3a^2) = 1$ exactly $\Rightarrow J = 1/27$) — the Gaussian–Pythagorean code selects the single step. NO FIXED MICROSTEP: $B^2 \neq U^2 ^2$ exact; Dirichlet recurrence witness $n^* = 967909$ (min diag $U^{n^*} ^2 = 0.999999$ while B^n is uniform to 5.6×10^{-17}) — $U_6 \neq U_1^6$ (clock-vs-walk sharpened coherently). CENSUS (hard kill passed): 238 valid family points, 4 with rational J, EXACTLY ONE full-code point = the deployed $(2/3, 1/3)$ ($0.42\% \ll 10\%$). PMNS NEAR-MISS stays NEGATIVE (branch phase 240.2551° vs deployed 240°; $-1/27 \neq -0.02965$; all angles differ). FIREWALL: the $\text{sgn } J$ branch selection, CP/time readings and the $A \rightarrow$ angles intertwiner stay [O].
v983_simple_current_generator.py	SEAM.SIMPLECURRENT.GENERATOR.01 [O update: the generator IDENTIFIED, its lattice-arithmetic shadow complete] (external master-object review wave 2, 2026-08-28): THE ONE GLUE VECTOR $\lambda = (\omega_s, \omega_f)$ GENERATES THE FULL 128 SPINOR SECTOR — exact at the lattice level — $\ \omega_s\ ^2 = 5/4$, $\ \omega_f\ ^2 = 3/4$, $\ \lambda\ ^2 = 2$, conformal weight $h_\lambda = 1$ (integer $\Rightarrow$ trivial self-monodromy); $[\lambda]$ has ORDER FOUR in the discriminant group $\mathbb{Z}_4 \times \mathbb{Z}_4$ of $D_5 \oplus A_3$ ($4\lambda \in L_0$, $\lambda, 2\lambda \notin$); $\lambda \cdot L_0 \subset \mathbb{Z} \Rightarrow$ isotropic glue, the glued lattice is EVEN; $\det = 16/4^2 = 1 \Rightarrow$ UNIMODULAR rank 8 $\Rightarrow E_8$ (classification [C]; explicit certificate v1). COSET ROOT CENSUS [52, 64, 60, 64] (total 240; +8 Cartan = $248 = (45 + 15) + (16, 4) + (10, 6) + (\overline{16}, \overline{4})$); the odd fusion powers carry $64 + 64 = 128 =$ the FULL missing spinor sector — ONE field generates all four cosets. KILL TESTS FIRE: the vector-class glue (norm $7/4$) and the mismatched glue (norm $9/4$) both break evenness. HOLOMORPHY SHADOW: $\det 1 \Rightarrow$ one sector vs $\det(D_8) = 4 \Rightarrow SO(16)_1$ has four (the lattice shadow of N4 only). FIREWALL: the analytic half (implementer convergence S1/S2, crossed-product/scaling exchange S3, operator-algebraic holomorphy S4) stays [O]; 1+1D in and out; no marker move.

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Script	What it machine-checks (<i>continued</i>)
v984_markov_qca_dilation.py	DYN.UNITARY.DILATION.01 [O update: the DISCRETE leg realized constructively] (external master-object review wave 2, 2026-08-28): THE EXACT COLLISION MODEL — B^n as the reduced dynamics of an exactly unitary, strictly local QCA band — the collision step $V = C(U_B \otimes I)$ with the mod-3 record $C j, k\rangle = j, j+k\rangle$ is unitary on system + ancilla; the STINESPRING IDENTITY $\Phi(\rho) = \text{Tr}_A[V(\rho \otimes 0\rangle\langle 0)V^\dagger] = \sum_j P_j U_B \rho U_B^\dagger P_j$ holds as a symbolic operator identity (Kraus completeness $\sum_j K_j^\dagger K_j = I$); $\text{diag } \Phi(\text{diag } p) = Bp$ exactly with vanishing off-diagonals; SIX fresh ancillas give $\text{diag } \Phi^6 = B^6 p = Tp$ exactly — the v977 macro-gate as reduced dynamics of a radius-1 collision band. MUST-FAIL FIRES: the closed unitary has $ U_B^2 ^2 \neq B^2$ (31/54 vs 0.2450) — the dilation is necessary. TYPED REMARK (probe finding AGAINST the review text): a REUSED mod-3 adder ancilla still gives $\text{diag} = B^2 p$ exactly (the record $j_1 + i$ stays distinguishable) — fresh ancillas are needed for the coherences, not the populations. The conjugate branch V^* dilates the SAME B ($\text{sgn } J = \pm 1/27$ stays classically invisible; selection stays [O]). FIREWALL: the discrete finite leg only; quasi-local Hamiltonian dilation, OS continuation to e^{-itH} and any 3+1D reading stay [O]; no marker move.
v985_quillen_channel_swap.py	ALPHA.QUILLEN.EXACT.01 [O update: the CHANNEL-SWAP face resolved at the finite level by μ_4 -character grading] (external master-object review wave 2, 2026-08-28; v974 anchors read-only): THE DECK GRADING RESOLVES THE v974 KERNEL SWAP EXACTLY — the jump pattern $\text{circ}(2, -1, 0, -1)$ has μ_4 eigenvalues $[0, 2, 4, 2]$ (kernel $k = 0$), the mark pattern $\text{circ}(0, 1, 2, 1)$ has $[4, -2, 0, -2]$ (kernel $k = 2$) — the v974 swapped-kernel fact symbolically; the DECK SWAP $r \rightarrow r+2$ ($P_0 \leftrightarrow P_2, P_1 \leftrightarrow P_3$) maps the jump [spectrum] onto the mark pattern EXACTLY — after the swap both kernels sit in the same channel and the graded comparison is well defined; the ODD swap $r \rightarrow r+1$ does NOT match (must-fail fires); the graded $\det'$ difference is c_3 -FREE: $\text{gr}(\text{jump}) - \text{gr}(\text{mark}) = \log(\ln 2/4)$ exactly; the channelwise unit ratio is UNIFORM = $4/\ln 2$ in every matched nonzero channel (the v974 doublet ratio extended to full uniformity). FIREWALL: finite 4×4 μ_4 circulants only; continuum Bismut–Freed, KMS rigidity, the 2^{-4} /Quillen-metric compensation and the exactness of $F_{U(1)}$ stay [O]; α^{-1} untouched; no marker move.
v986_nu_scalaron_rung.py	FLAV.NUSCALE.05 [C]/[N] candidate (external master-object review wave 2, 2026-08-28): THE SCALARON-TRACE RUNG $M_R = N_{\text{fam}} M_{\text{scal}} = 3c_3^{7/2} \bar{M}_{\text{Pl}}$ — a structured point INSIDE the v481 window, 1.8% from the 1-loop requirement — $3M_{\text{scal}} = 9.180 \times 10^{13}$ GeV vs the v481-required 9.346×10^{13} GeV (same frozen 1-loop inversion, $y_\nu = y_t$ [P]) — deviation -1.8% (the review said ‘about 1%’; the honest value is 1.8), m_3 at the candidate = 0.0512 eV ($+1.9\%$, inside the $> 50\%$ v482 RG envelope); EXACT ladder position $3c_3^{7/2} = (3\sqrt{c_3})c_3^3$ with $3\sqrt{c_3} = 3/\sqrt{8\pi} = 0.598413$, 0.26% from the $3/5$ of the v482/v488 story — ADJACENCY TYPED HONESTLY: v488 killed $3/5$ as an $SO(10)$ CLEBSCH; the scalaron-trace reading is a DIFFERENT mechanism class (wave-3 retype: $\text{Tr } I = 3$ is loose, $\text{Spec}(I) = \{1, 1, 1\}$; operator reading is Q_+ $\text{Spec}\{1, 2, 3\}$; texture DATA_CONSTRAINS_TEXTURE) and itself stays [O]; $\sim 20\times$ sharper than the declined integer rung $c_3^3 \bar{M}_{\text{Pl}}$ (0.019 vs 0.401 in m_3); the same M_{scal} already carries $f_a = M_{\text{scal}}/128$ (v185) — no new scale atom. KILL TEST: Σm_ν (NO) = 0.059 eV; a robust bound below, or a $\gtrsim 5\%$ required- M_R shift, kills the candidate. FIREWALL: $y_\nu = y_t$ stays [P]; NO seesaw closure; the v481 window candidate and the v488 negative untouched; no PMNS claim.
v987_os_dilation_package.py	DYN.UNITARY.DILATION.01 [O update: OS/dilation ladder executed] (promote round 2026-08-28): kernel OS continuation exact ($B = P_1 + \frac{2}{3}P_2 + \frac{1}{3}P_3 > 0$, $H = -\log B$ PSD, gap $\log \frac{3}{2}$, Wick $U(-in) = B^n$); size-uniform free band; congruence interacting family SPD; quantum SWAP $d(\theta) \sim \theta^2$, CPTP, LR radius 1. Continuous field-level OS stays [O]. Python-only / Wolfram mirror deferred.

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Script	What it machine-checks (<i>continued</i>)
v988_psi_lambda_reduction.py	SEAM.SIMPLECURRENT.GENERATOR.01 [O update: S3 exact + S1/S2 skeleton measured + lemma REDUCED, not closed] (promote round 2026-08-28): S3 crossed-product/tower exchange exact (naturality); S1 window Cauchy + sector collapse; S2 Shale plateau + topological $a + b \log N$ vs trivial saturation; energy envelope $f_n < C^{n+1}(n!)^2$. Reduction to cited quasi-free theorems + MMST identification – not closure. Python-only / Wolfram mirror deferred.
v989_lattice_gate_battery.py	TFPT4D.LATTICE.ACTION.01 + CHIRAL4D.NOMIRROR.01 [O update: T1–T7 harness + Euclidean T2 kill + Hamiltonian route clears T2] (promote round 2026-08-28): T4 exact SM anomalies; T5/T6 2D overlap index q ; T7 toy $\kappa_4 \neq 0$. Euclidean T2 kill (N_t -exact Z2: violation absent at $N_t = 2$, appears at $N_t = 4$ det-only -0.249 ; Wilson PSD). Hamiltonian route clears T2 by construction. Chiral Gauss census: single-exponent iff $q_L = q_R$. Contracts stay [O]. Python-only / Wolfram mirror deferred.
v990_wj_transduction_mechanism.py	FTRANSFER.GENERATING.01 + OBS.TRANSDUCTION.01 [O update: content shadow + finite $W[J]$ + transduction] (promote round 2026-08-28): Z6-centre 6Y table; $dW/dJ = \langle O \rangle$ (6×10^{-11}), Hessian = Kubo (10^{-7}); mixed $\partial^2 W / \partial J \partial \theta$ seam-coupled -9.3×10^{-3} , e^c control exactly 0. Contracts stay [O]. Python-only / Wolfram mirror deferred.
v991_detline_bulk_edge.py	SEAM.DETLINE.UNIFICATION.01 [O update: finite bulk-edge shadow [E]; continuum Bismut–Freed stays Open] (promote round 2026-08-28): occupied-frame FHS Chern +1 equals seam holonomy winding +1 (diff 6×10^{-16}) on the v367 QWZ collar; $M = 3$ control 0 = 0; conjugation mutant flips both signs. Continuum identification stays [O]. Python-only / Wolfram mirror deferred.
v992_joint_likelihood_v1.py	PRED.JOINTLIKELIHOOD.01 [O update: v1 executed [N]; promotion conditions typed; contract stays Open] (promote round 2026-08-28): nine-observable joint likelihood $\chi^2 = 11.80/\text{dof } 9$ ($p = 0.225$), $\nu_{\text{eff}} = 1$, TFPT at 0th percentile of 200 scrambled decoders, LOO stable. Holdouts declared not consumed. Python-only / Wolfram mirror deferred.
v993_minimal_defect_selector.py	AX.P2.01 / AX.P1.01 / SEAM.SIMPLECURRENT.GENERATOR.01 [O update: census lifts v624 architecture conditionality at lattice level; axiom typing UNCHANGED] (external review wave 3, 2026-08-28): full rank-8 ADE census (SNF) selects (D_5, A_3) uniquely – the $D+A$ split is an OUTPUT of (rank 8 + cyclic $\mathbb{Z}_4$ both sides). $[\lambda]^2 = [v]$ exact (parity shadow of $U^2 = (-1)^F$). Unique finite CE (module property needed; kernel 36/720 without it). Axioms unchanged. Python-only / Wolfram mirror deferred.
v994_mmst_criteria_battery.py	SEAM.EQUIV.MMST.01 / SEAM.SIMPLECURRENT.GENERATOR.01 [O update: 5/7 MMST identification criteria executed [E-measured]; C6 written-out [C]; C7 cited/open] (completeness wave, 2026-08-28): measured $c = 8.005$ (16 Majorana copies); conformal edge spectrum $[0.506, 1.516, 2.523, 3.524]$ with degeneracies $[1, 0, 1, 1, 2]$; current normalisation $k = 1.000000000000$; sector collapse $\det D_8 = 4 \rightarrow \det E_8 = 1$; FLAGSHIP: μ_4/GSO -projected lattice character sums reproduce the $(E_8)_1$ vacuum character coefficients $[1, 0, 248, 0, 4124, 0, 34752]$ three orders deep. C6 = the quasi-free convergence theorem is now WRITTEN OUT (articles/2026-08-28/psi_lambda_convergence_theorem_en.tex ; $2/\pi^2 = 0.20264$ vs measured 0.203, 0.18%). C7 modular invariance stays cited. Python-only / Wolfram mirror deferred.
v995_kms_subnet_rigidity.py	SEAM.STATE.RPMIXING.01 [E update: finite KMS rigidity] + ALPHA.QUILLEN.EXACT.01 [O note: rigidity premise finite] (completeness wave, 2026-08-28): ALL 33 v972 mixing directions killed by KMS ALONE on the finite CAR algebra ($\text{CAR}_8 = M_{256}$); covariance provably redundant under full KMS (COVARIANCE_DROP_REDUNDANT_UNDER_FULL_KMS); unique E -invariant crossed-product state extension ($196608 \rightarrow 0$). Type-III/continuum stays cited/open. Python-only / Wolfram mirror deferred.

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Script	What it machine-checks (<i>continued</i>)
v996_gauge_grammar_kill.py	GAUGE.DETLINE.FIXPOINT.01 [O update: naive grammar extension excluded [E]; genuinely nonabelian structure required – typed] + ALPHA.QUILLEN.EXACT.01 [O note: ln-2-rate shadow] (completeness wave, 2026-08-28): H0 STRUCTURAL KILL – negative b_2/b_3 flip the stationary-root signs ($SU(2)$ inverse -151.2 , $SU(3)$ -115.9); 64 conventions 0 hits; $U(1)$ control 137.0359992168 survives all mutants. Detline curvature $\rightarrow 2\pi$ exponentially, rate $0.6936 \sim \ln 2$ (numerical Bismut–Freed shadow, not the continuum theorem). $\alpha_s(M_Z)$ remains an external input. Python-only / Wolfram mirror deferred.
v997_spin2_smg_witnesses.py	GRAV.SPIN2.EMERGENCE.01 [O update: quadratic witnesses [E]; content pinned on the untruncated form factor] + CHIRAL4D.NOMIRROR.01 [O update: SMG mechanism toy-proved [E]; 4D Spin(10) theorem stays [O]] (completeness wave, 2026-08-28): exact Barnes–Rivers decomposition – $R+R^2$ clean (one massless TT pole, two helicities, scalaron at M_{scal} exact); local a_4 Weyl ² truncation NECESSARILY carries a spin-2 ghost (opposite residue) – typed. FK SMG toy: $N = 8$ unique Spin(7)-singlet ground state, Schmidt rank 1, volume-independent gap 14 at $L = 1, 2, 3$; $N = 4$ contrast 2^L -degenerate; physical chiral edge keeps its π/L spectrum exactly. Python-only / Wolfram mirror deferred.
v998_seam_modular_closure.py	SEAM.EQUIV.MMST.01 / SEAM.SIMPLECURRENT.GENERATOR.01 [O update: C7 arithmetic shadow now exact; net-level C7 stays cited] (review wave 4, 2026-08-29): two-edge HS remainder ≤ 2.11 on the plateau $N_x \in (16, 24, 32, 48, 64, 96)$; lattice character θ_{E_8}/η^8 EXACT four orders $[1, 0, 248, 0, 4124, 0, 34752]$; $\Theta_{E_8}(\tau) = E_4(\tau)$ q -expansion ≥ 8 orders exact (Jacobi vs Eisenstein); $j^{1/3}$ numeric transform at 60 digits; S -weight bookkeeping. Net-level C7 stays cited/open. Python-only / Wolfram mirror deferred.
v999_weak_collision_hp.py	DYN.UNITARY.DILATION.01 [O update: finite ladder now COMPLETE – discrete/kernel/field-free/interacting-classical/quantum-coupled/CONTINUOUS-TIME; open = thermodynamic field limit] (review wave 4, 2026-08-29): weak-collision HP – Richardson 1.098×10^{-10} , diag $L = Q$ symbolic, $e^Q = B$ exact, GNS splitting defect 0, locality 1.355×10^{-20} , strong-collision rank 9/81. Contract stays [O]. Python-only / Wolfram mirror deferred.
v1000_spin2_sk_witnesses.py	GRAV.SPIN2.EMERGENCE.01 [O update: quadratic Hamiltonian half executed] + FTRANSFER.SK.RHO0.01 [O update: SK mechanism executed] (review wave 4, 2026-08-29): lattice graviton – positivity exact, 2 helicities at all 5852 momenta ($N = 6..12$), $\omega = k - k^3/24$ exact. SK – KMS/FDT $\sim 10^{-17}$, ρ_0 contrast 3.550×10^{-3} vs static 10^{-16} , saddle 5-fold degenerate, $3\pi/5$ unique in the μ_4 lift [C]. Both contracts stay [O]. Python-only / Wolfram mirror deferred.
v1001_nu_pentagon_chain.py	FLAV.NUSCALE.06 Candidate [C]/[N] (review wave 4, 2026-08-29; NO closure; mechanism = Q_+ -to-flavor operator [O]): $U_e = I$ inventory + analytic 13/23 misalignment; pentagon double hit $\phi = 288^\circ = 4(2\pi/5)$, $\theta = 2\pi/35$ unique LEE survivor 2.7%, max pull 0.557; v3 chain SHA-16 a4c28732fa687620: $\Sigma = 0.0599$ eV, $m_\beta = 9.0$ meV, $m_{\beta\beta} \in [1.5, 3.8]$ meV, $\delta_{\text{CP}} = 287.66^\circ$; v270- θ_{23} tension 1.85σ TYPED; census 0/1607. Kills: DESI floor, DUNE δ_{CP} 287.7 vs 240, JUNO. FLAV.NUSCALE.05 unmoved. Python-only / Wolfram mirror deferred.
v1002_spin10_mirror_projector.py	CHIRAL4D.MIRROR.DET16.01 Candidate [C] (review wave 5, 2026-08-29; exact finite-cluster gapping; open: dynamical gauge fields, domain-wall geometry, 4D volume theorem). [E-finite] DET16 rank-one projector on 2^{16} : $\Omega^\dagger\Omega = P_{16}$, $\Omega\Omega^\dagger = P_0$, P_ϕ hermitian idempotent 2.8×10^{-18} , h_{mir} spectrum $\{0^1, 1^{65535}\}$ gap 1, 45 $\mathfrak{so}(10)$ Fock commutators 0 ($\det \rho_{16} = 1$). [N] hopping gaps 0.90/0.86 at $t = 0.2$. [X] number-preserving Casimir route excluded (census $N=8:0$, $k=2:27$, $k=3:1463$, $ W(D_5) =1920$). Python-only / Wolfram deferred.

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Script	What it machine-checks (<i>continued</i>)
v1003_nu_structural_nulls.py	FLAV.NU.TEXTURE.MECHANISM.01 [O] (review wave 5, 2026-08-29; binding constraints, no texture). [E] charged-sector $h = (1, 1, 1)$, $d = (64, 60, 64)$. [X] Schur-texture NULL: $8/8$ (K, B) fail; D4 reflection forces $\lambda_1 = \lambda_3$; required $K \sim [3536.998, 1768.499, 1/3]$ matches none of 9 comparators. [E] orientation-doubling: $\text{sgn } J$ odd sector generically lifts degeneracy. [X] scale NULL: $12/12$ fail; $1 - c/a = 1.885 \times 10^{-4}$ not supplied. Mechanism must be D4-odd AND supply $\sim 2 \times 10^{-4}$ cancellation; pure seam data excluded. Python-only / Wolfram deferred.
v1004_milnor_frobenius_gray.py	SEAM.MILNOR.LOCALRING.01 [O] (review wave 6, 2026-08-30; finite algebra; corpus identification stays open). CLASSICAL (cite, no claim): Milnor algebra of $x^2 + y^3 + z^5 \cong \mathbb{Q}[y, z]/(y^2, z^4)$ dim 8; spectral numbers = E_8 exponents $\{1, 7, 11, 13, 17, 19, 23, 29\}$. NEW-IN-CORPUS EXACT [E-finite]: rank clock $(2-a)(4-b)$, table sum $30 = h(E_8)$; $S = pqr \cdot \mu/8$; self-clock iff $\mu = 8$; $(2, 3, 5)$ unique among ordered spherical triples; Galois-Gray $11/7 - 1$; CP = socle/Frobenius; integral D^4 bridge basis-dependent. [C] $PG(3, 2) = AG(3, 2) \sqcup PG(2, 2)$ interpretive only. Contract stays [O]. Python-only / Wolfram deferred.
v1005_relative_pencil_bridges.py	Relative pencil bridges (review wave 6, 2026-08-30; circularity-flagged). EXACT [E-finite]: Hankel $p_n p_{n+2} - p_{n+1}^2 = 2^{n+1} + \text{Jacobi spec } \{1, 2\}$ diag $(4/3, 5/3)$ (v106/v119); winding spec $\{5/2, 1, 1\} + \text{fixed plane (v4)}$. EXACT BUT [C] (circularity-flagged): unique $t = 2$, $\lambda = 7/3$, CM $J_0^2 = -I$, index $25 = g_{\text{car}}^2$ SNF $(1, 1, 25)$ – BUT carrier 5 already sits in the column sums of Q_2 and C : NOT a P2 selector. [C] Klein-four SNF $(2, 2)$ only after $D = 2d$. AX.P2.01 unmoved. Python-only / Wolfram deferred.
v1006_mmst_lemma_battery.py	SEAM.MMST.TYPEIII.CHARGED.01 [O]: L3 crossed-product; UGF $K_G = \pi^2/4$; TEL-a N^{-2} isometries; integer D5+A3 pairings; Z4 outerness with finite-inner correction. Round-4 guard requires v1026's $\ R_N\ _{\text{HS}} < 2.995906 < 3$ at fixed $M = 1$, $N_y = 8$ for every even $N \geq 16$, and explicitly open FE-GEN/ALG-EXH/MMST. Historical finite-grid 2.11 is not the proof. 68/68; no TOE closure.
v1007_det16_stability_battery.py	CHIRAL4D.MIRROR.DET16.01 Candidate [C] (review wave 7, 2026-08-30). T1/T2 proved (v1002); T3 Michalakís–Zwolák cited-verified (LTQO, $t_* > 0$, gap $\geq 1/2$). [N] counting line $n = 2, 3$; $n = 2$ closing scan through $t = 4$; dynamical $\mathbb{Z}_2/\mathbb{Z}_4$ uniquely gapped (full-probe min 0.728854416); SW $1 - \alpha t^2 + O(t^4)$; c_{geo}/L bounded. [X] ordinary hopping not block-diagonal so $1/192$ boxed; BDL supplies no volume-uniform gap remainder. Stays [C]. Python-only / Wolfram deferred.
v1008_master_assembly_scaffold.py	QFT4D.LATTICE.FUNDAMENTAL.01 Decision / GAUGE.DETLINE.FIXPOINT.01 [O] (review wave 7, 2026-08-30; 2+1D scaffold-coherent). Prototype $K = 0$ plaquette-exponent theorem; matter frozen-link $q^2 \sim 4$, $K(q = 0) = 0$, unique-contractive $ R' < 1$; wall/mirror QWZ slope ~ -0.9989 , DET gap ≥ 1.5 through $t = 0.6$; assembly Z6 $(1, 2, 3, 0)$, clock $[0, 1, 1, 2]$, χ_{phys} vs χ_{mirror} . No marker moves. Python-only / Wolfram deferred.
v1009_rho0_minimizer.py	FTRANSFER.SK.RHO0.01 [O] (review wave 7, 2026-08-30). [E-finite] unique KMS compression (Klein), Hessian strictly positive, centre dim 1, identity $\sim 8 \times 10^{-17}$. [X typed] V1000_CONSEQUENCE_MISMATCH (compression kills the SK response vs frozen contrast 3.550×10^{-3}) + CENTER_FLATNESS_PREMISE_FALSE. Canonical formula needs a weaker admissible set. Contract stays [O]. Python-only / Wolfram deferred.

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Script	What it machine-checks (<i>continued</i>)
v1010_simplicity_ bridge_census.py	Simplicity census + W/Q canonicity + Milnor strong-bridge double obstruction (afternoon harvest, 2026-08-30). Derivation matrix; unique remainder min S4=2; anchor (1, 1, 2) not among 3 declared Milnor maps; φ_0 four novel NULL. Bridge Q CANONICAL: ladder forces sums (9, 5, 1); C's 5 inherited from $R - v1005$ circularity flag corrected as forced provenance. Bridge W CHOICE-but-conditionally-unique ($1078 \rightarrow 1$). Milnor all-structure bridge NONEXISTENT at $\mathbb{F}_2$ and all upstairs homes; coarse $D+$ pairing exists; $ \text{Aut}(X) = 36864$, $ \text{Aut}(Y) = 8$. SEAM.MILNOR.LOCALRING.01 stays [O]; AX.P2.01 stays an axiom. Python-only / Wolfram deferred.
v1011_3p1d_ladder_ battery.py	3+1D ladder B6–B9 (afternoon harvest, 2026-08-30). Minimal 3+1D viable (Gauss 32768, confinement, exact isotropy, $g_\star \sim 1.915$); exact tree-fixing $524288 \rightarrow 4096$, tree-independence, DET-under-coupling, back-reaction; periodicity restores K ; charged channels $\sim 2.014\times$ at weak g ; K collapses in the confined phase. BINDING: matching scale of the coupling functional must sit in the deconfined/weak regime. QFT4D.LATTICE.FUNDAMENTAL.01 stays Decision; GAUGE.DETLINE.FIXPOINT.01 stays [O]. Python-only / Wolfram deferred.
v1012_toe_gate_ witnesses.py	Evening TOE-gate wave (2026-08-30). T5 IR witnesses + typed SPLIT (physical $c \rightarrow 1$, $\xi\text{-gap} \sim 1.089$ vs power 2.034, $v_{\text{LR}} = 5/3$, curvature $\rightarrow 1/6$; holonomy+clock not propagating modes). T8 ρ_0 8-candidate NO_SET_WORKS (hard sectors response-dead; KMS-affine sets selection-vacuous). T6 κ six-fold NULL (K_4 $18.8\times$ too large; 4D functional required). T7 interacting TT (conservation/positivity/sum-rules/Z-persistence; gapped). FIREWALL: TFPT.TOE.COMPLETE.01 / FTRANSFER.SK.RH00.01 / FLAV.NU.TEXTURE.MECHANISM.01 / GRAV.SPIN2.EMERGENCE.01 stay [O]. Python-only / Wolfram deferred.
v1013_ thermodynamic_ dynamics.py	Thermodynamic dynamics (late-evening harvest, 2026-08-30). Mandatory-dynamics leg CLOSED at Hamiltonian-class level (theorem memorandum). Uniform LR bound $J = 12/5$, $R = 2$, $z = 4$, $\kappa = 16043/450$, $v_{\text{LR}} = 32086e/225 \sim 387.64$; norm-convergent τ_t ; gauge-invariant quasilocal $\mathcal{A}^G$; existence of ground/ β -KMS states. Numeric twin: measured $v = 2.0 \ll$ proved bound; convergence bound dominates buffers $8/16/32$. Remaining: phase uniqueness, limit gap, IR universality. QFT4D.LATTICE.FUNDAMENTAL.01 stays Decision. Python-only / Wolfram deferred.
v1014_bridge_ refinements.py	Bridge refinements (late-evening harvest, 2026-08-30). Finite detline restriction isomorphism VERIFIED ($c_{\text{phase}} 3.7 \times 10^{-16}$; orientation $2 \rightarrow 1$; residual constant $U(1)$ fixed by the A_0 reference normalization). W-bridge: P-anch DERIVED ($e_1 = R^{-1}a$ via winding lock); P-dem PARTIAL ($\mathbb{Z}_4$ average annihilates nontrivial characters; missing = character-blind determinant-response map, MMST/Quillen externalized leg). ALPHA.QUILLEN.EXACT.01 / AX.P2.01 unmoved. Python-only / Wolfram deferred.
v1015_axiom_core_ closure.py	Axiom-core closure (Monday-morning harvest, 2026-08-31). Character-blind P-dem response DERIVED ($r = (1, 1, 1)$ exactly at collar sizes 12 and 16, democracy residual 0; mutants (1, 0, 0) and (5/4, 1, 5/4)). Together with P-anch (v1014) BOTH W-bridge premises are derived at finite level; axiom-core remainder ZERO modulo the externalized MMST identification. AX.P2.01 stays an axiom (finite shadows; continuum identification is the same external leg). T1 note: structure-postulate route fully premise-supported at finite level. Python-only / Wolfram deferred.

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Script	What it machine-checks (<i>continued</i>)
v1016_state_gap_batteries.py	State/gap batteries (Monday-morning harvest, 2026-08-31). R_4 seam-modular cap unique finite-level non-entropic selector ($D_{\text{tr}} = 0.1434$, SK RMS 3.038×10^{-3} , saddle preserved; finite-proxy caveat). TEL-B certified-tail BLOCKED ($N^2 D_N$ $530 \rightarrow 19032$); scalar dyadic $A_R < 43$ with factor-350 headroom; N -uniform CAR nuclearity proved ($C_\beta = 67.97/29.73/12.15$); ALG-EXH unchanged. DFP volume-uniform gap cited-verified for $\mathbb{Z}_2/\mathbb{Z}_4$ open chains ($a = 0.0233$, $a/16 = 0.00146$); remaining rotor/wall/3+1D. FTRANSFER.SK.RH00.01 stays [O] / SEAM.MMST.TYPEIII.CHARGED.01 stays [O] / CHIRAL4D.MIRROR.DET16.01 stays [C]. Python-only / Wolfram deferred.
v1018_e8_directed_readout.py	E8.DIRECTED.READOUT.01 [E] (2026-09-02, r609): seven exact E_8 readout cells (C7 open) – re-derived (no probe imports). Seifert $S + S^\top = A_{E_8}$, $\text{charpoly}(-S^{-1}S^\top) = \Phi_{30}$, $\text{rank}(S - S^\top) = 8$; Hamming $1 + 14y^4 + y^8$, $240 = 16 + 14 \cdot 16$, $S(3, 4, 8)$; $\text{srg}(120, 56, 28, 24)$ eig $56/8/ -4$ mult $1/35/84$; $N(n) = 240\sigma_3(n)$ for $n \leq 10$; $A_P(n)/A_P(1) = \tau(n)$ for $n \leq 8$, $E_4^3 - E_6^2 = 1728\Delta$; $(\mathbb{Z}/30\mathbb{Z})^\times \cong C_2 \times C_4$, $D_\chi = L(s, \chi)L(s-3, \chi)$ for $n \leq 200$; $E_6 \oplus A_2$ index 3, Smith $(1^6, 3, 3)$, glue $78/81/81$. C7 Gauss-code transform stays OPEN (rem:c7-audit). NO RH CLAIM. Python-only / Wolfram deferred.
v1019_coxeter_euler_completion.py	E8.COXETER.EULER.COMPLETION.01 [E]+Numerical (2026-09-02, r617): Coxeter–Euler completion – re-derived (no probe imports). Exact: $\det(I - xC) = \Phi_{30}$, $\text{Tr } C = -1$; Moebius $\Phi_{30} = (1 - x^2)(1 - x^3)(1 - x^5)(1 - x^{30})/[(1 - x)(1 - x^6)(1 - x^{10})(1 - x^{15})]$ (classical); $U = 1 \oplus C$, $\det(I - xU) = (1 - x)\Phi_{30} = 1 - x^2 - x^3 + x^6 + x^7 - x^9$, $\text{Tr } U = 0$. Global $Z_C = \zeta(2s)\zeta(3s)\zeta(5s)\zeta(30s)/[\zeta(s)\zeta(6s)\zeta(10s)\zeta(15s)]$, $D_{E_8} = \zeta(6s)\zeta(10s)\zeta(15s)/[\zeta(2s)\zeta(3s)\zeta(5s)\zeta(30s)]$, abs. conv. $\text{Re } s > 1/2$. Numerical ($X = 10^5$): D_{E_8} residual 4.76×10^{-4} at $s = 0.75$, 4.16×10^{-12} at $s = 1.5$. Class: vanishing linear term generic from $\text{Tr } C = -1$; E_8 selects only the divisor set of 30. Beurling-generic. FENCE: The trace-free completion is zero-free and pole-free in $\text{Re } s > 1/2$. The splitting into the scalar zeta channel and the Coxeter channel is open and RH-equivalent. No RH claim. NO-GO E8.COXETER.REGULARIZED_SPLIT.NO_GO.01: $\det_2$ cannot isolate $1/\zeta(s)$. Python-only / Wolfram deferred.
v1020_spectator_sector_obstruction.py	Spectator-sector obstruction (r644 audit harvest, 2026-09-04): finite free-fermion witness, re-derived (no probe imports). Stacking a decoupled trivial gapped sector C ($M=3$, Chern 0, gap ≥ 1.095) onto the seam model B ($M=1$, $N_Y=8$, 16 modes) leaves every seam datum unchanged (A1–A5: Chern $C_B=C_{B \oplus C}=-1$, $C_C=0$; zero modes $2/0/2$ with B -support 1.0; edge dispersion coincident to 1.4×10^{-15} ; seam-restricted covariance identical to 0.0 both grids; edge-profile overlap 1.0) and changes the bulk (A6: dim 16 vs 32, $E_0(C)=-25.31$, mid-strip rank 4 vs 8, $\ \Gamma_0 - \Gamma_\alpha\ _{\text{HS}} 0.752536$ vs 0.760202). Repaired criterion (B): Krylov generatedness $\text{spectator_dim}(B \oplus C) - \text{spectator_dim}(B)=16$ at all 128 momenta; commutant dim 1 (B) vs 17 ($B \oplus C$) generically, $\Pi_C=0 \oplus 1$ in commutant (residual 0.0); selection unique (B selected, $B \oplus C$ rejected). Honest: $\text{spectator_dim}(B)=10$ at $p=0$ only – criterion generated a.e. in p . SEAM.BULK4D.RECON.01 stays [O]; BULK.PRIME_COMPLETION.01 registered [O]; NO marker move. DIMENSION.UPLIFT.FIREWALL.01 F2: 2+1D free-fermion hypothesis, re-scoped 4D conclusion. The 2D modular-invariant uniqueness of the holomorphic $(E_8)_1$ net is untouched and is NOT a 4D no-spectator theorem. Python-only / Wolfram mirror deferred.

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Script	What it machine-checks (<i>continued</i>)
v1022_telb_round3_certificates.py	TEL-B round-3 certificates (2026-09-05): native 256-bit Arb/Acb over 5812 rational cells gives $\text{TV}_p(F'') \leq 15.817695962988924 \dots < 15.928674$ and $K_3^{\text{TV}} < 2.517464500835$. The analytic C2b scalar reduction plus executable Arb arithmetic gives $c_e = 0.288547359238 \dots$, $c_\zeta = 0.110677064901 \dots$, total $0.399224424139 \dots < 0.400$; full C2b remains open exactly at $\text{CF} \leq 0.139/\sqrt{N}$ and $\text{DG} \leq 0.060/\sqrt{N}$. An exact one-mode countermodel refutes the old ALG2 Vandermonde implication; FE-GEN or a precise gauge/code projection is still required. T2/TOE stay [O] . Native <code>python-flint==0.9.0</code> , not Pyodide. NO RH CLAIM.
v1023_derivative_filtered_wall.py	Derivative-filtered wall block (2026-09-05): H_{df} preserves $\ker D_{\text{GW}}$ exactly; block determinant $\lambda g^2 \Delta s^2$; the adiabatically mirror-continued high band is $\geq \Delta + \lambda$ and the low branch is quadratic. The bare mirror operator is not invariant and has low-band weight for $s > 0$ —no bare-mirror response gap and no Weyl cone. Gauge defect 2.41×10^{-15} , spectral defect 1.78×10^{-15} . Finite quasi-free block lemma only; canonical DET16/DET32 realization, many-body parent, admissibility/quasilocality, measure/anomaly/index control, universality and the 4D limit remain open. No marker move. NO RH CLAIM.
v1024_parent_internal_boundaries.py	Parent-internal T6–T8 boundaries (2026-09-05): finite A_3 – D_4 seam/neutrino-pair intertwiner with no new factor; positive, even, gauge compatible, non-additive, local gap 0.25 conditional on the inherited full-parent bound, mixed resolvent 0.104712041885 . Internal 12D $\mathbb{Z}_5$ cap gap 0.197423715893 , but arbitrary, D_4 -breaking and not a global ρ_0 . Exact boundaries: projective full-Fock D_4 lift; relative commutant under unital enlargement; a full $\mathbb{Z}_5$ Weyl pair needs $5 \mid D$ only unprojected; a uniform full gap excludes a massless spin-2 pole; exact TT projection is not finite-range. 49/49; T6–T8/TOE stay [O] . NO RH CLAIM.
v1025_telb_c1_c2a_certificates.py	TEL-B C1/C2a certificates (2026-09-05): native <code>python-flint==0.9.0</code> . C1: 100-bit Arb/Acb over 3888 analytic rectangles plus a closed axis-strip majorant and exact imaginary contribution $1/12$ gives $C_\star \leq 0.1520453048 \dots < 0.1525$. C2a: exact cotangent reindexing, Peano monotonicity and the shifted-Euler remainder reduce the theorem for every even $N \geq 16$ to interval comparisons; $N \sup_k \varphi_N(k) \leq 0.5082287792 \dots < 0.509$. C1/C2a close; C2b CF/DG, ALG-EXH, MMST scaling and TOE remain open. Native-only, not Pyodide. NO RH CLAIM.
v1026_telb_round4_closure.py	uniform TEL-B norm $\ R_N\ _{\text{HS}} < 2.995906 < 3$ at fixed $M = 1$, $N_y = 8$ for all even $N \geq 16$; native interval CF/DG/CROSS and Fourier aliases; ALG-EXH open
v1027_signed_det_car_wall.py	canonical DET-CAR rotation and signed $z = 1$ wall; fixed classical backgrounds only; high band ≥ 4 in the stated example; no full chiral continuum
v1028_gauss_d4_cap.py	Gauss site/cube residues $3/0 \pmod{5}$ with full 192-mode sites and nine-irrep cube links; selected-pair-space D_4 cap gap one; Majorana obstruction; T6/T8 open
v1029_local_tensor_constraints.py	local first-class tensor target: two positive $z = 1$ modes at nonzero momentum; unstable zero mode requires global removal; T7 open
v1030_alg2_sector_frame.py	sector-connectivity criterion and uniform section $2MD^{3/2}/\sigma$; actual microscopic words and joint-adjoint tails required; ALG2 open
v1031_quantum_tensor_curvature.py	free zero-mean Weyl/Fock target with $C = r^4 P_{TT}$ and distribution limit; TFPT parent open
v1032_covariant_curvature.py	positive local covariant free curvature field with helicities ± 2 ; nonlinear gravity and shared parent open
v1033_charged_disorder.py	auxiliary $\mathbb{Z}_4$ flux corners and $h = 1/4 \neq h_\lambda = 1$; microscopic MMST open
v1034_parent_mirror.py	factorized gap $1 + \sqrt{3}/2$ and bare-hopping relative-bound obstruction; interacting mirror gap open

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Script	What it machine-checks (<i>continued</i>)
v1035_matter_coupling.py	physical Fourier Ward propagation and prescribed-source response; dynamical and universal quantum coupling open
