TFPT in One Map

Boundary Polarization, Carrier Rigidity, and Observable Closure

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Orientation Note for the TFPT 4.5 paper series – April 27, 2026

Abstract

This note is the thin entry document for the TFPT 4.5 series. It does not attempt to prove the full theory. Its purpose is to state what TFPT claims, what it does not claim, how the closed branch is organized, and where each load-bearing argument is isolated in the paper sequence.

Scope box: inputs, contribution, non-claims, audit surface

Inputs from previous papers. None. This is the public orientation layer for the series.
New theorem contribution. None. The note contributes only organization, status discipline, and a dependency map.
Not claimed here. No carrier proof, no exact electromagnetic calculation, no CMB fit, no mass ledger, no E8 stage atlas, and no nonperturbative QFT proof.
Falsification or audit surface. The note can fail if it misstates the dependency order, overstates the status of a downstream module, or hides where an assumption first enters.

Claim contract

Claim. Orientation and dependency map only; no theorem proof.
Inputs. None.
First assumptions. Status vocabulary and series dependency order.
Proof status. Reader contract / orientation.
Kill condition. Misstates dependency order or promotes downstream targets to core claims.

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1 What TFPT Claims

TFPT is organized as a boundary-polarized spectral theory whose primitive input is a one-sided boundary datum

$$\mathfrak{T}_\partial^{\min} = (\mathcal{A}_+, \mathcal{H}_+, D_+, J, \Gamma, B_\Sigma).$$

The main theorem chain in the source draft is not a collection of unrelated numerological readouts. It is a staged reconstruction:

$$\mathfrak{T}_\partial^{\min} \Rightarrow (\tau_{\mathrm{dbl}}, \iota_C, P_{\mathrm{prim}}, [u_\Sigma], c_3) \Rightarrow d^\star_{\mathrm{disc}} \Rightarrow P_{\mathrm{adm}} \Rightarrow \mathcal{M}_{d^\star_{\mathrm{disc}}} \Rightarrow \mathcal{Z}_{\mathrm{cl}} = \{x^\star_{\mathrm{cl}}\} \Rightarrow \mathfrak{T}_\star.$$

The split series follows this burden of proof rather than the order in which a reader might find the numerics exciting.

2 What TFPT Does Not Claim at This Level

The orientation note does not certify every downstream comparison row as a theorem. In particular, the CMB interface, sky-map realization, horizon continuations, transient channels, and E8 scale grammar remain outside the primitive theorem chain. They are comparison and programmatic layers unless explicitly promoted by a later proof obligation.

3 The Three Decoders

The source manuscript condenses the closed branch through three decoders:

$$\begin{aligned} Y &\quad \text{generates structure,} \\ [u_\Sigma] = 1 &\quad \text{generates counting,} \\ u := \varphi_0^{\mathrm{ret}} &\quad \text{generates bridge observables.} \end{aligned}$$

This orientation is the reason the paper series separates the primitive kernel, the carrier packet, the precision readouts, the QFT closure layer, the metrology layer, and the cosmology interface.

4 Status Matrix

Layer	Status language	Where handled
Boundary primitive kernel	Theorem-level target	Paper 1
Carrier rigidity and SM packet	Theorem-level target with representation audit	Paper 2
Electromagnetic and flavor readouts	Closed-branch prediction layer with no-knobs audit	Paper 3
Admissibility and QFT closure	Conditional nonperturbative closure under stated hypotheses	Paper 4
Boundary-normalized metrology	Dimensionless observable functor from λ_Σ	Paper 5
Cosmology and CMB	Downstream interface; Stage 1 spectra, Stage 2 sky realization target	Paper 6
Extended comparison maps	Appendix and companion material	Technical Companion

5 Series Map

1. **Boundary Polarization and the Primitive Kernel of TFPT.** Establishes $\mathfrak{T}_\partial^{\min} \Rightarrow (\tau_{\mathrm{dbl}}, \iota_C, P_{\mathrm{prim}}, [u_\Sigma], c_3)$ and keeps all Standard-Model claims out.

2. **Carrier Rigidity, Hypercharge, and the Standard Model Packet from Boundary Polarization.** Establishes the rigid $3+2$ carrier, hypercharge, $S^+ = \Lambda^{\mathrm{even}} E$, G_{phys}, $N_{\mathrm{fam}} = 3$, $\Omega_{\mathrm{adm}} = 48$, $N_\Phi = 1$, and $b_1 = 41/10$.

3. **Electromagnetic Fixed Point and Flavor Transport on the Rigid TFPT Branch.** Isolates α, δ_{ph}, λ_C, β_{rad}, Ω_b, θ_{13}, CKM, and PMNS.

4. **Admissibility, Strong CP, and Nonperturbative QFT Closure on the TFPT Branch.** Separates selector from dynamics and states the positivity, OS, local-net, scattering, and exact-flow obligations.

5. **Geometric Hodge Closure and Dimensionless Metrology from the TFPT Boundary Branch.** Treats λ_Σ, Planck normalization, electroweak matching, and boundary-normalized observables.

6. **Cosmology Interfaces of the TFPT Closed Branch.** Treats seam transfer, determinant-line phase, axion sector, reheating, leptogenesis, CMB spectra, and sky-realization targets.

6 Publication Order

The recommended public order is Paper 0, Paper 2, Paper 1, Paper 3, Paper 4, Paper 5, and finally Paper 6. The mathematical dependency order remains Paper 1 before Paper 2;

the publication order uses Paper 2 as the clearest visible hook while Paper 0 explains the dependency discipline.

7 Source Boundary

Source extraction map

Primary source: `../tfpt-42.tex`.
The orientation note draws especially from the abstract, the closed-architecture box, Sections 1 and 2, the canonical rigid-object discussion, the structural falsification map, and the conclusion. It intentionally does not import the extended empirical ledgers, E8 stage atlas, CMB figures, or mass tables.

8 Main Technical Development

This section contains the main technical development assigned to this paper by the TFPT 4.5 clean split. Cross-paper background is referenced through dependency and scope boxes; extended backend material is kept in the Technical Companion.

Abstract

From the one-sided boundary datum

$$\mathfrak{T}_{\partial}^{\min} = (\mathcal{A}_+, \mathcal{H}_+, D_+, J, \Gamma, B_\Sigma),$$

the manuscript derives the Calderón polarization P_C, the boundary involution $\iota_C := 2P_C - 1$, the exact-double deck involution $\tau_{\rm dbl}$, and the doubled closed datum

$$\mathfrak{T}^{\rm cl}_{\min} = (\mathcal{A}, \mathcal{H}, D, J, \Gamma, \tau_{\rm dbl}, \iota_C).$$

The hard core is now read through three decoders. First, the carrier decoder Y satisfies

$$6Y^2 - Y - \mathbf{1} = 0, \qquad \mathrm{Tr}_E\, Y = 0,$$

and in the primitive realization forces the rigid $3+2$ carrier split $E = E_3 \oplus E_2$, the primitive two-point generator $X = 6Y$, the one-family packet $S^+ = \Lambda^{\rm even}E$, and the physical gauge quotient

$$G_{\rm phys} = \frac{SU(3) \times SU(2) \times U(1)_Y}{\mathbb{Z}_6}.$$

Second, the global winding decoder $[u_\Sigma] = 1$ fixes the rigid family surface $X_f^\circ \cong \mathbb{P}^1 \setminus \mu_4$, yields the minimal family repair

$$16\gamma = \frac{40}{3} \qquad \Longrightarrow \qquad N_{\rm fam} = 3, \qquad \Omega_{\rm adm} = 48,$$

and, on the transport branch, fixes the intrinsic pole as the lower critical point of the cusp cubic

$$P(z) = (z-1)\left(z - \frac{64}{729}\right)\left(z - \frac{1}{729}\right), \qquad P'(z) = 0.$$

Third, the retained seed decoder

$$u := \varphi_0^{\rm ret}$$

projects simultaneously to $(\lambda_C, \beta_{\rm rad}, \Omega_b, \theta_{13})$, while the closed transport-plus-Higgs budget

$$\sum_{f,j} L^{\rm diag}_{f,j} + N_\Phi = 41$$

closes the exact electromagnetic fixed point α.

The theorem flow is therefore no longer presented as a strictly linear carrier-then-family arrow chain. After the boundary datum has fixed the doubled primitive reconstruction, the primitive seam generator, and the primitive Hodge selector, the manuscript solves one joint discrete admissibility problem and only afterwards the continuous Euler–Lagrange problem:

$$\mathfrak{T}_{\partial}^{\min} \Rightarrow (\tau_{\rm dbl}, \iota_C, P_{\rm prim}, [u_\Sigma], c_3) \Rightarrow d^\star_{\rm disc} \Rightarrow P_{\rm adm} \Rightarrow \mathcal{M}_{d^\star_{\rm disc}} \Rightarrow \mathcal{Z}_{\rm cl} = \{x^\star_{\rm cl}\} \Rightarrow \mathfrak{T}_\star.$$

Here the unique discrete datum is

$$d^\star_{\rm disc} := \big(E_3 \oplus E_2,\ Y,\ S^+,\ X_f^\circ,\ [\nabla_F^\star],\ c_1(L_2),\ c_1(L_3),\ N_{\rm fam} = 3,\ \theta_{\rm eff} = 0\big),$$

so carrier, family, determinant data, and strong CP are fixed jointly from one boundary primitive kernel rather than in a one-way family-after-carrier rhetoric. Here $P_{\rm adm} := \Pi_{\ker \Delta_{\rm adm}}$ selects the physical admissible sector, while the actual dynamics is carried by the

relative generating functional Z_{rel}, the admissible Schwinger distributions, the Osterwalder–Schrader reconstruction, the local Minkowski net on the admissible Hilbert space, the exact admissible flow Γ_k, and its infrared limit $\Gamma^{\mathrm{ren}}_{\mathrm{TFPT}}$.

The same seam transfer, determinant-line phase, and scalaron sector then fix the closed-branch cosmology interface data from which infrared continuation, reheating, and leptogenesis readouts are computed. Two further structural maps are attached strictly outside the theorem chain: the structural falsification map $\mathsf{F}_{\mathrm{fals}}(\mathfrak{T}_\star)$ in the main text and the appendix-level comparison map $\mathcal{R}_{\mathrm{cmp}}(\mathfrak{T}_\star)$. Above the rigid core, the manuscript records an internal reduction on the weakened ambient class $\widehat{\mathrm{PhysAdm}}_1$, an internal renormalized low-energy layer $\Gamma^{\mathrm{ren}}_{\mathrm{TFPT}}$, and a reality-first observable stratification

$$\mathfrak{T}_\star \xrightarrow{\mathfrak{R}_{\mathrm{ren}}} \Gamma^{\mathrm{ren}}_{\mathrm{TFPT}} \xrightarrow{\mathfrak{M}_{\mathrm{phys}}} \mathbf{O}^{\mathrm{TFPT}}_{\mathrm{phys}} \xrightarrow{\mathfrak{M}_{\mathrm{scheme}}} \mathbf{O}^{\mathrm{TFPT}}_{\mathrm{scheme}}/\mathbf{Sch}.$$

This output layer is read in boundary-normalized form: with

$$\lambda_\Sigma := \lambda_1^+(|B_\Sigma|), \qquad \frac{O}{\lambda_\Sigma^{d_O}} = \mathcal{F}_O(\mathfrak{T}_\star),$$

so dimensionless gravitational, electroweak, pole-mass, flavor-ratio, and infrared readouts are internal branch outputs rather than external metrological inputs. The final theorem-level claim is the canonical rigid object of the boundary-polarized branch, the admissible QFT closure on the retained sector, and the renormalized physical observable layer, with cosmology carried at the level of closed-branch interface data and appendix comparison continuations. In the condensed decoder reading,

$$\begin{aligned} Y &\text{ generates structure,}\\ [u_\Sigma] = 1 &\text{ generates counting,}\\ u &\text{ generates bridge observables.}\end{aligned}$$

Closed architecture of the paper

$$\widehat{\mathrm{PhysAdm}}_1 \xrightarrow{\overline{\mathfrak{R}}} \mathbf{TFPT}^{\mathrm{rig}} \simeq \{\mathfrak{T}_\star\} \xrightarrow{\mathfrak{R}_{\mathrm{ren}}} \Gamma^{\mathrm{ren}}_{\mathrm{TFPT}} \xrightarrow{\mathfrak{M}_{\mathrm{phys}}} \mathbf{O}^{\mathrm{TFPT}}_{\mathrm{phys}} \xrightarrow{\mathfrak{M}_{\mathrm{scheme}}} \mathbf{O}^{\mathrm{TFPT}}_{\mathrm{scheme}}/\mathbf{Sch}.$$

Main theorem stack:

$$\begin{aligned}\mathfrak{S}_{\min} &\Rightarrow \mathcal{B}_{\min} \Rightarrow \mathfrak{T}_\partial^{\min} \Rightarrow (\tau_{\mathrm{dbl}}, \iota_C, P_{\mathrm{prim}}, [u_\Sigma], c_3) \Rightarrow d^\star_{\mathrm{disc}}\\ &\Rightarrow P_{\mathrm{adm}} \Rightarrow \mathcal{M}_{d^\star_{\mathrm{disc}}} \Rightarrow \mathcal{Z}_{\mathrm{cl}} = \{x^\star_{\mathrm{cl}}\} \Rightarrow \mathfrak{T}_\star.\end{aligned}$$

Compressed decoder reading:

$$\begin{aligned} Y &\text{ generates structure,}\\ [u_\Sigma] = 1 &\text{ generates counting,}\\ u := \varphi_0^{\mathrm{ret}} &\text{ generates bridge observables.}\end{aligned}$$

$$6Y^2 - Y - \mathbf{1} = 0,\ \operatorname{Tr} Y = 0 \Rightarrow E_3 \oplus E_2,\ S^+,\ \gamma = \frac{5}{6},$$

$$16\gamma = \frac{40}{3} \Rightarrow N_{\mathrm{fam}} = 3 \Rightarrow \Omega_{\mathrm{adm}} = 48.$$

$$P'(z) = 0 \Rightarrow \delta_{\mathrm{ph}}, \qquad \sum_{f,j} L^{\mathrm{diag}}_{f,j} + N_\Phi = 41 \Rightarrow \alpha.$$

The input-side reduction to $\mathfrak{T}_\star$ and the internal passage from $\mathfrak{T}_\star$ to $\Gamma^{\mathrm{ren}}_{\mathrm{TFPT}}$ and $\mathbf{O}^{\mathrm{TFPT}}_{\mathrm{phys}}$ are theorem-level. Only the final projection to $\mathbf{O}^{\mathrm{TFPT}}_{\mathrm{scheme}}/\mathbf{Sch}$ is an appendix-facing interface. From $\mathfrak{T}_\star$ the structural falsification map $\mathsf{F}_{\mathrm{fals}}(\mathfrak{T}_\star)$ stays in the main text, while the comparison map $\mathcal{R}_{\mathrm{cmp}}(\mathfrak{T}_\star)$ together with thresholds, schemes, and empirical rows is collected only in the appendix-level empirical readout.

Contents

9 Reading guide and claim map

The paper is organized in three reading layers:

- **Big picture:** one section explains what TFPT claims in plain language before the detailed datum and conventions begin.
- **Detail:** the main body then runs from boundary polarization and hard carrier rigidity through kernel numerics, the two closure-architecture sections, the closure theorem stack, the canonical rigid object, the seam-transfer cosmology block, and the internal-reduction / readout-organization section, while the appendix-level empirical readout may be read afterwards.
- **Proof-complete core:** the load-bearing completion theorems are proved in full in the manuscript. The appendices keep manuscript-level analytic proofs, auxiliary elaborations, optional continuations, and interface tables, but they are not needed for the logical closure of the primitive kernel, the continuous master functional, or the canonical rigid object.

The role language is also fixed once and for all:

- **Boundary datum** means the one-sided theorem package $\mathfrak{T}_{\partial}^{\min}$ induced by the minimal operational seed and used downstream to reconstruct the Calderón polarization, doubled closed datum, and admissibility projector. The later minimal-packaging theorem shows that no extra primitive discrete datum is needed beyond it.
- **Theorem** means a statement proved directly from the operational-seed / boundary-datum chain and earlier theorem-level outputs.
- **Derived consequence** means a downstream structural output obtained by composing already proved theorems without introducing a new datum.

Below theorem level the manuscript uses only five auxiliary tags:

- **Exact identity** means an algebraic equality on an already fixed branch or kernel package.
- **Derived consequence** means a nonprimitive output obtained by composing earlier theorem-level statements.
- **Appendix continuation** means a downstream numerical or conceptual extension that requires one extra assumption beyond the main theorem surface.
- **Programmatic closure target** means a mathematically precise downstream target whose statement is fixed clearly enough to define a falsifiable obligation, but whose proof is not claimed in the present version.
- **Interpretive reading** means a heuristic or explanatory picture not used as theorem input.

Comparison conventions are isolated in the appendix-level empirical interface and are not used as main-text theorem labels. To keep theorem language, benchmark semantics, and appendix bookkeeping lexically stable, all prose, captions, and role labels are kept in English throughout.

9.1 Version 4.5 completion surface

The manuscript now contains a fully rigid algebraic core together with analytic closure blocks whose exact status is recorded theorem by theorem in the proof-obligation ledger. The remaining explicit standard-theorem interface is

$$O_{7\mathrm{d},0},$$

while the other former B/C interfaces have now been pulled into the manuscript proof surface. The eight items below are therefore not a promise of later completion; they are the status-coded 4.5 surface of the present manuscript.

Version 4.5 completion surface

1. **[A] Operational seed generation of the one-sided boundary datum.** Introduce the thinner operational seed class $\mathbf{Seed}^{\mathrm{op}}$ and prove that it functorially induces the one-sided admissible boundary datum. Proof architecture: reflection positivity and the collar generator reconstruct the one-sided OS Hilbert space and adapted boundary operator, while the seam class induces the spectral-flow datum.

2. **[A] Minimal packaging inside the induced admissible boundary class.** Organize the induced one-sided boundary class by lexicographic minimality without hiding a second primitive discrete layer. Proof architecture: lexicographic minimality of seam winding, finite primitive carrier rank, corner count, determinant charge, and boundary kernel dimension; collar product form then yields the one-sided boundary operator and reflection-positive doubling.

3. **[A] D_4 Riemann–Hilbert rigidity theorem.** Close the family-holonomy debt by fixing the four puncture loops, the local $\{1, \omega, \omega^2\}$ conjugacy classes, the trivial determinant line, and the full D_4 puncture symmetry. Proof architecture: monodromy is forced up to global $SU(3)_F$ conjugation, then Riemann–Hilbert yields the unique flat Hermitian family-connection class.

4. **[A] Compact determinant and Higgs index theorem.** Promote the determinant-line / Higgs block from a near-complete closure to a compact Dolbeault index theorem on the seam-normal sphere. Proof architecture: $(c_1(L_2), c_1(L_3)) = (1, 0)$ gives $L_2 \cong \mathcal{O}(1)$ and $L_3 \cong \mathcal{O}$, so Birkhoff–Grothendieck and Riemann–Roch force exactly one weak doublet and no light color triplet.

5. **[A] Canonical transport-kernel theorem.** Recast the transport block at theorem level in operator language rather than in path rhetoric. Proof architecture: the structural kernel K_f^{str} together with the rigid family holonomy produces the Yukawa matrices in the canonical family basis; the primitive indecomposable Yukawa generator then forces the rigid $3+2$ carrier split.

6. **[A] Stratified master-functional theorem.** Replace the last appearance of separate closure stories by one stratified functional on admissible spectral bordisms. Proof architecture: a lexicographic barrier fixes the minimal discrete stratum, while the relative partition function, zeta determinant, and eta term generate the continuous Euler–Lagrange equations on the retained branch.

7. **[A] Spectral UV completion and renormalized 1PI readout theorem.** Close the continuum side at the spectral rather than purely local Einstein level. Proof architecture: a positive-kernel Birkhoff contraction fixes the unique admissible UV profile, Stieltjes form factors give the ghost-free two-point gravitational kernel, the projective-limit measure supplies the constructive UV object, and the renormalized observable hierarchy is read as the exact 1PI / Legendre layer of the same admissible measure.

8. **[A] Absolute spectral Planck closure and stationary vacuum theorem.** Fix the boundary spectral unit λ_Σ, the unique stationary root $\rho_\star$ of the boundary-normalized gravi-

tational functional, and the resulting reduced-Planck / Newton / Schwarzschild–de Sitter readouts directly on the main theorem surface.

9. **[A] FRW reduction and cosmology interface theorem.** Turn seam transfer, determinant-line dynamics, and the scalaron sector into one reduced low-curvature action together with explicit cosmology interface data. Proof architecture: homogeneous/isotropic reduction in $(a, \phi, \theta_\Sigma, N_i)$ yields Λ_{IR}, the axion displacement data, and the reheating / leptogenesis input block on the same admissible branch, while the final nonequilibrium readouts remain comparison-layer outputs.

Remark (Remaining interface for the 4.5 map). The target blocks above are now accompanied by only one explicit standard-theorem interface that should remain visible rather than absorbed into rhetoric: the infrared-dressed massless scattering interface on the low-curvature branch ($O_{7\mathrm{d},0}$). The OS/CAR reconstruction, massive Haag–Ruelle / LSZ closure, and the FRW cosmology interface are now carried by manuscript-level appendix proofs.

Remark (Status of the 4.5 completion surface). The nine theorem blocks above are integrated into the manuscript, but their exact status is still recorded line by line in the proof-obligation ledger. The point is therefore not rhetorical completion language but synchronized proof metadata.

Extended downstream closure surface

1. **[P] Horizon modular thermality and compact-object thermodynamics.** Upgrade the split-inclusion horizon package to stationary modular flow, Hawking temperature, Wald entropy, and Kerr / scalaron correction bounds on the vacuum branch.

2. **[P] Primordial perturbation closure from the seam state.** Fix the reheating e-fold number, seam-state Bogoliubov data, and Mukhanov–Sasaki / tensor initial conditions on the closed branch.

3. **[P] CMB transfer, baryogenesis, and late-time matter readout.** Carry the seam-fixed primordial spectrum through the transfer hierarchy, the flavored Boltzmann system, and the late-time H_0 / $P_m(k, z)$ readouts.

4. **[P] Late-time dark-sector structure and relative vacuum-energy control.** Record the axion Schrödinger–Poisson branch and the finite relative admissible vacuum-energy formula as the late-time dark-sector closure target.

5. **[P] Pole-mass completion and Higgs readout.** Read quark / lepton pole masses and the Higgs pole from the admissible RG branch rather than from source rows or raw UV data.

6. **[P] Admissible code subspace and pointer dynamics.** Promote the appendix record / Born machinery to a global code-subspace reading of entanglement, pointer stability, and record growth on $\mathcal{H}_{\mathrm{adm}}$.

7. **[P] Topological transient channels.** Keep phase-slip burst phenomenology as a precise falsifiable transient target without promoting it to theorem status.

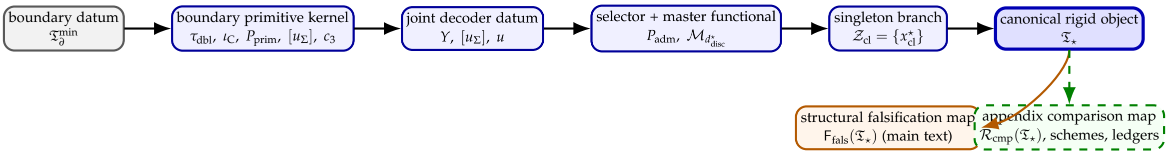


Figure 1. Closed dependency map with decoder core.

Closed theorem surface

- **Initial layer:** the minimal operational seed $\mathfrak{S}_{\rm min}$ induces the minimal admissible bordism $\mathcal{B}_{\rm min}$ and hence the one-sided boundary datum $\mathfrak{T}_\partial^{\rm min}$.
- **Boundary datum:** $\mathfrak{T}_\partial^{\rm min}$ with one-sided center, self-adjoint boundary operator, seam collar, and canonical doubling data.
- **Theorem layer I:** doubling / deck involution / boundary polarization $(\tau_{\rm dbl}, \iota_C)$, the doubled primitive reconstruction $\mathfrak{T}_{\rm prim}$, and the primitive Hodge projector $P_{\rm prim}$ from the Calderón projector, APS realization, and $D_{\rm rel}$.
- **Theorem layer II:** the primitive winding class $[u_\Sigma] = 1$ and the rigid D_4 family geometry fix $X_f^\circ \cong \mathbb{P}^1 \setminus \mu_4$ and $N_{\rm fam} = 3$; the trace-balanced carrier decoder $6Y^2 - Y - \mathbf{1} = 0$, $\operatorname{Tr} Y = 0$ is realized minimally as the rigid $3+2$ carrier kernel $E_3 \oplus E_2$, the primitive hypercharge generator Y, the one-family packet S^+, and $\gamma = 5/6$; together with the compact Higgs index this fixes $\Omega_{\rm adm} = 48$, the determinant class $(c_1(L_2), c_1(L_3)) = (1,0)$, and $\theta_{\rm eff} = 0$.
- **Theorem layer III:** after the discrete datum has been fixed, the full selector $P_{\rm adm}$ and the projected modular free energy determine the electromagnetic, geometric, transport, and vacuum sectors as one continuous Euler–Lagrange problem; on the retained branch this is read as $\lambda_\Sigma = \lambda_1^+(|B_\Sigma|)$, $\partial_\rho \widehat{V}_{\rm Pl}^{\rm ren}(\rho_\star) = 0 \Rightarrow (\bar{M}_{\rm Pl}/\lambda_\Sigma,\ G_N\lambda_\Sigma^2)$, $P'(z) = 0 \Rightarrow \delta_{\rm ph}$, $u := \varphi_0^{\rm ret} \Rightarrow (\lambda_C, \beta_{\rm rad}, \Omega_b, \theta_{13})$, and $\sum_{f,j} L_{f,j}^{\rm diag} + N_\Phi = 41 \Rightarrow \alpha$.
- **Theorem layer IV:** the intrinsic branch is the singleton fiber product of the discrete sector and the four continuous sector solution sets; from this follow internal analytic closure, essential injectivity on the rigid image, and the canonical rigid object $\mathfrak{T}_\star$.
- **Input/output layer:** internal reduction $\mathfrak{R}$ from $\widehat{\mathrm{PhysAdm}}_1$ to the rigid TFPT class is proved on the input side; the renormalized observable chain $\mathfrak{T}_\star \to \Gamma^{\rm ren}_{\rm TFPT} \to \mathbf{O}^{\rm TFPT}_{\rm phys}$ is theorem-level on the output side; only the final scheme projection to $\mathbf{O}^{\rm TFPT}_{\rm scheme}/\mathbf{Sch}$ remains appendix-facing.
- **Side maps:** a structural falsification map $\mathsf{F}_{\rm fals}(\mathfrak{T}_\star)$ in the main text, and an appendix-only comparison map $\mathcal{R}_{\rm cmp}(\mathfrak{T}_\star)$ for thresholds, schemes, and empirical rows after the physical observable layer has already been fixed.

The family closure used throughout the main text is now read as topologically fixed, variationally stabilized, and canonically compatible with the doubled admissible branch; no separate family datum remains outside the theorem surface. Likewise the finite chiral packet condition $\dim \Lambda^{\rm even} E = 16$ is no longer left as ambient residue but is reconstructed internally by the bosonic-rank and branch-Yukawa carrier closure.

10 Big picture: what TFPT actually claims

TFPT is presented here as a boundary-polarized closed theory of admissible vacua on the oriented double cover. The formal theorem stack now starts from a thinner operational seed which functorially induces the one-sided boundary datum, and the manuscript also shows that within the induced boundary class no extra primitive discrete datum is needed. On the one-sided branch, the self-adjoint boundary operator B_Σ determines the Calderón projector, the Calderón projector determines the seam polarization ι_C, and the canonical doubling then reconstructs the doubled scaffold $\mathfrak{T}_{\mathrm{prim}}$ together with the primitive Hodge projector P_{prim}. From this boundary kernel the manuscript next solves one joint discrete admissibility problem, now best read through three decoders. The trace-balanced carrier decoder

$$6Y^2 - Y - \mathbf{1} = 0, \qquad \operatorname{Tr} Y = 0$$

fixes the rigid $E_3 \oplus E_2$ split, hypercharge, and the one-family packet S^+. The global winding decoder $[u_\Sigma] = 1$ fixes the rigid family surface $X_f^\circ \cong \mathbb{P}^1 \setminus \mu_4$, the minimal family count $N_{\mathrm{fam}} = 3$, and the admissible occupancy $\Omega_{\mathrm{adm}} = 48$. On the retained branch the seed decoder

$$u := \varphi_0^{\mathrm{ret}}$$

simultaneously bridges $(\lambda_C, \beta_{\mathrm{rad}}, \Omega_b, \theta_{13})$, while $P'(z) = 0$ fixes the intrinsic transport pole and the closed budget $\sum_{f,j} L_{f,j}^{\mathrm{diag}} + N_\Phi = 41$ closes the electromagnetic fixed point α. Only after that discrete theorem is the selector promoted to its full form $P_{\mathrm{adm}} = P_{\mathrm{prim}} P_{\mathrm{sing}} P_\Theta$, and the projected modular free energy drives the continuous electromagnetic, geometric, transport, and vacuum closure: the geometric Hodge sector yields the gravity/scalaron branch, and the exact transport grammar emits Yukawas, hadronic admissibility, and strong-CP closure on the same admissible branch. The resulting theorem stack does not merely emit a closed output package; it characterizes a canonical rigid object $\mathfrak{T}_\star$ in the rigid TFPT theorem class. The structural falsification map $\mathsf{F}_{\mathrm{fals}}(\mathfrak{T}_\star)$ stays in the main text, while all comparison conventions live only in the appendix-level $\mathcal{R}_{\mathrm{cmp}}(\mathfrak{T}_\star)$ side card.

Figure 2 compresses that statement into six headline claims. The point is that the manuscript now presents three hard decoders inside one joint discrete theorem, one continuous master functional, and one canonical rigid object rather than competing closure stories with a separate readout layer.

TFPT master equation and closed indices

$$S_{\mathrm{TFPT}} = \operatorname{Tr} f\left(\frac{D_{\mathrm{rel}} + A_\Sigma^{\mathrm{seed}}}{\chi_{\mathrm{seed}}}\right) - \operatorname{Tr} f\left(\frac{D_{\mathrm{ref}}}{\chi_{\mathrm{seed}}}\right) + \frac{i\pi}{2}\Delta\eta_\Sigma, \qquad A_\Sigma^{\mathrm{seed}} := \mathcal{B}_{\mathrm{rel}} \oplus \nabla_{\chi_{\mathrm{seed}}}. \quad (1)$$

$$\underset{\alpha,\chi_{\mathrm{seed}},e,\varpi_{\mathrm{spin}}}{\mathrm{Stat}} S_{\mathrm{TFPT}} = 0, \qquad P_{\mathrm{adm}} := \Pi_{\ker \Delta_{\mathrm{adm}}}, \qquad \partial_\alpha \Gamma_{U(1)}(\alpha) = 0,$$
$$\operatorname{Ind}(D_{\mathrm{fam}}^+) = 3, \qquad \operatorname{Ind}(\mathcal{B}_{E_2}^+) = 1, \qquad \operatorname{Ind}(\mathcal{B}_{E_3}^+) = 0. \quad (2)$$

The hard carrier theorems below do not require the full theorem stack behind [TFPT cross-reference: `eq:tfpt-master,eq:tfpt-selectors`]. In the present paper the master equation is the organizing closed form: the carrier theorems are hard, the later closure theorems are internal statements on the reconstructed branch, and the empirical interface is kept outside this theorem box. At this overview level the seed package is written as A_Σ^{seed}; on the later geometric branch it is reorganized as A_Σ^{geo} with $\chi_{\mathrm{seed}} \mapsto \chi_{\mathrm{geo}} = \Lambda e^\sigma$.

Remark (Selector versus dynamics). The admissibility projector P_{adm} selects the physical sector but is not itself the full Minkowski dynamics. The actual dynamics is carried by the

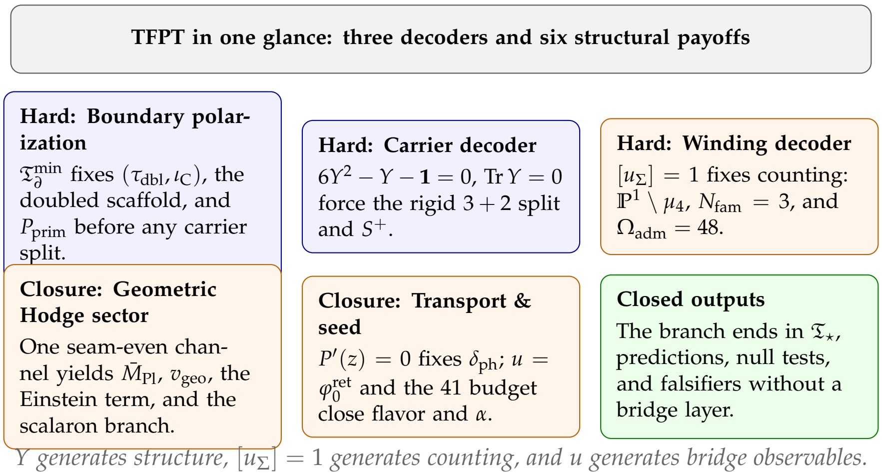


Figure 2. Headline claims of the present draft. The figure is intentionally simpler than the dependency maps that follow: its job is to put the manuscript's decoder core on one page while keeping the closed datum, theorem, and derived-consequence flow visible.

relative generating functional $Z_{\rm rel}$, its Schwinger distributions, the reconstructed local net on the admissible Hilbert space, the running effective actions Γ_k and $\Gamma^{\rm ren}_{\rm TFPT}$, and the resulting scattering theory.

Closed TFPT Chain

$$\begin{aligned} \mathfrak{T}_\partial^{\min} &\Rightarrow (\tau_{\rm dbl}, \iota_C, P_{\rm prim}, [u_\Sigma], c_3) \Rightarrow d^\star_{\rm disc} \\ &\Rightarrow P_{\rm adm} \\ &\Rightarrow \mathcal{M}_{d^\star_{\rm disc}} \Rightarrow \mathcal{Z}_{\rm cl} = \{x^\star_{\rm cl}\} \Rightarrow \mathfrak{T}_\star, \\ \mathfrak{T}_\star = \big(&E_3 \oplus E_2,\ X,\ Y,\ a_\Sigma,\ \Gamma_{\rm grav}, \\ &\Lambda_{\rm IR},\ x^\star_{\rm cl}\big). \end{aligned} \tag{3}$$

At chain level the same architecture is read through three hard decoders:

$$\begin{aligned} Y &\Rightarrow \text{carrier structure}, \\ [u_\Sigma] = 1 &\Rightarrow \text{family counting}, \\ u = \varphi_0^{\rm ret} &\Rightarrow \text{bridge observables}. \end{aligned}$$

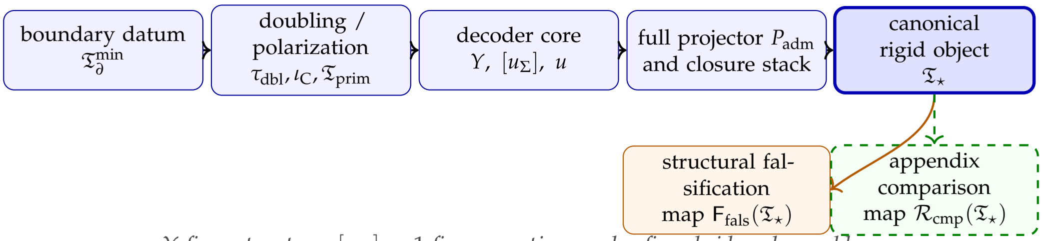
On the retained branch this further compresses to

$$P'(z) = 0 \Rightarrow \delta_{\rm ph}, \qquad \sum_{f,j} L^{\rm diag}_{f,j} + N_\Phi = 41 \Rightarrow \alpha.$$

From $\mathfrak{T}_\star$ the structural falsification card $\mathsf{F}_{\rm fals}(\mathfrak{T}_\star)$ remains inside the main text; the appendix-only comparison card $\mathcal{R}_{\rm cmp}(\mathfrak{T}_\star)$ collects scheme conventions and empirical ledgers.

Closed Theorem Stack in the Present Version

$$\mathfrak{T}_\partial^{\min} \Rightarrow (\tau_{\rm dbl}, \iota_C, P_{\rm prim}, [u_\Sigma], c_3) \Rightarrow d^\star_{\rm disc} \Rightarrow P_{\rm adm} \Rightarrow \mathcal{M}_{d^\star_{\rm disc}} \Rightarrow \mathcal{Z}_{\rm cl} = \{x^\star_{\rm cl}\} \Rightarrow \mathfrak{T}_\star.$$



Y fixes structure, $[u_\Sigma] = 1$ fixes counting, and u fixes bridge observables.

Figure 3. Closed theorem surface with two hard-separated side maps and a decoder core.

Hard-decoder form:

$$\begin{aligned} 6Y^2 - Y - \mathbf{1} = 0,\ \operatorname{Tr} Y = 0 &\Rightarrow 3 + 2, \\ [u_\Sigma] = 1 &\Rightarrow N_{\rm fam} = 3, \\ u = \varphi_0^{\rm ret} &\Rightarrow (\lambda_C, \beta_{\rm rad}, \Omega_b, \theta_{13}). \end{aligned}$$

The manuscript contains no additional primitive ontology beyond the operational seed layer. The falsification map $\mathsf{F}_{\rm fals}$ is a structural side card on the main-text side; the comparison map $\mathcal{R}_{\rm cmp}$, optional arithmetic continuations, asymptotic expansions, and horizon language are kept only in appendices.

The remainder of the main text sharpens each arrow of this chain in turn.

11 Canonical rigid object and falsification interface

11.1 Canonical rigid object

Collecting the operational-seed generation theorem, the minimal-packaging theorem for the induced boundary class, the boundary datum, the boundary primitive kernel, the joint discrete admissibility theorem, the derived selector, and the continuous closure theorems of [TFPT cross-reference: `sec:closure-theorems`], the main-text reconstruction now takes the rigid two-stage form

$$\begin{aligned} \mathfrak{S}_{\min} &\Rightarrow \mathcal{B}_{\min} \Rightarrow \mathfrak{T}_\partial^{\min} \Rightarrow (\tau_{\rm dbl}, \iota_C, P_{\rm prim}, [u_\Sigma], c_3) \Rightarrow d^\star_{\rm disc} \\ &\Rightarrow P_{\rm adm} \Rightarrow \mathcal{M}_{d^\star_{\rm disc}} \Rightarrow \mathcal{Z}_{\rm cl} = \{x^\star_{\rm cl}\} \Rightarrow \mathfrak{T}_\star. \end{aligned} \tag{4}$$

Here

$$\mathfrak{T}_\star := \left(E_3 \oplus E_2,\ X,\ Y,\ G_{\rm phys},\ S^+,\ X_f^\circ,\ [\nabla_F^\star],\ \Phi,\ a_\Sigma,\ U_\Sigma, \Gamma_{\rm grav},\ \mathcal{H}_{\rm phys},\ \Lambda_{\rm IR},\ \{Y_f\},\ x^\star_{\rm cl}\right)$$

is the canonical rigid object of [TFPT cross-reference: `thm:no-alternatives-tfpt`], and the intrinsic branch is the singleton $\mathcal{Z}_{\rm cl} = \{x^\star_{\rm cl}\}$ carried by that object. This line is not meant as a slogan: each arrow is attached to a hard theorem or one of the closure theorems of [TFPT cross-reference: `sec:closure-theorems`]. From $\mathfrak{T}_\star$ the manuscript opens exactly two side cards: the structural falsification map $\mathsf{F}_{\rm fals}(\mathfrak{T}_\star)$ of [TFPT cross-reference: `sec:structural-falsification-map`] (main text) and the appendix-level empirical comparison map $\mathcal{R}_{\rm cmp}(\mathfrak{T}_\star)$ of [TFPT cross-reference: `sec:appendix-empirical-readout`]. Neither side card enters the theorem chain. Section [TFPT cross-reference: `sec:downstream_closure_modules`] records additional downstream closure modules starting from $\mathfrak{T}_\star$, the admissible local net, the renormalized branch, and the cosmology interface package, but it does not insert new arrows into this core theorem chain.

The corresponding selector-to-dynamics extension of the closed branch is

$$P_{\mathrm{adm}} \Rightarrow Z_{\mathrm{rel}} \Rightarrow \{S_n^T\} \Rightarrow (\mathcal{H}_{\mathrm{adm}}, \mathfrak{A}_{\mathrm{adm}}) \Rightarrow \Gamma_k \Rightarrow \Gamma^{\mathrm{ren}}_{\mathrm{TFPT}} \Rightarrow (\mathbf{O}^{\mathrm{TFPT}}_{\mathrm{phys}}, S_{\mathrm{massive}}) \quad \text{together with} \quad \mathcal{I}_{\mathrm{dress}}.$$

Here

$$\mathcal{I}_{\mathrm{dress}} := (\Omega_+^{\mathrm{dress}}, \Omega_-^{\mathrm{dress}}, S_{\mathrm{dress}})$$

denotes the dressed massless interface package on the low-curvature branch. Thus P_{adm} is the selector of the physical branch, while local dynamics, running couplings, 1PI graphs, and scattering are carried by Z_{rel}, its reconstructed local net, and the exact admissible flow.

11.2 Canonical rigid-object corollary

Corollary 11.1 (Canonical rigid object)**.** *By* [TFPT cross-reference: `thm:intrinsic-closed-branch,thm:canoni` *there exists a canonical rigid object*

$$\mathfrak{T}_\star := \big(E_3 \oplus E_2,\ X,\ Y,\ G_{\mathrm{phys}},\ S^+,\ X_f^\circ,\ [\nabla_F^\star],\ \Phi,\ a_\Sigma,\ U_\Sigma,\ \Gamma_{\mathrm{grav}},\ \mathcal{H}_{\mathrm{phys}},\ \Lambda_{\mathrm{IR}},\ \{Y_f\},\ x_{\mathrm{cl}}^\star\big)$$

in $\mathbf{TFPT}^{\mathrm{rig}}$ *such that* $\mathcal{Z}_{\mathrm{cl}} = \{x^\star_{\mathrm{cl}}\}$ *and every rigid closed admissible realization is uniquely unitarily equivalent to* $\mathfrak{T}_\star$*.*

Remark (Status of the corollary)*.* This statement is recorded as a corollary rather than as a separate theorem because it adds no content beyond [TFPT cross-reference: `thm:intrinsic-closed-branch,thm:ca` In plain language: once the intrinsic branch is closed and essential injectivity rules out a second rigid realization, the canonical object $\mathfrak{T}_\star$ is already fixed. The present corollary only collects its data tuple; the physically relevant main-text consequences below are reported as structural predictions and falsifiers in $\mathsf{F}_{\mathrm{fals}}(\mathfrak{T}_\star)$, while appendix-level empirical readout through $\mathcal{R}_{\mathrm{cmp}}(\mathfrak{T}_\star)$ does not define extra theorem objects.

11.3 Structural falsification map

The main text closes the theorem chain at $\mathfrak{T}_\star$ and then attaches one structural side card, the falsification map

$$\mathsf{F}_{\mathrm{fals}} : \mathbf{TFPT}^{\mathrm{rig}} \to \{\text{structural failure modes}\}, \qquad \mathfrak{T}_\star \mapsto \mathsf{F}_{\mathrm{fals}}(\mathfrak{T}_\star).$$

This map reports which local or global structural failure mode would break each arrow of the reconstruction. It is hard-separated from the appendix-level empirical comparison map $\mathcal{R}_{\mathrm{cmp}}(\mathfrak{T}_\star)$, which acts only after $\mathfrak{T}_\star$ has been fixed and is collected in [TFPT cross-reference: `sec:appendix-empirical-readout`].

12 Conclusion

12.1 Closed theorem stack and interface layers

TFPT is organized around the one-sided boundary datum

$$\mathfrak{T}_\partial^{\min} = (\mathcal{A}_+, \mathcal{H}_+, D_+, J, \Gamma, B_\Sigma)$$

induced by the minimal operational seed, and reconstructs in a two-stage closure order

$$\begin{aligned} \mathfrak{S}_{\min} \Rightarrow \mathcal{B}_{\min} \Rightarrow \mathfrak{T}_\partial^{\min} \Rightarrow (\tau_{\mathrm{dbl}}, \iota_C, P_{\mathrm{prim}}, [u_\Sigma], c_3) \\ \Rightarrow d^\star_{\mathrm{disc}} \Rightarrow P_{\mathrm{adm}} \Rightarrow \mathcal{M}_{d^\star_{\mathrm{disc}}} \Rightarrow \mathcal{Z}_{\mathrm{cl}} = \{x^\star_{\mathrm{cl}}\} \Rightarrow \mathfrak{T}_\star. \end{aligned}$$

This reconstruction first fixes the joint discrete datum and only afterwards the continuous Euler–Lagrange branch, thereby identifying the canonical rigid object of the boundary-polarized branch:

$$\forall \mathfrak{T}_{\mathrm{pre}} \in \mathbf{TFPT}^{\mathrm{rig}} : \qquad \mathfrak{T}_{\mathrm{pre}} \cong \mathfrak{T}_\star \quad (\text{[TFPT cross-reference: } \texttt{thm:no-alternatives-tfpt}\text{]}).$$

The selector-to-dynamics continuation of the same branch is

$$P_{\mathrm{adm}} \Rightarrow Z_{\mathrm{rel}} \Rightarrow \{S_n^T\} \Rightarrow (\mathcal{H}_{\mathrm{adm}}, \mathfrak{A}_{\mathrm{adm}}) \Rightarrow \Gamma_k \Rightarrow \Gamma^{\mathrm{ren}}_{\mathrm{TFPT}} \Rightarrow (\mathbf{O}^{\mathrm{TFPT}}_{\mathrm{phys}}, S_{\mathrm{massive}}) \quad \text{together with} \quad \mathcal{I}_{\mathrm{dress}}.$$

Above that rigid core, the manuscript records one theorem-level input reduction and one output-side interface

$$\widehat{\mathrm{PhysAdm}}_1 \xrightarrow{\mathfrak{R}} \mathbf{TFPT}^{\mathrm{rig}} \simeq \{\mathfrak{T}_\star\} \xrightarrow{\mathfrak{R}_{\mathrm{ren}}} \Gamma^{\mathrm{ren}}_{\mathrm{TFPT}} \xrightarrow{\mathfrak{M}_{\mathrm{phys}}} \mathbf{O}^{\mathrm{TFPT}}_{\mathrm{phys}} \xrightarrow{\mathfrak{M}_{\mathrm{scheme}}} \mathbf{O}^{\mathrm{TFPT}}_{\mathrm{scheme}} / \mathbf{Sch}.$$

Combined with [TFPT cross-reference: `sec:absolute-dimensionless-metrology`], this yields the closed metrology chain

$$\mathfrak{T}^{\min}_{\partial} \Rightarrow (B_\Sigma, \lambda_\Sigma, \rho_\star, \chi_{\mathrm{geo},0}, \alpha_\star, \delta_{\mathrm{ph}}, U_\Sigma, \Gamma^{\mathrm{ren}}_{\mathrm{TFPT}}) \Rightarrow \mathfrak{M}_{\mathrm{TFPT}}(\mathfrak{T}_\star),$$

so the boundary branch fixes gravitational, electroweak, pole-mass, flavor-ratio, and infrared dimensionless readouts before any SI translation or scheme representative is chosen. The left arrow is the internal reduction theorem on the weakened ambient class $\widehat{\mathrm{PhysAdm}}_1$; the middle arrows build the theorem-level renormalized and physical observable layers; only the final scheme arrow is an appendix-facing interface. Strong-CP closure is part of the core theorem stack, whereas cosmology is carried at the level of closed-branch interface data and appendix comparison maps. TFPT therefore does not identify admissibility with dynamics: P_{adm} selects the physical sector, while the actual dynamics is carried by Z_{rel}, the Schwinger functions, the reconstructed local net on $\mathcal{H}_{\mathrm{adm}}$, the exact admissible flow Γ_k, and its infrared limit $\Gamma^{\mathrm{ren}}_{\mathrm{TFPT}}$.

12.2 Two side maps from $\mathfrak{T}_\star$

From $\mathfrak{T}_\star$ exactly two side maps are attached, both hard-separated from the theorem chain:

- **Structural falsification map (main text).** The map $\mathsf{F}_{\mathrm{fals}} : \mathfrak{T}_\star \mapsto \mathsf{F}_{\mathrm{fals}}(\mathfrak{T}_\star)$ of [TFPT cross-reference: `sec:structural-falsification-map`] reports the structural failure mode that would break each arrow of the reconstruction. It uses no scheme conventions, no thresholds, and no comparison data.

- **Empirical comparison map (appendix only).** The map $\mathcal{R}_{\mathrm{cmp}} : \mathfrak{T}_\star \mapsto \mathcal{R}_{\mathrm{cmp}}(\mathfrak{T}_\star)$ of [TFPT cross-reference: `sec:appendix-empirical-readout`] translates the physical observable layer of $\mathfrak{T}_\star$ into scheme-specified representatives and records chosen elements of the canonical orbit $[\mathfrak{M}(\mathfrak{T}_\star)]_{\mathbf{Sch}}$. Threshold conventions, comparison schemes, and empirical residuals live only in the appendix and never enter the theorem chain.

Comparison conventions and numerical threshold maps therefore act only after this chain via $\mathcal{R}_{\mathrm{cmp}}$ and do not belong to the theorem surface itself.

12.3 Conditional closure layer and status of the four downstream readouts

The closed-branch theorem stack is supplemented by a single, explicitly labeled *conditional closure layer*, organized so that every numerical readout can be promoted to a theorem as soon as a single named lift hypothesis is discharged. The four downstream readouts and their current status are

Λ_{IR} : theorem level as determinant of $1 - U_\Sigma$ ([TFPT cross-reference: `thm:cosmology-closure`]);
numerical value conditional on $S_{\mathrm{IR}} = 2/\alpha_\star$ ([TFPT cross-reference: `cor:conditional-lambda-ir-reado`
H_0 : downstream readout of $(\Lambda^\star_{\mathrm{IR}}, \Omega^\star_b, \omega^\star_a, \omega^\star_\nu, \omega^\star_r)$ ([TFPT cross-reference: `cor:late_time_hubble_readout`
m_q : scheme-fixed RG readout $\mathbf{m}_q^{\mathrm{TFPT}}(\mathcal{S}, \mu)$ ([TFPT cross-reference: `def:scheme-fixed-yukawa-kernel,thm`
hadronic pole masses are physical ([TFPT cross-reference: `thm:hadron_pole_masses_singlet_spectru`
C_ℓ : Stage 1 spectral closure from $\{\lambda_j(U_\Sigma)\}$ ([TFPT cross-reference: `thm:cmb_transfer_closure_closed_b`
$a_{\ell m}$: Stage 2 ergodic microcanonical seam lift from $(\{\lambda_j(U_\Sigma)\}, u_\Sigma, \mathcal{W}_\Sigma)$ ([TFPT cross-reference: `thm:cmb_se`
scalar phase law falsified; finite-field seam mixer ([TFPT cross-reference: `rem:finite-field-seam-mixe`
Weil-bound theorem-friendly candidate; "good CMB world" but not yet "this CMB world"
([TFPT cross-reference: `rem:good-vs-this-cmb-world`]), pending the SMICA-resolved r_ℓ test.

The compressed integrated story is

$$\alpha_\star \;\Rightarrow\; \text{seam transfer} \;\Rightarrow\; \Lambda_{\mathrm{IR}} \;\Rightarrow\; H_0 \;\Rightarrow\; C_\ell \;\Rightarrow\; a_{\ell m},$$

and in the matter sector

$$Y_q^\star \;\Rightarrow\; \Gamma^{\mathrm{ren}}_{\mathrm{TFPT}} \;\Rightarrow\; m_q^{\mathcal{S}}(\mu) \;\Rightarrow\; m^{\mathrm{pole}}_{\mathrm{had}}.$$

The four downstream readouts are therefore not isolated numerical claims but coordinated projections of the same admissible-branch operator stack. Each entry of the conditional closure layer ships with a named kill test inside its own block; together they define the empirical attack surface of the present version.

12.4 Main claim

A compressed decoder reading of the closed branch is

$$\boxed{\begin{aligned} &6Y^2 - Y - \mathbf{1} = 0, \quad \operatorname{Tr} Y = 0 \Rightarrow 3+2,\\ &\qquad\qquad \Xi_{S^+}(t) \Rightarrow \text{hypercharge sectors and } 5!,\\ &\qquad 16\gamma = \frac{40}{3} \Rightarrow N_{\mathrm{fam}} = 3 \Rightarrow \Omega_{\mathrm{adm}} = 48. \end{aligned}}$$

$$\boxed{\begin{aligned} &P'(z) = 0 \Rightarrow \delta_{\mathrm{ph}},\\ &u := \varphi_0^{\mathrm{ret}} \Rightarrow (\lambda_C, \beta_{\mathrm{rad}}, \Omega_b, \theta_{13}),\\ &\sum_{f,j} L^{\mathrm{diag}}_{f,j} + N_\Phi = 41 \Rightarrow \alpha. \end{aligned}}$$

In this condensed form, Y generates the carrier structure, the primitive winding class $[u_\Sigma] = 1$ fixes the counting, and the retained seed u decodes the bridge observables.

The final main-text form contains no theorem arrow ending in a raw comparison functor and no claim that comparison conventions or bridge assumptions belong to the primitive ontology. Optional arithmetic continuations, appendix-level E_8 scale grammar, threshold maps, and empirical residuals remain outside the closed theorem body. The defensible end claim of the present version is the rigid reconstruction statement

$$\boxed{\begin{aligned} &\text{minimal operational seed} \Longrightarrow \text{canonical rigid object } \mathfrak{T}_\star\\ &\qquad \Longrightarrow Z_{\mathrm{rel}} \Longrightarrow (\mathcal{H}_{\mathrm{adm}}, \mathfrak{A}_{\mathrm{adm}})\\ &\qquad \Longrightarrow \Gamma^{\mathrm{ren}}_{\mathrm{TFPT}} \Longrightarrow (\mathbf{O}^{\mathrm{TFPT}}_{\mathrm{phys}}, S_{\mathrm{massive}}) \text{ and } \mathcal{I}_{\mathrm{dress}} \end{aligned}}$$

or, equivalently,

$$\begin{aligned}\mathfrak{S}_{\min} \Rightarrow \mathcal{B}_{\min} \Rightarrow \mathfrak{T}_{\partial}^{\min} &\Rightarrow (\tau_{\rm dbl}, \iota_{\rm C}, P_{\rm prim}, [u_\Sigma], c_3) \Rightarrow d^{\star}_{\rm disc} \\ &\Rightarrow P_{\rm adm} \Rightarrow \mathcal{M}_{d^{\star}_{\rm disc}} \Rightarrow \mathcal{Z}_{\rm cl} = \{x^{\star}_{\rm cl}\} \Rightarrow \mathfrak{T}_{\star} \\ &\Rightarrow Z_{\rm rel} \Rightarrow \{S_n^T\} \Rightarrow (\mathcal{H}_{\rm adm}, \mathfrak{A}_{\rm adm}) \\ &\Rightarrow \Gamma_k \Rightarrow \Gamma^{\rm ren}_{\rm TFPT} \Rightarrow (\mathbf{O}^{\rm TFPT}_{\rm phys}, S_{\rm massive}) \text{ and } \mathcal{I}_{\rm dress}.\end{aligned}$$

$$\forall \mathfrak{T}_{\rm pre} \in \mathbf{TFPT}^{\rm rig}: \qquad \mathfrak{T}_{\rm pre} \cong \mathfrak{T}_{\star}.$$

The input-side reduction theorem is explicitly relative to the ambient category $\widehat{\mathrm{PhysAdm}}_1$, now without a packet-size axiom. Carrier minimality is already internalized by the algebraic normal-form lemma together with the later bosonic-rank and branch-Yukawa discharge of its residual carrier signatures, and the readout hierarchy organizes theorem-level physical observables before any appendix scheme projection. Comparison rows and threshold conventions remain outside the theorem core.

Exported objects

Exports: series dependency order; status vocabulary; publication strategy; global falsification categories.

Layer or statement	Role	Proof source or remaining note	Main structural test or falsifier
Operational seed generation, minimal packaging, and boundary datum $\mathfrak{T}_\partial^{\min}$	Boundary datum	operational-seed theorem, minimal-packaging theorem, and Calderón polarization theorem	failure would collapse the operator-level starting point
Doubling data τ_{dbl}, boundary polarization $\iota_{\mathbb{C}}$, doubled scaffold, and seam	Theorem	doubling / deck-involution / Calderón polarization theorem in the main text	structural consistency of every later theorem
Canonical admissibility projector P_{adm}	Theorem	canonical admissibility complex and Hodge projector lemma	unified electroweak / QCD / CP / gravity selection must survive one common projector
Carrier decoder Y, bosonic rank-two closure, branch Yukawa rigidity, and one-family packet S^+	Theorem	algebraic normal-form lemma, primitive trace-balanced carrier lemma, compact Higgs index corollary, branch Yukawa rigidity theorem, exterior-packet decomposition, and derived $48 = 4 \cdot 12$ identity	group/matter mismatch would be global
Winding decoder $[u_\Sigma] = 1$, $\mathcal{H}_F \cong F \cong \mathbb{C}^3$, and $\Omega_{\mathrm{adm}} = 48$	Theorem	four-corner / four-puncture theorem, harmonic family-mode theorem, family-integrality-repair corollary, and occupancy corollary	flavor multiplicity must be fixed without extra family input
Determinant classes and unique Higgs doublet	Theorem	minimal clutching theorem and compact bosonic index on the seam normal sphere	any unavoidable extra light triplet would falsify the theorem
Electromagnetic fixed point, retained-seed decoder, exact charged-lepton ratios, and closed 41 chain	Theorem	stationary $U(1)$ effective action, retained-seed decoder proposition, mass-compression theorem, and family/Higgs specialization	failure would break the fixed-point equation or the exact seed compression
Geometric Hodge gravity sector, boundary spectral unit, absolute spectral Planck closure, and low-curvature spectral branch	Theorem	spectral Einstein functional, boundary spectral-unit rigidity, absolute spectral Planck closure, Schwarzschild–de Sitter corollary, sectorial Hamilton decomposition, constructive geometric measure theorem, and spectral UV completion theorem	inability to obtain one coupled gravity/Higgs closure with one boundary-normalized stationary root would break the branch
D_4 family minimization, rigid family holonomy, cubic transport decoder, and residue–winding transport closure	Theorem	variational family theorem, monodromy-rigidity theorem, algebraic transport-pole theorem, regularized transport-pole stability lemma, exact C_6 resolvent, hard holonomy theorem, and winding sum rule	hierarchy grammar and winding lock must agree on one packet set
Determinant-line phase and strong-CP closure	Theorem	positive polar decomposition, determinant-line phase theorem, and admissible vacuum positivity	a stable nonzero effective strong-CP angle would falsify the theorem
FRW reduction, seam transfer, and cosmology interface data	Theorem	seam-transfer theorem, boundary-winding theorem, FRW/interface theorem, determinant-line axion interface theorem, and leptogenesis-interface theorem	positive trace-class seam transfer and scalaron closure must persist
Canonical rigid object and uniqueness	Theorem	internal analytic closure, essential injectivity on the rigid image, and canonical-object corollary	existence of a second nonisomorphic rigid realization would falsify the theorem
Internal reduction on the weakened ambient class $\widehat{\mathrm{PhysAdm}}_1$	Theorem	weakened ambient admissibility category, internal carrier / family / transport reductions, canonical rigid closure, and uniqueness theorem	existence of a physically admissible candidate in $\widehat{\mathrm{PhysAdm}}_1$ not closing canonically to $\mathfrak{T}_\star$ would falsify the theorem
Renormalized observable hierarchy and scheme projection discipline	Theorem	admissible 1PI package, renormalized observable theorem, physical observable factorization, minimal observable basis, and appendix scheme conventions	existence of an admissible observable not factoring through $\Gamma^{\mathrm{ren}}_{\mathrm{TFPT}} \to \mathbf{O}^{\mathrm{TFPT}}_{\mathrm{phys}}$ or a hidden fit parameter outside **Sch** would falsify the theorem

Table 1. Closed theorem surface for the present version. Internal reduction and the passage to the renormalized and physical observable layers are theorem-level; only the final scheme projection remains an appendix-facing interface. Comparison conventions, threshold rows, and empirical ledgers stay isolated in the appendix-level readout.

Closed statement	Input data	Output package	Role in rigid reconstruction	Principal structural falsifier (entry of $\mathsf{F}_{\text{fals}}(\mathfrak{T}_\star)$)
Boundary polarization from one-sided datum	$\mathfrak{T}_\partial^{\min}$	$(\tau_{\text{dbl}}, \iota_{\text{C}}), \mathfrak{T}_{\text{prim}}, \mathfrak{T}_{\min}^{\text{cl}}$	establishes the doubled scaffold and reference/relative split	failure of the primitive scaffold
Carrier rigidity and physical gauge quotient	$\mathfrak{T}_{\text{prim}}$	$X, E_3 \oplus E_2, G_{\text{phys}}, S^+, b_1$	fixes the particle-theory kernel	group or matter mismatch
Two-stage projector and winding-balance family theorem	$P_{\text{prim}}, P_{\text{sing}} P_\Theta$, seam polarization	$X_f^\circ \cong \mathbb{P}^1 \setminus \mu_4$, F, $\Omega_{\text{adm}} = 48$, $[\nabla_F^\star]$	closes multiplicity, harmonic family geometry, and admissible holonomy class	wrong family multiplicity, residual family modulus, or broken projector
Determinant line and geometric Hodge sector	P_{adm}, D_{geo}	Φ, a_Σ, $\bar{M}_{\text{Pl}}$, v_{geo}, $\mathcal{H}_{\text{phys}}$	closes Higgs, strong-CP seed, and low-curvature gravity	extra light triplet or broken gravity/Higgs closure
Transport, hadronic admissibility, and strong-CP closure	P_{adm}, U_6, family holonomy	Y_f, V_{CKM}, U_{PMNS}, δ_{ph}, $\mathcal{H}_{\text{had}}$, $\bar{\theta} = 0$	closes flavor, hadrons, and the effective strong angle	broken sum rule, bad winding lock, or nonzero effective strong-CP angle
FRW reduction and cosmology interface data	Γ_{grav}, U_Σ	S_Σ, Λ_{IR}, axion/reheating inputs, leptogenesis input map	records closed-branch cosmology interface data	non-trace-class seam transfer or broken scalaron closure
Branch uniqueness, essential injectivity, and canonical rigid object	invariant tuple $\mathcal{I}(\mathfrak{T}_{\text{pre}})$	$\mathfrak{T}_\star$ up to unique unitary equivalence	removes all remaining nonisomorphic rigid alternatives	existence of a second rigid realization with the same invariants, or failure of the vacuum-closure chain
Internal reduction on the weakened ambient class	$\widehat{\text{PhysAdm}}_1$	every physically admissible candidate in $\widehat{\text{PhysAdm}}_1$ closes canonically to $\mathfrak{T}_\star$	records the theorem-level input reduction	existence of a physically admissible candidate in $\widehat{\text{PhysAdm}}_1$ not closing canonically to $\mathfrak{T}_\star$
Renormalized observable hierarchy	$\mathfrak{T}_\star, \Gamma_{\text{TFPT}}^{\text{ren}}, \mathbf{Sch}$	$\Gamma_{\text{TFPT}}^{\text{ren}}$, $\Gamma_{\text{TFPT}}^{\text{ren}}$, $\mathbf{O}_{\text{phys}}^{\text{TFPT}}$, and the scheme orbit $[\mathfrak{M}(\mathfrak{T}_\star)]_{\mathbf{Sch}}$	records the output-side physical and scheme stratification	existence of an admissible observable not factoring through $\Gamma_{\text{TFPT}}^{\text{ren}} \to \mathbf{O}_{\text{phys}}^{\text{TFPT}}$ or a hidden fit parameter outside **Sch**

Table 2. Structural falsification map $\mathsf{F}_{\text{fals}}(\mathfrak{T}_\star)$ in main-text form. Each row records a theorem arrow of the reconstruction together with the structural failure mode that would break it. Appendix-level empirical readout via $\mathcal{R}_{\text{cmp}}(\mathfrak{T}_\star)$ is handled separately and does not appear as a theorem arrow in this table.