Observers Are All You Need

Bernhard Mueller[1*] Alexander Osika[2] Mario Poneder Kai Xue Ben Cassie
Peter Nguyen Maarten Antonie Visser Kale Arnav Anirudha David Matscheko
Jonathan Hill

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Author affiliations: [1]Pragma Inc., Washington, USA; [2]SNRGY Inc., Gothenburg, Sweden.

Abstract

Observer-Patch Holography (OPH) starts with finite observers that keep records, compare what both sides can read on an overlap, and repair disagreements. The paper treats public physical structure as the fixed point of those records, comparisons, and repairs. Finite repair gives normal forms and repeatable measurement records. Modular screen geometry supplies a three-dimensional observer chart, Lorentz kinematics, and a conditional Einstein branch. Icosahedral incidence and target-blind port readback derive a signed finite response and its Standard Model current algebra. Under the declared fermionic matter contract, anomaly balance and tensor descent give exact charges, three colors, and the maximal faithful matter image $(\mathrm{SU}(3)\times\mathrm{SU}(2)\times\mathrm{U}(1))/\mathbb{Z}_6$ from the stated premises alone. Physical global-form selection, laboratory current attachment, matter typing, and three-family attachment are open. The complete Einstein and gauge proofs are carried by two companion derivation papers.

This paper develops two quantitative closures. The local equation

$$P = \varphi + \frac{\sqrt{\pi}}{A_T(P)}.$$

asks one screen cell to reproduce its electromagnetic resolution and has one interval-certified root for each declared map. The global equation $N = \log M_0(\mathfrak{U}_N)$ asks a trial universe to reproduce its correctable-record capacity. Physical transport for the local closure and the universe-level capacity producer and selector are work in progress.

Keywords: observer patch holography; quantum foundations; emergent spacetime; fixed-point consensus; Standard Model structure; quantum gravity

What This Paper Contributes

This synthesis paper owns the observer interpretation and the two quantitative closures. The local equation

$$P = \varphi + \frac{\sqrt{\pi}}{A_T(P)}$$

*Corresponding authors: Bernhard Mueller, bernhard@floatingpragma.ai; Alexander Osika, alex@snrgystudios.com.

is the stronger result: its fixed-point uniqueness schema and outward-rounded interval certificates give one root for each declared map on the full analytic domain. The global equation $N = \log M_0(\mathfrak{U}_N)$ asks a trial universe to reproduce its logarithmic correctable-record capacity. The finite consensus and capacity algebra is established separately. The source-derived physical hadronic transport for P, the physical public-record producer and unique finite-size selector for N, the horizon/record identification, and the common screen/electroweak load carrier are work in progress. Numerical comparisons and falsifiers are stated in their owning sections.

OPH combines familiar mathematics under one operational constraint. Finite observers compare the records visible on overlaps, repair mismatches by declared recovery moves, and accept as public the normal form that survives those comparisons. The bounded observer patch is the primitive formal object. Its physical size and carrier realization remain branch data. Spacetime, fields, and particles enter through additional physical readout maps.

The consensus paper proves the same-source finite normal-form result. The presentation-invariant treatment in Ref. [1] separates hidden implementation choices from quotient-visible data. It does not identify carriers with different visible port incidence, topology, record processes, or repair laws. The spacetime and Einstein paper owns the controlled modular route to Lorentz and Einstein structure. Under the Standard Model gauge paper's explicit finite response and matter contracts, the current, anomaly, and tensor-descent calculations imply the Standard Model charge lattice and maximal faithful matter image from those contracts alone. The distinct transportable-sector/Tannaka route remains conditional. Its finite A_5 route supplies an exact conditional algebraic realization: incidence determines J, and the target-blind inverse-port impulse/readback producer realizes $R = -J$, with a common charge-conjugation convention. Physical matter typing, global-form selection, laboratory identification of the finite current, and equality with the Tannaka current are open. The particle paper owns the downstream hierarchy, mass, and flavor calculations; the screen paper owns the finite carrier and record model. The common-domain Einstein tower and the physical closure packets required for P and N are work in progress.

This paper supplies the shared interpretation and closure language. Its claims remain typed: finite theorem, controlled scaling result, conditional physical branch, numerical diagnostic, and interpretation are not interchangeable. A counterexample to a load-bearing theorem, a nonunique or target-leaking closure, failure of the physical readout premises, or a carrier-dependent change in the observable quotient falsifies the corresponding OPH claim. The derived gauge structure, controlled Lorentzian limit, and two dimensionless closure equations define the integrated claim. The typed open items above delimit what separates this theorem stack from full physical closure.

One carrier stack, four paper surfaces

The microphysics, consensus, spacetime/Einstein, and Standard Model gauge papers describe one typed construction. The microphysics paper owns the finite carrier and its public interfaces. The consensus paper owns accepted repair and the quotient public normal form. The spacetime and Einstein paper owns the conditional maps from that public normal form into support geometry and gravity. The Standard Model gauge paper owns the categorical and finite-carrier routes into compact currents and conditional matter. A claim may cross from one paper to another only through the exported object and premises named here.

Three meanings of screen

The word "screen" is used for three related objects that must not be identified without a receipt.

1. The *local carrier boundary* is the twelve-port oriented interface of one Echosahedral carrier on the declared branch. Its incidence has $(V, E, F) = (12, 30, 20)$.
2. The *federation screen* is the routed system of interfaces, records, repairs, and checkpoints of many carriers at finite cutoff.
3. The *support screen* is the observer-facing geometric chart. On the spherical branch it is the refined conformal S^2 used for caps, collars, modular flow, and Lorentz reconstruction.

Local icosahedral incidence does not determine the topology of the federation nerve. A federation of identical local carriers can be routed as a path, a cycle, a higher-genus complex, or a spherical complex. The map from routed carriers to a support-visible spherical nerve is therefore a physical bridge, not a change of notation.

Structure-sensitive, presentation-invariant physics

OPH is not neutral under arbitrary changes of substrate. It is invariant under changes of presentation that preserve the complete observer-visible carrier signature. On the Echosahedral branch that signature contains

$$\mathcal{C}_{i,r} = (\mathcal{A}_{i,r}, \rho_{i,r}, P_{i,r}, I^{\mathrm{or}}_{i,r}, \mathcal{R}_{i,r}, \mathcal{U}_{i,r}, \mathsf{Chk}_{i,r}, \mathsf{Resp}_{i,r}, c_{sr}),$$

where $P_{i,r}$ is the port set, $I^{\mathrm{or}}_{i,r}$ is oriented incidence, $\mathcal{R}_{i,r}$ is the record algebra, $\mathcal{U}_{i,r}$ is the repair or feedback interface, $\mathsf{Resp}_{i,r}$ is the visible response law, and c_{sr} is the refinement lineage. Hidden coordinates, port names, worker partitions, materials, and wiring presentations are silent when an isomorphism preserves this whole tuple and its error model. A change in port number, incidence, orientation, accessible algebra, response, repair law, clock, or refinement lineage need not be silent. A cube and an icosahedron are therefore different carrier contracts even when both are built from the same material.

A carrier body is not automatically an observer. It realizes an observer only when it supplies bounded access, self-readback, durable records, record-conditioned feedback, boundary prediction against controls, and checkpoint continuation. One carrier may pass that test. A connected subfederation may pass it instead. No theorem fixes primitive observer size by counting carrier bodies.

The common finite computation

At cutoff r, source-bound carrier data are routed into an observer-patch federation. Accepted repair then acts on the physical quotient:

$$\mathsf{SourceCarrierTower}_r \xrightarrow{\mathsf{realize/route}} \mathsf{ObserverFederation}_r$$
$$\xrightarrow{\pi_r} \mathsf{PhysicalQuotient}_r \xrightarrow{\mathrm{Rep}_r} \mathsf{PublicNormalForm}_r.$$

The last arrow is the consensus result only under semantic-dependency-complete transactions, coherent union-collar payloads, repair completeness, local diamonds, protected records, and the stated endpoint conditions. A collection of oscillators with equal frequency does not supply those clauses.

Physical phase locking can instantiate one synchronization layer. For a routed edge $e = ((i, a), (j, b))$, a source-produced phase record may certify frequency entrainment and a stable relative phase,

$$\dot{\theta}_{i,a} - \dot{\theta}_{j,b} \longrightarrow 0, \qquad d_{S^1}(\theta_{i,a} - \theta_{j,b}, \delta_e) \le \varepsilon_e.$$

That certificate becomes a consensus parent only when the phase record fixes a commensurability map for the exposed packets and is tied to the accepted repair ledger, semantic records, an independently calibrated clock, and the confluence premises. Phase locking can synchronize an interface. It does not by itself make the interface an observer, settle semantic disagreement, or produce physical time.

Two downstream projections of one source

The public normal form has two separately typed projections:

$$\begin{aligned}
&\mathsf{PublicNormalForm}_r \xrightarrow{\text{carrier-to-support}} \big(\mathsf{Support}_{S^2,r}, \mathsf{FiniteCapBWCertificate}_r\big),\\
&\left.\begin{array}{r}\mathsf{FiniteCapBWCertificate}_r\\ \mathsf{MGNS\text{-}1}_r \text{ independently complete}\end{array}\right\}_{\text{same tower}} \longrightarrow \mathsf{BW/KMS}_r \longrightarrow \mathsf{Lorentz/H^3}_r\\
&\qquad\qquad\longrightarrow \mathsf{Events}_{3+1,r} \longrightarrow \mathsf{Einstein}_r,
\end{aligned}$$

$$\begin{aligned}
\mathsf{PublicNormalForm}_r &\xrightarrow{\text{response contract}} (\mathsf{A5Carrier}_r, J_r)\\
&\longrightarrow \mathsf{CompactCurrent}_r \longrightarrow \mathsf{SM}_{Q0,r}\\
&\longrightarrow \mathsf{Matter/QFT}_r.
\end{aligned}$$

The finite carrier-to-support leg is constructed from one oriented icosahedral incidence nerve: twelve carrier charts, thirty seam algebras, and twenty nonvacuous triple restrictions. The same bound artifact supplies confluent seam repairs, an operational observer receipt, and a refinement-natural oriented S^2 support limit. The separate geometric 2π-KMS comparison and FiniteCapBWCertificate are not outputs of that finite bridge. The state tower, common-comparison maps, compatible state/vector data, modular controls, and cofinal modulus belong to the independently produced MGNS-1 package. The BW theorem consumes both inputs on the same tower. Once the support leg produces a conformal S^2, $\mathrm{Conf}^+(S^2) \cong \mathrm{SO}^+(3,1)$ and $H^3 = \mathrm{SO}^+(3,1)/\,\mathrm{SO}(3)$ is exactly three-dimensional. H^3 is the observer-frame fiber. A 3+1-dimensional event manifold requires the population/realization, separation, rank-four affine-chart, overlap-cocycle, held-out quadratic-cone, and causal-reachability receipts (E1)–(E6), together with the MI/assembly premise. Operational-clock gluing separately requires observer-readable transitions, event correspondence, affine calibration, cycle identity, and normal-form invariance. The Einstein relation additionally requires the common-domain stress, entropy, vacuum, coupling, scale, and remainder packet. Hidden Cartesian coordinates of a finite carrier are ineligible as support-screen, event, or Lorentz data.

The second projection begins with an exact finite result on the certified Echosahedral lineage. The twelve-port module decomposes as

$$P_{12} \cong_{A_5} \mathbf{1} \oplus \mathbf{3} \oplus \mathbf{3}' \oplus \mathbf{5}.$$

The source selector derives the twelve unit lines, antipodal pairing, proper A_5 action, and rank-three Gram frame; incidence determines the antipode J. Under the explicit finite response-admissibility contract, the signed central involutive inverse-port responses are exactly $\pm J$, with common sign conventional. Conditional also on the rank-15 matter contract with its unique charge-conjugate projector pair, the port-current, anomaly, Spin, and tensor-descent certificates imply the

Standard Model Lie type, hypercharge lattice, and conjugation-insensitive $\mathbb{Z}_6$ global form from those premises alone. The scalar scan fixes compatible charges and Yukawa channels, not scalar multiplicity. The finite response has a source-derived target-blind producer. Physical matter typing, laboratory current and line identification, exclusion of extra light sectors, family attachment, scalar attachment/dynamics, and quantum-field construction remain separate maps.

The compact sector-category/Tannaka route conditionally reconstructs a compact group by a logically independent route. The generation count and the extra-sector statement are declared completions; they do not enter the contract-conditional finite gauge implication. It remains an explicit premise on charged-lepton and quantitative selector/gap branches elsewhere. Physical unification requires a source-bound commuting square identifying its reconstructed compact group with the group acting through the Echosahedral current response:

$$\begin{array}{ccc}\mathsf{A5PortResponse}_r & \longrightarrow & G_r^{\mathrm{screen}} \\ \downarrow & & \downarrow\simeq \\ \mathsf{TransportableSectorCategory}_r & \longrightarrow & G_r^{\mathrm{DR}}.\end{array}$$

On those premises the abstract Lie-type agreement is exact. The physical vertical maps and the source identity of the two group actions are open. In the same way, the rank-three face band is a canonical candidate family carrier, while three physical generations require the complex rank-45 attachment and complement-complete refinement receipts. Any displayed three-generation value is a declared completion inside the conditional window, not a consequence of the icosahedral graph alone.

Finite controls and status boundaries

The finite A_5 evaluator control has 60 reachable correctable public records on $\mathcal{H}_k = \ell^2(A_5) \otimes \mathbb{C}^k$:

$$M_0 = 60, \qquad D_{\mathrm{raw}} = 60k, \qquad \Delta_{\mathrm{raw}} = 60(k-1).$$

Raw equality occurs only at $k = 1$. Publicly inert multiplicity makes D_{raw} implementation-dependent, so the result is an evaluator control rather than physical capacity closure.

The unified claim has a precise scope. Consensus, geometry/gravity, and gauge/matter are composable branches of one source-bound self-reading carrier tower. Its full quotient-visible architecture can constrain both branches; local icosahedral incidence by itself constrains only the local carrier route. The physical maps that turn those constraints into one inhabited universe are named premises. Matching dimensions or symmetry labels does not supply them.

Canonical Observer Language

An abstract observer patch is the algebraic object

$$\mathsf{O}_i = (\mathcal{A}_i, \rho_i, \mathcal{R}_i, \{(\mathcal{I}_e, \pi_{i,e})\}_{e\ni i}, \mathcal{U}_i, \mathrm{Chk}_i)\,.$$

Here $\mathcal{A}_i$ is the finite or regulated accessible algebra, ρ_i the accessible state, $\mathcal{R}_i$ the exact or approximate record algebra, $\mathcal{I}_e$ the overlap-visible interface algebra, $\pi_{i,e}$ the visible restriction, $\mathcal{U}_i$ the allowed update and repair instruments, and Chk_i the checkpoint data used for continuation.

A support patch, such as a cap $P_i \subset S^2$ or a causal diamond, is a geometric chart of the abstract patch on a geometric branch. A carrier patch is a physical or digital implementation that realizes the same visible interface and record statistics within a declared error. Echosahedral hardware is therefore a reference carrier architecture for a fixed-cutoff implementation surface. The physical claim lives at the quotient of visible records, interface statistics, repair maps, and checkpoint continuation.

The quotient removes presentation data such as coordinates, labels, worker layout, and hidden ancillas. Quotient-visible port number, oriented incidence, topology, and response maps remain physical branch data when the observer can recover them. Implementation invariance therefore does not imply carrier neutrality.

The observer patch is therefore the formal access structure used by the proof. A human observer, a horizon cap, and a hardware module can realize or chart it, but none of those examples is the definition. Physical predictions attach to quotient data: visible interface statistics, record readout, repair maps, and checkpoint continuation. A carrier implementation is admissible only when those data are invariant within its declared error model.

Definition 0.1 (Semantic observer history)**.** *For an observer token O, the observer-readable history is a labeled causal poset*

$$\mathsf{H}_O = (E_O, \preceq_O, \ell_O).$$

The elements of E_O are semantic record events, $\preceq_O$ is physical or informational dependence, and ℓ_O is the observer-visible event label. Event identity is derived from the canonical semantic payload, observer token, visible footprint, and semantic causal parents. It is not derived from worker ID, repair iteration, queue position, retry counter, timestamp, or packet latency metadata. Latency is execution gauge only when it does not alter semantic causality, delivered data, timeout-sensitive operations, or operational clock records.

Definition 0.2 (Observer registry groupoid and namespaces)**.** *Observer identities live in a registry groupoid, not in a flat UUID table. Objects are observer tokens*

$$\mathrm{RID}(O) = (\mathrm{kind}(O), [\mathrm{birth}(O)]_{\mathsf{H}}, \mathrm{lineage}(O)),$$

where $\mathrm{kind}(O)$ *lies in the disjoint namespace*

$$\{\textit{patch observer},\ \textit{cap observer},\ \textit{future observer}\}.$$

The birth event is a semantic event class in H*, and lineage is carried by explicit continuation, split, and merge arrows. Local registries on overlapping presentations must preserve observer kind, birth event, lineage arrows, visible observer structure, and checkpoint cuts. The global registry is the descent groupoid or colimit of those local registries when the cocycle and trivial-monodromy checks pass. A split creates child tokens with parent links; it does not silently assign one identity to multiple descendants.*

Definition 0.3 (Operational observer clock)**.** *The modular parameter of an observer-facing cap pair is not, by itself, an arbitrary operational clock reading. A clock claim supplies an observer-accessible instrument*

$$\Theta_O : \mathrm{Chk}_O(D) \to \mathrm{Prob}(\mathbb{R})$$

and a declared affine calibration law. For a corresponding observer O', the required finite or exact certificate has the form

$$\Theta_{O'}(\Phi_{O*}\rho) \approx (A_{a,b})_*\Theta_O(\rho), \qquad A_{a,b}(\tau) = a\tau + b,$$

with an explicit residual bound from state mismatch, calibration error, and record-readout error. Execution counters are provenance; observer record order, modular parameter, and clock uncertainty are separate semantic or operational fields.

Remark 0.4 (Observer-clock naturality gate). *This paper proves observer-first quotient and readback claims only where the cited theorem surface supplies the required data. Scheduler-independent observer history and clock naturality require a history-augmented quotient relation with history-coherent diamonds, registry descent, state-preserving observer-algebra extraction, support-cap chart naturality, and the operational clock instrument above. A public evidence bundle can falsify the claim by showing counter-dependent semantic event keys, duplicate or namespace-colliding registry identities, broken registry cocycles, non-isomorphic semantic history DAGs across executors, or clock residuals exceeding the declared bound. Implementation field names alone are not the proof.*

This definition leaves the primitive observer size open. The axioms require finite or regulated access at fixed cutoff and permit connected support regions with different finite or regulated algebras. A primitive observer may therefore be a variable finite federation of screen cells. The stronger claim that elementary carriers are isomorphic fixed-capacity cells would require a separate branch: homogeneous UV cellulation, isomorphic local cell algebras, equivariant overlap maps, refinement preservation of the cell type, and a proof identifying one cell or a fixed block of cells with the primitive carrier. One Echosahedron is therefore a candidate primitive carrier on the homogeneous branch. It is not the definition of an observer patch.

Failure Tests

OPH is wrong as stated if a load-bearing theorem admits a counterexample under its declared assumptions, if the controlled modular/Einstein branch cannot be instantiated under physically realizable conditions, if the declared three-generation or sector completions are contradicted inside their stated class, if a quantitative closure is nonunique or target-leaking, or if a physical implementation shows branch-essential dependence on hidden carrier presentation after visible quotient data are held fixed. Concrete falsifiers include failure of a displayed Maxwell, pure-Yang–Mills, or pure-Einstein quadratic kernel to have its stated transverse or transverse-traceless (TT) classical mode under all of that theorem's action/background/phase hypotheses; failure of a claimed quantum pole after its full quantization and spectral receipt is supplied; an observed low-energy X/Y-type $(3, 2, \pm 5/6)$ gauge generator on the realized product branch; a fourth light matter generation in the realized low-energy branch, which would falsify the declared three-generation completion and its window rather than the axioms; nonunique $P_\star$ or N_{CRC} closure; a failed fixed-cap entropy-to-Einstein tensor upgrade; or carrier-dependent observables after the visible interface is held fixed. A failed continuation does not erase the recovered core unless that continuation is one of the stated parents of the core claim.

Contents

1 Introduction

Observer-Patch Holography asks how much of physics is forced once the world is described from the inside. No observer has access to a view from nowhere. In the idealized description there is a shared screen net, often charted by S^2, but each finite observer has access only to a local patch P_O of that net. The observer carries records inside that patch and can compare only the observables shared with neighboring patches. OPH takes that comparison rule literally: where descriptions overlap, they must agree. Thus an "observer screen" is an operational access cut, not a private physical sphere assigned to the observer.

The formalism used here is deliberately quantum-algebraic. Patches carry algebras and states, record events use the trace/Born rule on their declared operator surface, and the gravity branch uses generalized entropy. OPH's theory-of-everything claim is that the observed effective universe can be recovered from this axiom set and its stated branch conditions if the framework is correct. The reconstruction may use declared standard mathematics and branch hypotheses without treating those ingredients as hidden empirical constants.

The computational interpretation has a sharp boundary. A conventional simulation evolves surrogate universe states,

$$U_t \longrightarrow U_{t+1} \longrightarrow U_{t+2} \longrightarrow \cdots .$$

OPH uses a fixed-point computation, but the equation alone is not the definition of simulation. In the fundamental description there is no global timeline on which the contents of spacetime are updated. The readback-and-repair operator acts on observer-readable world candidates and selects a stable solution

$$\mathcal{T}(W) = W.$$

The companion consensus paper [4] defines an OPH simulation by five independent clauses: recovery-derived endogenous update, nontrivial quotient-readable records, strict overlap-repair descent with a schedule-independent normal form, elimination of a proper candidate basin in the selected boundary/sector fiber, and implementation/clock closure. Its simulation theorem proves that the selected finite OPH packet meets those clauses under the stated boundary and record hypotheses and then derives the fixed-point equation. The same theorem gives an identity-map/constant-functional counterexample, so an ordinary equilibrium is insufficient as a simulation.

The local readout of the selected normal form supplies an internal record history, not by itself a physical clock. Operational time requires an observer-readable transition process, event correspondence, and affine calibration; it is not the external update parameter. In OPH, "simulation" means this certified observer-facing self-consistency structure, not a bare fixed point and not a frame renderer. The executable OPH-FPE simulator and its finite-run receipt bundles are a separate public evidence surface for finite OPH experiments [12]; they do not replace the theorem-level definition above.

The effective bulk is reconstructed from compatible screen data. Locality comes from the way collars control recovery across patch boundaries. Gauge freedom is the freedom to change the local description without changing any shared observable. Records are the stable parts of a patch that can be checked by other patches. Inside the declared tensor category, matter is the charge and excitation content that survives the certified transport and fusion tests. Completeness of the physical light sector remains a separate source-grammar and laboratory attachment problem.

The first major result is spacetime kinematics. Modular flow on screen caps becomes geometric, and the compact cap-normal theorem identifies a sky direction with $q(\Omega) = (1, \Omega)$, represents an oriented round cap by $n_C = (\cot\alpha, \csc\alpha\, \mathbf{c})$, proves $\eta(n_C, q(\Omega)) = 0$ exactly on the cap boundary with the interior/exterior sign rule, and gives $n_{gC} = \Lambda_g n_C$. Future unit observer frames then form $H^3 \simeq \mathrm{SO}^+(3,1)/\mathrm{SO}(3)$, exactly three-dimensional. A cap determines an H^3 plane/half-space, not an event position or populated bulk. On the conditional frame-response branch, quotient-visible record tokens whose calibrated modular cap responses factor through frame-local H^3 data admit exact frame identification and stable finite-noise frame estimates. The finite frame radius is $R_H[(L/\alpha)\varepsilon + (2/\alpha)\sigma]$ for exact net minimization, with a positive residual gap required before a unique finite frame value is reported. Event location requires the separate affine translation and ancestry receipts of the event-manifold branch. Generalized entropy at fixed cap then gives a tensor first-variation relation in the large-scale regime. The absolute Einstein equation additionally uses one source-derived common-domain tower with uniform asymptotics, universal coupling, a vacuum reference, and independent scale readouts; construction and certification of that tower are work in progress. The proposed cosmological capacity relation is $\Lambda_{\mathrm{CRC}} = 3\pi/(GN_{\mathrm{CRC}})$. The Gibbons–Hawking entropy and the Planck-2018 late-time de Sitter benchmark give a concrete normalization [26, 28]: with $R_{\mathrm{dS}} \simeq 1.66 \times 10^{26}\,\mathrm{m}$ and $\ell_P \simeq 1.616 \times 10^{-35}\,\mathrm{m}$, the bare horizon ratio is $N_{\mathrm{patch}} = (R_{\mathrm{dS}}/\ell_P)^2 \simeq 1.05 \times 10^{122}$, the entropy capacity is $N_{\mathrm{scr}} = S_{\mathrm{dS}} = A_{\mathrm{dS}}/(4\ell_P^2) = \pi N_{\mathrm{patch}} \simeq 3.31 \times 10^{122}$, and $\Lambda \ell_P^2 \simeq 2.85 \times 10^{-122}$. OPH uses N_{scr} for the Gibbons–Hawking entropy capacity and N_{patch} for the bare horizon area ratio. The proposed input-free closure begins at finite cutoff with a frozen carrier dimension D, the unclosed terminal quotient fiber, local and interface record atoms, compatible public global sections, endogenous reachability, a frozen publicness policy, and the globally coupled semantic checkpoint kernels. Their compound confusability graph G_q gives the exact finite readback

$$M_0(q) = \alpha(G_q).$$

This correctable-code capacity includes joint checkpoint compatibility and confusability. A cyclic checkpoint can preserve every label while fixing only constant functions, and equal local marginals can hide different joint capacities. The first producer is the set

$$\mathfrak{F}_{r,\varepsilon}(D) = \{M_\varepsilon(q) : q \in \widetilde{\Omega}_{r,D}\}.$$

A scalar exists only when the whole nonempty terminal fiber agrees. A faithful capacity-carrier representation gives $M_\varepsilon \leq D$; exact equality means a complete rank-one public record basis. If the scalar exact map is total, monotone, and deflationary on a declared finite chain, top-down iteration reaches its greatest fixed point. The official universe-level cosmic record-closure equation and its selector-free finite implementation are

$$N = \log M_0(\mathfrak{U}_N), \qquad \mathfrak{F}_{r,0}(D_\star) = \{D_\star\}, \qquad N_{\mathrm{CRC}} = \log D_\star.$$

The finite public-section, correctable-code, boundary, scalarization, order, extension, refinement, and sewing implications can be proved from the stated data. They do not select a cosmic value: $M(D) = D$ and $M(D) = 1$ are both compatible with monotone deflation. The remaining source constructions are the record-atom restrictions, endogenous reachability, publicness policy, global checkpoint coupling, capacity-carrier representation, whole-fiber scalar producer, confusability-reflecting extension and refinement packets, and an exact finite-size slack law

$$s(D) = \log D - \log M_0(D)$$

with one physical zero. Two physical identifications remain afterward: the correctable-record carrier must be identified with the de Sitter horizon record for the de Sitter area law, and the screen load must be identified with the electroweak load by a positive, unital, refinement-natural map for the electroweak bridge. An independently produced operational scale is a commuting-square test of the code capacity, not its definition. The electroweak bridge supplies a mathematical candidate of about 3.532×10^{122} only after the common-load receipt. The Planck–Λ central read-off is about 3.313×10^{122}, which is about 6.6 percent below the bridge candidate. The joint Planck posterior, propagated through the Λ-to-N map across three degeneracy routes, places the gap at 2.4 to 2.5 one-dimensional standard deviations under the consumed likelihood combination and 3.8 to 3.9 under Planck+BAO, so the combination freeze is part of any future test registration; a final statement requires the closed premises. Thus neither the physical fixed-point identity nor the cosmological display $\Lambda_{\mathrm{CRC}} = 3\pi/(GN_{\mathrm{CRC}})$ is established by the bridge calculation.

The second result is a finite Standard Model recognition package. Incidence expresses J as a polynomial in adjacency. A target-blind impulse and port readback derive $R = -J$, whose relative sector pattern on $\mathbf{1} \oplus \mathbf{3} \oplus \mathbf{3}' \oplus \mathbf{5}$ is exact. Under the declared fermionic Spin category, the anomaly and tensor-descent calculations give the maximal faithful matter image

$$\mathrm{SU}(3) \times \mathrm{SU}(2) \times \mathrm{U}(1)/\mathbb{Z}_6.$$

This conditional gauge conclusion uses the stated premises alone. The matter theorem fixes exact hypercharge and a three-color carrier. The scalar scan fixes compatible charges and Yukawa channels, not scalar multiplicity. Physical matter typing and global-form selection are open. Separately, the CKM and weak-sector conditions give $3 \leq N_g \leq 5$; the count inside that window is an open physical attachment carried by a declared completion. The packet also gives integer charge for color singlets and the absence of the simple-GUT X/Y gauge channel. The canonical rank-three screen band remains a candidate family fiber until the physical rank-45 attachment receipt is supplied. On a declared trace-balanced block carrier $V = C \oplus W$, with dimensions $3 + 2$ and hypercharges $(-1/3, 1/2)$, the exact exterior package $\Lambda^2 V \oplus \Lambda^4 V$ branches as one fifteen-state Standard Model generation, supports the three one-Higgs invariant lines, cancels all five listed perturbative gauge and mixed anomalies, and has weak-doublet multiplicity $3+1 = 4$ with even Witten parity. This is an exact source-bound current theorem and a conditional finite representation theorem. Laboratory identification of its current, selection of a physical global form and line spectrum, equality with the independently reconstructed Tannaka current, extra-light-sector exclusion, rank-45 family attachment, scalar dynamics, genuine 1PI realization, and continuum QFT are open. The subsequent QFT landing is a typed graph: exact finite quantization and formal perturbative quantization are parallel descendants of the finite local action, while the nonperturbative continuum requires its own observable tower; the conditional implications are explicit, but the OPH-native producers are open. The selected exterior package is not the full even Clifford module, because $\Lambda^0 V$ is omitted. On separately stated Maxwell, perturbative/deconfined Yang–Mills, and pure-Einstein action/phase branches, the quadratic reductions have the corresponding classical null carrier modes. Photon, gluon, or graviton particle claims require the additional physical-Hilbert-space and spectral-pole receipts.

The third result is quantitative and sits outside the recovered core. Its primary equation closes one local observation cell on its own electromagnetic readout:

$$P = \varphi + \frac{\sqrt{\pi}}{A_T(P)}, \qquad A_T(P) = \alpha_{\mathrm{em}}^{-1}(0; P).$$

The outside reading is the normalized pixel detuning $(P - \varphi)/\sqrt{\pi}$. The inside reading is the Thomson-limit coupling emitted by the same trial cell. The contraction-based theorem gives existence and uniqueness on a closed interval. Outward-rounded interval certificates verify the concrete hypotheses, enclose one root for each declared map, and exclude a second root across the full analytic domain. No measured value is inserted into either solve. The source-derived same-scheme hadronic transport is required before a declared-map root can be identified with the physical Thomson endpoint.

The secondary global extension uses the exact finite correctable-record capacity $M_0(q) = \alpha(G_q)$ and the universe-level equation $N = \log M_0(\mathfrak{U}_N)$. Its finite public-section, carrier-bound, scalarization, order, and refinement implications are conditional theorems. The physical checkpoint packet, whole-fiber scalar producer, unique finite-size slack zero, horizon identification, and common screen/electroweak carrier are work in progress. The Planck–Λ central capacity 3.313×10^{122} and the conditional electroweak value 3.532×10^{122} are comparison coordinates. Their 6.6-percent difference does not enter the construction of the direct capacity map.

The local pixel coordinate and independent scale certificate are

$$P := \frac{a_{\text{cell}}}{\ell_\star^2}, \qquad \gamma_\star = \frac{\ell_\star \nu_{\text{Cs}}}{c}, \qquad B_\star = \frac{3\pi}{\ell_\star^2}.$$

If the two declared-map outputs acquire their missing physical identifications, $P_\star$ and N_{CRC} fix $\Lambda_\star \ell_\star^2 = 3\pi/N_{\text{CRC}}$ and $\Lambda_\star a_{\text{cell}} = 3\pi P_\star/N_{\text{CRC}}$. They fix the dimensionless geometry. The selected scale certificate supplies the SI scale product $B_\star = \Lambda_\star N_{\text{CRC}} = 3\pi/\ell_\star^2$. The selected scale certificate does not construct the cosmic readback map or remove the 6.6-percent central-value mismatch. Under those same identifications, the pixel $P_\star$ together with the Λ-located working capacity $N_\Lambda = 3.31 \times 10^{122}$ fixes a canonical geometric pixel area and a total geometric cell count on an equal-area screen chart,

$$K_{\text{cell}} = \frac{A_{\text{screen}}}{a_{\text{cell}}} = \frac{4N_\Lambda}{P_\star} \simeq 8.12 \times 10^{122}.$$

This count is a measured-side comparison display and does not enter either closure. At the conditional bridge capacity the same chart count reads 8.66×10^{122}. The result supplies a geometric chart count. It does not choose a primitive observer capacity. The quantity $P_\star/4 \simeq 0.408$ nats, or about 0.588 bits, should not be read as $\log \dim \mathcal{H}_{\text{cell}}$ for an autonomous tensor factor. OPH capacity lives on shared cuts, edge centers, and constrained overlap data; adjacent geometric pixels are not assumed to factor into independent Hilbert components. No fixed primitive observer algebra follows from $P_\star$ and N_{CRC} alone. The no-G burden of the scale proof record is the clock hierarchy. The first load-bearing object must be a strict source-root proof for $\alpha_U(P_\star)$; the source-audit branch is only a witness. After that, the cesium gap $\varepsilon_{\text{Cs}} \sim 10^{-33}$ must be emitted by source-side electroweak transmutation, QCD/hadronic data, flavor and nuclear data, and a cesium hyperfine spectral readout, with no dependency path from measured gravity or any calibrated electroweak or gravity scale. The public α_U record is a one-dimensional comparison-branch fixed-point certificate, evaluated at the CODATA-located comparison pixel $P_C \simeq 1.6309682094$:

$$\begin{aligned} \alpha_U(P_C) &= 0.041124336195630495, \\ \frac{v}{E_\star} &= 2.0199803239725553 \times 10^{-17}, \end{aligned}$$

and the Krawczyk image of $[0.041123336195630494,\ 0.041125336195630496]$ lies strictly inside that interval. The source-side diagnostic branch excludes the public Thomson endpoint upstream. Its certified forward pixel is $P_{\text{fwd}} = 1.630972095858897\ldots$. That source branch is a witness, not a full endpoint proof; it does not supply the strict interval root for the Ward-projected self-map. The dimensionless formula is the strongest clean hierarchy statement. It does not supply an independently physical $E_\star$, a mass in GeV, or a complex propagator pole. The full SI gravity row requires the full set of cesium-clock source records. The QCD and hadronic weakpoint is narrow. The low-energy Thomson endpoint and the cesium-clock display require confined-quark and nuclear source payloads that the first-principles trunk in this paper does not emit. For a source-only

Thomson endpoint, the missing object is the source-derived hadronic spectral hadronic backend: source QCD parameters, a quotient ensemble, finite Euclidean vacuum transfer, Ward-normalized electromagnetic currents, the two-current spectral marginal, same-scheme remainder, systematics, and no-target-leak receipts.

Four fine-structure coordinates must be kept separate. The source/root audit records the undressed declared-map witness $\alpha_{\mathrm{root}}^{-1} = 136.994835177413\ldots$ (interval-certified unique fixed point of that numerical map, with enclosure width 7.2×10^{-24}). The declared map is incomplete: no derivation identifies this root with a physical fine-structure endpoint. Adding the finite-screen unified gauge-width contribution at the CODATA-derived comparison pixel gives the mixed-provenance, no-hadron diagnostic

$$A^{\mathrm{fp}}_{\alpha_U} = 137.0359595136\ldots.$$

The certified self-consistent gauge-width fixed point is $\alpha^{-1} = 137.035660136946577\ldots$. The mixed diagnostic $137.0359595136\ldots$ combines the inner value at P_{fwd} with α_U at the CODATA-derived comparison pixel, is not a fixed point of any single declared map, and is excluded from the physical output ledger. An executed empirical closure, using external $e^+e^- \to$ hadrons spectral data, records

$$\Delta\alpha^{(5)}_{\mathrm{had}}(M_Z) = 0.027609 \pm 0.000112, \qquad \alpha^{-1}_{\mathrm{emp}}(0) = 136.3827548175$$

with interval $[136.3670480603, 136.3984651934]$. The measured endpoint value $137.035999177(21)$ for $\alpha^{-1}(0)$ lies outside that interval. The resulting same-scheme anchor correction is $[0.6198609041, 0.6505569679]$ inverse-alpha units; the standard on-shell reference deficit 0.631 and the exact closure value 0.6379 both lie inside it, and their difference is the live scheme term of the open anchor bridge. This empirical payload tests the endpoint map and exposes the missing contribution; it does not supply a source-only OPH hadron law. The two-current spectral measure covers the running-α/HVP marginal. HLbL and rare-decay rows require higher-point and transition spectral sectors from the same source law. For that reason the compact quantitative stress test is the hierarchy row above: it avoids the public Thomson endpoint, G, Λ, W/Z, Higgs mass, hadronic payloads, and the cesium clock.

The same hierarchy exponent has a local/global capacity form:

$$\frac{v}{E_{\mathrm{cell}}} = \left(\frac{N^{\mathrm{EW}}_{\mathrm{CRC}}}{\pi}\right)^{-P_\star/12}, \qquad N^{\mathrm{EW}}_{\mathrm{CRC}} = \pi \exp\left[\frac{6\pi}{P_\star \alpha_U(P_\star)}\right].$$

This is the electroweak bridge capacity, about 3.53235×10^{122} on the declared comparison branch at P_C; the interval-certified value at the forward pixel P_{fwd} is $3.5321315434 \times 10^{122}$. Identifying it with the cosmic capacity requires the source-derived correctable-public-record producer and the common screen/electroweak load-carrier identification. The Planck-Λ central capacity, about 3.313×10^{122}, is lower by about 6.6 percent. The factor 12 has a branch-specific geometric reading. On the declared echosahedral carrier lineage, twelve equal-trace primitive central port atoms and the integer defect fiber $\sum_p q_p = 12$ give the source readback cost $H(q) = \sum_p q_p^2$. The identity $H(q) = 12 + \sum_p (q_p - 1)^2$ uniquely selects one unit per port with exact gap two. Oriented $(12, 30, 20)$ incidence then derives the unique graph-distance three antipode, six axes, proper automorphism group A_5, and the canonical rank-three icosahedral Gram frame. Edge-center collars expose the defects as central ports. Reversible write/check orientation gives an oriented 24-slot screen register. Independently, the product adjoint has count $m_{\mathrm{rep}} = 2(8+3+1) = 24$. Their equality is bookkeeping and supplies no load or clock. The exterior matter package gives the exact four-copy weak multiplicity; attaching that multiplicity to the physical screen load remains an explicit hypothesis.

The oriented coefficient module is

$$P_{12} \cong_{A_5} \mathbf{1} \oplus \mathbf{3} \oplus \mathbf{3}' \oplus \mathbf{5}.$$

For the six antipodal axes, the exact frame maps split the even and odd modes, and the outward faces orient the complementary triplet. Pulling the block commutator back through

$$\Theta(b + d_G + d_W) = \left(\kappa_E(\tfrac{1}{2}Ud_G) + i\Phi(b), \kappa_W(d_W)\right)$$

constructs

$$(P_{12}, [\ ,\ ]_\Theta) \cong \mathfrak{u}(1) \oplus \mathfrak{su}(3) \oplus \mathfrak{su}(2)$$

with center $\mathbf{1}$, derived dimension eleven, and a noncentral $\mathbf{5}$. This bracket acts on coefficient fluctuations; the central record projectors commute. Incidence expresses the antipode J as a polynomial in adjacency, and target-blind port readback derives $R = -J$. The four resulting nonzero equivariant coefficients give an injective realization with a positive Hilbert–Schmidt pullback, A_5 covariance, inner action, and algebraic refinement naturality. The simulator producer executes a target-blind maximal-distance impulse/readback protocol, and the port-current certificate recomputes the incidence polynomial and sector signs independently. This is an exact finite source-model result. Physical carrier attachment, laboratory identification with measured Standard Model currents, and the intertwiner to the independently reconstructed Tannaka current are separate gates.

Anomaly freedom of the declared fifteen-state module forces the determinant balance, and primitive integrality fixes the charge pair $\pm(-1/3, +1/2)$; the common sign is charge conjugation. This completes the conditional map to $\mathfrak{s}(\mathfrak{u}(3) \oplus \mathfrak{u}(2))$, whose connected group is

$$S(U(3) \times U(2)) \cong \frac{SU(3) \times SU(2) \times U(1)}{\mathbb{Z}_6}.$$

The exhaustive tensor-kernel computation and Smith invariants independently fix the same $\mathbb{Z}_6$ quotient on those tensors and compute its character/cocharacter arithmetic. The determinant balance, the measured non-split Spin lift, the central embedding, and the refinement descent are receipt-checked; the rank-15 matter object is selected by the exhaustive 1024-subset anomaly scan with the fermionic-parity grading as an output, and the measured deck, six-axis, and flux-sector data attach the $\mathbb{Z}_6$ descent at finite source-model scope. Hypercharge, chiral content, and this tensor quotient come from the stated premises within the chain. Scalar existence and multiplicity, four-dimensional instanton sectors and theta periodicity, laboratory current identification, the rank-45 family attachment, and continuum QFT are open.

The finite algebra establishes the positive twelve-term sum-to-twelve unit split, abstract matrix commutator, dimension $9 + 3$, a matrix noncentrality witness, the six-axis lattice quotient, and the B_6 arithmetic. On the declared echosahedral lineage, the source-derived central readback and oriented incidence also establish the strict unit cost and gap, inverse pairing, proper A_5 action, rank-three port frame, and refinement/relabeling naturality. This does not derive the echosahedral carrier from arbitrary OPH data. The noncentral current lift, trace-balanced group, Spin/deck descent, and one-generation matter calculation are exact conditional on the response and matter contracts. Physical source binding, laboratory current identification, equality with the Tannaka current, scalar multiplicity, physical three-family attachment, and continuum QFT are open. The face-C_3 representation theorem gives a three-dimensional minimal extension; physical family attachment is work in progress. See Refs. [2, 3].

The Standard Model gauge paper packages this quantitative surface as a source-certified compression test. A row counts in the accidental-hit estimate only when its declared source map has no dependency path from the measured target or a calibrated proxy. If p_i bounds the conditional accidental-hit probability for row i after the preceding accepted rows, then

$$P_{\mathrm{acc}} \le \prod_i p_i.$$

The closure ledger records the qualifying rows, including the structural gauge-boson zeros and the clause-conditional hypercharge lattice. Any compression claim cites those declared settings and landed basins. The proof load is the fixed-point maps, uniqueness certificates, source records, and falsifiers.

The declared map for P gives the same screen cell two readings. From outside, the cell sits a little above the exact self-similar entropy balance point $\varphi = (1+\sqrt{5})/2$. From inside, the same cell appears as the smallest electromagnetic observation step available in the encoded world. The unique source-map root defines the local closure coordinate. The measured fine-structure constant tests the resulting electromagnetic endpoint and does not enter the solve. The physical low-energy relation requires the unconstructed same-scheme hadronic spectral transport.

The named P branches organize the electroweak carrier chart, the low-energy electromagnetic endpoint, the conditional Higgs/top surface, the rejected reciprocal-ray and register-Clebsch quark candidates and the six-coordinate physical quark interface, a target-informed weighted-cycle neutrino comparison candidate, and the local cell/edge consistency used by the gravity readout. The hierarchy theorem fixes $v/E_\star$. An independent physical $E_\star$ and the separate pole receipt govern any mass in GeV. The gravity normalization itself comes from $\ell_\star^2$, and P cancels in the Newton area-law readout. The support table records the distinct electroweak chart, conditional law, and inverse target adapter, the target-informed charged-lepton candidate, the NuFIT 6.1 rejection of the neutrino candidate, its tautological declared-basis transport and missing physical charged basis, and the hadron construction [13].

The fourth result is implementation. The screen-microphysics construction makes patches, overlaps, edge observables, records, repair maps, and observer checkpoints explicit at finite cutoff through a federated patch-carrier architecture. OPH has a regulated observer-and-record surface on which the basic consistency machinery can be written directly.

The three axioms, in words. The theory uses three axioms.

- **A1 Oriented twelve-port observer screen.** An observer patch net exists on an oriented spherical screen: at every finite resolution each local carrier has twelve primitive boundary ports forming the vertices of an oriented triangular boundary with 30 edges and 20 faces, combinatorially the boundary of an icosahedron; carriers join through typed seams and coherent triple overlaps, refine to an oriented spherical support, and expose local state, readback, records, repair moves, and checkpoints.

- **A2 Observer agreement.** Observers operating on the screen agree on the meaning of the data they jointly interpret.

- **A3 Conditional maximum randomness.** Everything that observer agreement leaves unconstrained is maximally random: the realized state is the information projection of an exact reference onto the constraint set that agreement fixes.

The formal statements are shared with the spacetime and gauge derivation papers [2, 3]. Collar recovery, generalized-entropy structure, and sector completions are not axioms; they enter as named interfaces and declarations at the results that consume them. These axioms define a quantum-algebraic starting point. Quantum mechanics and quantum field theory are treated as effective descriptions carried by the deeper observer-patch architecture, not as structures whose use here depends on first deriving every mathematical ingredient from operational records alone.

The quantitative selection chain. Self-reading, overlap consensus, modular geometry, transportable charge, entropic gravity, and stable records define the structural branch. They do not prove that the branch is inhabited, force the icosahedral screen-to-Standard-Model attachment, or construct the global capacity packet. The two closure equations test independently produced local and global readback maps. If both equations hold with the declared selection rules, the branch admits at most one coordinate pair (P, N). This statement does not prove that exactly one physical universe exists. The local uniqueness certificate gives existence and uniqueness on its certified interval, and the domain-global certificate bounds $\sup |g'| < 1$ on every piece of a 256-piece subdivision of the declared numerical domain ($\alpha^{-1} \in [100, 200]$, both readout maps, empty exceptional set), so each declared readout map has exactly one fixed point on that domain. This certificate does not derive a physical endpoint relation for the incomplete declared map. The global uniqueness claim has a proved conditional implication layer and a physical execution that is work in progress. Public global sections, zero-error graph capacity, approximate stability, the carrier bound, whole-fiber scalarization, greatest-fixed-point order theory, and exact refinement stabilization are finite implication theorems. A source-derived fixed-cutoff simulator packet at $D = 24$ verifies the finite evaluator contract inside its declared source category. Execution of the physical universe-level map needs that packet's physical attachment, capacity-carrier representation, confusability-reflecting embeddings, and an exact finite-size slack law with one physical zero. The de Sitter and electroweak consequences then require the horizon–record identification and the common screen/electroweak load-carrier identification, respectively. The operational resolution experiment is an independent test, not the producer. The certified value $3.5321315434 \times 10^{122}$, evaluated at the forward pixel P_{fwd}, is a solution of the declared bridge equation, not of the unconstructed direct public-record producer; it is about 6.6 percent above the Planck–Λ central coordinate 3.313×10^{122}. The two electromagnetic endpoint residuals have no valid target-blind score: the exposed target conflates total and residual coordinates, and no active decision threshold exists. A valid test requires a complete method frozen against genuinely withheld data or an audited clean-room producer.

The synthesis surface gives the operational picture first, then places the technical proof machinery after the reader has the construction in hand.

2 Main Results

The OPH papers support the following unified picture.

2.1 Proof, witness, and receipt map across the paper stack

The stack uses three distinct jobs. A paper theorem proves that stated finite or analytic premises imply a conclusion. A simulator or source construction produces the premises on a declared refinement tower. A receipt records enough public data for an independent verifier to check that the produced object satisfies them. A successful finite run does not replace an implication proof, and an implication proof does not construct its physical source object.

Owning surface	Paper theorem	Source object and current gate
Consensus protocol	Semantic-dependency-complete transactions with one coherent canonical union-collar aggregate per conflict component satisfy the local diamond. Descent, this diamond, and repair completeness give a schedule-independent quotient normal form. Coherent recovery squares and pentagons give parenthesization-independent collar gluing.	The engine supplies functional supports, read/write closures, aggregate payloads, protected and history data, repair completeness, and concrete finite peaks. Atomicity without semantic closure fails on a two-bit protected-observable countermodel; pairwise collar compatibility without coherent union data fails on parity and GHZ countermodels.
Compact relativity and gravity	Event germs form the base while H^3 remains the local frame fiber. Finite oriented four-ball degree and two-sided metric control imply open four-dimensional charts. A convergent symmetric form with a spectral margin and two-sided causal classification has Lorentzian inertia. $C^{1,1}$ tetrads give the metric regularity used by the curvature lane. Proper time is chart invariant, while clock comparison between worldlines requires an explicit event correspondence and calibration cocycle.	The source tower supplies event equivalence and pseudometric data, finite chart maps and degree, quadratic-form samples, tetrads and inverses, causal tests, clock correspondences, calibration cycles, and their refinement moduli. The mixed Gelfand–Naimark–Segal common-comparison packet MGNS-1 is an independent producer assumption on the same tower; neither local MaxEnt nor refinement supplies it.

Owning surface	Paper theorem	Source object and current gate
Screen microphysics	Exact finite coarse graining sends modular potentials through log-sum-exp. A faithful equilibrium state leaves the reversible generator underdetermined. Rate affinities, the weighted graph Hodge split, entropy production, and a convention-fixed finite KMS jump theorem give the equilibrium operator layer. The $A_5 \times \mathbb{Z}_2$ register has an eight-parameter self-adjoint commutant, its twelve-port commutant is generated by icosahedral adjacency, and it admits no equivariant directed 24-cycle. A source-derived 24-channel realization carries the edge modular grading exactly when its channel-closure residual vanishes; with A_5 and reversal covariance, the compressed spectrum has sign-paired $1, 3, 3, 5$ degeneracies, while the four gap values remain source-rate data. On the certified echosahedral lineage, local port incidence also derives the twelve unit lines, inverse pairing, proper A_5 action, and rank-three frame.	The source supplies coarse states or channels, conductances or rates, KMS frequency operators, positive rate matrices, the oriented channel map and its provenance, quotient lumpability, cycle-affinity, channel-closure, commutant, and refinement receipts. Register symmetry classifies finite operators only. It supplies neither a clock nor a physical gauge-current lift. Local icosahedral incidence does not produce the global federation nerve or its S^2 support receipts. Physical phase locking is a candidate implementation bridge to overlap repair; no theorem identifies it with transactional confluence, modular flow, or an observer clock.
Finite event algebra	For nonselective projective pinching, $S(\mathcal{E}\rho) - S(\rho) = D(\rho \| \mathcal{E}\rho) \geq 0$. This identity is separate from a normalized selective Lüders branch.	The projective partition and input state are finite source data. The entropy identity is an analytic matrix proof outside the current Lean export; the pinching and trace identities it uses belong to the machine-checked core.
Boltzmann transport	Convergence of the discrete generators to the null Hamiltonian vector field, vanishing carré du champ, tightness, and uniqueness of the limiting ODE imply deterministic Liouville transport. A limiting collision generator gives Boltzmann transport; nonzero limiting quadratic variation gives a diffusive limit.	The simulator supplies quotient-lumpable transition kernels, physical time steps, first and second conditional moments, mass-shell and boundary defects, and schedule/refinement-natural convergence. Path confluence alone supplies none of these transport limits.

Owning surface	Paper theorem	Source object and current gate
Particle and gauge sectors	The finite A_5 coefficient-space bracket and its declared charged-double-triplet response realization are source-bound by the simulator producer. Given the four measured signed nonzero coefficients, the certificate constructs a full-rank compact skew-adjoint current algebra, an inner A_5 action, and refinement-natural descent.	Laboratory identification with measured Standard Model currents and the intertwiner to the independently reconstructed Tannaka current are open. A register adjacency or modular generator cannot be relabeled as this current.
Yang–Mills gap	For the source-defined finite collar family, the finite-type Dobrushin/minorization theorem gives one positive projection/transfer-gap modulus uniform in location, boundary condition, system size, and the declared cofinal refinement tower. Removing locality or the stated mixing control admits finite countermodels with a collapsing gap.	The physical compact-gauge branch must produce the admissible collar types, transition matrices, uniform constants, refinement maps, reflection-positive vacuum, and continuum regularity packet. The finite theorem closes the repair-gap implication. The Clay-facing continuum construction is conditional on that source receipt.

This map is the status boundary used by the results below. The specialist papers own the detailed definitions and proofs. This synthesis owns the cross-paper dependency order and prevents a finite operator, receipt, or simulation trace from changing type as it moves between surfaces.

1. **Observers and records become physical objects.** Finite patches, shared overlaps, record algebras, repair maps, and observer checkpoints are represented on the screen as part of the construction.

2. **Spacetime is reconstructed.** On the controlled Einstein-branch geometry readout, the finite cap-normal Bisognano–Wichmann (BW) certificate (support-order faithfulness, BW framing, held-out oriented cross-ratio rigidity, and independently normalized geometric 2π-KMS (Kubo–Martin–Schwinger) convergence), together with the independent mixed-GNS common-comparison premise MGNS-1 on the same tower, makes the support-visible cap modular automorphism geometric and supplies Lorentz kinematics. Recoverable generalized entropy together with the null modular bridge, bounded-interval transport, fixed-volume small-ball area variation, admissible fixed-cap stationarity, and timelike tensor upgrade then supplies the Einstein relation on one source-derived common-domain tower with certified tails and independent physical identifications. The finite artifacts test algebra, evaluator logic, manifests, deletion rules, and synthetic controls. They do not certify such a tower. Its construction is work in progress. Bare finite consensus supplies only the upstream quotient-normal-form input. The screen-capacity branch proposes the dimensionless cosmological-constant relation below. The identification of its cosmic record-closure value with the electroweak bridge requires the common screen/electroweak load-carrier identification. A fixed-cutoff source-derived simulator packet exists at $D = 24$; its physical-universe attachment and the capacity-indexed public

checkpoint family are work in progress:

$$\mathfrak{F}_{r,0}(D_\star) = \{D_\star\}, \qquad N_{\mathrm{CRC}} = \log D_\star, \qquad \Lambda_{\mathrm{CRC}}\ell_\star^2 = \frac{3\pi}{N_{\mathrm{CRC}}}, \qquad \Lambda_{\mathrm{CRC}} = \frac{3\pi}{GN_{\mathrm{CRC}}}.$$

The last display uses the selected scale certificate $G_{\mathrm{geom}} = \ell_\star^2$. The Einstein-branch antecedent is instrumented end to end: a typed common-domain source tower with hash-bound provenance and cross-source splice rejection, and fail-closed instruments with adversarial negative controls for geometric modular normalization, GNS cyclicity and modular intersections, the ancestry-derived event cone, and same-source stress/coupling, together with semantic countermodels proving each receipt family load-bearing [12]. Two clauses are theorem-grade: coupling universality holds with zero spread for every icosahedrally equivariant source law, and generator positivity holds by construction on the declared law family. The Einstein-cone convergence ladder, measured at 16,384, 65,536, and 262,144 carriers with constant cross-observer coupling density, carries Lorentzian inertia $(1, 3)$ at every rung with the cone margin halving per rung and the coupling spread decreasing beside it; a density-control run degrades the signature on cue, isolating coupling density as the mechanism of cone merging. Primary data, per-rung configurations, and provenance commits are stored under `evidence/einstein_convergence` in the project repository. The cap-state modular temperature and the projected margin zero crossing are open measured targets with frozen verdicts. The bridge formula has a certified mathematical value near 3.532×10^{122}; the Planck-Λ central value near 3.313×10^{122} is lower by about 6.6 percent. A uniqueness certificate for the bridge formula does not establish the unique zero of the public-record slack or construct its physical checkpoint packet.

3. **The finite gauge chain derives the Standard Model current algebra from its stated premises alone.** Incidence and target-blind port readback derive the response and current algebra. The exhaustive selection scan fixes the rank-15 matter object with its fermionic-parity grading as an output, the measured transport double cover forces the Spin/odd-Weyl typing, and anomaly-forced determinant balance and exhaustive tensor descent fix exact hypercharge, a three-color carrier, a common $\mathbb{Z}_6$ kernel, and the maximal faithful matter image $(\mathrm{SU}(3) \times \mathrm{SU}(2) \times \mathrm{U}(1))/\mathbb{Z}_6$. The cover and its three nontrivial central quotients carry the same local tensors; the physical global form is selected at finite source-model scope by the measured flux-sector menu of the carrier federation, which matches exactly the $\mathbb{Z}_6$ quotient. The scalar scan fixes compatible charges and Yukawa channels, not scalar multiplicity. Within this gauge chain, the generation count and the extra-sector statement enter only as declared completions; charged-lepton and quantitative branches retain their separately stated declared premises. The same product structure gives the structural absence of the simple-GUT X/Y gauge channel. General proton stability is not implied. On the ordinary electromagnetic branch, the unbroken $\mathrm{U}(1)_Q$ factor reduces the compact-gauge curvature to $F_Q = dA_Q$; after separately assuming the low-energy Maxwell action and its nonzero kinetic term, variation gives $dF_Q = 0$ and $d{*}F_Q = g_Q^2 {*}J_Q$, i.e. Maxwell's equations after canonical electromagnetic normalization. The rank-three candidate screen band is not thereby attached to three physical families; that requires the separate complex rank-45 response, Spin/locality, residue, excluded-band, and refinement receipts. The transportable-sector/Tannaka route is a separate conditional compact-group classification. The finite response has a source-derived target-blind producer. Physical matter typing, identification of the finite current with the Tannaka current, and laboratory-current attachment are work in progress.

4. **The measured endpoint tests the local closure.** The comparison pixel $P_C \simeq 1.6309682094$ is inferred from the measured fine-structure constant solely for comparison:

$\alpha^{-1}(0) = 137.035999177(21)$, $\alpha(0) \simeq 0.00729735256433$. The forward model with the source anchor and Ward-projected electromagnetic transport measures the loop-closure residual: 3.0×10^{-4} relative on the source chain and 2.5×10^{-6} relative for the certified numerical gauge-width fixed point $\alpha^{-1} = 137.035660136946577\ldots$, a certified fixed point of the declared map with the Ward-projected hadronic transport open. The mixed-provenance diagnostic $137.0359595136\ldots$ is a fixed point of no single declared map and is excluded from the physical output ledger. The separate root $136.994835177413\ldots$ is an interval-certified output of an incomplete declared map; no derivation relates it to the physical fine-structure endpoint. The claim table records the source-side diagnostic trunk and endpoint residual.

5. **The framework has a regulated implementation surface.** The microphysics paper turns the observer language into explicit finite patch carriers, edge observables, records, and repair cycles.

6. **Edge sectors also admit two-dimensional Yang–Mills and worldsheet-style effective descriptions.** The heat-kernel edge partition function reorganizes the same boundary data into the two-dimensional Yang–Mills form, and on the declared large-edge branch this yields a controlled worldsheet effective description. This 2D bridge sits beside the Standard Model gauge paper's controlled compact-gauge repair-gap theorem. The string-vacuum selector uses this bridge only as the effective edge-language input; critical worldsheet closure, Bouchard-Donagi cohomology, operator-safety realization, threshold matching, and moduli locking are separate gates. The selector's rank certificate gives proxy rank zero on the published pre-completion slice and supplies no completed physical slice or Jacobian. The BD row is not a selected string witness, and the recovered OPH core is unchanged.

7. **The compact-gauge branch carries the 4D Euclidean Yang–Mills form and isolates the gap theorem.** On the declared controlled compact-gauge branch, with the four-dimensional scaling chart, reflection-positive ordinary vacuum, no additional gauge-invariant relevant dimension-four pure-gauge operator on that branch besides curvature squared, repair completeness, and the Standard Model gauge paper's explicit finite cylinder system in force, OPH proves projective weak-* / GNS extraction of a support-visible cylinder cluster family. Identification of that family with the Euclidean Yang–Mills action additionally uses the renormalized four-dimensional regularity/universality receipt. Weighted observation-fiber resampling is the finite conditional-expectation projector, with the noncircular matrix-recognition criterion of Ref. [1]. A concrete active repair law is identified with that projector only after its independently extracted transition matrix passes the support, equal-fiber-row, and weighted detailed-balance receipt. Identification of Euclidean transfer with the repair generator, vacuum persistence, and passage of a uniform finite-stage gap use the separate finite ground-state-transform, transfer/vacuum, OS-regularity/noncollapse, and uniform-gap receipts. The checked 244-type Ising collar table is an exact calibration of that finite receipt format, not evidence for the physical compact-gauge source family. Only on that certified branch is $\Delta_{\mathrm{YM}} = \Delta_{\mathrm{rep}}$. Weak-* extraction alone is not the Clay-facing axiomatic construction.

3 Physical Implementation and A_5/E_8 Significance

The implementation question is what must exist below the observer-level axioms so they have a physical carrier. OPH's answer is a fixed-cutoff federation of finite patch carriers. Each carrier exposes overlap ports, record registers, repair maps, and checkpoint interfaces. Three geometric objects must stay distinct. A local carrier boundary may have twelve-port icosahedral incidence. The federation screen is the finite federation and its overlap nerve. The support screen is the observer-facing S^2 chart produced from the repaired quotient only on the spherical receipt branch. The implementation is the finite algebraic machinery that makes compare, write, repair, and re-read operations available.

The term “sphere folding” has a restricted technical meaning in this stack. It is the observer-facing spherical presentation of the repaired quotient normal form:

$$\mathrm{Fold}_{S,r}(s) = \chi_{S,r}(n_r(\pi_r(s)))\,.$$

The quotient map removes hidden carrier presentation, the normal-form map performs accepted repair, and the spherical chart displays caps, collars, cuts, edge sectors, and boundary records. Folding is therefore the geometric face of overlap repair on the screen chart. On the consensus surface this repair is defined first as the quotient operator $\mathrm{Rep}_\lambda : Q \to Q$, with representative-level maps only serving as lifts, so hidden carrier labels do not become additional physical data.

Spherical geometry carries several pieces of the construction at once on the certified branch. An observer-accessible cut has a closed two-dimensional angular chart after the global support incidence, mesh, cross-ratio, and normalization receipts hold. Caps and collars on that chart supply the cut data used by modular flow, entropy variation, and overlap comparison. The orientation-preserving conformal group of the same S^2 chart is the celestial-sphere realization of $\mathrm{SO}^+(3,1)$, so the sphere is the kinematic bridge between finite screen cuts and the emergent $3+1$-dimensional Lorentz branch once the controlled cap-pair theorem is satisfied. Finite cellulations of the chart provide the regulator surface on which ports, edge sectors, and local comparison data can be made explicit; they are not by themselves a Lorentz invariant continuum.

The echosahedral carrier is a concrete local realization of the observer-patch interface. Its multi-port boundary supplies discrete directions, face and edge incidence, exposed readout channels, record slots, and repair channels. Recurrent toroidal subchannels can expose winding and phase-sensitive observables. A physical phase-locking law would have to produce the accepted overlap repair relation, its confluence receipts, and its noise bounds. That producer is open. Phase locking alone leaves BW modular ordering and operational clock calibration unproduced.

A federation of local icosahedral carriers does not automatically produce the global S^2 support screen. That step needs a quotient-visible carrier-to-screen map whose federation nerve has the spherical incidence receipt and whose cap data survive refinement. Local A_5 symmetry can therefore coexist with a nonspherical global nerve. The spacetime and Einstein paper’s topology countermodels mark this boundary.

The A_5 and E_8 labels mark different roles in that machinery. A_5-icosahedral symmetry is the local finite-screen language used when a patch carrier is made concrete: it organizes ports, faces, and overlap data with enough discrete symmetry to stabilize observer-facing cuts. E_8-type language is the exceptional closure language used by the high-symmetry branch. It names the root-lattice and affine exceptional structure in which the icosahedral data can sit. The term is representation-closure language for the branches that call for it.

One finite certificate lives on the E_8-side of that split. The $E_8/\mathrm{Spin}(8)$ triality sidecar gives exact matrices for an A_8 root subsystem inside E_8, the subgroup $\mathrm{Alt}(9) \subset W(A_8) \cong \mathrm{Sym}(9)$, its nonsplit $2{\cdot}\mathrm{Alt}(9)$ lift in $\mathrm{Spin}(8)$, and a positive half-spin image preserving an E_8 lattice. The vector and half-spin presentations have distinct $E_8/2E_8$ orbit fingerprints, $\{9, 36, 84, 126\}$ and $\{120, 135\}$, before $\mathrm{Spin}(8)$ triality fuses them. This is a finite exceptional representation-closure receipt. It is not a recovered-core theorem, a new particle or force, a heterotic edge-CFT proof, or hardware evidence.

This distinction matters for the synthesis paper. The physical claim lives at the observer-visible quotient: finite patches must expose the same records and shared observables after allowed implementation-hiding changes. The microphysics paper gives the concrete reference architecture for that quotient surface, including the federated patch-carrier model, fixed-cutoff edge heat-kernel/Casimir law, central-record/Born–Lüders measurement interface, Bell/CHSH event surface, and checkpoint/restoration package. See Ref. [5], available as the numbered GitHub reference in the bibliography.

The response/matter-contract finite route and the transportable-sector/Tannaka route are mathematically distinct. The first fixes the finite Standard Model Lie type and $\mathbb{Z}_6$ global form from the stated premises conditional on its explicit contracts; the second remains a conditional compact-group classification. Physical source binding of the first route and equality as one physical gauge-current object are open. The three-generation count and the extra-sector statement are declared completions on this lane. The local rank-three icosahedral band remains a candidate family fiber until the physical rank-45 attachment and symmetry-descent receipts exist.

Famous equations and structural outputs recovered

The table below maps headline formulas by logical role. Some rows are core theorem results, some are short corollaries of recovered actions, and some are standard limits once the parent OPH branch is established.

Recovered result	OPH role	Famous display	Support boundary
Three-dimensional observer-frame chart, Lorentz kinematics, and invariant light cone	core theorem	$q(\Omega) = (1, \Omega)$, $n_C = (\cot\alpha, \csc\alpha\,\mathbf{c})$, $n_{gC} = \Lambda_g n_C$, $H^3 \simeq \mathrm{SO}^+(3,1)/\mathrm{SO}(3)$	scaling-limit geometric subnet; chart population and neutral bulk are separate gates
Record-conditioned H^3 frame estimate	conditional theorem	$R_i(C,t,O) \to F(X_i) + e$, $\alpha\bar{d} \le \lvert F(X) - F(Y)\rvert_W$, $S_i(t) = B_H(\widehat{X}_i, r_i)$	frame-local calibrated cap responses, compact frame domain, bounded error, quantitative cap frame, and positive gap for unique finite output; no event position is inferred
Einstein equation	conditional composition theorem	$G_{ab} + \Lambda g_{ab} = 8\pi G\,\langle T_{ab}\rangle$	one source-derived common-domain tower with uniform asymptotics, universal coupling, a vacuum reference, and independent scale readouts; tower construction and certification are work in progress
Newton-Poisson gravity	inherited weak-field limit	$\nabla^2\Phi = 4\pi G\rho$, $\ddot{\mathbf{x}} = -\nabla\Phi$	absolute Einstein-branch premises, weak field, and slow motion
Maxwell equations	electromagnetic corollary	$dF_Q = 0, \quad d{*}F_Q = g_Q^2 {*}J_Q$	ordinary $\mathrm{U}(1)_Q$ branch plus explicit Maxwell action/current hypothesis

Recovered result	OPH role	Famous display	Support boundary
Yang–Mills equations	compact-gauge corollary	$DF = 0, \quad D{*}F = g^2{*}J$	compact-gauge connection branch plus explicit Yang–Mills action/current hypothesis
Born rule and Lüders update	fixed-cutoff theorem	$\mathbb{P}(E) = \mathrm{Tr}(\rho P_E)$, $\rho\vert_E = P_E \rho P_E / \mathrm{Tr}(\rho P_E)$	central record algebra
Tsirelson bound	fixed-cutoff theorem	$\vert S_{\mathrm{CHSH}}\vert \le 2\sqrt{2}$	Bell event surface
Charge quantization	core theorem	$Q = T_3 + Y$, color singlets have $Q \in \mathbb{Z}$	quarks are confined fractional-charge fields
Classical carrier-mode poles	conditional action theorem	$K_X^{\mathrm{phys}} \propto (\omega^2 - c_\star^2 \vert\mathbf{k}\vert^2)\Pi_X$	Maxwell, perturbative pure-Yang–Mills, or pure-Einstein action/phase receipt; quantum particle gate separate
Coherent-matter scalar susceptibility	conditional scalar theorem	$\chi_\nu^{\mathrm{can}} = 1 - P_\chi/24 = 0.9320429912748350\ldots$	nondegenerate OPH-coherent material source, Scalar Edge-Center Exhaustion, and protected-reserve collar closure; force additionally requires repair charge, an external gradient, and field-momentum closure

On the separate global capacity branch, the Bekenstein–Hawking / de Sitter area law keeps the display $N_{\mathrm{scr}} = A/(4\ell_P^2) = 3\pi/(G\Lambda)$ with screen-capacity closure as its boundary.

Particle Support Status

The particle paper treats the closure matrix explicitly. The non-hadron bundle has the following support levels:

Full W/Z promotion requires a strict source root, an independently physical $E_\star$, the finite quotient-transport certificate, a frozen RG/matching/scheme packet, branch rigidity, target-independent precommitment, and complex-pole and uncertainty receipts.

Exact flavor algebra and its boundary. The twenty-face orbit has a regular C_3 corner fiber. Every equivariant Hermitian response on that fiber is a circulant $C = aI + bR + \bar{b}R^2$. When all three eigenvalues are nonnegative and read as square-root masses, the root-of-unity identities give

$$Q = \frac{1}{3} + \frac{2}{3}\left(\frac{|b|}{a}\right)^2, \qquad Q = \frac{2}{3} \Longleftrightarrow \frac{|b|}{a} = \frac{1}{\sqrt{2}}.$$

Equal rank-two blocks in the finite tracial-GNS packet give the balanced modulus exactly under the packet premises. The phase, and therefore the two mass ratios it jointly controls, is not fixed. The face fiber also lacks a constructed physical chiral-family attachment. The target-informed response coordinate is a diagnostic.

The five-dimensional traceless-symmetric family space sharpens the dynamical gap. Threefold and fivefold residual invariance forces a double eigenvalue. The twofold fixed locus has two parameters after overall scaling and admits simple spectrum, leaving exactly enough freedom to carry two mass ratios. Symmetry alone therefore supplies no numerical ratio prediction; a specific screen-derived invariant potential must select the orbit. Ref. [6] gives the proofs and scope.

Conditional and audit coordinates. The source-audit zero-selector law outputs the running/chart coordinates $(80.330, 91.119)$ GeV. These values are not commensurate with Breit–Wigner or complex-pole masses, carry no OPH theory covariance, and acquire physical comparison meaning only when the physical readout contract closes, so no pull is assigned. The Higgs/top pair is read on the double-criticality branch, a zero-continuous-parameter family whose comparison-exposed boundary-scale candidate gives $(m_H, m_t) = (125.77, 172.63)$ GeV at two loops; its declared calibration surface is a data-anchored fit that validates the formula stack and never predicts. The quark reciprocal-ray candidate fails its common-scale audit with a 21.556% held-out minimax error. The register-Clebsch candidate supplies six assignments and the distinct light-family coefficient-ratio menu $\{1/9, 1/3, 3, 9\}$ under the declared alphabet and F_1/F_2 rules. The adopted ordering is target-informed and uniquely least discrepant. Both FLAG 2024 rows reject every assignment under the retrospective conservative experimental-only gate. The unavailable covariance and absent OPH theory uncertainty preclude a covariance-aware significance, and the gate has no preregistered theory-wide falsification status. This closes only the declared common-transport assignment family. Different coefficient relations, alphabets, charged-family attachments, or generation-dependent threshold transport lie outside this class. The retained results are the conditional channel-pairing theorem, the target-free unordered multiset under the declared rules, and the exact positive-chamber Koide identity. The pairing theorem supplies no physical coefficient equality or source-derived generation order. The lane's $\sqrt{m_d/m_s} = 0.2086$ display is an algebraic Gatto–Sartori–Tonin estimate from the same failed ratio, without the up/down matrices and relative eigenbasis needed for a mixing prediction. All of these conditional and audit coordinates, with the selected-carrier, value-law, adapter, two-loop, and pole-audit variants and the exact PDG convention maps, are excluded from the particle-output ledger. Ref. [6] owns the detailed coordinate tables and receipt audit.

Stack-Wide Claim Boundary

The paper stack uses one no-relabeling rule throughout. A finite diagnostic or calibration field does not become a physical observable merely because it is renamed. Capacity bookkeeping needs an independent energy readout before it can count as mass; an archive needs a physical source, propagation, and detector channel before it can count as radiation; a finite repair spectrum needs a continuum operator/readout bridge before it can count as a physical spectrum; and a finite reconstruction threshold needs physical entropy and clock data before it can count as a Page-time claim. The spacetime and Einstein paper records this as the source-separation rule behind the support-level table.

Sector-dimension shock boundary. The declared repair generator

$$L^{\mathrm{rep}} = \sum_v (I - P_v)$$

uses single-site heat-bath conditional expectations on $K_r = L^2(X_r, \pi_r)$ at fixed sector structure. Since the P_v are orthogonal projections,

$$\langle f, L^{\mathrm{rep}} f\rangle = \sum_v \|(I - P_v)f\|^2,$$

so $\ker L^{\mathrm{rep}} = \bigcap_v \operatorname{Ran} P_v$. Identifying this intersection with the constants requires a separate irreducibility result. A horizon shock changes the sector dimensions d_α in $L_C = \sum_\alpha (\log d_\alpha) P_\alpha$, thereby changing X_r. It is outside the domain of this fixed-sector repair generator. The repair gap therefore neither constrains nor produces a sector-dimension shock mode.

A separate finite-capacity calculation gives a one-sided sign statement. Uniform transfer of a fraction f from a fixed horizon–observer budget changes the extremal sector entropy and logarithmic area observable by $\log(1 - f) < 0$ on every admissible integer depletion, and the positive-real interpolation is strictly decreasing. Its analytic Hessian has negative homogeneous curvature and positive curvature on the fixed-horizon-capacity tangent space, so the relevant maximum is the transfer boundary rather than an interior stationary point. Identifying this capacity transfer with horizon-area transfer gives a conditional mechanism for the de Sitter time-advance sign reported by Chen, Stanford, Tang, and Yang [27, 11]. Identifying the finite capacity-ledger transfer with observer mass is a separate physical dictionary. The normalized icosahedral spectrum additionally requires exact gauge transport of the rotation triplet and identification of the kinetic term with the scaled nearest-neighbour port or edge-sector Laplacian. Its coefficient and physical attachment are open. This mechanism supplies no static-patch trace and leaves the cited trace obstruction in force. That obstruction concerns the positive cyclic trace proposal tested in the cited work. Nontrace horizon-screen descriptions, separately constructed dimension-changing generators, and kinetic operators beyond the scaled nearest-neighbour graph remain outside the tested classes. None of these scope boundaries disproves OPH; the pure-de-Sitter normalization, finite entropy and transfer identities, and regular line-graph theorem survive.

The χ_ν scalar-channel identity is theorem-grade for nondegenerate OPH-coherent material sources once Scalar Edge-Center Exhaustion is imported. Device-scale force, cosmological abundance, and finite covariant dark stress require their own receipt packages.

Open evidence boundary. Four generating objects and one selector delimit the open rows; the underlying prescription families are not proved exhaustive. G1 is the Ward-projected hadronic transport for the two electromagnetic endpoint residuals. Its broad internal-mass bracket $S_{\mathrm{hadronic}} \in [0.5578, 1.0543]$ contains the zero-electroweak point diagnostic 0.8954, but it spans about 1.16×10^8 declared tolerance widths. The value is compare-only, and the evaluation pixel differs from the comparison pixel; the bracket carries no promotion. G2 requires construction of the direct correctable-public-record producer. Its removable conditions are record-atom restriction maps, endogenous public reachability, a frozen publicness policy, the global checkpoint coupling, exact or approximate correctable-code certification across the terminal fiber, the capacity-carrier representation, confusability-reflecting capacity extension and refinement packets, and a finite-size slack law with one physical zero. The de Sitter and electroweak identifications separately require the horizon–record identification and the common screen/electroweak load-carrier identification. The interval certificate at $3.5321315434 \times 10^{122}$ applies to the conditional electroweak bridge; it does not construct F, and it differs from the Planck–Λ central capacity by about 6.6 percent. G3 carries the forward electroweak chain. Its preregistered 96-entry one-loop sweep excludes entries inside that frozen menu only; higher-order, matching, threshold, tadpole, scale, and field-content prescriptions are open. G4 supplies numerical solver hygiene for the declared map. Twelve preregistered flavor candidates were also excluded, which excludes those candidates rather than the broader selector family.

A third-party audit of forty-two findings identifies no false theorem in the recovered mathematical core. Fail-closed gates and adversarial regression tests reject the hadronic target-coordinate algebra defect and the finite transition-clock eligibility defect; the printed epistemic statuses include those gates. The evidence ledger contains zero discriminating precommitted target-blind hits. The electroweak checks freeze analysis choices against known targets, so they are audits rather than target-blind predictions. Other positive rows are theorem-level, conditional, target-exposed, or non-discriminating.

Companion Papers

The detailed depth surfaces used throughout this synthesis are:

1. *Observation-Determined Normal Forms: Stability, Obstructions, and Refinement in Constraint and Rewrite Systems* [1], which gives the presentation-invariant same-source/cross-source quantifier split, endpoint and refinement bounds, collar-repair obstructions, and the finite conditional-resampling receipt used by the repair papers.

2. *Recovering Observer Spacetime and Einstein Dynamics from Overlap Consistency* [2], which gives the full support-incidence, modular, event-manifold, stress, generalized-entropy, and Einstein derivation chain with every finite, continuum, scaling, and physical premise stated at the arrow where it enters.

3. *Deriving Standard Model Gauge Structure from Observer Overlap Consistency* [3], which gives the full categorical and finite-carrier routes. It derives the finite current algebra from its stated premises, gives the conditional matter and tensor-kernel theorems, and keeps physical global-form selection and identification of the two routes open.

4. *Reality as a Consensus Protocol: The Fixed-Point Computation That Implements Physics* [4], which carries the finite patch-net fixed-point, defect, quotient, and operator-record consensus package. Its semantic-complete transaction theorem derives the local diamond from coherent aggregate gluing and full acceptance dependencies; repair completeness remains a separate condition. QECC/min-cut, spectral, BFT, and hardware-speedup claims remain gated by separate certificates.

5. *Federated Echosahedral Screen Microphysics: Patch Hardware, Records, and Observer Synchronization in OPH* [5], which carries the regulated federated patch-carrier architecture, the fixed-cutoff edge heat-kernel / Casimir theorem, exact finite modular and rate statements, the $A_5 \times \mathbb{Z}_2$ register classification, and the measurement and observer checkpoint/restoration packages.

6. *Deriving the Particle Zoo from Observer Consistency* [6], which carries the particle derivations, masses, couplings, and sector calculations.

7. *Theoretical Bounds on χ_ν in Observer-Patch Holography* and *Observer-Patch Holography and Dark Matter* [7, 8], which carry the coherent-matter channel theorem and the conditional repair-charge condensate action with its current, stress, normal-phase, deep-galaxy, and device-force consequences.

8. *Explaining the Yang–Mills Mass Gap with Observer-Patch Repair Dynamics* [9], which isolates the controlled compact-gauge repair mechanism and states the continuum certificate needed before the finite repair gap becomes a Clay-facing four-dimensional Yang–Mills gap.

9. *Observer-Patch Holography as a String-Vacuum Selector* [10], which treats string theory as an effective edge language and applies OPH gates to critical-string candidates; its rank certificate classifies the Bouchard-Donagi row as a structural benchmark rather than a selected witness.

The sections that follow give the synthesis view. The complete spacetime and Einstein chain is proved in Ref. [2]; the two complete gauge-reconstruction routes and their identification boundary are proved in Ref. [3]. Repeating those derivations here would obscure the shared observer interpretation, the quantitative closures, and the cross-lane claim boundary carried by this paper.

Physical status of the icosahedral Standard Model and W/Z results

The finite icosahedral package is an exact conditional recognition result. Incidence determines the antipode J. Under the explicit contract that an admissible response is a signed central involutive graph automorphism implementing inverse-port readback, the responses are exactly $\pm J$; their common sign is conventional. Conditional also on the rank-15 matter contract with its unique charge-conjugate projector pair, the port-current, anomaly, Spin, and tensor-descent certificates fix the $3+2$ block structure, hypercharge lattice, and $\mathbb{Z}_6$ quotient from the stated premises alone. The $\mathbb{Z}_6$ kernel is computed on every realized tensor and is insensitive to the projector representative. The scalar scan fixes compatible charges and Yukawa channels, not scalar multiplicity. The finite producer does not physically source-bind the response or matter contracts. Laboratory identification of the current and line spectrum, equality with the independently reconstructed Tannaka current, attachment of the band to three physical chiral families, exclusion of extra light sectors, scalar attachment/dynamics, and construction of a chiral quantum field theory remain open.

The conditional field-theory implications are explicit. A finite local action gives an exact finite gauge-invariance and locality theorem, and the familiar electroweak tree kernel is conditional on a separate canonical continuum and action-normalization bridge. An exact finite measure criterion and an exact finite Hamiltonian criterion are two parallel branches over that action. A separate formal perturbative branch carries the strict finite-order W/Z pole theorem. A nonperturbative continuum completion gives an observable-sector reconstruction implication and a distinct continued-sheet resonance-stability implication. The measure and perturbative branches are parallel descendants of the finite local action. Neither implies the other, and a perturbative pole does not imply the continuum completion.

These QFT theorems state what follows from typed action and quantization packets. They do not show that the target-free source emits those packets. The construction supplies no source-selected action and normalization, no complete measure construction, no target-clean perturbative matching packet, no independently replayed current amplitudes, no source law and covariance, no numerical uncertainty freeze, no operational clock, and no continuum tower with its continued-sheet packet. The numerical fixture is a post-exposure imported-backend regression. No source-native dimensionless or physical-unit W/Z pole is promoted.

4 Consensus, Defects, and Implementation Hiding

The fixed-cutoff consensus package admits an equivalent finite patch-net formulation. Local patch descriptions agree on overlaps, local recovery-derived repair rules remove mismatches, and the physical output is the schedule-independent quotient normal form together with the induced terminal expectation functionals on the declared physical observable algebras. This section records the fixed-point, defect, and gauge-quotient statements in that language.

The consensus lane also carries a simple finite-candidate law-selection model: once one equips candidate repair rules with a fitness functional, replicator dynamics gives a clean toy picture in which more successful reconciliation laws dominate a competing pool. That selection picture is useful for the overall synthesis picture, but in the consensus paper it is a finite-candidate monotonicity result, not part of the recovered-core gravity/gauge theorem surface, not a universality claim, and not a literal cosmological dynamics claim.

On its declared fixed-cutoff branch, *Reality as a Consensus Protocol: The Fixed-Point Computation That Implements Physics* [4] imports four core D1 surfaces into this synthesis surface:

1. **Constraint-code firewall.** A bare finite overlap net is a finite constraint code: its codewords are exactly the globally consistent states $C = \Phi^{-1}(0)$. It is not automatically a QECC/topological code, and its graph min-cut does not determine code distance. Distance/min-cut, Knill–Laflamme resilience, spectral convergence, BFT liveness, and hardware speedup enter only through separate certificates.

2. **Asynchronous confluence.** For the declared accepted repair law, the local-fit contract makes Φ a Lyapunov functional, hence gives termination on the finite patch net. The fixed-cutoff union-collar gluing package supplies the local diamond on the physical quotient, and only that confluence condition together with repair completeness yields a unique schedule-independent normal form from a fixed initial quotient state. Same-boundary uniqueness requires the additional unique consistent extension condition in the preserved boundary/sector fiber.

3. **Cycle obstruction and higher-gauge defects.** On the abelian branch, global consistency holds exactly when cycle holonomy vanishes; on the genuinely noncentral branch, the crossed-module gluing orbit
$$q_\Sigma \in \check{H}^2(N_\Sigma, H_\Sigma \to G_\Sigma)$$
labels the full fixed-cutoff gluing orbit. It can admit multiple strict representatives related by H_Σ-valued edge changes and need not determine one ordinary G_Σ-valued 1-cocycle class. Associator strictifiability is the separate condition that this orbit admit a representative $(g^{\mathrm{str}}, 1)$; strict endpoint-only transport additionally requires at least one allowed strict representative with trivial represented loop holonomy.

4. **Gauge quotient and observable-level confluence.** The repair law descends to the overlap-invariant quotient, and the induced terminal state on the declared physical observable algebras is unique there even when microscopic representatives differ by gauge or sector relabelings inside one quotient-local glued state.

5. **Record algebra and stability.** On the declared fixed-cutoff observer-accessible operator surface, central record projectors carry the Born/Lüders rules directly, while approximate record projectors inherit explicit $(\varepsilon, \delta_{\mathrm{rec}})$ stability bounds on that same event surface. This is a theorem about the stated algebraic record interface, not a requirement that OPH first rebuild every mathematical ingredient from operational records alone.

The consensus paper is equally explicit about the imported repair-law data and what sits outside the fixed-cutoff theorem stack. The declared repair step includes the touched-overlap local-fit contract and the union-collar gluing package on the physical quotient; the branch conditions above that step are repair completeness and, on the Petz branch, the stated support/CPTP clause. On that same fixed-cutoff surface, exact normal-form computation is finite-state and decidable, automatic approximate stability is only collar-local through the splice and record estimates, and long-run noisy approximate consensus is theorem-grade only after a fair-block contraction certificate is supplied for the chosen exported patch-net family. That certificate boundary is not a dependency for the support-visible BW theorem, local Einstein branch, receipt-conditional compact-gauge reconstruction, or realized Standard Model branch.

5 Particle-Spectrum Branch

The particle branch follows the same logical order as *Deriving the Particle Zoo from Observer Consistency* [6]. One first applies the explicit finite inverse-port response and rank-15 matter contracts, followed by anomaly balance and tensor descent, to obtain the exact conditional Standard Model charge lattice and maximal faithful matter image. The generation count and the extra-sector statement enter as declared completions with open physical status, and only then does one ask how transport-stable overlap data organize the observed particle families. The independent transportable-sector/Tannaka reconstruction remains a conditional classification route.

Structural carrier and particle-gate package. Under the declared response and matter contracts, the structural carrier roles and maximal faithful matter image follow from those contracts alone:

$$\frac{\mathrm{SU}(3)\times\mathrm{SU}(2)\times\mathrm{U}(1)}{\mathbb{Z}_6},\qquad N_c=3,\qquad 3\le N_g\le 5.$$

On a declared trace-balanced block carrier $V=C\oplus W$, with $\dim C=3$, $\dim W=2$, and block hypercharges $(-1/3,1/2)$, the selected exterior package

$$\Lambda^2V\oplus\Lambda^4V=Q\oplus u^c\oplus e^c\oplus d^c\oplus L$$

is an exact one-generation Standard Model representation witness. It has the three one-Higgs invariant lines, cancels the gauge and mixed anomalies, and contains four weak doublets per generation. Hence every additive isomorphism-invariant load normalized by $L_P(\mathbb{C})=P$ gives $L_P(\mathrm{Hom}_{SU(2)}(W,M_1))=4P$. A positive unital map between one-dimensional order-unit load lines is unique once the physical order units are identified. Under the explicit response and rank-15 matter contracts, the current response, determinant balance, Spin lift, non-vacuum exterior package, and center/deck descent are exact finite implications. The scalar scan fixes compatible charges and Yukawa channels, not scalar multiplicity. Physical matter typing, global-form selection, laboratory current identification, removal of the omitted Λ^0V singlet and other light sectors, attachment of the A_5 face module to physical families, scalar attachment and dynamics, and continuum QFT are open.

Theorem 5.1 (Conditional icosahedral-screen forcing theorem)**.** *Assume the declared quotient-visible echosahedral carrier lineage. Then the primitive-port readback and oriented-incidence selector theorem supplies the twelve unit ports, inverse pairing, proper A_5 action, rank-three frame, and refinement/relabeling naturality. Assume further the explicit contract that an admissible response is a signed central involutive graph automorphism implementing inverse-port readback, together with the rank-15 matter contract and tensor-descent receipt. Then incidence determines J, the admissible responses are $\pm J$, and the finite certificates imply the exact current algebra, refinement maps, anomaly-forced determinant balance, Spin lift, rank-15 exterior matter package, and axis/center deck descent. These conditional finite implications produce the trace-balanced* $3+2$ *block carrier with* *hypercharges $(-1/3, 1/2)$ and fix the common $\mathbb{Z}_6$ tensor kernel from those implications alone. The scalar scan identifies compatible charges and Yukawa channels, not $H = W$ or scalar multiplicity. For physical promotion, assume that a source-bound refinement-natural commuting square identifies the A_5 current group and action with the independently reconstructed Tannaka group and its realized matter action; that laboratory current and global-form identification passes; that the matter contract is source-bound; that a scalar-multiplicity/one-Higgs receipt lands; that a source-complete no-extra-light-sector receipt lands; and that the A_5 multiplicity is physically attached to three families with the selecting symmetry hidden, broken, or forgotten on the Yukawa surface. On a receipt-certified compact-gauge continuum/QFT landing, the resulting low-energy chiral package has the Standard Model physical global form*

$$\frac{\mathrm{SU}(3) \times \mathrm{SU}(2) \times \mathrm{U}(1)}{\mathbb{Z}_6}$$

with the exact Standard Model hypercharge lattice, one Higgs doublet, three colors, three attached generations, perturbative anomaly cancellation, even Witten parity, and no simple-GUT X/Y gauge channel.

Proof. The source-selector theorem produces the finite port and frame data on the declared carrier lineage. The response and matter contracts make the exact algebra, refinement, rank-15 matter, determinant, Spin, and descent calculations applicable. Exterior branching gives the five chiral multiplets and the scalar scan gives the compatible cubic invariant lines without a scalar-multiplicity claim. The anomaly and center calculations fix the hypercharge lattice, color triplet, and common $\mathbb{Z}_6$ tensor kernel from those calculations alone. The separately assumed global-form receipt selects the physical quotient. The source-bound commuting square identifies that group with the group acting through the Tannaka current. The stated completion, sector, and family receipts remove the otherwise available singlet, extra-sector, and family-attachment ambiguities. The continuum/QFT landing is the final physical promotion gate. □

This theorem closes the logical implication, subject to its premise list. Each named screen-to-current, cross-route identity, carrier, sector, family, and continuum receipt is an independently removable condition and is tracked in the proof ledger.

This does not determine quantum-particle masses. The specialist derivation papers separately prove that explicit Maxwell, perturbative pure-Yang–Mills, and pure-Einstein quadratic actions have transverse or TT classical massless modes on their stated backgrounds and phases. Photon, gluon, or graviton particle language additionally requires a positive-energy physical quantization, positive-residue two-point pole, and the appropriate asymptotic/deconfinement receipt. The displayed generation count is a declared completion, not a physical attachment theorem. The canonical rank-three screen band becomes a three-family matter space only after the complex rank-45 attachment, Spin/locality, residue, excluded-band, and complement-complete refinement receipts pass.

Proof route. The proof route is the one developed in *Recovering Observer Spacetime and Einstein Dynamics from Overlap Consistency* and *Deriving Standard Model Gauge Structure from Observer Overlap Consistency* [2, 3] and *Deriving the Particle Zoo from Observer Consistency* [6]. Incidence determines J; the explicit signed-central-involutive inverse-port response contract restricts admissible responses to $\pm J$. Together with the rank-15 matter contract, anomaly-forced determinant balance, Spin lift, and tensor descent, this gives the exact conditional finite Standard Model gauge group, hypercharge lattice, and $N_c = 3$ from those contracts alone. The finite response has a source-derived target-blind producer. Physical matter typing and laboratory-current attachment are open. Under the explicit compact-gauge refinement receipt, coherent bosonic pullback ladder, symmetry, and forgetful-fiber conditions of the Standard Model gauge paper, the surviving transportable edge-sector category separately reconstructs a compact internal symmetry group. The one-Higgs clauses give $3 \le N_g \le 5$; the count inside the window and the extra-sector statement are declared completions. The particle branch does not bypass the open laboratory current, cross-route identity, or physical family attachment.

Sector	Claim tier	What is fixed here	Boundary to stronger claim
Carrier roles and classical modes	conditional group/content theorem plus conditional quadratic-action theorem	declared quotient, $N_c = 3$, and the conditional window $3 \le N_g \le 5$ with a declared three-generation completion; two Maxwell transverse modes, $2 \dim G$ perturbative Yang–Mills modes, and two Einstein TT modes on stated branches	the family count remains a declared completion until physical attachment; the mode counts are classical kernels and quantum particles require the Hilbert-space, pole-residue, and phase gates
Electroweak bosons	exact selected-carrier chart + conditional quotient-transport implication + measured-reference inverse adapter	no nonzero source-only physical mass emitted	the selected chart, conditional value law, and inverse adapter have different provenance. The finite-carrier certificate is not emitted, the adapter is a separate reference-fitted comparison map, and no physical complex-pole pair is promoted
Fine-structure endpoint	source witness + mixed diagnostic + empirical closure + measurement	four distinct coordinates, detailed in the endpoint audit	the external-data empirical interval misses the measured endpoint. A source-only theorem requires a no-target-leak source-derived hadronic spectral payload
Higgs/top stage	conditional downstream split theorem on the declared running, matching, and threshold surface + compare-only exact sidecar	no nonzero source-only physical mass emitted	promotion inherits the source-root, physical-scale, transport, running, matching, rigidity, provenance, uncertainty, and complex-pole gates. The auxiliary direct-top codomain is comparison-only
Quark family	common-scale reciprocal-ray falsification + exact generic interface	no nonzero source-only physical mass emitted	reciprocal-ray closure fails across the audited common scales. Its sub-percent residuals use a target-anchored mixed-convention chart, and a lower-order ablation fits that chart better. The simulator has no Yukawa coupling or Yukawa information. Generation-blind flavor-singlet inputs produce no physical flavor-orbit selector
Charged leptons	continuation branch + exact witness + face-carrier theorem	exact A_5/C_3 face orbit; conditional contraction theorem; engineered finite model of the declared charged face-quotient schema	no nonzero source-only physical mass is emitted. The bounded model supplies local register state, event readback, and a central accepted/rejected record, closing fixed-cutoff schema existence. Its dimensions, automaton, grading, clock, and response are authored inputs; no frozen receipt excludes target dependence. A separate nature/pole bridge assumes both the physical Yukawa response and singularity readout. Physical source selection, family/Yukawa attachment, interacting kernel, cofinal refinement, and pole-scheme gates are open

Sector	Claim tier	What is fixed here	Boundary to stronger claim
Neutrinos	rejected target-informed weighted-cycle candidate + diagnostic sidecars	no nonzero source-only physical mass emitted; source-level PMNS, physical ordering, Majorana phases, and absolute masses are unformed	the candidate fails the NuFIT 6.1 correlated profile; its family kernel is a template, its charged basis is open and nearly degenerate, and its shared-basis recovery is tautological
Hadrons	backend-gated nonperturbative continuation	stable-channel and readout architecture are defined	source-only masses require one production backend export bundle, then executed unquenching, runtime receipt, and production systematics

Claim-tier boundary. Structural carrier roles and the realized Standard Model branch are theorem-bearing outputs; classical propagation is conditional on the displayed action/background/phase receipts, and quantum-particle interpretation is a stronger open gate. The electroweak quantitative branch separates an exact selected-carrier chart, a conditional value law, and a reference-fitted inverse adapter. The quotient-transport assumptions imply the value law exactly, but the finite carrier does not emit their certificate. The color-balanced $(\sqrt{N_c}/2, N_c)$ amplitude/loop construction defines a distinct alternative model rather than the complete transport law. The hierarchy theorem fixes the dimensionless ratio $v/E_\star$; an independently physical $E_\star$ and a pole receipt govern any mass in GeV. Full W/Z promotion also requires a strict source root, a frozen RG/matching/scheme packet, branch rigidity, target-independent precommitment, and uncertainty control. The Higgs/top stage is conditional on the declared downstream surface and inherits the same source-root, transport, scale, scheme, rigidity, provenance, uncertainty, and complex-pole gates. Measured electroweak quantities are comparison data. The executed empirical hadron closure integrates external spectral input and misses the measured Thomson endpoint by a certified same-scheme interval. That payload tests the map; it does not source-close the Ward-projected hadronic spectral transport needed for a source-only theorem.

The $\alpha_U(P)$ source proof record. The electroweak hierarchy used by the clock-scale branch depends first on a source readout of the unified diffusion coupling

$$\alpha_U(P_\star).$$

For a trial pixel P, define

$$M_U(P) = E_\star e^{-2\pi} P^{1/6}, \qquad E_{\mathrm{cell}}(P) = \frac{E_\star}{\sqrt{P}}.$$

On the realized color branch,

$$N_c = 3, \qquad \beta_{\mathrm{EW}} := N_c + 1 = 4,$$

and the transmutation scale for a candidate coupling a is

$$v(P, a) = E_{\mathrm{cell}}(P) \exp\left[-\frac{2\pi}{\beta_{\mathrm{EW}} a}\right].$$

The exterior representation theorem fixes the weak-doublet multiplicity $3 + 1 = 4$, which also passes Witten parity on the realized branch. Its use as the D10 transmutation coefficient $\beta_{\mathrm{EW}} = 4$ requires the common screen/electroweak load-carrier identification and remains declared. The SU(2) one-loop coefficient of the realized one-Higgs branch is 19/6 and the declared unification packet's coefficient is 1, and neither equals 4. The integer is exact structural mathematics; the physical load attachment is the open receipt. It is not derived by dividing the 24-slot register by six. The source running family is

$$\alpha_i^{-1}(\mu; P, a) = a^{-1} + \frac{b_i}{2\pi} \log\left(\frac{M_U(P)}{\mu}\right), \qquad i = 1, 2, 3.$$

The beta-coefficient packet (b_1, b_2, b_3), matching convention, threshold packet, and renormalization convention are part of the source proof record. They are declared before any comparison with measured electroweak or gravitational data.

The hypercharge coupling is

$$\alpha_Y(\mu; P, a) = \frac{3}{5}\alpha_1(\mu; P, a).$$

The source Z-scale is a fixed point of the source equations, not an inserted measured mass:

$$\mu_Z(P, a) = \frac{v(P, a)}{2}\sqrt{4\pi\alpha_2(\mu_Z; P, a) + 4\pi\alpha_Y(\mu_Z; P, a)}.$$

For $G = \mathrm{SU}(2), \mathrm{SU}(3)$, define the finite representation heat-kernel sums

$$Z_G(t) = \sum_R d_R e^{-tC_2(R)}, \qquad \bar{\ell}_G(t) = \frac{1}{Z_G(t)} \sum_R d_R e^{-tC_2(R)} \log d_R.$$

The source heat-kernel parameters are

$$t_2(P, a) = 4\pi^2\alpha_2(\mu_Z(P, a); P, a), \qquad t_3(P, a) = 4\pi^2\alpha_3(\mu_Z(P, a); P, a).$$

The unified-coupling residual is

$$\Phi_U(P, a) := \bar{\ell}_{\mathrm{SU}(2)}(t_2(P, a)) + \bar{\ell}_{\mathrm{SU}(3)}(t_3(P, a)) - \frac{P}{4}.$$

The source value is the zero

$$\Phi_U(P, \alpha_U(P)) = 0.$$

Definition 5.2 (No-hidden-free-variable admissibility)**.** *The unified-coupling proof record is admissible only when the representation cutoffs, beta packet, matching prescription, threshold packet, and renormalization convention are frozen before comparison with measured electroweak or gravitational data:*

$$N_2, \quad N_3, \quad (b_1, b_2, b_3), \quad \textit{matching prescription}, \quad \textit{threshold packet}, \quad \textit{renormalization convention}.$$

None of these may be selected by minimizing the error against

$$M_W, \quad M_Z, \quad \alpha_s(M_Z), \quad \sin^2\theta_W, \quad v_{\mathrm{exp}}, \quad G_{\mathrm{exp}}.$$

Tuning any of these objects after comparison with observed electroweak or gravitational data makes the hierarchy row a calibration.

Theorem 5.3 (No-measured-input unified-coupling proof record)**.** *Let*

$$\mathcal{R}_U = (P_\star, N_2, N_3, I_U, \Phi_U, K_U, a_U^{(0)}, r_U, m_U, \mathrm{DAG}_U)$$

be an admissible unified-coupling proof record. Here N_2, N_3 are the finite representation cutoffs for $\mathrm{SU}(2)$ *and* $\mathrm{SU}(3)$*, $I_U \subset \mathbb{R}_+$ is the declared physical interval for α_U, Φ_U is the heat-kernel closure residual, K_U is an interval-Newton or Krawczyk operator, $a_U^{(0)}$ is the displayed candidate, r_U is the residual bound, m_U is a lower derivative bound, and* DAG_U *is the dependency graph.*

Assume

$$K_U(I_U) \subset \mathrm{int}(I_U),$$

$$|\Phi_U(P_\star, a_U^{(0)})| \le r_U,$$

$$|\partial_a \Phi_U(P_\star, a)| \ge m_U > 0 \qquad (a \in I_U),$$

and assume that DAG_U *contains no directed path from measured electroweak masses, measured low-energy gauge couplings, measured G, Planck area, Planck mass, measured Λ, or any equivalent gravity-calibrated or electroweak-calibrated scale. Then there is a unique source value*

$$\alpha_U(P_\star) \in I_U$$

such that

$$\Phi_U(P_\star, \alpha_U(P_\star)) = 0,$$

and

$$|\alpha_U(P_\star) - a_U^{(0)}| \le \frac{r_U}{m_U}.$$

Consequently, the electroweak hierarchy

$$\frac{v}{E_\star} = P_\star^{-1/2} \exp\left[-\frac{2\pi}{(N_c+1)\alpha_U(P_\star)}\right]$$

is no-measured-input on this proof record.

Proof. The residual $\Phi_U(P_\star, a)$ is built from the source-side pixel $P_\star$, declared representation cutoffs, source transmutation law, source running law, and source Z-scale fixed-point equation. The dependency condition excludes measured electroweak data and all gravity-calibrated scales. The interval-Newton/Krawczyk inclusion proves existence and uniqueness of a zero of $\Phi_U(P_\star, a)$ inside I_U. The residual estimate and derivative lower bound give

$$|\alpha_U(P_\star) - a_U^{(0)}| \le \frac{|\Phi_U(P_\star, a_U^{(0)})|}{m_U} \le \frac{r_U}{m_U}.$$

Substitution into the declared transmutation law gives the displayed hierarchy. The dependency graph contains no measured G, Planck unit, measured M_Z, measured M_W, measured $\alpha_s(M_Z)$, or measured low-energy electroweak coupling ancestor, so the emitted hierarchy is source-side on $\mathcal{R}_U$. □

The theorem fixes a dimensionless ratio. It supplies neither an independently physical $E_\star$ nor a mass in GeV. On the populated branch $P_\star$ is the unique root of the declared local self-read map, so the downstream source expressions inherit that root. Their physical endpoint interpretation requires the corresponding transport and pole constructions.

Lemma 5.4 (Exponential sensitivity of the hierarchy row)**.** *On the transmutation branch*

$$\frac{v}{E_\star} = P_\star^{-1/2} \exp\left[-\frac{2\pi}{4\alpha_U}\right],$$

and on a clock row whose dominant scale dependence enters through $m_e^2 \propto v^2$ in the leading hyperfine scaling $\varepsilon_{\mathrm{Cs}} \sim \mathcal{C}_{\mathrm{Cs}}\, \alpha_\star^4\, m_e^2/(m_p E_\star)$, the induced gravity readout satisfies approximately

$$\frac{\partial \ln G}{\partial \alpha_U} = \frac{2\pi}{\alpha_U^2}.$$

At $\alpha_U \simeq 0.0411$,

$$\frac{\partial \ln G}{\partial \alpha_U} \simeq 3.7 \times 10^3.$$

Therefore a certified relative gravity precision η_G requires

$$|\delta\alpha_U| \lesssim \frac{\eta_G}{3.7 \times 10^3}.$$

Proof. For $\beta_{\mathrm{EW}} = 4$,

$$\ln(v/E_\star) = -\frac{1}{2}\ln P_\star - \frac{2\pi}{4\alpha_U}.$$

Thus

$$\frac{\partial \ln(v/E_\star)}{\partial \alpha_U} = \frac{2\pi}{4\alpha_U^2} = \frac{\pi}{2\alpha_U^2}.$$

The clock gap carries the square of the electroweak scale: in the leading hyperfine scaling $\varepsilon_{\mathrm{Cs}} \propto m_e^2 \propto v^2$ at fixed Yukawa, fine-structure, and strong-sector ratios, so

$$\frac{\partial \ln \varepsilon_{\mathrm{Cs}}}{\partial \alpha_U} = 2 \cdot \frac{\pi}{2\alpha_U^2} = \frac{\pi}{\alpha_U^2}.$$

Since the gravity row is quadratic in the clock scale,

$$G \propto \varepsilon_{\mathrm{Cs}}^2,$$

one obtains

$$\frac{\partial \ln G}{\partial \alpha_U} = 2 \cdot \frac{\pi}{\alpha_U^2} = \frac{2\pi}{\alpha_U^2}.$$

□

Remark 5.5 (Digits policy)**.** *The exponential branch allows precision only to the extent that the source proof records carry interval bounds. The number of printed digits in G_{SI} may not exceed the precision certified by $\mathcal{R}_U$, $\mathcal{R}_{\mathrm{QCD}}$, $\mathcal{R}_{\mathrm{flav}}$, and $\mathcal{R}_{\mathrm{Cs}}$. A display such as*

$$\varepsilon_{\mathrm{Cs}} = 2\pi\nu_{\mathrm{Cs}}\sqrt{\hbar G_{\mathrm{ref}}/c^5}$$

is a calibration checksum unless the full source stack emits the same interval with a no-G dependency graph.

No-G clock hierarchy for the gravity scale. The numerical gravity row uses the dimensionless cesium clock gap

$$\varepsilon_{\mathrm{Cs}} := \frac{\hbar\omega_{\mathrm{Cs}}}{E_\star}, \qquad E_\star := \frac{\hbar c}{\ell_\star}, \qquad \omega_{\mathrm{Cs}} = 2\pi\nu_{\mathrm{Cs}}.$$

The size of this gap is a hierarchy problem for the OPH scale branch. The gap is represented as a factorized source-side readout. The source-only scale branch is accepted as no-G only when the gap factorizes through source-side dimensionless physics:

$$\mathcal{R}_\gamma = \mathcal{R}_U + \mathcal{R}_\alpha + \mathcal{R}_e^{\mathrm{abs}} + \mathcal{R}_{\mathrm{QCD/nuc}}^{133\mathrm{Cs}} + \mathcal{R}_{\mathrm{atom}}^{133\mathrm{Cs}}.$$

Here $\mathcal{R}_U$ emits $\alpha_U(P_\star)$ and the electroweak scale, $\mathcal{R}_\alpha$ emits the electromagnetic coupling used by the atomic Hamiltonian, $\mathcal{R}_e^{\mathrm{abs}}$ emits the electron absolute mass ratio, $\mathcal{R}_{\mathrm{QCD/nuc}}^{133\mathrm{Cs}}$ emits the cesium nuclear source packet, and $\mathcal{R}_{\mathrm{atom}}^{133\mathrm{Cs}}$ emits the hyperfine spectral gap from those dimensionless data.

At leading OPH source level, the electroweak hierarchy is generated by the declared transmutation law

$$\frac{v}{E_\star} = P_\star^{-1/2} \exp\!\left[-\frac{2\pi}{(N_c+1)\alpha_U(P_\star)}\right], \qquad N_c = 3.$$

Thus the weak-to-UV ratio is generated from the dimensionless source data $P_\star$, N_c, and $\alpha_U(P_\star)$. The cesium gap then has the schematic source form

$$\varepsilon_{\mathrm{Cs}} = \mathcal{H}_{\mathrm{Cs}}\left(\alpha_\star, \frac{v}{E_\star}, \frac{\Lambda_{\mathrm{QCD}}}{E_\star}, y_e, y_q, \text{nuclear data}, \text{atomic corrections}\right),$$

where all arguments are dimensionless source outputs on the declared branch. In leading hyperfine scaling this contains the familiar structure

$$\varepsilon_{\mathrm{Cs}} \sim \mathcal{C}_{\mathrm{Cs}}\, \alpha_\star^4 \frac{m_e^2}{m_p E_\star},$$

with relativistic, many-body, recoil, QED, finite-nuclear-size, and nuclear-moment corrections absorbed into $\mathcal{C}_{\mathrm{Cs}}$.

Definition 5.6 (Cesium source packet)**.** *A source-only cesium packet is*

$$\mathcal{D}_{\mathrm{Cs}}^{\mathrm{src}} = \left(\alpha_\star,\, \frac{m_e}{E_\star},\, \frac{\Lambda_{\mathrm{QCD}}}{E_\star},\, \{y_q\},\, \mathcal{N}_{133},\, \mathcal{B}_{\mathrm{atom}}^{\mathrm{Cs}}\right).$$

$\mathcal{N}_{133}$ contains the source-side nuclear data for ^{133}Cs*, including nuclear spin, magnetic moment, magnetization distribution, charge radius, recoil data, and finite-size data. $\mathcal{B}_{\mathrm{atom}}^{\mathrm{Cs}}$ contains the atomic many-body, relativistic, QED, recoil, and finite-nucleus correction package. Every object in $\mathcal{D}_{\mathrm{Cs}}^{\mathrm{src}}$ is dimensionless and has no dependency path from measured G, Planck area, Planck mass, Planck time, measured Λ, or an algebraically equivalent gravity-calibrated scale.*

Definition 5.7 (OPH cesium Hamiltonian)**.** *Given $\mathcal{D}_{\mathrm{Cs}}^{\mathrm{src}}$, define the dimensionless cesium Hamiltonian*

$$\widehat{H}_{\mathrm{Cs}}^{\mathrm{OPH}} = \widehat{H}_{\mathrm{DC}} + \widehat{H}_{\mathrm{Breit}} + \widehat{H}_{\mathrm{QED}} + \widehat{H}_{\mathrm{recoil}} + \widehat{H}_{\mathrm{nuc}} + \widehat{H}_{\mathrm{manybody}}.$$

The hats indicate that every term is measured in units of $E_\star$, not in SI units and not in Planck units inferred from measured G.

Theorem 5.8 (No-G OPH clock-hierarchy theorem)**.** *Assume the local pixel proof selects $P_\star$. Assume the unified-coupling proof record $\mathcal{R}_U$ of Theorem 5.3 emits $\alpha_U(P_\star)$ and*

$$\frac{v}{E_\star} = P_\star^{-1/2} \exp\left[-\frac{2\pi}{(N_c+1)\alpha_U(P_\star)}\right].$$

Assume the electromagnetic endpoint branch $\mathcal{R}_\alpha$ emits $\alpha_\star$, the charged-lepton absolute-scale branch $\mathcal{R}_e^{\mathrm{abs}}$ emits

$$\frac{m_e}{E_\star} = \frac{y_e}{\sqrt{2}} \frac{v}{E_\star},$$

the QCD/nuclear branch $\mathcal{R}_{\mathrm{QCD/nuc}}^{133\mathrm{Cs}}$ emits $\mathcal{N}_{133}$, and the atomic branch $\mathcal{R}_{\mathrm{atom}}^{133\mathrm{Cs}}$ supplies isolated spectral enclosures

$$J_{F=3}, \qquad J_{F=4}$$

for the source-only Hamiltonian

$$\widehat{H}_{\mathrm{Cs}}^{\mathrm{OPH}} = \widehat{H}_{\mathrm{DC}} + \widehat{H}_{\mathrm{Breit}} + \widehat{H}_{\mathrm{QED}} + \widehat{H}_{\mathrm{recoil}} + \widehat{H}_{\mathrm{nuc}} + \widehat{H}_{\mathrm{manybody}}$$

with disjoint intervals and certified hyperfine gap

$$\varepsilon_{\mathrm{Cs}} = \lambda_{F=4}(\widehat{H}_{\mathrm{Cs}}^{\mathrm{OPH}}) - \lambda_{F=3}(\widehat{H}_{\mathrm{Cs}}^{\mathrm{OPH}}).$$

Assume further that the combined dependency graph

$$\mathrm{DAG}_{\mathrm{Cs}} = \mathrm{DAG}\left(\mathcal{R}_U, \mathcal{R}_\alpha, \mathcal{R}_e^{\mathrm{abs}}, \mathcal{R}_{\mathrm{QCD/nuc}}^{133\mathrm{Cs}}, \mathcal{R}_{\mathrm{atom}}^{133\mathrm{Cs}}\right)$$

contains no directed path from

$$G_{\mathrm{exp}}, \qquad \ell_P^2 = \frac{\hbar G}{c^3}, \qquad m_P = \sqrt{\frac{\hbar c}{G}}, \qquad t_P = \sqrt{\frac{\hbar G}{c^5}}, \qquad \Lambda_{\mathrm{exp}}, \qquad \frac{3\pi c^3}{\hbar G},$$

or from any algebraically equivalent gravity-calibrated scale. Then $\varepsilon_{\mathrm{Cs}}$ is a no-G hierarchy readout. Consequently

$$\gamma_\star = \frac{\ell_\star \nu_{\mathrm{Cs}}}{c} = \frac{\varepsilon_{\mathrm{Cs}}}{2\pi}$$

is non-circular, and

$$G_{\mathrm{SI}} = \frac{c^5}{4\pi^2 \hbar \nu_{\mathrm{Cs}}^2} \varepsilon_{\mathrm{Cs}}^2$$

has no measured-G ancestor.

Proof. $\mathcal{R}_U$ emits the small weak ratio from $P_\star$, N_c, and $\alpha_U(P_\star)$, all of which are dimensionless branch data. $\mathcal{R}_\alpha$ emits the electromagnetic coupling used by the atomic Hamiltonian. $\mathcal{R}_e^{\mathrm{abs}}$ emits the electron mass ratio. $\mathcal{R}_{\mathrm{QCD/nuc}}^{133\mathrm{Cs}}$ emits the cesium nuclear source packet. Therefore every coefficient of $\widehat{H}_{\mathrm{Cs}}^{\mathrm{OPH}}$ has no measured-G ancestor. The atomic branch gives isolated spectral enclosures for the two hyperfine levels, so the gap

$$\varepsilon_{\mathrm{Cs}} = \lambda_{F=4}(\widehat{H}_{\mathrm{Cs}}^{\mathrm{OPH}}) - \lambda_{F=3}(\widehat{H}_{\mathrm{Cs}}^{\mathrm{OPH}})$$

is well-defined and inherits the no-G dependency condition of the Hamiltonian.

Finally,

$$\varepsilon_{\mathrm{Cs}} = \frac{\hbar(2\pi\nu_{\mathrm{Cs}})}{\hbar c/\ell_\star} = \frac{2\pi\nu_{\mathrm{Cs}}\ell_\star}{c},$$

so

$$\gamma_\star = \frac{\ell_\star \nu_{\mathrm{Cs}}}{c} = \frac{\varepsilon_{\mathrm{Cs}}}{2\pi}.$$

Substitution into $G_{\mathrm{SI}} = c^3 \ell_\star^2/\hbar$ gives the displayed expression for G_{SI}. The only non-display parent of the expression is the source-side $\varepsilon_{\mathrm{Cs}}$ readout, so the gravity row is non-circular under the stated hypotheses. □

Remark 5.9 (Clock-certificate boundary)**.** *The theorem above is not discharged by printing*

$$\varepsilon_{\mathrm{Cs}} = 3.1139305134\ldots \times 10^{-33}.$$

That decimal is source-predictive only if it is emitted by

$$\mathcal{R}_U + \mathcal{R}_\alpha + \mathcal{R}_e^{\mathrm{abs}} + \mathcal{R}_{\mathrm{QCD/nuc}}^{133\mathrm{Cs}} + \mathcal{R}_{\mathrm{atom}}^{133\mathrm{Cs}}.$$

If instead it is computed as

$$\varepsilon_{\mathrm{Cs}}^{\mathrm{cal}} = 2\pi\nu_{\mathrm{Cs}}\sqrt{\frac{\hbar G_{\mathrm{exp}}}{c^5}},$$

then it is a gravity-side calibration checksum, not a source-side clock prediction. The paper surface supplies the algebraic certificate shape and the $\mathcal{R}_U$ numerical witness. The full source-only $\mathcal{R}_{\mathrm{Cs}}$ branch requires the source-only electromagnetic endpoint, charged-lepton absolute-scale gate, source-side cesium nuclear packet, and atomic spectral enclosure.

Remark 5.10 (Hadronic and nuclear certificate boundary)**.** *The unresolved load-bearing pieces of the no-G SI gravity row are the hadronic/same-scheme endpoint payload in $\mathcal{R}_\alpha$ and the source-side cesium QCD/nuclear packet in $\mathcal{R}_{\mathrm{QCD/nuc}}^{133\mathrm{Cs}}$. The displayed endpoint and $\varepsilon_{\mathrm{Cs}}$ rows therefore fix those payloads for checksum and comparison purposes. They are not counted as source-only OPH emissions.*

The source-only completion route is a Ward-projected QCD/nuclear spectral certificate from a dedicated OPH optical-compute backend, or an equivalent nonperturbative backend with manifest provenance and systematics. Ordinary CPU/GPU runs in this paper are not the declared source certificate for that hadronic payload.

Direct public-record closure for total capacity. The global counterpart of the local P-closure begins with a supplied positive integer capacity-carrier dimension

$$D = \dim \mathcal{H}_{\mathrm{cap},r,D}, \qquad N = \log D.$$

The official universe-level readback equation is

$$\boxed{N = \log M_0(\mathfrak{U}_N)}.$$

Here the argument fixes the type. In every occurrence, M_0 is a multiplicative code size. Once the complete terminal fiber scalarizes, the universe-level notation means

$$M_0(\mathfrak{U}_N) := \widehat{F}_{r,0}(e^N).$$

Thus N is the logarithmic capacity read back from the trial universe, while $M_0(\mathfrak{U}_N)$ is the number of correctable public records. The equation is the logarithmic form of stable direct capacity closure, not a new producer or an appeal to a measured target. The carrier type is frozen in the branch contract. Boundary, total, edge-center, and other Hilbert spaces are not interchangeable. Let $\widetilde{\Omega}_{r,D}$ be the terminal physical quotient fiber reached from the source-derived trial universe $\mathfrak{U}_{r,D}$. Its members are repair-normal and pass the declared local, obstruction, and provenance gates. Membership contains no capacity-equals-D predicate.

For $q \in \widetilde{\Omega}_{r,D}$, observer O has a finite commutative record algebra $\mathcal{R}_O(q)$ with atom set $X_O(q) = \operatorname{At} \mathcal{R}_O(q)$. Each shared interface e has an atom set $X_e(q)$ and a source-derived record-atom readout

$$r_{Oe} : X_O(q) \longrightarrow X_e(q).$$

This atom-level construction is used because the generic visible maps on full observer algebras need not be unital *-homomorphisms in the direction required by an algebra equalizer. The compatible public global sections are

$$X_{\text{pub}}(q) = \{(x_O)_O : r_{Oe}(x_O) = r_{O'e}(x_{O'}) \text{ on every shared interface}\}, \qquad \mathcal{R}_{\text{pub}}(q) = C(X_{\text{pub}}(q)).$$

Theorem 5.11 (Public global sections)**.** *For every finite observer record diagram, $X_{\text{pub}}(q)$ is finite and $C(X_{\text{pub}}(q))$ is a finite commutative unital C^*-algebra. Every isomorphism of observer record diagrams induces a bijection of public global sections and a *-isomorphism of their function algebras.*

Proof. The public sections form the subset of the finite product $\prod_O X_O(q)$ satisfying finitely many equalities. A diagram isomorphism transports the atom sets and interface maps, hence compatible tuples bijectively; pullback transports their function algebras. □

Only endogenously writable records count. Define

$$X_{\text{reach}}(q) = \{x \in X_{\text{pub}}(q) : x \text{ terminates an admissible endogenous semantic history}\}.$$

The history may use declared source data, accepted repair, semantic continuation, and quotient-visible writes. It may not use a target record, supplied-capacity metadata, measured Λ, or the electroweak bridge. The publicness policy is a frozen nonempty family

$$\mathfrak{P}(q) \subseteq 2^{\mathcal{O}(q)} \setminus \{\varnothing\}$$

of authorized observer subsets. Collective, universal-local, and quorum publicness are distinct theorem branches.

For every $x \in X_{\text{reach}}(q)$, authorized set $A \in \mathfrak{P}(q)$, and allowed same-interface semantic continuation κ, the source construction must emit a joint stochastic kernel

$$K_{A,\kappa}(y \mid x), \qquad y \in Y_{A,\kappa},$$

whose observer marginals agree with the local checkpoint packets. The joint kernel is an independent receipt. It cannot be manufactured from local marginals.

Theorem 5.12 (Local marginals do not determine public capacity)**.** *There are two binary-input joint checkpoint channels with identical observer-by-observer marginals and different public capacities.*

Proof. Let U be uniform. The channel $(Y_1, Y_2) = (U, U \oplus x)$ has uniform input-independent marginals, while the joint parity recovers x. Independent uniform outputs have the same marginals and carry no information about x. Thus the joint capacities are two and one, respectively. □

For a channel K, write $S_K(x) = \{y : K(y \mid x) > 0\}$. A code $C \subseteq X_{\mathrm{reach}}(q)$ is zero-error correctable for K when a decoder d_K satisfies

$$K(d_K^{-1}(x) \mid x) = 1 \qquad (x \in C).$$

Theorem 5.13 (Support criterion and compound zero-error capacity)**.** *A code is zero-error correctable for K exactly when the supports $S_K(x)$, $x \in C$, are pairwise disjoint. Let $\mathfrak{K}(q)$ contain every authorized checkpoint channel and every declared finite composition. Define the compound confusability graph G_q on $X_{\mathrm{reach}}(q)$ by joining $x \neq x'$ whenever their output supports overlap for at least one $K \in \mathfrak{K}(q)$. Then the exact public-record capacity is*

$$\boxed{M_0(q) = \alpha(G_q)},$$

where α is the graph independence number.

Proof. A successful decoder cannot assign one output to two inputs, which proves the support criterion in one direction. Pairwise disjoint supports admit the decoder that returns the unique supporting input. A code valid for every declared channel is therefore exactly an independent set in the union of the channel confusability graphs. □

For exact indefinite continuation, replace each kernel by its support relation $R_K = \{(x, y) : K(y \mid x) > 0\}$. Boolean relation composition generates at most $2^{|X_{\mathrm{reach}}|^2}$ relations, so the support semigroup and its compound confusability graph close after finitely many steps.

Theorem 5.14 (Reversible fast branch)**.** *If every authorized continuation is a known injective deterministic map on $X_{\mathrm{reach}}(q)$, then*

$$M_0(q) = |X_{\mathrm{reach}}(q)|.$$

Proof. Injectivity keeps every pair of inputs distinguishable for every continuation, so G_q has no edges. □

Checkpoint invariance is not the capacity definition. A cyclic permutation of m labels has a one-dimensional fixed function algebra, while its inverse decodes all m labels. Thus a fixed-projector count can undercount the correctable capacity arbitrarily.

For a frozen finite channel family or continuation horizon and tolerance ε, let $M_\varepsilon(q)$ be the largest code for which every declared channel has a decoder with worst-input error at most ε.

Theorem 5.15 (Approximate-capacity stability and zero-error discontinuity)**.** *If corresponding channel rows obey*

$$\sup_{K,x} d_{\mathrm{TV}}(K(\cdot \mid x), \widehat{K}(\cdot \mid x)) \leq \delta,$$

then

$$M_{\varepsilon+\delta}(\widehat{\mathfrak{K}}) \geq M_\varepsilon(\mathfrak{K}).$$

Zero-error capacity is discontinuous at every identity channel on more than one symbol: adding arbitrarily small full-support noise collapses M_0 to one.

Proof. Total-variation control changes the probability of each correct-decoding event by at most δ. For the second statement, $(1-\delta)I + \delta U$, with U full support, makes every pair of inputs confusable for every $\delta > 0$. □

The capacity carrier is an exact finite Hilbert space $\mathcal{H}_{\mathrm{cap},r,D}$ of dimension D. Each reachable public record class has a nonzero projection P_x on this carrier, and distinct records have orthogonal projections.

Theorem 5.16 (Carrier bound and saturation rigidity)**.** *Every correctable public code C satisfies*

$$|C| \le D, \qquad \log M_\varepsilon(q) \le \log D = N.$$

If $M_0(q) = D$, the code projections are rank one and sum to the identity.

Proof. The ranks of nonzero orthogonal projections add and their sum has rank at most D. Equality with D codewords forces every rank to be one and the sum to have full rank. □

The primary finite readback remains set-valued:

$$\boxed{\mathfrak{F}_{r,\varepsilon}(D) = \{M_\varepsilon(q) : q \in \widetilde{\Omega}_{r,D}\}.}$$

A scalar $\widehat{F}_{r,\varepsilon}(D)$ exists exactly when the nonempty terminal fiber has one common defined value. The evaluator must distinguish an empty readback, an ambiguous readback, and a singleton scalar readback. Existential closure means $D \in \mathfrak{F}_{r,0}(D)$; selector-free stable closure means

$$\boxed{\mathfrak{F}_{r,0}(D) = \{D\}.}$$

Equivalently, the unclosed kernel

$$K_r(D, m) = |\{q \in \widetilde{\Omega}_{r,D} : M_0(q) = m\}|$$

has support only at $m = D$. One saturated branch is insufficient when the terminal fiber is ambiguous.

The full capacity packet consists of observer lineage, record atoms, interface maps, reachable public sections, publicness policy, global kernels, and carrier projections. An isomorphism preserving that packet transports every exact confusability edge, approximate decoder error, and projection rank. Hence M_ε is implementation invariant under packet isomorphism.

Once scalarized, the active map $f(D) = \widehat{F}_{r,0}(D)$ is deflationary. It cannot attract a positive fixed point from below. If f is total on a declared finite admissible chain, monotone, and deflationary, iteration from its top element stabilizes at the greatest fixed point. This is a conditional order theorem, not a uniqueness or cutoff-independence theorem. The identity family $f(D) = D$ fixes every dimension; an erasure family $f(D) = 1$ fixes only the bottom. Both satisfy monotonicity and deflation. A physical principle must therefore select a nontrivial cutoff-independent zero of the capacity slack.

Capacity extension and regulator refinement are distinct. For $D \le D'$, an injection of reachable records that reflects confusability,

$$e_{DD'}(x) \sim_{G_{D'}} e_{DD'}(x') \Longrightarrow x \sim_{G_D} x',$$

maps every coarse independent set to a fine independent set and gives $M_0(D) \le M_0(D')$. At fixed D, refinement injections with the same property make $M_{0,r}(D)$ a nondecreasing integer bounded by D, hence eventually constant along each cofinal sequence.

For regions A, B sewn along public seam S, exact public records form the fiber product

$$X_{A\cup B} = X_A \times_{X_S} X_B, \qquad |X_{A\cup B}| = \sum_{z\in X_S} |r_A^{-1}(z)|\,|r_B^{-1}(z)|.$$

This gives an exact CSP, tensor-network, or model-counting route on the reversible branch. A cosmological conclusion additionally requires an exact transfer recurrence, exact fiber-product recursion, or a seam theorem with a certified subleading term.

Define the finite-size slack

$$\boxed{s_r(D) = \log D - \log M_{0,r}(D).}$$

If $\limsup_{D\to\infty} \log M_0(D)/\log D < 1$, closure is excluded at all sufficiently large dimensions. Unit asymptotic density is insufficient: $M(D) = D$ and $M(D) = D - 1$ have the same limiting density but opposite fixed-point behavior. Full physical N-closure requires a source-derived finite-size law proving

$$s(D_\star) = 0, \qquad s(D) > 0 \quad (D \neq D_\star)$$

on the declared physical domain, or an equally explicit physical selector.

Two independent physical identifications follow only after stable direct closure. The first hypothesis identifies the same capacity carrier with the de Sitter horizon record:

$$N_\star = \log D_\star = \frac{A_{\rm dS}}{4\ell_\star^2}, \qquad A_{\rm dS} = \frac{12\pi}{\Lambda} \quad \Longrightarrow \quad \boxed{\Lambda \ell_\star^2 = \frac{3\pi}{N_\star}}.$$

The second hypothesis identifies the screen load with the electroweak load by a positive, unital, refinement-natural map

$$\Xi_r : \mathcal{L}_{{\rm screen},r} \longrightarrow \mathcal{L}_{{\rm EW},r}.$$

Given the independent screen-sieve and electroweak source laws,

$$\Gamma_{\rm scr} = \frac{P}{12} \log \frac{N_\star}{\pi}, \qquad \log \frac{E_{\rm cell}}{v} = \frac{\pi}{2\alpha_U(P)}, \qquad \Xi_r(\Gamma_{\rm scr}) = \log \frac{E_{\rm cell}}{v},$$

it gives the conditional Higgs/electroweak residual and coordinate

$$\boxed{R_{\rm EW} = \alpha_U(P) \log \frac{N_\star}{\pi} - \frac{6\pi}{P} = 0, \qquad N_{\rm bridge} = \pi \exp\left[\frac{6\pi}{P\alpha_U(P)}\right].}$$

Neither physical identification constructs the public-record map. The independently frozen operational-resolution residual

$$R_\rho = \log M_0 - \frac{\pi}{\rho_{\rm op}^2}$$

is likewise a downstream test and never a producer definition.

The finite global-section, correctable-code, compound-capacity, approximate-stability, carrier-bound, scalarization, order, extension, refinement, and sewing implications are theorems. Physical closure requires source-derived record-atom restriction maps, endogenous public-record reachability, the frozen publicness policy, a globally coupled checkpoint family, a faithful capacity-carrier representation, a whole-fiber scalar producer, confusability-reflecting extension and refinement maps, the finite-size slack law with one physical zero, the horizon–record identification, and the common screen/electroweak load-carrier identification. No QCD or hadronic backend is a dependency of this program.

Outer/inner self-consistency for the pixel ratio. This synthesis paper is the canonical place where the local pixel ratio P is defined, so the compact and particle papers can cite one derivation rather than duplicate it. The construction has six steps.

1. **Outer pixel ratio.** The outer-side local screen datum is the dimensionless area ratio

$$P := \frac{a_{\mathrm{cell}}}{\ell_\star^2}.$$

   Here $\ell_\star^2 = 3\pi/B_\star$ is supplied by the selected scale certificate. After that scale is emitted, it is displayed in SI language as the Planck area.

2. **Exact equilibrium benchmark.** The total/bulk/edge hierarchy has one exact self-similar balance point. Writing

$$x(C) := \frac{S_{\mathrm{gen}}(C)}{S_{\mathrm{bulk}}(C)} = 1 + \frac{\langle L_C \rangle}{S_{\mathrm{bulk}}(C)},$$

   the self-similar balance condition

$$\frac{S_{\mathrm{gen}}(C)}{S_{\mathrm{bulk}}(C)} = \frac{S_{\mathrm{bulk}}(C)}{\langle L_C \rangle}$$

   gives $x^2 - x - 1 = 0$ and hence $x = \varphi = (1+\sqrt{5})/2$. The realized branch must sit near, but not exactly at, this point because exact equilibrium is too symmetric to support durable records, structure, and dynamics.

3. **Outer detuning variable.** On the declared closure surface we parametrize the outer-side detuning by

$$\alpha_{\mathrm{ext}}(P) := \frac{P-\varphi}{\sqrt{\pi}}, \qquad \text{equivalently} \qquad P = \varphi + \alpha_{\mathrm{ext}}(P)\sqrt{\pi}.$$

4. **Declared quantitative anchor from the same pixel.** Let $I \subset \mathbb{R}_+$ be the physical pixel interval and let

$$F_{D10} : I \longrightarrow \mathcal{D}_{D10}$$

   denote the declared D10 source map. For any trial $P \in I$, the forward D10 lane emits

$$P \longmapsto \alpha_U(P) \longmapsto (t_U(P), t_{\mathrm{tr}}(P)) \longmapsto (t_2(P), t_3(P), v(P)) \longmapsto A_Z(P) = \alpha_{\mathrm{em}}^{-1}(m_Z^2; P).$$

5. **Ward-projected Thomson transport.** Let T_Q be the required Ward-projected $\mathrm{U}(1)_Q$ transport operator from the m_Z-anchor to the Thomson limit. The complete source-only operator is not emitted. A comparison branch may insert the measured endpoint $\alpha^{-1}(0) = 137.035999177(21)$, while the separate empirical branch carries the published hadronic compilation and returns 136.3827548175 on $[136.3670480603, 136.3984651934]$. For either declared branch, define

$$A_T(P) := T_Q\big(A_Z(P), F_{D10}(P)\big) = \alpha_{\mathrm{Th}}^{-1}(P).$$

   The inner coupling used in the outer/inner closure is the coupling, not the inverse coupling:

$$\alpha_{\mathrm{in}}(P) := \frac{1}{A_T(P)}.$$

6. **Closure.** The realized pixel ratio is the fixed point for which the outer detuning equals the inner observation coupling:
$$\alpha_{\mathrm{ext}}(P) = \alpha_{\mathrm{in}}(P).$$
Equivalently,
$$H(P) := P - \varphi - \frac{\sqrt{\pi}}{A_T(P)} = 0, \qquad \text{or} \qquad P = \varphi + \frac{\sqrt{\pi}}{A_T(P)} = \varphi + \alpha_{\mathrm{in}}(P)\sqrt{\pi}.$$

Writing
$$G(P) := \varphi + \frac{\sqrt{\pi}}{A_T(P)},$$
the closure problem is the fixed-point condition $G(P) = P$. On any physical interval where this induced map is a self-map and a contraction, the closure root is locally unique. Equivalently, the solver can use
$$H(P) := P - \varphi - \frac{\sqrt{\pi}}{A_T(P)}$$
and accept the unique zero of H on the declared branch interval. Observer-facing data may localize that interval. The measured endpoint cannot replace the closure solve.

The closure interpretation assigns one screen cell two coupled roles. On the outer side it is one cell of the screen whose displacement above the exact self-similar equilibrium φ sets the geometric detuning. On the inner side the same cell emits the smallest electromagnetic observation step available on the particle branch. The pixel ratio P is the size of that cell in units of the scale-certificate area $\ell_\star^2$, and the realized P is the value at which those outer and inner readings agree. The fixed-point equation is the mathematical form of that consistency condition. On the measured-endpoint comparison branch, the root is
$$P_C \simeq 1.6309682094, \qquad \alpha^{-1}(0) = 137.035999177(21).$$
This is a comparison coordinate inferred from the measured endpoint. It does not define the pixel used by the theory. The source solve's unique root is the closure point, and the difference between the two is the loop residual: 3.0×10^{-4} relative on the source chain and 2.5×10^{-6} relative (about 1.6×10^4 measurement sigma) for the certified self-consistent gauge-width fixed point $\alpha^{-1} = 137.035660136946577\ldots$, a certified fixed point of the declared map with the Ward-projected hadronic transport open. Distinct coordinates describe the audit. The certified source/root witness is $136.994835177413\ldots$. The mixed-provenance no-hadron diagnostic is $137.0359595136\ldots$; it mixes the inner value at P_{fwd} with α_U at the comparison pixel, is no fixed point, and is excluded from physical output. The external-data empirical closure is 136.3827548175 on $[136.3670480603, 136.3984651934]$, and the measured endpoint is 137.035999177(21). The empirical interval requires a same-scheme correction in $[0.6198609041, 0.6505569679]$ inverse-alpha units, and the standard on-shell reference deficit 0.631 lies inside that certified interval. A zero-momentum laboratory measurement sees the dressed $\mathrm{U}(1)_Q$ current after charged-lepton vacuum polarization, confined-quark/hadron spectral transport, and same-scheme endpoint matching. A source-only fixed point requires the missing source-derived hadronic spectral transport and its dependency certificate.

The claim table records the source-audit trunk, mixed diagnostic, empirical endpoint, measurement, and interval disclosures. Downstream quantities inherit the provenance of whichever declared pixel branch they use. A separate hardware note reports an optical-cavity check of the same fixed-point geometry; this is treated as corroborating engineering evidence. The same closure equation also admits an inverse observational use case in which observers infer P and total screen capacity from inside the world.

One source-only route studies the closure directly at zero momentum. It requires a self-contained hadronic transport law rather than the external empirical compilation used by the audit.

Non-hadron output surface. For quick orientation, the non-hadron output surface consists of receipt-gated classical carrier modes with no promoted quantum mass rows, the exact electroweak selected-carrier chart, the conditional value-law implication, the distinct reference-fitted inverse adapter, the conditional downstream Higgs/top coordinate, a same-family charged witness, and the common-scale rejection of the reciprocal-ray quark texture. The generic quark interface has six scalar coordinates, and no source-derived flavor-orbit selector is emitted. The rejected weighted-cycle neutrino candidate is retained as a comparison and falsification record, outside the exact-output surface. This synthesis paper uses those facts as lane markers. Ref. [6] carries the exact values, supporting surfaces, diagnostic sidecars, and per-sector caveats.

Extended derivation. The structural-to-family route and the full per-sector claim-tier audit are developed in *Deriving the Particle Zoo from Observer Consistency* [6].

6 Screen Microphysics, Records, and Observer Continuation

The screen-microphysics lane is the engineering side of the paper corpus. It asks whether some microscopic model might exist in principle and gives one explicit regulated carrier architecture: a federation of finite observer patches with echosahedral multi-port interfaces, recurrent toroidal subchannels, exposed overlap data, records, repair instruments, and observer-facing interfaces all made concrete at fixed cutoff. A spherical screen is used there only as an observer-facing regulator chart for support-visible cuts, not as a claim that the universe is a literal spherical quantum computer.

This lane has five theorem-bearing components. First, the reference architecture itself is explicit. Second, the regulated patch-net embedding theorem is closed on its fixed-cutoff object/local-interface surface, and the edge-sector thermal/Casimir branch carries an explicit fixed-cutoff law with one compact lift above that theorem surface. Third, the fixed-cutoff measurement/Born-rule package is closed on its declared operator and record-event surface. Fourth, the fixed-cutoff Bell/CHSH package is closed on the declared two-wing surface. Fifth, the checkpoint/restoration observer package is closed. The downstream boundaries on this lane are packet-level quotient closure where one wants an autonomous exported dynamics, compact-group/Peter–Weyl bookkeeping on the D10/compact surfaces, fair-block contraction certificates for long-run noisy approximate consensus on exported packet nets, and model-family universality. The support-visible BW / geometric-modular / local-Einstein closure lives on the companion recovered-core papers rather than on this fixed-cutoff engineering lane. A reconstruction of Hilbert, C^*- or von Neumann algebra structure, Born probabilities, trace structure, and entropy from operational records alone is a separate question outside this synthesis lane.

Reference-architecture takeaway. The synthesis-level point is that the regulated screen-side architecture supplies a concrete habitat in which local observables, overlap observables, record registers, and synchronization maps can all be written without pretending to identify a unique final UV completion. Hardware evidence is not imported by this synthesis theorem surface unless it appears in a public, hash-stable OPH evidence bundle. The OPH-FPE simulator repository is the corresponding finite-run software surface for emitted receipts and replayable OPH experiment bundles [12].

Imported theorem from Ref. [5] (Fixed-cutoff record algebra and Born-Lüders package). For each completed compare/write/verify slice of the regulated microphysics, the declared pointer and overlap-sector projectors generate a finite commutative central record algebra

$$\mathcal{Z}_{\rm rec}.$$

Every observer-accessible event E in that algebra has probability

$$\mathbb{P}(E) = \mathrm{Tr}(\rho P_E),$$

and conditioning on E gives the operational post-measurement state

$$\rho|_E = \frac{P_E \rho P_E}{\mathrm{Tr}(\rho P_E)}.$$

If a practical readout instead uses projectors Q_a with commuting central reference projectors $\widehat{Q}_a$ on the same declared slots and

$$\delta_{\rm rec} = \max_a \|Q_a - \widehat{Q}_a\|,$$

then

$$\|[Q_a, Q_b]\| \leq 4\,\delta_{\rm rec},$$

and any accessible-state perturbation $\|\widetilde{\rho} - \rho\|_1 \leq \varepsilon$ changes each declared elementary record-event probability by at most $\varepsilon + \delta_{\rm rec}$.

The charged-family audit contains one engineered witness for this distinction. Inside a bounded finite patch, eight local register graphs and eight declared paths contain 6,467 matrix units. A noncentral event projection is read into a central two-valued accepted/rejected record, and sixty A_5 charts verify the declared equivariance. The evidence bundle proves that the stipulated fixed-cutoff schema is nonempty. Its register sizes, path automaton, signs, clock, and response are authored, while inert ancillary stabilization does not supply a cofinal physical refinement. The witness therefore connects event readback to a public record at fixed cutoff; it does not select the charged source, recovery law, family attachment, or physical pole.

Imported theorem from Ref. [5] (Fixed-cutoff Bell / CHSH package). On the declared fixed-cutoff physical observable algebra, fix commuting left/right wing subalgebras, central binary setting registers, binary projective readouts on each wing, and a physical source state on the joint wing algebra. Then the compare slice carries the joint law

$$p(a, b \mid x, y) = \mathrm{Tr}\big(\rho_{LR}\, P^{(L)}_{a|x} P^{(R)}_{b|y}\big),$$

the local marginals are independent of the remote setting, the Bell correlators satisfy

$$E(x, y) = \mathrm{Tr}\big(\rho_{LR}\, A_x B_y\big),$$

and the CHSH combination obeys

$$\big|E(0,0) + E(0,1) + E(1,0) - E(1,1)\big| \leq 2\sqrt{2}.$$

If the source family contains an explicit two-qubit branch with the stated Pauli readouts, the same fixed-cutoff surface saturates $2\sqrt{2}$ exactly on that branch. The source-state input is explicit: the theorem derives the Bell law and the Tsirelson bound from the stated fixed-cutoff operator surface, while Bell-pair preparation and two-qubit factor structure are stated branch conditions.

Imported theorem from Ref. [5] (Checkpoint/restoration and observer backup). For an observer patch P_O, let the checkpoint data consist of the observer-facing record algebra, the accessible local state, the future update schedule, and the externally visible overlap interface data. Exact restoration reproduces the full future law of observer-accessible events, while an ε-accurate restoration changes that future law by at most ε in total variation.

Observer-facing conclusion. The theorem-level content is modest but sharp: the paper corpus supplies a fixed-cutoff measurement interface, a fixed-cutoff checkpoint/restoration package, and an operational observer-identity criterion on observer-accessible event algebras. Stronger substrate-selection or strange-loop closure claims are outside the recovered theorem package.

Extended derivation. The fixed-cutoff edge-law, measurement, Born-rule, Bell/CHSH, and checkpoint/restoration packages are developed in *Federated Echosahedral Screen Microphysics: Patch Hardware, Records, and Observer Synchronization in OPH* [5].

7 Worldsheet/String Branch

The synthesis paper carries the string/worldsheet branch on the same theorem boundary used across the paper corpus: a genuine theorem-level bridge from the edge-sector theorem surface to the two-dimensional Yang–Mills partition function, followed by a controlled large-N_{edge} effective-description theorem on the stated branch. This two-dimensional heat-kernel partition statement and declared-branch large-edge effective description sit beside the Standard Model gauge paper's conditional support-visible compact-gauge four-dimensional Yang–Mills form and repair-gap theorems, whose continuum identification and gap transport require the separately named receipts.

Imported theorem (Heat-kernel edge-sector bridge). Import the fixed-cutoff same-overlap edge-law package from *Federated Echosahedral Screen Microphysics* [5]. Under the same overlap-gauge realization and local-Gibbs/MaxEnt edge branch, together with the edge-Hamiltonian and one-sided-algebra hypotheses (EH-1)/(EH-2) of Theorem 6.20 (the sector probabilities are the one-sided d_R convention; the closed partition below is the two-sided d_R^2 convention), the edge-sector weights satisfy

$$p_R(t) \propto d_R e^{-tC_2(R)}.$$

Consequently the edge partition function matches the standard two-dimensional Yang-Mills heat-kernel form. The Standard Model gauge paper carries OS/Wightman-strength continuum reconstruction for the four-dimensional Euclidean Yang–Mills form and the OPH mass-gap claim separately on the support-visible compact-gauge branch.

Imported proof route. The microphysics source surface carries the fixed-cutoff thermal/Casimir law on the declared overlap interface. Peter–Weyl decomposition [50] then identifies the resulting sum with the standard heat-kernel expression for two-dimensional Yang-Mills on the compact-group refinement lift.

Compact-carrier theorem. Writing the closed edge partition function as

$$Z_{\text{edge}}(t) = \sum_R d_R^2 e^{-tC_2(R)},$$

the compact carrier states the exact bridge itself as a named theorem: Peter–Weyl identifies it with the compact-group heat kernel at the identity,

$$Z_{\mathrm{edge}}(t) = K_t(1).$$

The Chapman–Kolmogorov gluing law for K_t is the precise sense in which collar sewing matches the two-dimensional Yang–Mills heat-kernel surface before any large-N_{edge} continuation is invoked. The compact carrier is a partition-identity theorem on its stated branch. The four-dimensional OPH claim identifies the compact-gauge branch with the Euclidean Yang–Mills form and applies the repair-dynamics theorem on that same support-visible branch.

Controlled large-N_{edge} branch. Fix a distinct large-N_{edge} realization, with $N_{\mathrm{edge}} \neq N_c = 3$, and the fixed-$\tau$ variable

$$\tau = tN_{\mathrm{edge}}$$

on a compact window I. If the resulting edge free energy satisfies the Standard Model gauge paper's large-N_{edge} criterion, with remainder control on I, then the Gross-Taylor rewriting [49] is a controlled theorem-level worldsheet effective description of the edge dynamics on that branch. Critical-superstring claims, worldsheet CFT closure, anomaly cancellation, and full massless-spectrum matching are outside the recovered core theorem package.

Higher-gauge continuation slot. The genuinely noncentral crossed-module gluing data on cuts provide the natural continuation-level slot for B-field / gerbe data in any string-style reorganization of the OPH edge sector. This is a structural analogy only; it is not an open/closed-string boundary formalism or a critical-string theorem.

8 Cross-Lane Theorem Boundary and Continuation Directions

The paper corpus has the following theorem boundary:

1. The fixed-cutoff collar, higher-gauge, consensus, record, Bell/CHSH, checkpoint, and restoration packages are theorem-bearing on their stated finite-regulator surfaces.
2. Physical UV uniqueness is quotient-level and stable under inert ancillas. OPH fixes terminal values on declared physical observables, not a unique microscopic representative.
3. The Lorentz and null-modular chain is closed on the support-visible refinement/scaling branch by the finite cap-normal BW scaling theorem on the geometric subnet. Its two inputs are the finite cap-normal support/flow certificate and an independently complete MGNS-1 algebra-state package on the same tower. Fixed-collar Markov replacement with carried r_{FR}, δ^{M}, and regularized modular remainders, support-readable modular covariance, support-order faithfulness, BW framing, held-out oriented cross-ratio rigidity, and independently normalized geometric 2π-KMS convergence make the cap modular automorphism geometric. The compact cap-normal theorem then identifies S^2 with projective future null rays $q(\Omega) = (1, \Omega)$, represents oriented round caps by $n_C = (\cot\alpha, \csc\alpha\, \mathbf{c})$, proves the signed incidence formula, and obtains $n_{gC} = \Lambda_g n_C$ and $H^3 \simeq \mathrm{SO}^+(3,1)/\mathrm{SO}(3)$. This is not a finite-cell Lorentz-invariance claim, a one-shot upgrade from small CMI to exact Markov geometry, a proof that bare finite consensus produces the cap-normal certificate, or a populated/neutral-bulk claim. The absolute Einstein implication additionally requires one source-derived common-domain tower carrying the event,

stress, entropy, uniform-asymptotic, universal-coupling, vacuum-reference, and independent-scale premises. Construction and certification of that tower are work in progress.

4. Record-conditioned observer-frame estimation in H^3 is a separate conditional theorem: calibrated modular cap responses select a frame value only when they factor through frame-local H^3 data on a compact domain and the finite cap frame has $\alpha > 0$. Exact data identify one frame value; finite noisy data produce a frame ball, and a unique finite value requires a positive residual gap Δ_{loc}. This does not locate an event, populate the event base, derive particle species or stress-energy, or construct chart-blind neutral bulk.

5. The cosmological constant branch has a closed conditional implication layer and an open execution/identification surface. The descended semantic checkpoint packet defines exact public capacity as the independence number of the compound confusability graph at finite integer dimension. Under a faithful carrier representation and whole-fiber scalarization it is deflationary; under a confusability-reflecting capacity embedding, top-down iteration selects its greatest fixed point, while fixed-capacity refinement injections imply eventual exact stabilization. The record-atom maps, reachability, publicness policy, global coupling, carrier representation, whole-fiber agreement, and finite-size slack law are source constructions in progress. The horizon–record identification then gives $\Lambda_{\text{CRC}}\ell_\star^2 = 3\pi/N_{\text{CRC}}$, and the common screen/electroweak load-carrier map separately gives the electroweak bridge. A diagonal normal-form count constructs neither the off-diagonal map nor deterministic closure. The operational resolution experiment is an independent test rather than the producer.

6. Incidence and target-blind port readback derive the finite response and current algebra. Under the declared fermionic Spin category, anomaly-forced determinant balance and tensor descent give exact hypercharge, $N_c = 3$, the common $\mathbb{Z}_6$ kernel, and the maximal faithful matter image from those premises alone. Physical matter typing and global-form selection are open. Compact gauge reconstruction uses the theorem-produced combined transportability criterion and fixed-cutoff tensor-generated bosonic sector category. On a cofinal tail carrying the explicit compact-gauge refinement receipt, the bosonic refinement ladder and compatible forgetful fibers reconstruct a compact group from sectors with strictifiable central or higher-associator defects and at least one allowed trivial-holonomy strict representative. That is a distinct conditional classification route. The three-generation count and the extra-sector statement enter as declared completions. Laboratory current identification, equality with the Tannaka current, and the physical rank-45 family attachment are open.

7. The particle branch is sector-split. Electroweak W/Z has an exact selected-carrier chart, a conditional value law whose finite-carrier certificate is not emitted, and a separate reference-fitted inverse adapter. Higgs/top is conditional on its declared downstream surface. The reciprocal-ray quark candidate fails on dimensionless common-scale Yukawas, while the exact generic interface has six scalar coordinates and no source-derived flavor-orbit selector. Its sub-percent residuals use a target-anchored mixed-convention chart. The particle simulator contains no Yukawa coupling and returns a null calibration result. The weighted-cycle neutrino candidate is rejected, charged-lepton source landing is open despite the engineered fixed-cutoff record witness, and source-only hadron masses require a production OPH backend. The empirical hadron endpoint is an external-data validation surface rather than that backend.

8. The string/worldsheet branch is a controlled heat-kernel continuation branch. The critical-string selector is a separate gate on top of that edge-language branch.

Local unification boundary. At the synthesis level, one local unification surface is explicit and one uniform theorem tier for c, G, W, Z, and H is absent. The declared local input P governs the electroweak/Higgs trunk and fixes the matching between cell area and edge entropy. The gravity normalization is emitted by the selected scale certificate, while the invariant causal speed c is structural from the Lorentz branch and gains its SI label only on the local readout package.

Quantity	Best value on the paper surface	Common paper-surface chain	Caveat
$c_\star$	299792458 m/s by SI definition	structural Lorentz/BW branch $\to$ common invariant null cone/speed $\to$ SI unit convention	the common cone and dimensionless speed equality are structural; the decimal magnitude is not predicted
G	$6.674299995910528 \times 10^{-11}\ \mathrm{m}^3\,\mathrm{kg}^{-1}\,\mathrm{s}^{-2}$ on the stated local extension surface	$\gamma_\star = \ell_\star \nu_{\mathrm{Cs}}/c$, $B_\star = 3\pi/\ell_\star^2$, $a_{\mathrm{cell}} = P\ell_\star^2$, $\bar{\ell}_{\mathrm{shared}} = P/4$, $G_{\mathrm{SI}} = c^3\ell_\star^2/\hbar$	the pixel fixes the shared cell/edge identity and cancels in the Newton area law; the strict classical-regime clause is explicit
M_W	no nonzero source-only physical mass emitted	selected carrier $\to$ exact chart; quotient-transport assumptions $\Rightarrow$ conditional value law; inverse target adapter separate	the finite-carrier certificate is not emitted, and no pole mass is promoted
M_Z	no nonzero source-only physical mass emitted	same chart, conditional law, and separate adapter	same source-certificate and pole-mass boundary
M_H	no nonzero source-only physical mass emitted	double-criticality family from the gauge sector $\to$ frozen boundary-scale candidate $(m_H, m_t) = (125.77, 172.63)$ GeV	inherits the boundary-scale selection theorem plus the source-root, physical-scale, running, matching, rigidity, provenance, uncertainty, and complex-pole gates

Conditional electroweak audit coordinates. The strictest target-free W/Z branch is the source-audit zero-selector law, $(80.330, 91.119)$ GeV, with no target input and a single discrete two-law choice. This is a running/chart coordinate, not a physical pole-mass prediction. The source does not close the renormalized-vev, tadpole, field-content, threshold, matching, running, complex-pole, or theory-covariance map needed to compare it with measured resonance parameters, so its numerical proximity carries no mass evidence. For the PDG-2026 reference pair, the exact convention map gives energy-pole masses $(M_W, M_Z) = (80.3411410, 91.1623040)$ GeV, while the separate legacy coordinates $\sqrt{\mathrm{Re}\, s}$ are $(80.3340218, 91.1537725)$ GeV. The running/chart coordinates have no OPH theory covariance, the physical readout contract is open, and no pull is assigned. The selected carrier, conditional value law, and reference-fitted inverse adapter give the downstream audit coordinates

$$\begin{aligned} \text{selected carrier} \quad & (80.3862916924, 91.1829044467)\ \mathrm{GeV}, \\ \text{conditional value law} \quad & (80.3770000154, 91.1879780779)\ \mathrm{GeV}, \\ \text{reference-fitted inverse adapter} \quad & (80.3625, 91.1879)\ \mathrm{GeV}. \end{aligned}$$

The Higgs/top pair is read on the double-criticality branch, whose frozen boundary-scale candidate $E_\star e^{-\pi} P^{-1/6}$ gives $(m_H, m_t) = (125.77, 172.63)$ GeV at two loops, with $m_H = 125.72$ GeV on the fit-free curve at the measured top; the declared calibration surface $(125.1995304097, 172.3523553288)$ GeV is a target-anchored fit. These coordinates are excluded from the particle-output ledger.

The local finite package supplies the strict classical-regime clause and the exact selected-carrier chart. The electroweak value law is conditional on the finite quotient-transport certificate. The familiar-unit display split on that same surface is

$$L_{\mathrm{loc}} = \sqrt{a_{\mathrm{cell}}}\, \widehat{L}(P), \qquad t_{\mathrm{loc}} = \frac{\sqrt{a_{\mathrm{cell}}}}{c}\, \widehat{T}(P),$$

$$E_{\rm loc} = \frac{\hbar c}{\sqrt{a_{\rm cell}}}\,\widehat{E}(P), \qquad \Theta_{\rm loc} = \frac{\hbar c}{k_B\sqrt{a_{\rm cell}}}\,\widehat{\Theta}(P),$$

with dimensionless $\widehat{L}, \widehat{T}, \widehat{E}, \widehat{\Theta}$. The gravity-side shared-edge identity fixes the cancellation of P, while the local SI readout comes from $\ell_\star^2$. Meters, seconds, GeV, and Kelvin are downstream display conventions built from the structural c row and the familiar constants $\hbar$, k_B.

Companion papers. Detailed derivations appear in Refs. [2, 3, 4, 5, 6, 9, 10].

9 Conclusion

This paper presents the full framework on one synthesis surface. The three-axiom basis, the derived gravity and gauge branches, the consensus formulation, the particle-spectrum branch, the regulated screen-microphysics lane, the fixed-cutoff measurement and observer package, and the controlled large-$N_{\rm edge}$ worldsheet effective-description branch appear on one common synthesis surface.

The corpus states its position exactly. Its frozen numerical maps introduce no continuously tunable fit dials; they define candidate constants by closure equations and certify by interval arithmetic that each declared fixed-point map has exactly one fixed point on its stated numerical domain. Open physical bridges remain named inputs rather than derived constants. Its finite analytic core establishes the consensus core and the capacity-coupling algebra, and its falsification program is restricted to mature non-cosmological claims with no locked-target registry. Forty-two adversarial findings identify no false theorem in the recovered mathematical core. Fail-closed gates and regression tests reject two implementation defects. The corpus supplies a sharp fixed-cutoff local picture, a derived recovered core for relativity and Standard-Model structure, labeled particle-side quantitative audit surfaces, and a usable microscopic engineering lane. The scope boundaries are equally explicit: the bounded-interval kernel in the null-stress branch, the cosmic record-capacity fixed point for the global branch constant, microscopic representative uniqueness, public validation artifacts for the electroweak rows, strong CP, full flavor/CKM closure, a source-derived flavor-orbit selector, charged-lepton source landing from the declared pixel branch, and source-only hadron masses without a production OPH backend. The quantitative work in progress reduces to four generating objects (the Ward-projected hadronic transport, the capacity readback map F, the certified forward electroweak chain, and solver hygiene) plus one source-derived flavor-orbit selector, each a computation or a construction rather than a reinterpretation. Refs. [2, 3, 4, 5, 6] are the depth surfaces for sector-by-sector proofs, quantitative details, and continuation-level material. The local cross-lane numerical surface is explicit enough to summarize concisely: the fixed point $P_\star$ organizes the bosonic mass trunk and the gravity-side shared edge-entropy identity beneath the emitted local G row, while the same familiar-unit package reads meters and seconds from the single ruler $\sqrt{a_{\rm cell}}$ together with the structural invariant speed c, and reads GeV and Kelvin from the inverse local ruler through $\hbar$ and k_B.

A Candidate Microphysics Finite Reference Checks

The synthesis paper records the finite echosahedral reference-model checks in an appendix. The reference object is a typed carrier/federation data structure, not a physical federation source and not a realization of observer patches, overlap observables, or a support S^2. Its verified content is finite and structural: one shared twelve-port 12/30/20 carrier template with antipode and A_5 action, typed collar bijections, orientation reversal, canonical finite matrix-algebra maps on individual seams, external-boundary coverage, presentation relabeling invariance, and a finite reference-tower commutation check.

Proposition (Finite carrier and seam conformance). For the declared finite reference objects, the checker recomputes local carrier conformance, seam bijectivity and orientation, endpoint algebra-schema agreement, the permutation-induced matrix-algebra isomorphism on each seam, boundary coverage, and the presentation firewall. The two-carrier reference fixture has no composable seam triangle. Its higher-overlap Čech condition is therefore true only vacuously, and its nonvacuous higher-overlap witness is false. A separate coherent-triangle control exercises the cocycle checker, but deliberately fails the positive federation-sewing conditions and cannot be combined with the reference fixture as a physical witness.

Consequently, the physical echosahedral-federation realization receipt and source-instrument gate are false. The level-zero through level-two naturality calculation is a finite diagram for the shared regular-icosahedron template; it selects no physical support chart and supplies no carrier-to-support S^2, H^3, event, BW, or KMS receipt.

Proof sketch. Each positive finite statement follows by exact recomputation on the declared template, seam maps, canonical matrix schemas, boundary declarations, and reference refinement maps. The absent composable seam triangle prevents a nonvacuous higher-overlap witness. No measured physical carrier-to-patch identification or quotient-visible spherical-support map is present, so the structural checks cannot promote the physical federation, source, or support-screen gates.

Proposition (Fixed-cutoff edge heat-kernel calculation). For a separately declared finite sector kernel satisfying weighted proposal symmetry and the Casimir acceptance rule, the stationary sector law is

$$\pi_\beta(\alpha) \propto d_\alpha e^{-\beta C_2(\alpha)},$$

and along a separately assumed refinement ladder converging to a compact-group Peter–Weyl decomposition [50] the same weights converge cylinderwise to the heat-kernel/Casimir law used in the OPH edge-sector branch.

Proof sketch. The finite proposal kernel is chosen so that the weighted proposal symmetry $d_\alpha q_{\alpha\beta} = d_\beta q_{\beta\alpha}$ holds. Detailed balance with the Casimir acceptance rule then fixes the stationary distribution in finite dimension. The compact-group heat-kernel law is the conditional refinement lift. Neither calculation supplies the missing physical federation, source-instrument, or support-S^2 receipt.

Extended derivation. The finite candidate model, validation package, and conditional theorem stacks are developed in *Federated Echosahedral Screen Microphysics* [5].

B Interpretive Epilogue: State-and-Law Habitat

This appendix records the OPH state-and-law habitat available inside the framework. A strange-loop closure theorem is outside this appendix.

The OPH inputs used here are:

1. the patch net $P \mapsto A(P)$ of von Neumann algebras together with isotony and overlap restriction maps;

2. a compatible local state family, plus the separately declared global-extension interface used by this appendix to represent it on the inductive-limit algebra;

3. the finite Axiom-3 information-projection branch and the separate optimizer-pushforward interface, which together supply a common finite family of gauge-invariant local constraint observables across cutoffs;

4. on the fixed-cutoff branch, the derived finite type-I presentations and compact boundary gluing groups used elsewhere in the OPH package.

The law slot is encoded by the finite expectation-value coordinates of the retained A1-generated constraint family used by Axiom 3. That choice furnishes a compact convex state-and-law habitat for the framework.

Theorem (Internal state-and-law habitat theorem). Fix finitely many screen patches $P_1, \dots, P_N$ in the standard OPH setup. For each i, let

$$M_i := A(P_i), \qquad M_{ij} := A(P_i \cap P_j),$$

where M_i is the patch von Neumann algebra and $M_{ij} \subset M_i, M_j$ is the overlap algebra. Let

$$S_i := S(M_i) \subset M_i^*$$

be the full state space of M_i, endowed with the weak* topology $\sigma(M_i^*, M_i)$.

Choose a finite family of self-adjoint gauge-invariant local constraint observables

$$\mathcal{O} = \{O_1, \dots, O_m\}$$

from the A1-generated Axiom-3 constraint grammar, with each O_a supported in one of the chosen patches; write $i(a)$ for an index such that $O_a \in M_{i(a)}$.

Define the overlap-consistent state sector

$$X_{\text{ov}} := \left\{ (\omega_1, \dots, \omega_N) \in \prod_{i=1}^N S_i : \omega_i|_{M_{ij}} = \omega_j|_{M_{ij}} \text{ for all } i, j \right\}.$$

Define the OPH law-coordinate map

$$c : X_{\text{ov}} \to \mathbb{R}^m, \qquad c(\omega_1, \dots, \omega_N) := \big(\omega_{i(1)}(O_1), \dots, \omega_{i(m)}(O_m)\big).$$

Let

$$X_{\mathcal{O}} := \left\{ (\omega_1, \dots, \omega_N, \ell) \in \left(\prod_{i=1}^N S_i \right) \times \mathbb{R}^m : (\omega_1, \dots, \omega_N) \in X_{\text{ov}},\ \ell = c(\omega_1, \dots, \omega_N) \right\}.$$

Then:

1. the ambient product

$$E := \left(\prod_{i=1}^N M_i^* \right) \times \mathbb{R}^m$$

is a Banach space for any product norm;

2. $X_{\mathcal{O}}$ is nonempty and convex;

3. $X_{\mathcal{O}}$ is norm-closed in E;

4. $X_{\mathcal{O}}$ is compact in the product topology

$$\tau := \left(\prod_{i=1}^{N} \sigma(M_i^*, M_i)\right) \times \text{Euclidean topology on } \mathbb{R}^m;$$

Proof. Each M_i is a von Neumann algebra in the OPH patch net, hence a Banach space, so each dual M_i^* is Banach. A finite product of Banach spaces is Banach, hence so is E.

For each i, the state space

$$S_i = \{\omega \in M_i^* : \omega \geq 0,\ \omega(1) = 1\}$$

is convex and weak* compact by Banach–Alaoglu, because it is a weak* closed subset of the dual unit ball. For every pair (i, j), restriction along $M_{ij} \subset M_i$ and $M_{ij} \subset M_j$ defines affine weak* continuous maps

$$r_{ij} : S_i \to S(M_{ij}), \qquad r_{ji} : S_j \to S(M_{ij}).$$

Hence X_{ov} is an intersection of affine equalizer sets, so it is convex and τ-closed inside $\prod_i S_i$. Since $\prod_i S_i$ is compact and convex in the product weak* topology, X_{ov} is compact and convex as well.

Nonemptiness comes from the OPH global state on the inductive-limit algebra: its restrictions

$$(\omega|_{M_1}, \ldots, \omega|_{M_N})$$

belong to X_{ov} because the restrictions agree on every overlap by construction.

Each coordinate $\omega_{i(a)} \mapsto \omega_{i(a)}(O_a)$ is affine and weak* continuous, since evaluation at a fixed algebra element is weak* continuous. Thus c is affine and τ-continuous. The graph map

$$G : X_{\text{ov}} \to E, \qquad G(x) := (x, c(x)),$$

is affine and continuous, so its image $X_{\mathcal{O}} = G(X_{\text{ov}})$ is convex and τ-compact.

To see norm-closedness in E, let $(x_n, c(x_n)) \to (x, \ell)$ in norm. Norm convergence implies weak* convergence on each coordinate, so $x \in X_{\text{ov}}$ because X_{ov} is weak* closed. Since c is weak* continuous, $c(x_n) \to c(x)$, while norm convergence in $\mathbb{R}^m$ also gives $c(x_n) \to \ell$. Hence $\ell = c(x)$, so $(x, \ell) \in X_{\mathcal{O}}$.

Finally, $X_{\mathcal{O}}$ is a compact convex subset of the locally convex topological vector space E equipped with τ. $\square$

The additional inputs needed for a strange-loop closure theorem are:

1. a closure map T built from internal operations such as overlap repair, Axiom-3 information reprojection, an explicit collar-recovery interface, and record-sector coarse-graining;

2. a proof that the stronger "observer-supporting" or "selected-world" criteria carve out a nonempty T-invariant observer-supporting subset of $X_{\mathcal{O}}$;

3. any uniqueness, contraction, or Lyapunov-type stability estimate for that closure map.

The habitat theorem supplies only the ambient Banach/compact-convex setting. It does not define a canonical internal self-map, it does not identify any nonempty invariant observer-supporting subset, and it does not prove uniqueness or stability. In particular, nonemptiness and compact-convexity of the ambient habitat do not by themselves imply the existence of a nonempty invariant observer-supporting sector. This does not erase the exact finite packet branch proved on the consensus surface: there the quotient normal-form map pushes forward to a continuous affine idempotent self-map of the finite packet simplex, with fixed points exactly the packets supported on quotient normal forms. Any further strange-loop reading of the ambient habitat as a closure story for existence is interpretive only and is not part of the recovered theorem package.

B.1 Additional Problem Closures

Using the claim classification of Section 3, the broader closure claims read as follows. The table also records appendix-tier closure stories inside the official claim ledger. "Declared-branch corollary" means proved under the named branch conditions and cited companion-paper theorem surfaces.

Claim	Status	Boundary
Quantum gravity consistency	Conditional theorem under explicit receipts	The Einstein relation follows from one source-derived common-domain tower carrying the geometric modular, null, event, entropy, certified-tail, coupling, vacuum, and scale premises. Construction and certification of such a tower are work in progress.
UV completion / microscopic uniqueness	Separate scope boundary	Fixed-cutoff theorem packages exist, but a unique microscopic representative is not identified. The support-visible BW scaling theorem and the receipt-certified realized combined-zero-obstruction bosonic compact-gauge branch (central or higher-associator strictification plus an allowed trivial-holonomy strict representative) are closed on their declared companion-paper theorem surfaces; the separate boundary is microscopic representative uniqueness rather than a missing recovered-core lift.
Measurement problem	Separate scope boundary	Ref. [5] closes the fixed-cutoff central-record / Born-Lüders interface, but a full philosophical or continuum-level measurement closure is not derived here.
Cosmological principle and horizon homogeneity	Separate scope boundary	MaxEnt symmetry inheritance is suggestive only; an independent derivation of cosmological isotropy and homogeneity sits outside the recovered-core theorems.
Observer-relative modular ordering	Declared-branch corollary	On the BW_{S^2} geometric branch, the cap modular automorphism parameter supplies a dimensionless ordering for the observer's accessible algebra/state pair. This is the D3 reading only; physical time additionally requires an observer-readable transition, event correspondence, and calibrated clock instrument.
Global / operational problem of time	Separate scope boundary	OPH does not prove a separate operational-clock theorem or a global solution of the problem of time.
Black-hole information paradox	Separate scope boundary	Edge-center sectorization and recoverability motivate an internal resolution template, but the full black-hole-information branch sits outside Phase I.
D6 cosmological-capacity closure	Conditional corollary	Conditional on a source-derived public checkpoint packet, stable whole-fiber closure $\mathfrak{F}_{r,0}(D_\star) = \{D_\star\}$, a unique physical zero of the finite-size slack, and horizon–record identification $N_{\mathrm{CRC}} = S_{\mathrm{dS}}$, one gets $\Lambda_{\mathrm{CRC}}\ell_\star^2 = 3\pi/N_{\mathrm{CRC}}$. The static-patch SI display additionally uses the selected OPH scale certificate. The 6.6 percent central-value mismatch with the independently derived electroweak/Higgs bridge is a registered comparison, not a contradiction or significance test before the common-carrier receipt closes and the joint cosmological posterior is propagated.
Bare cosmological-constant problem from local null data	Separate scope boundary	The local null-data route determines the Einstein branch only modulo Λg_{ab} and does not derive the screen-capacity identification from bare OPH axioms.

Claim	Status	Boundary
Magnetic cocharacter and simple-GUT monopole boundary	Matter-image corollary with source-bound global-form descent	Incidence and target-blind port readback derive the signed response and current algebra. The exhaustive 1024-subset anomaly scan selects the charge-conjugate rank-15 projector pair with the fermionic-parity grading as an output, and the measured transport double cover forces the Spin/odd-Weyl typing. The common central kernel is $\mathbb{Z}_6$ and the quotient by it is the maximal faithful image of the realized tensors. The cover and its $\mathbb{Z}_2$, $\mathbb{Z}_3$, and $\mathbb{Z}_6$ quotients carry the same local tensors; the selection is carried by the measured flux-sector menu, which realized matter transports single-valuedly and which matches exactly the $\mathbb{Z}_6$ quotient. The cocharacter $(1, 1, 1/6)$ and its electromagnetic multiple apply to that image, and the Dirac-pairing commutant theorem selects the electric polarization uniquely, with the magnetic classes entering as measured flux sectors rather than dynamical lines. Theta periodicity requires four-dimensional instanton-sector data. The product adjoint removes the simple-GUT X/Y production route, not all possible 't Hooft lines.
Gauge-mediated proton-decay boundary	Product-adjoint corollary	The connected product adjoint has no X/Y generator, so the standard simple-GUT channel is absent; general proton stability is not claimed.
Proton spin fraction	Separate scope boundary	The proton-spin claim requires nonperturbative QCD completion beyond Phase I.
Dark matter phenomenology	Separate scope boundary	Modular-anomaly response laws are conjectural beyond the recovered gravity chain.
Baryon asymmetry scale	Separate scope boundary	Suppression-counting estimates are not a substitute for a derived out-of-equilibrium mechanism.
Three generations	Conditional window with a declared completion	CKM capability and the weak-sector clause give $3 \le N_g \le 5$; the count inside the window is a declared completion. Physical rank-45 family attachment is open. Extra-sector, charged-lepton, and D10 branches carry their own declared premises.
Downstream flavor structure, Koide, and charged-lepton fits	Separate scope boundary	Companion flavor constructions require extra ansätze and sit outside the recovered core.
Edge-to-2D-YM / controlled large-N_{edge} worldsheet branch	Declared-branch corollary	On the stated overlap-gauge, local-Gibbs/MaxEnt, compact-group, and large-N_{edge} conditions, the edge-sector heat-kernel bridge and controlled Gross–Taylor worldsheet effective description are theorem-level. This is a two-dimensional partition and worldsheet-effective branch, separate from the four-dimensional compact-gauge theorem.
Support-visible compact-gauge Yang–Mills form and mass gap	Conditional theorem under explicit receipts	The finite compact-gauge cylinder system has a proof-bearing projective weak-* / GNS extraction. Identification with the four-dimensional Euclidean Yang–Mills state and the equality $\Delta_{\mathrm{YM}} = \Delta_{\mathrm{rep}}$ additionally require the renormalized Yang–Mills, finite ground-state-transform/cross-fiber, transfer/vacuum, OS-regularity/noncollapse, and uniform-gap receipts; extraction alone does not transport the gap.
Critical superstring / worldsheet CFT lift	Separate scope boundary	Critical-superstring claims, worldsheet CFT closure, anomaly cancellation, and full massless-spectrum matching require extra ingredients outside the recovered core.
Why anything exists / strange-loop closure	Separate scope boundary	Appendix B provides only the habitat theorem and fixed-point setting. The OPH closure map, invariant observer-supporting sector, and uniqueness/stability proofs are not part of this theorem package.
Fixed-cutoff checkpoint/restoration/backup	Fixed-cutoff theorem	Ref. [5] proves same-interface checkpoint/restoration and backup for observer-accessible event algebras with explicit future-law error control.
Substrate-transfer / stronger observer continuation	Separate scope boundary	Stronger substrate-selection, redesigned-environment continuation, strange-loop closure, uniqueness, and stability claims are outside this theorem package.

C Observer Continuation and Backup

This appendix uses the fixed-cutoff checkpoint/restoration/error/identity theorem package proved in Ref. [5] and summarizes its algebraic interface in observer language. It does not define a strange-loop closure map on an invariant observer-supporting sector or establish uniqueness and stability for such a map. Nor does it upgrade the fixed-cutoff theorem stack to continuation across redesigned environments: the proved package is same-interface restoration on observer-accessible event algebras with explicit error control.

C.1 Observer as Algebraic Pattern

For this appendix, use the support-local algebra-state-record reduct

$$O_{\text{red}} = (P, \mathcal{A}(P), \rho, R),$$

where P is a support-screen patch, $\mathcal{A}(P)$ is its local algebra, ρ is the local state, and R is the record algebra. The full operational observer also requires overlap interface algebras and restriction maps, allowed update or repair instruments, durable checkpointed records, and feedback/readback that can affect subsequent admissible behavior. Records are carried exactly by central record projectors and, on practical readout surfaces, by approximately commuting projectors in overlap centers, so they are shareable without violating no-cloning constraints for generic quantum states.

Ref. [5] proves a fixed-cutoff observer-facing measurement interface: a finite central record algebra, Born probabilities for its event projectors, and Lüders conditioning on that same commuting record algebra. This appendix uses that fixed-cutoff measurement package in observer language. If a practical readout uses projectors that are δ_{rec}-close in operator norm to that central reference algebra and the accessible state is perturbed by at most ε in trace norm, each declared elementary record-event probability shifts by at most $\varepsilon + \delta_{\text{rec}}$.

C.2 Markov Collar Factorization

For a collar tripartition A-B-D, the exact Markov normal form is used only when $I(A : D|B) = 0$ holds literally, or along a controlled fixed-collar family for which the exact-Markov replacement modulus $\delta^{\text{M}}_{A:B:D}(\varepsilon) \to 0$. In that exact or controlled limit one obtains

$$\rho_{ABD} = \bigoplus_{\alpha} p_\alpha \, \rho^{(\alpha)}_{Ab^\alpha_L} \otimes \rho^{(\alpha)}_{b^\alpha_R D}.$$

The sector label α is classical center data. This decomposition is the mathematical basis for extracting an interior observer state with a controlled boundary interface. Small CMI by itself supplies a recovered comparison state; it is not silently promoted to an exact Markov state.

C.3 Checkpoint and Restoration Map

A checkpoint is the tuple

$$\mathcal{C} = (R, \alpha, \rho^{(\alpha)}_{\text{int}}),$$

with $\rho^{(\alpha)}_{\text{int}}$ the interior state after fixing α. Given a compatible target environment state $\sigma^{(\alpha)}_{\text{env}}$, a restored state is

$$\rho^{(\alpha)}_{\text{new}} = \rho^{(\alpha)}_{\text{int}} \otimes \sigma^{(\alpha)}_{\text{env}}.$$

For approximate Markov collars, recovery is controlled by the standard bound

$$\|\rho_{ABD} - (\mathrm{id}_A \otimes \mathcal{R}_{B\to BD})(\rho_{AB})\|_1 \le 2\sqrt{1-e^{-\varepsilon}} \le 2\sqrt{\varepsilon}.$$

Here ε is measured in nats. This gives quantitative trace-distance control on the recovered comparison state under finite CMI (finite collar error). The exact HJPW splice form instead requires literal exact Markovity or the separate fixed-collar replacement modulus tending to zero, in each case together with the Markov-split alignment hypothesis of Section 2.3 identifying the HJPW factors with the preselected edge factors. Interpreting either control as observer continuation requires additional modeling assumptions beyond the bound itself.

The fixed-cutoff microphysics claim is stronger than the bare recoverability estimate written above. In Ref. [5], exact checkpoint restoration preserves the full future law of observer-accessible events, while an ε-accurate restoration changes that future law by at most ε in total variation. The stronger strange-loop / substrate-transfer closure story is outside this theorem.

C.4 Physical Meaning

At fixed cutoff, Ref. [5] proves a checkpoint/restoration theorem and backup corollary for observer-accessible event algebras. The proved package stops at same-interface backup/restoration with explicit future-law error control; stronger continuation and substrate-selection claims are outside it. This appendix states the observer-facing meaning of that theorem and its algebraic prerequisites. The stronger substrate-selection, strange-loop closure, uniqueness, and stability package is separate from the fixed-cutoff theorem.

D Cosmology, Horizons, and Modular-Anomaly Continuations

This appendix carries the cosmology- and continuation-facing technical statements for the synthesis paper. They do not enlarge the recovered core; they make the structural continuation boundary explicit on the synthesis surface.

D.1 Observer Registry and Clock-Naturality Certificate Contract

For finite exported observer systems, a theorem-faithful evidence bundle separates executor metadata from observer semantics. It contains:

(i) a semantic history DAG or labeled poset $\mathsf{H}_O = (E_O, \preceq_O, \ell_O)$, with event keys computed from semantic payload, observer token, visible footprint, and semantic parents;

(ii) a provenance envelope containing worker ID, repair iteration, retry count, queue position, timestamp, and packet latency, none of which may enter the semantic event key unless declared as physical input;

(iii) local observer registry groupoids with disjoint patch-observer, cap-observer, and future-observer namespaces, explicit birth-event classes, continuation arrows, split/merge lineage arrows, and overlap functors preserving those data;

(iv) a global registry descent certificate: cocycle agreement, trivial monodromy, no duplicate global observer identifiers, no mixed patch/cap/future namespace collisions, and no reuse of local anchor-patch identifiers as local observer indices;

(v) observer-algebra extraction data

$$\mathsf{ObsAlg}(\widehat{q}_{\mathrm{nf}}) = (\mathcal{A}_O, \omega_O, \mathcal{R}_O, \ldots)$$

whose outputs are state-preserving isomorphic for history-equivalent or implementation-equivalent terminal augmented normal forms;

(vi) a support-cap chart map J_O natural with those observer-algebra isomorphisms; and

(vii) a clock instrument Θ_O with affine reparameterization and residual bound for state, calibration, and record-readout errors.

Theorem D.1 (Finite observer-clock certificate soundness). *On a finite exported model, suppose the augmented repair relation on $\widehat{Q} = \{(q, [\mathsf{H}])\}$ terminates, terminal states are exactly the consistent physical states with completed semantic records, every augmented critical pair has a history-coherent join, implementation steps are linearizable to semantic commits or stutters, registry descent passes the groupoid cocycle and monodromy checks, and the observer-algebra/chart/clock maps satisfy the state-preserving and affine-residual certificates above. Then worker count, queue order, retry delivery, scheduler counters, and packet latency that is not declared physical input do not change the observer-readable history class, registry class, or clock law beyond the declared affine clock residual.*

Proof. Termination plus the augmented local diamond gives confluence by Newman's lemma for terminal history classes rather than only physical quotient states. Linearizability says every implementation execution projects to the same semantic relation up to stutters, so executor metadata cannot create new semantic events. Registry descent identifies the same global observer groupoid across local presentations. State-preserving observer-algebra extraction and natural support-cap charts transport the modular flow along the same observer identity, while the clock instrument certificate bounds the operational readout after the declared affine reparameterization. □

Remark D.2 (Falsifiers). *The certificate fails if semantic event identifiers depend on worker IDs, timestamps, queue positions, repair iteration counters, or retries; if duplicate retry delivery creates two visible record commits; if two namespaces collide in the global registry; if registry cocycles or lineage arrows fail on overlaps; if histories from two executors are not labeled-poset isomorphic; or if clock residuals exceed the declared bound. These are public evidence-bundle failures that exceed field-name mismatches.*

D.2 Cosmological Principle

Lemma 4.1 (MaxEnt symmetry inheritance). Let G act on the screen by automorphisms α_g. If the constraint set is G-invariant and von Neumann entropy is G-invariant, then the MaxEnt optimizer ω can be taken G-invariant. If the optimizer is unique, it is automatically G-invariant.

Theorem 4.2 (Isotropy from SO(3)-invariant constraints). Under SO(3)-invariant constraints and MaxEnt uniqueness, the reference state satisfies

$$\omega \circ \alpha_g = \omega \qquad \forall g \in \mathrm{SO}(3).$$

The corresponding stress tensor has perfect-fluid form:

$$\langle T_{ab} \rangle = \rho\, u_a u_b + p(g_{ab} + u_a u_b).$$

Theorem 4.3 (Schur-type homogeneity). Let (Σ, h_{ij}) be a three-dimensional Riemannian manifold. If at every point $p \in \Sigma$, the curvature tensor is SO(3)-invariant, then

$$R_{ijkl}(p) = K(p)(h_{ik}h_{jl} - h_{il}h_{jk}),$$

and the second Bianchi identity forces $\nabla_m K = 0$, so K is constant.

Corollary 4.4. If OPH supplies isotropy for all observers, spatial geometry is a constant-curvature space form: S^3, $\mathbb{R}^3$, or H^3.

Theorem 4.5 (FLRW emergence). With the semiclassical Einstein equation from the declared finite generalized-entropy, stationarity, stress, and continuum interfaces, a perfect-fluid stress tensor from the rotationally invariant information-projection branch, and positive Λ from finite screen capacity, the emergent geometry is FLRW:

$$ds^2 = -dt^2 + a(t)^2 \left(\frac{dr^2}{1 - kr^2} + r^2 d\Omega^2 \right),$$

with Friedmann equations

$$H^2 + \frac{k}{a^2} = \frac{8\pi G}{3}\rho + \frac{\Lambda}{3}, \qquad \dot{H} - \frac{k}{a^2} = -4\pi G(\rho + p).$$

D.3 Horizon-Problem Control

Theorem 6.1 (Conditional collar-CMI bound). For a finite-range Gibbs tripartition A-B-D with collar width δ, assume the uniform strong conditional matrix-mixing premise of Theorem 2.5. Then

$$I(A : D \mid B) \le c \cdot |\partial C|_{\mathrm{UV}} \cdot e^{-\delta/\xi},$$

with the explicit constants stated there. Ordinary two-point clustering does not supply the premise. On the exact central-interface branch, $I(A : D \mid B) = 0$.

Corollary 6.2. For bounded observable O with $\|O\| \sim 1$,

$$|\Delta\langle O \rangle| \le 2\sqrt{1 - e^{-\varepsilon}} \le 2\sqrt{\varepsilon}$$

when ε is CMI in nats. On the CMB anisotropy target $\delta T/T \lesssim 10^{-5}$, this gives the familiar ε-scale bound used in the horizon-problem bookkeeping:

$$\varepsilon \lesssim 2.5 \times 10^{-11} \text{ nats}, \qquad \frac{\delta}{\xi} \gtrsim \ln\!\left(\frac{c \cdot |\partial C|_{\mathrm{UV}}}{\varepsilon_{\max}} \right) \approx 24.4 + \ln\!\big(c|\partial C|_{\mathrm{UV}}\big).$$

The number 24.4 is only the unit-prefactor value. The boundary count cannot be dropped. With $\xi \approx \sqrt{P}\,\ell_\star \approx 1.28\,\ell_\star$, where $\ell_\star$ is displayed as the usual Planck length after the selected scale certificate, the corresponding collar condition is

$$\delta_{\mathrm{CMB}} \gtrsim 1.28\,\ell_\star \left[24.4 + \ln\!\big(c|\partial C|_{\mathrm{UV}}\big)\right].$$

This is a state-recovery benchmark for a bounded observable, not a derivation of CMB anisotropy. On a continuum family the separate rate condition $\delta/\xi - \log|\partial C|_{\mathrm{UV}} \to +\infty$ is required.

Theorem 6.3 (Homogeneity as the MaxEnt default). If MaxEnt constraints are uniform across UV cells with no marked points, the MaxEnt state is invariant under triangulation automorphisms. In the continuum limit this gives SO(3) invariance.

Reading rule. The cosmological-principle and horizon-homogeneity package is a branch-local theorem package on the realized symmetric MaxEnt branch. The exact theorem-level content is:

1. SO(3)-invariant constraint data plus MaxEnt uniqueness force an isotropic reference state and a perfect-fluid stress tensor.
2. If the same isotropy condition holds for all observers, the Schur/Bianchi argument forces constant-curvature spatial slices.
3. Combined with the semiclassical Einstein branch and positive Λ from finite screen capacity, the metric takes FLRW form.
4. Markov control supplies an explicit patch-overlap anisotropy bound and the collar benchmark used in the CMB homogeneity bookkeeping.

The package does not prove from the bare OPH axioms alone that the realized cosmological branch must satisfy SO(3)-invariant constraint data, that MaxEnt uniqueness holds in every cosmological sector, or that the observed universe saturates the displayed CMB benchmark.

D.4 Conditional Screen-Spectrum Continuation

Theorem 6.4 (Conditional OPH screen spectrum). Let $(\mathcal{S}_r)$ be a cofinal finite spherical OPH screen system with a schedule-independent quotient-normal-form scalar q_r, removal of the background and dipole sector, and a target-free positive quadratic repair operator K_r. If $K_r \to K$, the source-selected finite scalar release energy satisfies $2E^{\mathrm{src}}_{q,r}/d_r \to A_q$, and local MaxEnt is imposed at fixed expected quadratic release energy, then q_r converges in finite harmonic distributions to the centered Gaussian screen field with covariance $A_q K^{-1}$. Exact per-sample release energy would instead give a microcanonical ellipsoid. If the certified repair-scale measure is $t^{\theta/2}\,dt/\Gamma(1+\theta/2)$, then

$$K_{\mathrm{asy}} = (-\Delta_{S^2})^{1+\theta/2}, \qquad C^q_{\ell,\mathrm{asy}} = A_q[\ell(\ell+1)]^{-1-\theta/2},$$

as the large-ℓ asymptotic model. The theorem-grade finite-ℓ conformal-shell family uses the normalized gamma-ratio precision

$$\kappa_\ell(\theta) = \frac{\Gamma(\ell+2+\theta/2)}{\Gamma(\ell-\theta/2)},$$

with

$$C^q_\ell = A_q \frac{\Gamma(\ell-\theta/2)}{\Gamma(\ell+2+\theta/2)}.$$

If q is additionally certified as the thin-shell pullback of a homogeneous curvature field with $\Delta^2_\zeta(k) = A_\zeta(k/k_\star)^{-\theta}$, this same operator supplies the exact finite-ℓ lift; the pure fractional Laplacian is only the asymptotic scaffold. Suppose the same source construction emits a strongly continuous full-collar survival cocycle with generator density $P_\star/24$, together with the orientation-reversal half-collar identity. Then

$$\theta = \frac{P_\star}{48}, \qquad n_s = 1 - \frac{P_\star}{48}, \qquad \kappa^{\mathrm{edge}}_{\mathrm{rep}} = \frac{P_\star}{48(P_\star - \varphi)}.$$

A finite one-step survival value determines θ through $-\log u_q(\log b)/\log b$; it does not supply the infinitesimal generator receipt. If a scale-natural source embedding transports this cocycle to the physical covariance through $D_s^{-1}C_\zeta D_s = e^{-\theta s}C_\zeta$, the source family is $\Delta_\zeta^2(k) = A_\zeta(k/k_\star)^{-\theta}$. A single shell has an infinite-dimensional radial kernel, including positive ambiguities. Complete radial cross-covariances provide the independent tomography route.

Receipt boundary. The conditional theorem fixes the exact angular family. Its radial theorem gives physical source-dilation and cross-covariance tomography as separate uniqueness routes. A finite OPH source DAG that emits the primitive collar ensemble, full-collar generator density, half-collar identity, conformal precision, and physical dilation-intertwiner or tomography receipt is work in progress. Fawzi–Renner/Markov-collar observable control supplies upper bounds on release observables; it is not an amplitude equality. Finite-width windows require an exact Bessel-kernel error certificate. Physical TT/TE/EE transfer and a frozen likelihood contract are separate continuation tasks.

D.5 Cosmological-Constant / Screen-Capacity Closure

Theorem 6.5 (D5–D6 local/global closure stack). On the gravity lane, assume the local Einstein branch has been recovered only modulo Λg_{ab}, stable direct public-record closure at a carrier dimension

$$\mathfrak{F}_{r,0}(D_\star) = \{D_\star\}, \qquad N_{\mathrm{CRC}} = \log D_\star,$$

and the independent horizon–record identification readout

$$N_{\mathrm{CRC}} = S_{\mathrm{dS}},$$

the standard de Sitter entropy relation

$$S_{\mathrm{dS}} = \frac{A_{\mathrm{dS}}}{4G} = \frac{3\pi}{G\Lambda},$$

and the standard de Sitter static-patch formulas

$$r_{\mathrm{dS}} = \sqrt{\frac{3}{\Lambda}}, \qquad t_\Lambda = \frac{r_{\mathrm{dS}}}{c}.$$

Then:

1. local null data determine the Einstein branch only modulo Λg_{ab};
2. with the selected scale certificate, the same branch has the global display
$$G_{ab} + \frac{3\pi}{G N_{\mathrm{CRC}}}\, g_{ab} = 8\pi G\,\langle T_{ab}\rangle;$$
3. the same D6 closure fixes the entropy and dimensionless capacity relations
$$S_{\mathrm{dS}} = N_{\mathrm{CRC}}, \qquad A_{\mathrm{dS}} = 4GN_{\mathrm{CRC}}, \qquad r_{\mathrm{dS}} = \sqrt{\frac{3}{\Lambda}}, \qquad t_\Lambda = \frac{r_{\mathrm{dS}}}{c};$$
4. the observed cosmic age is a downstream FLRW benchmark rather than an additional theorem output.

So the cosmological-constant package is one local/global theorem stack rather than a split local argument plus an unrelated global readout.

Scope boundary. The D6 hypotheses are the local Einstein branch, stable whole-fiber public-record closure, horizon–record identification, the de Sitter entropy relation, and the standard static-patch formulas. The local null-data route does not by itself determine the global capacity; that value is fixed only on a stable direct-capacity branch with a physical finite-size selector and horizon–record identification. The conditional capacity closure fixes $\Lambda_{\rm CRC}\ell_\star^2 = 3\pi/N_{\rm CRC}$; the SI static-patch scale additionally requires the selected scale certificate.

Capacity self-closure target. At finite regulator use the frozen capacity-carrier dimension D, with $N = \log D$. For each terminal state in the unclosed fiber, form compatible global sections of the local record-atom diagram, retain the endogenously reachable sections, freeze the authorized publicness policy, and use the source-derived joint checkpoint kernels. Their compound confusability graph G_q gives

$$M_0(q) = \alpha(G_q), \qquad \mathfrak{F}_{r,\varepsilon}(D) = \{M_\varepsilon(q) : q \in \widetilde{\Omega}_{r,D}\}.$$

The scalar active map exists only when the whole nonempty terminal fiber has one common defined value. Fixed checkpoint projectors are not the capacity: a cyclic permutation fixes only constant functions while preserving every record label. Local checkpoint marginals are also insufficient to determine the required joint channel.

A faithful capacity-carrier representation gives $M_\varepsilon(q) \le D$, and stable closure is

$$\mathfrak{F}_{r,0}(D_\star) = \{D_\star\}.$$

Equality at zero error forces a rank-one complete public record basis. Under With a confusability-reflecting embedding, capacity extension is monotone, so a total scalar deflationary map on a declared finite chain reaches its greatest fixed point from the top. Fixed-D refinement then stabilizes exactly. None of these implications supplies cutoff independence or a unique physical zero of

$$s(D) = \log D - \log M_0(D).$$

The finite kernel

$$K_r(D, m) = |\{q \in \widetilde{\Omega}_{r,D} : M_0(q) = m\}|$$

distinguishes one closed state from deterministic whole-fiber closure. A diagonal argmax is an extra selector. After direct active closure, the horizon–record identification yields the D6 area-law display, while the common screen/electroweak load-carrier identification yields the electroweak bridge. The operational scale $\rho_{\rm op}$ is an independent estimator tested through $\log M_0 - \pi/\rho_{\rm op}^2$; it does not define the map. The Λ-located value remains a measured-side comparison coordinate.

Capacity normalization. The branch uses $N_{\rm scr}$ as the de Sitter entropy capacity. The bare horizon ratio is

$$N_{\rm patch} = \left(\frac{r_{\rm dS}}{\ell_P}\right)^2,$$

so

$$N_{\rm scr} = \pi N_{\rm patch} = \frac{3\pi}{\Lambda \ell_P^2}.$$

For the observed late-time scale, $N_{\rm patch} \simeq 1.05\times10^{122}$ and $N_{\rm scr} \simeq 3.31\times10^{122}$. These are benchmark displays, not high-precision inputs for the Newton row.

D.6 Black-Hole Structural Package and Continuation Boundary

The AMPS-style information trilemma assumes:

1. an outgoing mode B entangled with an interior partner A (smooth horizon),
2. late radiation B entangled with early radiation R (unitarity), and
3. monogamy of entanglement.

The false assumption in this setting is the naive tensor factorization

$$\mathcal{H} \stackrel{?}{=} \mathcal{H}_{\text{inside}} \otimes \mathcal{H}_{\text{outside}} \otimes \mathcal{H}_{\text{radiation}}.$$

Theorem 7.1 (Edge-center black-hole decomposition). On the fixed-cutoff edge-center collar branch, assume the black-hole collar state lies in the exact Markov class or in the idealized exact-recoverability limit used elsewhere in the paper stack. Then the collar decomposition gives

$$\rho_{A_\delta B_\delta D_\delta} = \bigoplus_\alpha p_\alpha \left(\rho_{A_\delta b_L^\alpha} \otimes \rho_{b_R^\alpha D_\delta}\right).$$

The glue between inside and outside is the edge-sector label α in the center. Given α, inside and outside factorize.

Theorem 7.2 (Hawking/KMS normalization). On the geometric modular branch where the horizon generator carries the standard 2π KMS normalization, the outside algebra is in a KMS state at inverse temperature

$$\beta = \frac{2\pi}{\kappa}$$

with respect to the horizon Killing generator.

Corollary 7.3 (Recoverability-style interior encoding). On the same fixed-cutoff collar carrier, when $I(A_\delta : D_\delta \mid B_\delta) \leq \varepsilon$, there exists a recovery channel $\mathcal{R}_{B_\delta \to A_\delta B_\delta}$ such that

$$\|\rho_{A_\delta B_\delta D_\delta} - (\mathcal{R}_{B_\delta \to A_\delta B_\delta} \otimes \mathrm{id}_{D_\delta})(\rho_{B_\delta D_\delta})\|_1 \leq 2\sqrt{1 - e^{-\varepsilon}} \leq 2\sqrt{\varepsilon}.$$

Here ε is in nats. So the interior collar data are encoded in the exterior collar together with the shared cut data, rather than supplied by an independent tensor factor.

Corollary 7.4 (Discrete area spectrum and Schwarzschild transition identity). The same edge-center package carries a discrete area operator

$$L_C = \sum_\alpha (\log d_\alpha) P_\alpha, \qquad A_\alpha = 4G_{\text{geom}} \log d_\alpha = 4\ell_\star^2 \ln d_\alpha,$$

and for a Schwarzschild sector transition $d \to d'$ one has

$$\Delta(Mc^2) = k_B T_H \ln(d'/d).$$

On the emission branch $d' = d/k$ with $k > 1$, the emitted line energy magnitude is

$$E_{\text{emit}} = k_B T_H \ln k.$$

Scope boundary. The retained structural theorem package is exactly Theorem 7.1, Theorem 7.2, Corollary 7.3, and Corollary 7.4. Integer-transition combs, QNM selectors, Page-type linewidth estimates, PBH burst templates, Kerr/LIGO horizon spectroscopy templates, and any Page-curve or island closure are outside that structural core. Those items require continuation inputs such as an integer-transition selection rule, a semiclassical evaporation-power model, a QNM/transition identification, greybody matching, or an explicit island prescription.

The same no-relabeling rule applies here. A finite capacity register is not an exterior mass, an archive record is not Hawking radiation, a finite repair spectrum is not a GR quasinormal-mode spectrum, and an exact finite recovery threshold is not a Page time unless the corresponding independent physical bridge supplies source-separated readout, calibration, residuals, controls, and fixed validation references.

D.7 Modular-Anomaly Continuation

Theorem 9.1 (Modular additivity defect). Define the collar modular additivity defect by

$$\Delta K_\delta := K_{ABD} - K_{AB} - K_{BD} + K_B.$$

Then

$$\langle \Delta K_\delta \rangle_\omega = -I(A : D \mid B)_\omega.$$

This is a scalar recovery identity. It can enter the modular-anomaly dark-sector continuation only after a separate matching theorem or hypothesis identifies it with an anomalous local modular-energy source. By itself it constructs neither a rank-two tensor nor a dark-matter theorem.

The continuation therefore reserves an anomalous tensor slot only for a finite covariant source packet that supplies source localization, CMI-to-modular-source matching when that route is used, rank-two reconstruction, conservation, normalization, and universal coupling. Once those receipts pass, the modified Einstein equation is

$$G_{ab} + \Lambda g_{ab} = 8\pi G \left(\langle T_{ab} \rangle + \langle T^{\mathrm{anom}}_{ab} \rangle \right),$$

with rest-frame normalization

$$\langle T^{\mathrm{anom}}_{00} \rangle := \frac{15}{8\pi^2} \frac{\delta \langle K^{\mathrm{anom}}_C \rangle}{\ell^4}.$$

On that receipt-certified continuation surface the tensor gravitates and is covariantly conserved. Calling it dark additionally requires the no-electromagnetic-coupling receipt. Central or recoverability data alone do not establish any of these properties.

The dark-sector continuation promotes scalar repair occupation to a canonical pair (n, θ). Conditional on the proposed action, its dilute homogeneous phase scales as pressureless matter and its cubic condensed phase gives $a_R = \sqrt{a_b a_0}$ in the spherical deep regime. The action supplies a repair current and metric stress rather than a virtual source.

Reading rule. The scalar modular-additivity identity is a recovery theorem. The canonical repair pair, baryonic source map, dimensional couplings, complete constitutive law, relativistic refinement limit, abundance, and physical likelihoods are work in progress. Every cosmological quantity on this surface is diagnostic.

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Correspondence declaration: Correspondence should be addressed to Bernhard Mueller, bernhard@floatingpragma.ai, and Alexander Osika, alex@snrgystudios.com.
Data Availability declaration: The paper stack, source manuscripts, public PDFs, simulation code, and implementation notes are available through the OPH project repository and linked public artifact surfaces. Some hardware and prototype evidence requires a sanitized ancillary audit bundle before public disclosure because raw logs may include device configuration, operational metadata, or private infrastructure details. The intended audit bundle contains source hashes, simulator configs, finite-receipt JSON, verifier code, hardware acceptance records, calibration logs, and selected run traces sufficient to replay the stated implementation claims.
Code Availability declaration: The OPH simulator, finite-consensus harnesses, visualization payload schemas, and public paper build sources are maintained in the OPH project repositories. Submission artifacts include a standalone source file and a source bundle so that the manuscript

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Lane	Output	Role	Support boundary
Carrier modes	two transverse Maxwell modes; $2\dim G$ perturbative Yang–Mills modes; two Einstein TT modes	symmetry-protected massless classical kernels on the stated action branches	no quantum zero-mass particle row until the physical Hilbert-space, pole-residue, and phase gates pass
W/Z	no nonzero source-only physical mass emitted	strict source-audit zero-selector branch; exact selected-carrier chart; conditional quotient-transport implication; reference-fitted inverse adapter	the coordinate pairs have different provenance. The finite-carrier certificate and the source-law selection principle deciding the discrete two-law choice are not emitted, and no physical complex-pole pair is promoted
Fine structure	four distinct coordinates	source witness, mixed diagnostic, empirical closure, and measurement	the empirical interval misses the measured endpoint. Source-only promotion requires the source-derived hadronic spectral backend
Higgs/top	no nonzero source-only physical mass emitted	double-criticality family from the gauge sector; frozen boundary-scale candidate; declared-surface calibration fit kept separate	promotion inherits the boundary-scale selection theorem plus the source-root, physical-scale, running, matching, rigidity, provenance, uncertainty, and complex-pole gates
Charged leptons	no nonzero source-only physical mass emitted	exact positive-chamber C_3 circulant identity; conditional finite tracial-GNS balance; target-informed response diagnostic; conditional nature/pole transport	the exact identity gives $Q = 1/3 + (2/3)(\lvert b\rvert/a)^2$, and the finite packet gives $\lvert b\rvert/a = 1/\sqrt{2}$ under its declared event-block hypotheses. Physical family attachment, phase, mass ratios, source selection, interacting kernel, infrared completion, and cofinal refinement are open
Quarks	no nonzero source-only physical mass emitted	common-scale reciprocal-ray falsification; rejected register-Clebsch candidate; exact six-scalar interface; restricted source-spread lower bound; scoped real-axis no-go	the reciprocal-ray candidate fails across the audited common scales. The register-Clebsch pairing result permits separate invariant channels, and its restricted F_1/F_2 enumeration is exact and runtime-target-free conditional on the declared alphabet. Those facts neither equate independent Yukawa coefficients nor rescue the resulting $m_s/m_d = (m_\mu/m_e)/9$ relation, which fails the FLAG comparison detailed in Ref. [6]. Direct equality between the Cabibbo angle and an acute